Operating and Service Manual

MODEL HP 3335A

Synthesizer/Level Generator

Serial Numbers
1640A00286 and Greater

HEWLETT
PACKARD

HP Part Number 03335-90003
Microfiche Part No. 03335-90051
Printed in U.S.A.

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Latest changes as of 21 Nov 1991.

HEWLETT PACKARD

MANUAL CHANGES

Model Number: HP 3335A
Manual Print Date: August 1978
Manual Part Number: 03335-90003

New or Revised Item

This supplement contains important information for correcting manual errors and for updating the manual to instruments containing improvements made after printing of the manual.

To use this supplement:

1. Make all Manual ADDENDA and ERRATA changes.
2. Make all additional changes that pertain to your instrument serial number.

CHANGE NO. 1 for all Serial Numbers.

Page vii, Table of Contents, Section III. Add the symbol ⚠ next to paragraph 3-56 "Front Panel Output Connectors".

Page 1-4 (Rev. A) Table 1-1. Under "Attenuator Accuracy": (Impedance*) - Delete "50 Ω" (3 places).

Add new Attenuator Accuracy chart for 50 Ω as follows:

Impedance*	Attenuation (dB)	Accuracy 200 Hz to 80 MHz
50 Ω	0 to 38	± 0.025 dB
50 Ω	40 to 58	± 0.03 dB
50 Ω	60 to 98	± 0.09 dB

Page 1-6, Table 1-3. Under the Digital Voltmeter 'Required Characteristics', change the Accuracy requirement from ± 0.5% to ± 0.1% and the Recommended Model to -hp- 3455A Option 001. 3458A in AC Volts Synchronous Mode

Page 2-4, Paragraph 2-29(b). Change Part Number 5061-0083 to 5020-8874.

Page 4-2, Paragraph 4-14i. In the first sentence, change "+6 dB" to "+3 dB" and change "57 or greater" to "60 or greater".

Page 4-5 (Rev. A), Table 4-4. Delete 3335A Frequency 10.005 kHz and Spurious Frequency 20.005 kHz from the table.

Page 4-5 (Rev. A), Table 4-5. Change the Spurious Frequency 15 MHz to 150 MHz.

Page 4-5, Paragraph 4-18b. Add "FREQUENCY..........100kHz".

Page 4-5, Paragraph 4-18c. Delete "0.99423 V to 1.00577 V". Add "0.99547 V to 1.00452 V". see HP letter dated

Page 4-5, Paragraph 4-20b. Change the first sentence to read "...when the input changes 0.07 dB."

Page 4-5, Paragraph 4-20d. Change step d to read "Change AMPLITUDE to +12.94 dBm (50 Ω) or +11.18 dBm (75 Ω).".

Page 4-8 (Rev. A), Paragraph 4-22(a). Delete the last sentence on the page beginning: "Since the 18 dB, . . .". Replace with the following:

"Since the specification for the 50 ohm output at 18 dB and 2 MHz is ± 0.025 dB and the specification for the 75 ohm output at 18 dB and 2 MHz is ± 0.04 dB, the measured 2 MHz level is within the specification for either output."

Performance Test Record, Page 1. Under "HARMONIC DISTORTION", change the 40 MHz Test Limit from < -45 dB to < -40 dB.

Performance Test Record, Page 2. Replace the table for known Spurs with the table given on the following page.

Spur Frequency	Test Limits	Test Measurement	Spur Frequency	Test Limits	Test Measurement
25.5 kHz	≤ -75 dB	________	10.0 MHz	≤ -75 dB	________
20.5 kHz	≤ -75 dB	________	40.0 MHz	≤ -75 dB	________
20.15 kHz	≤ -75 dB	________	49.0 MHz	≤ -75 dB	________
			0.40 MHz	≤ -75 dB	________
			10.3 MHz	≤ -75 dB	________
			150 MHz	≤ -75 dB	________

Performance Test Record, Page 3. Change the "Attenuator Accuracy Test:" for the 50 ohm Impedance (only) as follows:

In left-hand column, change 18 dB to 38 dB. Change "Test Limit" for 38 dB (3 places) from ± 0.04 dB to ± 0.025 dB. Change "Test Limit" for 58 dB (3 places) from ± 0.09 dB to ± 0.03 dB. Change "Test Limit" for 98 dB (3 places) from ± 0.2 dB to ± 0.09 dB.

Page 5-2, Paragraph 5-10(b). Change figure reference from Figure 5-5 to Figure 5-6.

Page 5-3, Paragraph 5-17. Change Spectrum Analyzer Model Numbers from 141T/3552B/3553B to 141T/8552B/8553B.

Page 5-7, Paragraph 5-31(h). In the first sentence, change CCW to CW.

Page 5-11/5-12. Change Figure 5-5 to Figure 5-6.

Page 5-11/5-12. On A2 DIVIDER-FILTER drawing, there are two sets of circles with Q22, Q23 and Q24 inside. Upper set should be: Q22 = L28, Q23 = L29, Q24 = L30.

Page 6-6, Table 6-3. Change the part number of W30 from 03335-61630 to 03335-61636. Delete the 1 in the Qty column for W30. Change the 1 to 2 in the Qty column for W26.

Page 6-6, Table 6-3. Change the part number of W12 from 03335-61612 to 03335-61613. Delete the 1 from the Qty column for W13.

Page 6-8, Table 6-3. Delete RACK MOUNT, FLANGE (Option 908), Part Number 5020-8862. Add RACK FLANGE KIT (Option 908), Part Number 5061-0077.

Page 6-8, Table 6-3. Delete B100, FAN-TBAX 120 CFM, Part Number 3160-0259. Add B100, FAN-115 CFM 115 VAC, Part Number 3160-0097.

Page 8-7, Figure 8-7. Change U10A to U12A. Change U10B to U12B. Change U31A to U21A. Change "U10 FUNCTION TABLE" to "U12 FUNCTION TABLE". Under OUTPUTS in the table, column H should be $\overline{Q}$.

Page 8-16, Paragraph 8-126. Change last word of last sentence from microseconds to nanoseconds.

Page 8-16, Figure 8-14. Change pulse width from 25 μsec to 25 nsec.

Page 8-17, Paragraph 8-139. In the second sentence, change "Figure 8-16" to "Figure 8-17".

Page 8-26, Figure 8-32. On first ramp, change "VCO = 01 MHz" to "VCO = 1.01 MHz".

Page 8-37, Figure 8-43. Change C18 to C22, L2 to L4, C54 to C75, CR2 to CR43, and L27 to L36.

Page 8-40, Paragraph 8-281. Second sentence, change ". . . monitors three amplitude . . ." to ". . . monitors the amplitude . . .".

Page 8-41, Paragraph 8-292. Last sentence. Change ". . . eight . . ." to ". . . eighth . . .".

Pages 8-D-7/8-D-8, Table 8-D-6. (Note: The following changes are being made because of differences between parts (U26) with the same part number.) Delete the test signatures associated with XA13A pins 16, 17, 18, and V. Delete the test signatures associated with U26 pins 2, 10, and 11. Change the label "U26" to "U26*" and add the following note at the bottom of page 8-D-9: *NOTE: The signal output signatures (pins 2, 10, 11) for U26 are not consistent between working instruments. Use standard troubleshooting procedures if U26 is suspect.

Page 8-F-3. Add INSULATOR-XSTR, Part Number 0340-0566, 1 each.

Page 8-F-5. On the component locator drawing for A14, change R34 above R35 to R39. On the schematic (Figure 8-F-1), change CR6 at U1(11) to CR2. Change CR3 at U2(4) to CR6.

Page 8-G-2. Change the part number of A17C5 from 0160-0301 (.012μF) to 0160-4299 (.0022μF).

Page 8-H-3. Change the part number of A3L8 from 9100-2543 to 9140-0180. Delete the Manufacturer's code and part number.

Page 8-H-3. Change the part number of A3CR1-CR4 from 1906-0082, QTY: 4 each, to 1906-0246, "Matched Diodes", QTY: 1 Set.

Page 8-H-3. Add A3Q16, XSTR-NPN 2N4384, Part Number 1854-0226.

Page 8-I-2. Under "A. VERIFY PHASE DETECTOR.", change all references to U7 over to U9.

Under "B. VERIFY OR/NOR GATE U8.", change reference to U1 in the second sentence over to U8.

Pages 8-J-7/8-J-8. For A5C1,3,4,6,7,9,13,15,16,19,21,22,27, 33,34,35,39,50,52,62,66, change the part number of the .01μF capacitor from 0150-0093 to 0160-2930.

Page 8-J-13/8-J-14, Figure 8-J-3. The unnumbered test point in the lower left-hand corner of the schematic is TP5. The unnumbered test point in the lower right-hand corner is TP1. Add TP10 right at the output of U25b(6).

Page 8-J-15/8-J-16, Figure 8-J-4. Change A5R159 from 100k to 10k ohms.

Page 8-K-4. Add A8J1, part number 1250-1205, "Connector".

Page 8-K-7/8-K-8, Figure 8-K-1. The connection between A8U2(13) and TP5 should be drawn as a shielded cable and identified as W1.

Pages 8-L-7/8-L-8. For A7C2,4,9,10,13,26-29, change the part number of the .01uF capacitor from 0150-0093 to 0160-2930.

Page 8-L-11/8-L-12, Figure 8-L-1. On A2 Component Locator diagram, there are two sets of circles with Q22, Q23, Q24 inside. The upper set should be: Q22 = L28, Q23 = L29, Q24 = L30.

Page 8-L-11/8-L-12, Figure 8-L-1. Change A7R30 from 40 to 402 ohms. R51 at the emitter of Q6 should be R2. R52 at the emitter of Q7 should be R5. Q3 under Q6/Q7 should be Q8. Change the origin of the signals shown at the bases of Q9, Q12, Q15, Q18, Q21, and Q24 as shown below:

Location	Signal	New Origin	Old Origin
Q9	LPF 80	U2(6)	U11(6)
Q12	LPF 56	U2(4)	U11(4)
Q15	LPF 40	U2(2)	U11(2)
Q18	LPF 28	U3(10)	U10(10)
Q21	LPF 20	U3(6)	U10(6)
Q24	LPF 14	U3(4)	U10(4)

Page 8-M-9/8-M-10, Figure 8-M-1. Move C89 (18 μF) from emitter of Q15 to a point in parallel with C55 (connected to the + 15 V bus).

Page 8-M-9/8-M-10, Figure 8-M-1. Change R32 from 903 to 909 ohms.

Page 8-M-11/8-M-12, Figure 8-M-2. The pin number for the +15V at U10C and U3D should be pin 4, not pin 7.

CHANGE NO. 2 for all Serial Numbers with ROM's Revision B or higher.

Page 8-N-19. Delete C1-C5, R4-R6.

Page 8-N-20. Delete U1 and U2.

Page 8-N-23, Figure 8-N-15. Delete C1-C5, R4-R6, U1 and U2.

CHANGE NO. 3 for Serial Numbers 1640A-00376 and greater.

Page 6-6, Table 6-3. Add W32, 03335-61642, 1 each, "Cable, Options 002,003, and 004, A13 to rear panel toggle switch (S400) labeled TRACK/NORM".

Page 6-8, Table 6-3. Assign reference designator S400 to the "Switch-tgl; TELECOMMUNICATIONS SWEEP" (Part Number 3101-1258).

Page 8-D-43, Figure 8-D-1. Add a SPST switch (S400), rear panel chassis-mounted, labeled TRACK (closed position) and NORM (open position). Connect the switch across the two pins of A13J1 in the upper left-hand corner of the schematic using W32 (part number 03335-61642). Add a fixed jumper connection between the nongrounded pin of A13J1 and TEST pin "A". Add the words "Options 002,003,004 only." alongside the switch. (NOTE: A13J1 is a dual test pin jumper point on the A13 board, not a connector.)

CHANGE NO. 4 for Serial Numbers 1640A00421 and greater.

Page 8-M-8. Delete R155, 51 ohm, Part Number 0683-5105. Add R155, 510 ohm, Part Number 0683-5115.

Page 8-M-11, Figure 8-M-2. Change R155 from 51 ohms to 510 ohms.

CHANGE NO. 5 for Serial Number 1640A00451 and greater.

Page 8-M-5. Delete C71 and C74, 15,000 pF, Part Number 0160-0194. Add C71 and C74, .1 μF, Part Number 0160-4557.

Page 8-M-7. Delete R127 and R128, 4.7 M ohm, Part Number 0683-4755. Add R127 and R128, 698 K ohm, Part Number 0698-8348.

Page 8-M-11, Figure 8-M-2. Change C71 and C74 from .015 μF to .1 μF. Change R127 and R128 from 4.7 M ohms to 698 K ohms.

CHANGE NO. 6 for Serial Number 1640A00601 and greater.

Page 8-I-6. Delete R71, 20 ohms, Part Number 0757-0384. Add R71, 49.9 ohms, Part Number 0757-0277.

Page 8-K-5. Delete R82, 20 ohms, Part Number 0757-0384. Add R82, 49.9 ohms, Part Number 0757-0277.

Page 8-I-7, Figure 8-I-1. Change R71 from 20 ohms to 49.9 ohms.

Page 8-K-7, Figure 8-K-1. Change R82 from 20 ohms to 49.9 ohms.

CHANGE NO. 7 for Serial Number 1640A00661 and greater.

Page 8-N-22. Delete A25A1R1-R4, 120 ohms, Part Number 0683-1215. Add A25A1R1-R4, 68 ohms, Part Number 0683-6805.

Page 8-N-23, Figure 8-N-15. Change A25A1R1-R4 from 120 ohms to 68 ohms.

CHANGE NO. 8 for Serial Number 1640A00704 and greater.

Page 8-K-3. Delete C19 and C20, 470 pF, Part Number 0140-0149. Add C19 and C20, .01 μF, Part Number 0160-3847.

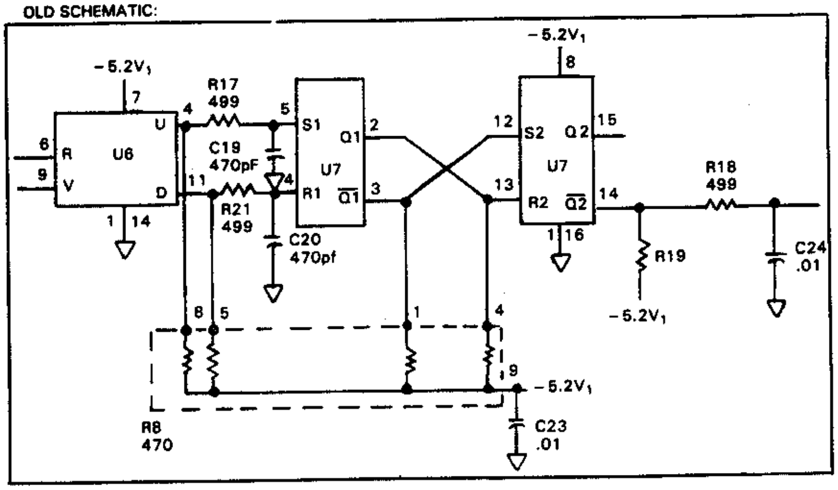
Page 8-K-4. Delete R18, 499 ohms, Part Number 0698-4123. Add R18, 100 ohms, Part Number 0757-0401.

Page 8-K-6. Delete U7, MC10135L, Part Number 1820-0820. Add U7, MC10116P, Part Number 1820-0810.

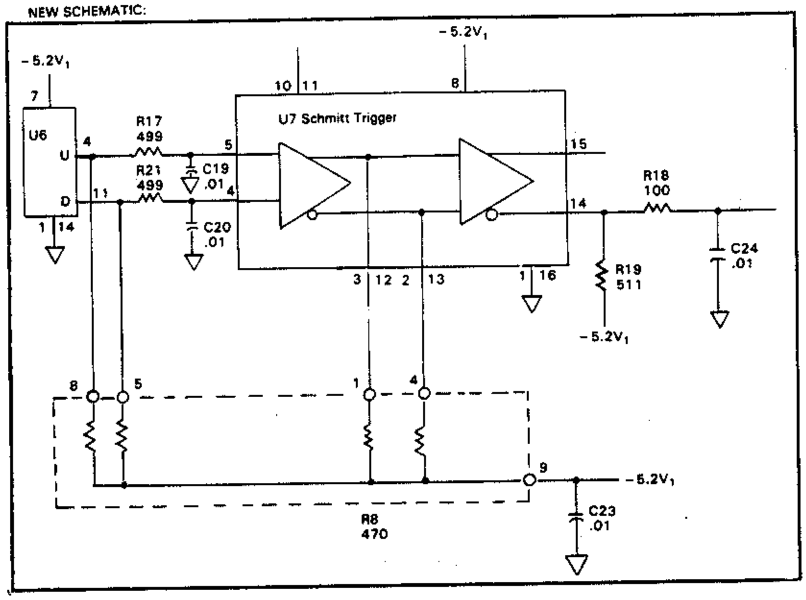
Page 8-K-6. Add SOCKET-IC (16 pin), Part Number 1200-0473.

Page 8-K-7, Figure 8-K-1. Change circuit between U6 and TP9 as shown below:

OLD SCHEMATIC:



NEW SCHEMATIC:



CHANGE NO. 9 for Serial Number 1640A00731 and greater.

Page 8-D-42. Delete U22, AD7530JN, Part Number 1820-1789. Add U22, IC7530J, Part Number 1826-0356.

CHANGE NO. 10 for Serial Number 1640A00811 and greater.

Page 8-I-5. Delete L9, COIL 20 μH, Part Number 9140-0183.

Page 8-I-6. Add R105, 499 ohms .01, Part Number 0698-4123.

Page 8-K-4. Delete L15, COIL 20 μH, Part Number 9140-0183.

Page 8-K-6. Add R115, 499 ohms .01, Part Number 0698-4123.

Page 8-I-7, Figure 8-I-1. Replace L9 (20 μH) with R105 (499 ohms).

Page 8-K-7, Figure 8-K-1. Replace L14 (20 μH) with R115 (499 ohms).

CHANGE NO. 11 for Serial Numbers 1640A-00996 and greater.

Page 8-M-5. Change the part number of A6C59 from 0160-2237 (1.2 pF) to 0150-0091 (1.5 pF).

Page 8-M-11, Figure 8-M-2. In the upper left-hand corner of the schematic, change A6C59 from 1.2 pF to 1.5 pF.

CHANGE NO. 12 for Serial Numbers 1640A-01046 and greater.

Page 6-6, Table 6-3. Change the part number for W21 from 03335-61621 to 8120-3137.

Page 8-M-8. Change the part number of A6R147 from 2100-3286 (R-V TRMR 10K) to 2100-3089 (RES-TRMR 5K).

Page 8-M-11, Figure 8-M-2. Change A6R147 from 10k ohms to 5k ohms.

CHANGE NO. 13 for Serial Numbers 1640A-01121 and greater.

Page 8-0-4. Delete A1J4 (part number 1250-1339) entirely.

CHANGE NO. 14 for Serial Numbers 1640A-01176 and greater.

Page 8-L-8. Change the part number of A7R24 from 2100-0567 to 2100-3273.

CHANGE NO. 15 for Serial Numbers 1640A-01206 and greater.

Page 8-F-5/8-F-6, Figure 8-F-1. Change the wire color-coding for cable assembly W16 (Part Number 03335-61616), which connects the power supply diode rectifiers (CR100/CR200) to the Pass Transistor Assembly (A15J2), as follows:

A15J2 Pin #	New Color	Old Color
1	9 white	6
2	6 blue	96
3	2 red	92
4	4 yellow	94
5	3 orange	93

Change the wire color-coding for cable assembly W5 (Part Number 03335-61605), which connects the A14 Power Supply (A14J4) to the A10 Controller (A10J3), as follows:

A14J4 Pin #	New Color	Old Color
1	3 orange	3
2	4 yellow	93
3	2 red	92
4	6 blue	94
5	9 white	9

CHANGE NO. 16 for Serial Numbers 1640A-01236 and greater.

Page 8-J-9. Change the part number of A5Q47 from 1855-0332 (XSTR-MOSFET 3N138) to 1855-0081 (XSTR-JFET 2N5245). In the Qty column after A5Q27, change 4 to 5.

CHANGE NO. 17 for Serial Numbers 1640A-01296 and greater.

Page 8-G-2. Change the part number of A18A1 from 10544B to 10811A.

Page 8-H-3. Change the part number for Q11 and Q12 from 1854-0215 (XSTR-2N3904) to 1854-0092 (XSTR-2N3563).

Page 8-H-4. Change the part number of A3R77 from 0698-4123 (499 ohms) to 0757-0413 (392 ohms). Change the part number of A3R78 from 0757-0401 (100 ohms) to 0757-0291 (24.9 ohms). Change the part number of A3R80 from 0698-3447 (422 ohms) to 0698-0082 (464 ohms).

Page 8-H-7, Figure 8-H-1. Change the following resistors to the new values indicated: R77 (392 ohms), R78 (24.9 ohms), R80 (464 ohms).

CHANGE NO. 18 for all Serial Numbers.

Page 6-3. Change the description of the A20 assembly to "... (itemized parts list in Service Group N)"

Page 6-4. In some instruments, the MP19 1460-0553 CLIP, WINDOW has been replaced by 0460-1336 TAPE, INDUSTRIAL.

Page 6-6. On the description of W6, change "... PASS TRANSISTOR (A16)" to "... PASS TRANSISTOR (A15)."

Page 8-31, Paragraph 8-213. Change the last sentence to "... the pulse remove trigger is enabled, triggering a divide-by-three by the (-/-2)/(-/-3) counter. The (-/-2)/(-/-3) counter reverts to divide-by-two after three input pulses.

Page 8-32, Paragraph 8-223. Reverse "UP" and "DOWN" in the first sentence.

Page 8-33, Paragraph 8-227. The N.F. Loop Analog Schematic Diagram is Figure 8-J-4.

Page 8-33, Paragraph 8-229. Delete the sentence "During the BIAS current less the current drawn by the API source."

Page 8-34, Paragraph 8-231. In the second sentence, change CR11 to CR12.

Page 8-34, Figure 8-41. In the upper right corner, reverse "UP DRIVE" and "DOWN DRIVE."

Page 8-35, Paragraph 8-242. In the sixth sentence, change C6 to C12.

Page 8-36, Paragraph 8-249. Delete the sentence "The Divider-Filter transmits the band of frequencies from 200 Hz to less than 10 MHz."

Page 8-B-2. On newer instruments, the part number for A11S1 has been changed to 3101-2498. The parts are interchangeable. Also on Page 8-B-2, the part numbers for A11S2 through S39 have been changed to 3101-2458 on newer instruments. The parts are interchangeable.

Page 8-H-3. On newer instruments, the part numbers for L3, L5, and L6 have been changed to 9140-0748. The parts are interchangeable.

Page 8-I-5. On newer instruments, the part numbers for L1, L2, L3, and L12 have been changed to 9140-0748. The parts are interchangeable.

Page 8-J-8. On newer instruments, the part numbers for L1, L2, L3, L4 and L5 have been changed to 9140-0748. The parts are interchangeable.

Page 8-J-15/8-J-16, Figure 8-J-4. In the phase detector, change the symbol for Q7 to PNP.

Page 8-J-17/8-J-18, Figure 8-J-5. In the Fractional-N Analog section, connect the INCREASE FREQ I SOURCE to +15V.

Page 8-K-4. On newer instruments, the part numbers for L1, L2, L3, and L18 have been changed to 9140-0748. The parts are interchangeable.

Page 8-M-6. On newer instruments, the part numbers for L2 and L3 have been changed to 9140-0748. The parts are interchangeable.

CHANGE NO. 19 for instruments with serial numbers 1640A01391 and greater.

Page 8-N-23/8-N-24. On W19, line #6 (one side of the 135 ohm balanced line), change the 905 color code to 9.

CHANGE NO. 20 for instruments with serial numbers 1640A01601 and greater.

Page 8-F-5/8-F-6. Change the color codes for cable W6 (connects A14 and A15), as follows:

W6 Pin #	New Color	Old Color
1	1 - brown	6
2	2 - red	6
3	3 - orange	2
4	4 - yellow	2
5	5 - green	4
6	6 - blue	4
7	7 - violet	3
8	8 - gray	3

CHANGE NO. 21 for instruments with serial numbers 1640A01646 and greater.

Page 8-L-4. Change A2C16 to 0180-0161 CAPACITOR-FXD 3.3UF.

Page 6-8. Change the part number for the B100 FAN to 3160-0394.

CHANGE NO. 22 for instruments with serial numbers 1640A1691 and greater.

Page 8-F-2. Add C9 1000PF 0160-4822 1 ea.

Page 8-F-5. Add C9 1000PF between pins 6 and 7 of U2B.

CHANGE NO. 23 for instruments with serial numbers 1640A01846 and greater.

Page 8-M-6. Change A6Q1 to 1854-0305 XSTR-SS98.

CHANGE NO. 24 for instruments with serial numbers 1640A01966 and greater.

Page 8-D-42. Delete 1200-0659 SOCKET-IC 2 ea.
Change 1200-0583 to 1200-0541.

CHANGE NO. 25 for all Serial Numbers

The hardware for all Corporate System II cabinet parts has been changed from English to metric. Instruments with serial number prefix 1640A- use English hardware; those with serial number prefix 2516A- use both English and metric hardware.

Listed below are the parts affected by this change. When ordering replacement parts, check the instrument serial number to determine the appropriate hardware type.

Update Section II (Installation) to reflect the following changes:

Page 2-4, Paragraph 2-29a, Rack Mounting

- Rack Mount Flange Kit, Opt 908:
(English version) HP P/N 5061-0077
(Metric equivalent) HP P/N 5061-9677

Page 2-4, Paragraph 2-29b, Rack Mounting

- Rack Mount Flange/Front Handle Kit, Opt 909:
(English version) HP P/N 5061-0083
(Metric equivalent) HP P/N 5061-9683

Update Section VI (Replaceable Parts) to reflect the following changes:

Pages 6-4 & 6-8, Table 6-3, Replaceable Parts List.

Ref Desig	Description	English P/N	Metric P/N	Qty
MP01	Bottom Cover	5060-9847	5061-9447	1
MP06	F Strap Hdl Cap	5040-7219	5041-6819	1
MP08	R Strap Hdl Cap	5040-7220	5041-6820	1
MP11	Top Cover	5060-9835	5061-9435	1
MP13	Rear-Casting	5020-8804	5021-5804	1
MP15	Corner Strut	5020-8837	5021-5837	4
MP17	Side Cover Asy	03335-04101	03335-04111	1
	Side Cover	5061-1930	5061-8019	1
MP18	Front Frame	5020-8803	5021-5803	1
MP20	Sub-Panel	03335-00201	03335-00211	1
†	Caution Label		7121-2527	1
†	Screw-Mach[1]	2360-0311	0515-0889	4
†	Screw-Mach[2]	2680-0172	0515-1132	4
†	Screw-Mach[3]	2510-0192	0515-1331	16
	Ft Hdls Opt 907	5060-9899	5061-9689	
	Rk Mnt Opt 908	5061-0077	5061-9677	
	Rk Mnt Opt 909	5061-0083	5061-9683	

† Part is not listed in the current manual
1 Front subpanel, Front frame
2 Strap handles
3 Corner struts, Front & Rear frames

The attenuator is no longer repairable to the component level.

Page 8-N-1. Delete paragraph "Tools".
Page 8-N-2. Delete page 8-N-2.
Page 8-N-3. Delete page 8-N-3.
Page 8-N-4. Delete page 8-N-4.
Page 8-N-5. Delete page 8-N-5.
Page 8-N-6. Delete page 8-N-6.
Page 8-N-7. Delete page 8-N-7.
Page 8-N-8. Delete page 8-N-8.
Page 8-N-9. Delete page 8-N-9.
Page 8-N-10. Delete page 8-N-10.
Page 8-N-11. Delete page 8-N-11.
Page 8-N-12. Delete page 8-N-12.
Page 8-N-13. Delete page 8-N-13.
Page 8-N-14. Delete page 8-N-14.
Page 8-N-15/8-N-16. Delete page 8-N-15/8-N-16.
Page 8-N-17/8-N-18. Delete page 8-N-17/8-N-18.
Page 8-N-17/8-N-18A. Delete page 8-N-17/8-N-18A.
Page 8-N-22. Delete A25J1-J3, A25MP1-8, A25MP11-19, A25MP21-23, A25MP25, A25MP26, A25ZU1-8, A25MP25S, A25A1-A4, A25A1SL1,2.

Page 8-I-4. Change the part number of A9CR3 and A9CR4 from 0122-0089 to 0122-0162. 0122-0089 is obsolete. The parts are interchangeable.

Page 8-K-3. Change the part number of A8CR9 and A8CR10 from 0122-0089 to 0122-0162. 0122-0089 is obsolete. The parts are interchangeable.

Page 6-8. Change the part number for T100 to 9100-3875.

Page 6-8. Change the part number for EA100 to 0960-0684.

Page 8-M-5. Change the part number for A6C59 to 0160-2243.

Page 8-M-11/8-M-12. On newer instruments, the factory-installed value of C59 has changed from 1.2 pF to 2.7 pF. This change improves the accuracy of the 75 ohm attenuator at 20 MHz. This part may be selected from the following list:

1.2pF	0160-2237
1.5pF	0160-2238
2.7pF	0160-2243
5.6pF	0160-2251

Page 6-5. Add cable clamp (P/N 1400-1229). This mounts to the card nest to secure W7.

Page 6-6. Change the part number of W5 to 03335-61615. Change the part number of W18 to 03335-61622 for standard instruments. Change the part number of W18 to 03335-61631 for option 002/004. Change the part number of W20 to 03335-61632.

CHANGE NO. 26 for Serial Number 1640A03082 and greater.

This change modifies the 03335-66507 board from Rev B to Rev C. The boards are interchangeable but the ICs are not.

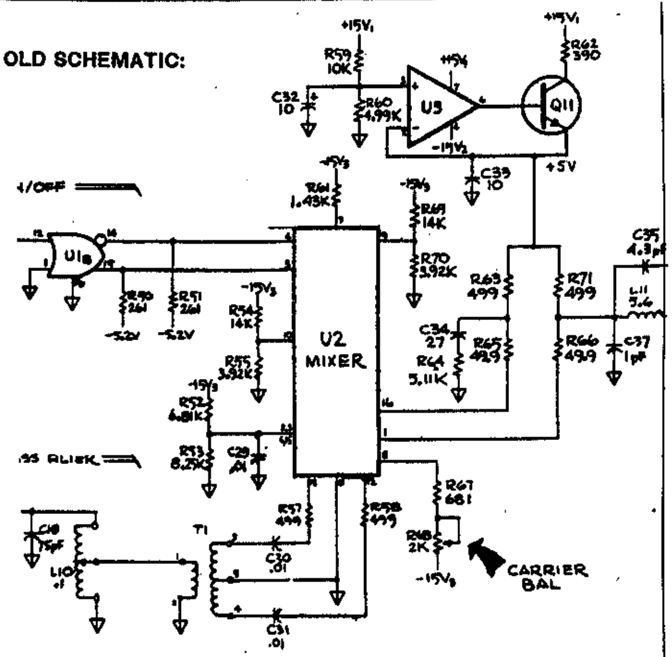
Page 8-L-7. Change the part number of A7C7 and A7C14 from 0150-0121 to 0160-4571. Change A7C2, A7C4, A7C9, A7C10, A7C11, A7C13, A7C26 from 0150-0093 to 0160-3847.

Page 8-L-8. Change the part number of A7C27, A7C28, and A7C29 from 0150-0093 to 0160-3847.

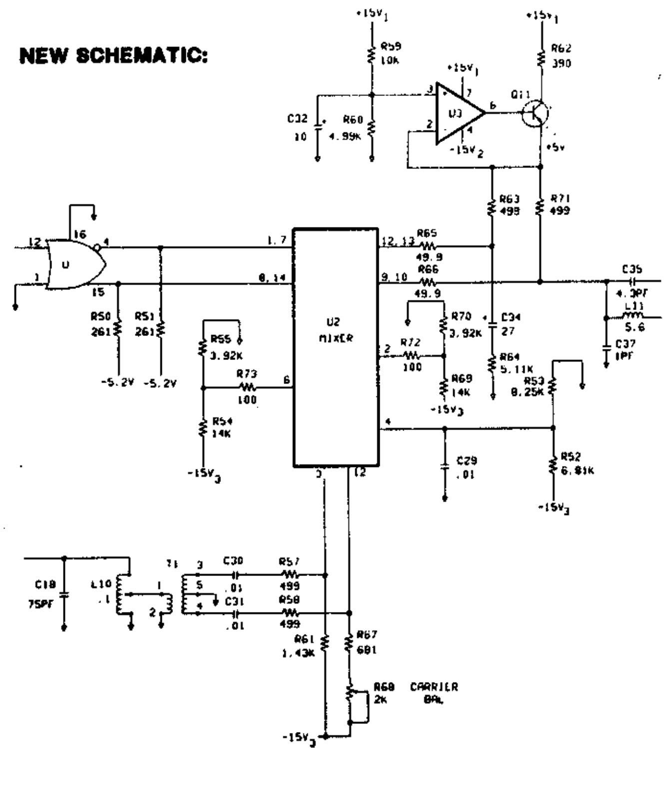
Page 8-L-9. Add A7R72 and A7R73 part number 0757-0401. Change A7U2 from 1826-0062 to 1858-0101.

Page 8-L-11/8-L-12. Change circuit between U1B and C35 as shown.

OLD SCHEMATIC:



NEW SCHEMATIC:



CHANGE NO. 27

This change modifies the 03335-66511 board from Rev D to Rev E. Note: Rev F is the same as Rev E.

Interchangeability:

Rev A through Rev F loaded boards (P/N 03335-66511) are interchangeable.

P/Ns 1818-0284, -0285, -0286 must be used **only** on Rev A through Rev D boards.

P/Ns 1818-3616, -1784 must be used **only** on Rev E and Rev F boards.

Page 8-D-41. Delete A13C1, A13C2, A13R1, A13R2, A13R3, A13R9, A13R10, A13R11, A13R12, A13U3, A13U4, A13U9, A13U10.

Change A13C7 to 0160-4803, A13C8 to 0160-4821, A13C10 to 0160-4823, A13C15 to 0160-4835, A13U2 to 1818-3616, A13U7 to 1818-1784, A13U8 to 1820-2889.

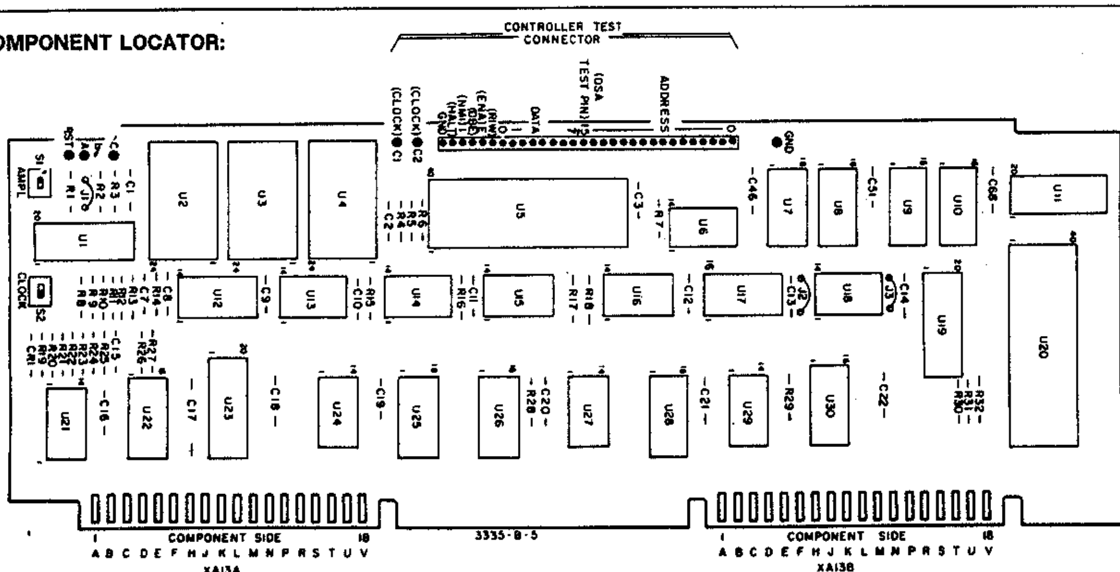
Add A13C24-29 and A13C68 part number 0160-3847. Add A13R34 part number 0683-1025. Add A13RP1 part number 1810-0206.

Page 8-D-42. Delete sockets part number 1200-0473 and 1200-0583.

Page 8-D-43/8-D-44.
Add C29 from U27 pin 14 to ground.
Change C8 to C68, value .01 pF.
Add C28 from U24a pin 14 to ground.
Add C27 from U1 pin 20 to ground.
Change R1 through R12 to RP1.

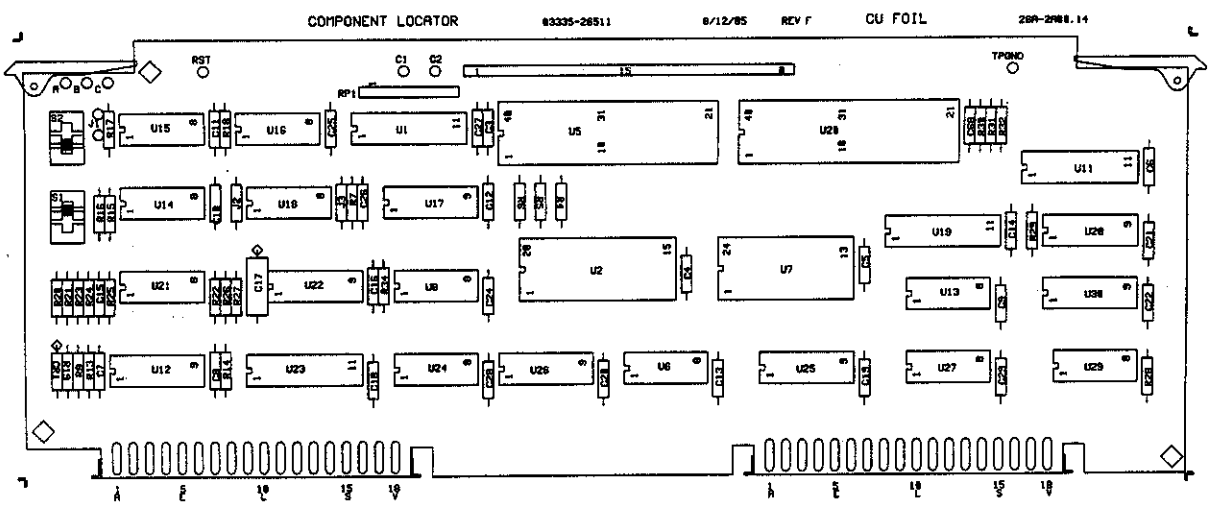
Page 8-D-43/8-D-44. Change component locator and circuit as shown

OLD COMPONENT LOCATOR:

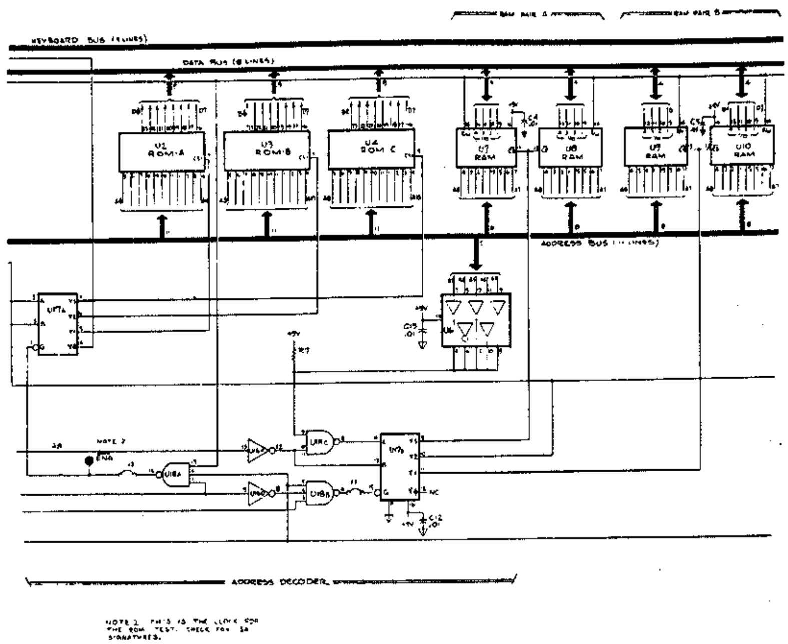


A13
-hp- Part No. 03335-66511

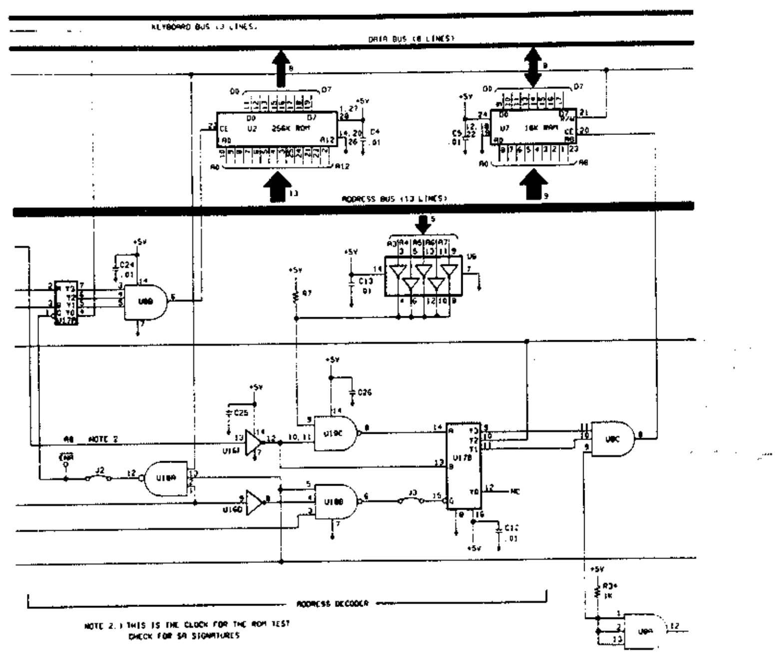
NEW COMPONENT LOCATOR:



OLD SCHEMATIC:



NEW SCHEMATIC:



CHANGE NO. 28

Page 8-M-6. On newer instruments the part numbers for A6Q2, A6Q3, A6Q9, A6Q12 have been changed to 1853-0405.

CHANGE NO. 29

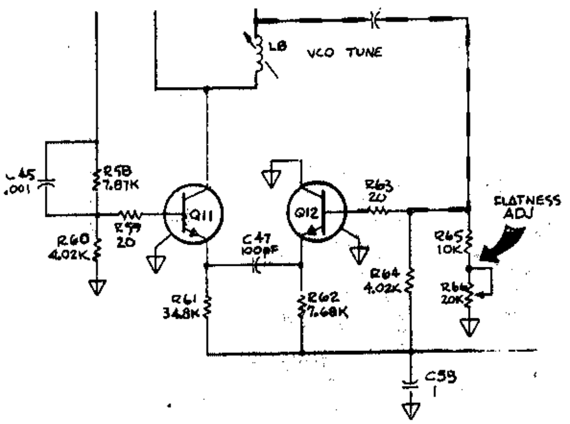
This change modifies the 03335-66501 board to Rev B. The boards are interchangeable.

Page 8-I-4. Delete A9C45.
Change A9C51 to part number 0160-0763.
Change A9C23 to part number 0160-3847.
Change A9R68 to part number 7175-0057.
Change A9R72 to part number 0698-0063.
Add A9C81 and A9C82, part number 0160-4822.
Add A9C84-A9C90, part number 0160-3847.

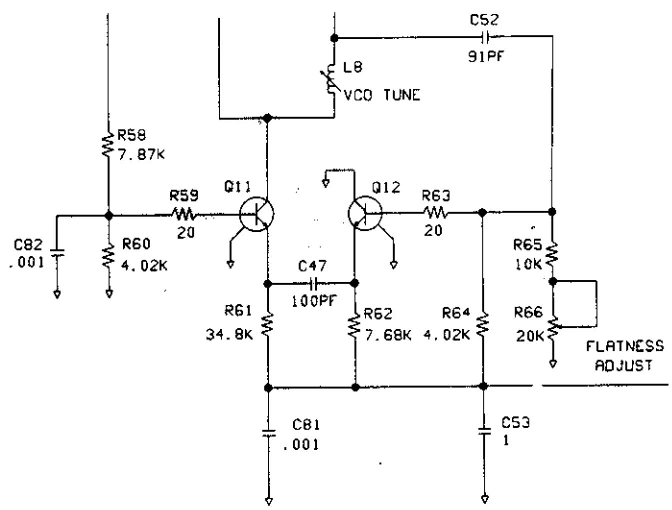
Page 8-I-7/8-I-8. (Left side of the schematic.)
Add C86, value .01, from the junction of C1 and L1 to ground.
Add C87, value .01, from the junction of C2 and L2 to ground.
Add C88, value .01, from the plus side of C3 to ground.
Add C89, value .01, from the junction of C4 and L3 to ground.
Add C90, value .01, from the junction of C6 and C5 to ground.

(N-Step Voltage Controlled Oscillator) Add C84, value .01, from the junction of R105 and C50 to ground. Change the value of C51 to 5 pF. Change the value of R68 to 0. Add C85, value .01, from the junction of R76 and C62 to ground. Change the circuit as shown below.

OLD SCHEMATIC:



NEW SCHEMATIC:



Paragraph 4-18c: (3335A manual)

50Ω	.994196V to	1.005737V
75Ω	.994298V to	1.005844V

Warning

To prevent potential fire or shock hazard, do not expose equipment to rain or moisture.

RECORD OF REVISIONS

Model 3335A

Manual Part No. 03335-90003

To aid in keeping service documentation up-to-date, this manual is bound in a loose-leaf binder. This allows updates to be made by reprinting only those pages requiring revision and incorporating them into the manual. At the first printing of revised pages, the manual is considered a Revision A manual and each revised page contains a "Rev. A" notation at the bottom of the page. The second printing of pages of this set contains a "Rev. B" notation at the bottom of the pages. Each revised page can then be associated with a particular revision data. A revision does not change the manual part number.

The manual revision index is provided as a record of the revision material contained in the manual. Each revision is identified by a letter. The index lists for each revision, the page number, paragraph, figure or table number with its title and a brief description of the revision. Keep this index with your manual for future reference.

Revision A, October 1978

Page No.	Paragraph, Figure or Table Number	Title	Description
III	— — —	Safety Summary	Addition
VII	— — —	Table of Contents	Revised
IX	— — —	List of Tables	Revised
X	— — —	List of Illustrations	Revised
XI	— — —	List of Illustrations	Revised
1-3	Paragraph 1-29	— — —	Revised
	Paragraph 1-30	— — —	Revised
1-5	Table 1-2	General Information	Revised
1-6	Table 1-3	Recommended Test Equipment	Revised
2-1	Paragraph 2-5(b)	— — —	Revised
3-3	Figure 3-1	Front and Rear Panels (cont'd)	Add Information
3-14b	Paragraph 3-91 to Paragraph 3-94	Telecommunications	Revised
3-15	Paragraph 3-94	— — —	Revised
4-5	Paragraph 4-20 (step b)	— — —	Add Information
4-6	Paragraph 4-22	— — —	Add Information
4-7	Figure 4-8	Attenuator Verification Test Equipment Layout.	Add Information
5-11/5-12	Figure 5-5	Adjustment Locations	Add Information
6-4	Table 6-3	Replaceable Parts	Revised
6-8	Table 6-3	Replaceable Parts	Revised
7-1	Paragraph 7-5	Change B	Backdating Information
7-21	Figure 8-49	Service Items	Backdating Information
8-D-1	— — —	— — —	Number page
8-D-2	Table 8-D-1	3335A Mnemonic Dictionary	Revised
8-D-7	Table 8-D-6	SA TEST 1 Signatures	Revised
8-D-8	Table 8-D-6	SA TEST 1 Signatures (cont'd)	Revised
8-D-9	Table 8-D-6	SA TEST 1 Signatures (cont'd)	Revised
8-D-11	Table 8-D-7	SA TEST 2	Revised
8-D-12	Table 8-D-8	SA TEST 2 (Defective)	Revised
8-D-14	Table 8-D-9	SA TEST 3	Revised
8-D-15	Table 8-D-10	SA TEST 3 (Defective)	Revised
8-D-17	Table 8-D-11	SA TEST 4	Revised
8-D-18	Table 8-D-12	SA TEST 4 (Defective)	Revised
8-D-23/ 8-D-24	Table 8-D-14	SA TEST 7 Signatures	Revised
8-D-36	Table 8-D-20	SA TEST 8 Probed Signatures	Revised
8-J-7	— — —	Replaceable Parts	Add Information
8-J-9	— — —	Replaceable Parts	Add Information
8-J-15 8-J-16	Figure 8-J-4	Schematic Diagram, Fractional - N Analog (03335-66504) A5	Add Information
8-L-13/ 8-L-14	Figure 8-L-2	Block Diagram, Divider-Filter (03335-66536) A2 Mixer (03334-66507) A7	Add Information
8-M-13/ 8-M-14	Figure 8-M-3	Block Diagram, Output Amplifier (03335-66538) A6	Add Information
8-M-15/ 8-M-16	Figure 8-M-4	Block Diagram, Level Control (03335-66538) A6	Add Information
8-O-5/ 8-O-6	Figure 8-O-1	TS Flowchart, Section Level Troubleshooting	Revised

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LIST OF ILLUSTRATIONS

HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

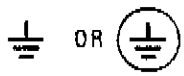
Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

SAFETY SUMMARY.

General Definitions of Safety Symbols Used On Equipment or In Manuals.

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).

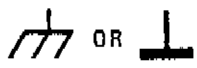


Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.

Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.

Logic return connected to chassis (outguard) ground.

Logic return isolated (inguarded) from chassis ground.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Alternating current (power line).

Direct current (power line).

Alternating or direct current (power line).

DANGER

The DANGER sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which could result in injury or death to personnel even during normal operation.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which,if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

NOTE:

The NOTE sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This Operating and Service Manual contains information relative to the installation, operation, performance testing, adjustment and maintenance of the Hewlett-Packard Model 3335A Synthesizer/Level Generator. Figure 1-1 shows the Synthesizer/Level Generator and the accessories supplied with the instrument.

1-3. Packaged with this manual is an Operating Information Supplement. This is simply a copy of the first three sections of this manual. This supplement should be kept with the instrument for use by the operator. Additional copies of the Operating Information Supplement or the Operating and Service Manual can be ordered through your nearest Hewlett-Packard Sales and Service Office (a list of these offices is provided at the end of this manual). The part numbers are listed on the title page of this manual.

1-4. Also listed on the title page of this manual following the Operating and Service Manual and Operating Information Supplement part numbers are Microfiche part numbers for these publications. These numbers can be used to order 4 x 6 inch microfilm transparencies of these publications. The Microfiche package includes the latest Manual Changes supplement and all pertinent Service Notes.

1-5. The manual is divided into eight sections, each covering a particular topic for the operating and service of the Synthesizer/Level Generator. The topics by section number are:

Section	Topic
I	General Information
II	Installation
III	Operation
IV	Performance Tests
V	Adjustments
VI	Replacement Parts
VII	Manual Changes
VIII	Service

1-6. This section contains general information about the Model 3335A Synthesizer/Level Generator. The information includes an instrument description, specifications, option and accessory information and instrument and manual identification.

1-7. DESCRIPTION.

1-8. The Model 3335A Synthesizer/Level Generator is a wide range source operating over the range of 200 Hz to 80 MHz with output resolution of .001 Hz. The Synthesizer/Level Generator is capable of making a step frequency sweep both automatically or manually under operator control from the keyboard. Output amplitude is selectable over the range of + 13.01 dBm to - 86.98 dBm for the 50 ohm output and + 11.25 dBm to - 88.74 dBm for the 75 ohm output.

1-9. The 3335A Synthesizer/Level Generator provides three communications-oriented options in addition to the standard 50 ohm and 75 ohm output impedance. Options 002 and 004 provide output impedance of 75 ohms unbalanced, 124 ohms balanced and 135 ohms balanced each terminated in equivalent WECO output connectors (Option 004 contains miniature connectors). Option 003 provides a 75 ohm unbalanced BNC output and a 150 ohm balanced BNC pair output. Refer to Table 1-2, General Information, for the amplitude range of the Options.

1-10. The Synthesizer/Level Generator develops the output signal by an indirect synthesis technique. This technique uses voltage controlled oscillators which are phase-locked to reference signals generated by a 40 MHz master oscillator in the reference section. The master oscillator is phase-locked to an internal temperature-stabilized oscillator or can be phase-locked to an external reference signal. A 10 MHz signal derived from the master oscillator is available at a rear panel connector for use as a reference signal for other equipment.

1-11. Frequency and amplitude can be selected manually from the keyboard or externally when connected to the Hewlett-Packard Interface Bus (HP-IB). A programmable device such as a programmable calculator is capable of remotely controlling the Synthesizer/Level Generator from the HP-IB. When operated in this mode, keyboard inputs are disabled.

1-12. SPECIFICATIONS.

1-13. Table 1-1 is a complete list of the Model 3335A critical specifications that are controlled by tolerances. Any changes in specifications due to manufacturing, design or traceability to the U.S. National Bureau of Standards are included in Table 1-1 of this manual. Specifications listed in this manual supersede all previous specifications for the Model 3335A.

1-14. GENERAL OPERATING INFORMATION.

1-15. Table 1-2 contains general information describing the major operating characteristics of the 3335A. This information does not constitute specifications but is supplemental operating information.

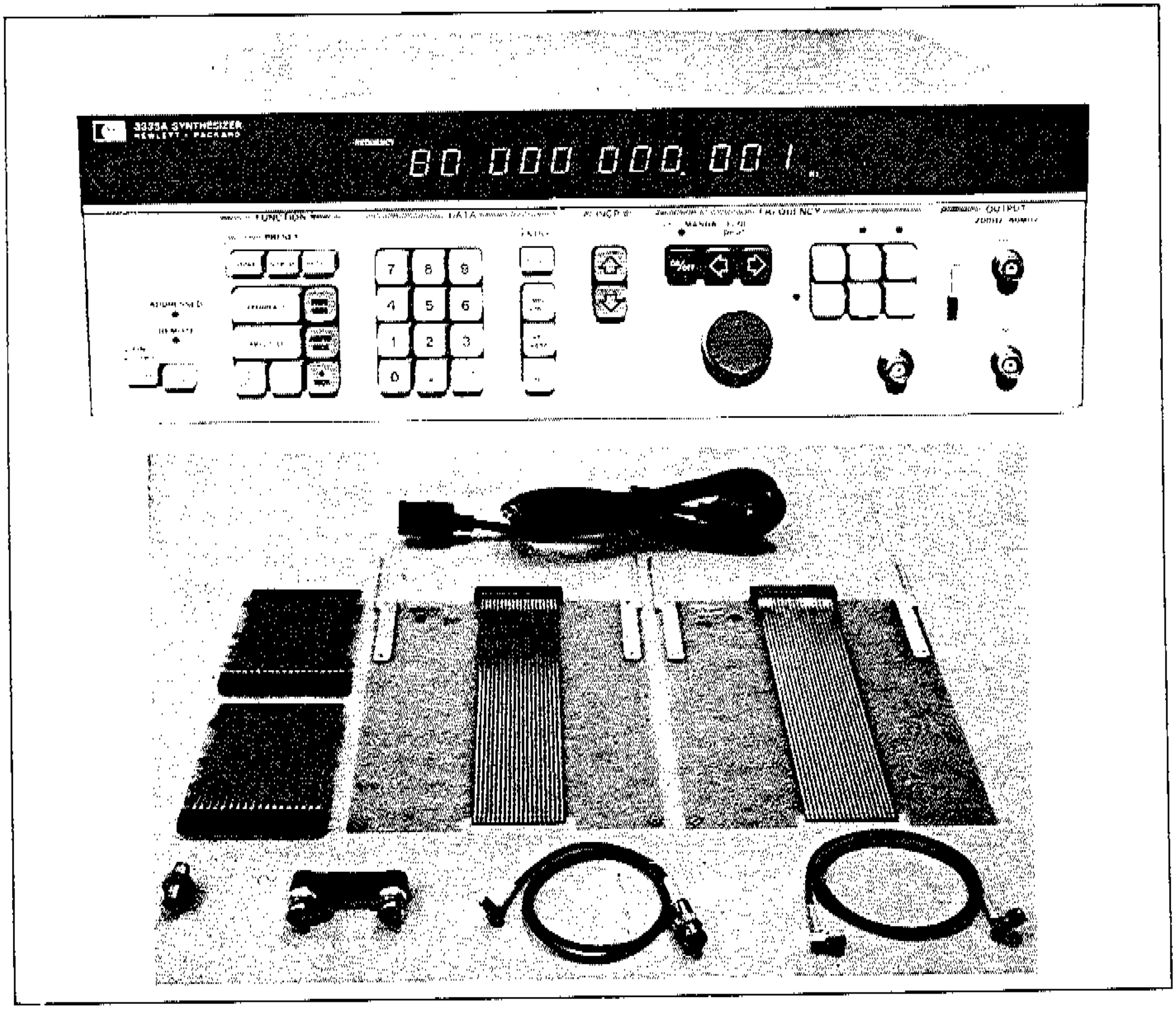


Figure 1-1. -hp- 3335A With Supplied Accessories.

1-16. OPTIONS.

1-17. There are both equipment options and accessory options available with the 3335A Synthesizer/Level Generator. All options are designated by a three digit number. The first digit of the option number identifies the option as either equipment or accessory. For an equipment option, the first digit is a zero and for an accessory option, the first digit is a nine. The following is a list of equipment and accessory options available with the 3335A:

Option	Description
001	High stability crystal oven (10544A)
002	75 Ω Unbalanced Output Connector: Commercial equivalent of WECO type 477B (Accepts WECO plug 358A). 124 Ω Balanced Output Connectors: Commercial equivalent of WECO type 477B (Accepts WECO plug 372A). 135 Ω Balanced Output Connectors: Commercial equivalent of WECO type 223A (Accepts WECO plug 241A).
003	75 Ω Unbalanced Output Connector: BNC 150 Ω Balanced Output Connectors: BNC pair.
004	75 Ω Unbalanced Output Connector: Commercial equivalent of WECO type 560A (Accepts WECO plug 439A or 440A). 124 Ω Balanced Output Connectors: Commercial equivalent of WECO type 562A (Accepts WECO plug 443A). 135 Ω Balanced Output Connectors: Commercial equivalent of WECO type 223A (Accepts WECO plug 241A).
907	Front Handle Assembly
908	Rack Mount Flange Kit
909	Rack Mount Flange Kit/Front Handle Assembly
910	Additional Operating and Service Manual

1-18. For more information concerning these options, refer to Table 1-2, General Information, or contact your local -hp- Sales and Service Office. A list of the -hp- Sales and Service Offices is provided at the end of this manual.

1-19. ACCESSORIES SUPPLIED.

1-20. The following is a list of accessories supplied with the Model 3335A. This list comprises the 3335A service kit, -hp- Part No. 03335-87901.

Accessory	Qty.	-hp- Part No.
Extender Board	2	5061-0775
Extender Board	2	03335-66518
Service Cable	1	03335-61602
Service Cable	1	03335-61627
SMA–to–BNC Adapter	1	1250-1548
BNC-to-BNC Adapter	1	1250-1499

1-21. ACCESSORIES AVAILABLE.

1-22. The following is a list of Hewlett-Packard accessories available for use with the Model 3335A:

Accessory	-hp- Model No.
50 Ω Feedthrough	11048C
75 Ω Feedthrough	11094C

1-23. HP-IB INTERFACING AND PROGRAMMING INFORMATION.

1-24. Section II of this manual contains instructions for interfacing the Model 3335A with the HP-IB. A brief description of the sequence of events comprising the transfer of data by the HP-IB is provided in Section III followed by programming information. Information concerning the design criteria of the bus is available in IEEE Standard 488-1975, titled "IEEE Standard Digital Interface for Programmable Instrumentation".

1-25. INSTRUMENT AND MANUAL IDENTIFICATION.

1-26. The instrument serial number is located on the rear panel. Hewlett-Packard uses a two-section serial number consisting of a four-digit prefix and a five-digit suffix. A letter between the prefix and suffix identifies the country in which the instument was manufactured (A = USA, G = West Germany, J = Japan, U = United Kingdom). All correspondence with Hewlett-Packard concerning this instrument should include the complete serial number.

1-27. If the serial number of your instrument is lower than the serial number on the title page of this manual, you must modify your manual for agreement with your instrument. Refer to Section VII, MANUAL CHANGES, for the information that will adapt this manual to your instrument.

1-28. SAFETY CONSIDERATIONS.

1-29. The Synthesizer/Level Generator is a Safety Class I instrument and has been designed according to international safety standards. To ensure safe operation and to retain the instrument in a safe condition, this Operating Manual contains information, cautions and warnings which must be adhered to by the user.

1-30. The 3335A's front panel contains a ⚠ symbol which is an international symbol meaning "refer to the

Operating Manual." The symbol flags important operating instructions located in Section III required to prevent damage to the instrument. To retain the operating condition of the instrument, these instructions must be adhered to.

1-31. RECOMMENDED TEST EQUIPMENT.

1-32. Equipment required to maintain the Model 3335A is listed in Table 1-3. Other equipment can be substituted if it meets or exceeds the critical specifications listed in the table.

Table 1-1. Specifications.

STANDARD/OPTION 001

FREQUENCY:

Range: 50 Ω / 75 Ω } 200 Hz to 80.999 999 999 MHz

Stability (Standard):

Long Term: ± 1×10^{-8} per day
± 1×10^{-7} per month

Stability (Option 001):

Long Term: < 5×10^{-10}/day after 24-hour warmup and oscillator off time less than 24 hours. < 1×10^{-7}/year for continuous operation

Spectral Purity:

Harmonic Distortion:

All harmonically related signals will be less than the following levels (relative to the fundamental) at full output:

Freq Range	Harmonic Level
200 Hz to 10 MHz	−45 dB
10 MHz to 80 MHz	−40 dB

Integrated Phase Noise:

(30 kHz band, excluding ± 1 Hz, centered on the carrier)

9.9 MHz:	< −63 dB
20 MHz:	< −70 dB
40 MHz:	< −64 dB
80 MHz:	< −58 dB

Spurious (25°C ± 10°C):

All non-harmonically related signals are > 75 dB below the carrier or −125 dBm whichever is greater.

AMPLITUDE:

Range: 50 Ω: +13.01 dBm to −86.98 dBm
75 Ω: +11.25 dBm to −88.74 dBm

Absolute Level Accuracy:

(Maximum output at 100 kHz, 10°C to 35°C) ± 0.05 dB

Flatness: (Relative to 100 kHz, Full Amplitude)

50 Ω/75 Ω { 1 kHz–25 MHz: ± .07 dB
200 Hz–80 MHz: ± .15 dB

Attenuator Accuracy: (Relative to Full Output, 100 kHz, In 2 dB Steps)

Impedance*	Attenuation (dB)	Accuracy 200 Hz – 25 MHz	Accuracy 25 MHz – 80 MHz
~~50 Ω~~ 75 Ω	0 to 18	± 0.04 dB	± 0.15 dB
~~50 Ω~~ 75 Ω	20 to 58	± 0.09 dB	± 0.25 dB
~~50 Ω~~ 75 Ω	60 to 98	± 0.20 dB	± 0.50 dB

50 Ω	0 to 38	± 0.025 dB
50 Ω	40 to 58	± 0.03 dB
50 Ω	60 to 98	± 0.09 dB

Table 1-1. Specifications (Cont'd).

OPTION 002/004

FREQUENCY:

Range:
75 Ω: 200 Hz to 80.999 999 999 MHz
124 Ω: 10 kHz to 10 MHz
135 Ω: 10 kHz to 2 MHz

Stability:

Long Term: ± 1 x 10^{-8} per day
± 1 x 10^{-7} per month

See STANDARD/OPTION 001 table for Option 001 stability.

Spectral Purity:

Harmonic Distortion:

All harmonically related signals will be less than the following levels (relative to the fundamental) at full output: (75 Ω) 0 dBm (124 Ω, 135 Ω)

Impedance	Freq Range	Harmonic Level
75 Ω	200 Hz to 10 MHz	–45 dB
	10 MHz to 80 MHz	–40 dB
124 Ω	10 kHz to 10 MHz	–45 dB
135 Ω	10 kHz to 2 MHz	–45 dB

Integrated Phase Noise:

(30 kHz band, excluding ± 1 Hz, centered on the carrier)

9.9 MHz: < –63 dB
20 MHz: < –70 dB
40 MHz: < –64 dB
80 MHz: < –58 dB

Spurious (25°C ± 10°C):

Impedance	All non-harmonically related signals (whichever is greater)
75 Ω	–125 dBm or –75 dBc
124 Ω	–97 dBm or –75 dBc (dc to 200 MHz)
135 Ω	–100 dBm or –75 dBc (dc to 10 MHz) –68 dBm or –75 dBc (10 MHz–200 MHz)

AMPLITUDE:

Range: 75 Ω, 124 Ω, 135 Ω: +11.25 dBm to –88.74 dBm

Absolute Level Accuracy: (Maximum output at 100 kHz, 10°C to 35°C)

75 Ω: ± 0.05 dB
124/135 Ω: ± 0.1 dB

Flatness: (Relative to 100 kHz, Full Amplitude)

75 Ω	1 kHz–25 MHz: ± .07 dB
	200 Hz–80 MHz: ± .15 dB
124 Ω	50 kHz–10 MHz: ± .15 dB
	10 kHz–10 MHz: ± .4 dB
135 Ω	10 kHz–2 MHz: ± .18 dB

Amplitude Accuracy (includes effects of flatness and attenuator):

75 Ω:

75 Ω Output Level (dBm)	200 Hz – 1 kHz	1 kHz – 25 MHz	25 MHz – 50 MHz
+11.25 to – 8.74	± 0.25 dB	± 0.15 dB	± 0.35 dB
– 8.74 to –48.74	± 0.30 dB	± 0.20 dB	± 0.45 dB
–48.74 to –70.0*	± 0.40 dB	± 0.30 dB	± 0.70 dB

124 Ω:

124 Ω Output Level (dBm)	10 kHz – 50 kHz	50 kHz – 10 MHz
+11.25 to – 8.74	±0.60 dB	± 0.35 dB
– 8.74 to –48.74	± 0.65 dB	± 0.40 dB
–48.74 to –70.0*	± 1.1 dB	± 0.85 dB

135 Ω

135 Ω Output Level (dBm)	10 kHz – 2 MHz
+11.25 to – 8.74	± 0.35 dB
– 8.74 to –48.74	± 0.40 dB
–48.74 to –70.0*	± 0.85 dB

Output Balance: 124/135 Ω: >60 dB

*Levels to –88.74 dBm can be selected but accuracies are unspecified due to the spurious noise floor of –100 dBm.

Table 1-1. Specifications (Cont'd).

OPTION 003

FREQUENCY:

Range: 75 Ω: 200 Hz to 80.999 999 999 MHz
150 Ω: 10 kHz to 2 MHz

Stability:

Long Term: $\pm 1 \times 10^{-8}$ per day
$\pm 1 \times 10^{-7}$ per month

See STANDARD/OPTION 001 table for Option 001 stability.

Spectral Purity:

Harmonic Distortion:

All harmonically related signals will be less than the following levels (relative to the fundamental) at full output:

Freq Range	Harmonic Level
200 Hz to 10 MHz	–45 dB
10 MHz to 80 MHz	–40 dB

Integrated Phase Noise:
(30 kHz Band, excluding ± 1 Hz, centered on the carrier)

9.9 MHz < –63 dB
20 MHz < –70 dB
40 MHz < –64 dB
80 MHz < –58 dB

Spurious (25°C ± 10°C)

Impedance	All non-harmonically related signals (whichever is greater)
75 Ω	–125 dBm or –75 dBc
150 Ω	–100 dBm or –75 dBc

AMPLITUDE:

Range: 75 Ω, 150 Ω: +11.25 dBm to –88.74 dBm

Absolute Level Accuracy (Maximum Output at 100 kHz, 10°C to 35°C)

75 Ω: ± 0.05 dB
150 Ω: ± 0.10 dB

Flatness (relative to 100 kHz, Full Amplitude):

75 Ω: 1 kHz–25 MHz: ± 0.07 dB
200 Hz–80 MHz: ± 0.15 dB
150 Ω: 10 kHz–2 MHz: ± 0.18 dB

Amplitude Accuracy (includes the effects of flatness and attenuator):

75 Ω:

75 Ω Output Level (dBm)	200 Hz – 1 kHz	1 kHz – 25 MHz	25 MHz – 80 MHz
+11.25 to – 8.74	± 0.25 dB	± 0.15 dB	± 0.35 dB
– 8.74 to –48.74	± 0.30 dB	± 0.20 dB	± 0.45 dB
–48.74 to –88.74	± 0.40 dB	± 0.30 dB	± 0.70 dB

150 Ω:

150 Ω Output Level (dBm)	10 kHz – 2 MHz
+11.25 to – 8.74	± 0.35 dB
– 8.74 to –48.74	± 0.40 dB
–48.74 to –70.0*	± 0.85 dB

*Levels to –88.74 dBm can be selected but accuracies are unspecified due to the spurious noise floor of –100 dBm.

Table 1-2. General Information.

Output Impedance: (Selected by a front panel switch)
Standard: 50 ohms or 75 ohms
Option 002/004: 75 ohms unbalanced, 124 ohms balanced and 135 ohms balanced
Option 003: 75 ohms unbalanced and 150 ohms balanced

Frequency Range:
Standard:
50 Ω: 200 Hz to 80 099 999.999 Hz
75 Ω: 200 Hz to 80 099 999.999 Hz
Option 002/004:
75 Ω: 200 Hz to 80 099 999.999 Hz
124 Ω: 10 kHz to 10 MHz
135 Ω: 10 kHz to 2 MHz
Option 003
75 Ω: 200 Hz to 80 099 999.999 Hz
150 Ω: 10 kHz to 2 MHz

Frequency Resolution: 0.001 Hz

Frequency Display: 11 digits

Frequency Settling Time: < 20 msec to within 90° of final phase.

Frequency Sweep Mode:
Auto: ≈8 sweeps/sec, 100 steps/sweep
Manual, single 10 sec and 50 sec sweep: 1000 steps/sweep

Amplitude Range:
Standard:
50 ohms: +13.01 dBm to –86.98 dBm
75 ohms: +11.25 dBm to –88.74 dBm
Option 002:
75 ohms unbalanced:
124 ohms balanced: } +11.25 dBm to –88.74 dBm
135 ohms balanced:
Option 003:
75 ohms unbalanced: +11.25 dBm to –88.74 dBm
150 ohms balanced:
Option 004: Same as Option 002

Amplitude Settling Time: < 500 msec to within 0.02 dB of final value.

Internal Frequency Reference:
Frequency stability is obtained by use of a 10 MHz crystal oscillator in a temperature-stabilized oven. A high-stability 10 MHz temperature-stabilized crystal oscillator is provided by Option 001. The master 40 MHz oscillator of the instrument reference section is capable of operating open loop (no oven or external reference) but the frequency stability is not specified.

External Frequency Reference:
The 40 MHz master oscillator of the reference section can be phase-locked to an external reference through a rear panel BNC connector. The amplitude and frequency requirements of the external signal are - 7 dBm to + 7 dBm (+ 0.1 V to + 0.5 V) with frequency being a sub-harmonic of 40 MHz and ⩾1 MHz.

Remote Programming:
The 3335A is a fully programmable instrument designed for systems interfacing with the Hewlett-Packard Interface Bus (HP-IB). It will recognize a preset listen address and accept bit-parallel, word (byte) serial ASCII coded instructions. The address is preset by five rear panel listen address switches. A brief description of the HP-IB with address and programming information is provided in Section III.

Programmability:
All FUNCTION keys except DISPLAY, all DATA keys including the ENTRY keys, all INCR keys and all FREQUENCY keys except the MANUAL TUNE keys and MANUAL SWEEP key are programmable. The POWER key and the impedance selection switch are not programmable.

HP-IB Connector:
The rear panel HP-IB connector provides all lines for remote control and digital output using the HP-IB. The connector is compatible with the -hp- 10631 (A, B or C) HP-IB cables and contains metric threaded cable mounting studs.

Maximum HP-IB Cable Length:
2 meters (6.56 feet) per device; 20 meters (65.6 feet) total accumulation per system.

HP-IB Lines:
The 3335A uses all of the HP-IB lines except EOI (End or Identify), SRQ (Service Request) and the data line DIO 8.

Data Input/Output:
All data is received through the HP-IB Data Input/Output (DIO) lines.

Data Transfer Timing:
Timing of data transfer is controlled by "handshake" lines DAV, NRFD and NDAC.

HP-IB Logic Levels:
TTL compatible low true (true state = digital ground or 0 V to 0.4 V dc; false state = open or + 2.5 V dc to + 5 V dc).

Isolation:
The HP-IB lines and 3335A are optical coupled.

Listen Address Code:
The 3335A is shipped from the factory with an ASCII listen address of $ (octal 044). Instructions for changing the listen address are provided in Section III.

HP-IB Bus Commands:
The 3335A will respond to certain Unaddress, Universal and Addressed Commands (see information on Remote Programming in Section III).

Telecommunications Features:
Amplitude blanking of the output signal at each change of output frequency is obtainable except in the manual tune and manual sweep modes. Special sweep feature allows each frequency step to be held for four seconds and also includes amplitude blanking.

General
Operating Temperature: 0 °C to 55 °C
Storage Temperature: - 40 °C to + 75 °C
Power Requirements: 100 V, 120 V, 220 V or 240 V ac, + 5% - 10%, 48 Hz to 66 Hz, 200 VA Maximum

Dimensions:
Dimensions in millimeters and (inches):
Height: 133.4 (5 1/4)
Width: 425.5 (16 3/4)
Depth: 501.7 (19 3/4)

Weight:
Weight in kilograms and (pounds): 19.05 (42)

Table 1-3. Recommended Test Equipment.

Equipment	Required Characteristics	Perf. Tests	Adj.	T.S.	Recommended Model
3335A Service Kit	(Supplied with the instrument)		X	X	-hp- 03335-87901
Consists of:					
(2) Extender Boards				X	-hp- 5061-0775
(1) Extender Board			X	X	-hp- 03335-66518
(1) Extender Board			X	X	-hp- 03335-66520
(1) Service Cable			X	X	-hp- 03335-61602
(1) Service Cable			X	X	-hp- 03335-61627
(1) SMA-to-BNC			X	X	-hp- 1250-1548
Terminations:					
50 Ω Feedthru		X		X	-hp- 11048C
75 Ω Feedthru		X		X	-hp- 11094B
Adapters:					
BNC "TEE"		X			-hp- 1250-0781
Conn. Adapter		X			-hp- 1250-0591
(2) BNC Male-to-Male		X			-hp- 1250-0216
(2) Type N(f) to BNC (m)		X			-hp- 1250-0077
(2) Type N(m) to BNC (f)		X			-hp- 1250-0780
(2) BNC (f) to dual banana plug		X	X	X	-hp- 1251-2277
Thermal Converter	Impedance: 50 Ω or 75 Ω Frequency Range: 200 Hz – 10 MHz Frequency Response: ± 0.05 dB 200 Hz – 10 MHz Input Voltage: 1 V rms	X			-hp- 11050A (50 Ω) or -hp- 11050A/H01 (75 Ω)
Double Balanced Mixer	Impedance: 50 Ω Frequency Range: 50 kHz to 80 MHz	X			-hp- 10534A
Attenuator	Certified (See Note 1) Range: 0–12 dB Steps: 1 dB	X			-hp- 355C
Attenuator	Certified (See Note 1) Range: 0–120 dB Steps: 10 dB	X			-hp- 355D
Attenuator	Fixed: 3 dB Accuracy: ± 0.3 dB	X			-hp- 8491A Option 003
Attenuator	Fixed: 6 dB Accuracy: ± 0.3 dB	X			-hp- 8491A Option 006
Digital Voltmeter	AC Function: Full Scale Ranges: 1 V, 10 V Freq. Range: 200 Hz–100 kHz Accuracy: ± ~~0.5%~~ ±0.1% Resolution: 0.1 mV Input Impedance: > 1 mΩ < 90 pF DC Function: Full Scale Ranges: 100 mV–20 V Accuracy: ± 0.15% Resolution: 5 digits Input Resistance: > 1 MΩ	X	X	X	-hp- 3455A option 001
AC Voltmeter	Full Scale Ranges 0.1 – 1 V Frequency Range: 200 Hz to 4 MHz Accuracy: ± 10% Input Impedance: 10 MΩ, < 25 pF	X		X	-hp- 400FL
Oscilloscope	Vertical Sensitivity: 0.005 V/div to 2 V/div Sweep: 0.05 μs/div to 0.1 sec/div Input Impedance: 1 MΩ, < 20 pF Input Coupline: ac/dc	X	X	X	-hp- 180C/D, 1805A, 1825A
Tracking Generator	Freq. Range: 100 kHz to 110 MHz Amplitude Range: 0 to –10 dB		X		-hp- 8443A

Table 1-3. Recommended Test Equipment.

Equipment	Required Characteristics	Perf. Tests	Adj.	T.S.	Recommended Model
Spectrum Analyzer	Frequency Range: 1 kHz–1.25 GHz Amplitude Accuracy: ± .5 dB Response: ± 0.5 dB	X	X	X	-hp- 141T, 8552B, 8553B, 8554B
Spectrum Analyzer	Frequency Range: 5 Hz to 50 kHz Amplitude Accuracy: ± 0.5 dB Response: ± 3% Battery operation	X		X	-hp- 3580A Option 001
Wave Analyzer	Frequency Range: 15 Hz–50 kHz Accuracy: ± 3 Hz Amplitude Range: – 150 dBm – +30 dBm Accuracy: ± 0.5 dB Recorder Output: 0–+5 V ± 2.5%	X			-hp- 3581A
Amplifier	Frequency Range: 0.1–80 MHz Gain: 20 dB ± 0.5 dB at 10 MHz Response: ± 0.5 dB Noise Figure: < 5 dB Harmonic Distortion: –32 dB for 0 dBm output Impedance: 50 Ω	X			QB–300 Q-Bit Corp. P.O. Box 2208 Melbourne, FL 32901
Quartz Frequency Standard	Output: 5 MHz, 1 V rms into 50 Ω Short Term Stability: 5 parts in 10^{12} for 1 sec averaging time		X		-hp- 105A/B
Universal Counter	Frequency: 200 Hz–80 MHz Sensitivity: 50 mV rms Impedance: 1 MΩ, < 50 pF	X		X	-hp- 5328A
Power Meter	Power Range: 13.5 dB Frequency Range: 100 kHz to 80 MHz Accuracy: ± 0.05%	X			-hp- 436A
Power Sensor	Power Range: 0.3 μW to 100 mW Impedance: 50 Ω or 75 Ω Freq. Range: 100 kHz–80 MHz	X			-hp- 8482A (50 Ω) or -hp- 8483A (75 Ω)
1 MHz LPF	Cut Off Freq: 1 MHz Stopband Attn: 50 dB by 4 MHz Stopband Freq: 4 MHz–80 MHz	X			J903 TT Electronics, Inc. 2214 S. Barry Ave. Los Angeles, CA 90064
Synthesizer	Frequency Range: 10 MHz–80 MHz Amplitude Range: –10 dBm to +10 dBm Accuracy: ± 0.05 dB Phase Noise (30 kHz Integrated): 9.9 MHz: < –63 dB 20 MHz: < –70 dB 40 MHz: < –64 dB 80 MHz: < –58 dB	X			-hp- 3335A
Power Supply	Output: + 15 V	X			-hp- 6215A
(2) Cables		X			-hp- 11170A
(2) Cables		X			-hp- 11170B
(2) Cables		X			-hp- 11170C
Active Probe	Input Impedance = 100 kΩ shunted by 3 pfds		X		-hp- 1120A

NOTE 1

Attenuators of known accuracy are required. Certification is obtainable from Hewlett-Packard. Contact your nearest Hewlett-Packard Sales and Service Office. A list of offices is provided at the back of this manual.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains instructions for installing and interfacing the Model 3335A Synthesizer/Level Generator. Included are initial inspection procedures, power and grounding requirements, line voltage selection, environmental requirements, installation instructions, HP-IB connection procedure and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. The contents of the shipment should be as shown in Figure 1-1. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of mars or scratches and in perfect electrical order upon receipt. Procedures for checking electrical performance are given in Section IV. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance test, notify the nearest Hewlett-Packard Sales and Service Office. If the shipping container is damaged or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection. The warranty statement is located at the front of this manual.

2-5. PREPARATION FOR USE.

2-5(a). Reference Frequency.

2-5(b). A stable frequency reference must be connected to the 40/N MHz REFerence INPUT located on the rear panel. If the internal 10 MHz reference is to be used, the BNC-to-BNC Adapter (see Figure 6-2 Item 25) must be connected from the 10 MHz REFerence OVEN output, also located on the rear panel, to the 40/N M/Hz REFerence INPUT. The BNC-to-BNC Adapter is packed with the accessories.

2-6. Power Requirements.

2-7. The Model 3335A Synthesizer/Level Generator requires a power source of 100, 120, 220 or 240 V ac, + 5%, - 10%, 48 to 66 Hz single phase. Power consumption is 200 VA maximum.

2-8. Line Voltage Selection.

CAUTION

Before switching on this instrument, be sure it is set for the line voltage of the power source. Also ensure the line power cord is connected to a protective earth contact.

2-9. Line voltage and fuse selection instructions are provided on the rear panel above the ac line connector. The line voltage is selected by the position of the two rear panel line voltage selection switches.

NOTE

The correct fuse rating for the line voltage selected is located on the rear panel between the fuse location and line voltage selection switch.

The line voltage and fuse are factory installed for 120 V operation.

WARNING

To maintain operator safety, the following precautions must be followed before the instrument power cable is connected:

a. Before the power cable is connected to a power source, the protective earth terminal of the instrument must be connected to earth ground. This is accomplished by ensuring that the instrument's ac line input connector earth terminal is correctly connected to the instrument's chassis and that the power cord ground conductor has continuity from end to end.

b. Note that the protection provided by grounding the instrument cabinet will be lost if a power cable not containing a ground conductor like the type supplied is used to connect the ac line voltage to the instrument.

c. The power cable plug must be inserted into a socket outlet provided with a protective earth contact. The protection of the grounded instrument cabinet must not be negated by the use of an extension cord without a protective ground conductor.

d. If this instrument is to be energized via an auto-transformer to reduce or increase the line voltage, make sure that the common terminal is connected to the earthed pole of the power source.

2-10. Power Cable.

2-11. In accordance with international safety standards, this instrument is equipped with a three-wire power cable. When connected to an appropriate power line outlet, this cable grounds the instrument cabinet. The type of power cable plug shipped with each instrument depends on the country of destination. Refer to Figure 2-1 for the part numbers of the power cable plugs available.

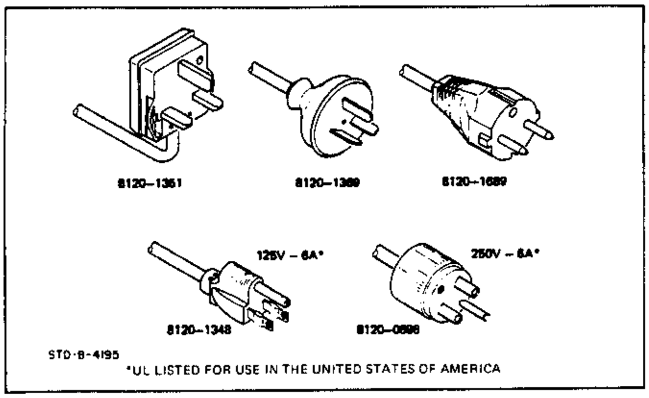


Figure 2-1. Power Cables.

2-12. HP-IB Connections.

2-13. Interconnection data concerning the rear panel HP-IB connector is provided in Figure 2-2. This connector is compatible with the -hp- 10631 (A, B, or C) HP-IB Cables. With the HP-IB system, you can interconnect up to fourteen (including the controller) HP-IB compatible instruments. The HP-IB Cables have identical "piggyback" connectors on both ends so that several cables can be connected to a single source without special adapters or switch boxes. You can interconnect system components and devices in virtually any configuration you desire. There must, of course, be a path from the calculator (or other controller) to every device operating on the bus. As a practical matter, avoid stacking more than three or four cables on any one connector. If the stack gets too large, the force on the stack produces great leverage which can damage the connector mounting. Be sure that each connector is firmly screwed in place to keep it from working loose during use (see CAUTION of Figure 2-2).

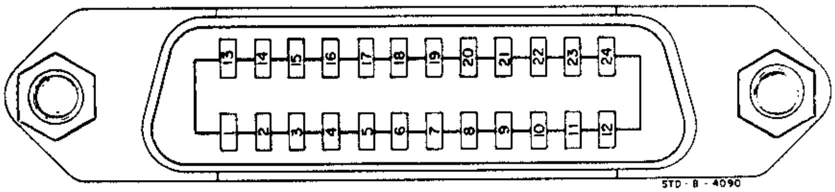
2-14. Cable Length Restrictions. To achieve design performance with the HP-IB, proper voltage levels and timing relationships must be maintained. If the system cable is too long, the lines cannot be driven properly and the system will fail to perform. Therefore, when interconnecting an HP-IB system, it is important to observe the following rules:

a. The total cable length for the system must be less than or equal to 20 meters (65 feet).

b. The total cable length for the system must be less than or equal to 2 meters (6 feet) times the total number of devices connected to the bus.

2-15. 3335A Listen Address.

2-16. The 3335A contains a rear panel HP-IB Instrument listen address selection switch. There are five switches



PIN	LINE	
1	DI01	
2	DI02	
3	DI03	
4	DI04	
13	DI05	
14	DI06	
15	DI07	
16	DI08	
5	EOI	
17	REN	
6	DAV	
7	NRFD	
8	NDAC	
9	IFC	
10	SRQ	
11	ATN	
12	SHIELD–CHASSIS GROUND	
18	P/O TWISTED PAIR WITH PIN 6	THESE PINS ARE INTERNALLY GROUNDED
19	P/O TWISTED PAIR WITH PIN 7	
20	P/O TWISTED PAIR WITH PIN 8	
21	P/O TWISTED PAIR WITH PIN 9	
22	P/O TWISTED PAIR WITH PIN 10	
23	P/O TWISTED PAIR WITH PIN 11	
24	ISOLATED DIGITAL GROUND	

CAUTION

The 3335A contains metric threaded HP–IB cable mounting studs as opposed to English threads. Metric threaded -hp- 10631A, B, or C HP–IB cable lockscrews must be used to secure the cable to the instrument. Identification of the two types of mounting studs and lockscrews is made by their color. English threaded fasteners are colored silver and metric threaded fasteners are colored black. DO NOT mate silver and black fasteners to each other or the threads of either or both will be destroyed. Metric threaded HP-IB cable hardware illustrations and part numbers follow.

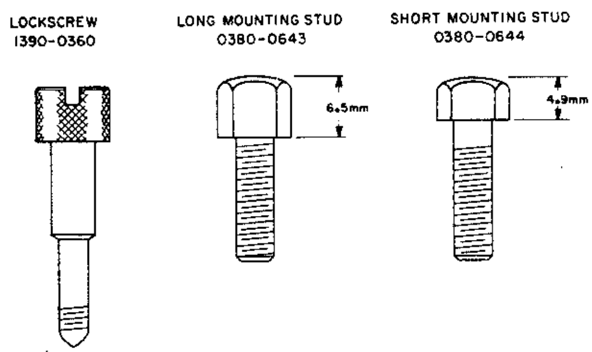


Figure 2-2. HP-IB Connector.

designated (5 . . . 1)which are used to select the listen address. Instructions for changing the listen address are provided in Section III of this manual along with 3335A programming codes.

2-17. HP-IB Descriptions.

2-18. A description of the HP-IB is provided in Section III of this manual. A study of this information is necessary if you are not familiar with the HP-IB concept. Additional information concerning the design criteria and operation of the bus is available in IEEE Standard 488-1975 titled "IEEE Standard Digital Interface for Programmable Instrumentation".

2-19. OPERATING ENVIRONMENT.

WARNING

To prevent potential electrical or fire hazard, do not expose equipment to rain or moisture.

2-20. Operating and Storage Temperature.

2-21. In order for the 3335A to meet the specifications listed in Table 1-1, the operating environment must be within the following limits:

Temperature. . . . . .0 to + 55°C
Humidity. . . . .< 85% relative
Altitude. . . . . < 15,000 feet

2-22. Cooling System.

2-23. A forced air cooling system is used to maintain the operating temperature required by the instrument. The cooling fan is located on the right side of the instrument drawing air through the filtered side panel. When operating the instrument, choose a location that provides at least three inches of clearance at the rear and at least one inch for each side. Failure to provide adequate air clearance will result in excessive internal temperature reducing instrument reliability. The clearances provided by the plastic feet in bench stacking and the filler strip in rack mounting allow air passage across the top and bottom cabinet surfaces.

NOTE

Rack Mount side slide assemblies cannot be used with the 3335A. These assemblies block air passage to the fan and will cause overheating.

2-24. Thermal Cutout Switch.

2-25. The 3335A is equipped with a thermal cutout switch which automatically removes line voltage when the internal temperature becomes excessive. The switch resets automatically when the instrument cools. If a thermal cutout occurs, check for an inoperative fan, clogged fan parts or filter and other conditions that could obstruct air flow. To clean the fan filter, the side panel/filter assembly must be removed. Flush the filter with soapy water, rinse clean and air dry.

2-26. Bench Operation.

2-27. The instrument has plastic feet attached to the bottom panel. The front feet contain foldaway tilt stands for convenience in bench operation. The tilt stand raises the front of the instrument for easier viewing of the control panel. The plastic feet are shaped to make full-width modular instruments self-align when they are stacked. A front handle kit, -hp- Part No. 5060-9899 (Option 907), can be installed for ease of handling the instrument on the bench (see Figure 2-3). The kit is shipped with the instrument if Option 907 is also ordered. Otherwise, the front handle kit is available separately by its -hp- part number.

2-28. Rack Mounting.

2-29. The 3335A can be rack mounted in a rack having an EIA standard width of 482.6 mm (19 inches). The instru-

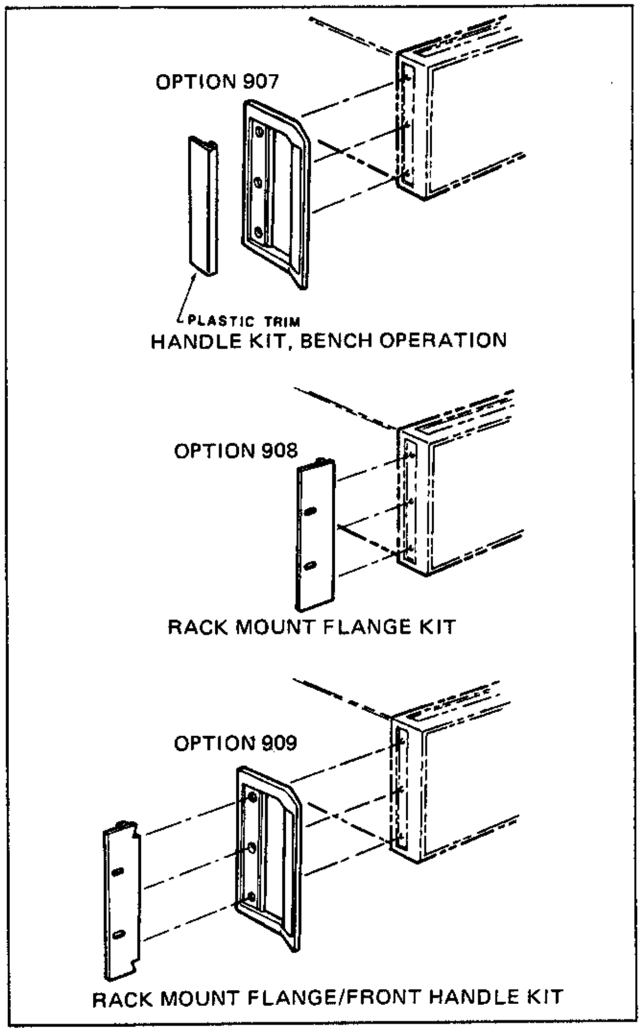


Figure 2-3. Rack Mount and Handle Kits.

ment can be rack mounted with or without a handle kit by use of the following items:

a. Rack mounting without handles: use Rack Mount Flange Kit -hp- Part No. 5061-0077 (Option 908).

b. Rack mounting with handles: use the combination Rack Mount Flange/Front Handle Kit -hp- Part No. ~~5061-0083~~ (Option 909).
5020-8874

NOTE

The Rack Mount Flange Kit of item a will not provide the space requirement for rack mounting when used with the bench handle assembly (-hp- Part No. 5060-9899, Option 907). To rack mount with handles, the combination kit of item b (Option 909) must be used (see Figure 2-3). If either Option 908 or 909 is ordered, the corresponding kit is shipped with the instrument. Otherwise, both kits are available separately by their -hp- part numbers.

CAUTION

If instrument is to be rack mounted, do not install standard slide kit. Use of a slide kit blocks air passage to the side mounted fan and will cause excessive heating to occur within the instrument.

2-30. STORAGE AND SHIPMENT.

2-31. Environment.

2-32. The instrument should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment:

Temperature. . . . . - 40°C to + 75°C
Humidity. . . . . < 95% relative
Altitude. . . . . < 25,000 feet

2-33. Packaging.

2-34. Original Packaging. Containers and materials equivalent to that used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also, mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-35. Other Packaging. The following general instructions should be used for repackaging with commercially available materials.

a. Wrap the instrument in heavy paper or plastic. (If shipping to a Hewlett-Packard office or service center, attach a tag indicating the type of service required, return address, model number, and full serial number.)

b. Use a strong shipping container. A doublewall carton made of 250-pound test material is adequate.

c. Use enough shock-absorbing material (3-to-4 inch layer) around all sides of the instrument to provide firm cushion and prevent movement inside the container. Protect the control panel with cardboard.

d. Seal the shipping container securely.

e. Mark the shipping container FRAGILE to assure careful handling.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains operating and programming instructions for the -hp- Model 3335A Synthesizer/Level Generator. Included is a description of controls, connectors and indicators, operating instructions and operator's maintenance. A list of operating features is tabulated in Table 3-1 which can be used as an index to locate operating information.

3-3. PANEL FEATURES.

3-4. Figure 3-2 illustrates and describes the function of all front and rear panel controls, connectors and indicators. Items requiring additional description are referenced to paragraphs in the operating instructions.

3-5. OPERATOR'S MAINTENANCE.

3-6. Operator's maintenance of the -hp- Model 3335A Synthesizer/Level Generator is limited to rear panel power line fuse replacement.

CAUTION

When replacing fuses, always verify the replacement fuse is of the correct amperage and is FAST-BLO.

3-7. POWER/WARM-UP.

3-8. The Model 3335A Synthesizer/Level Generator requires a power source of 100, 120, 220 or 240 V ac, + 5%, - 10%, 48 to 66 Hz single phase. The selection of line voltage and input power fuse is described in Section II, Paragraph 2-5, PREPARATION FOR USE.

3-9. The 3335A has a two-position power switch, STBY and ON. It is important that the instrument remain connected to the power source in the STBY mode when not in use. This supplies power to the crystal oven maintaining a constant oven temperature thus eliminating the need for a long warm-up period. When the STBY mode is not used and power is disconnected from the instrument, allow 30 minutes from the application of external power in the ON mode for the instrument to warm up.

3-10. Modes of Operation.

3-11. There are two manual modes of operation and an automatic sweep mode of operation for the Model 3335A Synthesizer/Level Generator. One manual mode is manual tune operation allowing the user to manually tune any frequency in the 3335A's range. The other manual mode is the manual sweep mode which allows the user to manually sweep the frequency between predetermined end points. The automatic sweep mode allows the user to initiate a single sweep or a continuous sweeping output. The automatic sweep modes are remotely programmable through the HP-IB.

3-12. OPERATING INSTRUCTIONS.

3-13. Operating the Model 3335A Synthesizer/Level Generator requires programming the operating parameters by use of front panel keys. These keys are contained in four major groupings. From left to right across the front panel the groups are:

Table 3-1. Operating Information Index.

Operating Item	Paragraph
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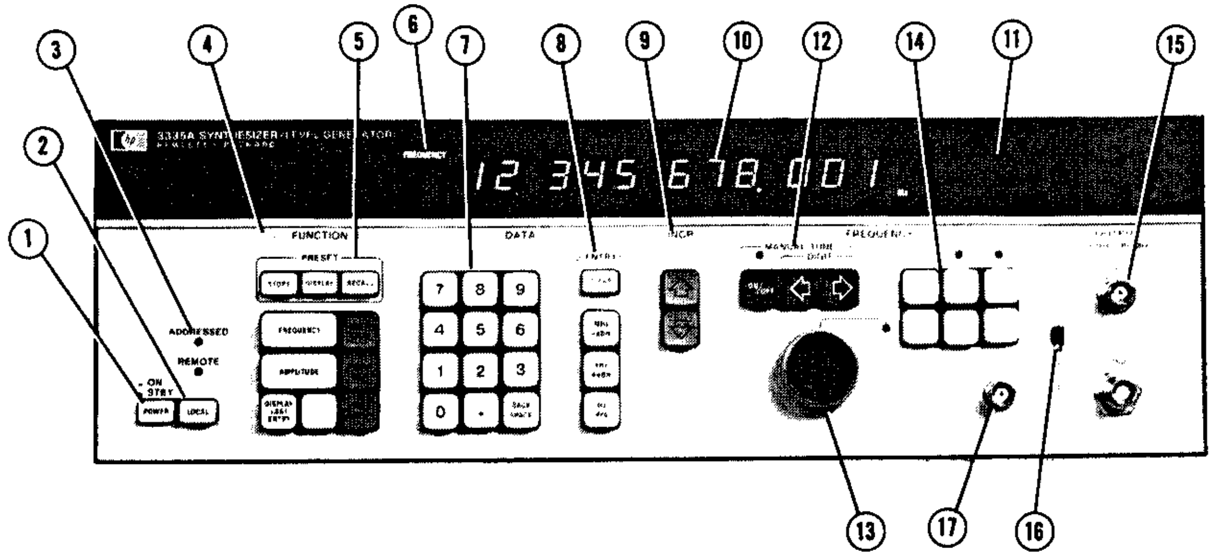
a. FUNCTION
b. DATA
c. INCR
d. FREQUENCY

3-14. FUNCTION Keys.

3-15. The FUNCTION keys control which operating parameter is displayed. Within the FUNCTION group is a subgroup called PRESET. This subgroup controls ten storage registers each capable of storing all of the operating parameters of the FUNCTION group. This is useful for recalling a particular set of operating parameters without having to enter each one.

3-16. DATA Keys.

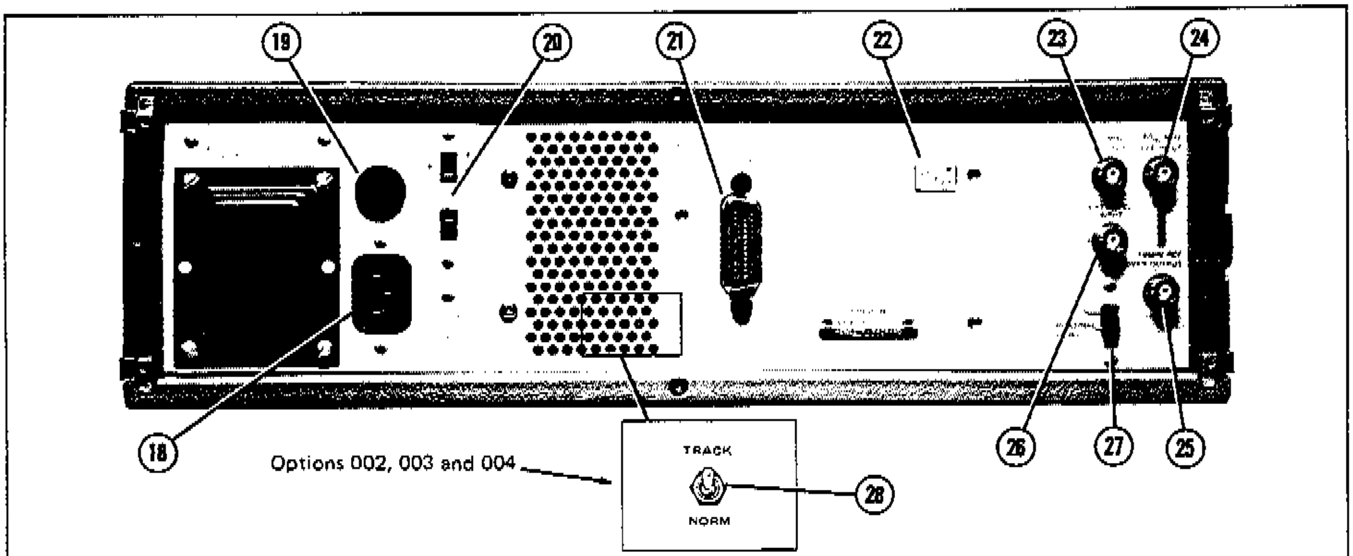
3-17. The DATA keys are used to enter a new operating parameter which is selected by the FUNCTION keys. This group contains a subgroup called ENTRY. The ENTRY



1. POWER Switch. A two position switch (ON and STBY) for controlling line power. In the STBY position, power is applied to the internal temperature-stabilized crystal oven to maintain the operating temperature. This eliminates the need for long warm-up periods when the instrument is turned on. Additionally, unregulated 8 V is present on the Controller and Attenuator Driver Assemblies in the STBY mode.
2. LOCAL Switch. Returns the instrument to local control when operated remotely and Local Lockout command has not been issued.
3. HP-IB Annunciators. Indicates when the instrument is under remote control and if it is addressed to listen.
4. FUNCTION Keys. Used to display a particular operating parameter or preface a data entry.
5. PRESET Keys. Provide access to ten storage registers each capable of storing all operating parameters of the FUNCTION group.
6. Annunciator Group 1. Indicates the operating parameter being displayed. Annunciators consist of CENTER, FREQUENCY, SWP WIDTH, AMPLITUDE, Ø and INCR.
7. DATA Keys. Used to make data entries.
8. DATA ENTRY Keys. Used to complete a data entry.
9. INCR Keys. Used to initiate a frequency, amplitude or phase increment.
10. Numeric Display. Indicates the magnitude (and polarity if applicable) of the parameter being displayed.
11. Annunciator Group 2. Indicates the units of the operating parameter displayed (MHz, kHz, Hz, dBm or deg). Also contains the annunciators ENTRY, UNLOCKED, SWEEPING and UNLEVELED.
12. Manual Tune Keys. Initiates the manual tune frequency mode and establishes the degree of resolution of the manual tuning.
13. Frequency Tune Knob. Used to manually alter the frequency when in the manual tune or manual sweep mode.
14. Sweep Keys. Initiates and controls the frequency sweep mode of operation.
15. Output Connectors. Provides the programmed output at the output impedance selected by the front panel impedance switch.
16. Impedance Switch. Used to select the desired output impedance. This switch determines which output connector (item 15) is active.
17. SWEEP OUTPUT Connector. Provides a 0 to + 2 V dc sweep ramp for use in driving external equipment (oscilloscope, X—Y recorder, etc.) when in the sweep mode.

⚠ Symbol. This symbol is an international symbol meaning "refer to the Operating and Service Manual". This symbol appears in this section of the manual flagging operating instruction information.

Figure 3-1. Front and Rear Panels.



(18) AC Line Input Connector.

(19) AC Line Fuse.

(20) Line Voltage Selection Switches. Used to select the ac line input for the voltage of the power source.

(21) HP-IB Connector. Used to interface the instrument with the HP-IB for remote operation.

(22) HP-IB Listen Address Selection Switches. Used to set the instrument listen address.

(23) 10 MHz OUTPUT Connector. Provides a 10 MHz external reference signal generated by the instrument's reference section.

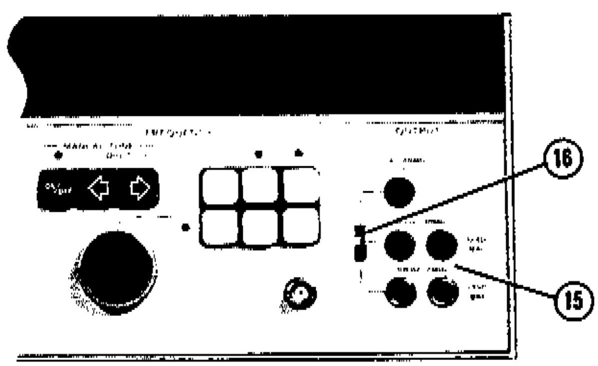
(24) 40/N MHz REF INPUT Connector. Provides the input to the reference section sampling detector to phase-lock the master oscillator. The notation 40/N MHz means this input must be a subharmonic of 40 MHz. The input can be the internal 10 MHz crystal oscillator from the REF OUTPUT (item 25) or an external standard.

(25) 10 MHz REF OVEN OUTPUT Connector. Provides the output from the temperature-stabilized crystal oscillator. It is coupled to the 40/N MHz INPUT connector (item 24) to supply the reference signal when an external standard is not used.

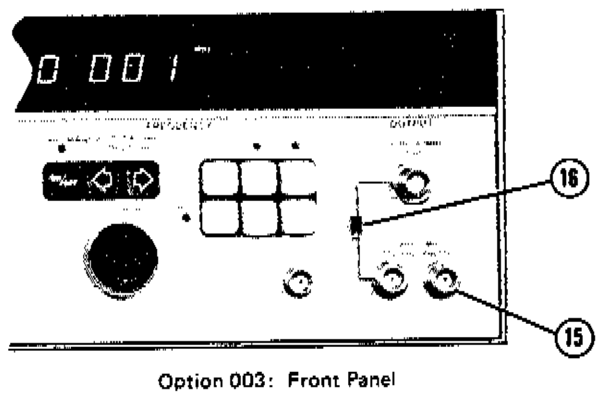
(26) EXT LEVEL INPUT Connector. Provides a means of controlling amplitude by use of an external amplitude reference.

(27) LEVELING Switch. Activates the EXT LEVEL INPUT when in the top position. When in the INTERNAL LEVEL position, leveling is controlled by the instrument.

(28) TELECOMMUNICATIONS SWEEP Switch. In Track position, alters the AUTO sweep by slowing it to ≈ 4 sec per step and blanking the amplitude during frequency changes. (Options 002, 003 and 004 only.)



Option 002/004: Front Panel.



Option 003: Front Panel

Figure 3-1. Front and Rear Panels (Cont'd).

keys are used to complete a data entry or to clear an entry made in error. The FUNCTION and DATA groups together are used to program the operating parameters.

3-18. INCR Keys.

3-19. There are two keys in the INCR group—an arrow up and an arrow down. These keys are used to increment the frequency, amplitude or phase (whichever function is displayed), by the increment parameter programmed from the FUNCTION group. The key pressed determines the direction the increment is made.

3-20. FREQUENCY Keys.

3-21. The FREQUENCY keys are divided into two sub-

groups, MANUAL TUNE and SWEEP. Below the MANUAL TUNE keys is a tuning knob. When the MANUAL TUNE function is selected, a "flashing" digit appears on the display. The left and right arrow digit keys can be used to select any digit to be the "flashing" digit. Turning the knob changes the frequency by the resolution of the "flashing" digit.

3-22. The SWEEP subgroup allows the frequency to automatically sweep a programmed set of frequencies determined by the frequency of operation (center frequency) and the SWEEP WIDTH programmed from the FUNCTION group. A manual sweep mode allows the user to manually sweep the programmed set of frequencies. To return to keyboard operation of the other key groups, the STOP key in the SWEEP subgroup must be pressed.

3-23. Turn-On Operating Parameters.

3-24. When the Model 3335A is turned on, the output parameters of the FUNCTION group initially are:

Frequency	1 000 000. 0 Hz
Amplitude	- 86.98 dBm (50 Ω)
	- 88.74 dBm (75 Ω)
FREQ INCR	1.0 Hz
AMPTD INCR	1.0 dB (Note: For AMPTD INCR display, the annunciator dBm is used for dB)
Ø INCR	1.0 deg
SWEEP WIDTH	100.0 Hz

3-25. The 3335A turns on with the frequency displayed. To check the initial conditions of the other operating parameters, press the key in the FUNCTION group of the parameter of interest. The display should indicate the initial conditions stated in the preceding paragraph. If the instrument was not previously connected to a power source and in STBY, the out-of-lock annunciator "UNLOCKED" will be displayed until the reference oven temperature stabilizes (< 20 minutes). If "UNLOCKED" is still displayed after twenty minutes, check to be sure the BNC-to-BNC adapter from the 10 MHz REF OVEN OUTPUT connector to the 40/N MHz Ref Input has been installed (see Figure 6-2, Item 25).

3-26. Frequency Entry.

3-27. The 3335A has a frequency range of 200 Hz to 80 099 999. 999 Hz with resolution of 0.001 Hz. The desired output frequency is programmed by activating the FREQUENCY FUNCTION key, DATA keys 0 through 9 and a DATA ENTRY key Hz, kHz or MHz. A description of these keys and the frequency display indicators follows.

NOTE

For the following Operating Instructions, refer to Figure 3-1.

FREQUENCY Key. Preface key for entering frequency. When pressed, the front panel displays the present output frequency and the controller is enabled to accept new frequency data.

DATA Keys. These keys are used to enter the desired frequency. Notice that when data is entered, the digits enter the display from right to left. Holding a digit key down causes that digit to be entered respectively. If a wrong digit is entered, press the BACK SPACE key and the right-most digit of the display (the last digit entered) will be deleted. Continue with the correct entry.

DATA ENTRY Keys. If an entry is completely in error, the CLEAR key can be used to reset the display entry to zero. The correct entry can then be made. An entry is finalized by pressing one of the three range keys. The display changes to indicate the new output frequency. If an illegal entry has been finalized, the output frequency does not change and the display flashes.

DISPLAY INDICATORS:

FREQUENCY Indicator. Indicates the front panel is displaying the output frequency or a frequency entry.

ENTRY Indicator. Indicates the front panel is not displaying the output frequency but holding a frequency entry that has not yet been finalized by a data entry key.

The numeric display indicates the output frequency programmed. The digits are entered from right to left as frequency digits are keyed in. The frequency can be displayed in Hz, kHz or MHz dependent on which range key is pressed. The units of the display can be changed at any time by pressing the desired range key.

Example:

Program a frequency of 12345678.901 Hz

Display Result: 12 345 678.901 Hz

Change units to kHz: Press kHz ENTRY key.

Display Result: 12 345.678 901 kHz

Change units to MHz: Press MHz ENTRY key.

Display Result: 12.345 678 901 MHz

NOTE

If the front panel is displaying frequency, it is not necessary to preface a frequency entry with the FREQUENCY key.

3-28. Frequency Increment Entry.

3-29. Frequency increment is used when it is desired to manually change the frequency by a specified increment. The desired frequency increment is programmed by activating the FREQ INCR FUNCTION key, DATA keys 0 through 9 and a DATA ENTRY key Hz, kHz or MHz just as the frequency was programmed. A frequency increment of zero (no increment) can be programmed while the maxi-

mum increment programmable is the maximum output frequency of 80 099 999. 999 Hz. Trying to program an increment greater than the maximum results in a flashing display indicating an illegal entry. To change the output frequency by the programmed increment, the INCR keys are activated incrementing the frequency either up or down. A description of the keys and frequency step display indicators follows.

KEYS:

FREQ INCR Key. Preface key for entering frequency increment. When pressed, the front panel displays the present frequency increment and the controller is enabled to accept new frequency increment data.

DATA Keys. Used to enter the desired frequency increment.

DATA ENTRY Keys. Used to finalize the frequency increment entry. If an increment is programmed that exceeds the maximum, the display flashes indicating an illegal entry.

INCR Keys. These keys are used to change the output frequency by the programmed increment. The frequency can be incremented either up or down dependent upon the INCR key activated. If an INCR key is held activated, the frequency continues to be incremented providing a step frequency sweep. The magnitude of each step is determined by the frequency increment programmed.

DISPLAY INDICATORS:

FREQUENCY INCR Indicator. Indicates the front panel is displaying the present frequency increment or a frequency increment entry.

ENTRY INDICATOR. Indicates the display holds a frequency increment entry not yet finalized by a data entry key.

The numeric display indicates the frequency increment programmed. Can be displayed in kHz or MHz by pressing the desired range key.

Example:

Program a frequency increment of 12500 Hz.

Display Result: 12 500. 0 Hz

Display present frequency by pressing FREQUENCY FUNCTION key.

Display Result: Present frequency is displayed.

NOTE

This step can be omitted and the frequency incremented by pressing an INCR key even though FREQ INCR is displayed.

Increment the frequency by pressing the INCR down arrow.

Display Result: Present frequency is decreased by 12 500.0 Hz

Return to initial frequency by pressing the INCR up arrow.

Display Result: Initial frequency is displayed.

NOTE

If the front panel is displaying frequency increment, it is not necessary to preface a frequency increment entry with the FREQ INCR key.

3-30. Amplitude Entry.

3-31. The 3335A Amplitude limits are determined by the output impedance selected. In the standard instrument a 50 ohm or 75 ohm output impedance can be chosen. With a 50 ohm output, the amplitude range is - 86.98 dBm to + 13.01 dBm. For a 75 ohm output, the amplitude range is - 88.74 dBm to + 11.25 dBm. Any amplitude within the range can be programmed with 0.01 dBm resolution. For option 002, 003 or 004 instrument amplitude ranges, refer to Table 1-2, General Information.

3-32. The desired output amplitude is programmed by activating the AMPLITUDE FUNCTION key, DATA keys 0 through 9 and a DATA ENTRY key - dBm or + dBm. A description of these keys and the amplitude display indicators follows:

KEYS:

AMPLITUDE Key. Preface key for entering amplitude. When pressed, the display indicates the present output amplitude and the controller is enabled to accept new amplitude data.

DATA Keys. These keys are used to enter the desired amplitude.

DATA ENTRY Keys. Used to finalize the amplitude entry. If an amplitude is programmed which exceeds the range of the instrument, the output amplitude does not change and the display flashes.

DISPLAY INDICATORS:

AMPLITUDE Indicator. Indicates the front panel is displaying the present output amplitude or an amplitude entry.

ENTRY Indicator. Indicates the display holds an amplitude entry not yet finalized by a data entry key.

The numeric display indicates the amplitude programmed.

Example:

Program an amplitude of - 23.45 dBm.

Display Result: - 23.45 dBm

NOTE

1. It is normal to hear relay operation when the attenuator changes attenuator pads.

2. If the front panel is displaying amplitude, it is not necessary to preface and amplitude entry with the AMPLITUDE key.

3. With a negative amplitude displayed, depressing the BACK SPACE key will cause an ENTRY preceded by a negative sign. With this type of amplitude entry displayed, the "–dBm" and "+dBm" entry keys will both finalize a negative amplitude.

3-33. Amplitude Increment Entry.

3-34. Amplitude increment is used when it is desired to manually change the amplitude by specific increments. The desired amplitude increment is programmed by activating the AMPTD INCR FUNCTION key, DATA keys 0 through 9 and a DATA ENTRY key, - dBm or + dBm. If an amplitude increment greater than 99.99 dBm is programmed, the display flashes indicating an illegal entry. A description of the keys and amplitude increment display indicators follows.

KEYS:

AMPTD INCR Key. Preface key for entering amplitude increment. When pressed, the front panel displays the present amplitude increment and the controller is enabled to accept new amplitude increment data.

DATA Keys. These keys are used to enter the desired amplitude increment.

DATA ENTRY Keys. Used to finalize the amplitude increment entry. If an increment is programmed that exceeds the maximum, the display flashes indicating an illegal entry.

INCR Keys. These keys are used to change the output amplitude by the programmed increment. By holding an INCR key activated, the amplitude can be stepped through an amplitude sweep.

DISPLAY INDICATORS:

AMPLITUDE INCR Indicator. Indicates the front panel is displaying the present amplitude increment or an amplitude increment entry.

ENTRY Indicator. Indicates the display holds an amplitude increment entry not yet finalized by a data entry key. The numeric display indicates the amplitude increment programmed.

NOTE

Amplitude increment is actually in dB but the dBm annunciator is used.

Example:

Program an amplitude increment of + 2.75 dBm.

Display Result: 2.75 dBm

Display present amplitude, press AMPLITUDE FUNCTION key.

Display Result: Present Amplitude display

Increment amplitude by pressing the INCR up arrow.

Display Result: Present amplitude is incremented by 2.75 dBm.

3-35. Phase Increment Entry.

3-36. The phase increment can be used to change the output phase relationship with respect to another signal by a fixed phase increment. As an example, the 10 MHz rear panel output and the front panel output signal have a certain phase difference at turn-on. By phase incrementing the output, the output signal will increase or decrease the initial phase difference by the magnitude of the phase increment programmed. An example of using the phase increment function is illustrated in the integrated phase noise test of Section V. The desired phase increment is programmed by activating the Ø INCR FUNCTION key, DATA keys 0 through 9 and the deg DATA ENTRY key. An increment range of 0 degree to 360 degrees is obtainable with a resolution of 0.1 degree. Any increment attempted greater than 360 degrees causes the display to flash indicating an illegal entry. A description of the keys and the Ø and Ø increment displays follows.

KEYS:

Ø INCR Key. Preface key for entering phase increment. When pressed, the front panel displays the present phase increment and the controller is enabled to accept new phase increment data.

DATA Keys. These keys are used to enter the desired phase increment.

DATA ENTRY Key. Used to initialize the phase increment entry. If an increment is entered exceeding 360 degrees, the display flashes when the ENTRY key is pressed.

DISPLAY INDICATORS:

Ø INCR Indicator. Indicates the front panel is displaying the present phase increment or a phase increment entry.

Ø Indicator. Indicates the phase difference introduced with respect to the initial phase of the present frequency. This indicator appears when an INCR key is pressed when Ø INCR is displayed.

ENTRY Indicator. Indicates the display holds a phase increment entry not yet finalized by a data entry key.

The display indicates the phase increment programmed.

Example:

Program a phase increment of 45.0 degrees.

Display Result: 45.0 deg

Press the INCR up arrow two (2) times.

Display Result: Display annunciator shows Ø and display shows 90.0 deg.

NOTE

If an INCR key is held, the output is phase incremented continuously.

3-37. Phase/Phase Increment Displays.

3-38. When the display indicates the Ø difference introduced by the phase increment and a new phase increment entry is made which is not prefaced by the Ø INCR key, the display automatically reverts to a Ø INCR display. The entry can be finalized like any other phase increment entry. Therefore, if the display is indicating phase, a phase increment entry need not be prefaced by the Ø INCR key.

3-39. Preset Entries.

3-40. All operating parameters of the FUNCTION group can be stored in one of ten PRESET registers. The ten registers are numbered 0 through 9 and are capable of storing ten different sets of the operating parameter's frequency, amplitude, frequency increment, amplitude increment, phase increment and sweep width. At turn-on, all registers contain the turn-on operating parameters. The PRESET keys which control the registers are STORE, DISPLAY and RECALL. A description of the PRESET keys follows.

KEYS:

STORE Key. Used to store the operating parameters of the front panel output. The digit key of the register to store the parameters must be pressed following the STORE key. This stores the operating parameters frequency, amplitude, frequency increment, amplitude increment, phase increment, sweep width, and the state of the manual tune control without affecting the output signal.

RECALL Key. Used to recall the operating parameters of a particular register. The digit key of the register containing the operating parameters desired must be pressed following the RECALL key. This changes the amplitude and frequency of the output signal to that stored in the register. It also changes all other FUNCTION parameters to that stored in the register (e.g., AMPTD INCR, FREQ INCR, Ø INCR and SWEEP WIDTH).

DISPLAY keys. Used to display a particular operating parameter stored in a register. Displaying a parameter does not change the output signal but is displayed as an entry. This entry can be finalized by pressing a DATA ENTRY key.

Example.

Preset the following operating parameters in storage register 2.

FREQUENCY	2 MHz
AMPLITUDE	2 dBm
FREQ INCR	200 Hz
AMPTD INCR	0.2 dBm
Ø INCR	2 degrees
SWEEP WIDTH	2 kHz

Preset the following operating parameters in storage register 3.

FREQUENCY	3 MHz
AMPLITUDE	3 dBm
FREQ INCR	300 Hz
AMPTD INCR	0.3 dBm
Ø INCR	3 deg
SWEEP WIDTH	3 kHz

First program all parameters; then press STORE 2.

NOTE

In the examples for STORE 2 and STORE 3, different parameters are displayed when the STORE key is pressed to preset the register. SWEEP WIDTH is displayed when STORE 2 is pressed. ϕ INCR is displayed when STORE 3 is displayed. In the next two examples, the RECALL function is illustrated. When data is recalled from a preset register, the parameter displayed when that register was preset is the parameter returned to the display. In the case of RECALL 2, SWEEP WIDTH will be returned to the display. All other parameters will be changed to that preset in register 2. For the RECALL 3 case, ϕ INCR will be returned to the display. All other parameters will be changed to that preset in register 3.

Recall parameters of register 2 by pressing RECALL 2.

Result: Display indicates SWEEP WIDTH of 2.0 kHz. When this set of parameters was stored, SWEEP WIDTH was last displayed. When recalled, the parameter last displayed at STORE is returned to the display.

Check the other operating parameters in register 2 by pressing their respective FUNCTION key. The display should indicate the quantities previously programmed.

Recall the operating parameters of register 3 by pressing RECALL 3.

Result: Display indicates Ø INCR of 3.0 deg (Ø INCR was the parameter displayed when STORE 3 was initiated).

Check other operating parameters in register 3 as previously done for register 2.

Display the frequency of register 2 without changing the output frequency by pressing DISPLAY, FREQUENCY, 2.

Display Result: FREQUENCY 2 000 000. 0 ENTRY (This frequency can be initiated by activating a DATA ENTRY key.)

Initiate by pressing the Hz DATA ENTRY key.

Display result: 2 000 000. 0 Hz

Recall the operating parameters of register 4 by pressing RECALL 4.

Result: FREQUENCY 1 000 000. 0 Hz (This is an initial turn-on condition. The other operating parameters stored in register 4 are also initial conditions. When a register containing initial conditions is recalled, FREQUENCY is displayed.)

3-41. Merging Data Into a Preset Register.

3-42. Any operating parameter stored in a PRESET register can be changed by merging the new parameter into the register without changing the other parameters of the stored sets. This allows the user to change a parameter in a PRESET register and only be concerned with the parameter being changed. Merging a parameter is done much like storing a complete parameter set as described in the preceding paragraph. The difference is the function key, corresponding to the parameter to be merged, is pressed prior to the register number key. Several examples of merging data follow.

EXAMPLE:

Recall from the previous examples that all parameters in PRESET register 2 contain two's and those in PRESET register 3 contain three's.

Change the frequency in PRESET register 2 to 4 MHz and the amplitude increment of register 3 to 0.6 dBm by pressing FREQUENCY, 4 MHz, STORE, FREQUENCY, 2 an and AMPTD INCR, 0.6, + dBm, STORE AMPTD INCR, 3.

Verify these parameters have been merged by displaying each parameter after recalling registers 2 and 3.

3-43. Recalling Data From a Preset Register.

3-44. Any operating parameter stored in a PRESET register can be recalled individually without recalling the entire parameter set. This allows the user to change an output parameter by recalling only that parameter from one of the ten PRESET registers. This is done like the merging of data. The function key, corresponding to the parameter to be recalled, is pressed prior to the register number key. Several examples of recalling a single parameter follow.

EXAMPLE:

Press RECALL 5.

Display Result: Display indicates a frequency of 1 MHz and all operating parameters are initial conditions.

Recall the frequency increment of PRESET register 2 by pressing RECALL, FREQ INCR, 2.

Display Result: Display indicates a frequency increment of 200 Hz. All other parameters are still initial conditions.

Recall the amplitude of PRESET register 3 by pressing RECALL, AMPLITUDE, 3.

Display Result: Display indicates amplitude of + 3 dBm. All other parameters except frequency increment are initial conditions. Frequency increment is 200 Hz.

3-45. Display Last Entry.

3-46. The DISPLAY LAST ENTRY KEY of the FUNCTION group is used to recall to the display the last entry made. It will not recall the function the entry was made in but only the digits. If an operating parameter from one of the ten storage registers is displayed as an entry by activating the DISPLAY key of the PRESET FUNCTION keys, it becomes the last entry. Conversely, when the CLEAR key is pressed, the display shows an entry of zero but this does not constitute a last entry. This is because a display entry cleared in error can be recalled by pressing the DISPLAY LAST ENTRY key.

3-47. Sweep Width Entry.

3-48. In the sweep mode, the 3335A frequency can be swept over a specific range. The operating frequency before the sweep mode is the center frequency of the sweep. The starting point of the sweep is determined by the sweep width programmed. Half the sweep occurs below the center frequency and half above the center frequency. The sweep width is programmed by activating the SWEEP WIDTH FUNCTION key, DATA keys 0 through 9 and a DATA ENTRY key Hz, kHz or MHz. Programming a sweep width greater than the instrument's capability causes the display to flash indicating an illegal sweep. A description of the keys and the sweep width display indicators follows.

KEYS:

SWEEP WIDTH Key. Preface key for entering sweep width. When pressed the front panel displays the present sweep width and the controller is enabled to accept new sweep width data.

DATA Keys. These keys are used to enter the desired sweep width.

DATA ENTRY Keys. Used to finalize the sweep width entry.

DISPLAY INDICATORS:

SWEEP WIDTH Indicator. Indicates the front panel is displaying the present sweep width or a sweep width entry.

ENTRY Indicator. Indicates the display holds a sweep width entry not yet finalized by a data entry key.

The numeric display indicates the sweep width programmed.

Example:

Program a sweep width of 580.34 kHz

Display Result: 580.34 kHz.

3-49. Manual Frequency Tune.

3-50. The frequency can be manually altered in the manual tune mode. The frequency change is controlled by a front panel frequency knob. The 3335A can be put in the manual tune mode by the MANUAL TUNE ON/OFF key. When the manual tune key is activated, an annunciator above the key is illuminated.

3-51. In addition to the ON/OFF key, the MANUAL TUNE controls include two digit keys, a left arrow and a right arrow. These keys are used to select the sensitivity of the manual tune knob. When the manual tune mode is first activated, the fourth digit from the right flashes. The frequency can be changed with the sensitivity of the flashing digit by turning the frequency knob. For more or less sensitivity, the flashing digit can be moved using the left and right digit arrows. Holding an arrow key down causes the flashing digit to step successively to the end digit. When in the MANUAL TUNE mode, the frequency can be incremented by the frequency increment using the INCR keys and all operating parameters can be checked using the FUNCTION keys. A description of the MANUAL TUNE controls follows.

KEYS:

MANUAL TUNE ON/OFF. This key activates the manual tune mode. When on, an annunciator above the key is illuminated.

LEFT ARROW Digit Key. Steps flashing digit to the left.

RIGHT ARROW Digit Key. Steps flashing digit to the right.

Frequency manual tune knob. Used to change the frequency with the sensitivity of the flashing digit.

3-52. Sweep Mode.

3-53. The sweep mode can be used to sweep the output frequency over a specified center frequency. This mode of operation is controlled by the FREQUENCY SWEEP keys which include GO TO START FREQ, START SINGLE 10 SEC, START SINGLE 50 SEC, MANUAL, START AUTO and STOP. A SWEEP OUTPUT connector below the keys provides an output proportional to the sweep frequency for use with a plotter. The frequencies of a frequency sweep are determined by the sweep width and center frequency. The sweep rate in AUTO is approximately 8 sweeps/second, 100 steps/sweep. In MANUAL, 10 SEC and 50 SEC sweeps, the sweep contains 1000 steps.

NOTE

Whenever the -hp- 3335 sweeps through either 20 MHz or 40 MHz, the amplitude of the output will drop severely for approximately 5 msec. Other, much less drastic amplitude discontinuities may be observed. When the instrument sweeps through 10 MHz, 14 MHz, 28 MHz and 56 MHz.

KEYS:

GO TO START FREQ Key. This key is used to display and output the starting frequency of the sweep. The starting frequency is determined by the center frequency and the sweep width. Half the sweep, determined by the sweep width, is below the center frequency establishing the start frequency.

START SINGLE 10 SEC Key. This key is used to initiate a single sweep beginning at the start frequency below the center frequency. The time for the sweep to go from start to finish is approximately 10 seconds and consists of 1000 steps. When the sweep is in this mode, an annunciator above the key is illuminated. The sweep rate can be changed during the sweep by pressing the 50 SEC key or can be stopped by pressing the STOP key. Pressing the AUTO key will put the sweep into auto sweep. During any sweep, depressing a key outside the frequency sweep group has no effect on operation.

START SINGLE 50 SEC Key. This key is used to initiate a single sweep which requires approximately 50 seconds to complete and consists of 1000 steps.

START AUTO Key. This key is used to initiate the sweep which sweeps continuously from the start frequency to the upper limit. The sweep resets to the start frequency when the upper limit is reached and again sweeps up in frequency at a rate of approximately 8 sweeps/second and 100 steps/sweep. The frequency is only swept in the increasing frequency direction in both the single sweep or auto sweep modes. When the instrument is in the auto sweep mode, the display is blank except for the SWEEPING annunciator. The STOP key must be used to exit an auto sweep.

MANUAL key. This key is used to put the sweep into a manual sweep mode. When activated, an annunciator is illuminated to the left of the MANUAL key. The frequency sweep between the start frequency and upper limit can be manually controlled by the frequency knob making 1000 steps between the two limits. When either the upper limit or start frequency is reached, the manual sweep stops. When the frequency knob is rotated changing the frequency, the display segments and annunciators may dim slightly.

STOP Key. This key is used to stop a single sweep before it is complete or to halt an auto sweep and return to keyboard control. When pressed the frequency is returned to the center frequency which was the frequency of operation prior to activating the sweep mode.

SWEEP OUTPUT: The sweep output provides a dc voltage from 0 to + 2 V. 0 V dc corresponds to the start frequency of the sweep and + 2 V the upper limit. During the sweep the output is proportional to the frequency and can be used to drive the horizontal axis of a plotter or an oscilloscope. When the instrument is not in the sweep mode, the SWEEP OUTPUT is + 1 V dc. When GO TO START FREQ is pressed, the instrument displays the start frequency of the sweep and the SWEEP OUTPUT is 0 V. After a single sweep is complete and the upper limit is displayed, the SWEEP OUTPUT is + 2 V dc. These points can be used to adjust the plotter end points.

DISPLAY INDICATORS:

NOTE

In any sweep mode, the frequency display is in hertz.

CENTER FREQUENCY Indicator. Indicates the front panel is displaying the center frequency of the sweep. When the frequency passes through the center frequency during a sweep, the CENTER annunciator flashes.

SWEEPING Indicator. Indicates the instrument is in the SWEEP mode. If the instrument is not in an active single sweep or in auto sweep (i.e., if it is in manual, at start frequency or at the end of a single sweep), pressing any key on the keyboard out of the sweep group will take the instrument out of the sweep mode.

Example:

Program the Synthesizer to sweep a 500 kHz band centered on 12 500 kHz.

Program the center frequency by programming a frequency of 12 500 kHz.

Display Result: 12500.0 kHz

Program the sweep width by pressing SWEEP WIDTH, 500, kHz.

Display Result: 500.0 kHz

Check START FREQ by pressing GO TO START FREQ.

Display Result: 12 250 000.0 Hz SWEEPING annunciator on.

Initiate a single 10 second sweep by pressing START SINGLE 10 SEC key.

Display Result: Annunciator above key illuminates, display shows frequency sweep which stops at 12 750 000.0 Hz. Sweep time is 10 seconds.

Initiate single 50 second sweep by pressing START SINGLE 50 SEC key.

Display Result: Annunciator above key illuminates, display shows frequency sweep which stops at 12 750 000.0 Hz. Sweep time is 50 seconds.

Initiate an Auto Sweep by pressing START AUTO key.

Display Result: Display blanks except for SWEEPING annunciator. (Instrument is continuously sweeping from start frequency to the upper limit.)

Stop Auto Sweep by pressing STOP key.

Display Result: Instrument returns to the center frequency. Display indicates 12 500. 0 kHz, SWEEPING annunciator extinguishes.

Initiate MANUAL Sweep by pressing MANUAL key.

Display Result: SWEEPING annunciator illuminates again. Annunciator next to MANUAL key illuminates.

Manually Sweep Frequency: Rotate frequency knob.

Display Result: Frequency increases and decreases with CW and CCW rotation of knob. CENTER annunciator flashes when sweep passes through 12 500. 0 kHz (the center frequency).

Press GO TO START FREQ key.

Display Result: 12 250. 0 kHz

Press MANUAL key of SWEEP group.

Display Result: No change in display.

Rotate frequency knob CW.

Display Result: Frequency increases.

Rotate frequency knob CCW.

Display Result: Frequency decreases until 12 250. 0 kHz (start frequency) is reached. Further CCW rotation of knob will not lower the frequency.

NOTE

The same result occurs at the upper limit of the sweep.

Return the instrument to full keyboard control by pressing the STOP key. This will result in returning to the center frequency.

NOTE

The single sweep speed of a sweep in progress can be changed by depressing the other single sweep key. To go from the single sweep mode to the auto sweep mode, it is recommended the STOP key be used to terminate the single sweep prior to activating the auto sweep mode.

3-54. HP-IB Indicators and LOCAL key.

3-55. The keyboard contains two HP-IB annunciators—REMOTE and ADDRESSED. One indicates when the 3335A is under remote control; the other indicates when the 3335A is addressed to listen by the HP-IB controller.

If the 3335A is under remote control, it can be returned to local control (control by keyboard inputs) by activating the LOCAL key providing a local lockout command has not been sent by the HP-IB system controller.

3-56. Front Panel Output Connectors.

CAUTION

The output of the -hp- 3335A is directly coupled. Do not allow external dc currents to develop more than 5 volts across the output terminals. For Option 002/004 and Option 003 the dc voltage across the output should not be greater than 10 volts.

3-57. The front panel contains the instrument output connectors located in the right-most group labeled OUTPUT and the SWEEP OUTPUT located in the FREQUENCY group. The output connectors provide the programmed output. The SWEEP OUTPUT provides a dc voltage between 0 and + 2 V proportional to the sweep when the Synthesizer is in the sweep mode. When not in the sweep mode the SWEEP OUTPUT is + 1 V. During the sweep, the SWEEP OUTPUT is proportional to the frequency and can be used to drive the horizontal sweep of a plctte: or an oscilloscope.

3-58. Rear Panel BNC Connectors.

3-59. 40/N Input. This is the input for the reference frequency that essentially determines the frequency accuracy and stability of the -hp- 3335A. As the name of the input suggests, the reference frequency must be an integral sub multiple of 40 MHz (i.e., 40, 20, 13.333, 10, etc.). The 40 MHz master oscillator in the -hp- 3335A is phase locked to this signal. Lock will occur with 40/N INPUT levels as low as -7 dBm. When an external frequency reference is not used, the 10 MHz REFerence OVEN OUTPUT is coupled to this input with the BNC-to-BNC adapter.

3-60. 10 MHz REFerence OVEN OUTPUT. This is a reference frequency that is coupled to the 40/N INPUT whenever an external frequency reference is not used. When it is used, its accuracy and stability determine the accuracy and stability of the -hp- 3335A output frequency. The parameters of this output are described in Table 1-1. They depend on the Option selected.

3-61. 10 MHz OUTPUT. This output is used to lock the phase of other synthesizers to the phase of the -hp- 3335A. Its output level and output impedance are typically around 0 dBm and 50 ohms.

3-62. EXTernal LEVEL INPUT. This input is selected using the INTERNAL LEVEL/EXT LEVEL INPUT switch located on the rear panel. When it is selected, the dc level on this input determines the output amplitude. The sensitivity is non-linear, however, it is typically about .5 V rms output per dc volt input. With 0 volts dc on this input, the maximum output amplitude of the -hp- 3335A is nominally .5 volts rms into 50 ohms (or 75 ohms). An "UN–LEVELED" annunciator on the front panel will light whenever this input is selected.

3-63. Remote Programming.

3-64. This part of Section III contains a brief description of the HP–IB operation and includes programming information for operating the Model 3335A on the HP–IB. It also includes information on the HP–IB connector, HP–IB logic levels and programming codes.

3-65. The HP–IB. The HP–IB is a carefully defined instrumentation interface which simplifies the integration of instruments, calculators and computers into systems. The 3335A is a fully programmable instrument interfacing with the HP–IB by means of a rear panel HP–IB connector (see Figure 3-1). The HP–IB connector is directly compatible with the mating connectors on the -hp- 10631 (A, B or C) HP–IB Cable Assemblies.

3-66. HP–IB Logic Levels. The 3335A HP–IB lines use standard TTL levels and are low-true. The logic levels are:

Low = digital ground or 0 V to +0.4 V dc
High = open or +2.5 V dc to +5 V dc

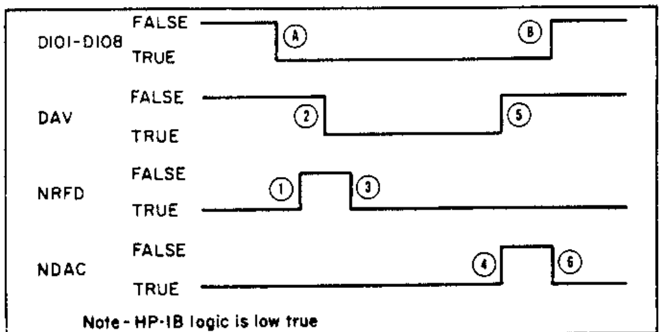
3-67. Isolation. The 3335A is located from the HP–IB by optical couplers. The components located on the HP–IB side of the optical couplers are powered by a separate + 5 V power supply deriving power from an ungrounded secondary transformer winding. This provides isolation of the instrument from the bus.

3-68. Capability. The capability of a device connected to the HP–IB is specified by its interface functions. The interface functions of the 3335A are listed in Table 3-2 and indicate the particular capability of that function as defined in Appendix C of IEEE Std 488-1975. The interface functions indicate what activity a device will respond to or that which it is capable of initiating. Each item indicating a device capability appears on the rear panel next to the HP–IB connector.

3-69. The instrument will recognize a preset "listen" address and accept bit-parallel, word (byte)-serial ASCII-coded data. All data is received through the Data Input/Output (DIO) lines of the HP–IB. The data transfer is controlled by "handshake" lines DAV, NRFD and NDAC. Figure 3-2 illustrates the "handshake" sequence of events and describes each event during the transfer of data. More detailed information is obtainable by ordering a copy of "Condensed Description of the Hewlett-Packard Interface Bus", -hp- Part No. 59401-90030, Microfiche Part No. 59401-90090.

Table 3-2. Interface Functions.

Identification	Description
SH0	No source handshake capability
AH1	Acceptor handshake capability
T0	No talker capability
L2	Basic listener
SR0	No service request capability
RL1	Remote/Local capability
PP0	No parallel poll capability
DC1	Device clear capability
DT0	No device trigger capability
C0	No controller capability



Event	Comment
(A) and (B)	The interval between A and B indicates when one byte of information is on the data lines, DIO1 through DIO8. **NOTE** *For the remainder of this explanation,, the term "data" refers to one byte of information (one seven-bit ASCII character).*
(1) NRFD goes false	Listener indicates he is ready to receive data.
(2) DAV goes true	Source recognizes listener is ready for data, places a new character on theDIO lines and indicates to the listener the data on the DIO lines is valid.
(3) NRFD goes true	Listener recognizes the data is valid and indicates to the source he is not ready for any new data. The listener accepts the data on the DIO lines to store internally after NRFD goes true.
(4) NDAC goes false	The listener indicates to the source that he has stored internally the data on the DIO lines. When the data is stored, internal processing begins.
(5) DAV goes false	Source recognizes that the listener has accepted and stored internally the data on the DIO lines. Source removes the data valid indication by setting DAV false in preparation for placing the next byte of information on the DIO lines.
(6) NDAC goes true	Listener recognizes that the source has acknowledged its acceptance of the data and removes the data accepted indication. Listener continues to process the internally stored data.
(1) NRFD goes false	When the listener completes processing the internally stored data, the. listener sets NRFD false which indicates he is ready to receive the next byte of information.

NOTE: Events (1) through (6) must occur for each byte of information transferred between devices on the HP-IB.

Figure 3-2. HP-IB "Handshake" Sequence of Events.

Table 3-3. Bus Messages.

Function	Message	Description
Device Communications	Data	Transfers device-dependent information from one device to one or more devices on the Bus.
Device Control	Trigger	Causes a group of selected devices to simultaneously initiate a set of device-dependent actions.
	Clear	Causes an instrument to be set to a predefined state (a certain range, function, etc.).
	Remote	Permits selected devices to be set to remote operation, allowing parameters and device characteristics to be controlled by Bus Messages.
	Local	Causes selected devices to return to local (front panel) operation.
	Local Lockout	Disables local (front panel) controls of selected devices.
	Clear Lockout & Local	Returns all devices to local (front panel) control and simultaneously clears the Local Lockout Message.
Interrupt and Device Status	Require Service	Indicates a device's need for interaction with the controller.
	Status Byte	Presents status information of a particular device; one bit indicates whether or not the device currently requires service, the other 7 bits (optional) are used to indicate the type of service required.
	Status Bit	A single bit of device-dependent status information which may be logically combined with status bit information from other devices by the controller.
Passing Control	Pass Control	Passes bus controller responsibilities from the current controller to a device which can assume the Bus supervisory role.
Bail Out	Abort	Unconditionally terminates Bus communications and returns control to the system controller.

3-70. Messages are the means by which devices communicate on the HP–IB. Table 3-3 lists the Bus Messages by Bus function and provides a description of each.

3-71. HP–IB Remote Operation.

3-72. The HP–IB Remote Enable (REN) line controls the instrument's mode of operation, LOCAL or REMOTE. With no input on the REN line, it is held high by an internal pullup maintaining the 3335A in the LOCAL mode of operation. When the 3335A listen address is transmitted, the REN line is pulled low causing it to go into the remote control mode. The REN lines does not have internal storage and must be held in the low state as long as remote operation is required. Once the 3335A has been put into the

REMOTE mode of operation, it can be unaddressed, and it will remain in REMOTE operation until the REN line is released or the LOCAL key is pressed.

3.73. When the REN line is low and the 3335A is addressed, the instrument goes into the REMOTE mode and the following things take place.

a. The front panel REMOTE annunciator lights.

b. The front panel controls (except POWER and the impedance switch) are disabled. When addressed to listen, the 3335A will accept REMOTE instructions.

c. The output parameters established by keyboard control in the LOCAL mode are retained in the REMOTE mode until remotely changed.

3-74. When the HP-IB system controller releases the REN line, the following things take place:

a. The front panel REMOTE annunciator goes out and the 3335A output parameters remain as last programmed in the REMOTE mode of operation.

b. The 3335A will no longer respond to remote instructions. It will respond to its listen address and the unlisten command.

3-75. Addressing to Listen. All instruments using the HP-IB share a common set of data and control lines because they are connected in parallel. Since the system controller must be able to communicate with individual instruments on the bus, each instrument is given a unique address. The address is a 7-bit ASCII character (byte) which a given instrument recognizes and responds to.

3-76. When addressing instruments, the system controller pulls the ATN line low to get the attention of all instruments on the bus. It then gives the ASCII coded address for one of the instruments on the bus. When the addressed instrument acknowledges receipt of the address by the "handshake" sequence, the controller clears the address code and addresses another instrument if more than one is to receive the same data. When the last addressed instrument acknowledges receipt of its address, the controller releases the ATN line and clears the last address code. With the ATN line released, the HP-IB is in the data mode. The addressed instruments respond by accepting data placed on the bus using the "handshake" sequence. This data programs the functions of the instruments.

3-77. The 3335A functions only as a listener on the HP-IB. It accepts instructions from the controller and responds by establishing the output parameters programmed. The 3335A can be addressed (or unaddressed) in either the LOCAL or REMOTE control mode. Note that the 3335A will not go to Remote unless it is addressed to listen *and* the REN line is low.

3-78. Changing the Listen Address. The 3335A is shipped from the factory with a listen address of ASCII character $ (octal code 044). This address can be changed by changing the positions of the rear panel listen address switches 1 through 5 which control address lines A1 through A5. Table 3-4 lists the listen addresses obtainable and the switch positions required to set each address. The addresses are provided in ASCII, Octal, Decimal and Hexadecimal codes. The upper position of the switch corresponds to "1", the lower position to "0". These positions correspond to the one's and zero's of Table 3-4. When changing the listen address, verify that the new address does not conflict with that of another instrument on the bus.

Table 3-4. Listen Addresses.

HP-IB Instrument Listen Address Switches 5 4 3 2 1	Instrument Listen Address ASCII	Octal	Decimal	Hex
0 0 0 0 0	SP	040	32	20
0 0 0 0 1	!	041	33	21
0 0 0 1 0	"	042	34	22
0 0 0 1 1	#	043	35	23
0 0 1 0 0	$	044	36	24
0 0 1 0 1	%	045	37	25
0 0 1 1 0	%	046	38	26
0 0 1 1 1	'	047	39	27
0 1 0 0 0	(	050	40	28
0 1 0 0 1	)	051	41	29
0 1 0 1 0	*	052	42	2A
0 1 0 1 1	+	053	43	2B
0 1 1 0 0	,	054	44	2C
0 1 1 0 1	—	055	45	2D
0 1 1 1 0	.	056	46	2E
0 1 1 1 1	/	057	47	2F
1 0 0 0 0	Ø	060	48	30
1 0 0 0 1	1	061	49	31
1 0 0 1 0	2	062	50	32
1 0 0 1 1	3	063	51	33
1 0 1 0 0	4	064	52	34
1 0 1 0 1	5	065	53	35
1 0 1 1 0	6	066	54	36
1 0 1 1 1	7	067	55	37
1 1 0 0 0	8	070	56	38
1 1 0 0 1	9	071	57	39
1 1 0 1 0	:	072	58	3A
1 1 0 1 1	;	073	59	3B
1 1 1 0 0	<	074	60	3C
1 1 1 0 1	=	075	61	3D
1 1 1 1 0	>	076	62	3E

3-79. Unaddressing. Once the 3335A is addressed to listen, it will remain addressed until it is "unaddressed" or cleared by the system controller. There are several ways to clear an address:

a. By giving the "Unlisten" comand (UNL, 077 Octal, ASCII "?") this command must be given in the HP-IB command mode (ATN line low).

b. By pulling the IFC (Interface Clear) line low. This asynchronously clears all instruments on the bus.

c. By giving the "GO TO LOCAL" command (GTL, 001 Octal, ASCII "SOH").

d. By turning the instrument off.

3-80. HP-IB Bus Commands. The Bus Commands are divided into three categories:

a. Unaddress Commands (UNL and UNT)
b. Universal Commands (LLO, DCL, SPE, etc.)
c. Addressed Commands (SDC, GTL, GET, etc.)

The 3335A will not respond to all of the bus commands. Its operation is unaffected by a command it does not recognize. The commands it will respond to are UNL (Unlisten), LLO (Local Lockout), DCL (Device Clear), SDC (Selective Device Clear) and GTL (Go To Local). Each of these commands is listed above following its respective command category.

3-81. PROGRAMMING.

3-82. Programming of the 3335A functions is by means of data messages sent by the system controller over the HP-IB.

Table 3-5. Programming Codes.

KEY	ASCII Character	Octal Code	Decimal Code	Hexadecimal Code
STORE	S	123	83	53
RECALL	R	122	82	52
FREQUENCY	F	106	70	46
FREQ INCR	I	111	73	49
AMPLITUDE	A	101	65	41
AMPTD INCR	I	111	73	49
Ø INCR	P	120	80	50
SWEEP WIDTH	W	127	87	57
DISPLAY LAST ENTRY	L	114	76	4C
0	0	060	48	30
1	1	061	49	31
2	2	062	50	32
3	3	063	51	33
4	4	064	52	34
5	5	065	53	35
6	6	066	54	36
7	7	067	55	37
8	8	070	56	38
9	9	071	57	39
		056	46	2E
BACK SPACE	B	102	66	42
CLEAR	C	103	67	43
MHz/–dBm	M	115	77	4D
kHz/+dBm	K	113	75	4B
Hz/deg	H	110	72	48
INCR ↑	U	125	85	55
INCR ↓	D	104	68	44
GOTO START FREQ	G	107	71	47
START 10 SEC SINGLE	X	130	88	58
START 50 SEC SINGLE	Y	131	89	59
START AUTO	Z	132	90	5A
STOP	Q	121	81	51
	–	055	45	2D
**See Paragraph 3-81	T	124	84	54

These messages are composed of two parts – the address command and the program information. The address command contains the "talk" and "listen" addresses of the devices involved, here the controller talk address and the 3335A listen address. The program information contains the codes of the 3335A keys to be programmed. Syntax of the address command portion of the data message is dependent on the controller used (see manual of the system controller). Syntax for the program information portion is comprised of the program codes listed in Table 3-5.

3-83. Each programming code is a single 7-bit word or "byte". Table 3-5 lists each front panel key that is programmable and lists the programming code by ASCII character and corresponding octal, decimal and hexidecimal equivalant. The last two entries of the table (– and T) are codes programmable but do not represent front panel keys. The "–" allows for ease in programming amplitudes since negative amplitudes can be preceded by the minus sign and all amplitudes finalized with the + dBm key (K) from the HP–IB. The character T is discussed in the following paragraph.

3-84. A special operating condition is obtainable by using the programming code ASCII character "T". This HP-IB command sets the attenuator to the straight-through position and the impedance to the 50 ohm mode. A change of amplitude cannot be programmed but the digits 1 through 7 will introduce the attenuator pad corresponding to the "AT" line associated with the programmed digit (i.e., programming the digit 4 causes the AT4 line to go low and introduce the 10 dB pad associated with line AT4). Programming a 0 sets the attenuator straight through again once a pad has been introduced. The digit 8 programs the 50 ohm output while the digit 9 programs the 75 ohm output. To return to normal amplitude control, the code C (CLEAR) must be programmed to exit the special operating condition. A summary of the "T" special operating codes and their function is shown in Table 3-6.

3-85. The 3335A will respond to programming codes only when it is addressed to listen in the remote mode. Front panel key instructions can be entered in any order desired by the programmer. The function key instruction must preface a data entry for that function. An entry instruction must follow the data to complete programming of the function changing that particular operating parameter. The key instruction sequence of a program is identical to the key activation sequence when operated manually. Examples of program data messages using a 9830A and 9825A calculator

3-86. Examples illustrating complete programs using a 9830A and 9825A calculator to program various parameters and functions of the 3335A are shown in Figure 3-4.

3-87. Programming the Increment Functions. Special attention to the programming of the amplitude, frequency and phase increment functions is required because the same instruction (ASCII character I) for increment is used. The increment parameter programmed depends on the instrument's operating function prior to the "I" instruction. If

the 3335A is in the frequency mode prior to the "I" instruction, FREQ INCR is programmed; if in the amplitude function prior to the "I" instruction AMPTD INCR is programmed; if in the phase mode, ϕ INCR is programmed. If the instrument is not in the frequency, amplitude or phase mode, an "I" instruction is ignored. To ensure the increment is properly programmed in either frequency or amplitude, it is recommended the increment instruction (I) be preceded by the amplitude or frequency function instruction (A or F).

NOTE

ϕ INCR can be programmed directly by the ASCII character P.

The instruction "PI" is legal but can be performed by just "P" to program ϕ INCR (see Table 3-5). The two left-most 9830A and 9825A examples in Figure 3-3 illustrate frequency programmed immediately preceding the increment instruction "I" and an "FI" instruction is not required.

Table 3-6. Special Attenuator Program Codes.

Code	AT7 40 dB	AT6 20 dB	AT5 20 dB	AT4 10 dB	AT3 4 dB	AT2 2 dB	AT1 2 dB	ATØ 50 Ω/75 Ω
T	1	1	1	1	1	1	1	1
Ø	1	1	1	1	1	1	1	**
1	1	1	1	1	1	1	Ø	**
2	1	1	1	1	1	Ø	1	**
3	1	1	1	1	Ø	1	1	**
4	1	1	1	Ø	1	1	1	**
5	1	1	Ø	1	1	1	1	**
6	1	Ø	1	1	1	1	1	**
7	Ø	1	1	1	1	1	1	**
8	**	**	**	**	**	**	**	1
9	**	**	**	**	**	**	**	Ø
C	RETURNS TO NORMAL AMPLITUDE OPERATION							

1 = Straight Through
Ø = Pad Introduced
** = Same As Previous State

Table 3-7. Attenuation Actuated, 50 Ohm Output Level.

Output Level (dBm)	Attenuation (dB)	Pads Actuated (dB)	Output Level (dBm)	Attenuation (dB)	Pads Actuated (dB)
+13.01	0	0	−36.99	50	20,20,10
+11.01	2	2	−38.99	52	20,20,10,2
+ 9.01	4	2,2	−40.99	54	20,20,10,2,2
+ 7.01	6	4,2	−42.99	56	20,20,10,4,2
+ 5.01	8	4,2,2	−44.99	58	20,20,10,4,2,2
+ 3.01	10	10	−46.99	60	40,20
+ 1.01	12	10,2	−48.99	62	40,20,2
− .99	14	10,2,2	−50.99	64	40,20,2,2
− 2.99	16	10,4,2	−52.99	66	40,20,4,2
− 4.99	18	10,4,2,2	−54.99	68	40,20,4,2,2
− 6.99	20	20	−56.99	70	40,20,10
− 8.99	22	20,2	−58.99	72	40,20,10,2
−10.99	24	20,2,2	−60.99	74	40,20,10,2,2
−12.99	26	20,4,2	−62.99	76	40,20,10,4,2
−14.99	28	40,4,2,2	−64.99	78	40,20,10,4,2,2
−16.99	30	20,10	−66.99	80	40,20,20
−18.99	32	20,10,2	−68.99	82	40,20,20,2
−20.99	34	20,10,2,2	−70.99	84	40,20,20,2,2
−22.99	36	20,10,4,2	−72.99	86	40,20,20,4,2
−24.99	38	20,10,4,2,2	−74.99	88	40,20,20,4,2,2
−26.99	40	20,20	−76.99	90	40,20,20,10
−28.99	42	20,20,2	−78.99	92	40,20,20,10,2
−30.99	44	20,20,2,2	−80.99	94	40,20,20,10,2,2
−32.99	46	20,20,4,2	−82.99	96	40,20,20,10,4,2
−34.99	48	20,20,4,2,2	−84.99	98	40,20,20,10,4,2,2

3-88. Programming Amplitude to Maximize Attenuator Life. The attenuator assembly of the 3335A introduces an attenuator pad by use of an electro-mechanical mechanism. As with any mechanical system, the more it is used, the greater the wear on the system. A programmer can minimize the mechanical wear on the 3335A attenuator by carefully selecting amplitudes which require minimum operation of the attenuator. Table 3-7 indicates the 50 ohm output level, the attenuation introduced by the attenuator and which pads are actuated to accomplish it. Note that the attenuator attenuates in 2 dB steps while amplitude changes from +.01 dB to +1.99 dB are realized electronically by the leveling loop circuit (A6 Assembly – Section VIII Service Group M). Programming amplitudes within the 1.99 dB capability of the leveling loop and/or selecting amplitudes that minimize pad actuations will increase attenuator life. Table 8-N-1 in Section VIII Service Group N provides a detailed indication of the attenuator pads selected for a particular programmed amplitude for both 50 ohm and 75 ohm output impedances.

3-89. Unaddressed or Local Operation When Connected To the HP-IB.

3-90. If the 3335A is connected to the HP-IB and operated locally or operated in remote but not addressed to listen, interruption of the display/keyboard scan and the sweep mode function can occur. The instrument is controlled by one microprocessor. The processor must service the instrument function and also handle the HP-IB lines. When the ATN line is true or when the 3335A is addressed to listen, microprocessor responds to every DAV handshake. As each data byte is placed on the bus, DAV is pulled true which activates the 3335A HP-IB interrupt request line (IRQ) to the controller section. This causes the controller to interrupt the scan and sweep operation and service the interrupt request before returning to local operation of the 3335A functions. If a long data string is sent on the HP-IB, a data byte rate can be achieved when the 3335A controller has only time to service the interrupt requests. At this point the 3335A controller cannot properly service the basic instrument. The following symptoms can occur; display completely or partially blanks, a keyboard entry is not recognized, sweep output is not linear, and the auto, single 10 or 50 second sweep in the sweep mode exceeds the time interval.

3-91. Telecommunications.

3-92. There is an amplitude blanking feature and a special sweep feature which make the -hp- 3335A especially suitable for applications in the telecommunications industry. These features are standard and appear on all instruments. On instruments equipped with Options 002, 003 or 004, the special sweep is switch selectable. Each feature is described separately in the paragraphs that follow.

NOTE

No instrument with a serial number below 1604A00376 is equipped with a TELECOMMUNICATIONS SWEEP Switch.

3-93. Amplitude Blanking. This feature causes the output amplitude to be blanked for 20 msec whenever a new frequency is entered or whenever the INCREMENT or DECREMENT controls are actuated. Since the amplitude is blanked, no signal will appear at the output during the time that the frequency is changing. This allows the instrument to be stepped from one channel to another without generating spurious signals that might interfere with operating channels. Amplitude Blanking is implemented by modifing the instrument internally. Only *qualified service personnel* can do the modification safely. *Hazardous voltages are exposed when the top cover is removed.* The procedure for implementing this feature is presented on the apron page of Figure 8-D-1 in Service Group D.

WARNING

Since access to the Amplitude Blanking Switch requires removal of the top cover, this feature should be implemented only by qualified service personnel. Hazardous voltage are exposed when the top cover is removed.

3-94. Telecommunications Sweep. This sweep is really a modification of the AUTO sweep. The amplitude is blanked for 20 msec after each step and the duration of each step is extended so that the time duration of the step plus the 20 msecs blanking equals 4 seconds. Since the AUTO sweep consists of 100 steps, the total sweep time is extended to 400 seconds or 6.7 minutes. Blanking the amplitude prevents the -hp- 3335A from outputting spurious signals while it is changing frequencies. The long time duration allows certain Selective Level Measuring Instruments to track the -hp- 3335A output frequency in an open loop test configuration (e.g. – see see Operating Manual for the -hp- 3745A/B Selective Level Measuring Set). If the output is displayed on an oscilloscope, a slight overshoot will be observed at the beginning of each frequency step. This is normal and will cause no problems in the tracking application for which this operating mode was designed. On instruments equipped with Options 002, 003 and 004, the communications sweep is implemented by moving the TRACK/ NORM switch, located on the rear panel, to the TRACK position. On standard instruments, it is implemented by modifying the instrument internally. Only *qualified service personnel* can do the modification safely. *Hazardous voltages are exposed when the top cover is removed.* The procedure for implementing this feature is presented on the apron page of Figure Group D.

<table><tr><td>

WARNING

Only qualified service personnel should implement the special sweep. Hazardous voltages are exposed when the top cover is removed.

</td><td>

NOTE

The single sweep operating modes should not be used while the telecommunications sweep is implemented. While the frequencies of the single sweeps are correct, the amplitude is higher than the level displayed and somewhat unpredictable.

</td></tr></table>

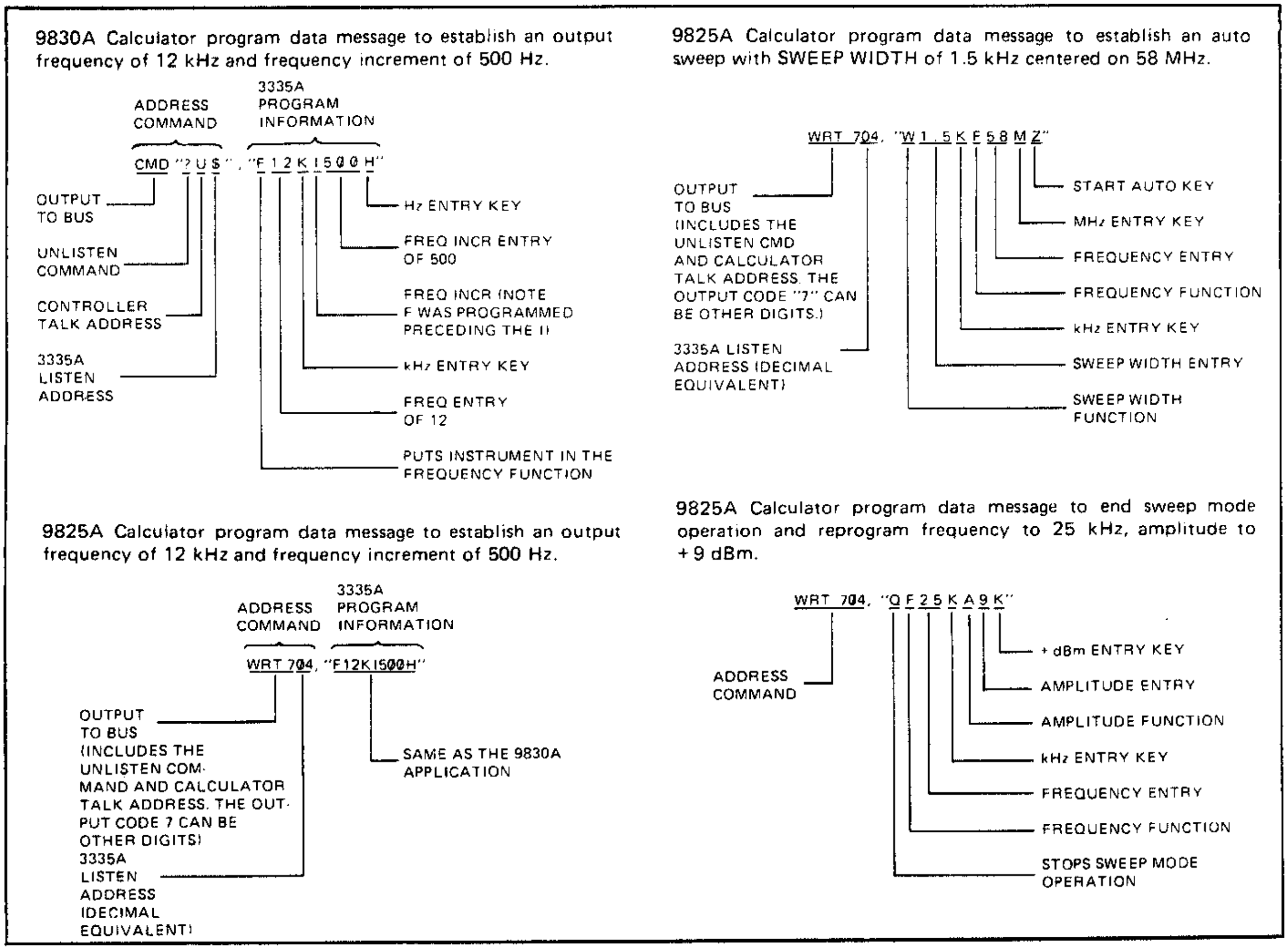


Figure 3-3. 9830A/9825A Program Data Messages.

EXAMPLE 1.

Programming a fixed frequency, e.g., 12.34 MHz:

9830A PROGRAM

```
10 FORMAT B
20 OUTPUT (13,10)768;
30 CMD "?U$","F12.34M"
40 OUTPUT (13,10)1024;
50 END
```

9825A PROGRAM

```
0: rem 7
1: wrt 704,"F12.34M"
2: lcl 7
3: end
*22953
```

EXAMPLE 2.

Programming a fixed amplitude, e.g., –40.01 dBm:

9830A PROGRAM

```
10 FORMAT B
20 OUTPUT (13,10)768;
30 CMD "?U$","A40.01M"
40 OUTPUT (13,10)1024;
50 END
```

9825A PROGRAM

```
0: rem 7
1: wrt 704,"A40.01M"
2: lcl 7
3: end
*28257
```

EXAMPLE 3.

Programming a fixed frequency increment, e.g., 4 kHz:

9830A PROGRAM

```
10 FORMAT B
20 OUTPUT (13,10)768;
30 CMD "?U$","FI4K"
40 OUTPUT (13,10)1024;
50 END
```

9825A PROGRAM

```
0: rem 7
1: wrt 704,"FI4K"
2: lcl 7
3: end
*29653
```

EXAMPLE 4.

Programming a frequency to be entered from the calculator keyboard:

9830A PROGRAM

```
10 FORMAT B
20 OUTPUT (13,10)768;
30 DISP "DESIRED FREQUENCY (IN MHZ)";
40 INPUT F
50 CMD "?U$"
60 FORMAT "F",F13.9,"M"
70 OUTPUT (13,60)F
80 OUTPUT (13,10)1024;
90 END
```

9825A PROGRAM

```
0: rem 7
1: ent "Desired Frequency (in MHz)?",F
2: fmt "F",f13.9,"M"
3: wrt 704,F
4: lcl 7
5: end
*16851
```

Figure 3-4. 9830A/9825A Program Examples.

EXAMPLE 5.

Programming an amplitude to be entered from the calculator keyboard:

9830A PROGRAM

```
10 FORMAT B
20 OUTPUT (13,10)768;
30 DISP "DESIRED AMPLITUDE (IN DBM)";
40 INPUT A
50 CMD "?U$"
60 FORMAT "A",F6.2,"K"
70 OUTPUT (13,60)A
80 OUTPUT (13,10)1024;
90 END
```

9825A PROGRAM

```
0: rem 7
1: ent "Desired Amplitude (in dBm)?",A
2: fmt 1,"A",f6.2,"K"
3: wrt 704.1,A
4: lcl 7
5: end
*12910
```

NOTE

The + dBm programming code is used for both a negative and positive amplitude entry since the 3335A will recognize a negative sign entered by the calculator.

EXAMPLE 6.

Programming a frequency sweep—all parameters entered from the calculator keyboard:

9830A PROGRAM

```
10 FORMAT B
20 OUTPUT (13,10)768;
30 DISP "START FREQ (IN MHZ)";
40 INPUT A
50 DISP "STOP FREQ (IN MHZ)";
60 INPUT B
70 DISP "# OF STEPS";
80 INPUT C
90 DISP "TIME PER STEP (IN MSEC)";
100 INPUT D
110 X=(B-A)/C
120 CMD "?U$"
130 FORMAT "F",F13.9,"M"
140 FOR F=A TO B STEP X
150 OUTPUT (13,130)F
160 WAIT D
170 NEXT F
180 OUTPUT (13,10)1024;
190 END
```

9825A PROGRAM

```
0: rem 7
1: ent "Start Freq (in MHz) ?",A
2: ent "Stop Freq (in MHz) ?",B
3: ent "# of Steps ?",C
4: ent "Time per Step (in msec) ?",D
5: (B-A)/C→X
6: fmt "F",f13.9,"M"
7: for F=A to B by X
8: wrt 704,F
9: wait D
10: next F
11: lcl 7
12: end
*2524
```

NOTE

If you prefer to enter center frequency and sweep width rather than start and stop frequencies, make the following changes to the respective lines of the Example 6 programs:

9830A PROGRAM CHANGES

```
30 DISP "CENTER FREQ (IN MHZ)";
50 DISP "SWEEP WIDTH (IN MHZ)";
110 X=B/C
```

9825A PROGRAM CHANGES

```
1: ent "Center Frequency (in MHz) ?",A
2: ent "Sweep Width (in MHz) ?",B
5: B/C→X
```

Figure 3-4. 9830A/9825A Program Examples (Cont'd).

EXAMPLE 7.

Programming a log sweep—all parameters entered from the calculator keyboard:

9830A PROGRAM

```
10 FORMAT B
20 OUTPUT (13,10)768;
30 DISP "START FREQ (IN MHZ)";
40 INPUT A
50 DISP "STOP FREQ (IN MHZ)";
60 INPUT B
70 DISP "# OF STEPS";
80 INPUT C
90 DISP "TIME PER STEP (IN MSEC)";
100 INPUT D
110 CMD "?U$"
120 FORMAT "F",F13.9,"M"
130 FOR I=0 TO C
140 F=10↑(LGTA+(LGTB-LGTA)*(I/C))
150 OUTPUT (13,120)F
160 WAIT D
170 NEXT I
180 OUTPUT (13,10)1024;
190 END
```

9825A PROGRAM

```
0: rem 7
1: ent "Start Freq (in MHz) ?",A
2: ent "Stop Freq (in MHz) ?",B
3: ent "# of Steps ?",C
4: ent "Time per Step (in msec) ?",D
5: fmt 1,"F",f13.9,"M"
6: for I=0 to C
7: 10↑(log(A)+(log(B)-log(A))(I/C))→F
8: wrt 704.1,F
9: wait D
10: next I
11: lcl 7
12: end
*31968
```

EXAMPLE 8.

Programming an amplitude sweep—all parameters entered from the calculator keyboard:

9830A PROGRAM

```
10 FORMAT B
20 OUTPUT (13,10)768;
30 DISP "START AMPLITUDE (IN DBM)";
40 INPUT A
50 DISP "STOP AMPLITUDE (IN DBM)";
60 INPUT B
70 DISP "# OF STEPS";
80 INPUT C
90 DISP "TIME PER STEP (IN MSEC)";
100 INPUT D
110 X=(B-A)/C
120 CMD "?U$"
130 FORMAT "A",F6.2,"K"
140 FOR I=A TO B STEP X
150 OUTPUT (13,130)I
160 WAIT D
170 NEXT I
180 OUTPUT (13,10)1024;
190 END
```

9825A PROGRAM

```
0: rem 7
1: ent "Start Amplitude (in dBm) ?",A
2: ent "Stop Amplitude (in dBm) ?",B
3: ent "#of Steps ?",C
4: ent "Time per Step (in msec) ?",D
5: (B-A)/C→X
6: fmt 1,"A",f6.2
7: for I=A to B by X
8: wrt 704.1,I
9: wait D
10: next I
11: lcl 7
12: end
*30595
```

Figure 3-4. 9830A/9825A Program Examples (Cont'd).

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION.

4-2. This section contains performance tests which are in-cabinet procedures designed to verify that the instrument meets the specifications listed in Table 1-1. They can be used for incoming quality control inspection, specification verification after a repair or for routine maintenance. The performance tests contained in this section are:

a. Frequency Accuracy Test
b. Harmonic Distortion Test
c. Integrated Phase Noise Test
d. Spurious Response Test
e. Maximum Output Level Accuracy Test
f. Flatness Test (Attenuator Straight Through)
g. Attenuator Verification Test

4-3. EQUIPMENT REQUIRED.

4-4. The test equipment required for the performance tests and for maintaining the Model 3335A Synthesizer/Level Generator is listed in Table 1-3. Any equipment that satisfies the required specifications given in the table can be substituted for the recommended model(s).

4-5. PERFORMANCE TEST RECORD.

4-6. Results of the performance tests can be tabulated on the Performance Test Record located at the end of the procedures. The Test Record lists all of the tested specifications and their acceptable limits. The results recorded at incoming inspection can be used for comparison in periodic maintenance, troubleshooting, after repairs or adjustments.

4-7. For ease of recording measured specifications at periodic intervals, additional copies of the performance test record are helpful. Prior to first use of the Test Record, copies should be made. The Performance Test Record may be reproduced without written permission from Hewlett-Packard.

4-8. PERFORMANCE TESTS.

4-9. Frequency Accuracy Test.

4-10. This test verifies that the -hp- 3335A is multipling the reference frequency by the correct factor.

Equipment Required:

Universal Counter -hp- 5328A

a. Connect the 10 MHz Output on the rear panel of the -hp- 3335A to the External Frequency Standard Input on the rear panel of the -hp- 5328A. Switch the INT/EXT Frequency Standard Switch on the rear panel of the -hp-5328A to EXTernal.

b. Connect the Universal Counter to the 3335A output.

c. Set the 3335A parameters as follows:

AMPLITUDE . . . . +13.01 dBm (50 Ω)
+11.25 dBm (75 Ω)
FREQUENCY .200 Hz

d. Counter should indicate 200 Hz ± 1 Hz.

e. Change the 3335A frequency to that stated in Table 4-1 and check for the Counter reading stated in Table 4-1.

Table 4-1. Frequency Accuracy Test.

Frequency (MHz)	Counter Reading (MHz)
10.999 999	10.999 999 ± 1 Hz
14.5	14.5 ± 1 Hz
20	20 ± 1 Hz
28.123 456	28.123 456 ± 1 Hz
40	40 ± 1 Hz
60	60 ± 1 Hz
80	80 ± 1 Hz

4-11. Harmonic Distortion.

4-12. This test verifies that the 3335A meets the harmonic distortion specification of Table 1-1.

Equipment Required:
50 ohm Feedthrough Termination, -hp- Model 11048C
Spectrum Analyzer (high frequency), -hp- Model 141T/8552B/8553B/8554B
Spectrum Analyzer (low frequency), -hp- Model 3580A
50 ohm-to-75 ohm Minimum Loss Pad, -hp- Model 85428B (Required for Options 002, 003 and 004 only)

a. Connect the test set up as shown in Figure 4-1. Note the use of the 50 ohm-to-75 ohm Minimum Loss Pad for the 75 ohm output of the option instruments.

b. Set the 3335A amplitude to:

AMPLITUDE . . . . + 13.01 dBm (50 Ω)
+ 11.25 dBm (75 Ω)

c. Set the 3335A frequency to those indicated in Table 4-2 and at each frequency check that all harmonic level meet the specification.

NOTE

The 3580A Spectrum Analyzer is used to measure harmonics of fundamental frequencies from 200 Hz to 15 kHz. The 3580A has a frequency range of 5 Hz to 50 kHz allowing the

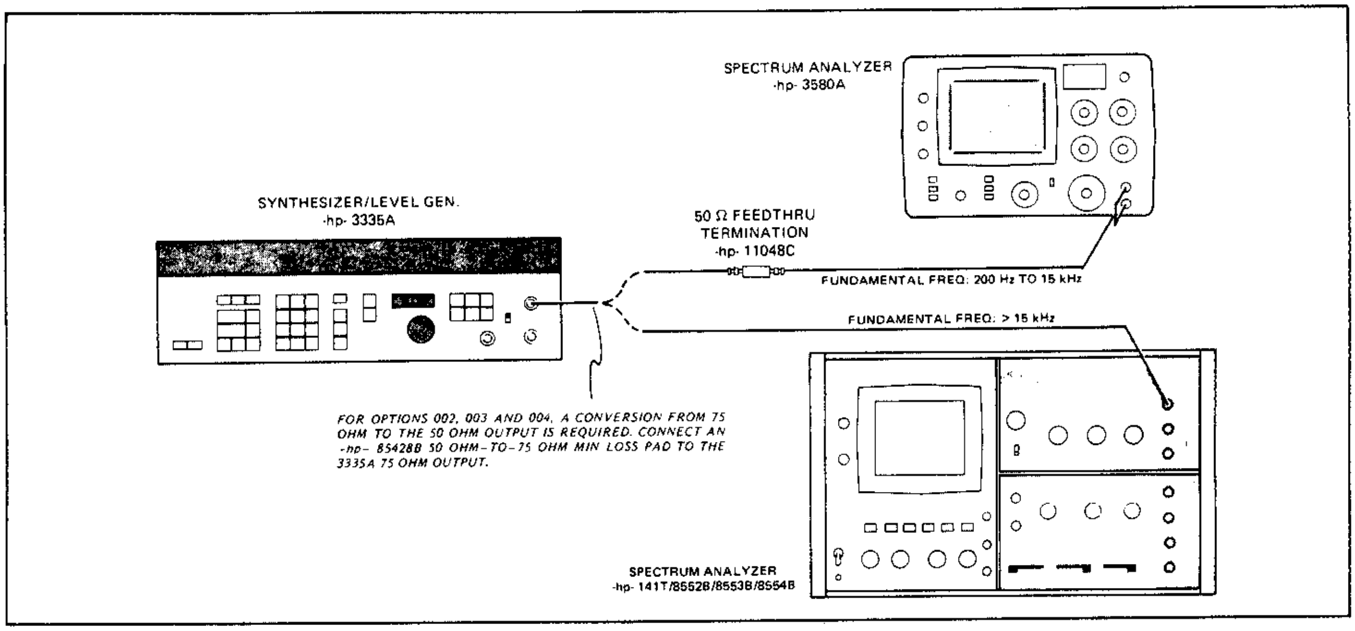


Figure 4-1. Harmonic Distortion Test.

measurement of the third harmonic with a 15 kHz fundamental. The 141T/8552B/8553B/8554B Spectrum Analyzer is used to measure harmonics of fundamental frequencies from 15 kHz to 80 MHz. The maximum frequency of this analyzer is 1250 MHz allowing adequate harmonic measurement.

Table 4-2. Harmonic Level Specification.

3335A Frequency	Harmonic Level Specification
200 Hz 1 kHz 1 MHz 9.9 MHz 10 MHz	< −45 dB
> 10 MHz 80 MHz	< −40 dB

4-13. Integrated Phase Noise Test.

4-14. This performance test ensures the 3335A meets the integrated phase noise specifications of Table 1-1. The specifications are for a 30 kHz band, excluding ± 1 Hz, centered on the carrier. The test set-up uses another 3335A in addition to the one under test as a reference. Any synthesizer with a noise floor equivalent to the 3335A can be used as a reference. (See required characteristics, Table 1-3). The reference and the tested signal are mixed and the difference signal is applied to a wideband ac voltmeter and a dc digital voltmeter through two filters (see Figure 4-2). The 1 MHz filter used in the test is available commercially (see Table 1-3). The 15 kHz filter must be constructed.

Equipment Required:

Synthesizer, -hp- Model 3335A or equivalent
Digital Voltmeter, -hp- Model 3455A
1 MHz LPF, TT Electronics Model J903
AC Voltmeter, -hp- Model 400FL
Mixer, -hp- Model 10514A
50 ohm Feedthrough Termination, -hp- Model 11048C
BNC TEE, -hp- Part No. 1250-0781
50 ohm-to-75 ohm Minimum Loss Pad, -hp- Model 85428B (Required for Options 002, 003 and 004 only)

a. Connect the test set-up shown in Figure 4-2.

b. Set the 3335A under test as follows:

AMPLITUDE . . . . 0 dBm (50 Ω)
+ 5 dBm (75 Ω)
FREQUENCY . . . . 9.901 MHz

c. Set the Reference Synthesizer as follows:

AMPLITUDE . . . . + 13.01 dBm (50 Ω)
+ 11.25 dBm (75 Ω)
FREQUENCY . . . . 9.9 MHz

d. Record the AC Voltmeter reading.

e. Change the frequency of the 3335A under test to 9.9 MHz.

f. Adjust the phase of the 3335A under test using Ø INCR for a minimum dc reading on the DVM.

g. Disconnect the DVM from the test set-up.

h. Record the AC Voltmeter reading and subtract it from the reading recorded in Step d. Enter this quantity on the performance test card.

i. The difference calculated in the previous step should satisfy the specification of Table 1-1 ~~36~~ +3 dB (i.e., if spec is

−63 dB, the difference must be ~~57~~ 60 or greater). This is a correction factor compensating for the folding action of the mixer.

j. Reconnect the DVM to the test set-up.

k. Change the frequency of both the 3335A under test and the Reference Synthesizer to the set of frequencies stated in Table 4-3. At each frequency set, record the AC Voltmeter reading.

l. Change the frequency of the 3335A under test to equal that of the Reference. At each new frequency step repeat Steps f through j.

Table 4-3. Phase Noise Test.

Set	Frequency	
	3335A Under Test	Reference
1.	20.001 MHz	20 MHz
2.	40.001 MHz	40 MHz
3.	80.001 MHz	80 MHz

4-15. Spurious Response Test.

4-16. This performance test verifies the spurious specification of Table 1-1. The test is in two parts – first checking for spurious signals within 1 kHz of the fundamental and secondly checking for known spurious signals.

Equipment Required:
- Digital Voltmeter, -hp- Model 3455A
- Synthesizer, -hp- Model 3335A or equivalent
- Mixer, -hp- Model 10514A
- 1 MHz LPF, TT Electronics Model J903
- Spectrum Analyzer, -hp- Model 3580A Option 001
- Spectrum Analyzer -hp- Model 141T/8552B/8553B/8554B
- 50 ohm Feedthrough Termination, -hp- Model 11048C

NOTE

Use the internal battery to power the -hp-3580A during this test.

a. Close-In Spurious Response Test.

1. Connect the test set-up as shown in Figure 4-3.
2. Set the parameters of the 3335A under test as follows:

AMPLITUDE . . . . .0.0 dBm
FREQUENCY . . . . 80.001 MHz

3. Set the parameters of the Reference Synthesizer in the test set-up as follows:

AMPLITUDE . . . .+ 13.01 dBm (50 Ω)
+ 11.25 dBm (75 Ω)
FREQUENCY . . . . 80 MHz

4. Adjust the Spectrum Analyzer for full scale.
5. Change the frequency of the Reference Synthesizer to 80.001 MHz.
6. Change the phase of the -hp- 3335A under test using the ∅ INCR parameter to obtain a minimum DVM dc voltage reading. After completing this step, disconnect the DVM.
7. With the Spectrum Analyzer adjust for a 1 kHz span (100 Hz/Div) and tune up to 50 kHz searching for spurious signals greater than −69 dB. All spurious signals less than −69 dB verify the spur-

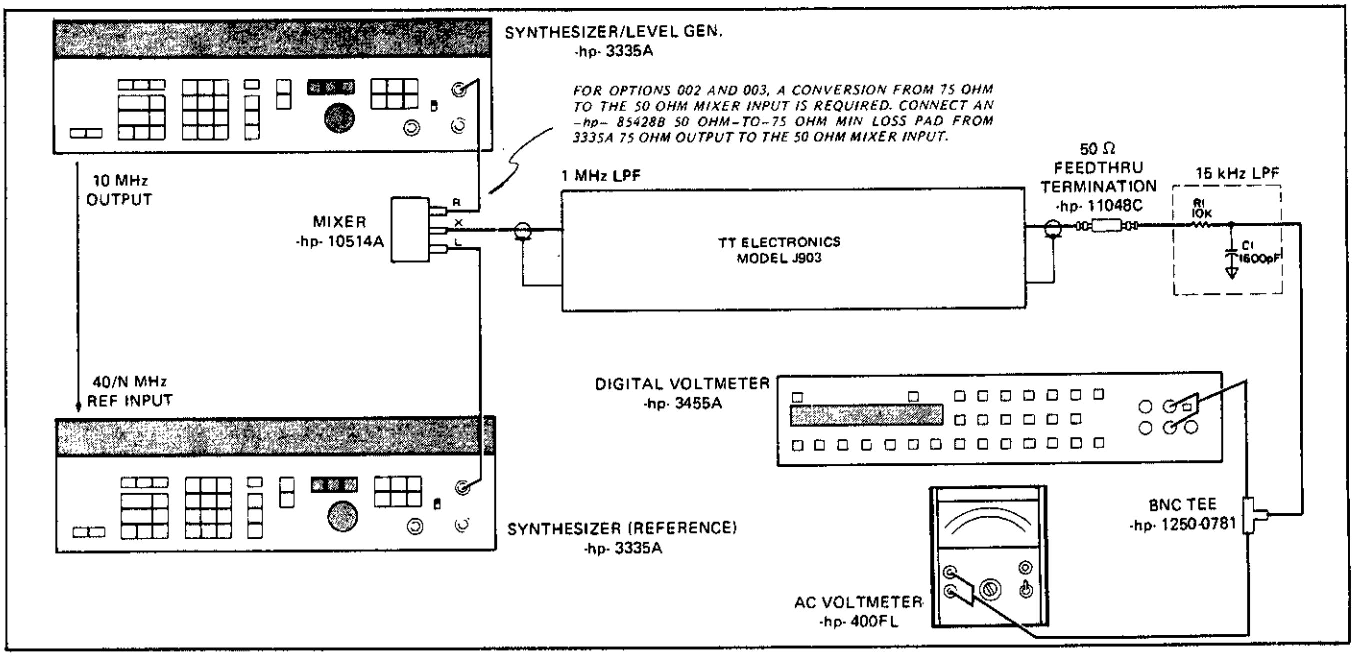


Figure 4-2. Integrated Phase Noise.

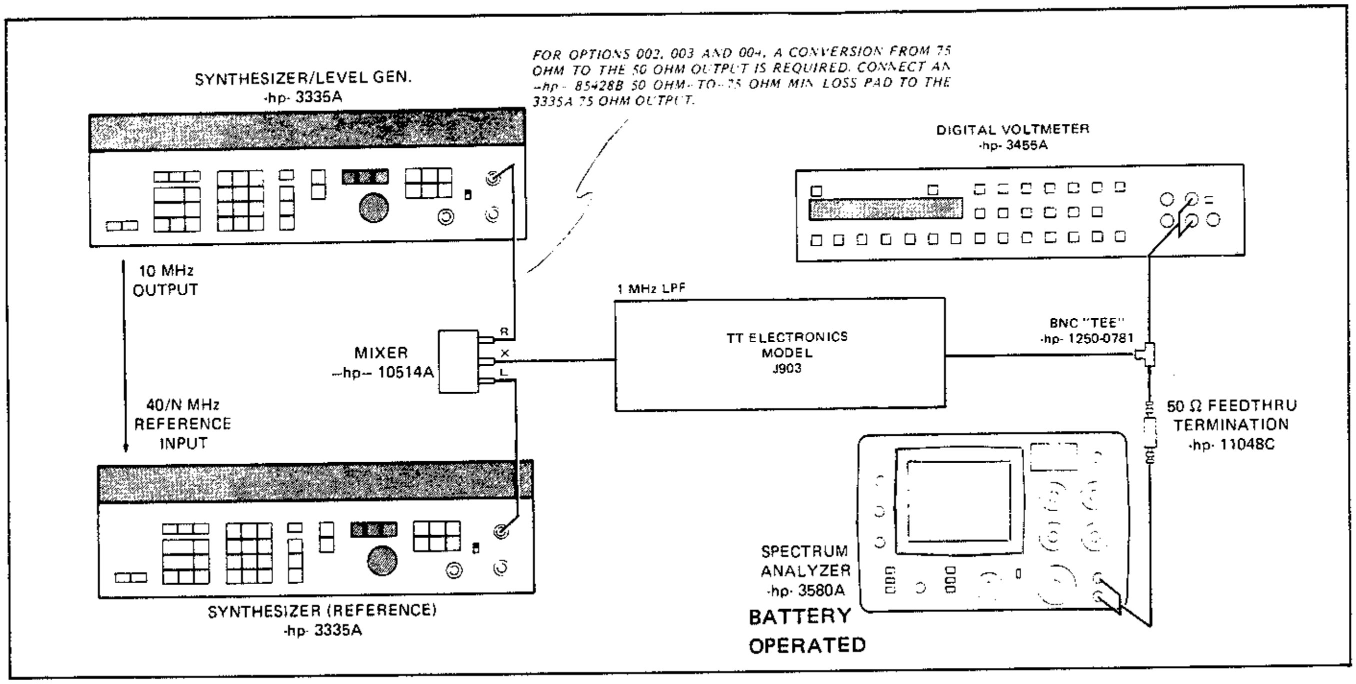


Figure 4-3. Spurious Response Test (Close—In).

ious specification. This incorporates a 6 dB correction factor due to the folding of coherent source sidebands as a result of mixing.

b. Known Spurious Response Test. This test checks for the presence of known worst case spurious signals that may exist. In some cases, this known spurious signal may not be present or detectable.

1. Connect the test set-up as shown in Figure 4-4 using the 3580A Spectrum Analyzer first.

2. Set the 3335A parameters as follows:

AMPLITUDE . . . . + 13.01 dBm (50 Ω)
+11.25 dBm (75 Ω)
FREQUENCY . . . . 16.5 kHz

3. Check for a 46.5 kHz spurious signal greater than −75 dB.

4. Set the 3335A to the frequencies in Table 4-4 and check for the corresponding spurious signal also stated in Table 4-4. All spurious signals less than −75 dB verify the spurious specification.

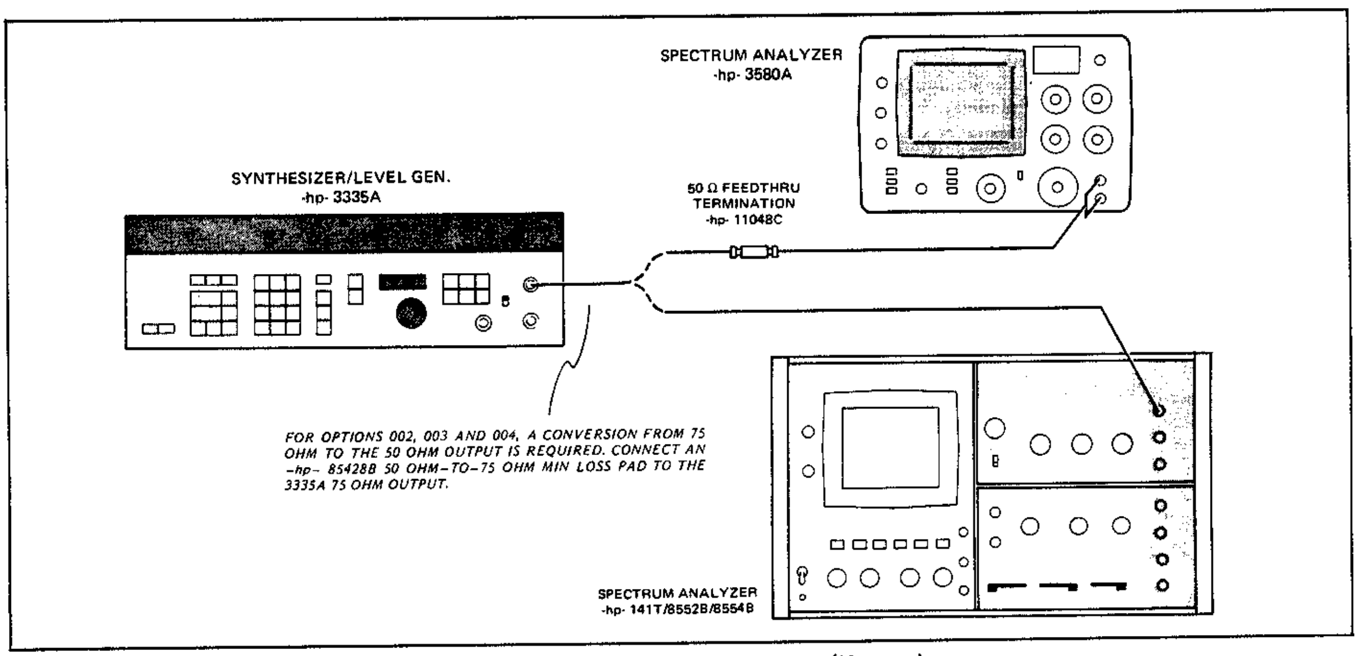


Figure 4-4. Spurious Response Test (Known).

5. Replace the -hp- 3580A Spectrum Analyzer with the 141T/8552B/8553B (see Figure 4-4) Spectrum Analyzer. Set the 141T/8552B/8553B for a normal display with the input attenuator set to 40 dB.

6. Overdrive the 141T/8552B/8553B input by setting the attenuator to 20 dBs. This effectively subtracts 20 dB from all vertical calibrating legends on the CRT face shield.

7. Set the 3335A to the frequencies in Table 4-5 and check for the corresponding spurious signal also stated in Table 4-5. All spurious signals less than −75 dB verify the spurious specification.

Table 4-4. Spurious Test (1).

3335A Frequency	Spurious Frequency
15.5 kHz	25.5 kHz
10.5 kHz	20.5 kHz
10.05 kHz	20.15 kHz
~~10.005 kHz~~	~~20.005 kHz~~

Table 4-5. Spurious Test (2).

3335A Frequency	Spurious Frequency
7.5 MHz	10.0 MHz
9.0 MHz	40.0 MHz
9.0 MHz	49.0 MHz
9.90 MHz	0.40 MHz
9.90 MHz	10.3 MHz
9.999 MHz	~~15.0 MHz~~ 150.0 MHz

4-17. Maximum Output Level Accuracy Test.

4-18. This performance test verifies the 3335A meets the maximum output level accuracy specification.

Equipment Required:
- 50 ohm Feedthrough Termination, -hp- Model 11048C (For Options 002, 003 and 004 a 75 ohm Feedthrough Termination, -hp- Model 11094B, is required in place of the 11048C)
- Digital Voltmeter, -hp- Model 3455A

a. Connect a Digital Voltmeter (DVM) in the ACV mode to the 3335A output (50 ohm for Standard; 75 ohm for Options 002, 003 and 004) through the appropriate feedthrough termination.

b. Set the 3335A as follows:

FREQUENCY 100 kHz
AMPLITUDE . . . . + 13.01 dBm (50 Ω)
+ 11.25 dBm (75 Ω)
(Includes the 75 Ω output for Options 002, 003 and 004)

c. The DVM reading should be as follows for either 50 ohm or 75 ohm output:
0.994196 V to 1.005737 V (50 Ω)
~~0.99423 V to 1.00577 V~~
0.994298 V to 1.005844 V (75 Ω)
This verifies the maximum output level accuracy test.

4-19. Flatness Test (Attenuator Straight Through).

4-20. This performance test verifies that the 3335A meets the flatness specification of Table 1-1 with no attenuation introduced.

Equipment Required:
- Thermal Converter, -hp- Model 11050A (50 Ω) or -hp- Model 11050A/H01 (75 Ω)
- Digital Voltmeter, -hp- Model 3455A
- Power Meter, -hp- Model 436A
- Power Sensor, -hp- Model 8482A (50 Ω) and/or -hp- Model 8483A (75 Ω)

a. Connect the test set-up as shown in Figure 4-5.

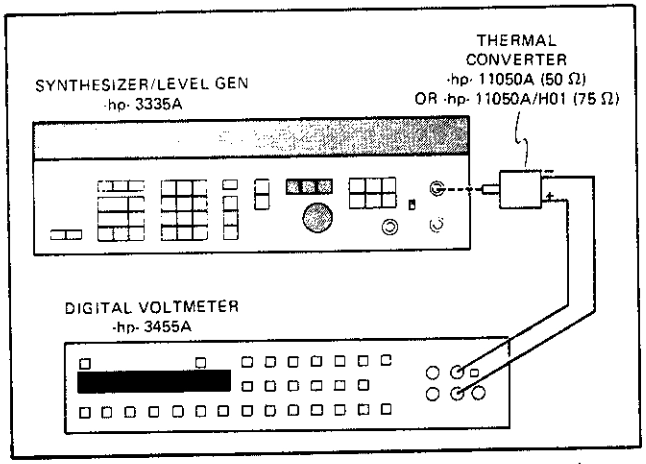


Figure 4-5. Flatness Test (200 Hz to 10 MHz).

b. The purpose of steps b through f is to find the change in the DC output voltage of the thermal convertor that occurs when the input changes ~~0.1~~ 0.07 dB. Set the 3335A as follows:

AMPLITUDE . . . . + 13.01 dBm (50 Ω)
+ 11.25 dBm (75 Ω)
FREQUENCY . . . . 100 kHz

c. Record the DVM reading.

d. Change AMPLITUDE to + ~~12.91~~ +12.94 dBm (50 Ω) or ~~+11.15~~ +11.18 dBm (75 Ω).

e. Record the DVM reading.

f. Calculate the allowable tolerance by subtracting the reading of Step e from the reading of Step c and record the tolerance.

g. Set AMPLITUDE to that stated in Step b.

h. Set FREQUENCY to the following frequencies, allow the 3455A reading to settle and record the reading:

200 Hz
50 kHz
500 kHz
1 MHz
5 MHz
10 MHz

i. Add the thermal converter's correctional data for each frequency to the readings of the previous step.

j. The result should indicate the reading of Step c ± the tolerance calculated in Step f for each frequency set in Step h verifying the flatness between 200 Hz and 10 MHz.

k. Disconnect the test set-up of Figure 4-5 and connect the test set-up shown in Figure 4-6.

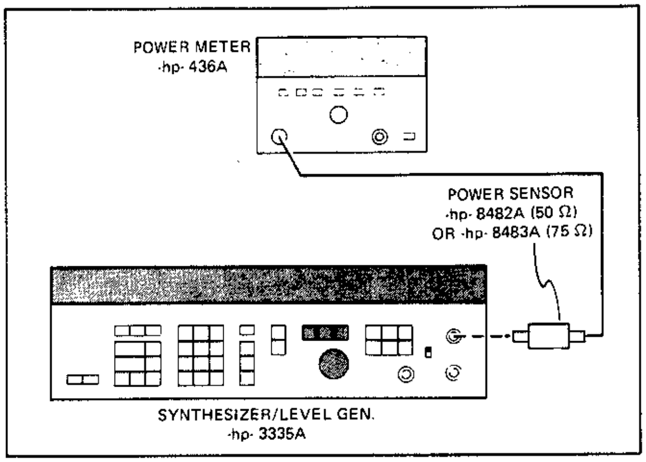


Figure 4-6. Flatness Test (10 MHz to 80 MHz).

l. Set the 3335A FREQUENCY to 10 MHz and AMPLITUDE to that stated in Step b.

m. With the Power Meter "CAL FACTOR %" set for the Power Sensor used, set the dB (REF) to the power level of the output from the previous step.

NOTE

The Power Meter readings will now indicate the deviation from the 10 MHz full output reference. The deviation with the 10 MHz tolerance from Step f incorporated should be within the specified tolerance.

n. Set the 3335A FREQUENCY to the following frequencies and record the Power Meter relative reading:

20 MHz	60 MHz
30 MHz	70 MHz
40 MHz	80 MHz
50 MHz	

o. The Power Meter readings incorporating the 10 MHz tolerance calculated in Step f, should be within the limits stated in Table 1-1 verifying the flatness from 10 MHz to 80 MHz.

4-21. Attenuator Verification Test.

NOTE

This test is not required unless the attenuator has been repaired.

4-22. This performance test verifies the attenuator accuracy of Table 1-1 for three attenuation levels at three different test frequencies. The test set-up is very critical to the results of the test. It is preferred that this test be performed in a screen room. If one is not available, an electrically "clean" environment is a must. It is important that the specified cables be used and that the test equipment be arranged as illustrated. Failure to follow test set-up instructions can result in erroneous data.

NOTE

A recertification program is available to verify the attenuator accuracy specifications. To recertify, the attenuator must be returned to Hewlett-Packard. The recertified attenuator will be returned with a computer printout containing the results of each attenuation test. Contact your nearest Hewlett-Packard Sales and Service Office for further details. A list of these offices is provided in the back of this manual.

Equipment Required:

Step Attenuator with certification chart, -hp- Model 355C
Step Attenuator with certification chart, -hp- Model 355D
6 dB Pad, -hp- Model 8491A Option 006
3 dB Pad, -hp- Model 8491A Option 003
50 ohm to 75 ohm Pad, -hp- Model 85428B
Amplifier, Q-Bit Corp. Model QB-300
Mixer, -hp- Model 10514A
50 ohm Feedthrough Termination, -hp- Model 11048C
Synthesizer, -hp- Model 3335A or equivalent
Wave Analyzer, -hp- Model 3581A
Digital Voltmeter, -hp- Model 3455A
Power Supply, -hp- Model 6215A
(3) BNC Male-to-Male Adapter, -hp- 1250-0216
(1) BNC Female-to-Female Adaptor, -hp- 1250-0080
(2) Type N(f) to BNC(m) Adaptor, -hp- 1250-0077
(2) Type N(m) to BNC(f) Adaptor, -hp- 1250-0780
(2) BNC(f) to dual Banana Plug, -hp- 1251-2277

Cables: (2) 11170A
(2) 11170B
(2) 11170C

a. Connect the test set-up as shown schematically in Figure 4-7 and by physical location as shown in Figure 4-8. If the 75 ohm output of the 3335A is being tested, an -hp- 85428B 50 ohm to 75 ohm minimum loss pad must be inserted between the 3335A under test and the connecting cable. Do not connect the amplifier into the test set-up at this time but connect the amplifier to the power supply and allow it to warm up prior to its use in Step q.

NOTE

The test set-up is very critical to the test results. It is important that the specified cables be used and the equipment arranged as shown in Figure 4-8. Do not crossover cables of the test set-up. Failure to use the specified test set-up can result in erroneous data.

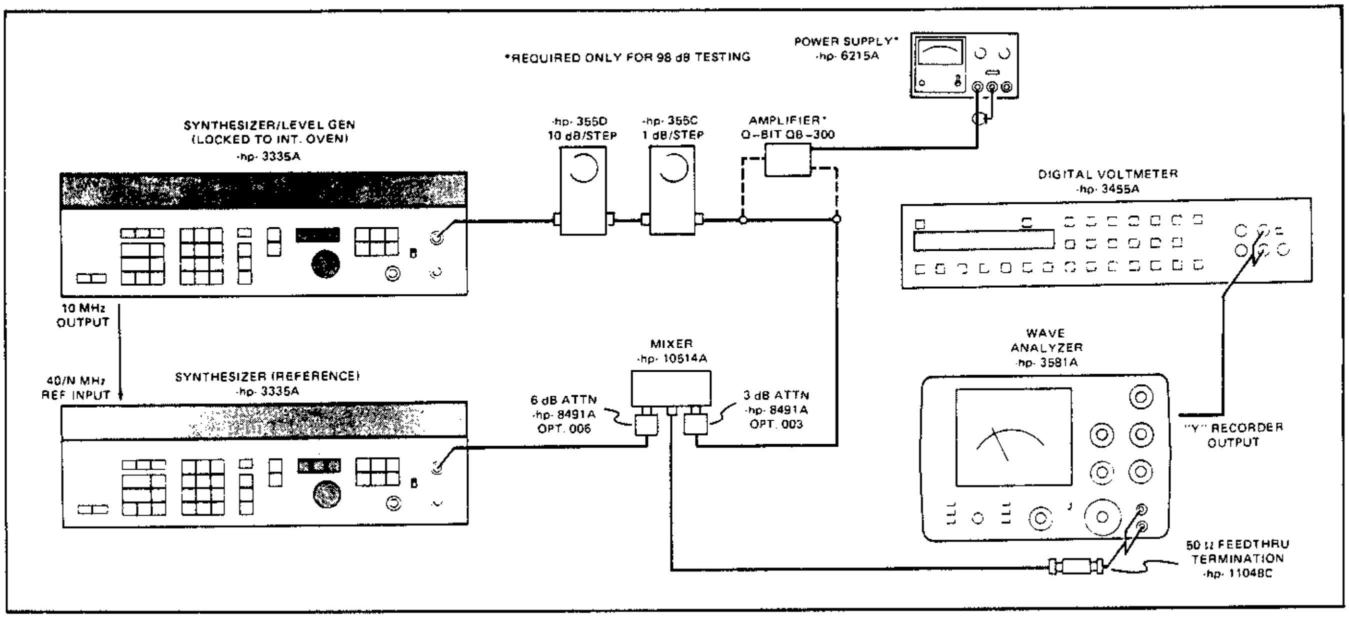


Figure 4-7. Attenuator Verification Test.

b. Set the 3335A under test as follows:

AMPLITUDE . . . . +13.01 dBm (50 Ω)
+ 11.25 dBm (75 Ω)
FREQUENCY . . . . 2 MHz

c. Set the Reference Synthesizer as follows:

AMPLITUDE . . . . +13.01 dBm (50 Ω)
+11.25 dBm (75 Ω)
FREQUENCY . . . . 2.008 MHz

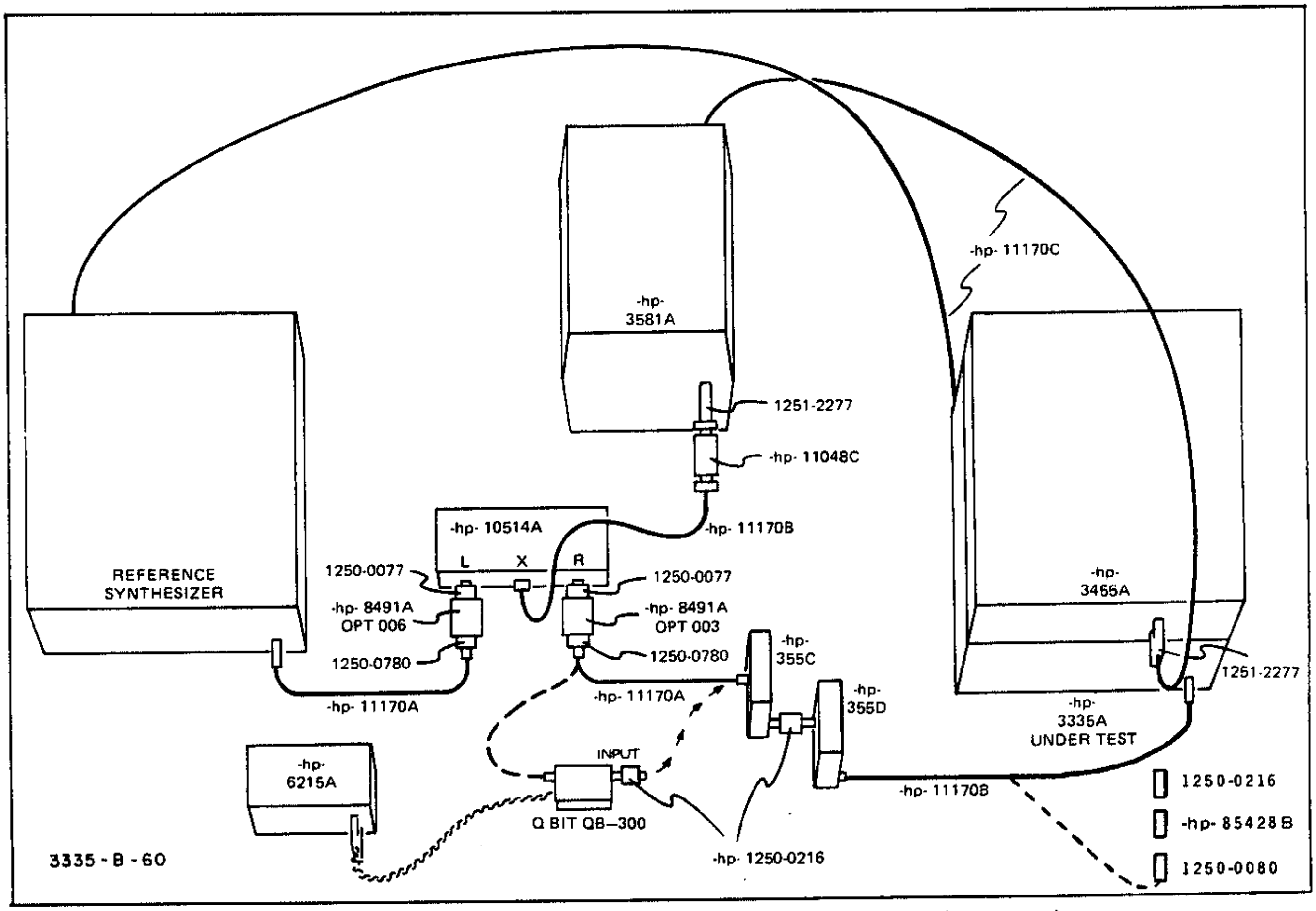


Figure 4-8. Attenuator Verification Test Equipment Layout (Top View).

d. Set the attenuation of the two standard attenuators to 18 dB.

e. Set the 3581A Wave Analyzer as follows:

SCALE	VOLTS
RESOLUTION BANDWIDTH	30 Hz
SWEEP TIME	1 sec
SWEEP MODE	OFF
AMPLITUDE REF LEVEL	NORMAL
AFC	OUT; Tune FREQUENCY to 8 kHz
AFC	After tuning to 8 kHz, push in to lock to 8 kHz

f. Adjust the 3581A INPUT SENSITIVITY for a DVM reading of approximately 4.6 V.

g. Observe the 3455A reading for several seconds. By observation, determine the average reading and record this average on the performance test record.

h. Program an AMPTD INCR of 18 dB and use this parameter to decrease the amplitude by 18 dB from maximum output then set the standard attenuators to zero.

NOTE

The amplitude of the 3335A is decreased before setting the standard attenuators to zero to eliminate saturating the mixer and introducing measurement errors.

i. Observe the 3455A reading for several seconds (do not readjust the 3581A INPUT SENSITIVITY). By observation, determine the average reading and record this average on the performance test record under the previously recorded reading.

j. Set the standard attenuator to 18 dB then change the frequency of the 3335A under test to 40 MHz and amplitude back to full output.

k. Change the frequency of the Reference Synthesizer to 40.008 MHz.

l. Repeat Steps f through i.

m. Set the standard attenuator to 18 dB then change the frequency of the 3335A under test to 80 MHz and amplitude to full output.

n. Change the frequency of the Reference Synthesizer to 80.008 MHz.

o. Repeat Steps f through i.

p. Repeat Steps b through o using attenuation of 58 dB in Step d and an AMPTD INCR of 58 dB in Step h.

q. Connect the amplifier into the test set-up.

r. Repeat Steps b through o using attenuation of 98 dB in Step d and an AMPTD INCR of 98 dB in Step h.

NOTE

For Steps s, t and u, an example illustrating the procedure is shown following Step u.

s. For each set of measurements (V_{std} and V_{3335}), calculate Δ dB from the equation

$$\Delta \text{ dB} = 20 \log_{10} \left(\frac{V_{std}}{V_{3335}}\right)$$

and record on the performance test record.

t. Determine the attenuation error of the two standard attenuators for each measurement frequency (including the algebraic sign) and record the STD ERROR on the performance test record.

u. Total the quantities Δ dB and STD ERROR on the performance test record. Compare this total to the test limits to determine if the attenuator is within specification.

EXAMPLE:

Measurements obtained for 18 dB attenuation at 2 MHz from the 3455A:

$V_{std} = 4.6005$ V
$V_{3335} = 4.5924$ V

Calcuation of Δ dB:

$$\Delta \text{ dB} = 20 \log \left(\frac{4.6005}{4.5924}\right) = 0.0153 \text{ dB}$$

From the certification record of the 355C and 355D attenuators, actual standard attenuation for 18 dB is:

Model	Setting	Actual Attn	Std Error
355D	10 dB	9.990 dB	–0.010 dB
355C	8 dB	7.995 dB	–0.005 dB

Total STD ERROR for 18 dB at 2 MHz is –0.015 dB.

Calculation of measured accuracy:

Δ dB	0.0153 dB
+STD ERROR	–0.0150 dB
Measured Accuracy	0.0003 dB

~~Since the 18 dB, 2 MHz specification is ± 0.04 dB, the 18 dB, 2 MHz level is within the specification.~~

see manual change

PERFORMANCE TEST RECORD

HEWLETT–PACKARD MODEL 3335A

SYNTHESIZER/LEVEL GENERATOR

SERIAL NO. ____________________

Tests Performed By ____________________

Date ____________

FREQUENCY ACCURACY TEST:

Frequency	Test Limits	Counter Reading
200 Hz	± 1 Hz	______
10.999 999 MHz	± 1 Hz	______
14.5 MHz	± 1 Hz	______
20 MHz	± 1 Hz	______
28.123 456 MHz	± 1 Hz	______
40 MHz	± 1 Hz	______
60 MHz	± 1 Hz	______
80 MHz	± 1 Hz	______

HARMONIC DISTORTION:

Frequency	Test Limits	Test Measurement
200 Hz	< - 45 dB	______
1 kHz	< - 45 dB	______
10 kHz	< - 45 dB	______
1 MHz	< - 45 dB	______
9.9 MHz	< - 45 dB	______
40 MHz	< -40 dB ~~< - 45 dB~~	______
41 MHz	< - 40 dB	______
80 MHz	< - 40 dB	______

INTEGRATED PHASE NOISE:

Frequency	Test Limits	Test Measurement (Calculated Difference)
9.9 MHz	> 57 dB	______
20.0 MHz	> 64 dB	______
40.0 MHz	> 58 dB	______
80.0 MHz	> 52 dB	______

SPURIOUS RESPONSES:

Close–In Spurs

Frequency	Test Limits	Test Measurement
79.9999 MHz	<–69 dB or –110 dB whichever is greater	________

Known Spurs

Frequency	Test Limits	Test Measurement
20.5 kHz	≤ –75dB	
25 kHz	≤–75 dB	________
20.15 kHz	≤ –75dB	
10 MHz	≤–75 dB	________
~~45~~ 40 MHz	≤–75 dB	________
49 MHz	≤–75dB	
~~80~~ MHz 0.40 MHz	≤–75 dB	________
10.3 MHz	≤–75dB	
150 MHz	≤–75dB	

MAXIMUM OUTPUT LEVEL ACCURACY TEST:

Frequency	Amplitude	Test Limits	Test Measurement
100 kHz	+13.01 dBm (50 Ω)	0.99423–1.00577 V	________
	+11.25 dBm (75 Ω)	0.99423–1.00577 V	________

FLATNESS TEST:

Frequency	Test Limits (Calculated Unless Stated)	Test Measurement
200 Hz	________	________
50 kHz	________	________
500 kHz	________	________
1 MHz	________	________
5 MHz	________	________
10 MHz	________	________
20 MHz	± 0.07 dB	________
30 MHz	± 0.15 dB	________
40 MHz	± 0.15 dB	________
50 MHz	± 0.15 dB	________
60 MHz	P 0.15 dB	________
70 MHz	± 0.15 dB	________
80 MHz	± 0.15 dB	________

ATTENUATOR ACCURACY TEST:

Impedance: 50 Ω		Test Frequency		
Attenuation	Measurements/ Calculations	2 MHz	40 MHz	80 MHz
~~18~~ 38 dB	$V_{Std\ Attn}$			
	V_{3335A}			
	ΔdB			
	Std Error			
	Total			
	Test Limit	~~± 0.04 dB~~ ±0.025dB	~~± 0.04 dB~~ ±0.025dB	~~± 0.04 dB~~ ±0.025dB
58 dB	$V_{Std\ Attn}$			
	V_{3335A}			
	Δ dB			
	Std Error			
	Total			
	Test Limit	~~± 0.09 dB~~ ±0.03dB	~~± 0.09 dB~~ ±0.03dB	~~± 0.09 dB~~ ±0.03dB
98 dB	$V_{Std\ Attn}$			
	V_{3335A}			
	Δ dB			
	Std Error			
	Total			
	Test Limit	~~± 0.2 dB~~ ±0.09dB	~~± 0.2 dB~~ ±0.09dB	~~± 0.2 dB~~ ±0.09dB

Impedance: 75 Ω

Attenuation	Measurements/ Calculations	2 MHz	40 MHz	80 MHz
		Test Frequency		
18 dB	$V_{Std\ Attn}$	________	________	________
	V_{3335A}	________	________	________
	Δ dB	________	________	________
	Std Error	________	________	________
	Total	________	________	________
	Test Limit	± 0.04 dB	± 0.15 dB	± 0.15 dB
58 dB	$V_{Std\ Attn}$	________	________	________
	V_{3335A}	________	________	________
	Δ dB	________	________	________
	Std Error	________	________	________
	Total	________	________	________
	Test Limit	± 0.09 dB	± 0.25 dB	± 0.25 dB
98 dB	$V_{Std\ Attn}$	________	________	________
	V_{3335A}	________	________	________
	Δ dB	________	________	________
	Std Error	________	________	________
	Total	________	________	________
	Test Limit	± 0.2 dB	± 0.25 dB	± 0.50 dB

WARNING

Maintenance described herein is performed with power supplied to the instrument, and protective covers removed. Such maintenance should be performed only by service-trained personnel who are aware of the hazards involved (for example, fire and electrical shock). Where maintenance can be performed without power applied, the power should be removed.

SECTION V
ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section contains the adjustment procedures required to return the instrument to its peak operating capability when repairs have been made. The adjustment procedures contained in this section are:

a. Power Supply Adjustment (Para. 5-9).

b. Temperature-Stabilized Oscillator Adjustments Paragraph 5-11).

c. Reference Oscillator Adjustments (Para. 5-14).

d. N Step Loop VCO Adjustments (Para. 5-16).

e. Fractional N (N.F) Loop Analog Adjustments (Para. 5-18).

f. Summation Loop VCO Adjustments (Para. 5-20).

g. Divider—Filter Low-Pass Filter Bank Adjustments (Para. 5-22 and 5-23).

h. Mixer 40 MHz Bandpass Filter Adjustment (Para. 5-24).

i. Mixer 10 MHz LPF Adjustment (Para. 5-26).

j. Output Amplifier Adjustments (Para. 5-28).

k. Level Control Loop Adjustments (Para. 5-30).

5-3. The adjustment procedures are arranged in the sequence the adjustments are to be made. Interaction of the Output Amplifier and Level Control Loop Adjustments require that these adjustments be performed if an adjustment in one or the other is affected. Adjustments in the phase-locked loops do not affect the filter, output amplifier or level control loop adjustments.

5-4. EQUIPMENT REQUIRED.

5-5. Each adjustment procedure in this section contains a list of test equipment and accessories required to perform the adjustment. All test equipment required for adjustments is itemized in Table 1-3, Test Equipment Required. Any equipment that satisfies the required specifications given in the table can be substituted for the recommended model(s).

5-6. FACTORY SELECTED COMPONENTS.

5-7. Some component values of certain circuits are selected at the factory. These components are identifiable by an asterisk next to the designation on the schematic. The nominal values of the factory selected components found in the standard -hp- 3335A are listed on the schematic and in the replaceable parts list. The range of values for these components is presented in Table 5-1.

5-7(a). The factory selected components used in Option 002/004 (75 ohm unbal/124 ohm bal/135 ohm bal outputs) and Option 003 (75 ohm unbal and 150 ohm bal outputs) are not to be replaced using the procedure described in Paragraph 5-8. The procedure for selecting these resistors is so intricate that it is impractical to include it in the manual (in fact it is computorized at the factory). Information presented in the Replaceable Parts list for these assemblies describes the proper replacement of these resistors.

Table 5-1. Factory Selected Components.

Reference Designation	Assembly Title	Component Values	-hp- Part No.
A14R5*, R17* R33*, R44*	Power Supply	10 Ω	0757-0346
		No Nominal	
		51 Ω	0757-0394
A14R40*	Power Supply	10 Ω	0757-0346
		20 Ω	0757-0384
		30.1 Ω Nominal	0757-0388
		40.2 Ω	0698-3262
		51.1 Ω	0757-0394
		60.4 Ω	0698-4387
A14R49*	Power Supply	10 Ω	0757-0346
		34.8 Ω	0698-3434
		60.4 Ω	0698-4387
		84.5 Ω	0698-4397
		110 Ω	0757-0402
		133 Ω Nominal	0698-3437
		162 Ω	0757-0405
		187 Ω	0698-6324
		210 Ω	0698-4419
		261 Ω	0698-3132
		387 Ω	0698-3442

5-8. The procedure for replacing standard factory selected components is as follows:

a. Install a replacement of the original value installed and perform the adjustment procedure for the section repaired as specified in this section.

b. If the adjustment cannot be made as specified, replace the selected component with the nominal value stated in Table 5-1.

c. If the adjustment cannot be made with the nominal value, substitute a value from the range stated in Table 5-1 until the adjustment is obtainable.

5-9. Power Supply Adjustment.

5-10. Voltage. There is one voltage power supply adjustment (A14R10) which sets the level of the +15 V dc regulated output.

Equipment Required:
Digital Voltmeter, -hp- Model 3455A

a. Set the Digital Voltmeter (DVM) to the dc FUNCTION, auto range.

b. Connect the DVM to the + 15 V test point located on Mother Board A1 between the halves of the module (see Figure 5-5). Assemblies A2 through A9 must be installed in the module for this adjustment.

c. Adjust A14R10 (+ 15 V adj) for a DVM reading of + 15 V ± .01 V.

d. One at a time, connect DVM to the remaining three test points (+ 5, - 15 and - 5.2) and verify their outputs are within the following range.

TP + 5: + 5.049 V to + 5.151 V
TP - 15: - 15.15 V to - 14.85 V
TP - 5.2: - 5.353 V to - 5.247 V

If one of the regulated outputs is out of range, troubleshoot the regulator associated with that output. *Each of these supplies are referenced to the + 15 V output. If the + 15 V supply is not within the specified value, the + 5 V, - 15 V and - 5.2 V supplies will be out of range. Note that the + 5 V and - 5.2 V outputs are actually + 5.1 V and - 5.3 V respecitvely at the Mother Board (A1) test points. This compensates for losses from this point to the assemblies of application.*

5-10A. Current.

NOTE

Current limit adjustments are not found on instruments with serial number 1640A00215 or lower.

There are four current limit adjustments corresponding to the four regulated power supplies located on board A14. The recommended method of implementing their adjustment is to use the test fixture diagramed in Figure 5-1.

The parts for the test fixture along with their Manufacturing Source are listed in Table 5-2. Construct the test fixture such that pins 1 and 2 are in the same position as the two black wires on W8's connector.

Table 5-2. Test Fixture Parts List.

Qty.	Description	-hp- Part No.	Manufacturing Source
10	Clips	1251-3073	-hp-
1	Connector	1251-3750	Molex Products (09-65-1101)
1	1 Ω Resistor 5 W 1%	0811-0040	-hp-
	Alligator Clip		
	No. 22 Wire		

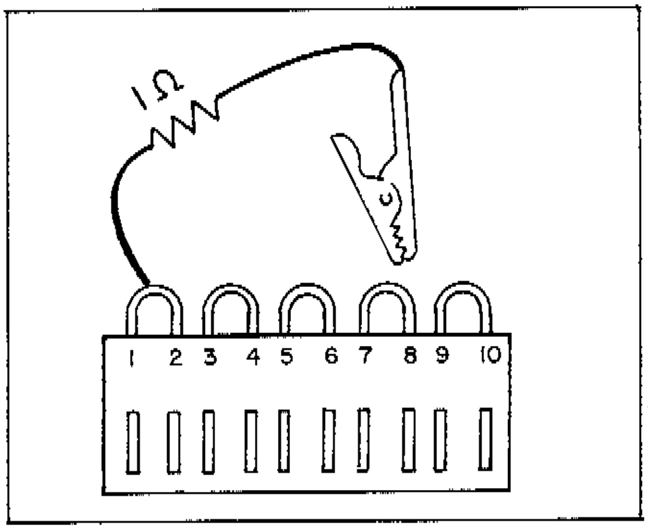


Figure 5-1. Current Limit Test Fixture.

5-10B. After the test fixture has been built, use the following procedure to adjust the current limit of the supplies.

CAUTION

The resistor used in this procedure gets HOT! Apply power only during the actual adjustment in order to reduce heating.

a. Complete the voltage adjustment procedure (Paragraph 5-10) before attempting to adjust any current limit.

b. With the instrument turned off, replace the connection of cable W8 to J2 with the test fixture.

c. Measure and note the line voltage.

d. Determine the specific adjustment and test fixture connection from Table 5-3.

Table 5-3. Current Limit Connections/Adjustments.

Power Supply	Connect Alligator Clip To	Adjust
−15	Jumper 3, 4	R27
+15	Jumper 5, 6	R25
−5.2	Jumper 7, 8	R54
+5.0	Jumper 9, 10	R29

e. Connect the voltmeter directly to the leads of the resistor. The ground of the voltmeter should go to the side of the resistor connected to jumper 1, 2.

f. Select the voltmeter readings column in Table 5-4 according to the line voltage noted in Step c. If the measured line voltage does not correspond to one of the columns, either use a variac to adjust it to 115 V ac or interpolate the voltmeter readings.

Table 5-4. Current Limit Voltmeter Readings.

Power Supply	105 V AC	Line Voltage 115 V AC	127 V AC
−15 V	−1.30 V	−1.47 V	−1.60 V
+15 V	1.27 V	1.33 V	1.43 V
−5.2 V	−2.22 V	−2.45 V	−2.62 V
+5.0 V	2.51 V	2.73 V	2.96 V

g. Adjust the appropriate potentiometer for the voltage indicated in Table 5-4. See Figure 5-6 for the locations of the current adjustments. If adjustment is impossible see Paragraph 5-6.

5-11. Temperature–Stabilized Oscillator Adjustments.

5-12. This adjustment procedure sets the 10 MHz temperature–stabilized oscillator frequency.

NOTE

This adjustment is required only if:

1. the 10 MHz REF OUTPUT does not meet the frequency specification;

2. the temperature-stabilized oscillator has been replaced;

3. a circuit repair was made to the oscillator interface assembly.

Equipment Required:
Oscilloscope, -hp- Model 180C/D/1805A/1824A
Quartz Oscillator, -hp- Model 105A/B

a. If the instrument contains Option 001 (high-stability crystal oscillator, A18 Assembly, 03335-66517) adjust the instrument as described in Paragraph 5-13.

b. The following steps apply only to the standard temperature-stabilized oscillator contained on the A17 Assembly (03335-66522).

c. The 3335A must be connected to ac power either in the ON or STBY power mode for at least 30 minutes prior to this adjustment.

NOTE

If adjustment for high frequency stability is required, warm-up time must be adjusted as described in Table 1-2, General Information.

d. Connect the Quartz Oscillator 5 MHz OUTPUT to an ac coupled input of one channel of the oscilloscope and trigger the display from this channel.

e. Connect the 3335A output to the second oscilloscope channel.

f. Program a 3335A frequency of 5 MHz and amplitude of + 13.01 dBm.

g. Set A17R11 (FINE FREQ ADJ) to mid-range.

h. Remove the bottom cover and through the rectangular hole beneath the oven in the floor panel assembly, remove the side FREQ ADJ screw from the A17A1 Assembly (oscillator can) to provide access to the adjustment.

i. With a non-metallic adjustment tool, adjust the A17A1 FREQ ADJ to stabilize the 3335A output trace on the oscilloscope (both signal traces should be stationary).

j. Expand the display to sweep one cycle or less.

k. If drift in the 3335A trace is detected, adjust A17R11 (FINE FREQ ADJ) to stabilize the oscilloscope trace.

l. This completes the adjustment. Disconnect the 3335A from the adjustment setup.

5-13. This procedure is for instruments containing Option 001. It sets the 10 MHz temperature-stabilized oscillator frequency.

a. The 3335A must be connected to ac power either in the ON or STBY power mode for at least 30 minutes prior to this adjustment.

NOTE

If adjustment for high frequency stability is required, warm-up time must be adjusted as described in Table 1-2, General Information.

b. Connect the Quartz Oscillator 5 MHz output to one channel of the oscilloscope and trigger the display from this channel.

c. Connect the 3335A output to the second oscilloscope channel.

d. Program a 3335A frequency of 5 MHz and amplitude of + 13.01 dBm.

e. With a non-metallic adjustment tool, adjust the A18A1 FREQ ADJ (oscillator can adjustment) to stabilize the 3335A output trace on the oscilloscope (both signal traces should be stationary).

f. Expand the display to sweep one cycle or less.

g. If drift in the 3335A trace is detected, adjust the A18A1 FREQ ADJ to stabilize (or nearly stabilize) the 3335A trace.

h. This completes the adjustment. Disconnect the 3335A from the adjustment setup.

NOTE

For all adjustments that follow, first perform the module troubleshooting/adjustment set-up procedure located in Service Group O. Second, fold out Figure 5-6 for a reference to all adjustment locations.

5-14. Reference VCXO Adjustments.

NOTE

See Note preceding Paragraph 5-14.

5-15. These adjustments center the automatic frequency control characteristic on 40 MHz and establish 40 MHz operation for a 0 V dc tune voltage.

Equipment Required:
Digital Voltmeter, -hp- Model 3455A
Spectrum Analyzer, -hp- Model 141T/8552B/8553B

a. Remove the A3 assembly and install it on an extender. Remove the BNC Jumper between the 10 MHz REF OVEN OUTPUT and the 40/N MHz REF INPUT rear panel connectors.

b. Connect the Spectrum Analyzer to the rear panel 10 MHz REF OVEN OUTPUT connector. Verify the signal is 10 MHz and all harmonics are ≤ - 40 dB.

c. Reconnect the BNC jumper between the 10 MHz REF OVEN OUTPUT connector and the 40/N MHz REF INPUT connector.

d. Set the Digital Voltmeter (DVM) to the dc volts function and connect it to A3TP1.

e. Set A3C21 (VCXO FREQ ADJ) to the full clockwise position.

f. Adjust A3C31 (GAIN ADJ) to obtain a minimum dc V reading at TP1. The minimum dc V should be approximately + 14.7 V.

g. Disconnect DVM and connect it to junction of A3R66 and A3U4 Pin 6.

h. Adjust A3C21 (VCXO FREQ ADJ) for a DVM reading of 0 V ± 0.3 V at A3U4 Pin 6.

i. Remove the DVM and install the A3 assembly in the module.

5-16. N Step Loop VCO Adjustments.

NOTE

See Note preceding Paragraph 5-14.

5-17. These adjustments establish the frequency tune voltage characteristic and the flatness response of the N Step Loop VCO.

Equipment Required:
Digital Voltmeter, -hp- Model 3455A
Spectrum Analyzer, -hp- Model 141T/3552B/3553B

a. Remove the A8 assembly (Summation Loop) from the module and install the A9 assembly on an extender.

b. Remove the VCO shield (both component and circuit side) on the A9 assembly and set A9L7 and A9R66 (FLATNESS ADJ) to the center of their adjustment range.

c. Connect the Digital Voltmeter (DVM) to A9TP3.

d. Set the 3335A frequency to 80 MHz and adjust A9L8 for a DVM reading as close to - 8.7 dc as can be adjusted. The voltage must be between 0 V and - 8.7 V dc.

e. Set the 3335A frequency to 40 MHz and check that the voltage at A9TP3 is ≤ + 8.7 V dc. If the voltage is > + 8.7 V dc, adjust A9L8 for + 8.7 V dc, set the frequency to 80 MHz and check that A9TP3 is ≥ - 8.7 V dc. It may be necessary to iterate the A9L8 adjustment at 40 MHz and 80 MHz until both limits are met. At 40 MHz, TP3 must be ≤ + 8.7 V dc and at 80 MHz it must be ≥ - 8.7 V dc. Adjust both end limits to be symmetrical about 0 V.

NOTE

If this adjustment cannot be made, replace varicaps A9CR3 and A9CR4.

f. Disconnect the DVM and connect the Spectrum Analyzer to the 39–79 MHz test point on Mother Board A1 of the module using service cable W1 (see Figure 8-49).

g. Set the Spectrum Analyzer to the linear mode.

h. Set the 3335A frequency to 40 MHz.

i. Adjust A9L7 for a peak reading on the Spectrum Analyzer.

j. Set the 3335A frequency to 60 MHz and program a SWEEP WIDTH of 40 MHz.

k. Press the START AUTO key in the FREQUENCY SWEEP key group.

l. With the 3335A now in the auto sweep mode sweeping from 40 MHz to 80 MHz (the N Step Loop VCO sweeps from 39 MHz to 79 MHz in 1 MHz steps), adjust A9R66 (FLATNESS ADJ) for flatness of ≤ 2 dB with the 39 MHz and 79 MHz end points of equal amplitude.

m. This completes the N Step Loop VCO adjustments. Disconnect the Spectrum Analyzer and install the VCO shield. Insert the Summation Loop Assembly (A8) and the N Step Loop (A9) into the module.

5-18. Fractional N (N.F) Loop Analog Adjustments.

NOTE

See Note preceding Paragraph 5-14.

5-19. The purpose of these adjustments is to tune the N.F Loop VCO frequency, adjust the tune voltage in the Sample/Hold section and calibrate the proportionality of the current sources in the API section.

Equipment Required:
Oscilloscope, -hp- Model 180C/D/1805A/1824A
Spectrum Analyzer, -hp- Model 141T/8552B/8553B

a. Place the A5 assembly on an extender and connect the Oscilloscope to the dotted end of A5C26 (Integrator capacitor)

b. Set the 3335A frequency to 1 MHz and adjust A5L7 of the VCO tank circuit for the waveform of Figure 5-2.

c. Disconnect the oscilloscope, remove extender board and place the A5 assembly into the module. Replace the screws before continuing.

d. Set the 3335A FREQUENCY to 20.5 kHz, AMPLITUDE to + 13.01 dBm and FREQ INCR to 10 kHz.

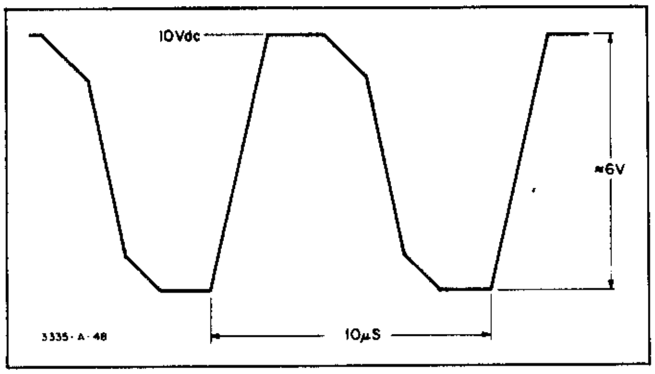


Figure 5-2. A5L7 Adjustment Waveform.

e. Connect the Spectrum Analyzer to the A6, OUTPUT AMPLIFIER's output connector located on the A6 assembly front extrusion (MP1).

f. Set the Spectrum Analyzer to 20.5 kHz MANUAL SWEEP MODE, 3 Hz BW and tune in the signal (obtain maximum amplitude display).

g. Press the INCR down key to set the frequency at 10.5 kHz.

h. Adjust A5R45 (API 1 ADJ) for a null of the Spectrum Analyzer display (< - 80 dB).

i. Set the 3335A FREQUENCY to 20.05 kHz.

j. Set the Spectrum Analyzer to 20.05 kHz and tune in the signal.

k. Press the INCR down key to set the FREQUENCY at 10.05 kHz.

l. Adjust A5R43 (API 2 ADJ) for a null of the Spectrum Analyzer display (< - 80 dB).

5-20. Summation Loop VCO Adjustments.

NOTE

See Note preceding Paragraph 5-14.

5-21. These adjustments establish the frequency tune voltage characteristic and the flatness response of the VCO. The adjustments procedure is identical to that for the N Step Loop VCO.

Equipment Required:
Digital Voltmeter, -hp- Model 3455A
Spectrum Analyzer, -hp- Model 141T/3552B/3553B

a. Remove the A2 assembly (Divider-Filter) from the module. This assembly is to be set aside while Summation Loop adjustments are made.

b. Remove the VCO Phase Detector shields on the A8 assembly and set A8L15 and A8R76 (FLATNESS ADJ) to the center of their adjustment range.

c. Connect the Digital Voltmeter (DVM) to A8TP3.

d. Set the 3335A frequency to 80 MHz and adjust A8L16 for a DVM reading as close to - 8.7 V dc as can be adjusted. The voltage must be between 0 V and - 8.7 V dc.

e. Set the 3335A frequency to 40 MHz and check that the voltage at A8TP3 is ≤ + 8.7 V dc. If the voltage is > + 8.7 V dc, adjust A8L16 for + 8.7 V dc, set the frequency to 80 MHz and check that A8TP3 is ≥ - 8.7 V dc. It may be necessary to iterate the A8L16 adjustment at 40 MHz and 80 MHz until both limits are met. At 40 MHz, TP3 must be ≤ 8.7 V dc and at 80 MHz it must be

≥ - 8.7 V dc. Adjust both end limits to be symmetrical about 0 V.

NOTE

If this adjustment cannot be made, replace varicaps A8CR9 and A8CR10.

f. Disconnect the DVM and connect the Spectrum Analyzer to the 40–80 MHz test point on Mother Board A1 or the module (see Figure 5-6).

g. Set the Spectrum Analyzer to the linear mode.

h. Set the 3335A frequency to 40 MHz.

i. Adjust A8L15 for a peak reading on the Spectrum Analyzer.

j. Set the 3335A frequency to 60 MHz and program a SWEEP WIDTH of 40 MHz.

k. Press the START AUTO key in the FREQUENCY SWEEP key group.

l. With the 3335A now in the AUTO SWEEP mode sweeping from 40 MHz to 80 MHz (the Summation Loop VCO sweeps from 40 MHz to 80 MHz), adjust A8R76 (FLATNESS ADJ) for a serial response of < 2 dB with the 40 MHz and 80 MHz end points of equal amplitude.

m. This completes the Summation Loop VCO Adjustments. Disconnect the Spectrum Analyzer and install the VCO and Phase Detector shields. Insert the Divider-Filter Assembly (A2) and the Summation Loop (A8) into the module.

5-22. Filter Adjustments.

NOTE

The Divider-Filter Low-Pass Filter Bank adjustments normally will not be required. Do not perform a filter adjustment unless the following test (Steps a through f) indicates it is required. Refer to Note preceding Paragraph 5-14.

a. Disconnect the Divider-Filter cable at the A6 assembly and remove the A6 assembly from the module.

b. Place the Divider-Filter assembly, A2, on an extender.

c. Short TP LC to TP LCT.

d. Program a FREQUENCY of 10 MHz and a FREQ INCR of 1 MHz.

e. Monitor the output of the Divider-Filter assembly at the disconnected cable with a 50 ohm input impedance oscilloscope. The output level should be 0 dBm ± 3 dB.

f. Increment the frequency. The output level should be 0 dBm ± 3 dB for all frequencies from 10 MHz to 80 MHz. If the output from the Divider-Filter is within ± 3 dB, filter adjustments are not required. If certain frequencies are out of range, determine the filter activated and adjust it by the following procedure.

5-23. Divider-Filter Low-Pass Filter Bank Adjustments. These adjustments align the band edge and flatness of the low-pass filters on the Divider-Filter assembly, A2.

Equipment Required:
Tracking Generator -hp- Model 8443A
Spectrum Analyzer -hp- Model 141T/3552B/3553B

a. Remove the Divider-Filter assembly, A2, from the module. All filter adjustments are made while the assembly is disconnected from the module.

b. Connect the Spectrum Analyzer with a 50 ohm input impedance to the output connector of the filter to be adjusted. The location of each filter, adjustment location and filter input and output is shown in Figure 5-3. Adjust only those filters requiring alignment. The following Steps c through i apply to each filter listed in Table 5-5.

NOTE

Keep cable lengths between filter pins and instrumentation as short as possible.

c. Connect a Tracking Generator to the input connector of the filter. Set the output level to - 10 dBm.

d. Set the marker frequency to f1 shown in Table 5-5.

e. Adjust the left-most adjustment (see Table 5-5) for a minimum reading on the spectrum analyzer.

Table 5-5. Filter Adjustment Data.

f0 Low Pass Filter	f1 (MHz)	f2 (MHz)	Filter Adjustment		
			Left-Most	Middle	Right-Most
14 MHz	19.6	22.7	L28	L29	L30
20 MHz	28.0	32.4	L24	L25	L26
28 MHz	39.1	45.3	L20	L21	L22
40 MHz	55.9	64.7	L16	L17	L18
56 MHz	78.3	90.6	L12	L13	L14
80 MHz	112	130	L37	L38	L39

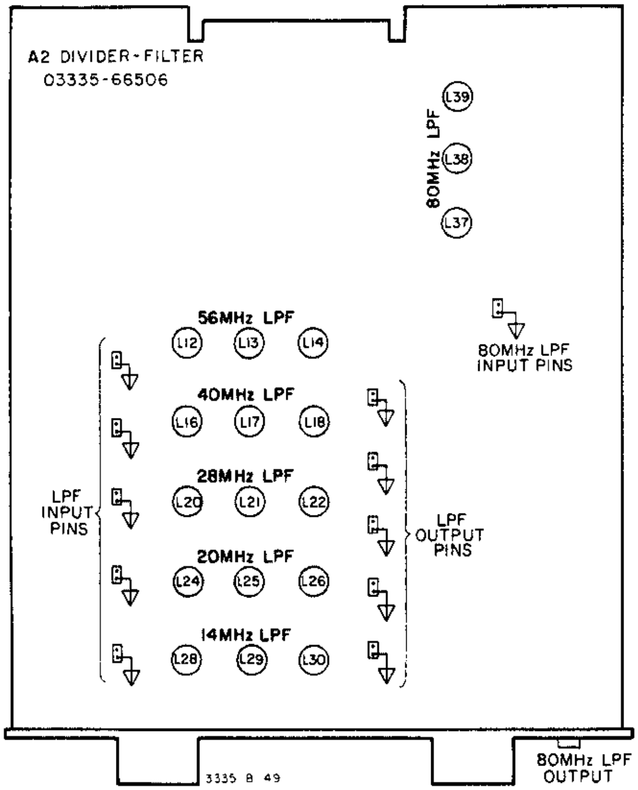


Figure 5-3. Filter Adjustment Location.

f. Set the marker frequency to f2 shown in Table 5-5.

g. Adjust the middle filter adjustment (see Table 5-5) for a minimum reading on the spectrum analyzer.

h. With the Tracking Generator, sweep the filter across the band edge (roll off) and adjust the right-most adjustment (see Table 5-5) for the best approximation of an ideal band edge as shown in Figure 5-4. Two examples of an improperly adjusted filter are shown in Figure 5-5.

i. Repeat Steps d to h once to compensate for adjustment interaction.

j. Install the A6 assembly in the module.

5-24. Mixer 40 MHz Bandpass Filter Adjustments.

5-25. This adjustment reduces the harmonic components of the 40 MHz reference signal to prevent undesired products from occurring in the mixer.

Equipment Required:
Spectrum Analyzer, -hp- Model 141T/8552B/8553B
Active Probe, -hp- Model 1120A

a. Remove the A6 assembly from the module and place the A7 assembly on an extender.

b. Remove shield MP3 covering the connection of cable W2 to L15.

c. Connect the Spectrum Analyzer, through the -hp- 1120A Active Probe, to the connection of cable W2 and L15.

d. Set the -hp- 3335A frequency to 1 MHz.

e. Short test point LC to test point LCT. This connection will turn the modulator on.

f. Adjust A7L9 and A7L10 for maximum signal indication on the spectrum analyzer. It will be necessary to work back and forth between these two adjustments because of their interaction.

g. Set the Spectrum Analyzer to the 2 dB log mode. Adjust R24 for 0 dBm indication on the Spectrum Analyzer. This is a cursory adjustment that makes subsequent adjustments easier.

h. Remove the short between test point LC and test point LCT. Replace shield MP3.

5-26. Mixer 10 MHz LPF Adjustment.

5-27. This adjustment establishes the amplitude flatness of the 10 MHz LPF located on the Mixer assembly, A7. All module assemblies must be installed and working properly before making this adjustment.

Equipment Required:
Spectrum Analyzer, -hp- Model 141T/3552B/3553B

a. Remove the A6 assembly from the module and place the A7 assembly on an extender. Connect a short between test points LC and LCT. (This fixes the dc control voltage applied to the modulator.)

b. Connect a spectrum analyzer to the module Mother Board 0–10 MHz test point.

c. Set the 3335A output parameters as follows:

FREQUENCY . . . . 5 000 099.999 Hz
SWEEP WIDTH. . . . . 9 999 799.000 Hz
AMPLITUDE . . . . + 13.01 dBm

d. Press the AUTO SWEEP key.

e. Adjust A7C38, C39 and R90 for best flatness.

f. Remove short from test points and install the A6 and A7 assemblies.

5-28. Output Amplifier Adjustments.

NOTE

See Note preceding Paragraph 5-14.

5-29. The purpose of these adjustments is to ensure that the output signal from the output amplifier does not contain a dc component.

Equipment Required:
Digital Voltmeter, -hp- Model 3455A

a. Install the A7 Assembly (Mixer) and the A6 Assembly (Output Amplifier and Level Control) on extenders.

b. Set the 3335A FREQUENCY to 10 kHz.

c. Set A6R85 (BIAS ADJ) to the midrange position.

d. Connect the Digital Voltmeter (DVM) to A6TP6.

e. Ground A6TP5.

f. Adjust A6R85 (BIAS ADJ) for 0 V ± .01 V dc at A6TP6.

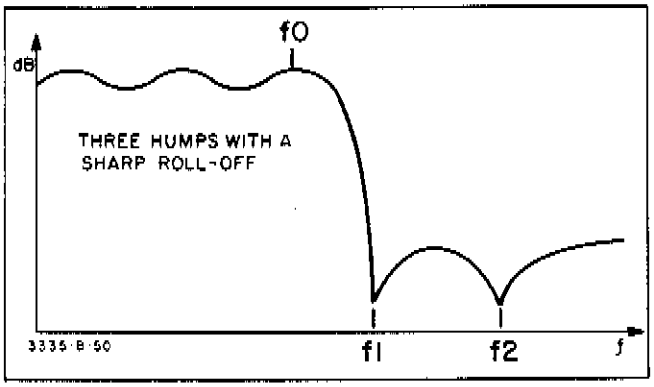


Figure 5-4. Ideal Filter Characteristics.

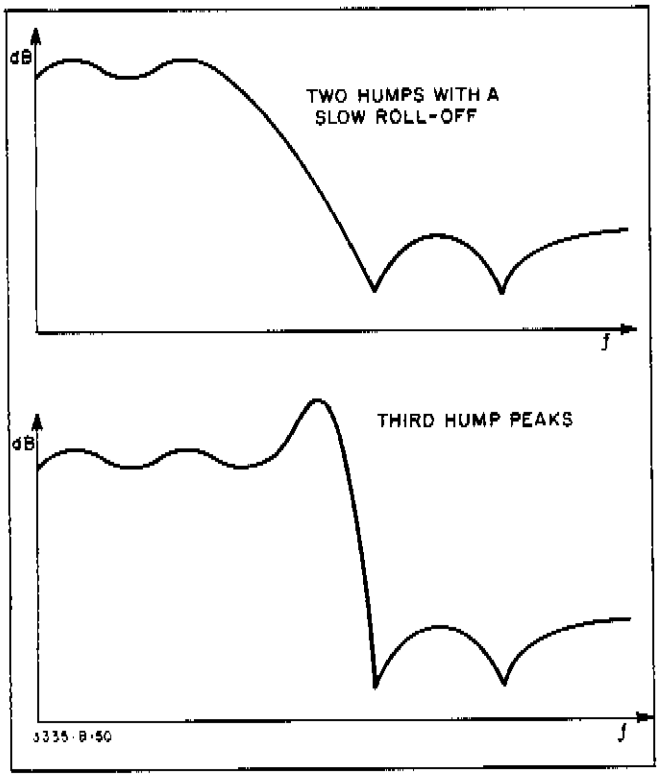


Figure 5-5. Improperly Adjusted Filter Characteristics.

g. Remove ground from A6TP5.

h. Adjust A7R92 (DC NULL ADJ) for 0 V ± .01 V dc at A6TP6.

5-30. Level Control Loop Adjustments.

NOTE

See Note preceding Paragraph 5-14.

5-31. The purpose of these adjustments is to set the - 10 V reference, establish the operation of the ac-to-dc converter, establish the 1.99 dB attenuation range of the loop and set the operation of the external leveling amplifier.

Equipment Required:
Digital Voltmeter, -hp- Model 3455A
Oscilloscope, -hp- Model 180C/D/1805A/1824A
50 Ω Feedthru Termination, -hp- Model 11048C
For Options 002 & 003 the following is also required:
75 Ω Feedthru Termination, -hp- Model 11094B
(2) Connector Adapter, -hp- Part No. 1250-0591

a. Verify that the + 15 V jumper between + 15 V and the LEVELING switch connector of the A1 Mother Board is properly installed. (This puts the instrument in the INTERNAL LEVEL mode of operation).

b. Set the Digital Voltmeter (DVM) to the dc FUNCTION, auto range and connect it to A6TP3.

c. Adjust A6R144 (−10 V ADJ) for a DVM reading of −10 V ± .01 V.

d. Set the 3335A frequency to 10 kHz.

e. Connect an alligator clip across the two pins of A6TP1.

f. Connect the Oscilloscope to A6TP2. Set the Oscilloscope to the dc coupled mode.

g. Adjust A6R122 (THERM CONV. BAL ADJ) for + 1.4 V ± 0.1 V at TP2.

h. Slowly adjust A6R122 in the CCW direction until the integrator (U4) begins to integrate in the negative direction. This is detected by the Oscilloscope at TP2 showing a decreasing dc voltage from that of the previous step. Verify that the rate of change of the decreasing voltage is ⩽ 1 V per second.

NOTE

If uncertain of the rate of change, adjust A6R122 slowly in the CW direction causing the voltage at TP2 to change in a positive direction. Check that the rate of change is ⩽ 1 V per second.

i. Remove short from TP1 and remove oscilloscope from TP2.

j. Insert the A6 assembly in the module.

k. Set amplitude to +13.01 dBm and frequency to 100 kHz.

l. Connect the DVM to the output connector of the A6 assembly through a 50 ohm feedthrough termination.

m. Adjust A6R147 (+ 13.01 dBm ADJ) for a voltmeter reading of 1 V ± .005 V. Note and record the difference from 1 V.

n. Set the 3335A amplitude to + 11.02 dBm.

o. Adjust A6R150 (+11.02 dBm ADJ) for the DVM reading stated in Table 5-6 corresponding to the difference recorded in Step m.

p. Install the A2 and A7 assemblies on extenders.

q. Set amplitude to + 13.01 dBm and frequency to 10 kHz.

Table 5-6. +11.02 dBm ADJ Specifications.

A6R147 + 13.01 dBm ADJ Difference	A6R150, + 11.02 dBm ADJ Adjustment Specification*
+ .005 V	+ .799 ± .001
+ .004 V	+ .798 ± .001
+ .003 V	+ .797 ± .001
+ .002 V	+ .797 ± .001
+ .001 V	+ .796 ± .001
± .000 V	+ .795 ± .001
- .001 V	+ .794 ± .001
- .002 V	+ .793 ± .001
- .003 V	+ .793 ± .001
- .004 V	+ .792 ± .001
- .005 V	+ .791 ± .001

*Adjustment specification is derived from the following formula:

Spec. = + 0.795 + [(0.79) x (Difference recorded in step M)] ± .001 V

r. Connect the DVM set to the dc FUNCTION, auto range, to test point LC (Level Control) on the module Mother Board, A1 (see Figure 5-6)

s. Adjust A7R24 (MOD LEVEL ADJ on Mixer Assy) for a DVM reading of + 1.75 V ± .05 V at TP LC.

t. Remove the A7 assembly from the extender and install in the module.

u. Set the 3335A frequency to 9.999 MHz, the amplitude to 13.01 dBm and record the DVM reading of TP LC.

v. Set the 3335A frequency to 10 MHz and amplitude to + 13.01 dBm.

w. Adjust A2R37 (MOD LEVEL ADJ on Divider-Filter Assembly) for the same DVM reading as noted in Step u for a frequency of 9.999 MHz.

x. Install the A2 assembly in the module.

y. Install the A6 assembly on an extender, set the 3335A frequency to 10 kHz and remove the jumper between LEVEL SW. pin and + 15 pin on A1 Mother Board.

z. Connect the DVM to the A6 assembly output through a 50 ohm feedthrough termination and adjust A6R164 for a DVM reading of +0.5 V ± 0.1 VAC.

aa. Install the A6 assembly into the module and install the module in the chassis. Connect the semi-rigid coaxial cable from A6 assembly to attenuator. Install the top cover.

bb. Allow the 3335A to operate for 30 minutes undesturbed.

cc. After 30 minutes, connect the Oscilloscope to the 3335A output and verify a frequency of 10 kHz.

dd. Disconnect the oscilloscope and connect the DVM to the 3335A output. (STD: 50 ohm output through 50 ohm termination, Option 002 and 003: 75 ohm output through 75 ohm termination).

ee. If the DVM does not read 1 V ± .005 V (+13.01 dBm = 1 V rms into 50 ohms, +11.25 dBm = 1 V rms into 75 ohms), use a short screwdriver to readjust A6R147 (+13.01 dBm ADJ) for a DVM reading of 1 V ± .005 V and record the difference from 1 V.

NOTE

DO NOT remove the A6 assembly from the module for this adjustment.

ff. For a 50 ohm output, program an amplitude of +11.02 dBm (for 75 ohm output, program +9.26 dBm), readjust A6R150 (+11.02 dBm ADJ) for a DVM reading as specified in Table 5-6.

gg. This completes the Level Control Loop Adjustments. Remove the DVM.

5-32. Carrier Balance Adjustment.

NOTE

See Note preceding Paragraph 5-14.

5-33. This adjustment provides a smooth transition from frequencies below 10 MHz to frequencies above 10 MHz.

Equipment Required:
Oscilloscope, -hp- 180C/D, 1805A, 1825A

a. Place the A6 and A7 assemblies on extender boards.

b. Connect the Oscilloscope to the output of the A6 board.

c. Terminate the output of the A6 assembly with a 50 ohm resistor or, if available, use the 50 ohm Oscilloscope Input impedance.

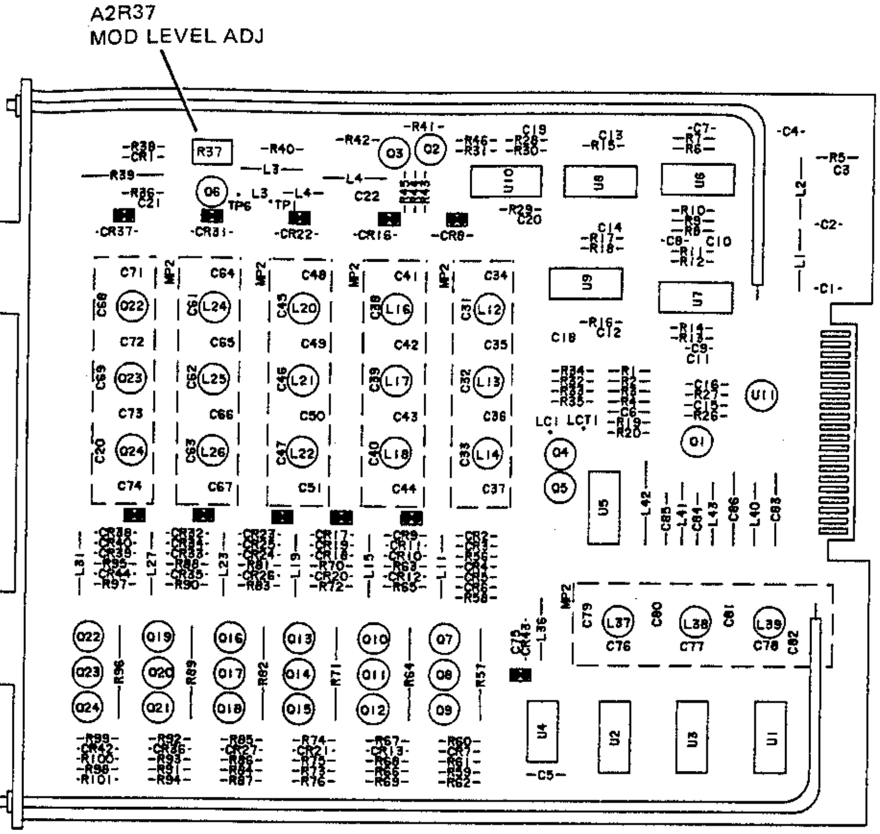
d. Set the -hp- 3335A output parameters as follows:

FREQUENCY . . . . 10 MHz
SWEEP WIDTH. . . . . .10 Hz
AMPLITUDE . . . . +13.01 dBm

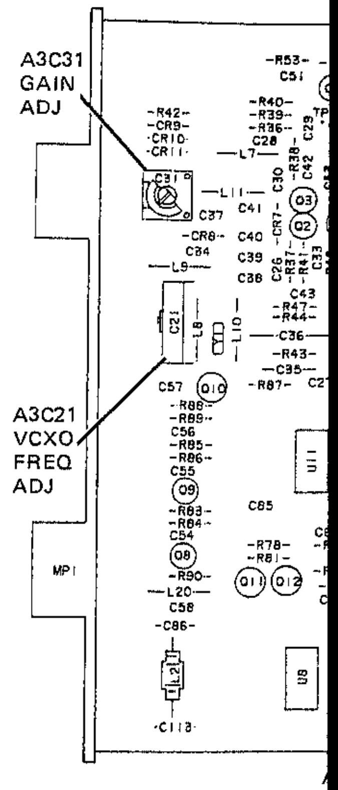
e. Press the Auto Sweep key.

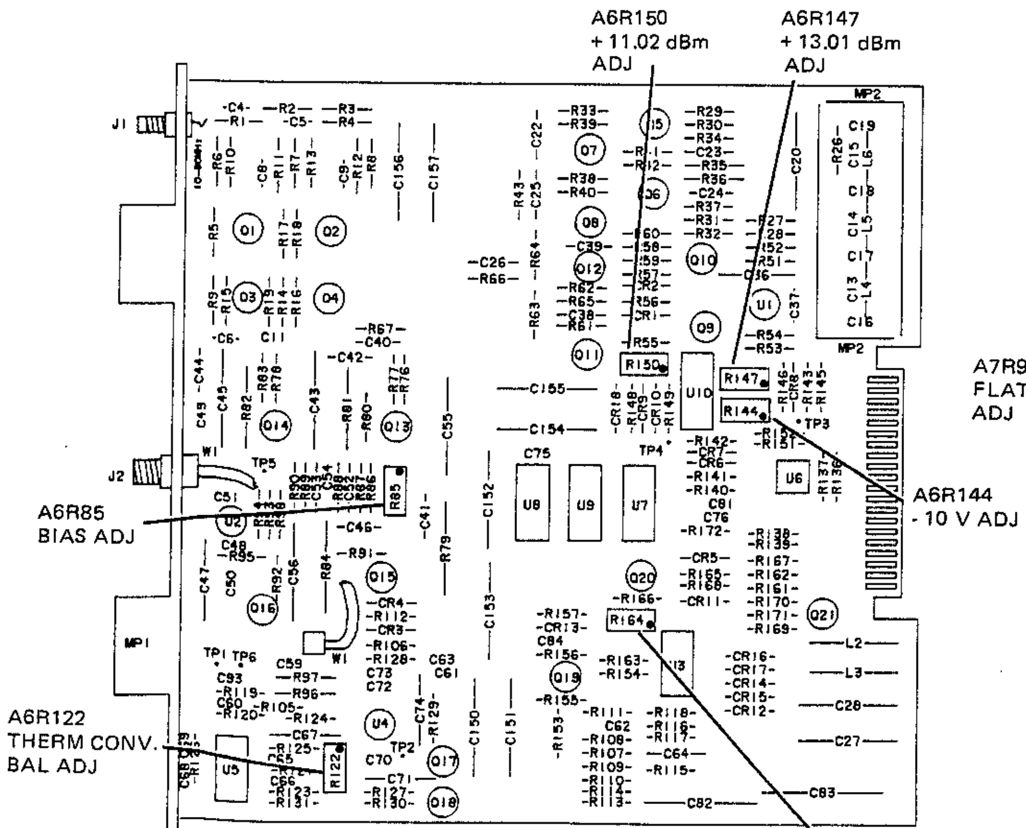
f. Adjust A7R68 for a smooth transition through 10 MHz.

Fig. 5-5
Sht 1 of 4

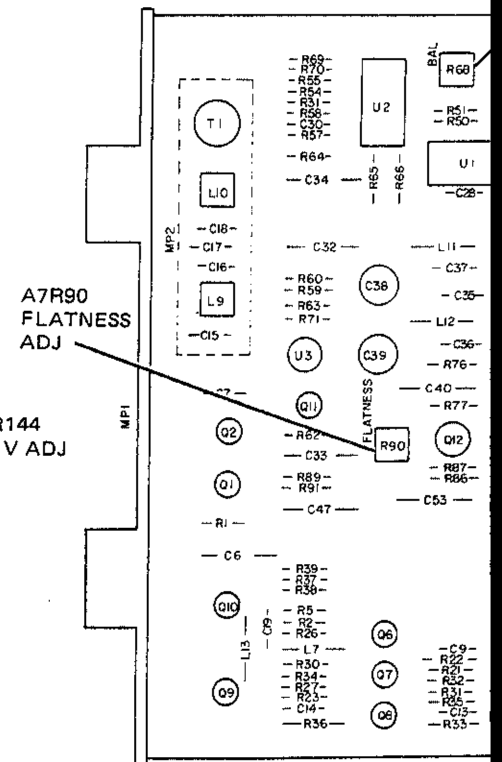


A2 DIVIDER—FILTER 03335-66536



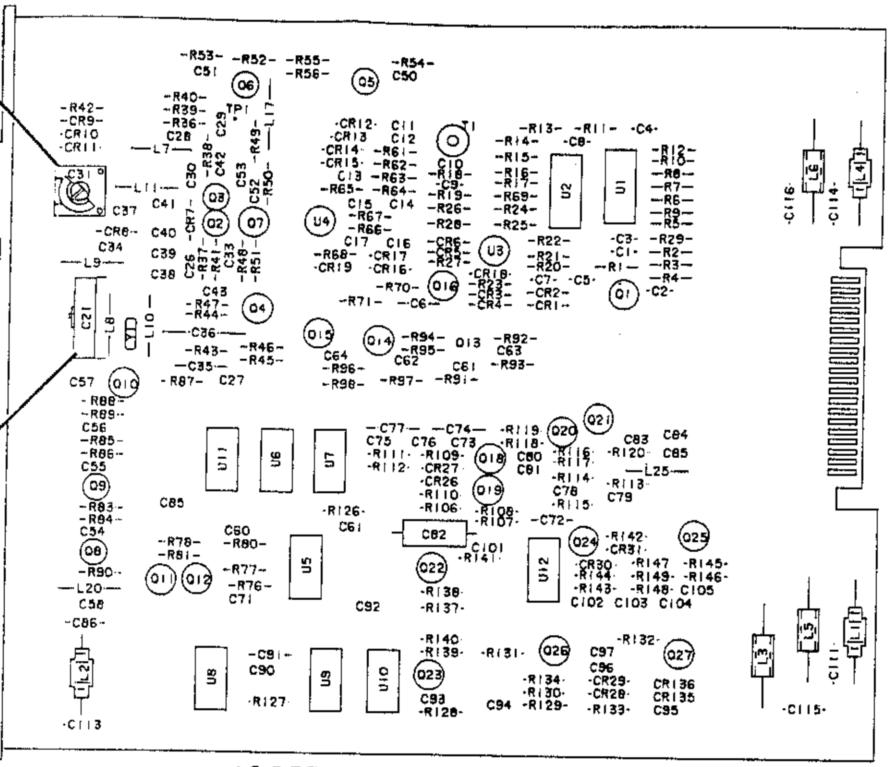


A6 OUTPUT AMP/LEVEL CONTROL 03335-66538

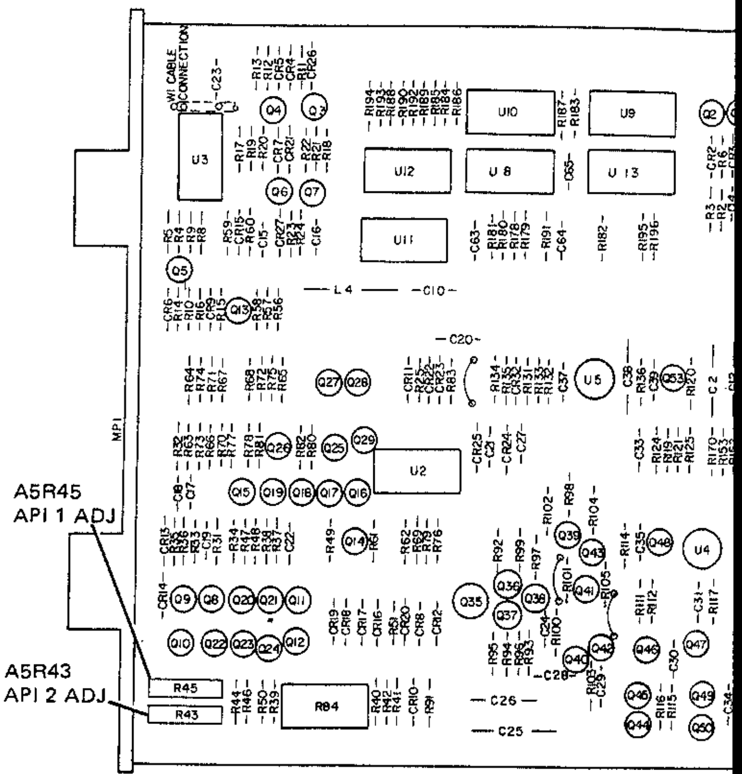


A7 MIXE

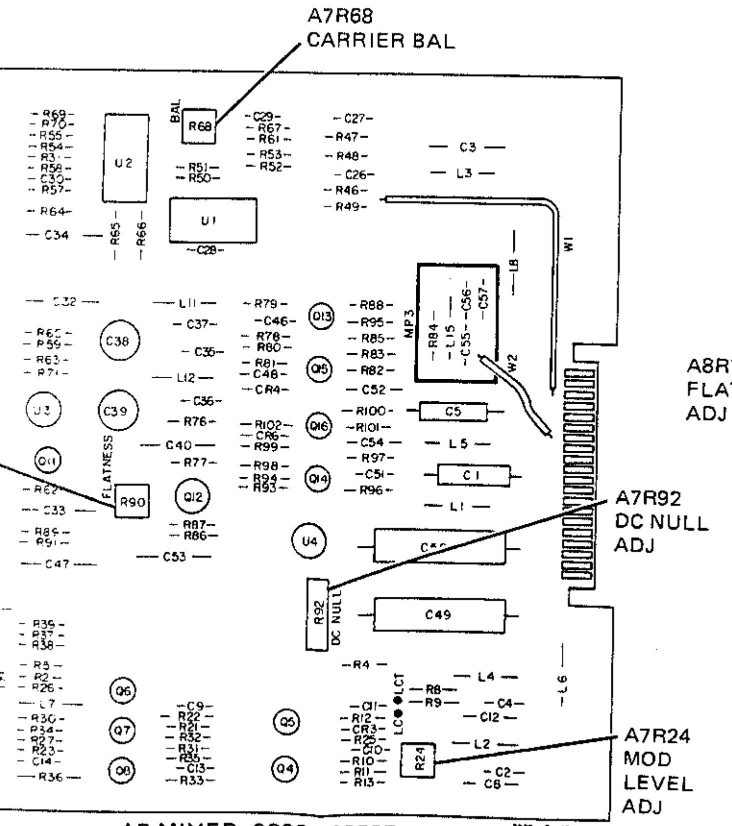
Fig 5-5
Sht 2 of 4



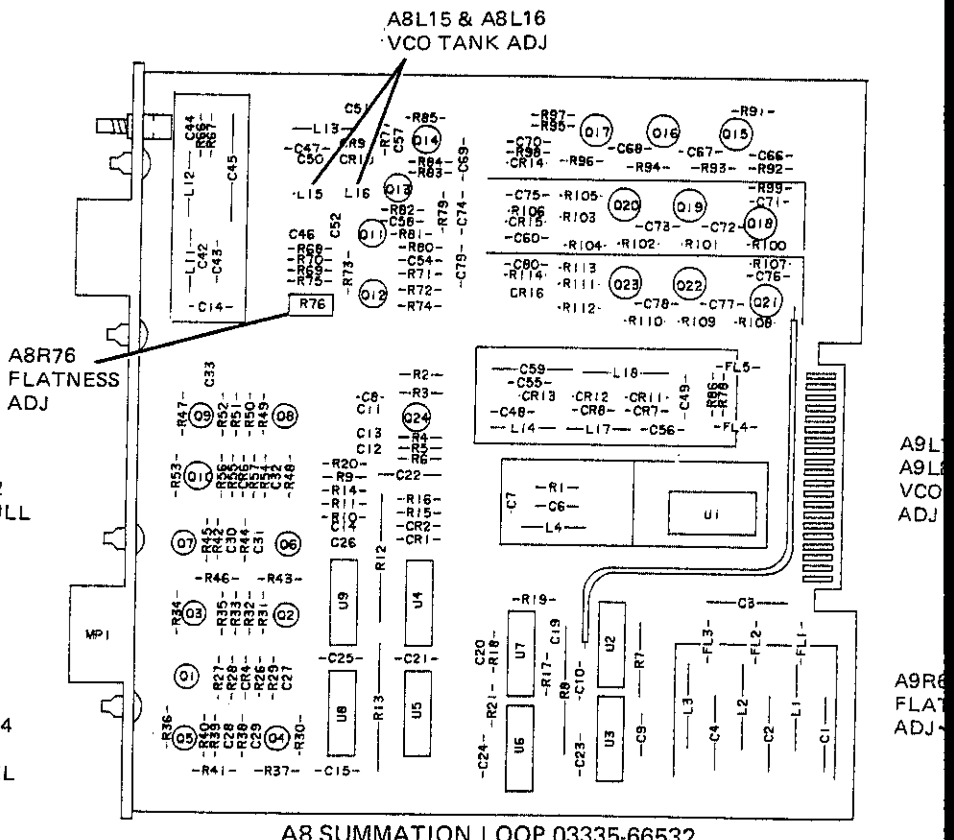
A3 REFERENCE 03335-66505



A5 FRACTIONAL—N ANALOG 0333

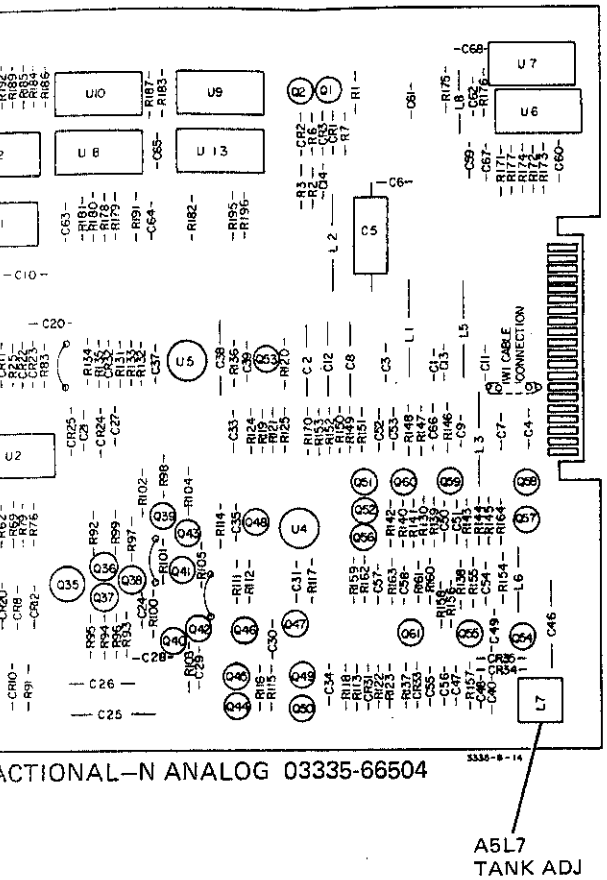


A7 MIXER 03335-66507

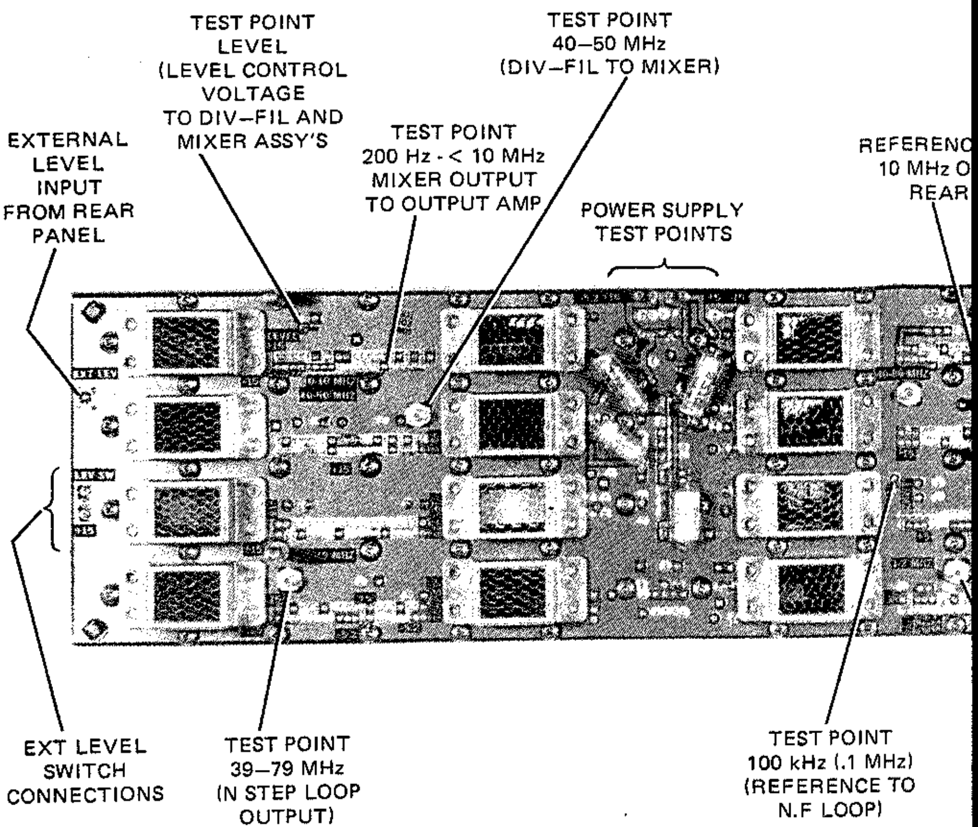


A8 SUMMATION LOOP 03335-66532

Fig 5-5
Sht 3 of 4

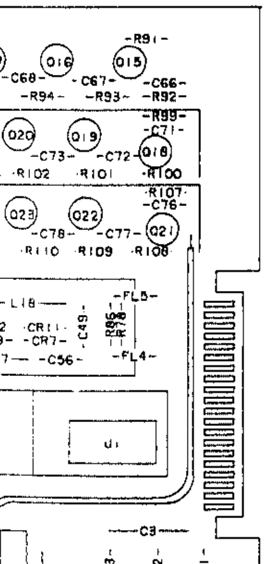


ACTIONAL–N ANALOG 03335-66504

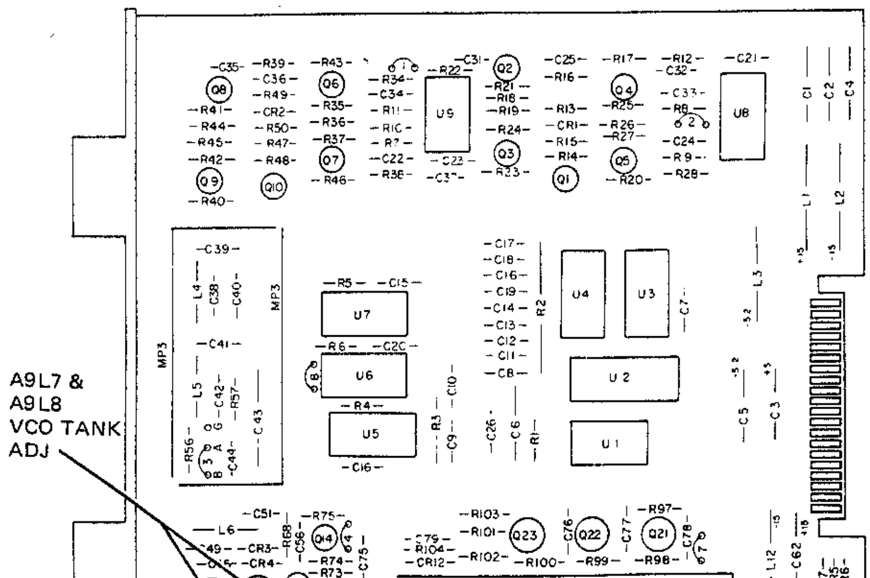


A1 MOTHER 03335-66515 (TEST CONNECTOR LOCATI

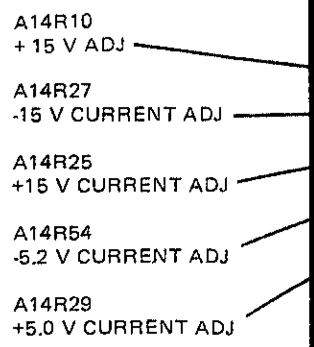
PO



35-66532

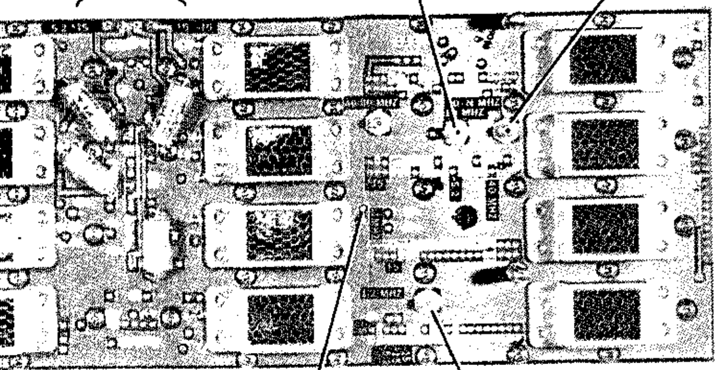


A9 N STEP LOOP 03335-66501

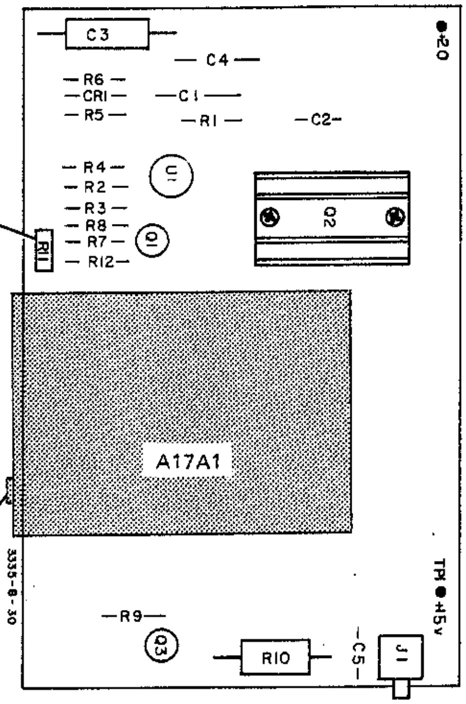


NOTE: INSTRUMENTS
AND LOWER DO NOT

Fig 5-5
Sht 4 of 4

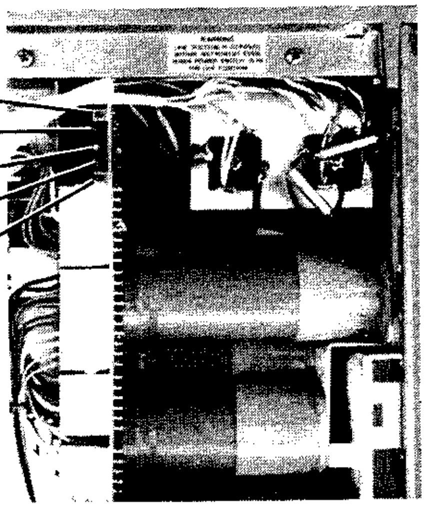


35-66515 (TEST CONNECTOR LOCATIONS)

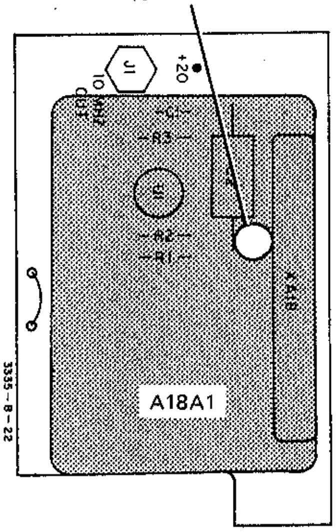


A17 TEMP–STABILIZED OSCILLATOR INTERFACE (STANDARD) 03335-66522

POWER SUPPLY SECTION



NOTE: INSTRUMENTS WITH SERIAL NUMBER 1640A00215 AND LOWER DO NOT HAVE CURRENT ADJUSTMENTS.



A18 TEMP–STABILIZED OSCILLATOR INTERFACE (OPTION 001) 03335-66517

3335-C-52

Figure 5-5. Adjustment Locations.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-3 lists parts in alphanumeric order of their reference designators and indicates the description, -hp- Part Number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (Qty column). The total quantity of a part is given the first time the part number appears.

b. Description of the part. (See list of abbreviations in Table 6-1.)

c. Typical manufacturer of the part is a five-digit code. (See Table 6-2 for list of manufacturers.)

d. Manufacturer's part number.

6-3. Miscellaneous parts are listed in Table 6-3 following their respective assemblies. General miscellaneous parts are listed at the conclusion of Table 6-3.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix A for list of office locations.) Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

6-6. NON–LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.
b. Instrument serial number.
c. Description of the part.
d. Function and location of the part.

6-8. PROPRIETARY PARTS.

6-9. Items marked by a dagger (†) in the reference designator column are available only for repair and service of Hewlett-Packard instruments.

6-10. PRINTED CIRCUIT ASSEMBLIES.

6-11. Printed circuit assemblies are listed in Table 6-3. An itemized parts listing of each assembly is located in the service group associated with the assembly. Table 6-3 indicates the service group associated with each printed circuit assembly.

Table 6-1. List of Abbreviations.

ABBREVIATIONS

Ag	silver
Al	aluminum
A	ampere(s)
Au	gold
C	capacitor
cer	ceramic
coef	coefficient
com	common
comp	composition
conn	connection
dep	deposited
DPDT	double-pole double-throw
DPST	double-pole single-throw
elect	electrolytic
encap	encapsulated
F	farad(s)
FET	field effect transistor
fxd	fixed
GaAs	gallium arsenide
GHz	gigahertz = 10^{+9} hertz
gd	guard(ed)
Ge	germanium
gnd	ground(ed)
H	henry(ies)
Hg	mercury
Hz	hertz (cycle(s) per second)
ID	inside diameter
impg	impregnated
incd	incandescent
ins	insulation(ed)
kΩ	kilohm(s) = 10^{+3} ohms
kHz	kilohertz = 10^{+3} hertz
L	inductor
lin	linear taper
log	logarithmic taper
mA	milliampere(s) = 10^{-3} amperes
MHz	megahertz = 10^{+6} hertz
MΩ	megohm(s) - 10^{+6} ohms
met flm	metal film
mfr	manufacturer
ms	millisecond
mtg	mounting
mV	millivolt(s) = 10^{-3} volts
μF	microfarad(s)
μs	microsecond(s)
μV	microvolt(s) = 10^{-6} volts
my	Mylar®
nA	nanoampere(s) = 10^{-9} amperes
NC	normally closed
Ne	neon
NO	normally open
NPO	negative positive zero (zero temperature coefficient)
ns	nanosecond(s) = 10^{-9} seconds
nsr	not separately replaceable
Ω	ohm(s)
obd	order by description
OD	outside diameter
p	peak
pA	picoampere(s)
pc	printed circuit
pF	picofarad(s) 10^{-12} farads
piv	peak inverse voltage
p/o	part of
pos	position(s)
poly	polystyrene
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
prec	precision (temperature coeffient, long term stability and/or tolerance)
R	resistor
Rh	rhodium
rms	root-mean-square
rot	rotary
Se	selenium
sect	section(s)
Si	silicon
sl	slide
SPDT	single-pole double-throw
SPST	single-pole single-throw
Ta	tantalum
TC	temperature coefficient
TiO_2	titanium dioxide
tog	toggle
tol	tolerance
trim	trimmer
TSTR	transistor
V	volt(s)
vacw	alternating current working voltage
var	variable
vdcw	direct current working voltage
W	watt(s)
w/	with
wiv	working inverse voltage
w/o	without
ww	wirewound
*	optimum value selected at factory, average value shown (part may be omitted)
**	no standard type number assigned selected or special type
®	Dupont de Nemours

DESIGNATORS

A	assembly
B	motor
BT	battery
C	capacitor
CR	diode
DL	delay line
DS	lamp
E	misc electronic part
F	fuse
FL	filter
HR	heater
IC	integrated circuit
J	jack
K	relay
L	inductor
M	meter
MP	mechanical part
P	plug
Q	transistor
QCR	transistor-diode
R	resistor
RT	thermistor
S	switch
T	transformer
TB	terminal board
TC	thermocouple
TP	test point
TS	terminal strip
U	microcircuit
V	vacuum tube, neon bulb,photocell, etc.
W	cable
X	socket
XDS	lampholder
XF	fuseholder
Y	crystal
Z	network

Table 6-2. Code List of Manufacturers.

Manufacturer Number	Manufacturer Name	Address
H9027	Schurter A G H	Luzern, Switzerland
0011J	Jermyn Industries	
0086S	Stettner—Trush Inc	Cazenovia, NY 13035]
01121	Allen-Bradley Co	Milwaukee, WI 53212
01295	Texas Instr Inc Semicond Cmpnt Div	Dallas, TX 75231
02113	Coilcraft Inc	Cary, IL 60013
02114	Ferroxcube Corp	Saugerties, NY 12477
02735	RCA Corp Solid State Div	Sommerville, NJ 08876
03877	Transitron Electronic Corp	Wakefield, MA 01880
03888	KDI Pyrofilm Corp	Whippany, NJ 07981
04713	Motorola Semiconductor Products	Phoenix, AZ 85008
06560	Airco Speer Elek Div Air Rdcn Co	Nogales, AZ 85621
06665	Precision Monolithics Inc	Santa Clara, CA 95050
06915	Richco Plastic Co	Chicago, IL 60646
07263	Fairchild Semiconductor Div	Mountain View, CA 94040
09023	Cornell-Dubilier Elek Div Fed Pac	Sanford, NC 27330
11237	CTS Keene Inc	Paso Robles, CA 93446
11502	TRW Inc Boone Div	Bonne, NC 28607
14604	Elmwood Sensors Inc	Cranston, RI 02907
15818	Teledyne Semiconductor	Mountain View, CA 94040
18324	Signetics Corp	Sunnyvale, CA 94086
19701	Mepco/Electra Corp	Mineral Wells, TX 76067
24226	Gowanda Electronics Corp	Gowanda, NY 14070
24355	Analog Devices Inc	Norwood, MA 02062
24546	Corning Glass Works (Bradford)	Bradford, PA 16701
24931	Specialty Connector Co Inc	Indianapolis, IN 46227
27014	National Semiconductor Corp	Santa Clara, CA 95051
27264	Molex Products Co	Downers Grove, IL 60515
28480	Hewlett-Packard Co Corporate HQ	Palo Alto, CA 94304
32997	Bourns Inc Trimpot Prod Div	Riverside, CA 92507
34335	Advanced Micro Devices Inc	Sunnyvale, CA 94086
56289	Sprague Electric Co	North Adams, MA 01247
70674	A D C Prod Div Magnetic Controls Co	Minneapolis, MN 55435
71785	TRW Elek Components Cinch Div	Elk Grove Village, IL 60007
72136	Electro Motive Corp Sub IEC	Willimantic, CT 06226
73138	Beckman Instruments Inc Helipot Div	Fullterton, CA 92634
74970	Johnson E F Co	Waseca, MN 56093
75915	Littelfuse, Inc	Des Plaines, IL 60016
8G464	Bergquist Co	Minneapolis, MN 55420
82389	Switchcraft Inc	Chicago, IL 60630
9D949	Amphenol Sales Div of Bunker-Ramo	Hazelwood, MO 63042
91637	Dale Electronics Inc	Columbus, NE 68601
95121	Quality Components Inc	St. Marys, PA 15857
95146	Alco Electronic Products, Inc	Lawrence, MA 01843
98291	Sealectro Corp	Mamaroneck, NY 10544

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			ASSEMBLIES		
A1	03335-66515	1	MOTHER BOARD (ITEMIZED PARTS LIST IN SERVICE GROUP O)	28480	03335-66515
A2	03335-66536	1	DIVIDER-FILTER ASSEMBLY (ITEMIZED PARTS LIST IN SERVICE GROUP L)	28480	03335-66536
A3	03335-66505	1	REFERENCE ASSEMBLY (ITEMIZED PARTS LIST IN SERVICE GROUP H)	28480	03335-66505
A4	03335-66503	1	FRACTIONAL N LOOP-DIGITAL (ITEMIZED PARTS LIST IN SERVICE GROUP J)	28480	03335-66503
A5	03335-66504	1	FRACTIONAL N LOOP-ANALOG (ITEMIZED PARTS LIST IN SERVICE GROUP J)	28480	03335-66504
A6	03335-66538	1	OUTPUT AMPLIFIER/LEVEL CONTROL (ITEMIZED PARTS LIST IN SERVICE GROUP M)	28480	03335-66538
A7	03335-66507	1	MIXER ASSEMBLY (ITEMIZED PARTS LIST IN SERVICE GROUP L)	28480	03335-66507
A8	03335-66532	1	SUMMATION LOOP (ITEMIZED PARTS LIST IN SERVICE GROUP K)	28480	03335-66532
A9	03335-66501	1	N STEP LOOP (ITEMIZED PARTS LIST IN SERVICE GROUP I)	28480	03335-66501
A10	03335-66512	1	CONTROLLER INTERFACE ASSEMBLY (ITEMIZED PARTS LIST IN SERVICE GROUP E)	28480	03335-66512
A11	03335-66510	1	KEYBOARD ASSEMBLY (ITEMIZED PARTS LIST IN SERVICE GROUP B)	28480	03335-66510
A12	03335-66509	1	DISPLAY ASSEMBLY (ITEMIZED PARTS LIST IN SERVICE GROUP A)	28480	03335-66509
A13	03335-66511	1	CONTROLLER ASSEMBLY (ITEMIZED PARTS LIST IN SERVICE GROUP D)	28480	03335-66511
	03335-69511		CONTROLLER ASSEMBLY (REBUILT)	28480	03335-69511
A14	03335-66514	1	POWER SUPPLY ASSEMBLY (ITEMIZED PARTS LIST IN SERVICE GROUP F)	28480	03335-66514
A15	03335-66516	1	PASS TRANSISTOR ASSEMBLY (ITEMIZED PARTS LIST IN SERVICE GROUP F)	28480	03335-66516
A16	03335-66513	1	HP-IB INTERFACE ASSEMBLY (ITEMIZED PARTS LIST IN SERVICE GROUP C)	28480	03335-66513
A17	03335-66522	1	TEMP-STABILIZED OSC. (STD) (ITEMIZED PARTS LIST IN SERVICE GROUP G)	28480	03335-66522
A18	03335-66517	1	TEMP-STABILIZED OSC. (OPTION 001) (ITEMIZED PARTS LIST IN SERVICE GROUP G)	28480	03335-66517
A19	03335-60104	1	OPTION 002/004 INTERFACE (ITEMIZED PARTS LIST IN SERVICE GROUP N)	28480	03335-60104
A20	03335-66521	1	OPTION 003 INTERFACE (ITEMIZED PARTS LIST IN SERVICE GROUP)	28480	03335-66521
A21-A24			UNASSIGNED		
A25	5060-9596	1	ATTENUATOR ASSEMBLY (ITEMIZED PARTS LIST IN SERVICE GROUP N)	28480	5060-9596
	5061-0783		ATTENUATOR ASSEMBLY (REBUILT)	28480	5061-0783

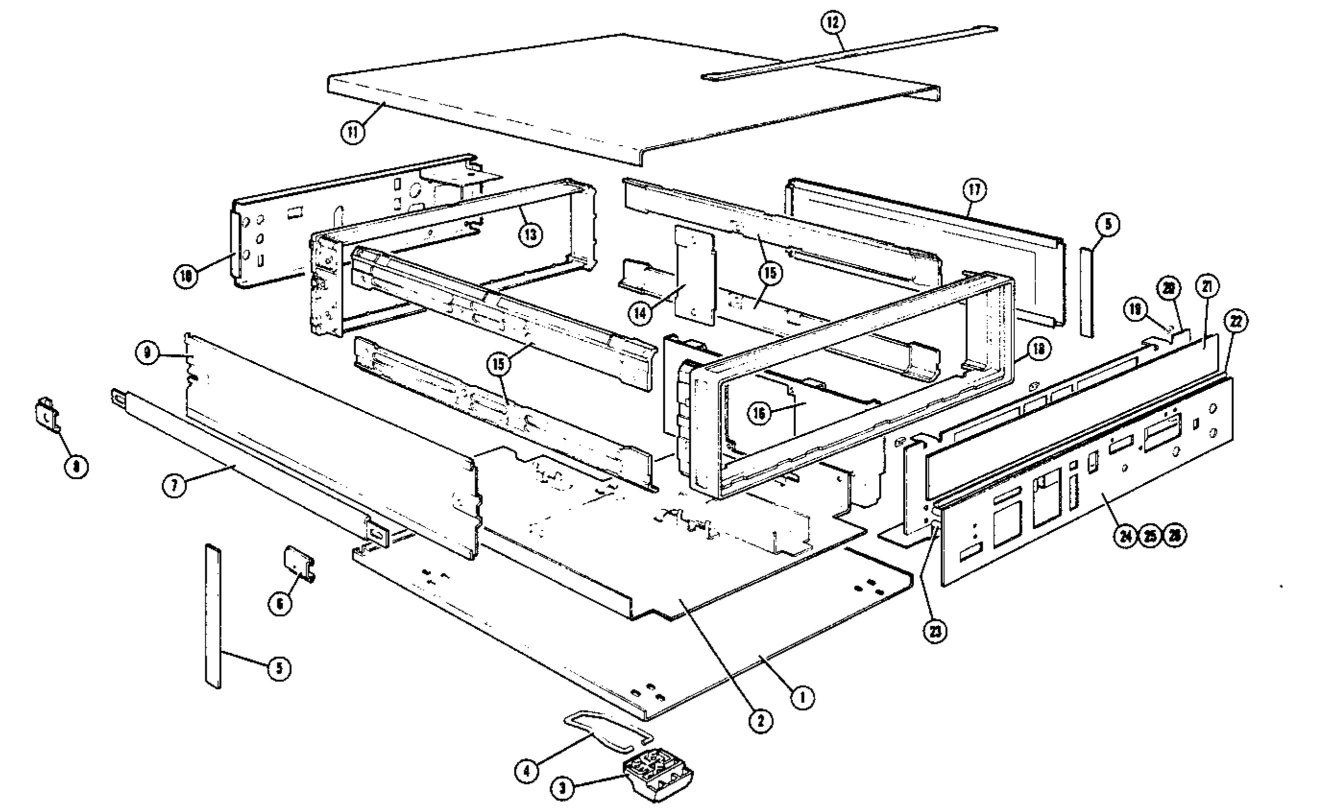


Figure 6-1. Mechanical Parts Identification.

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			MECHANICAL PARTS		
			NOTE: IF AN ASTERICK PROCEEDS THE DESCRIPTION OF A PART, THE PART IS A COMPONENT OF THE FIRST PREVIOUS UNASTERICKED PART IN THE LIST.		
MP1	5060-9847	1	BOTTOM COVER	28480	5060-9847
MP2	03335-60101	1	FLOOR PANEL ASSEMBLY	28480	03335-60101
	03335-00101	1	*FLOOR PANEL	28480	03335-00101
	1400-0617	2	*CLIP, TENSION	28480	1400-0617
	03335-01207	1	*HOLDING BRACKET, ATTENUATOR		
	03335-01205	1	*MOUNTING GUIDE, MODULE BOTTOM (172 MM)	28480	03335-01205
	03335-01201	2	*RETAINER, FLAT (74 MM)	28480	03335-01201
	03335-01216	2	*RETAINER, BRACKET (51 MM)	28480	03335-01216
MP3	5040-7201	4	FOOT	28480	5040-7201
MP4	1460-1345	2	TILT STAND, WAVEFORM 1.34W 3-LG SST	28480	1460-1345
MP5	5001-0439	2	SIDE TRIM	28480	5001-0439
MP6	5040-7219	1	FRONT STRAP HANDLE CAP	28480	5040-7219
MP7	5060-9804	1	STRAP HANDLE, 18 INCH	28480	5060-9804
MP8	5040-7220	1	REAR STRAP HANDLE CAP	28480	5040-7220
MP9	5060-9937	1	SIDE COVER (HANDLE SIDE)	28480	5060-9937
MP10	03335-00202	1	REAR PANEL	28480	03335-00202
	03335-01204	1	*BRACKET, RECTIFIER DIODE	28480	03335-01204
	7120-3530	1	*LABEL, CAUTION	28480	7120-3530
MP11	5060-9835	1	TOP COVER	28480	5060-9835
MP12	5040-7202	1	TRIM, TOP	28480	5040-7202
MP13	5020-8804	1	REAR CASTING	28480	5020-8804
MP14	03335-01217	1	GUSSET, SIDE	28480	03335-01217
MP15	5020-8837	4	CORNER STRUT	28480	5020-8837
MP16	03335-06601	1	FAN FRAME	28480	03335-06601
	0403-0029	1	*RUBBER FOOT	28480	0403-0029
MP17	03335-04101	1	SIDE COVER ASSEMBLY	28480	03335-04101
	5061-1930	1	*SIDE COVER	28480	5061-1930
	4208-0148	1	*FILTER, FOAM	28480	4208-0148
MP18	5020-8803	1	FRONT FRAME	28480	5020-8803
MP19	1460-0553	3	CLIP, WINDOW	28480	1460-0553
MP20	03335-00201	1	SUB-PANEL	28480	03335-00201
MP21	03335-09301	1	DISPLAY LENS	28480	03335-09301
MP22	5040-6928	1	DIVIDER STRIP, FRONT PANEL	28480	5040-6928
MP23	5040-8104	6	LED LIGHT PIPE	28480	5040-8104
MP24	03335-04302	1	DRESS PANEL (STANDARD)	28480	03335-04302
MP25	03335-04301	1	DRESS PANEL (OPTION 002)	28480	03335-04301
MP26	03335-04303	1	DRESS PANEL (OPTION 003)		

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
MP27			KEY CAPS AS FOLLOWS:		
	5041-0676	1	KEY CAP-1	28480	5041-0676
	5041-0677	1	KEY CAP-2	28480	5041-0677
	5041-0678	1	KEY CAP-3	28480	5041-0678
	5041-0679	1	KEY CAP-4	28480	5041-0679
	5041-0680	1	KEY CAP-5	28480	5041-0680
	5041-0681	1	KEY CAP-6	28480	5041-0681
	5041-0682	1	KEY CAP-7	28480	5041-0682
	5041-0683	1	KEY CAP-8	28480	5041-0683
	5041-0684	1	KEY CAP-9	28480	5041-0684
	5041-0685	1	KEY CAP-0	28480	5041-0685
	5041-0686	2	KEY CAP-L&R	28480	5041-0686
	5041-0820	1	KEY CAP-.	28480	5041-0820
	5041-0962	2	KEY CAP-UP & DOWN	28480	5041-0962
	5041-0963	1	KEY CAP-DSPL EN	28480	5041-0963
	5041-0964	1	KEY CAP-BACK,STP	28480	5041-0964
	5041-0965	1	KEY CAP-MHZ-DBM	28480	5041-0965
	5041-0966	1	KEY CAP-KHZ-DBM	28480	5041-0966
	5041-0967	1	KEY CAP-HZ DEG	28480	5041-0967
	5041-0968	1	KEY CAP-ON/OFF	28480	5041-0968
	5041-0969	1	KEY CAP-SW WIDTH	28480	5041-0969
	5041-0970	1	KEY CAP-MANUAL	28480	5041-0970
	5041-0971	1	KEY CAP-ST FREQ	28480	5041-0971
	5041-0972	1	KEY CAP-ST AUTO	28480	5041-0972
	5041-0973	1	KEY CAP-STOP	28480	5041-0973
	5041-0974	1	KEY CAP-SS 10SEC	28480	5041-0974
	5041-0975	1	KEY CAP-SS 50SEC	28480	5041-0975
	5041-0976	1	KEY CAP-FREQ INC	28480	5041-0976
	5041-0977	1	KEY CAP-AMPL INC	28480	5041-0977
	5041-0978	1	KEY CAP-0 INCR	28480	5041-0978
	5041-0979	1	KEY CAP-LOCAL	28480	5041-0979
	5041-0980	1	KEY CAP-POWER	28480	5041-0980
	5041-0981	1	KEY CAP-STORE	28480	5041-0981
	5041-0982	1	KEY CAP-DISPLAY	28480	5041-0982
	5041-0983	1	KEY CAP-RECALL	28480	5041-0983
	5041-0984	1	KEY CAP-CLEAR	28480	5041-0984
	5041-0985	1	KEY CAP-FREQ	28480	5041-0985
	5041-0986	1	KEY CAP-AMPLITUD	28480	5041-0986
MP28	03335-06602	1	POWER SUPPLY FRAME	28480	03335-06602
	0403-0147	1	*GUIDE-PC BOARD BLUE POLYC	28480	0403-0147
MP29	03335-01203	1	BRACKET, CAPACITOR	28480	03335-01203
MP30	03335-01215	1	BRACKET, PC ASSY A17 (STANDARD)	28480	03335-01215
MP31-35			UNASSIGNED		
MP36	03335-00605	1	PC SHIELD, PHASE DETECTOR TOP	28480	03335-00605
MP37	03335-00606	1	SHIELD, RF, PHASE DET BOTTOM	28480	03335-00606
MP38	03335-00607	1	PC SHIELD, ISOLATION AMP TOP	28480	03335-00607
MP39	03335-00608	1	SHIELD, RF, ISOLATION AMP BOTTOM	28480	03335-00608
MP40	03335-00609	1	PC SHIELD, ÷N TOP	28480	03335-00609
MP41	03335-00610	1	SHIELD, RF, ÷N BOTTOM	28480	03335-00610
MP42	03335-00612	1	PC SHIELD, PHASE DET TOP	28480	03335-00612
MP43	03335-00613	1	SHIELD, RF, PHASE DET BOTTOM	28480	03335-00613
MP44	03335-00614	1	PC SHIELD, ISOLATION AMP TOP	28480	03335-00614
MP45	03335-00615	1	SHIELD, RF, ISOLATION AMP BOTTOM	28480	03335-00615
MP46	03335-00616	1	PC SHIELD, RATE DET TOP	28480	03335-00616
MP47	03335-00617	1	SHIELD, RF, RATE DET BOTTOM	28480	03335-00617
MP48	03335-00625	2	PC SHIELD, VCO TOP	28480	03335-00625
MP49	03335-00626	2	SHIELD, RF, VCO BOTTOM	28480	03335-00626
MP50	03335-20601	2	CD NEST, LONG	28480	03335-20601
MP51	03335-20602	1	CD NEST, L-MILLED	28480	03335-20602
MP52	03335-20603	1	CD NEST, L-FLAT	28480	03335-20604
MP54	03335-20605	1	CD NEST, SH MILLED	28480	03335-20605
MP55	03335-20606	1	CD NEST, S FLAT	28480	03335-20606
MP56	03335-20607	4	FOOT, MODULE	28480	03335-20607
MP57	03335-20608	1	CD NEST	28480	03335-20608
MP58	03335-20610	1	CD NEST	28480	03335-20610
MP84	03335-00628		PC SHIELD, ISOLATION AMP TOP	28480	03335-00628
MP90	03335-00628		PC SHIELD, ISOLATION AMP TOP	28480	03335-00628
MP91	03335-00608		SHIELD, RF, ISOLATION AMP BOTTOM	28480	03335-00608

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			CABLE PARTS LIST		
W1	03335-61627	1	CABLE, SERVICE, BNC FEMALE-TO-PUSH-ON SELECTRO (PART OF SERVICE KIT 03335-87901)	28480	03335-61627
W2	03335-61602	1	CABLE, SERVICE, SMA-TO-SMA (PART OF SERVICE KIT 03335-87901)	28480	03335-61602
W3	03335-61603	1	CABLE, "EXT LEVEL" SIGNAL (REAR PANEL TO A1 MOTHER BOARD)	28480	03335-61603
W4	03335-61604	1	CABLE, OVEN TO "10 MHZ REF OVEN OUTPUT" CONNECTOR (OVEN TO REAR PANEL)	28480	03335-61604
W5	03335-61605	1	CABLE, POWER SUPPLY (A14) TO CONTROLLER INTERFACE (A10)	28480	03335-61605
W6	03335-61606	1	CABLE, POWER SUPPLY(A14) TO PASS TRANSISTOR(A16)	28480	03335-61606
W7	03335-61607	1	CABLE, CONTROLLER INTERFACE (A10) TO MOTHER BOARD (A1) (DIGITAL SIGNALS)	28480	03335-61607
W8	03335-61608	1	CABLE, POWER SUPPLY (A14) TO MOTHER BOARD(A1) (SUPPLY VOLTAGES)	28480	03335-61608
W9	03335-61609	1	CABLE, PWR SUPPLY RECTIFIER DIODES(CR100&CR200) TO SECONDARY OF TRANSFORMER, T100	28480	03335-61609
W10	03335-61610	1	CABLE, EXT LEVEL SWITCH (REAR PANEL) TO MOTHER BOARD (A1)	28480	03335-61610
W11	03335-61611	1	CABLE, PASS XSTR (A15) TO FAN (B100)	28480	03335-61611
W12	03335-61612	2	CABLE, REAR PANEL "10 MHZ OUTPUT"	28480	03335-61612
W13	03335-61613	1	CABLE, REAR PANEL "40/N MHZ REF INPUT"	28480	03335-61613
W14	03335-61614	1	CABLE, CONTROLLER INTERFACE (A10) TO HP-IB INTERFACE (A16)	28480	03335-61614
W15			UNASSIGNED		
W16	03335-61616	1	CABLE, DIODE BRIDGES (CR100 & CR200) TO PASS XSTR (A15)	28480	03335-61616
W17	SEE DESCRIPTION	2	22 GUAGE WIRE, YELLOW, 7 INCHES, WITH 0360-0227 CRIMP TERMINAL AT ONE END		
W18	03335-61618	1	CABLE, ATTENUATOR TO FRONT PANEL OUTPUT CONNECTOR (OPTION 002, 75 OHM UNBAL AND STANDARD 75 OHM)	28480	03335-61618
W19	03335-61619	1	CABLE, ATTENUATOR (A25) TO BALANCE TRANSFORMER ASSY (A19-OPTION 002) OR (A20-OPTION 003)	28480	03335-61619
W20	03335-61620	2	CABLE, BALANCE TRANSFORMER ASSEMBLY (A19-OPTION 002) TO 124 OHM CONNECTORS (FRONT PANEL)	28480	03335-61620
W21	03335-61621	1	CABLE, SEMI-RIGID COAX, OUTPUT AMP (A6) TO ATTENUATOR (A25)	28480	03335-61621
W22	03335-61622	1	CABLE, ATTENUATOR (A25) TO FRONT PANEL 75 OHM CONNECTOR (OPTION 003)	28480	03335-61622
W23	03335-61623	1	CABLE, ATTENUATOR (A25) TO FRONT PANEL 50 OHM CONNECTOR (STD)	28480	03335-61623
W24	03335-61624	2	CABLE, BALANCE TRANSFORMER ASSY (A20-OPTION 003) TO FRONT PANEL 150 OHM BALANCED OUTPUT (OPTION 003)	28480	03335-61624
W25	1250-1499	1	BNC-TO-BNC ADAPTER	28480	1250-1499
W26	03335-61636	1	CABLE, SUMMATION LOOP (A8) TO DIVIDER-FILTER (A2) NOTE: NOT FOUND ON INSTRUMENTS WITH SERIAL NUMBER 1640A00270 AND LOWER	28480	03335-61636
W27-29			UNASSIGNED		
W30	03335-61630	1	CABLE, MODULE INTERCONNECT, A2 OUTPUT TO A6 INPUT	28480	03335-61630
W31	8120-1348	1	CABLE, AC POWER	28480	8120-1348
			NOTE: SEE MISCELLANEOUS PARTS FOLLOWING FIGURE 6-2.		

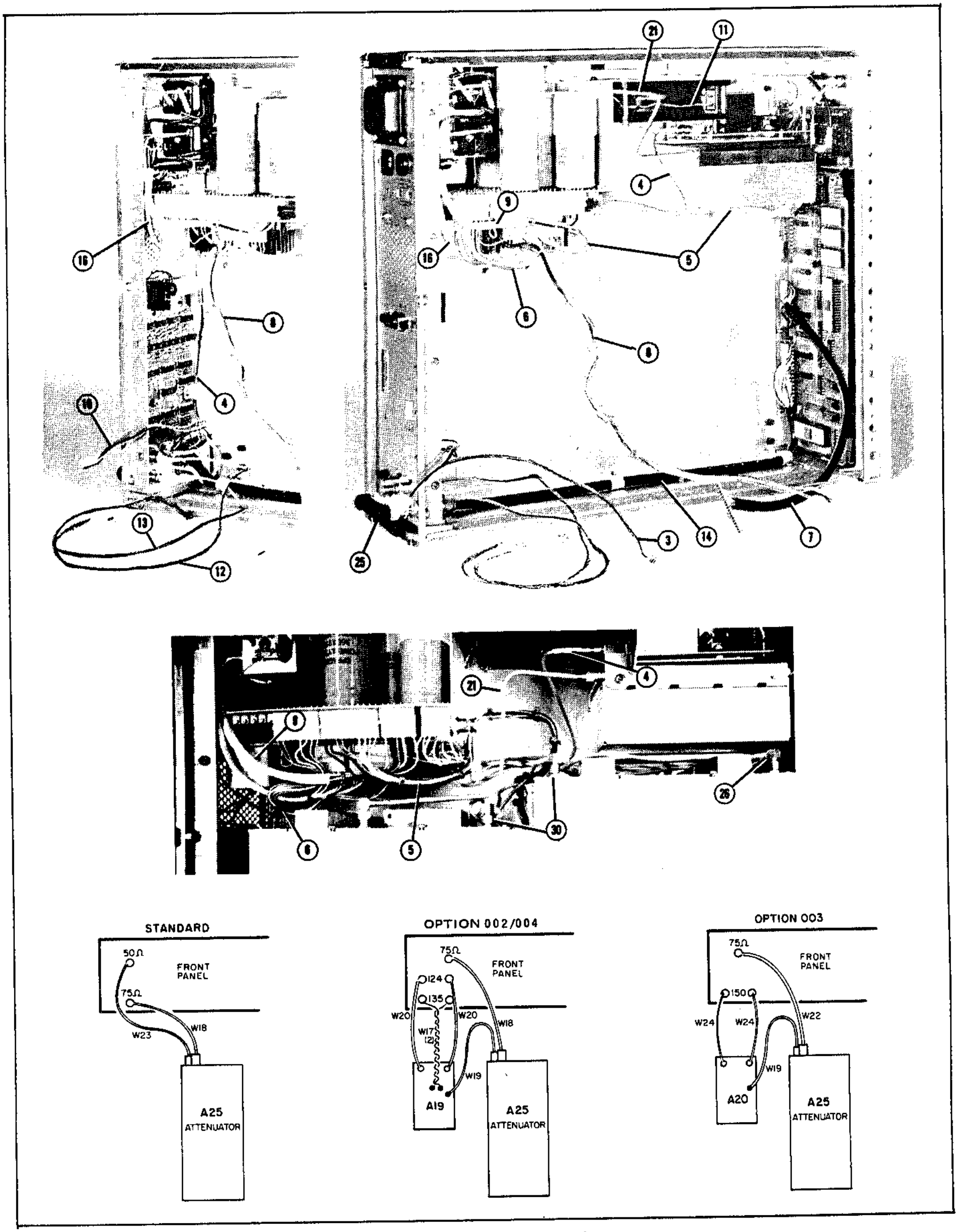


Figure 6-2. Cable Identification.

Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			MISCELLANEOUS PARTS LIST		
	5060-9899	1	FT HANDLES (OPTION 907)	28480	5060-9899
	5020-8862	1	RACK MOUNT, FLANGE (OPTION 908)	28480	5020-8862
	5020-8874	1	RACK MOUNT, FLANGE-FT HANDLE (OPTION 909)	28480	5020-8874
	03335-87901	1	SERVICE KIT; CONSISTING OF		
	03335-66518	1	EXTENDER BOARD	28480	03335-66518
	03335-66520	1	EXTENDER BOARD	28480	03335-66520
	5061-0775	2	EXTENDER BOARD, CONTROLLER	28480	5061-0775
	1250-1548	1	ADAPTER, SMA-TO-BNC		
	03335-61602	1	CABLE, SERVICE, SMA-TO-SMA		
	03335-61627	1	CABLE, SERVICE, BNC-TO-PUSH ON SELECTOR	28480	03335 61627
			CHASSIS MOUNTED COMPONENTS		
B100	3160-0259	1	FAN-TBAX 120-CFM 115V 50/60-HZ 1.5-THK	28480	3160-0259
C100, 200	0180-2671	2	CAPACITOR-FXD .012F +75-10% 30VDC AL	56289	36DX123G030AC2A
C300,400,500	0180-2670	3	CAPACITOR-FXD .015F +75-10% 15VDC AL	56289	36DX153G015AB2A
CR100, 200	1906-0037	2	DIODE-MULT FULL WAVE BRIDGE RECTIFIER	04713	MDA990 1
EA100	5060-0329	1	*ROTARY PULSE GENERATOR (RPG)	28480	5060-0329
	0370-2985	1	KNOB ASSEMBLY, RPG	28480	0370-2985
	3030-0320	2	SCREW, SET 6-32 .156-IN-LG CUP-PT ALY STL	28480	3030-0320
F100	2110-0002	1	FUSE 2A 250V FAST-BLO 1.25X.25 UL IEC	75915	312002.
	2110-0543	1	FUSEHOLDER-EXTR POST 6.3A 250V	H9027	FEC031 1603
	2110-0545	1	FUSEHOLDER-EXTR POST 6.3A 250V	H9027	FEK031 1613
FL100	9100-3121	1	FILTER-LINE CEE-TERMS	28480	9100-3121
J100	1250-0083	1	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	24931	28JR-130-1
	1250-0102	4	CONNECTOR-RF BNC FEM SGL HOLE FR	28480	1250-0102
J200	1250-1499	3	CONNECTOR, BNC	28480	1250 1499
J300	1251-3965	1	CONNECTOR 4-PIN F POST TYPE	27264	22-01 2041
S100	3101-2146	1	SWITCH, SLIDE, IMPEDANCE SELECTION	28480	3101-2146
S200	3101-0110	1	SWITCH-SL DPDT-NS STD .5A 125VAC DC SLDR LEVEL CONTROL	82389	11A 1039A
S300	3101-1609	1	SWITCH, VOLTAGE SELECTION	28480	3101-1609
	3101-1258	1	SWITCH-TGL*; TELECOMMUNICATIONS SWEEP	28480	3101-1258
T100	9100-3880	1	TRANSFORMER, POWER	28480	9100-3880

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION.

7-2. This section contains the information for adapting this manual to instruments with serial numbers preceding that on the title page. To adapt this manual to your instrument, refer to Table 7-1 and make all of the changes listed opposite your instrument serial number.

Table 7-1. Manual Changes.

Instrument Serial Number	Make Manual Changes
1640A00101 to 1640A00215	A, B, C
1640A00216 to 1640A00270	B, C
1640A00271 to 1640A00285	C

7-3. MANUAL CHANGES INSTRUCTIONS.

7-4. Change A.

Page 8-F-5/8-F-6, Figure 8-F-1:

Replace this figure with Figure 8-F-1, Page 7-5/7-6.

7-5. Change B.

Page 1-2, Figure 1-1:

Replace this figure with Figure 1-1 on Page 7-8.

Page 1-3, Paragraph 1-20:

Change the quantity of the 03335-66518 Extender Board from 2 to 1.

Delete (Qty) one 03335-66520 Extender Board from this list.

Page 5-9/5-10, Figure 5-6:

Replace this figure with Figure 5-6 on Page 7-9/7-10.

Page 6-3, Table 6-3:

Change the -hp- Part Number and the Mfr Part Number of the Divider-Filter (A2) to 03335-66506.

Change the -hp- Part Number and the Mfr Part Number of the Summation Loop (A8) to 03335-66502.

Page 6-5, Table 6-3:

Add the following parts to the list of Replaceable Parts:

Ref. Desig.	-hp- Part No.	Description	Mfr Code	Mfr Part No.
MP38	03335-00607	PC Shield,Isolation Amp Top	28480	03335-00607
MP44	03335-00614	PC Shield,Isolation Amp Top	28480	03335-00614
MP45	03335-00615	Shield,RF,Isolation Amp Bottom	28480	03335-00615

Delete the PC Isolation Shields (MP84, MP90, MP91) from the list of Replaceable Parts.

Page 6-8, Table 6-3:

Change the quantity of the 03335-66518 Extender Board to one.

Add the following part to the list of Replaceable Parts:

03335-66520, Extender Board, 28480, 03335-66520

Page 8-47, Figure 8-49:

Replace this figure with Figure 8-49 on page 7-21.

Page 8-49, SERVICE GROUP INDEX:

Change the -hp- Part Number of the Summation Loop (A8) to 03335-66502.

Change the -hp- Part Number of the Divider-Filter (A2) to 03335-66506.

Page 8-K-3, Replaceable Parts:

Change the -hp- Part Number and the Mfr Part Number of the Summation Loop (A8) to 03335-66502.

Page 8-K-4, Replaceable Parts:

Add the following part to the list of Replaceable Parts:

A8J1, 1250-1314, Connector-RF SM SLD FEM PC, 98291, 52-054-0000

Change the -hp- Part Number and the Mfr Part Number of the Extrusion Assembly (A8MP1) to 03335-61202.

Change the -hp- Part Number and the Mfr Part Number of the PC Shield (A8MP7) to 8160-0261.

Delete RF Connector (A8P1) from the Replaceable Parts List.

Page 8-K-7/8-K-8, Figure 8-K-1:

Replace this figure with Figure 8-K-1, Page 7-11/7-12.

Page 8-L-4, Replaceable Parts:

Change the -hp- Part Number and the Mfr Part Number of the Divider/Filter (A2) to 03335-66506.

Page 8-L-5, Replaceable Parts:

Change the quantity of the RF Connector (A2J1) to one.

Delete RF Connector (A2J2).

Page 8-L-6, Replaceable Parts:

Change the -hp- Part Number and Mfr Part Number of the Extrusion Assembly (A2MP1) to 03335-61206.

Page 8-L-7, Replaceable Parts.

Change the quantity of the Coaxial Cable (A2W1) to one.

Delete Coaxial Cable (A2W2).

Page 8-L-11/8-L-12, Figure 8-L-1:

Replace this figure with Figure 8-L-1 on Page 7-13/7-14.

Page 8-O-4, Replaceable Parts:

Change the quantity of the RF Connector (A1J4) to five.

Add the following part to the list of Replaceable Parts:

A1J7, 1250-1339, Connector-RF SM-SLD M PC 50 OHM, 98291, 52-051-0000

7-6. Change C.

Page ix, Table of Contents: Change the part number references in the listings for Figure 8-M-1 through Figure 8-M-4 from 03335-66538 to 03335-66508.

Page 5-11/5-12, Figure 5-5. Replace this figure with Figure 5-5, Page 7-19/7-20.

Page 6-5, Table 6-3: Change the -hp- part number and the manufacturing part number of the MP58 Card Nest from 03335-20610 to 03335-20609.

Page 8-49, Service Group Index: Change the -hp- part number of the Output Amplifier/Level Control Assembly (Service Group M) from 03335-66538 to 03335-66508.

Page 8-M-5, Table of Replaceable Parts: Change the -hp- part number and the manufacturing part number of the A6 PC assembly from 03335-66538 to 03335-66508.

Page 8-M-5, Table of Replaceable Parts: Add the following components to the list of Replaceable Parts.

Reference Designation	-hp- Part No.	Description
A6C7	0140-0198	Capacitor-Fxd 200±5% 300 wvdc
A6C10	0140-0198	Capacitor-Fxd 200±5% 300 wvdc

Page 8-M-5, Table of Replaceable Parts: Change the -hp- part number and description following each given reference disignation to the -hp- part number and description given below.

Reference Designation	-hp- Part No.	Description
A6C43	0180-0049	Capacitor-Fxd 20μ+75-10% 5v dc
A6C45	0180-0049	Capacitor-Fxd 20μ+75-10%v dc
A6C59	0160-2251	Capacitor-Fxd5.6±.25pF500wvdc
A6C60	0160-2247	Capacitor-Fxd3.9±.25pF500wvdc
A6C68,C59	0160-3622	Capacitor-Fxd.1μF+80-20%100wvdc

Page 8-M-5, Table of Replaceable Parts: Delete parts A6C85 through A6C93.

Page 8-M-6, Table of Replaceable Parts: Change the -hp- part number and description following each given reference designation to the -hp- part number and description given below.

Reference Designation	-hp- Part No.	Description
A6J1	1250-1495	Connector, Output
A6J2	1250-0826	Connector, Input .
A6MP1	03335-61208	Extrusion Assembly
A6MP2	8160-0267	PC Shield

Page 8-M-7, Table of Replaceable Parts: Change the -hp- part number and description given below.

Reference Designation	-hp- Part No.	Description
A6R85	2100-3207	Resistor - trmr 5 K 10%
A6R105	0698-3153	Resistor 3.83 K 1% .125 W
A6R122	2100-3161	Resistor - trmr 20 K 10%

Page 8-M-8, Table of Replaceable Parts: Change the -hp- part number and description following each given reference designation to the -hp- part number and description given below.

Reference Designation	-hp- Part No.	Description
A6R144	2100-3123	Resistor - trmr 500 10%
A6R147	2100-3103	Resistor - trmr 10 K 10%
A6R150	2100-3161	Resistor - trmr 20 K 10%
A6R164	2100-3353	Resistor - trmr 20 K 10%
A6W1	03335-61628	Cable, 10-80 MHz Input

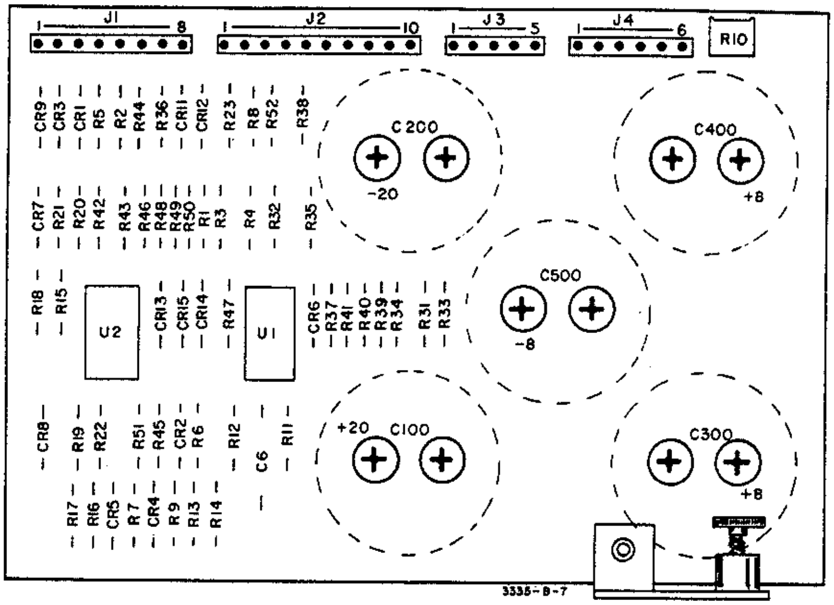
Page 8-M-8, Table of Replaceable Parts: Add the following component to the list of Replaceable Parts.

Reference Designation	-hp- Part No.	Description
A6W2	03335-61601	Cable,Semi-Rigid Coax Output

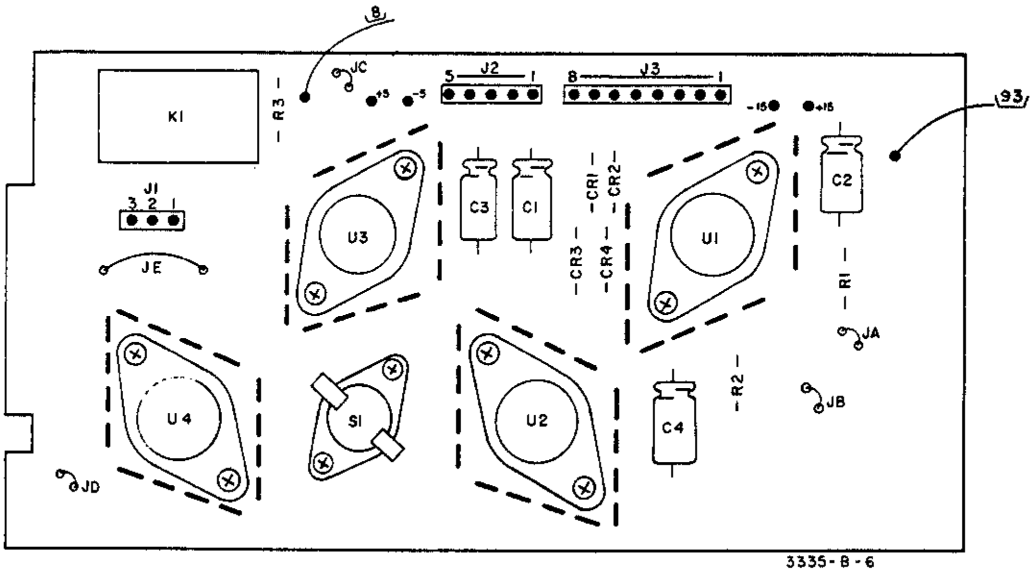
Page 8-M-9/8-M-10, Figure 8-M-1: Replace this figure with Figure 8-M-1 on pages 7-15/7-16.

Page 8-M-11/8-M-12, Figure 8-M-2: Replace this figure with Figure 8-M-2 on pages 7-17/7-18.

Fig 8-F-1
Sht 1 of 4

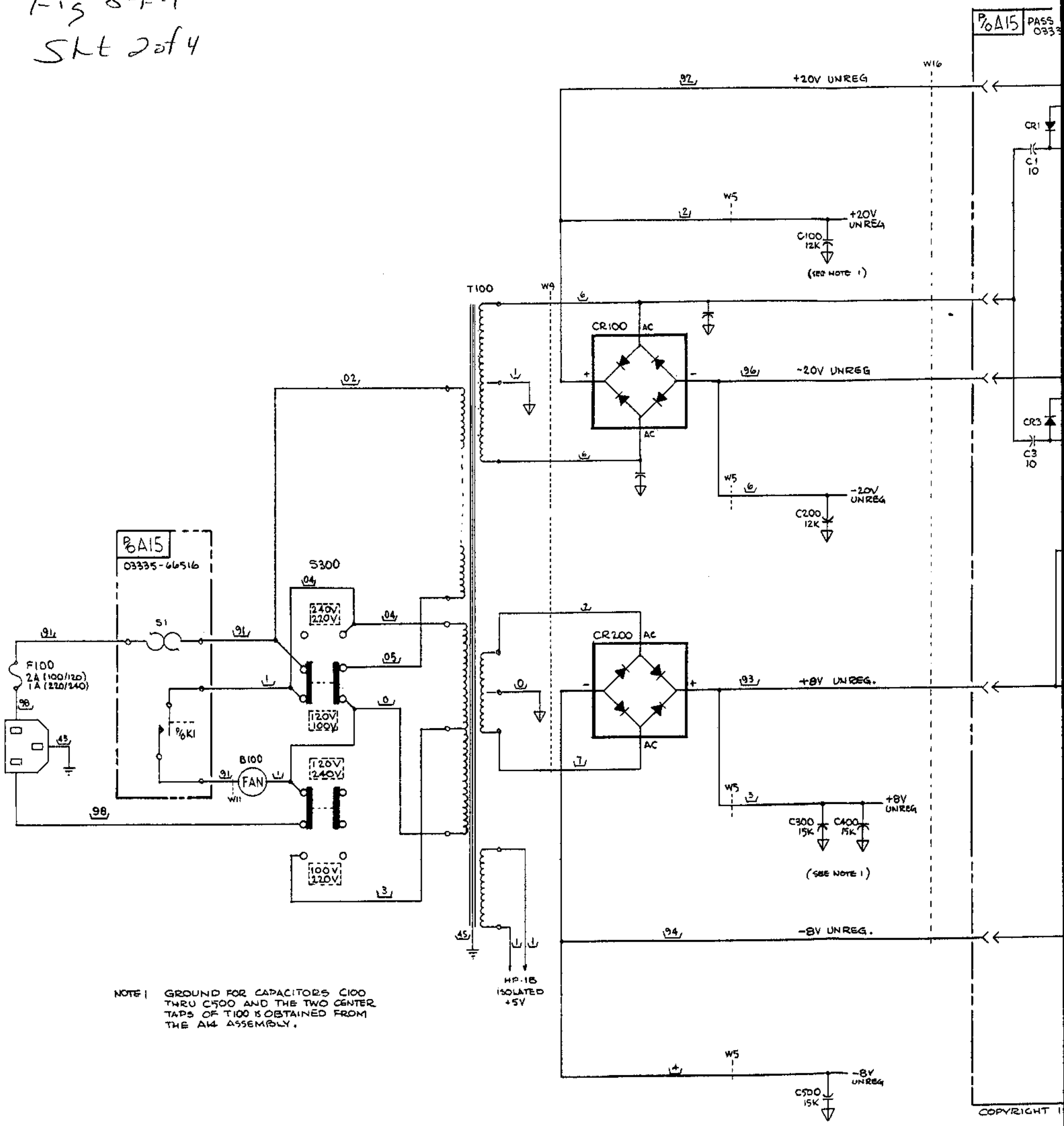


A14
-hp- Part No. 03335-66514



A15
-hp- Part No. 03335-66516

Fig 8-F-1
Skt 2 of 4



NOTE 1 GROUND FOR CAPACITORS C100 THRU C500 AND THE TWO CENTER TAPS OF T100 IS OBTAINED FROM THE A14 ASSEMBLY.

Fig 8-f-1 sht 3 of 4

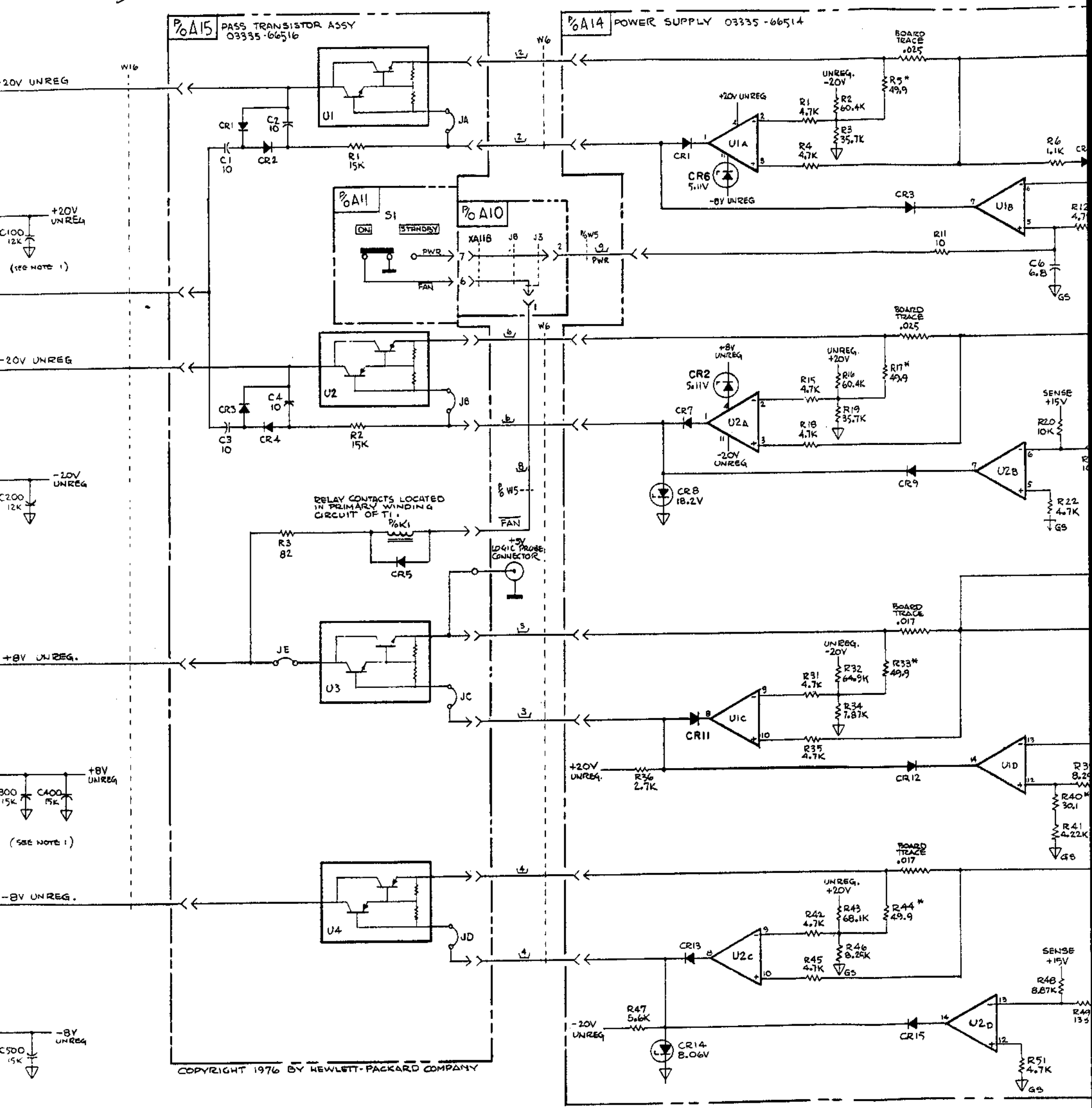
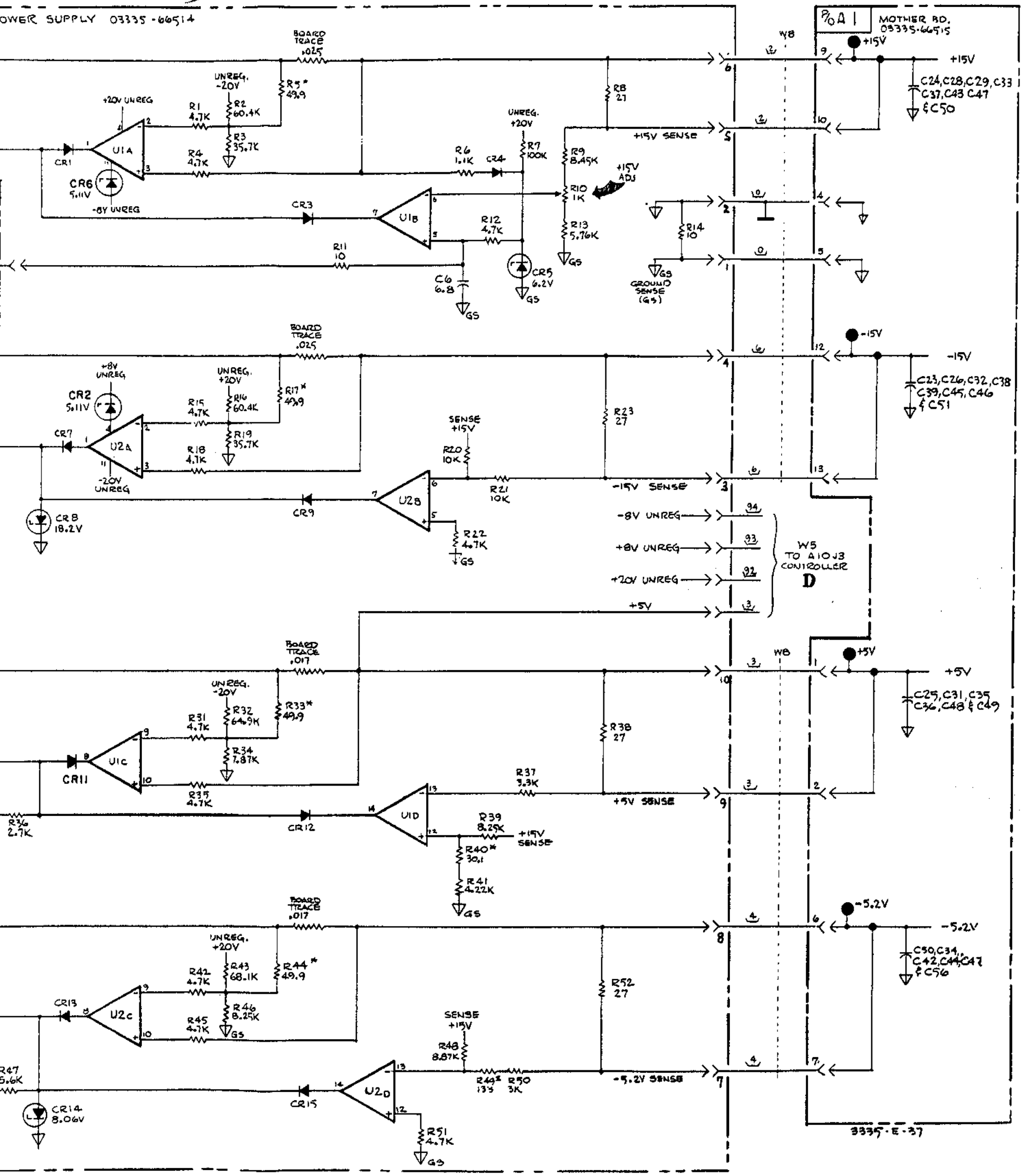


Fig 8-F-1 Sht 4 of 4



F

Figure 8-F-1. Schematic Diagram, Power Supply (03335-66514) A14, Pass Transistor (03335-66516) A15.

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This Operating and Service Manual contains information relative to the installation, operation, performance testing, adjustment and maintenance of the Hewlett-Packard Model 3335A Synthesizer/Level Generator. Figure 1-1 shows the Synthesizer/Level Generator and the accessories supplied with the instrument.

1-3. Packaged with this manual is an Operating Information Supplement. This is simply a copy of the first three sections of this manual. This supplement should be kept with the instrument for use by the operator. Additional copies of the Operating Information Supplement or the Operating and Service Manual can be ordered through your nearest Hewlett-Packard Sales and Service Office (a list of these offices is provided at the end of this manual). The part numbers are listed on the title page of this manual.

1-4. Also listed on the title page of this manual following the Operating and Service Manual and Operating Information Supplement part numbers are Microfiche part numbers for these publications. These numbers can be used to order 4 x 6 inch microfilm transparencies of these publications. The Microfiche package includes the latest Manual Changes supplement and all pertinent Service Notes.

1-5. The manual is divided into eight sections, each covering a particular topic for the operating and service of the Synthesizer/Level Generator. The topics by section number are:

Section	Topic
I	General Information
II	Installation
III	Operation
IV	Performance Tests
V	Adjustments
VI	Replacement Parts
VII	Manual Changes
VIII	Service

1-6. This section contains general information about the Model 3335A Synthesizer/Level Generator. The information includes an instrument description, specifications, option and accessory information and instrument and manual identification.

1-7. DESCRIPTION.

1-8. The Model 3335A Synthesizer/Level Generator is a wide range source operating over the range of 200 Hz to 80 MHz with output resolution of .001 Hz. The Synthesizer/Level Generator is capable of making a step frequency sweep both automatically or manually under operator control from the keyboard. Output amplitude is selectable over the range of + 13.01 dBm to - 86.98 dBm for the 50 ohm output and + 11.25 dBm to - 88.74 dBm for the 75 ohm output.

1-9. The 3335A Synthesizer/Level Generator provides three communications-oriented options in addition to the standard 50 ohm and 75 ohm output impedance. Options 002 and 004 provide output impedance of 75 ohms unbalanced, 124 ohms balanced and 135 ohms balanced each terminated in equivalent WECO output connectors (Option 004 contains miniature connectors). Option 003 provides a 75 ohm unbalanced BNC output and a 150 ohm balanced BNC pair output. Refer to Table 1-2, General Information, for the amplitude range of the Options.

1-10. The Synthesizer/Level Generator develops the output signal by an indirect synthesis technique. This technique uses voltage controlled oscillators which are phase-locked to reference signals generated by a 40 MHz master oscillator in the reference section. The master oscillator is phase-locked to an internal temperature-stabilized oscillator or can be phase-locked to an external reference signal. A 10 MHz signal derived from the master oscillator is available at a rear panel connector for use as a reference signal for other equipment.

1-11. Frequency and amplitude can be selected manually from the keyboard or externally when connected to the Hewlett-Packard Interface Bus (HP-IB). A programmable device such as a programmable calculator is capable of remotely controlling the Synthesizer/Level Generator from the HP-IB. When operated in this mode, keyboard inputs are disabled.

1-12. SPECIFICATIONS.

1-13. Table 1-1 is a complete list of the Model 3335A critical specifications that are controlled by tolerances. Any changes in specifications due to manufacturing, design or traceability to the U.S. National Bureau of Standards are included in Table 1-1 of this manual. Specifications listed in this manual supersede all previous specifications for the Model 3335A.

1-14. GENERAL OPERATING INFORMATION.

1-15. Table 1-2 contains general information describing the major operating characteristics of the 3335A. This information does not constitute specifications but is supplemental operating information.

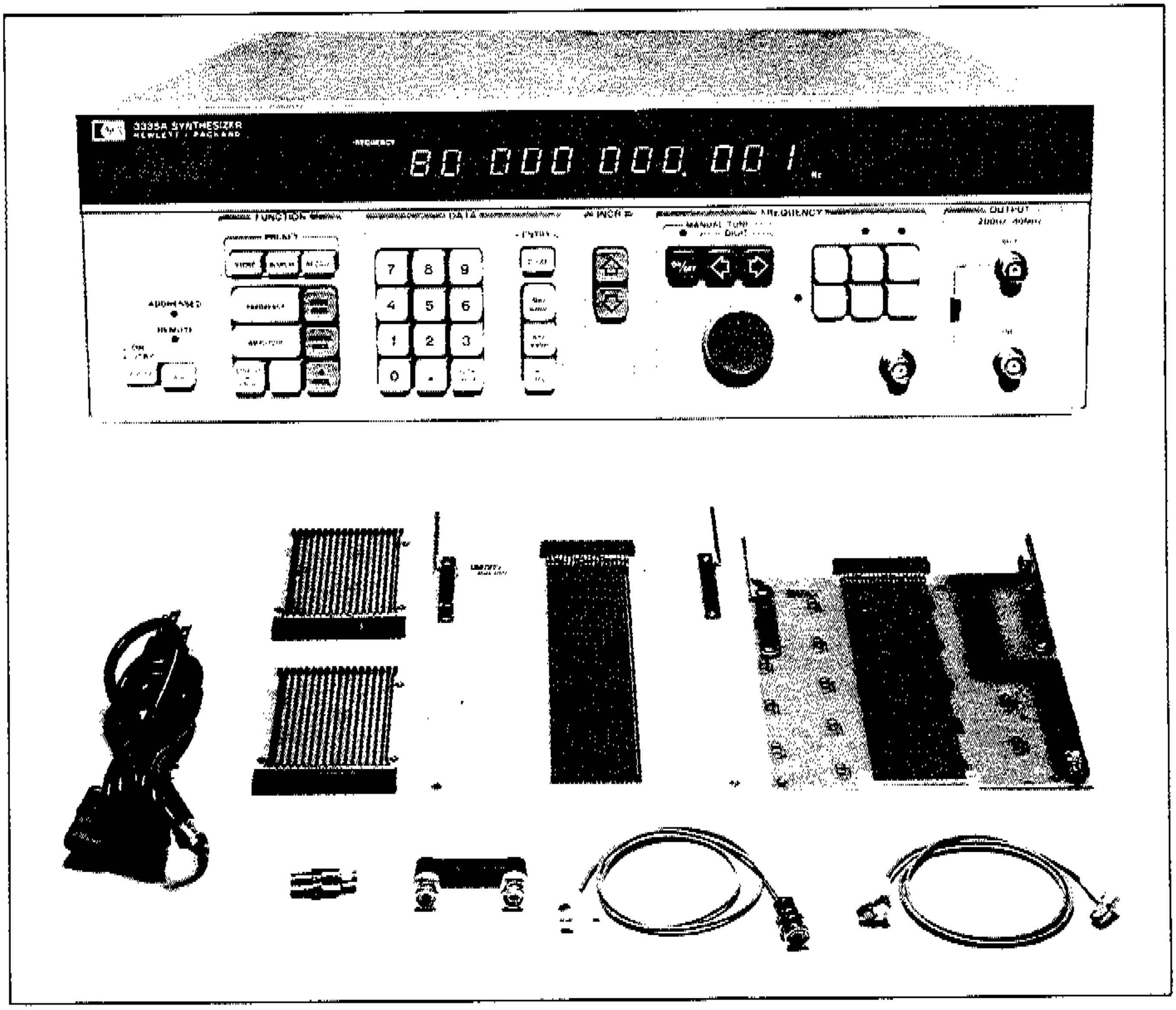
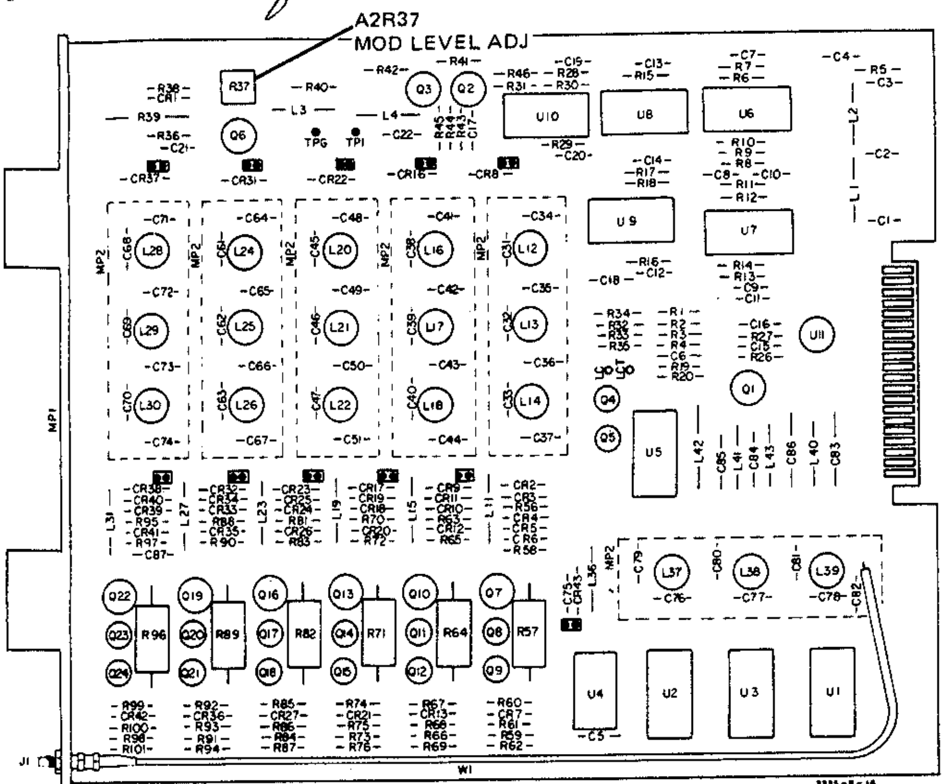
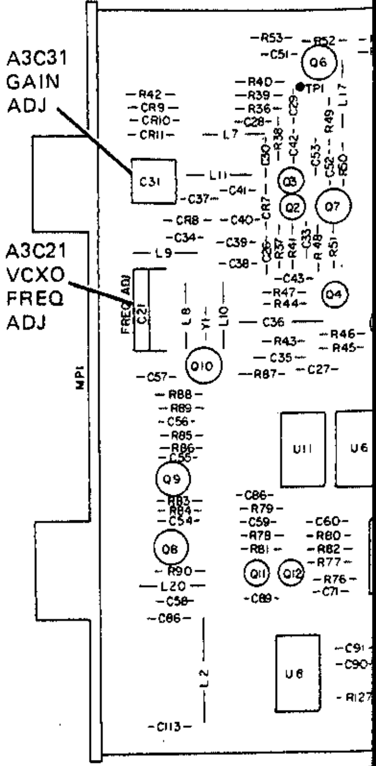


Figure 1-1. -hp- 3335A With Supplied Accessories.

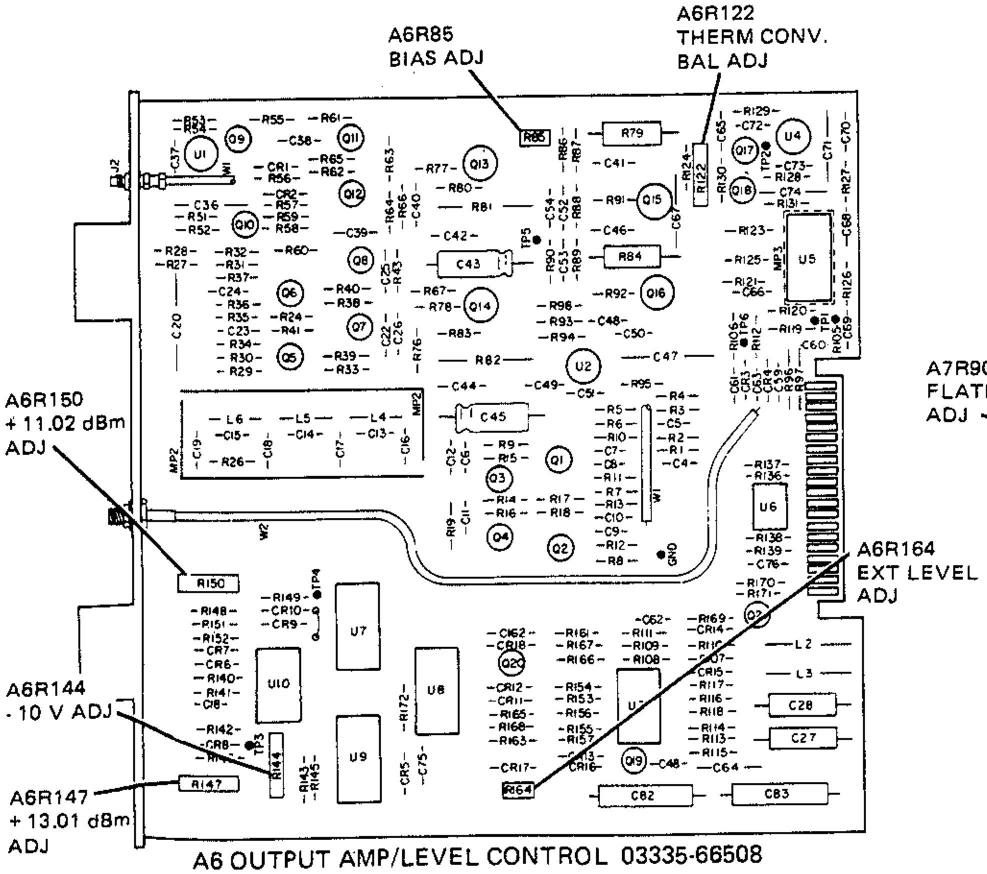
Fig 5-6 Sht 1of4



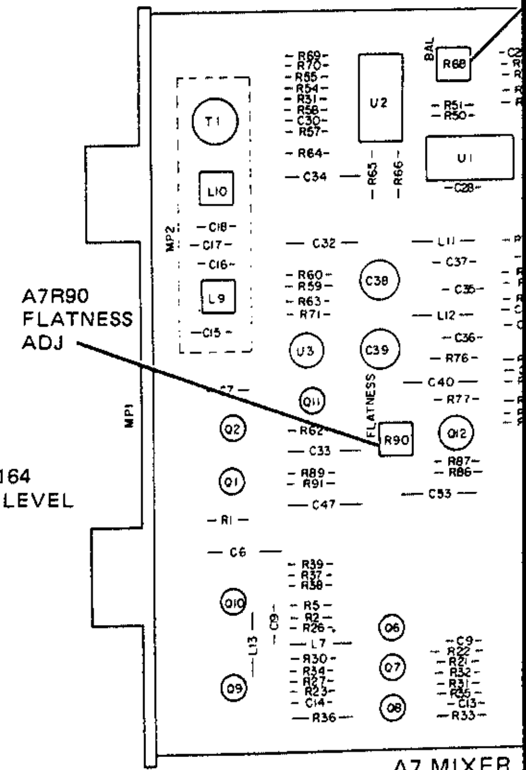
A2 DIVIDER—FILTER 03335-66506



A3

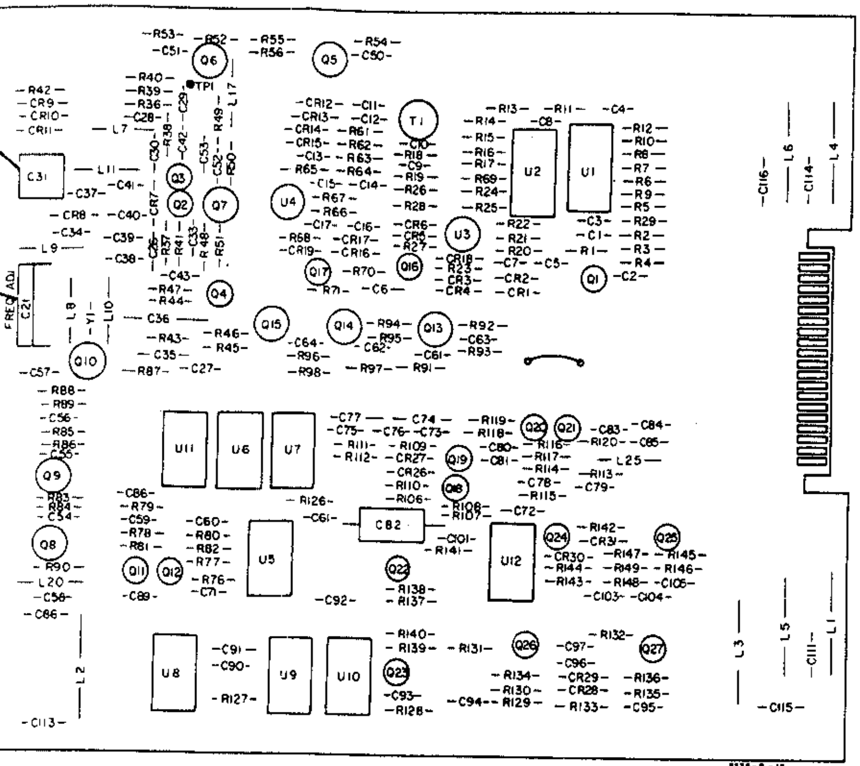


A6 OUTPUT AMP/LEVEL CONTROL 03335-66508

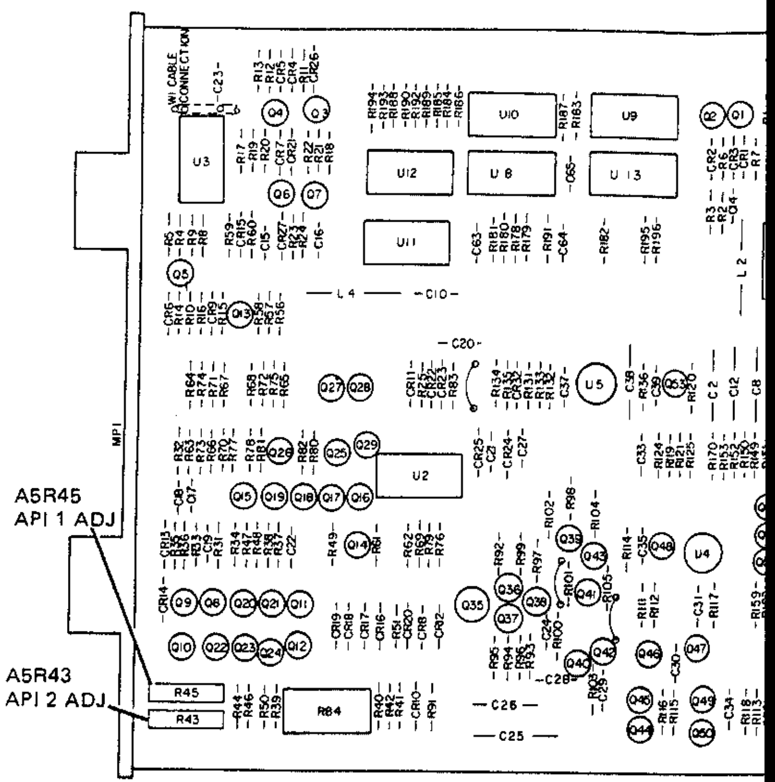


A7 MIXER

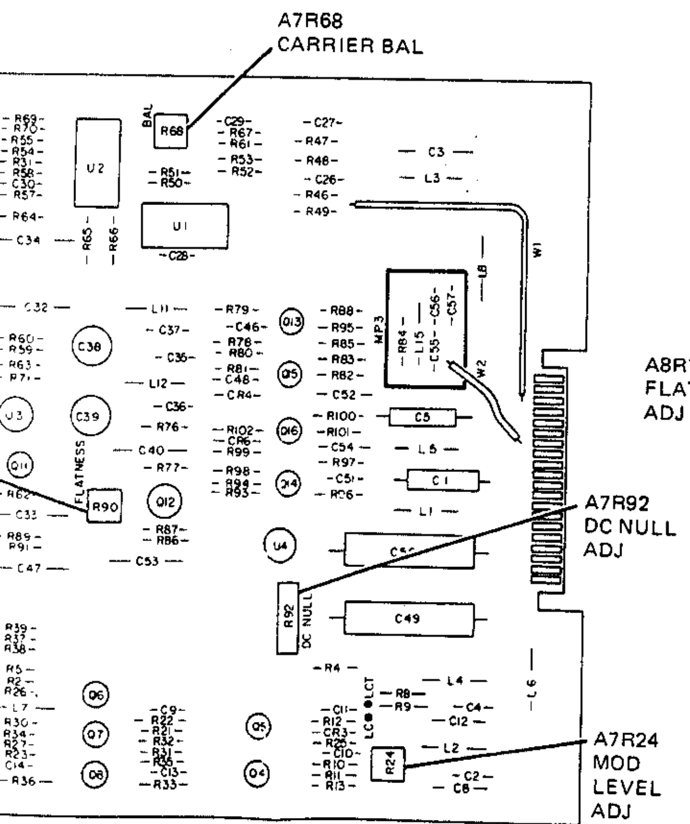
Fig 5-4 Sht 2 of 4



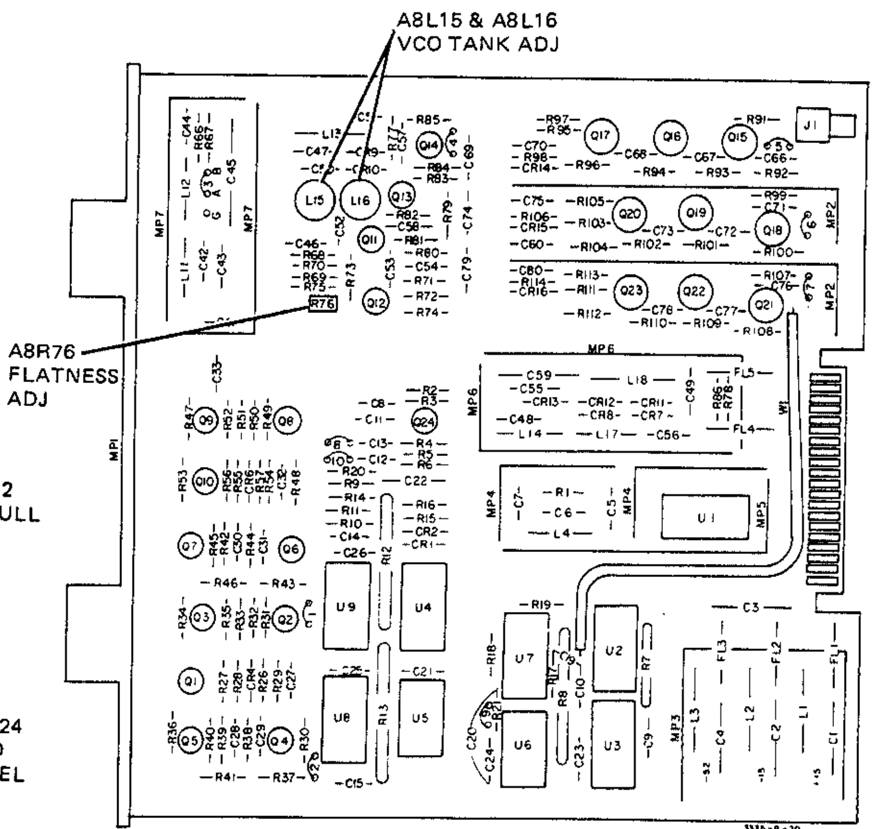
A3 REFERENCE 03335-66505



A5 FRACTIONAL—N ANALOG 03335-6

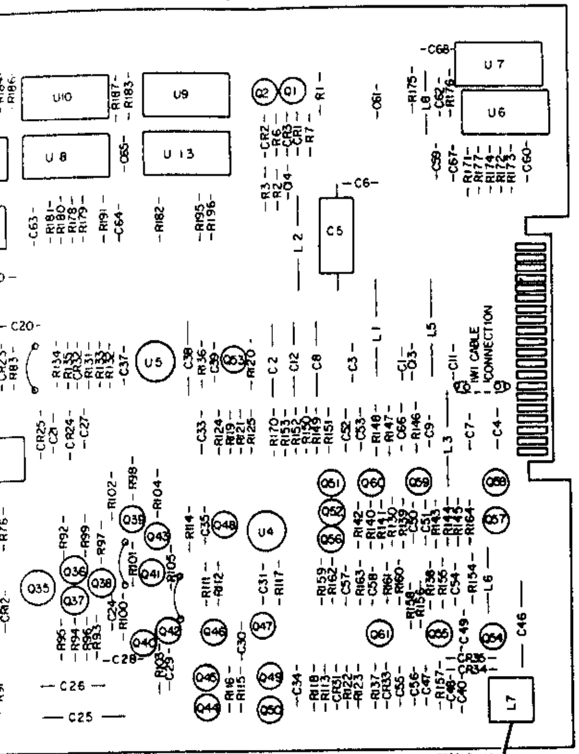


A7 MIXER 03335-66507

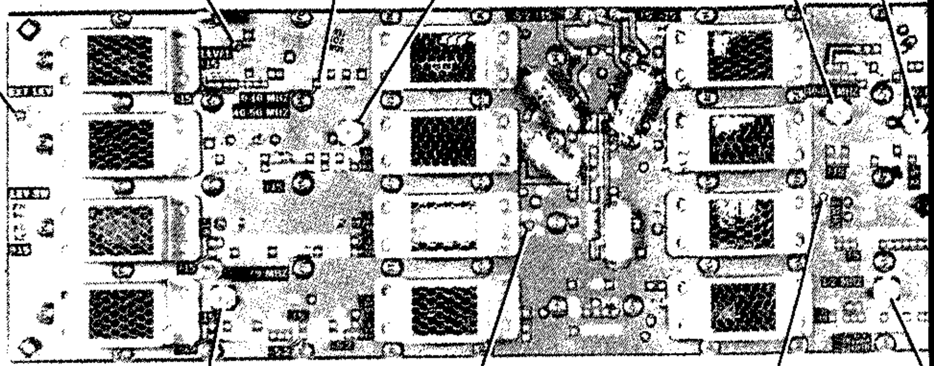


A8 SUMMATION LOOP 03335-66502

Fig 5-4 Sht 3 of 4

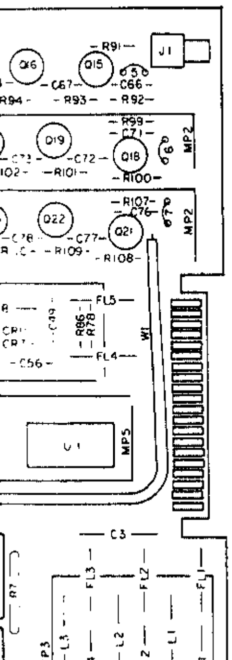


...TIONAL–N ANALOG 03335-66504

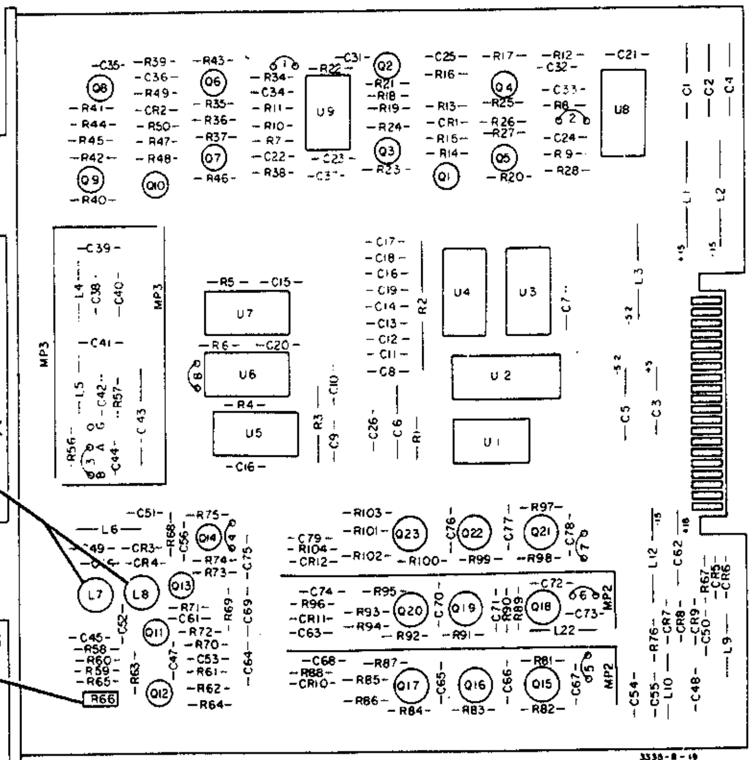


A1 MOTHER 03335-66515 (TEST CONNECTOR LOCATION

POWE



-66502



A9 N STEP LOOP 03335-66501

A14R10
+ 15 V ADJ

A14R27
-15 V CURRENT ADJ

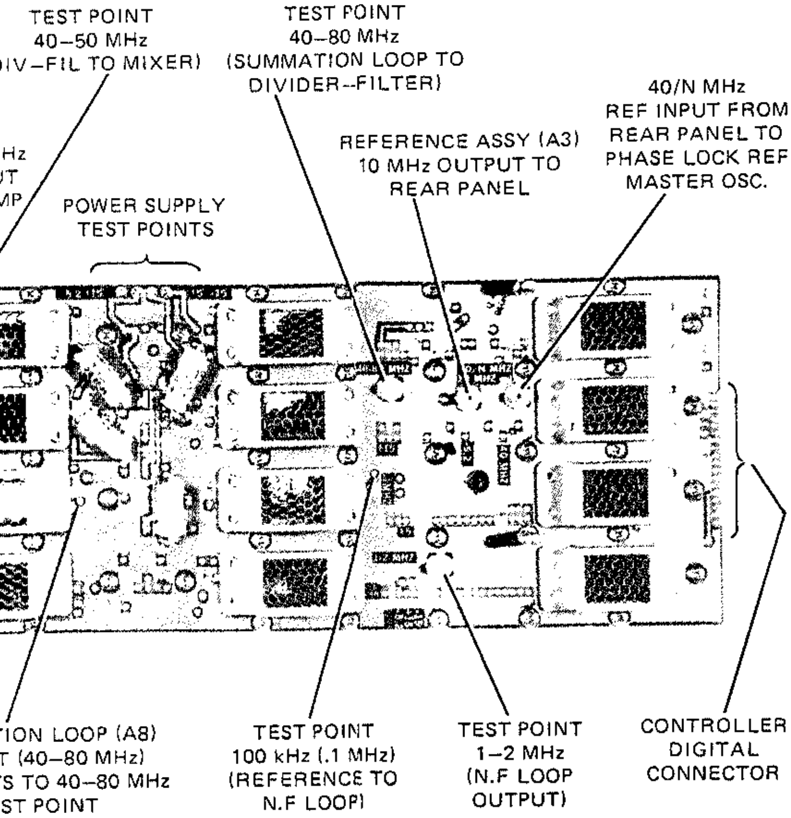
A14R25
+15 V CURRENT ADJ

A14R54
-5.2 V CURRENT ADJ

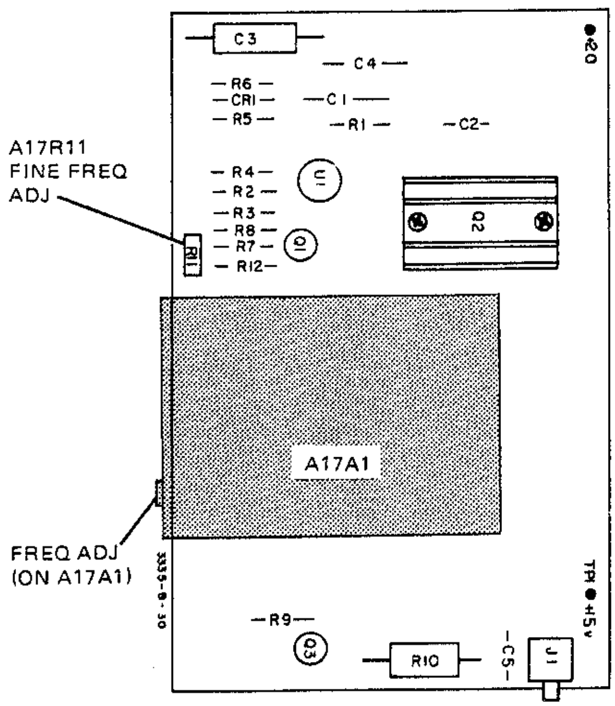
A14R29
+5.0 V CURRENT ADJ

NOTE: INSTRUMENTS W
AND LOWER DO NOT HA

Fig 5-4
Sht 4 of 4

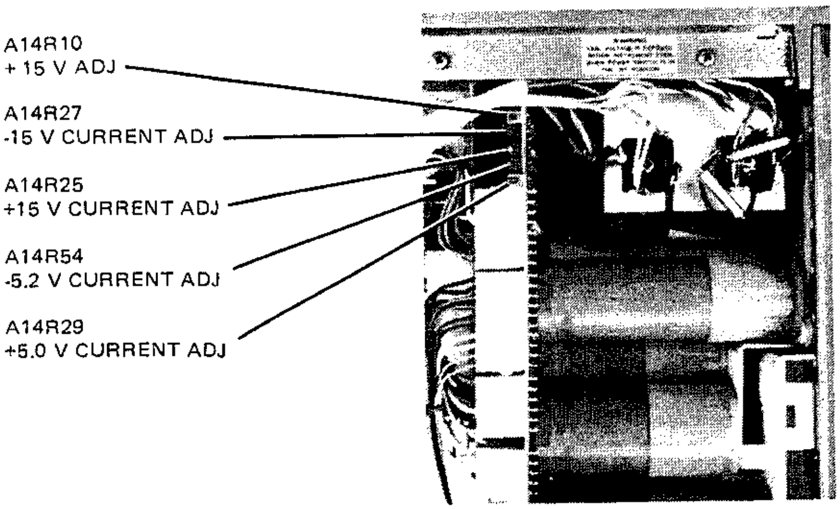


335-66515 (TEST CONNECTOR LOCATIONS)

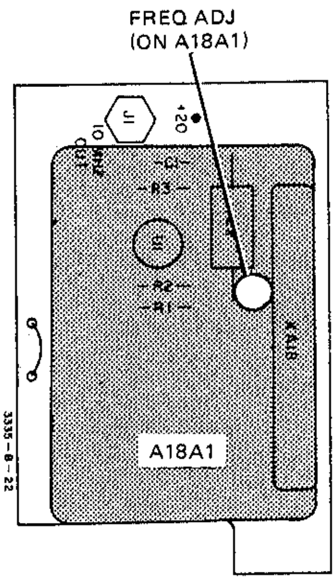


A17 TEMP–STABILIZED OSCILLATOR
INTERFACE (STANDARD)
03335-66522

POWER SUPPLY SECTION



NOTE: INSTRUMENTS WITH SERIAL NUMBER 1640A00215
AND LOWER DO NOT HAVE CURRENT ADJUSTMENTS.

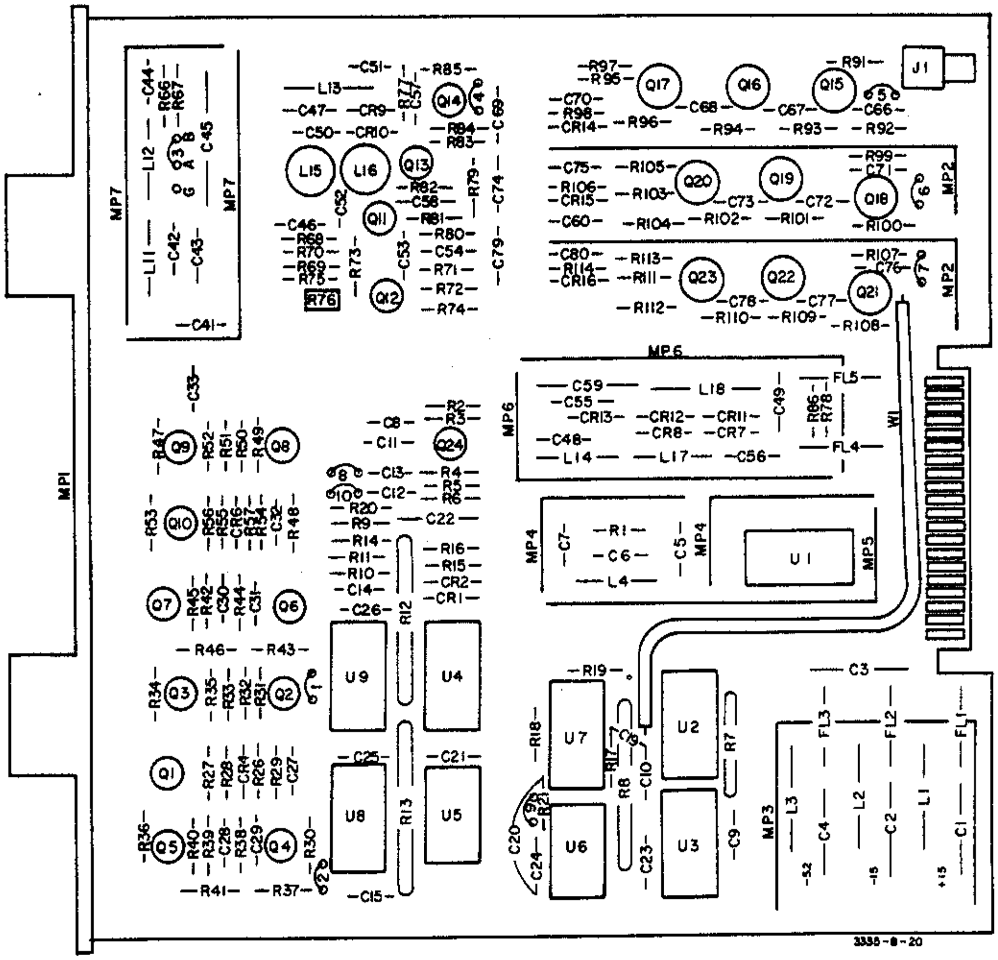


A18 TEMP–STABILIZED OSCILLATOR
INTERFACE (OPTION 001)
03335-66517

3335-C-52

Figure 5-6. Test Adjustment Locations Foldout.

Fig 8-K-1
Sht 1 of 5



A8
-hp- Part No. 03335-66502

Fig 8-K-1
Sht 2 of 9

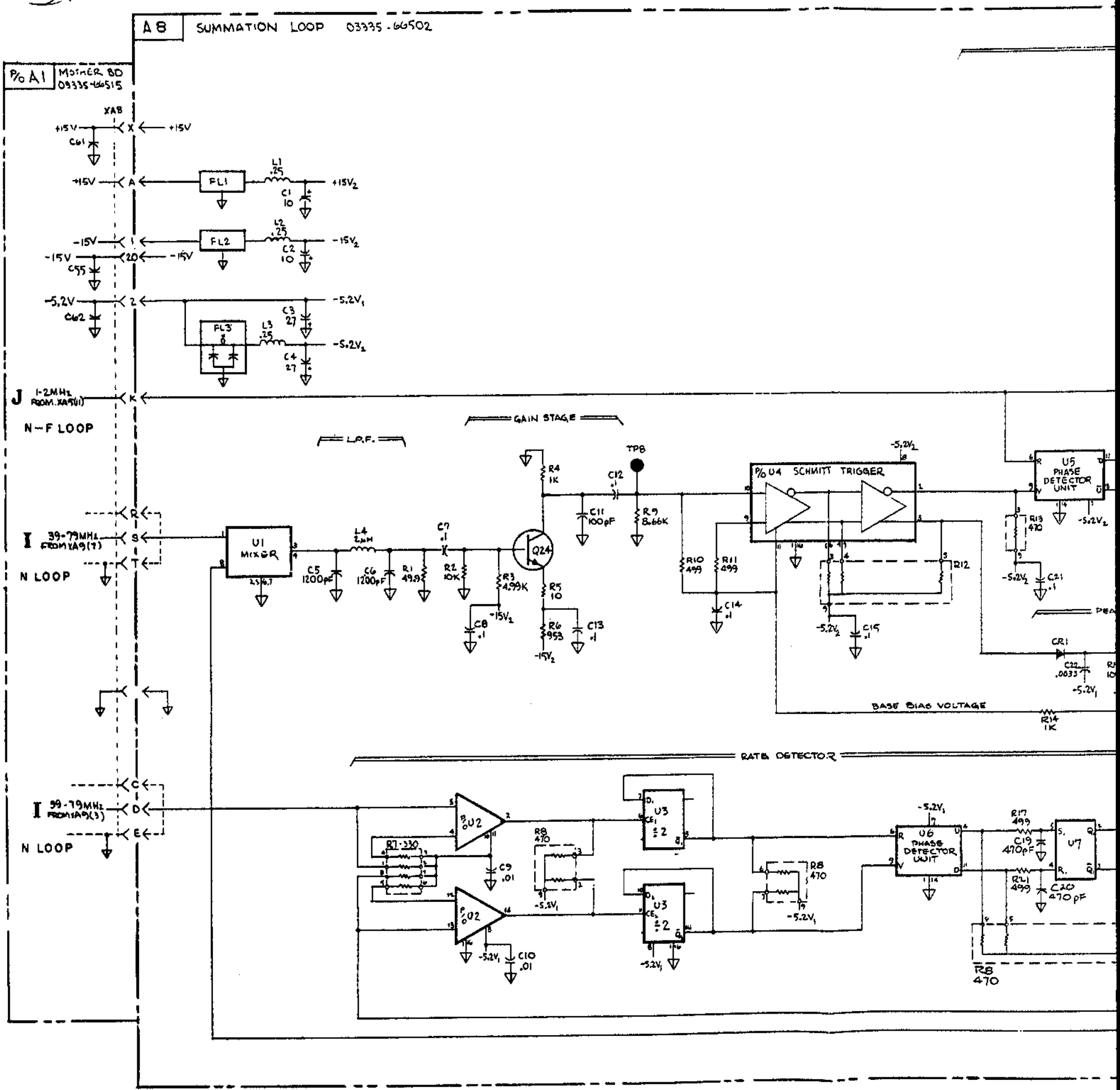


Fig 8-K-1
Sht 3 of 5

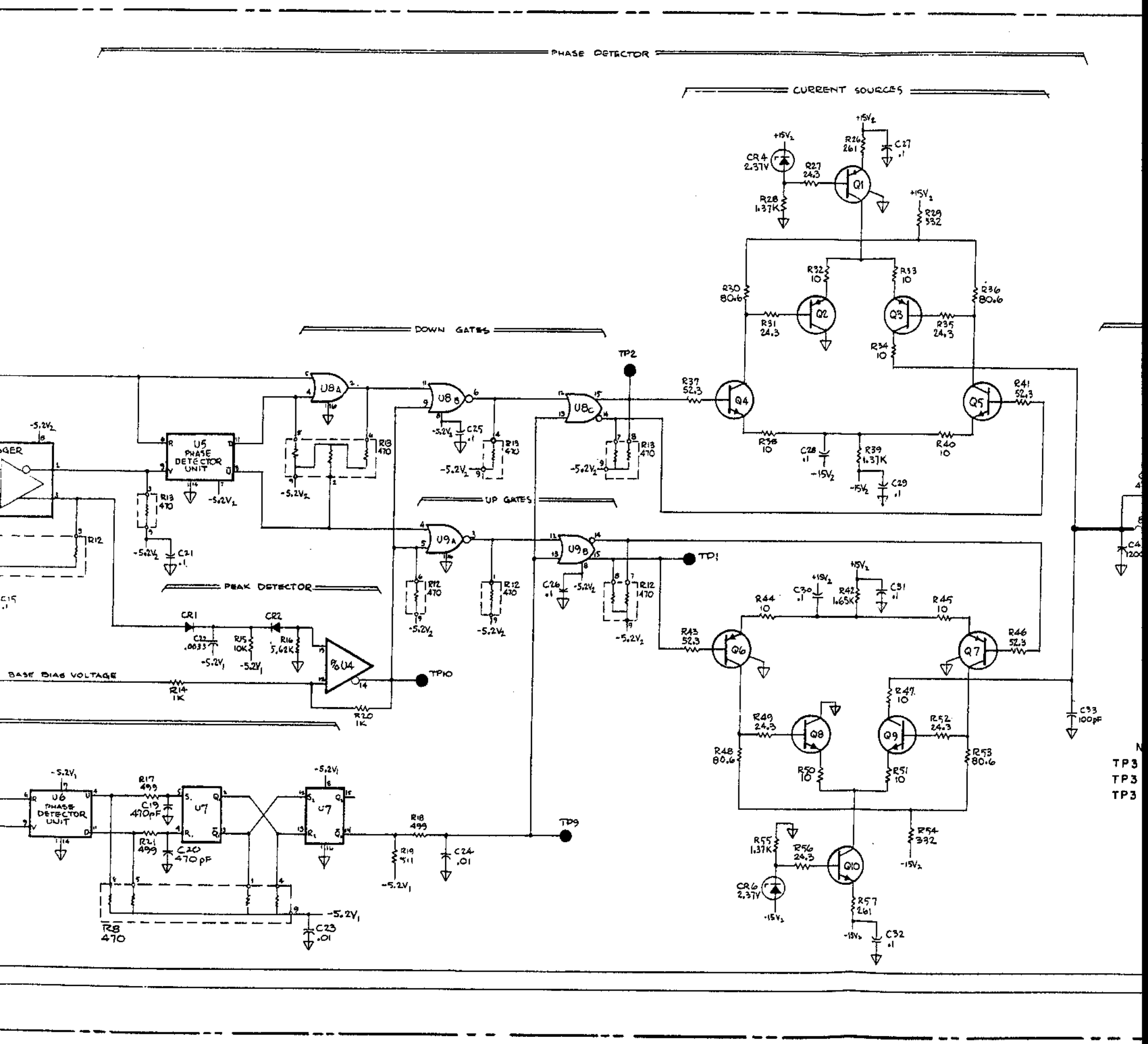
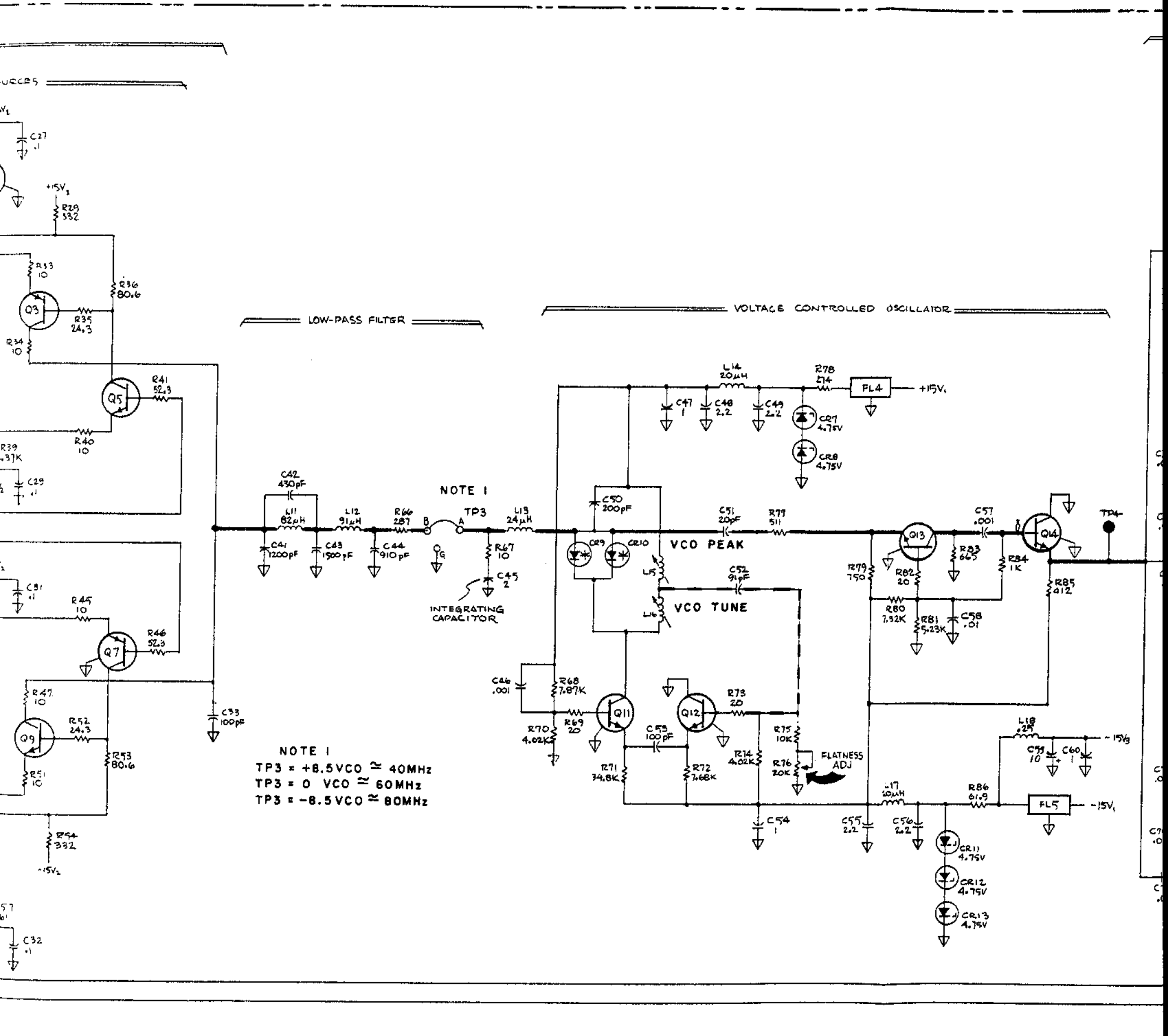


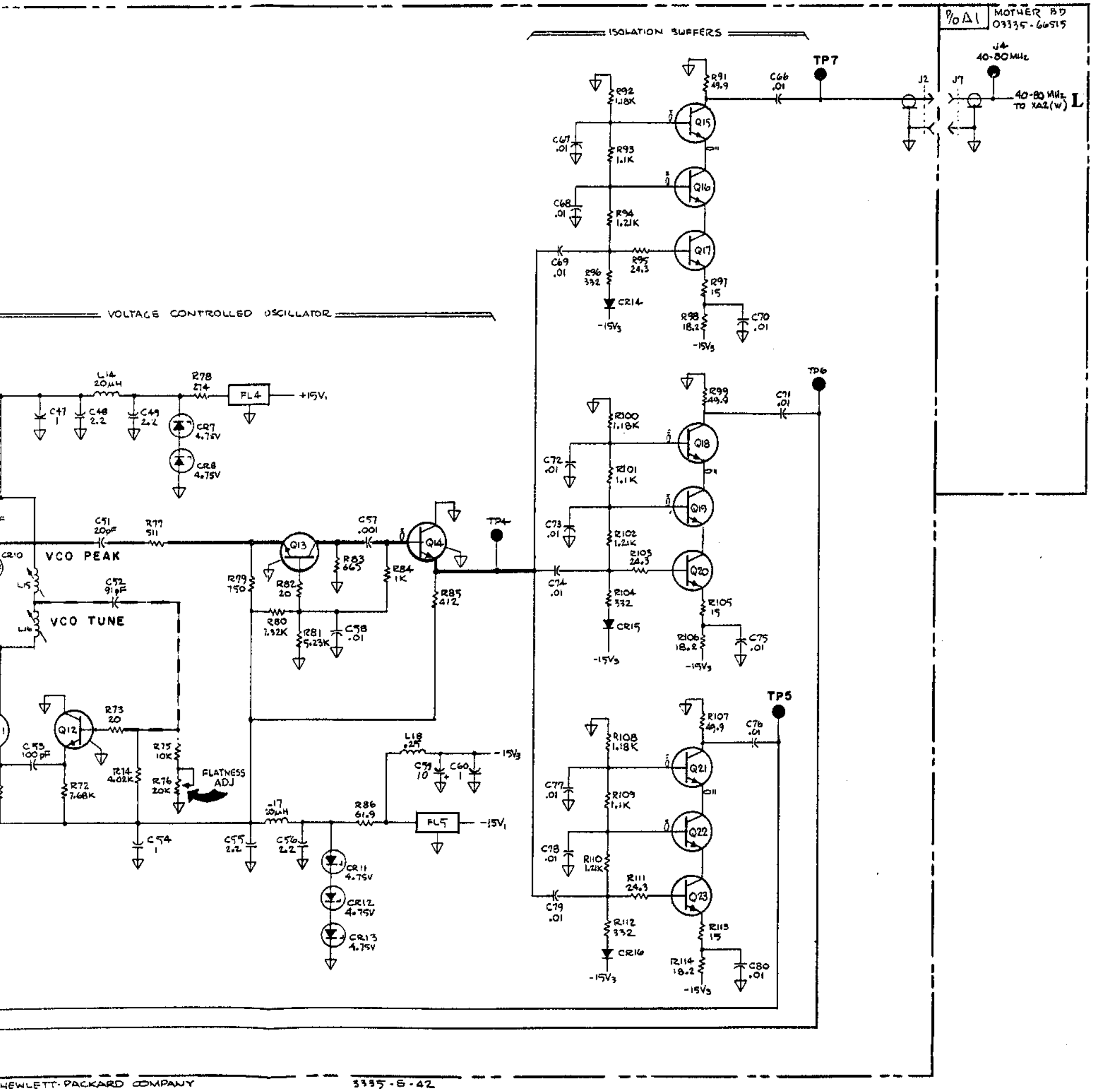
Fig 8-K-1
Sht 4 of 5



3335-E-42

Fig

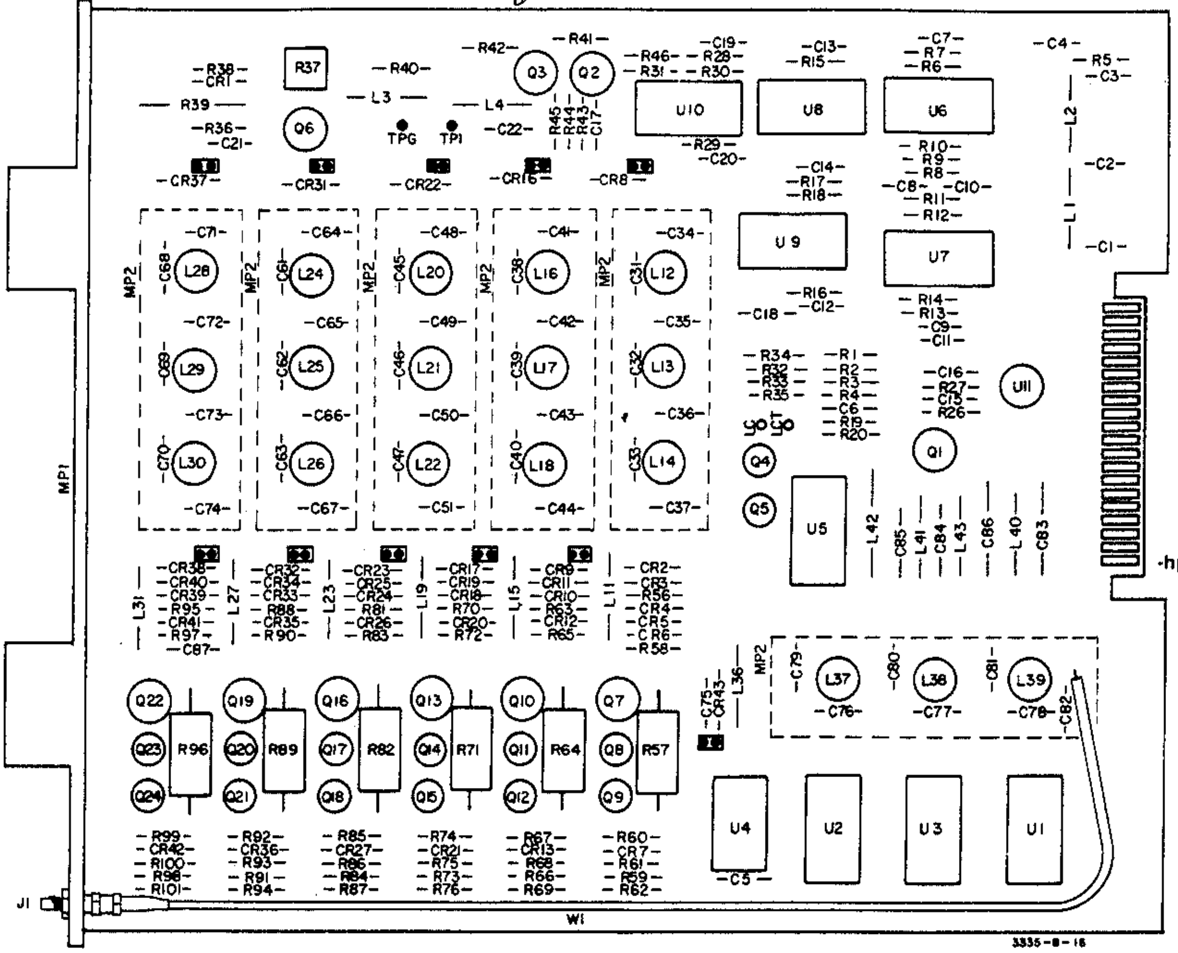
Fig 8-K-1
Sht 5 of 5



K

Figure 8-K-1. Schematic Diagram,Summation Loop(03335-66532) A8 .
Backdating 8-K-7/8-K-8

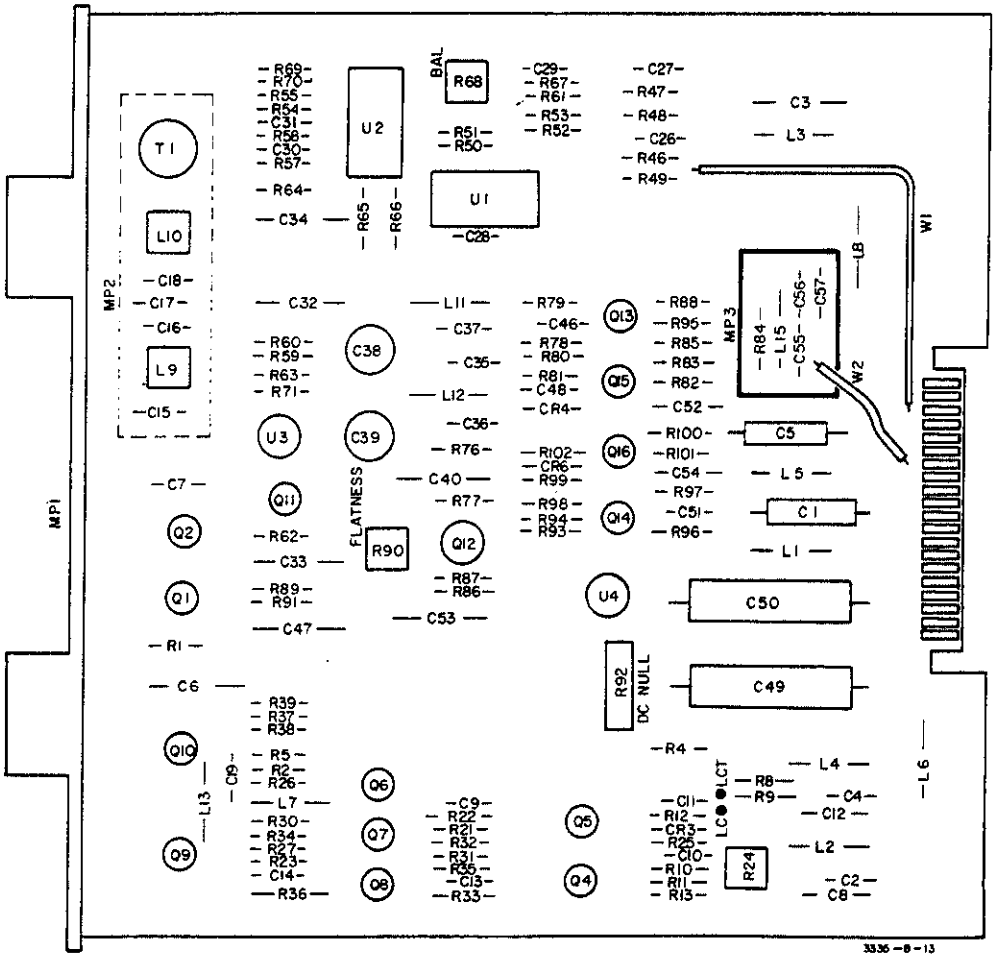
F-8-L-1 Sht 1 of 5



E

FROM CONTROL INTERFA AIO

A2
-hp- Part No. 03335-66506



A7
-hp- Part No. 03335-66507

Fig 8-L-1 Sht 2 of 5

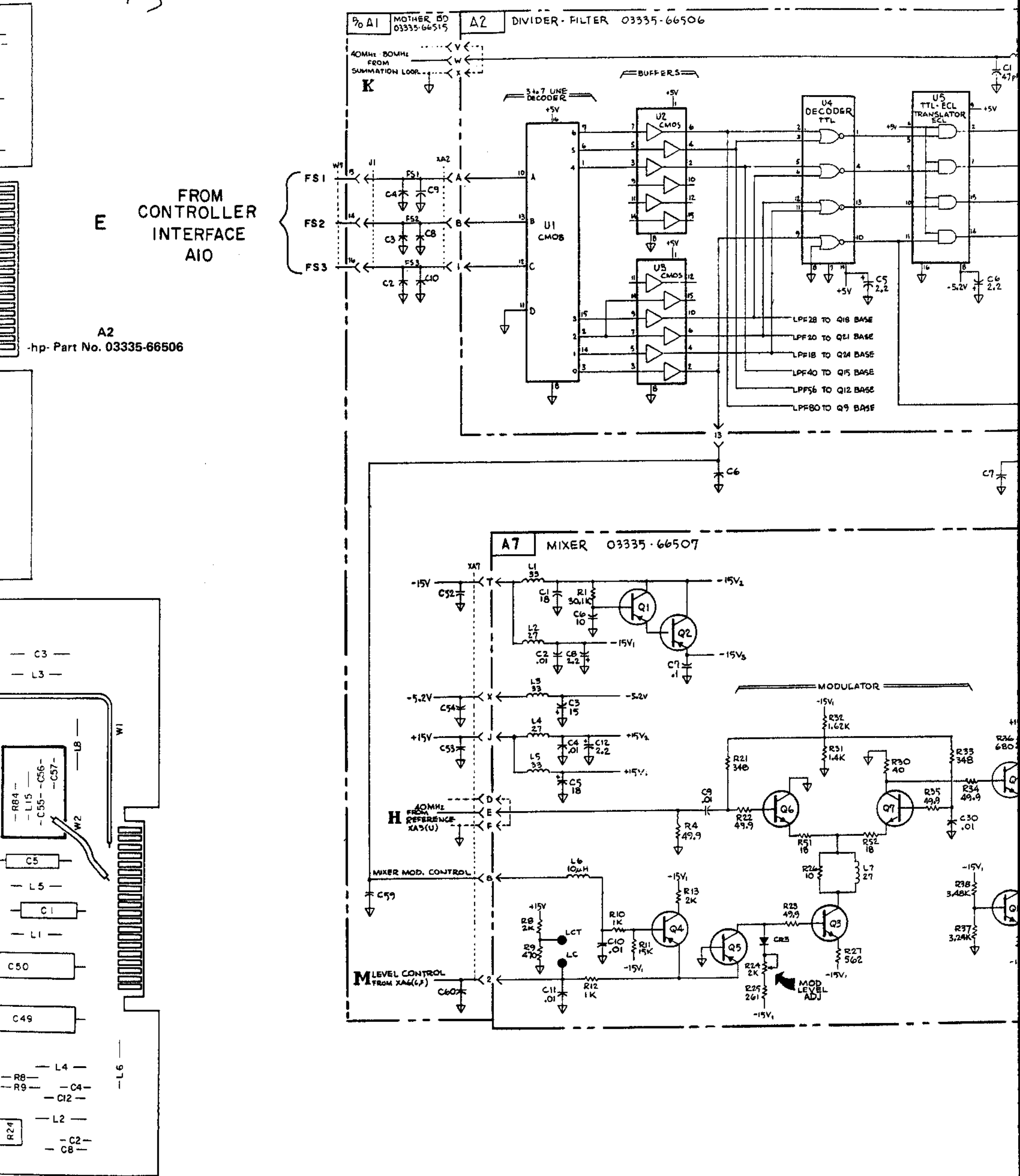


Fig 8-L-1 Sht 3 of 5

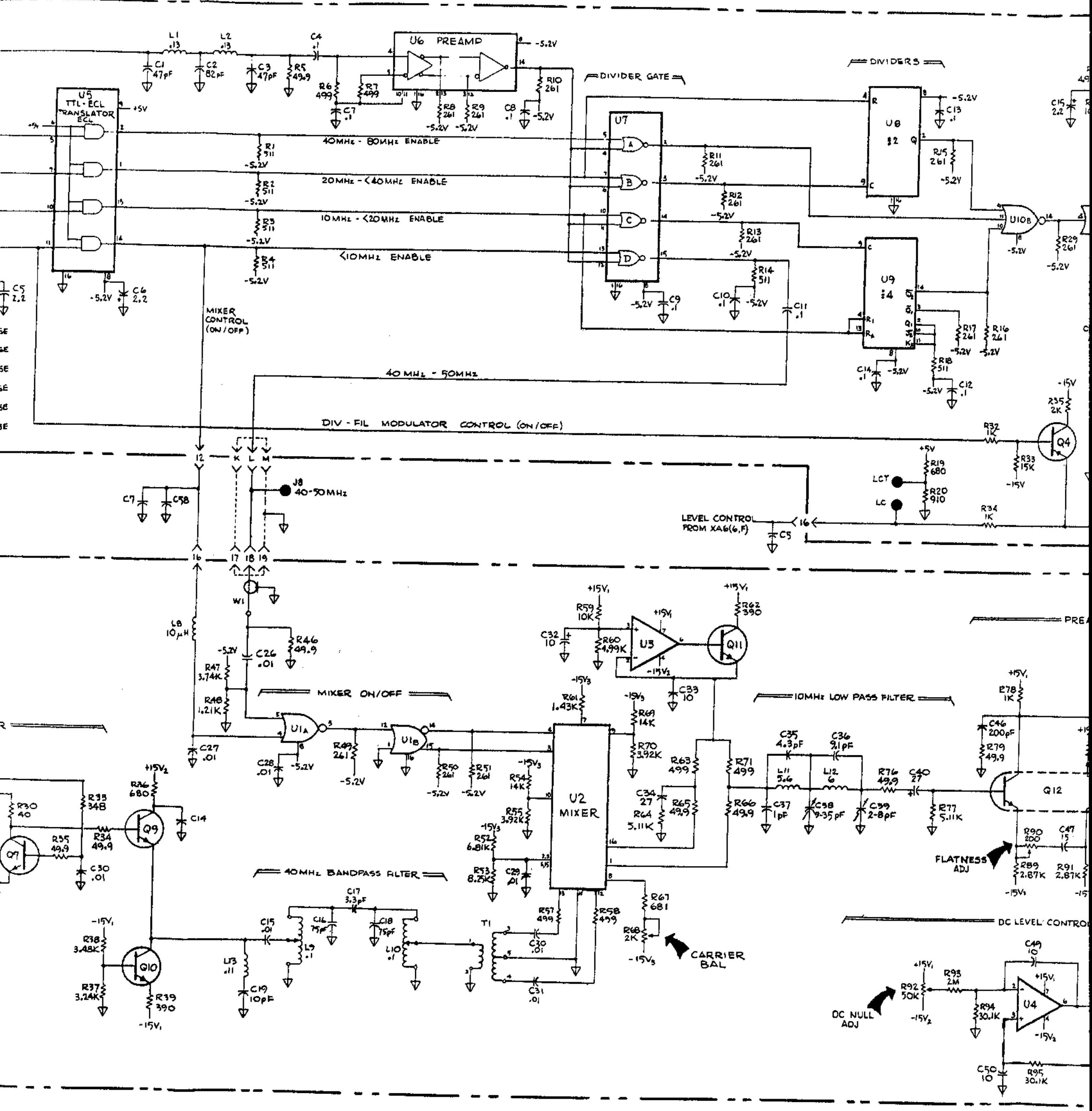


Fig 8-L-1 Sht 4 of 5

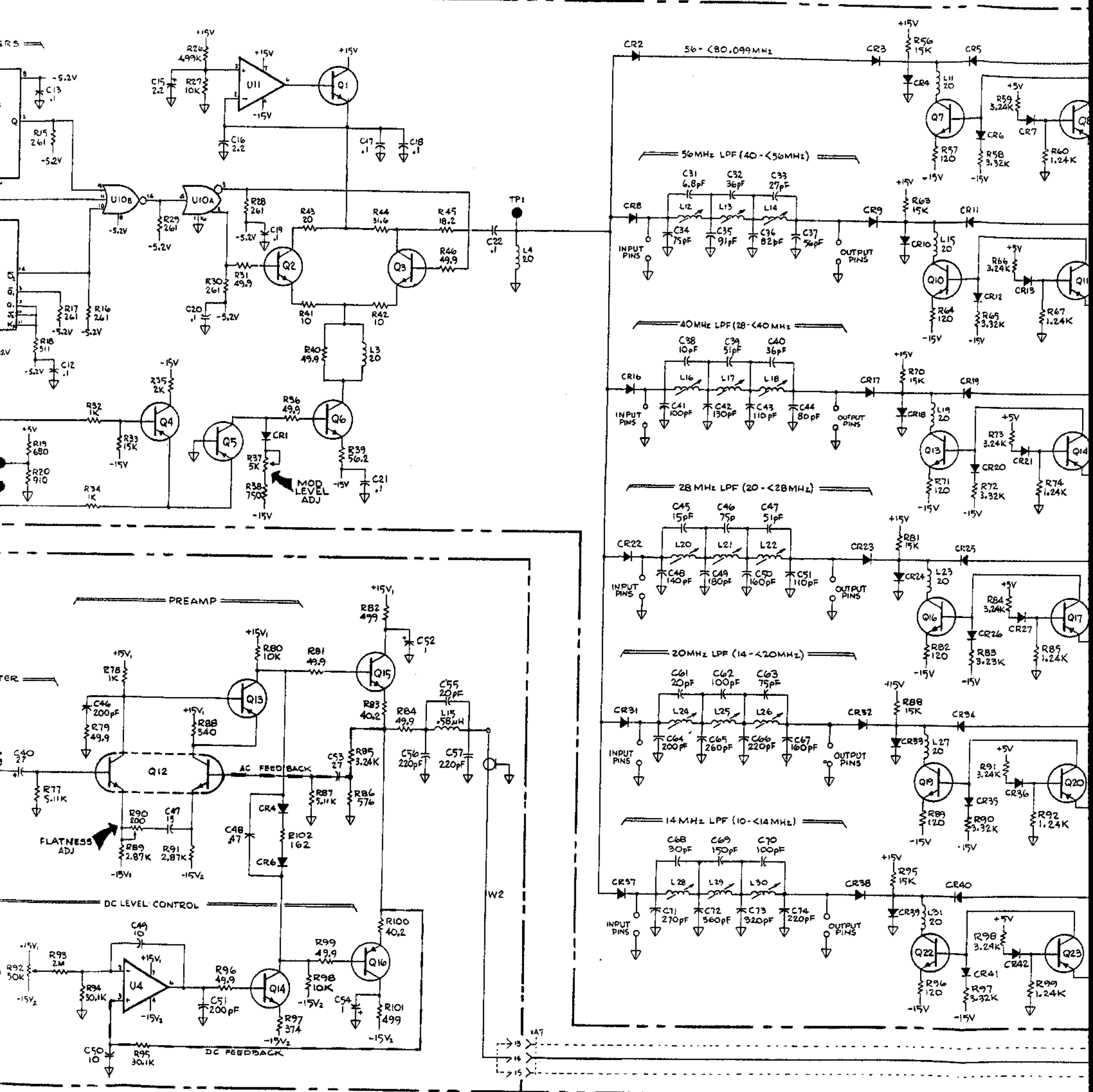
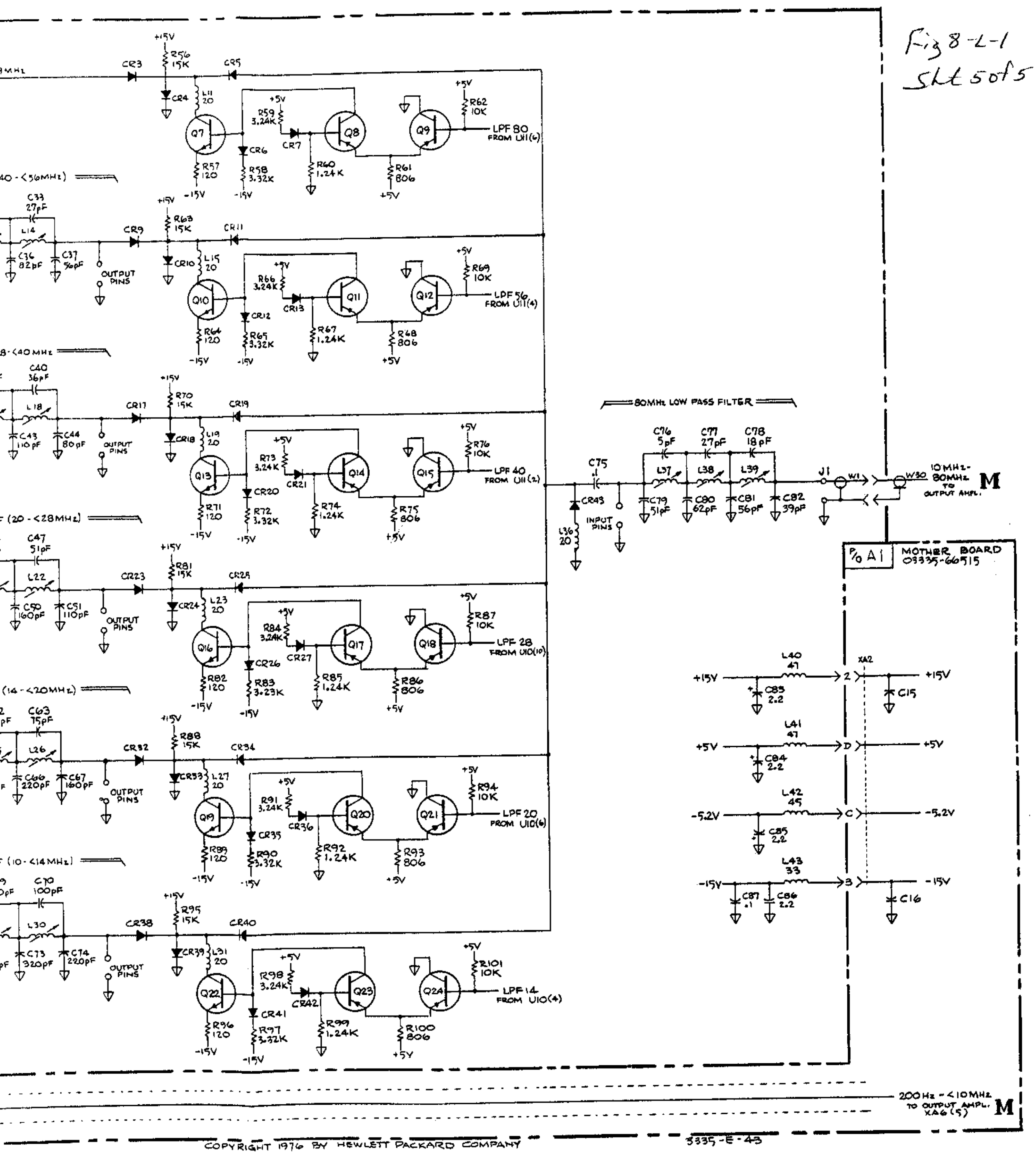


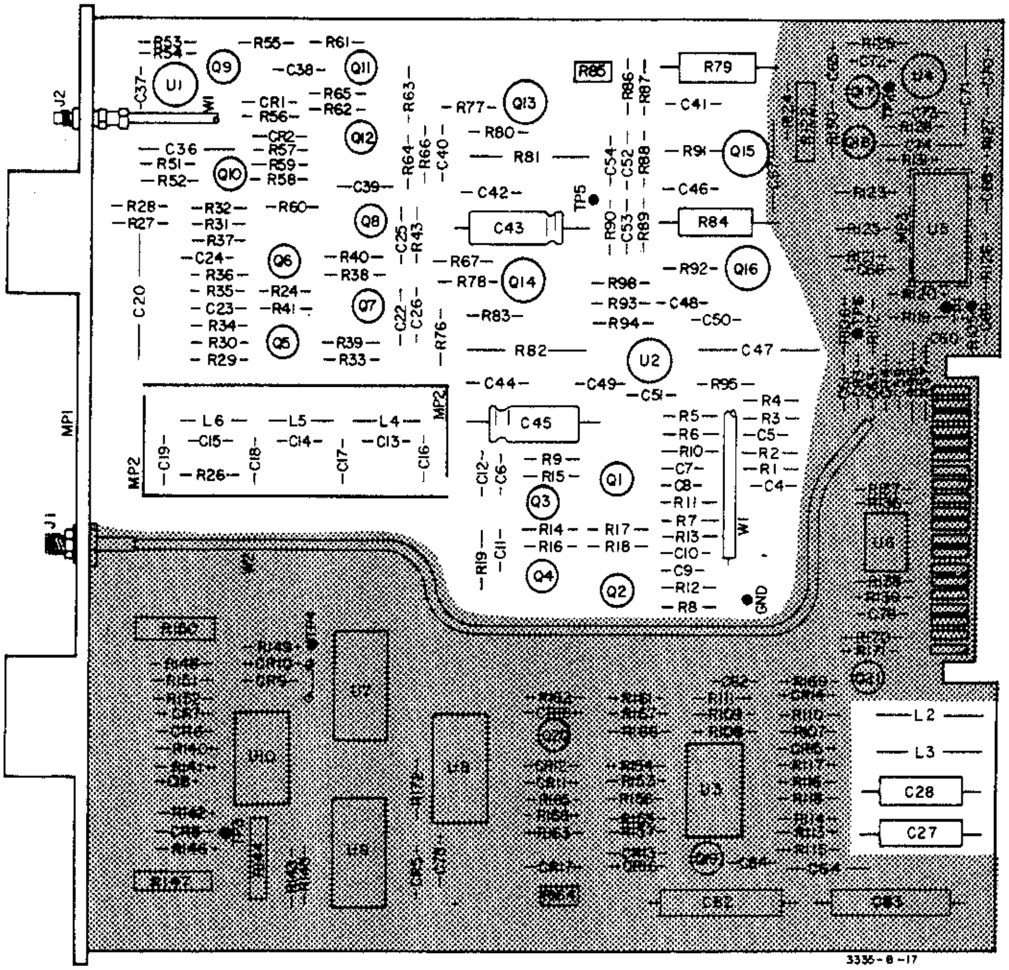
Fig 8-L-1
Sht 5 of 5



L

Figure 8-L-1. Schematic Diagram, Divider-Filter (03335-66506) A2 Mixer (03335-66507) A7.

Fig 8-M-1
Sht 1 of 4



3335-8-17

A6
-hp- Part No. 03335-66508
Output Amplifier

Fig 8-M-1
Sht 2 of 4

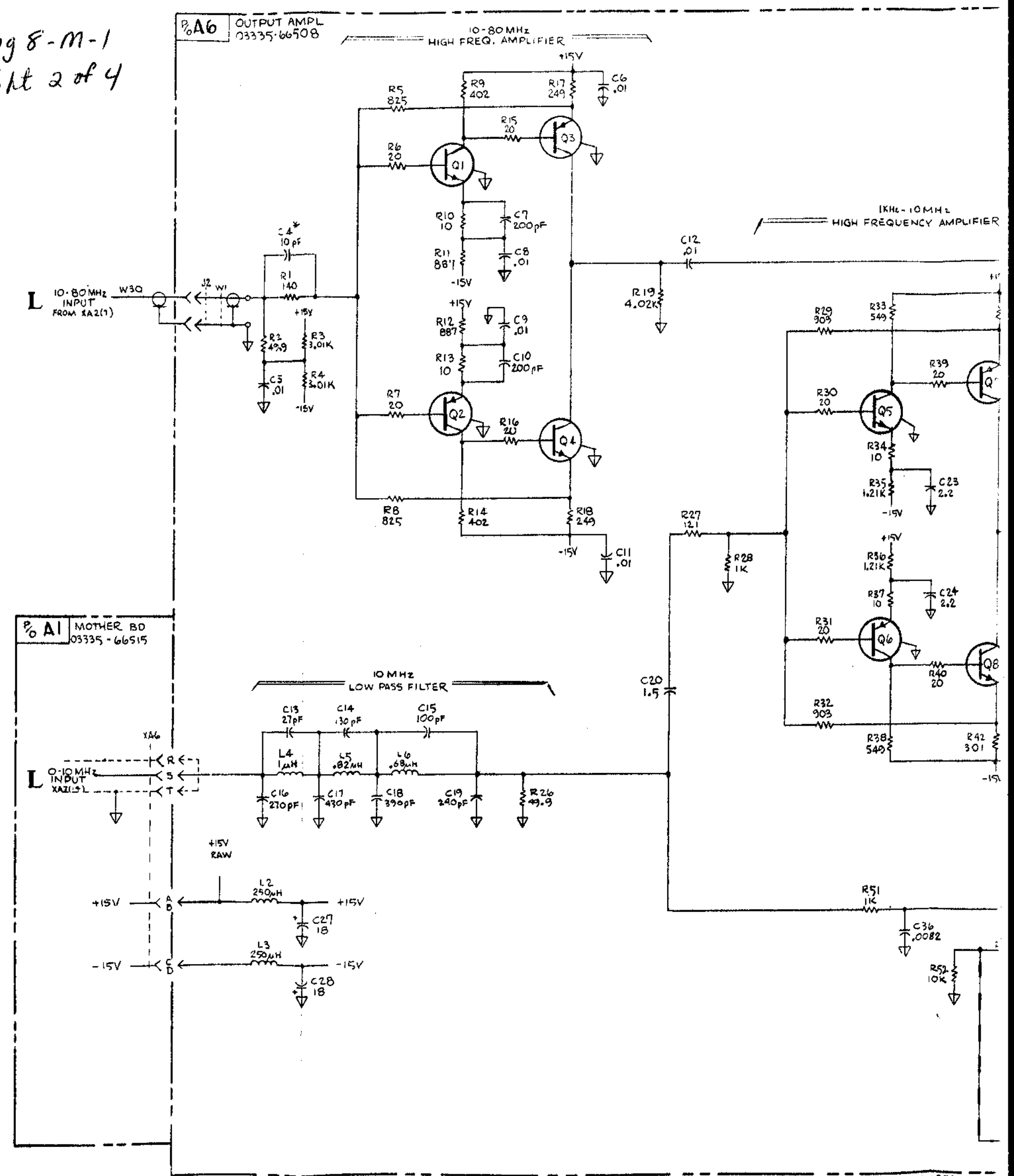
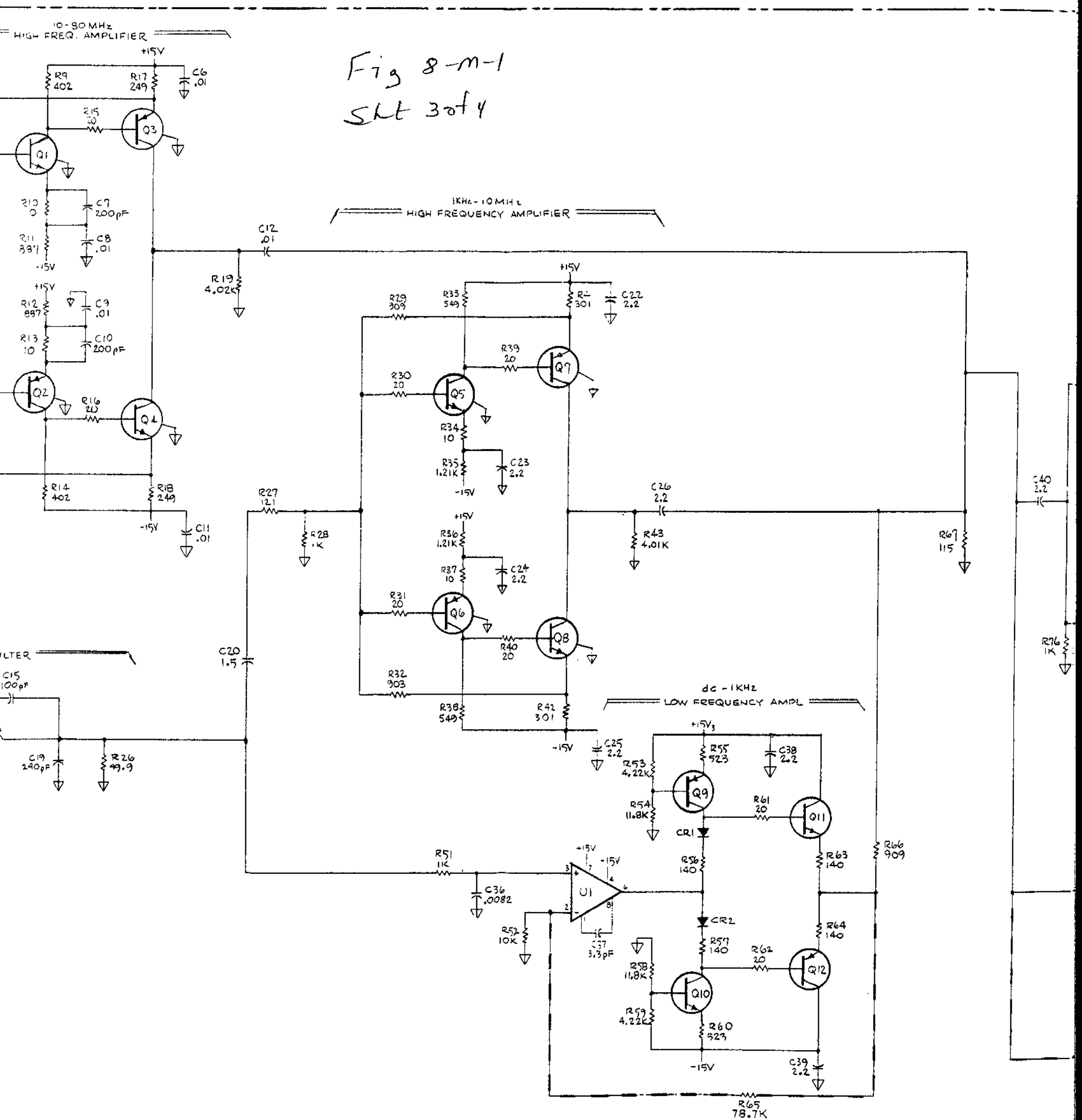
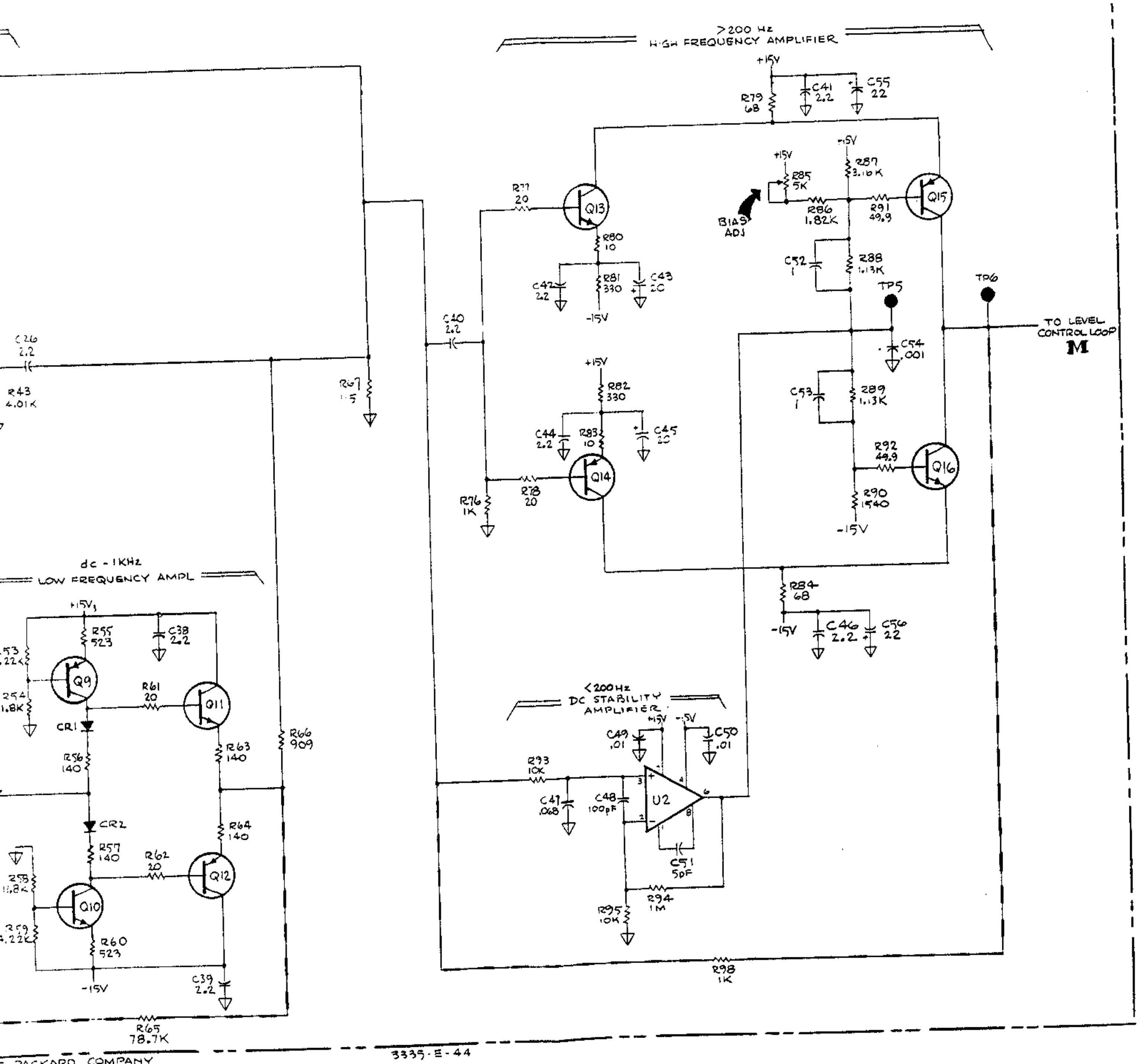


Fig 8-M-1
Sht 3 of 4



3335-E-44

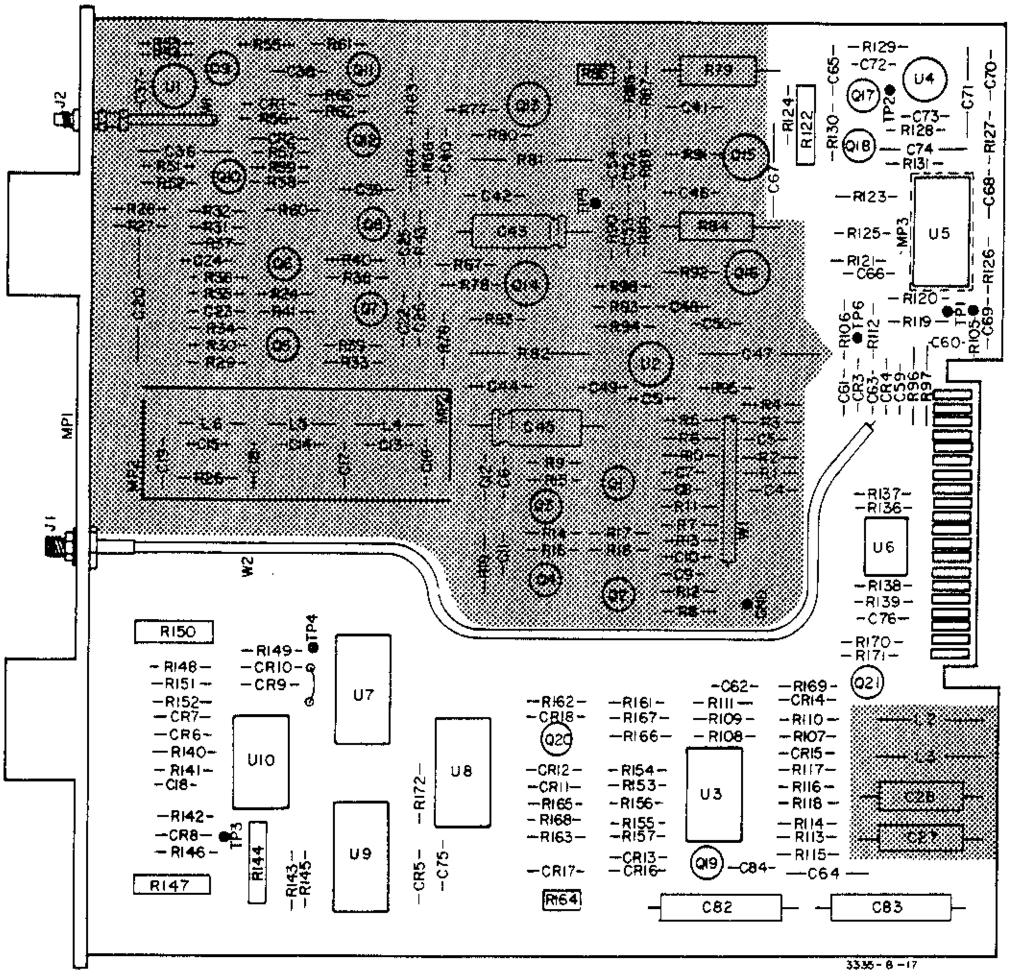
Fig 8-m-1
Sht 4 of 4



M

Figure 8-M-1. Schematic Diagram, Output Amplifier (03335-66508) A6.
Backdating 8-M-9/8-M-10

Fig 8-M-2
Sht 1 of 4



A6
-hp- Part No. 03335-66508
Level Control

Fig 8-m-2 Sht 2 of 4

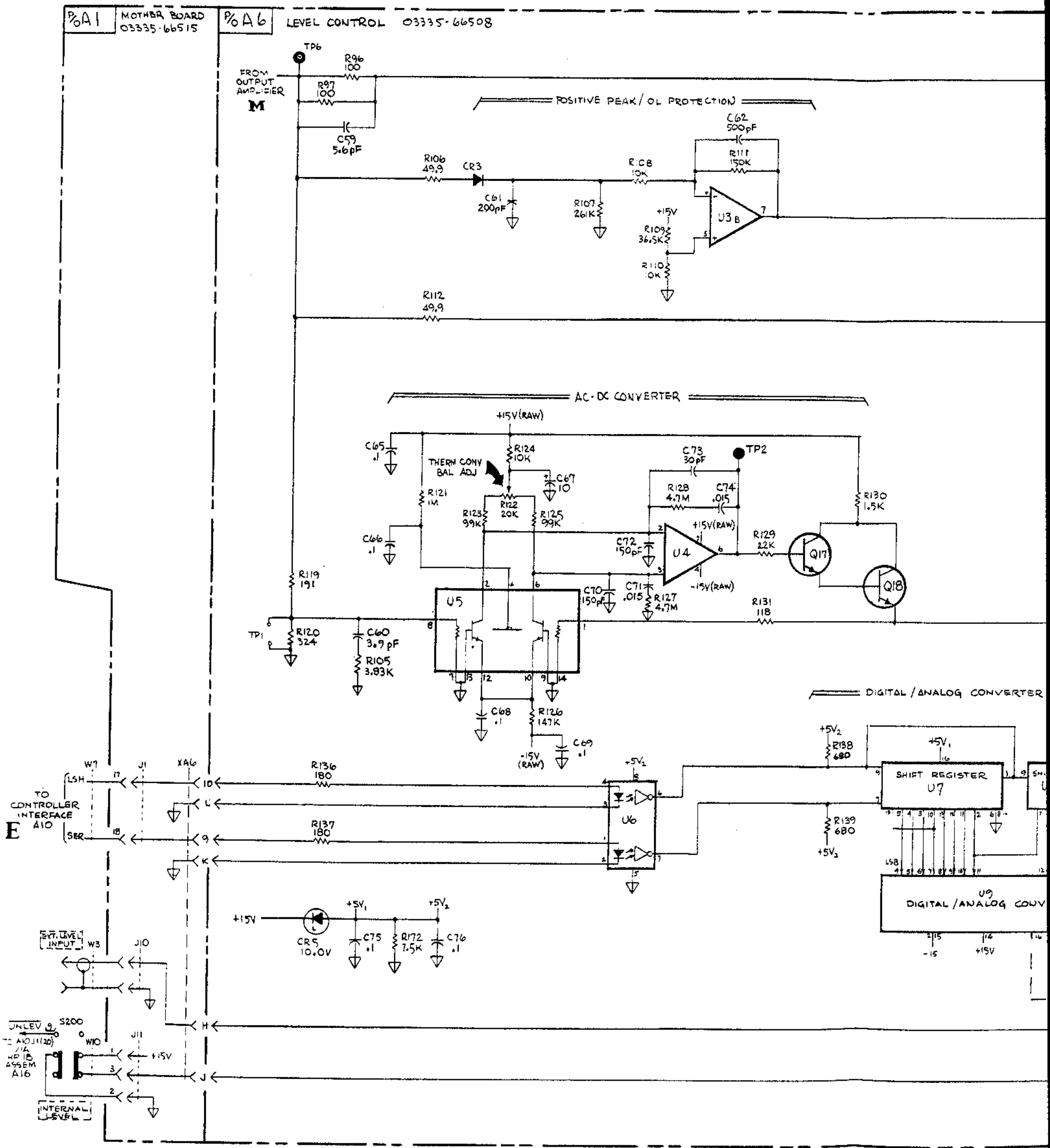
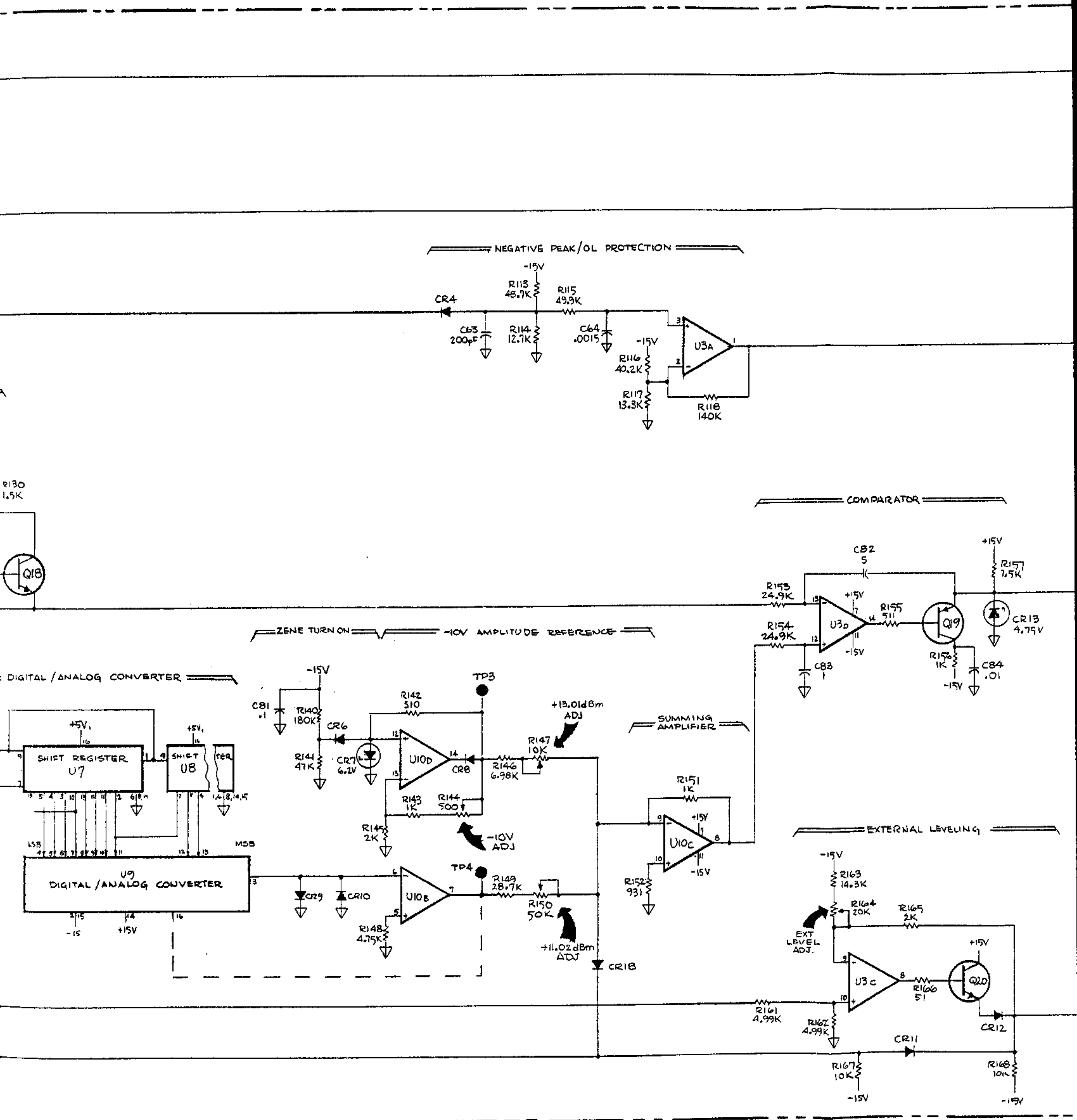
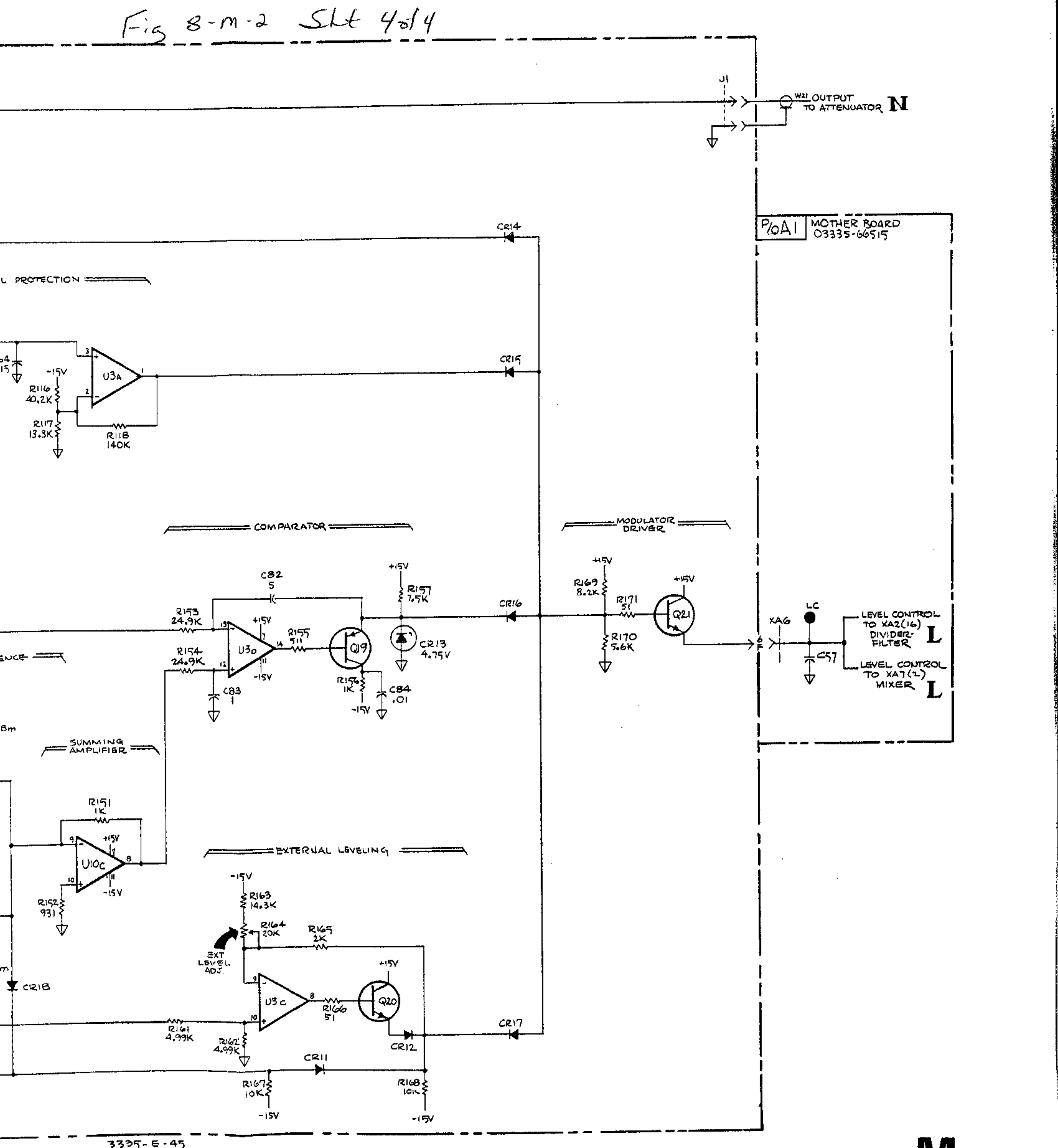


Fig 8-M-2 Sht 3 of 4



3335-E-45



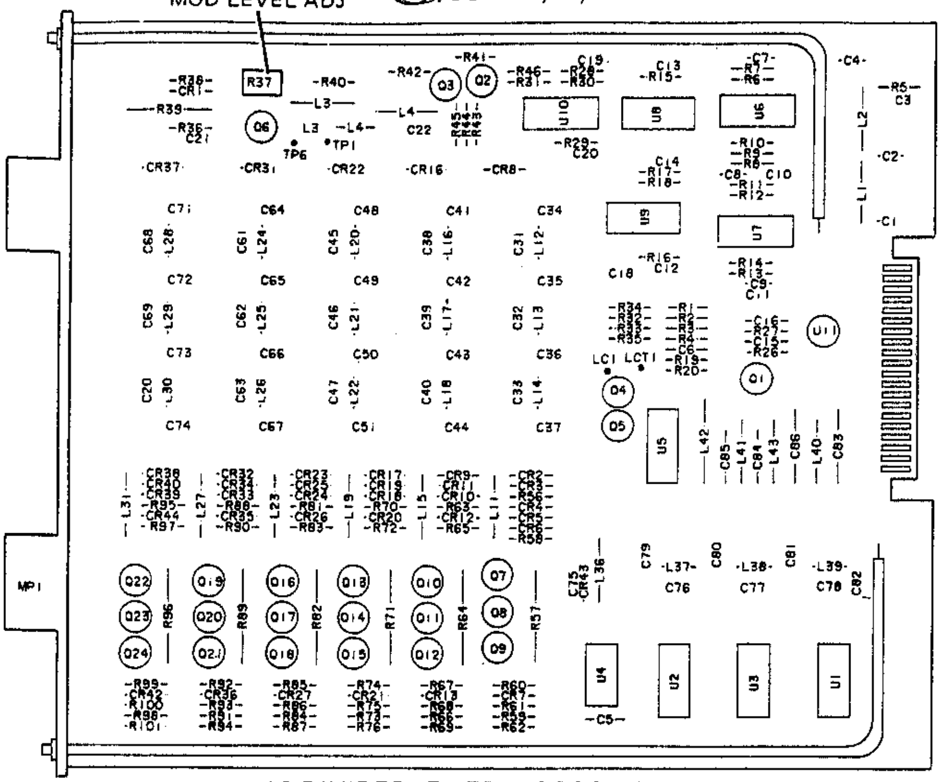
M

Figure 8-M-2. Schematic Diagram, Level Control (03335-66508) A6.

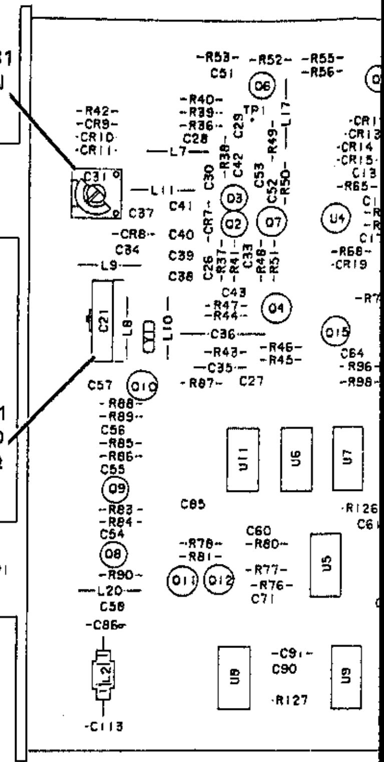
Backdating 8-M-11/8-M-12

7-17/7-18

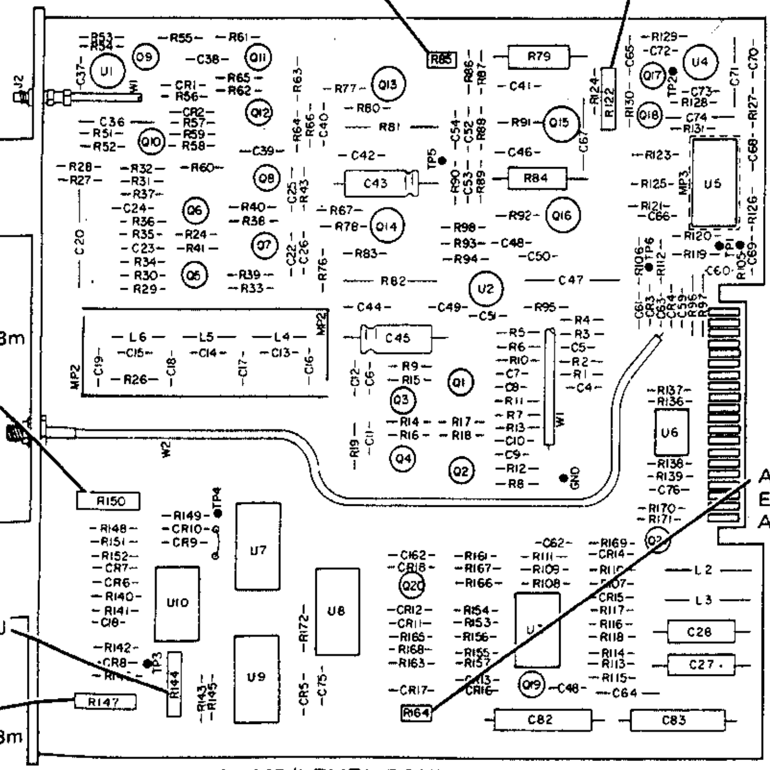
Fig 5-5
Sht 1 of 4



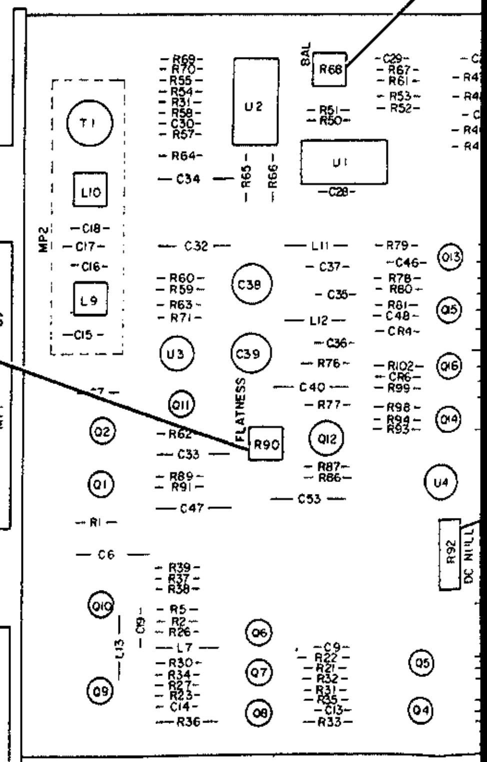
A2 DIVIDER—FILTER 03335-66536



A3 REFER

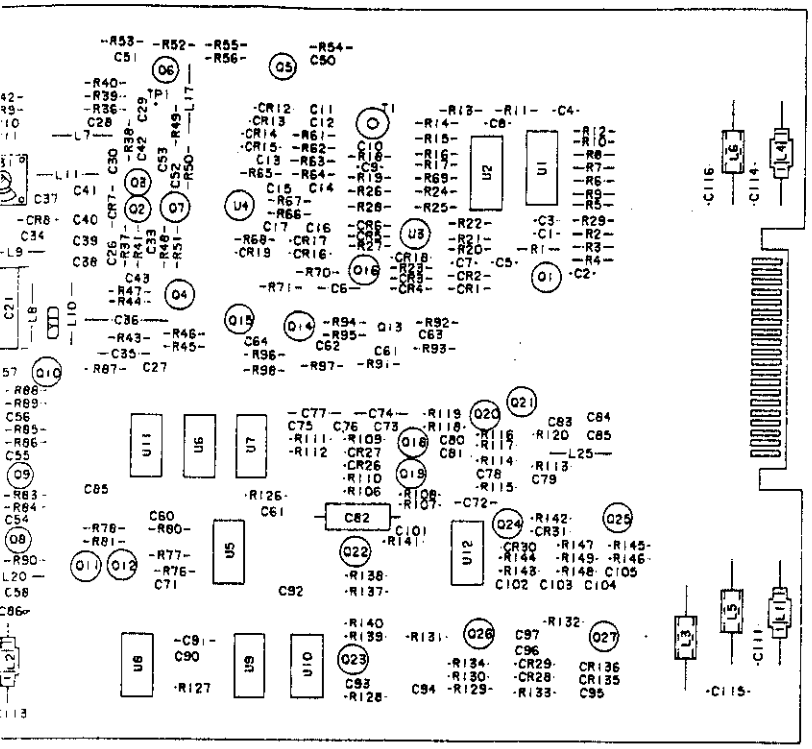


A6 OUTPUT AMP/LEVEL CONTROL 03335-66508

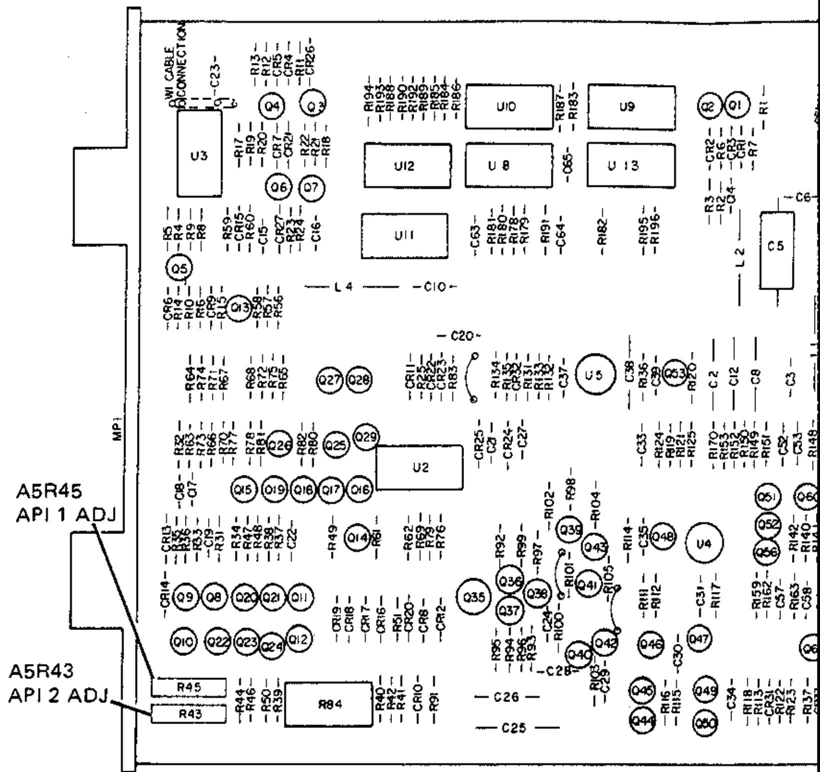


A7 MIXER 03335-6

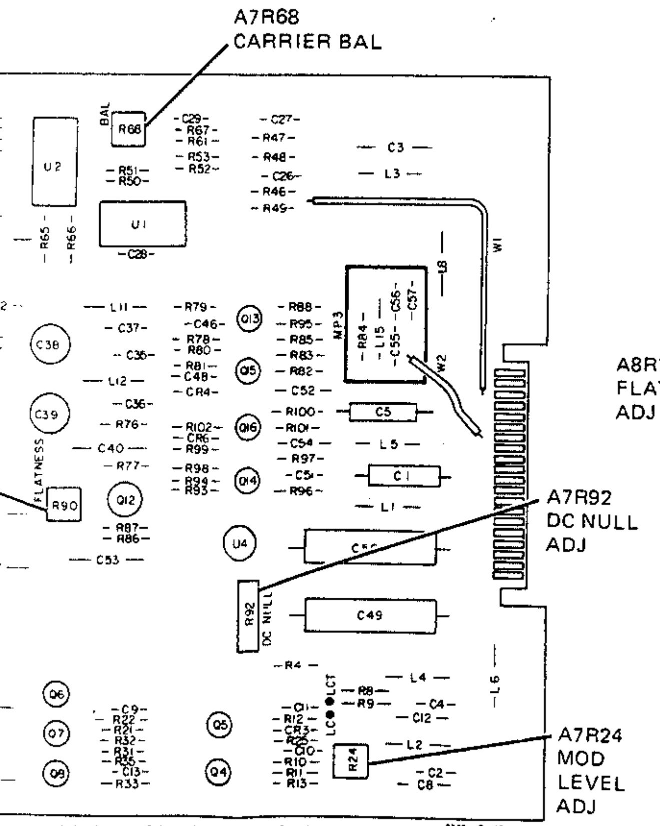
Fig 5-5
Sht 2 of 4



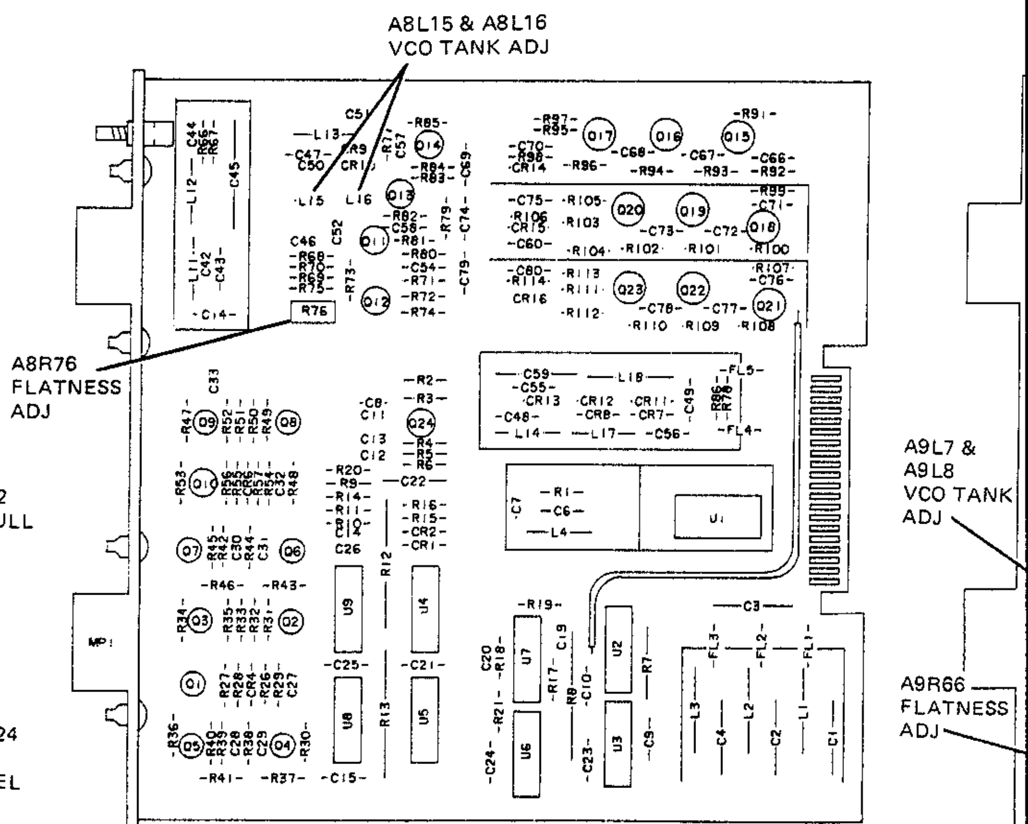
A3 REFERENCE 03335-66505



A5 FRACTIONAL—N ANALOG 03335-6650

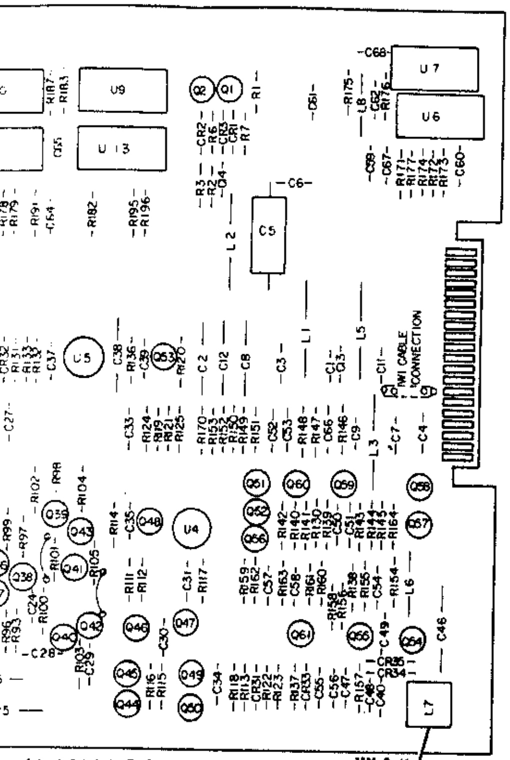


A7 MIXER 03335-66507

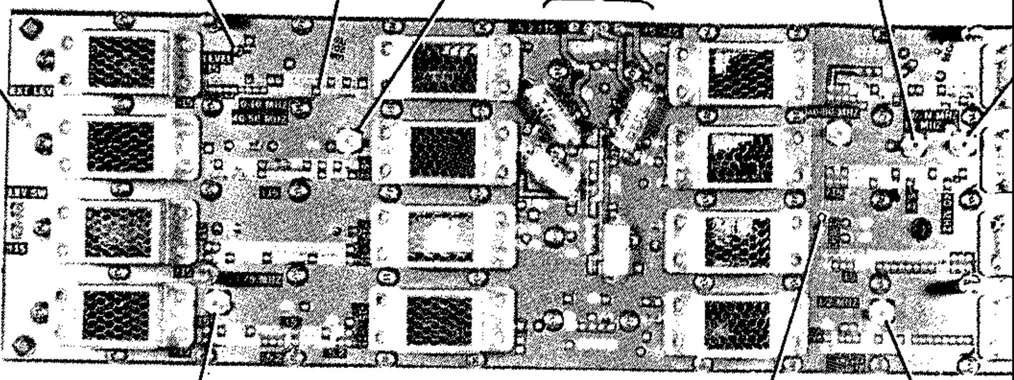


A8 SUMMATION LOOP 03335-66532

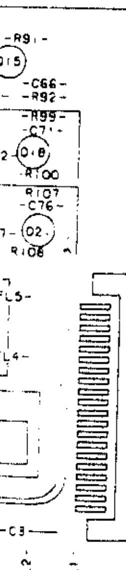
Fig 5-5
Sht 3 of 4

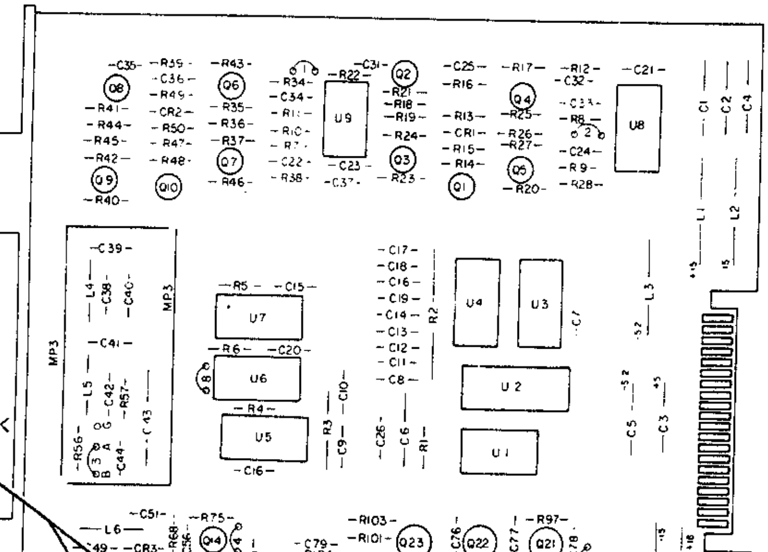


L–N ANALOG 03335-66504



A1 MOTHER 03335-66515 (TEST CONNECTOR LOCATIONS)



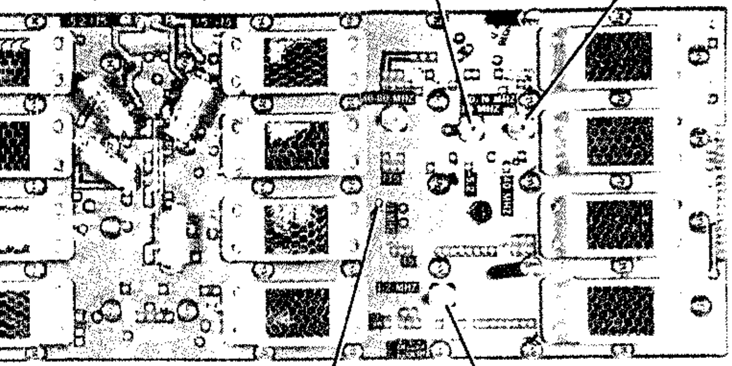


A9 N STEP LOOP 03335-66501

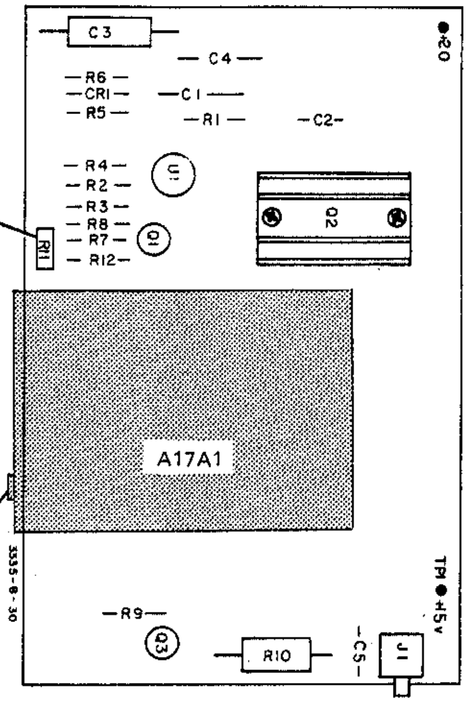
POWER SUPP

NOTE: INSTRUMENTS WITH SERIA
AND LOWER DO NOT HAVE CURRE

Fig 5-5
Sht 4 of 4

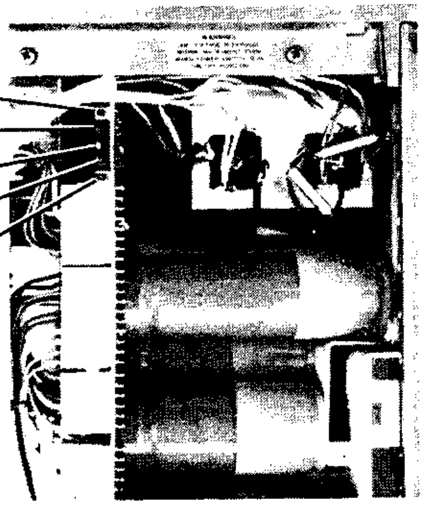


335-66515 (TEST CONNECTOR LOCATIONS)

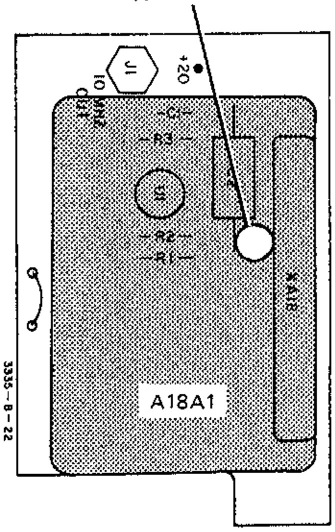


A17 TEMP–STABILIZED OSCILLATOR
INTERFACE (STANDARD)
03335-66522

POWER SUPPLY SECTION



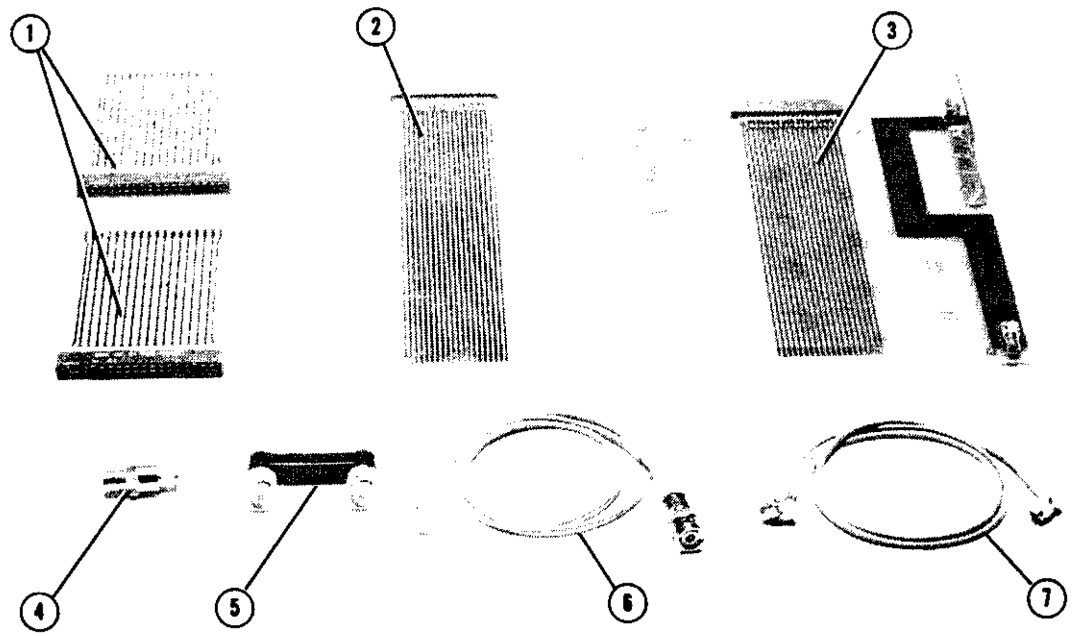
NOTE: INSTRUMENTS WITH SERIAL NUMBER 1640A00215
AND LOWER DO NOT HAVE CURRENT ADJUSTMENTS.



A18 TEMP–STABILIZED OSCILLATOR
INTERFACE (OPTION 001)
03335-66517

3335-C-52

Figure 5-5. Adjustment Locations.
Backdating



(1) EXTENDER BOARD (2). Used to place the Controller Assembly in position for servicing.

(2) EXTENDER BOARD. Used in servicing assemblies in the module.

(3) EXTENDER BOARD. Used in servicing the short assemblies of the module. RF connectors are present to accommodate the A8 assembly.

(4) SMA-to-BNC ADAPTER. Used to obtain a BNC connection at the module output (A6J1).

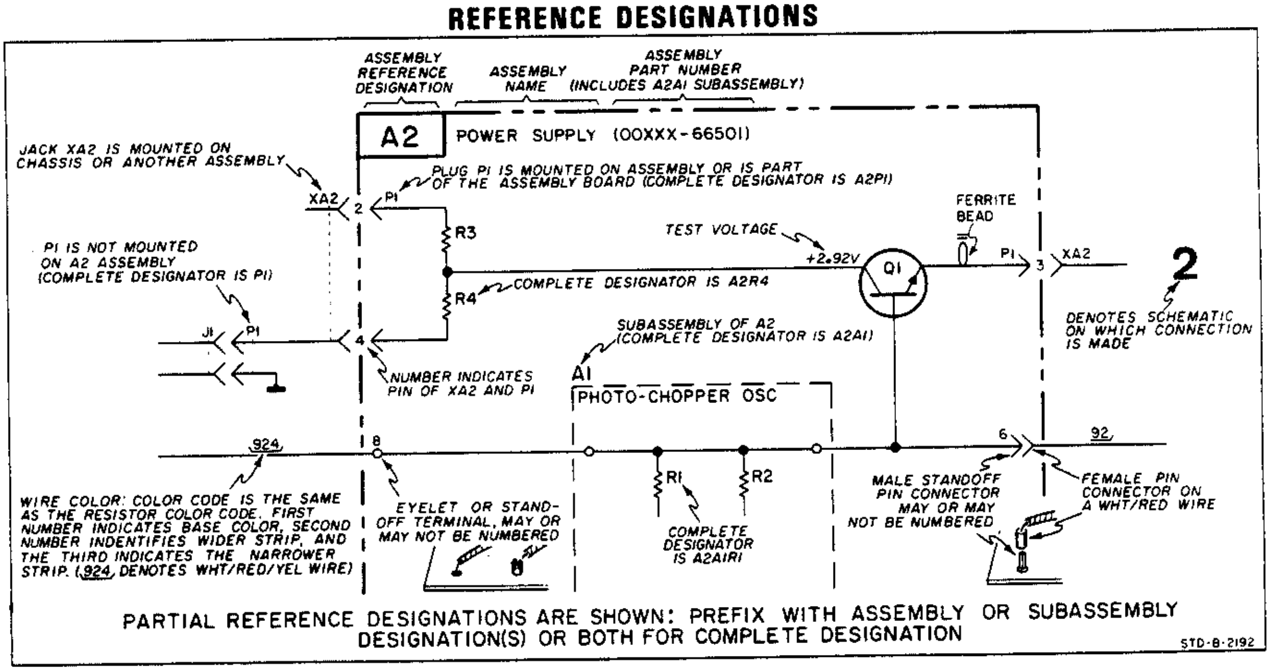
(5) BNC JUMPER. Used to interconnect the rear panel "10 MHz REF OVEN OUTPUT" to the "40/N MHz REF INPUT".

(6) CABLE W1. BNC-to-PUSH-ON SELECTOR. Used to obtain a BNC connection to the module for servicing.

(7) CABLE W2. SMA-to-SMA. Used to replace the semi-rigid coax between module and attenuator when the module is removed for servicing.

Figure 8-49. Service Items.

REFERENCE DESIGNATIONS



GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
   INDUCTANCE IN MILLIHENRYS

3. DENOTES EARTH GROUND. USED FOR TERMINALS WITH NO LESS THAN A NO. 18 GAUGE WIRE CONNECTED BETWEEN TERMINAL AND EARTH GROUND TERMINAL OR AC POWER RECEPTACLE.

4. DENOTES FRAME GROUND. USED FOR TERMINALS WHICH ARE PERMANENTLY CONNECTED WITHIN APPROXIMATELY 0.1 OHM OF EARTH GROUND.

5. DENOTES GROUND ON PRINTED CIRCUIT ASSEMBLY. (PERMANENTLY CONNECTED TO FRAME GROUND).

6. DENOTES ASSEMBLY.

7. DENOTES MAIN SIGNAL PATH.

9. DENOTES FEEDBACK PATH.

10. DENOTES FRONT PANEL MARKING.

11. DENOTES REAR PANEL MARKING.

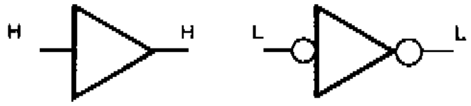
12. DENOTES SCREWDRIVER ADJUST.

13. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY. THE VALUE OF THESE COMPONENTS MAY VARY FROM ONE INSTRUMENT TO ANOTHER. THE METHOD OF SELECTING THESE COMPONENTS IS DESCRIBED IN SECTION V OF THIS MANUAL.

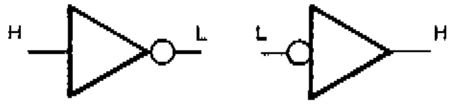
14. DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.

15. 924 DENOTES WIRE COLOR; COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES WIDER STRIP, THIRD NUMBER IDENTIFIES NARROWER STRIP. (e.g. 924 = WHITE, RED, YELLOW.)

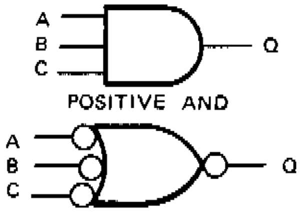
17. ALL RELAYS ARE SHOWN DEENERGIZED.



DENOTES BUFFER



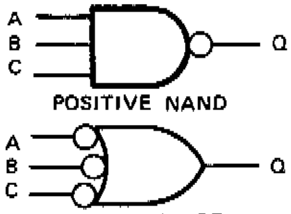
DENOTES INVERTER



POSITIVE AND

NEGATIVE OR

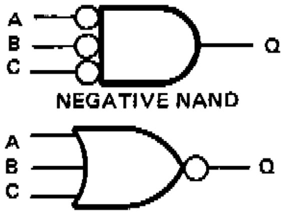
A	B	C	Q
L	L	L	L
L	L	H	L
L	H	L	L
L	H	H	L
H	L	L	L
H	L	H	L
H	H	L	L
H	H	H	H



POSITIVE NAND

NEGATIVE NOR

A	B	C	Q
L	L	L	H
L	L	H	H
L	H	L	H
L	H	H	H
H	L	L	H
H	L	H	H
H	H	L	H
H	H	H	L



NEGATIVE NAND

POSITIVE NOR

A	B	C	Q
L	L	L	H
L	L	H	L
L	H	L	L
L	H	H	L
H	L	L	L
H	L	H	L
H	H	L	L
H	H	H	L

EXCLUSIVE OR GATE

A	B	Q
L	L	L
L	H	H
H	L	H
H	H	L

SECTION VIII
SERVICE

WARNING

Line voltage is exposed within the instrument even when the power switch is in STBY position.

8-1. INTRODUCTION.

8-2. This section contains the information required to service the Model 3335A Synthesizer. The information includes recommended test equipment, a theory of operation and troubleshooting information which includes safety considerations, service aids, block diagrams and schematic diagrams. The structure and content of this section is outlined below.

a. Recommended Test Equipment: Defines the test instrumentation and accessories required to maintain the Synthesizer.

b. Theory of Operation: Theory of operation describes how the sections of the Synthesizer operate. A simplified block description presents an overview of the Synthesizer which is then described by individual sections. Some of the more complex sections contain two levels of discussion:

1. Simplified Theory
2. Detailed Theory

The theory of operation makes use of both block diagrams and schematic diagrams to describe circuit operation.

c. Troubleshooting: Provides procedures used to isolate faults to assembly level and then to component level. Assembly level troubleshooting information is located with the functional block diagram in Service Group O. Component level troubleshooting information is located with the associated assembly schematic (see item f, Service Groups).

d. Safety Considerations: Provides general safety precautions that should be observed when working on the Synthesizer.

e. Service Aids: Provides general information useful for servicing the Synthesizer.

f. Service Groups: Service groups contain the block diagram, schematic diagram, component locator and associated component level troubleshooting information. The block diagram and schematic diagram are foldout sheets. The troubleshooting information is contained on 8-1/2" x 11" pages which overlay the apron page of the schematic diagram foldout.

8-3. RECOMMENDED TEST EQUIPMENT.

8-4. Equipment required to maintain the Model 3335A is listed in Table 1-3. Other equipment can be substituted if it meets or exceeds the critical specifications listed in the table.

8-5. THEORY OF OPERATION.

8-6. The theory of operation is divided into two parts. First an overview of the entire instrument is presented using a simplified block diagram. This discussion introduces each of the individual sections of the instrument and illustrates the relationship of each section to the other sections. Secondly, each individual section is discussed in detail using a block diagram and schematic diagram.

8-7. Simplified Block Description.

8-8. The Model 3335A Synthesizer develops the output signal by an indirect synthesis technique. This technique uses tunable oscillators, phase-locked to sub-harmonics of a master reference oscillator, to "synthesize" the desired signal. This signal is filtered and amplified to the programmed amplitude generating the output amplitude and frequency desired.

8-9. The 3335A is comprised of fourteen major sections. Figure 8-1 is a simplified diagram of the Synthesizer illustrating each section. The fourteen sections are:

a. Controller
b. Keyboard
c. HP-IB Interface
d. Display
e. Temperature-Stabilized Oscillator

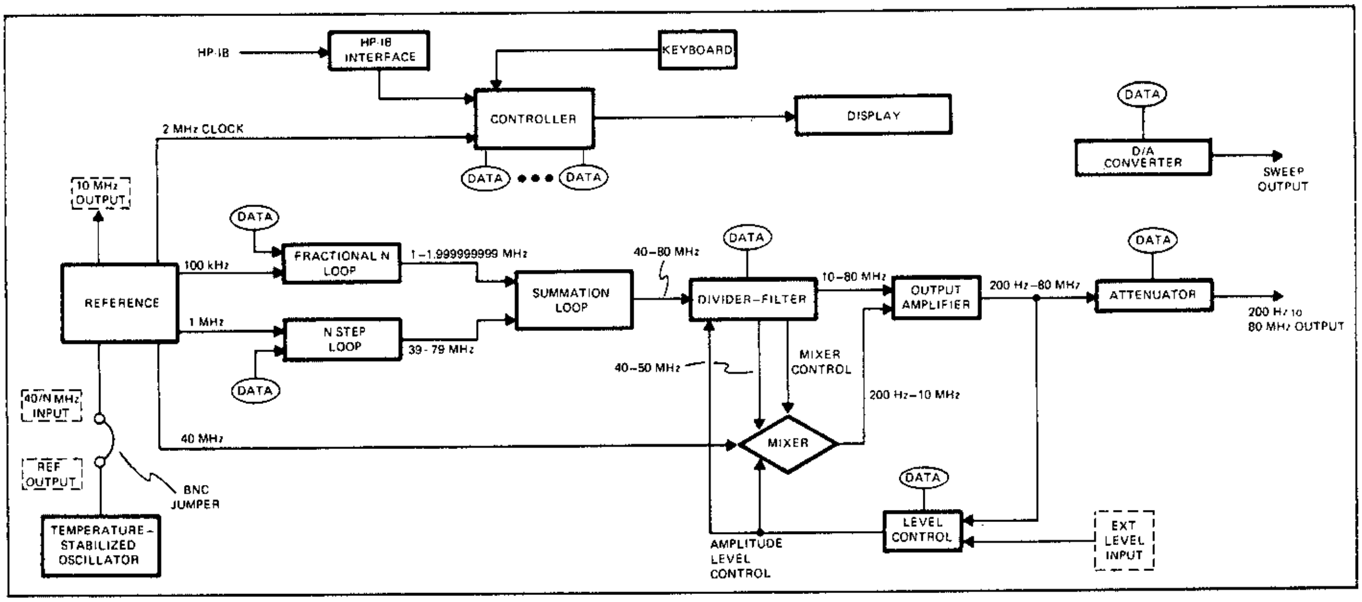


Figure 8-1. Simplified Block Diagram, 3335A Synthesizer/Level Generator.

f. Reference
g. Fractional N Loop
h. N Step Loop
i. Summation Loop
j. Divider-Filter
k. Mixer
l. Output Amplifier
m. Level Control
n. Attenuator

8-10. The Controller is the center of instrument operation. Data to program the various output parameters is input by the Keyboard in manual operation or the HP-IB Interface when operated remotely. The Controller processes the input data and transmits controller data to the various sections of the instrument to establish the programmed frequency and amplitude. The Controller also transmits data to the display section to generate the display.

8-11. To establish the programmed frequency, the controller transmits data to the Fractional N Loop and N Step Loop of the frequency synthesis section. This data fixes the output frequency from the Summation Loop between 40 MHz and 80 MHz. At all times the Summation Loop transmits a 40 MHz to 80 MHz signal to the Divider-Filter section which is responsible for routing the signal dependent on the output frequency selected.

8-12. The Divider-Filter and Mixer work in conjunction with each other to provide the signal to the Output Amplifier. Only one section transmits at a time; the Divider-Filter provides the signal when the output ranges from 10 MHz to 80 MHz and the Mixer is active when the signal ranges from 200 Hz to < 10 MHz. The Mixer is controlled by the Divider-Filter which receives controller data to establish which section generates an output.

8-13. The first situation is when the output is between 10 MHz and 80 MHz. The Divider-Filter receives controller data and transmits a portion of that data to disable the Mixer section. Other controller data establishes the routing to the correct dividers and filters of the Divider-Filter section before the signal is transmitted to the Output Amplifier. The Divider-Filter must divide the signal when an output from 10 MHz to less than 40 MHz is programmed since the synthesized signal it receives ranges from 40 MHz to 80 MHz. The appropriate filter is also selected by controller data.

8-14. The second situation is when the output is 200 Hz to less than 10 MHz. In this range the Divider-Filter does two things.

a. Activates the Mixer section and disables all the filters of the Divider-Filter section.

b. Routes the synthesized signal (40 MHz to < 50 MHz) to the Mixer section.

The 40 MHz to < 50 MHz signal is mixed with a 40 MHz signal from the Reference section to generate a signal less than 10 MHz. A frequency range of 200 Hz to 80 MHz is provided with the combined outputs of the Divider-Filter and Mixer sections.

8-15. Once the Divider-Filter or Mixer section has established the frequency of the output signal, the combination of the Output Amplifier, Attenuator and Level Control section establish the programmed amplitude. Controller data sets the attenuation of the attenuator and establishes the reference in the Level Control section. The Level Control section compares the Output Amplifier's output with the reference and generates a dc voltage which is applied to both the Divider-Filter and Mixer sections to adjust the amplitude of the signal applied to the Output Amplifier. This forms a loop with the Level Control section controlling the amplitude of the Divider-Filter or Mixer section output. In this manner, the amplitude of the signal

applied to the attenuator is maintained constant. The level control loop is capable of varying this amplitude over a range of 1.99 dB while the attenuator provides up to 98 dB of attenuation of the applied signal. The maximum attenuation obtainable from the instrument's maximum output is 99 dB. The attenuator provides 98 dB and the loop introduces 1 dB of attenuation to give a total of 99 dB.

8-16. The frequency and amplitude can both be referenced to an external standard. A BNC jumper selects either the temperature-stabilized oscillator or an external reference. When an external frequency reference is used, the temperature-stabilized oscillator is not used by the instrument. Similarly, when an external level reference is used, the Level Control section no longer relies on the reference established by controller data to maintain a stable amplitude. However, the amplitude still can only be varied over a 2 dB range.

8-17. Instrument Logic Levels.

8-18. Two types of digital signals are used in the synthesizer.

a. Transistor-Transistor Logic (TTL).

b. Emitter-Coupled Logic (ECL).

Digital signals are characterized by two logic states, HIGH and LOW. TTL and ECL signals differ by the voltage levels that define the HIGH and LOW states. Table 8-1 summarizes the voltage levels associated with TTL and ECL.

Table 8-1. TTL and ECL Voltage Levels.

Logic State	Voltage Levels	
	TTL	ECL
Low	0 to + 0.4 V	approx - 1.6 V
High	+ 2.4 V to + 5 V	approx - 0.8 V

8-19. Most sections of the instrument use only TTL while two sections use only ECL. Three sections contain both TTL and ECL. A summary of the types of logic present in each assembly is provided in Table 8-2.

Table 8-2. Assembly Logic Types.

Assembly or Section	Type of Logic
Controller Controller Interface Keyboard Display Fractional N Loop Level Control HP-IB Interface	TTL
Summation Loop Mixer	ECL
N Step Loop Divider-Filter Reference	TTL & ECL

8-20. Emitter coupled logic (ECL) is found in sections of the instrument that must handle high frequency signals greater than 40 MHz. The sections containing ECL and the frequency range of signals they handle are the Reference (40 MHz), N Step Loop (39–79 MHz), Summation Loop (40–80 MHz), Divider-Filter (40–80 MHz) and the Mixer (40–50 MHz). ECL is capable of operating at high speeds because it does not operate in the saturation or cutoff regions as does TTL. Secondly, there is a smaller voltage difference defining the HIGH and LOW states which require less time to change states.

8-21. DETAILED THEORY OF OPERATION.

8-22. This portion of Section VIII provides a complete theory of operation for the Model 3335A Synthesizer. Each section of the instrument is described here. Some sections also contain a simplified theory preceding the detailed discussion.

8-23. Controller, Simplified Theory (Service Group D).

8-24. The controller is the data and instruction center of the Synthesizer. It generates the control information required by the instrument dependent on inputs from one of two sources. See Figure 8-2.

a. Keyboard inputs when in manual control.

b. HP-IB inputs when in remote control.

During operation, inputs from one of these sources program the desired output parameters. These parameters are frequency, frequency increment, amplitude, amplitude increment, phase increment and sweep width. When the instrument is in the remote control mode, the keyboard switches are disabled and output parameters can be entered only through the HP-IB lines.

8-25. Output signals from the controller can be divided into three groups–control, data and external. The signals contained in each group are:

a. Control Output

1. Amplitude Control Lines
2. Frequency Control Lines
3. Display Control Lines

b. Data Output

1. Amplitude Data
2. Frequency Data
3. Display and Annunciator Data

c. External Output

1. Sweep Analog Front Panel Output

The control and data outputs are internal to the instrument while the external output signal is applied to the front

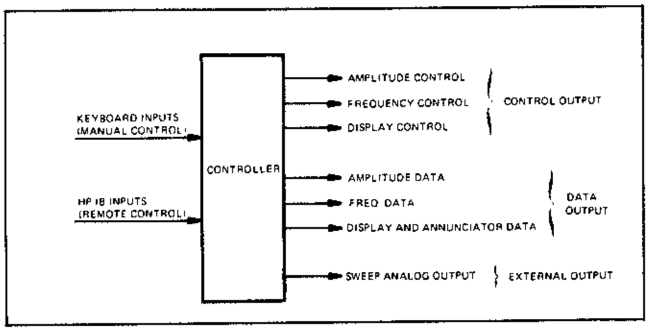


Figure 8-2. Controller Inputs and Outputs.

panel. The external output (SWEEP OUTPUT) provides a voltage proportional to the output frequency when the instrument operates in the sweep mode which can be used as the horizontal sweep for a plotter.

8-26. The controller is comprised of the following major elements. (See Figure 8-3, Basic Controller Structure.)

a. Microprocessor Unit (MPU)
b. Read Only Memory (ROM)
c. Random Access Memory (RAM)
d. Peripheral Interface Adapter (PIA)
e. Address Decoder
f. Control Line Decoder
g. Data Interface
h. Sweep D-to-A Converter

The operation of the controller is based on the "intelligence" designed into the controller. Hence "intelligence" refers to the control program which is a sequence of instructions that will guide the MPU through the various operations it must perform. The program is usually referred to as "software" or "firmware" and it is common to find the terms used interchangeably. The software or firmware is what is contained in the ROM's for access by the MPU.

8-27. Microprocessor Unit (MPU).

8-28. The purpose of the MPU is to perform the functions (routines) programmed into the ROM. Figure 8-4 indicates the input and output signals of the MPU. The MPU is driven by a two-phase clock (two clock signals which are non-overlapping). It contains two buses, an eight bit data bus and a sixteen bit address bus. The function of the address bus is to address a particular location in memory, either ROM, RAM or the PIA. The address decoder, also connected to the address bus, enables one of these elements. In the case of a RAM or the PIA (Peripheral Interface Adapter), the MPU also controls whether it is in the read or write mode. Data can then be transmitted in either direction over the eight bit bi-directional data bus connected to the MPU.

8-29. Read Only Memory (ROM).

8-30. The Read Only Memory (ROM) is a type of memory that cannot be written into but only read from. The data pattern of the ROM is fixed at the time of manufacture according to the design specifications of its application. Data from a particular memory location can be read by addressing the memory location and enabling the ROM. Addressing and reading data take place on the two separate buses of the ROM, the address bus and the data bus.

8-31. This instrument uses ROM's which require an eleven bit address. With eleven address lines, there are 2^{11} or 2048 different binary combinations that can be applied to the input. Each binary combination represents an "address" and the programmed ROM provides the 8-bit output from the addressed memory location. For all practical purposes, the ROM can be considered to be a decoder that transforms input addresses into specific output instructions. Instructions for particular routines are located in various ROM locations. To perform a routine, the MPU addresses the first memory location of the routine and responds to the

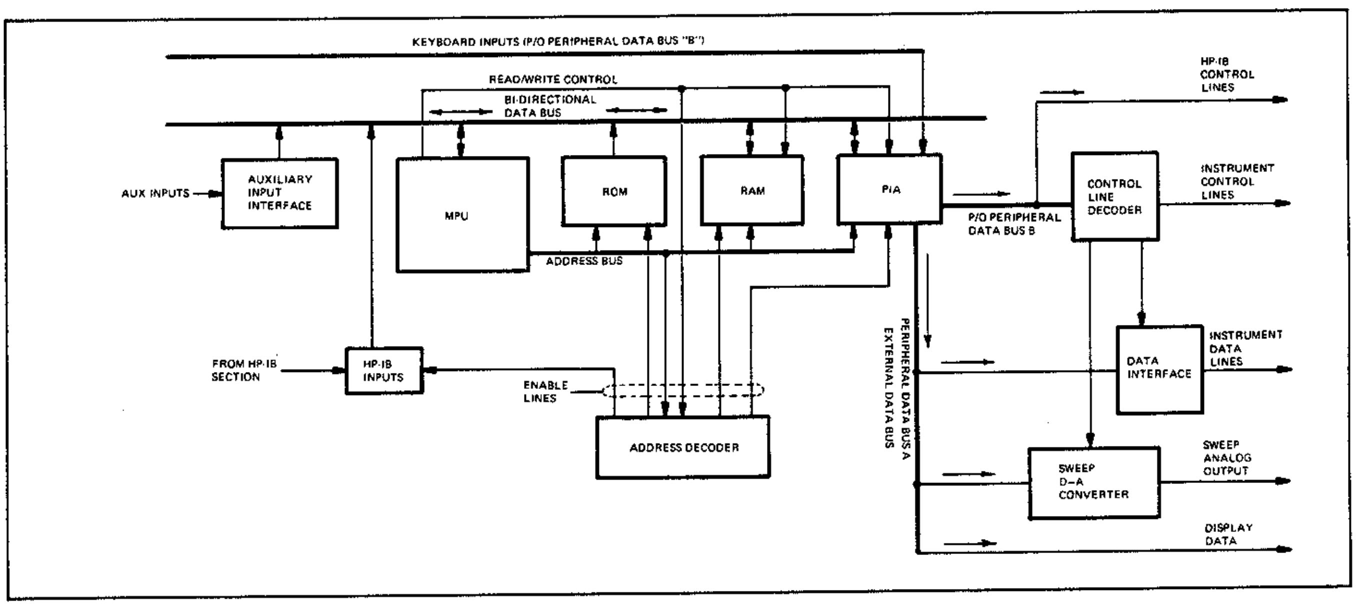


Figure 8-3. Basic Controller Structure.

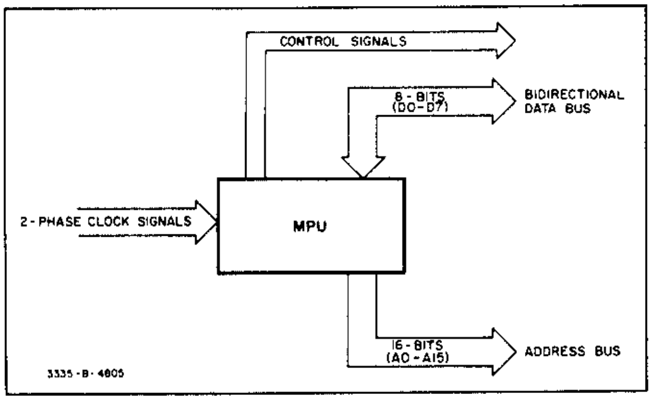


Figure 8-4. Microprocessor Unit Input and Output Symbols.

instruction it reads. When the instruction has been performed, the MPU addresses the next memory location of the routine, reads the instruction and performs the instruction. Some instructions may branch the controller to another routine; others provide instructions to the instrument based on the information programmed in the ROM's.

8-32. Random Access Memory (RAM).

8-33. Random Access Memory (RAM) is the "scratchpad" element of the controller. The memory locations of a RAM do not contain permanent data. Data can be written into a memory location and then read out again at a later time. Data written into a memory location destroys the data previously stored in that location which is no longer needed, thus the term "scratchpad". Data stored in a RAM is also destroyed any time power is switched to STBY or removed from the instrument.

8-34. RAM's contain two buses—an address bus for the addressing of a particular memory location and a bi-directional data bus for transmitting data in the read mode or receiving data in the write mode. Both RAM buses are connected to the address and data buses of the MPU. The address decoder is also connected to lines of the address bus and controls the enabling of each RAM. Read or write functions are controlled by a single line from the MPU. With this configuration, the MPU can enable a particular RAM and address a particular memory location for either a read or write function.

8-35. Peripheral Interface Adapter (PIA).

8-36. The peripheral interface adapter (PIA) is the communication link between the MPU and the outside world. (See Figure 8-3, Basic Controller Structure.) This includes keyboard input data, control and data outputs to internal sections of the instrument including the display, HP-IB control and the sweep analog output.

8-37. Figure 8-5 is a block diagram of the PIA showing internal registers and input/output lines. The PIA contains the following:

a. An 8-bit bi-directional data bus for communication with the MPU (DØ–D7).

b. Control lines to enable the PIA and establish the read or write mode of operation.

c. Two independent bi-directional 8-bit peripheral data buses "A" and "B" (PAØ–PA7 and PBØ–PB7), used enter data and generate instrument control and data signals.

d. Six internal registers, three associated with the Peripheral Data Bus "A" and three with Peripheral Data Bus "B". The three registers of each half are:

1. A programmable control register to control activation of the peripheral data bus.
2. A programmable data direction register to establish each individual peripheral bus line as either input or output.
3. Data registers for holding the data to be transmitted.

e. Address lines for enabling one of the six internal registers.

f. Peripheral control outputs, of which a single line (CB2) is used.

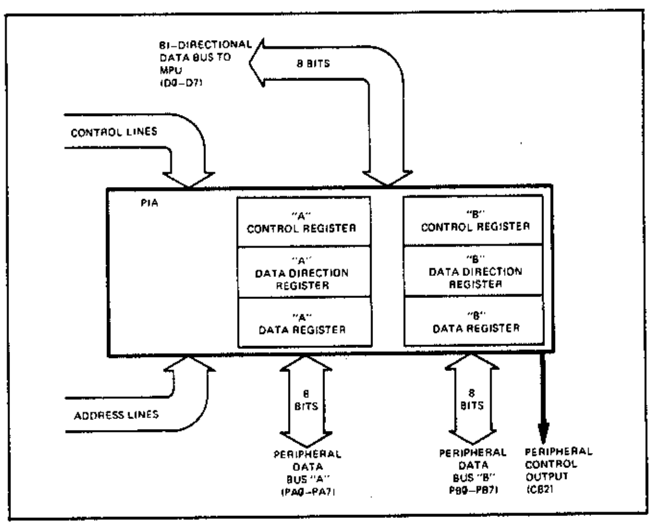


Figure 8-5. PIA Registers and Input/Output Lines.

8-38. From the MPU's viewpoint, the PIA is simply memory locations that are treated in the same manner as any other read/write memory. The read/write function is controlled by a single line (R/W) from the MPU. This is the same line used to control the read/write function of the RAM's.

8-39. Address Decoder.

8-40. The address decoder is an enabling device. See Figure 8-3, Basic Controller Structure. It enables a ROM, a RAM

pair, the PIA or the HP-IB data interface dependent on the address applied to the address bus by the MPU. The address performs a two-fold function; not only does it indicate the memory location within the ROM, RAM or PIA desired, but when applied through the address decoder, it identifies the element to be enabled.

8-41. Control Line Decoder.

8-42. The Control Line Decoder receives data from five lines of PIA Peripheral Data Bus "B" and a peripheral control line (CB2). These six inputs are decoded to provide the instrument control signals. Some of the outputs are used as control lines for the sweep digital-to-analog converter and data interface section which are internal to the controller. The remaining lines form the control output group. This group includes various clock, clear and latch signals and is discussed in detail in the detailed description of the controller.

8-43. Data Interface.

8-44. The data interface receives data from all eight lines of the PIA Peripheral Data Bus "A". It provides data for the Frequency Synthesis Section, Divider-Filter Section and Level Control Section. Latching of correct data from the data bus is controlled by lines from the control line decoder. A discussion in detail of these outputs is provided in the detailed description of the controller.

8-45. Sweep Digital-to-Analog Converter.

8-46. The sweep D-to-A converter is connected to the eight lines of th PIA Peripheral Data Bus "A". It provides a single analog output proportional to the output frequency during the sweep mode. Latching the correct data for operation of the converter is provided by the control line decoder. The analog output is applied to a front panel connector and can be used to provide the horizontal sweep for a plotter.

8-47. Controller, Detailed Theory.

8-48. In the previous simplified theory of the controller, a basic description of the major elements was presented. Here the detailed block diagram and schematic diagram of the controller are used to provide a detailed description of the interaction of the major elements.

8-49. The major elements of the controller are restated here.

a. Microprocessor Unit (MPU)
b. Read Only Memory (ROM)
c. Random Access Memory (RAM)
d. Peripheral Interface Adapter (PIA)
e. Address Decoder
f. Control Line Decoder
g. Data Interface
h. Sweep D-to-A Converter

8-50. MPU.

8-51. The MPU is the principle element of the controller (see Figure 8-D-2, Controller Detailed Block Diagram and Figure 8-D-1, Controller Schematic Diagram). It is an eight bit parallel microprocessor with a maximum addressing capability of 65,536 words. It is TTL compatible and requires a single 5 V supply. Several memory devices (ROM's and RAM's) and an input/output interface device (PIA) are used to support the MPU. Before describing the major elements in detail, an explanation of the MPU inputs and outputs will be presented. The inputs and outputs can be divided into four groups–Data, Address, Control and Supervisory. Figure 8-6 indicates the MPU lines in each of the four groups. This explanation will help to relate the other elements to the MPU.

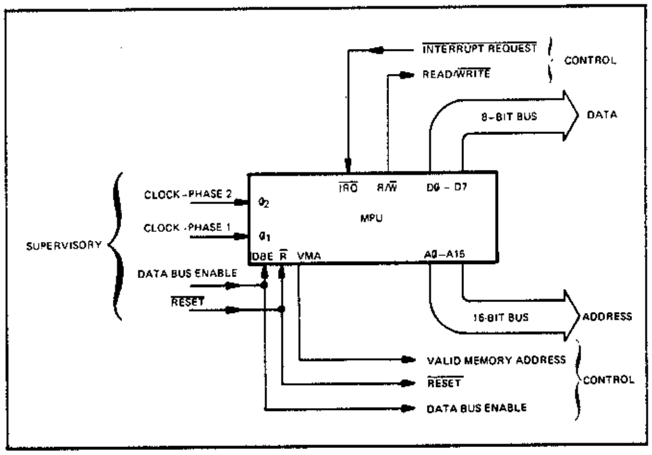


Figure 8-6. MPU I/O; Data, Address, Supervisory and Control.

8-52. Data Bus. The MPU data bus is an 8-bit bi-directional bus. It is the communication link between the MPU and the memory and interface elements.

8-53. Address Bus. The address bus contains 16-bits. Some lines of the bus are used to address a memory location and additionally are decoded to enable a particular memory or I/O device.

8-54. Control Signals. The control signals include $\overline{\text{Interrupt Request (IRQ)}}$, Read/$\overline{\text{Write}}$ (R/$\overline{\text{W}}$), $\overline{\text{Reset}}$ ($\overline{\text{R}}$), Valid Memory Address (VMA) and Data Bus Enable (DBE). The $\overline{\text{IRQ}}$ line is connected to the HP-IB interface. When it goes to a logic zero it initiates an interrupt sequence which is the HP-IB data input routine. R/$\overline{\text{W}}$ and VMA characterize the data bus and address bus respectively. R/$\overline{\text{W}}$ designates whether the MPU is in the read or write mode for each cycle, thus it indicates the direction of data transfer on the data bus. VMA indicates to the memory and I/O devices that the MPU is performing a read or write operation in a given cycle. DBE controls the data bus; it is the bus enable signal indicating when data is to be placed on or taken from the bus. $\overline{\text{Reset}}$, $\overline{\text{R}}$, actually originates as a supervisory signal. It is used following power-on or a power down condition

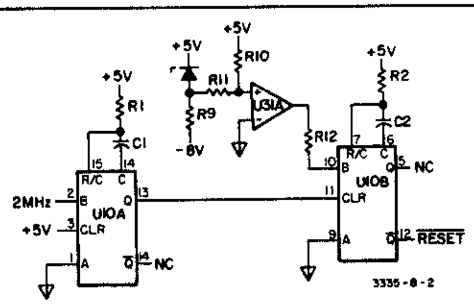
to go to an initializing routine to set up the controller starting conditions.

8-55. **Supervisory Signals.** These signals include the two-phase clock signals (Ø1 and Ø2 Data Bus Enable (DBE) and $\overline{\text{Reset}}$ (R). The two-phase clock signals and DBE are generated by the clock circuit. The clock signals drive the microprocessor and DBE enables the data bus. The start-up circuit provides the $\overline{\text{R}}$ line which initiates the start-up routine and resets the controller.

8-56. Supervisory Signal Generation.

8-57. **Clock Circuit.** The two-phase clock signals are derived from a 2 MHz signal generated by the Reference Section (see Figure 8-D-2, Controller Block Diagram). The clock circuit consists of a divide-by-two stage to provide the required 1 MHz signal which drives the two-phase clock. The two-phase clock is a series of inverters and NAND gates (see Figure 8-D-1, Controller Schematic). The delay introduced by the propogation time of the series inverters insures that the two clock signals are non-overlapping. In addition to the clock signals, the two-phase clock circuit generates the supervisory signal DBE from an intermediate point in the circuit.

8-58. **Start-Up Circuit.** The start-up circuit develops the $\overline{\text{Reset}}$ ($\overline{\text{R}}$) signal which is applied to the MPU, PIA and Sweep D-A Converter (see Figure 8-D-2, Controller Block Diagram and Figure 8-D-1, Controller Schematic). It also goes to the HP–IB interface and ATTN Data latch. This signal is generated only at initial turn-on or when a power failure has occurred and the supply voltages return to normal. When $\overline{\text{Reset}}$ is low, it causes the MPU to access the start-up routine from memory and set up the controller starting conditions such as the initial value of the program counter and initial PIA modes. The time required for set-up is eight clock cycles (8 microseconds). The start-up circuit provides



U10 Function Table

Inputs			Outputs	
Clear	A	B	Q	H
L	X	X	L	H
X	X	L	L	H
H	L	↑	⊓	⊔
↑	L	H	⊓	⊔

Figure 8-7. Start-Up Circuit.

a $\overline{\text{Reset}}$ pulse of approximately 10 microseconds which allows sufficient time for set-up.

8-59. The start-up circuit consists of dual retriggerable monostable multivibrators (U12) (see Figure 8-7, Start-Up Circuit). This discussion describes its operation from a power-on situation. Following power-on, the + 5 V supply reaches its normal level to activate the multivibrators and the 2 MHz signal from the Reference Section. Initially the Q output of the first multivibrator is low. With CLEAR connected to HIGH (+ 5 V), the first low-to-high transition of the 2 MHz applied to the B input will cause a positive pulse at the Q output (see Function Table of Figure 8-7). The length of this pulse is controlled by the external capacitor and resistor connected to the C and R/C terminals and is approximately 750 microseconds. Since the period of 2 MHz is 500 microseconds, the multivibrator is retriggered before the end of the timed pulse each low-to-high transition of the 2 MHz signal. This causes the Q output to remain at the HIGH state and this output is applied to the CLEAR input of the second multivibrator of the start-up circuit. If the 2 MHz signal frequency decreases appreciably, its period will exceed the period of the timed pulse and cause the Q output to be pulses instead of a steady state high.

8-60. The second multivibrator obtains its input from a voltage sense circuit consisting of op amp U21 and its associated components. When the + 5 V supply first reaches 5 V, CR1 is approaching its zener voltage, the U21 output is low and the U12 pin 13 Q output is low. The 2 MHz clock signal from the reference section causes the U12 pin 13 Q output to go high which enables the second multivibrator. When the voltage supplies comprising the voltage sense at the B input of U12 pin 10 causes a low-to-high transition on B, a pulse is output by the $\overline{\text{Q}}$ output. This pulse is the $\overline{\text{Reset}}$ ($\overline{\text{R}}$) signal and the length (10 microseconds) is determined by the external timing capacitor and resistor connected to the C and R/C terminals. Once the $\overline{\text{R}}$ line attains the HIGH state, this state remains unless the supply voltages drop due to a power failure which deactivates the circuit. When the voltage supplies return to normal, the $\overline{\text{Reset}}$ pulse is generated as previously described for a power-on condition.

8-61. Control Signal Generation.

8-62. Control signals include signals that are generated by the MPU, signals input to the MPU and signals both input to the MPU and transmitted to other parts of the controller. The control signals include Read/$\overline{\text{Write}}$ (R/$\overline{\text{W}}$) and VALID MEMORY ADDRESS (VMA) generated by the MPU, $\overline{\text{Interrupt Request}}$ ($\overline{\text{IRQ}}$) which is input to the MPU and DATA BUS ENABLE (DBE) and $\overline{\text{Reset}}$ ($\overline{\text{R}}$) which are input to the MPU and also transmitted to other parts of the controller. DBE and $\overline{\text{R}}$ are generated as supervisory signals.

8-63. The R/$\overline{\text{W}}$ is a signal from the MPU to RAM's or the PIA (see Figure 8-D-2, Controller Block Diagram) to indicate when it is in the read or write mode. VMA is transmitted by the MPU to the address decoder to indicate when

data on the address bus is valid. $\overline{IRQ}$ is transmitted to the MPU from the HP-IB interface. When $\overline{IRQ}$ is low, the MPU accesses the HP-IB data input routine in memory and through the routine, receives and acts according to the HP-IB data under remote control.

8-64. Address Operation.

8-65. The two remaining groups of lines are the address bus and data bus (see Figure 8-D-2 Controller Block Diagram). The address bus originates at the MPU and transmits to the address decoder, ROM's, RAM's, the PIA and the HP-IB interface. Data is transmitted to-or-from the MPU to-or-from the addressed memory location depending on whether the MPU is in the read or write mode.

8-66. A discussion of the interface of the ROM's, RAM's and the PIA to the address and data buses will now serve to tie the MPU and the support elements together. The number of address lines connected to each element varies. ROM's contain an 11-bit address and are connected to address lines AØ to A1Ø (see Figure 8-D-2 Controller Block Diagram and Figure 8-D-1 Controller Schematic). RAM's contain an 8-bit address and connect to address lines AØ to A7. The PIA connects to only those lines from the address bus, AØ, A1 and A2. The MPU is the only element to transmit on the address bus.

8-67. The ROM's, RAM's and PIA are each connected to all eight lines of the data bus (DØ – D7). This bus is bi-directional and is indicated as such by two-way arrows on the block diagram and schematic bus representations. The ROM's are one-way devices between ROM and MPU and are capable of only transmitting data from its memory when the MPU is in the read mode. RAM's are two-way devices and can be used to store data in a memory location when the MPU is in the write mode or to transmit stored data when the MPU addresses that device in the read mode. The PIA is the interface device connecting the MPU to the outside world. It both transmits or receives data on the data bus and its mode of operation (read or write) is controlled by the MPU control line R/W.

8-68. The selection of a particular ROM or RAM pair and the selection of a memory location is performed by one address. Certain lines address the memory location (ROM lines AØ – A1Ø, RAM lines AØ – A7) while other lines are decoded by the address decoder and enable a particular device. The address decoder is discussed in further detail in later paragraphs. In the case of the ROM's and RAM pairs, enabling is controlled by a single line from the decoder. The addressing and input/output control of the PIA is performed from a combination of inputs.

8-69. The PIA provides parallel interface of the MPU and the "outside world". It transfers signals between the MPU and peripherals under program control. Addressing and input/output control of the PIA is performed using five lines and one register location–the three chip select lines (CSØ, CS1 and $\overline{CS2}$), two register select inputs (RSØ and RS1) and bit two of the control register internal to the PIA. Figure 8-8 illustrates the interconnection between the MPU and PIA. Recalling from the simplified description that the PIA contains six registers–a control, data direction and a data register in side A and side B. It is the purpose of the five addressing lines and one register bit to select one of these registers to communicate over the data bus with the MPU. Table 8-3 indicates the correspondence between the five address inputs and the selection of the PIA internal registers. Notice that only the five address lines CSØ, CS1, CS2, RSØ and RS1 are used to access the control register and bit two of the control register selects one of the other two registers.

8-70. The PIA control register B is an 8-bit register but only four bits are used, bit two, three, four and five. Bit two addresses either the data direction register or the data register (see Table 8-3). Bits three through five control the peripheral control output CB2. The MPU can address the control register and change the data in bits three, four and five to dictate the function of output CB2.

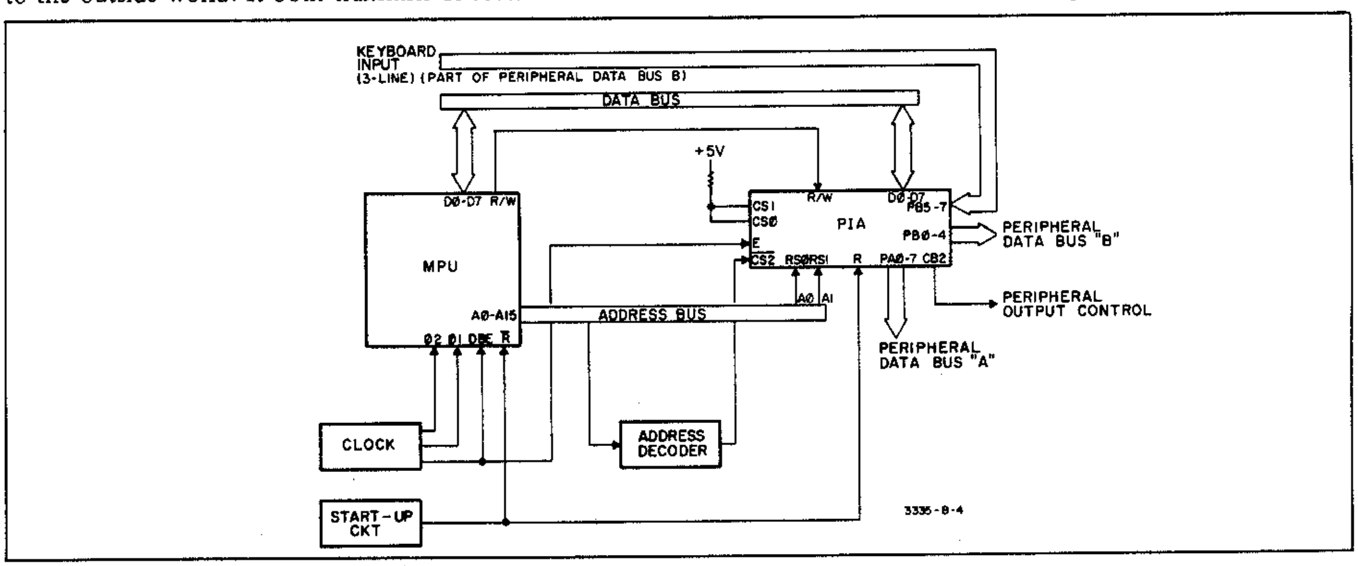


Figure 8-8. MPU and PIA Interconnection.

Table 8-3. PIA Register Addressing.

PIA Address Lines					Control Register Bit 2	PIA Register Selected
CS2	CS1	CSØ	RS1	RSØ		
Ø	1	1	Ø	Ø	Ø	Data Direction Register (A)
Ø	1	1	Ø	Ø	1	Data Register (A)
Ø	1	1	Ø	1	X	Control Register (A)
Ø	1	1	1	Ø	Ø	Data Direction Register (B)
Ø	1	1	1	Ø	1	Data Register (B)
Ø	1	1	1	1	X	Control Register (B)
1	X	X	X	X	X	PIA Not Addressed

1 = High, Ø = Low, X = don't care

8-71. The function of each line of peripheral data bus A and B can be established as either input or output. Each line is independent of the others. In this application, the eight lines of peripheral data bus A (PAØ – PA7) are always used as outputs. Peripheral data bus B contains both input and output lines. Lines PBØ through PB4 are established as outputs while Lines PB5, PB6 and PB7 are the input lines from the keyboard.

8-72. The data direction register of the PIA establishes either the input or output function for each peripheral bus line. When the MPU addresses the PIA data direction register, it writes "one's" (logic high) into the bit positions of those lines to be established as output lines. The MPU then addresses the PIA data register and the contents are transmitted in the direction established by the data direction register.

8-73. Address Decoder.

8-74. The purpose of the address decoder is to enable a particular MPU support element based on the address applied to the address bus by the MPU. See Figure 8-D-2 Controller Block Diagram. The elements controlled by the address decoder are the ROM's, RAM's, the PIA, the HP-IB input enable and the auxiliary input interface. Refer to both the controller block diagram and controller schematic, Figures 8-D-2 and 8-D-1 respectively, for the following discussion.

8-75. The address decoder is comprised of two 2-to-4-line decoders (U17), three NAND gates (U18) and seven inverters (U6 and U16). The entire address decoder is located below the ROM's and RAM's of the controller schematic. Address Lines A3 to A7 and A11 to A13 and the MPU control output VMA (Valid Memory Address) are applied to the address decoder. These lines are decoded to enable a particular support element.

8-76. The elements of the address decoder enabling the ROM's and RAM's are the two 2-to-4 line decoders. These decoders also control the auxiliary input interface and the HP-IB input enable. The RAM's each contain four I/O data lines and are used in pairs to provide an eight bit RAM. A single control line from the address decoder activates the RAM's in pairs.

8-77. Control Line Decoder.

8-78. The control line decoder accepts the five output lines of the PIA peripheral data bus "B" (PBØ to PB4) which comprise the control line bus and a peripheral control output (CB2). It decodes these six lines into control signals such as clock, latch and clear signals required to operate the controller data interface section and the other sections of the instrument.

8-79. The control line decoder is comprised of two 3-to-8 line decoders (U25 and U30) and six inverters (U29). All five control bus lines and the peripheral control output are transmitted to each decoder which generate the various control line outputs. These outputs are the keyboard clock and clear (KCLK and $\overline{KCLR}$), the annunciator latch clock (ANN), the attenuator latch clock (ATT), the level control D-A converter shift register clock (LSH), the N Loop serial-to-parallel data converter clock (NSH), the N Loop latch clock (NLCH), the N.F Loop data clock (FDC), the N.F Loop instruction valid signal (FIV) and one unused output. (The N Loop and N.F Loop are phase-locked loops in the frequency section.)All the previous mentioned control line outputs go to other sections of the instrument except the unused one which is terminated at the controller interface connector. A mnemonic dictionary of all controller output and input lines is provided in Service Group D. Seven control lines are used on the controller assembly to latch and interface the data on the external data bus. These lines control elements in the data interface section of the controller.

8-80. Data Interface.

8-81. The data interface section of the controller provides the interface between the PIA external data bus (Lines PAØ to PA7) and the other sections of the instrument. The external data bus performs a dual function.

a. It drives the instrument display.

b. It provides the instrument instruction data.

The bus cannot perform both functions simultaneously. Therefore, when instrument data is required, the display

scan is discontinued and data from the bus is routed to the data interface and latched or latched at the receiving instrument section.

8-82. The data interface section consists of a parallel-to-serial converter (U28) which generates the serial data required to operate the N Loop and the level control section. A data latch (U26) is used to hold data from the external data bus to operate the Divider-Filter Section. A D flip-flop (U13 pins 6, 8, 10–13) is activated by control lines to enable quad NAND gates (U27) which transmit the N.F Loop data. This data is latched on the N.F Loop by control Line FIV (Instruction Valid). The last portion of the data interface is the sweep digital-to-analog converter which consists of U21, U22, U23 and U24.

8-83. Sweep D-to-A Converter.

8-84. The sweep D-to-A converter section is present to perform one function. It generates a dc voltage proportional to the output frequency when the instrument is in the sweep mode which is applied to a front panel connector. This voltage is available for external use as the horizontal sweep signal of a plotter.

8-85. The sweep D-to-A converter section is comprised of a 10-bit data latch (U23 and U24), a digital-to-analog converter (U22), a current-to-voltage converter (part of U21), and a level shifting and gain stage (also part of U21). The eight bit latch, U23, and a dual D flip-flop, U24, together comprise a ten-bit latch. The ten-bit latch is clocked and cleared by control lines from the control line decoder section. All ten bits are obtained from the eight-line PIA external data bus (Lines PAØ to PA7). The data clocked into the dual D flip-flops is clocked at adifferent time than that clocked into the 8-bit latch. The ten bits of data are applied to a digital-to-analog converter to generate the sweep output voltage.

8-86. The digital-to-analog converter (U22) provides a current output. This output is applied to an op amp (P/O U21) which performs a current-to-voltage conversion. The voltage developed is applied to a level shifting and gain stage (P/O U21) which generates an output voltage between 0 V and + 2 V dc. This is the analog voltage (sweep output) proportional to the output frequency when in the sweep mode and is available at the front panel sweep output connector. Zero V dc corresponds to the start frequency and + 2 V dc corresponds to the ending frequency of the sweep. When the instrument is not operated in the sweep mode, the sweep output is + 1 V dc.

8-87. Keyboard (Service Group B).

8-88. The keyboard provides the interface between the user and the instrument during manual operation. Through the keyboard, the user can program the various operating parameters. A manual tune frequency control is also contained in the keyboard which allows the user to manually alter the output frequency. An auxiliary function of the keyboard is to provide the circuit paths for the display data lines between the controller interface and the display. The keyboard contains a total of thirty-nine keys, four function annunciators and two HP-IB annunciators. One of the keys is an ON/STBY key to control line power. Another is a LOCAL key which returns the instrument to local control when it is operating under remote control, providing the controller has not sent the LOCAL LOCK-OUT command. The remaining thirty-seven keys are used to program the operating parameters and mode of operation. Refer to the Keyboard Block Diagram, Figure 8-B-2 and the Keyboard Schematic, Figure 8-B-1.

8-89. Scan Circuit.

8-90. The scan circuit is comprised of two shift registers and a D-type flip-flop, U2, U4 and U6 respectively (see Figure 8-9). This circuit is clocked cleared or preset by two control lines from the controller (KCLK and $\overline{KCLR}$, Keyboard Clock and Clear). Initially the registers are cleared (all outputs set low) and the flip-flop is preset (Q output high). The output of register Line D13 is applied to the D input of the flip-flop U6. Initially this output is low so that on the first low-to-high transition of the clock, the Q output of the flip-flop goes low. The high state initially at the Q output is shifted into the register at the first low-to-high transition of the clock and the DØ output goes high while all others (D1 through D13) remain low. Each time the registers and flip-flop are clocked by a low-to-high transition of the clock, the high state shifts to the next output. When the high state arrives at Line D13, the high state also appears at the D input to the flip-flop. The next clock it is loaded back into the flip-flop (Q output high) leaving all strobe lines (DØ through D13) low for one clock cycle. The clock signal controlling the movement of the scan signal (KCLK) is not free running but regulated by the controller. It is dependent on the display requirement of the annunciators and a brightened digit in the manual tuning mode of operation. This requirement is further explained in the discussion of the display section.

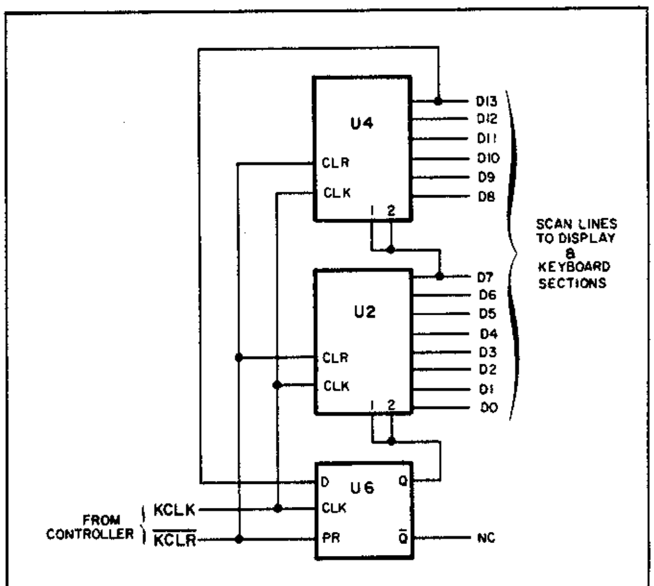


Figure 8-9. Scan Circuit.

8-91. Scan signals are transmitted to both the keyboard switches and the display. Before application to the keyboard switches, the signals are inverted to provide a logic low strobe. The display digit drivers in the display section also invert the strobe signal providing a logic low display strobe.

8-92. In the keyboard section, each scan line (DØ through D13) is connected to a maximum of three key switches. The other end of each key switch is connected to one of three controller data input lines (PB5, PB6 or PB7). See Figure 8-10, Typical Switch/Scan Line Connections and Table 8-4, Keyboard Switch Matrix. The matrix shows the association of scan lines and controller data input lines with the key switches.

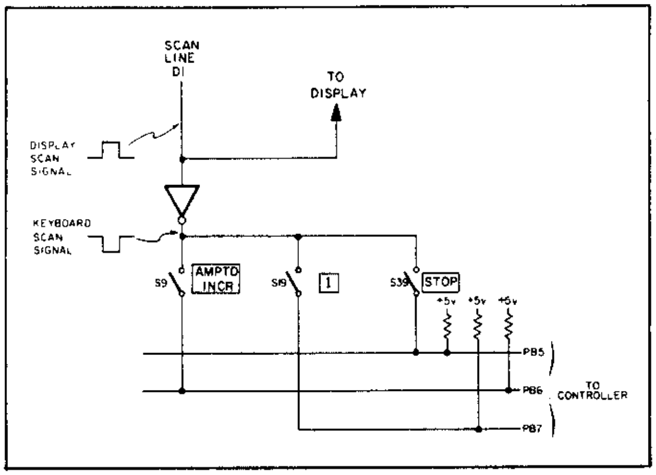


Figure 8-10. Typical Switch/Scan-line Connections.

8-93. The controller determines the operation of a key switch by the logic levels of the three controller data input lines. These three lines are tied to the + 5 V supply providing the logic high states to the controller when none of the key switches are activated. When a key switch is activated, the data input line connecting the switch to the controller is driven to a logic low state when the strobe line associated with that key switch is pulsed by the scan circuit. The controller identifies a particular activated data input line with the active scan line. The controller stores this information in a random access memory (RAM) for future use. When all scan lines DØ through D13 have been pulsed (one strobe cycle), the stored key operations of that scan cycle are recalled from the RAM and their corresponding key routines are initiated. If more than one key switch in a three key set is activated simultaneously, the controller recognizes the input lines in the following order—PB7, PB6 then PB5.

8-94. Manual Tuning Circuit.

8-95. The Synthesizer can be programmed from the front panel keyboard to sweep a range of frequencies automatically or to allow manual sweeping of frequency either in a manual type mode or a manual sweep mode. The manual tune or sweep mode of operation allows the user to manually increase or decrease the output frequency by use of the front panel MANUAL TUNE knob. Operating the MANUAL TUNE knob is analogous to tuning the variable capacitor in a non-synthesized signal generator. The controller determines which direction the MANUAL TUNE knob is being rotated (direction of tuning) from data transmitted by a direction sense circuit. The output of this circuit is connected to the controller by data input Lines PB5 and PB6. This output is activated by the uninverted scan Line DØ and appears in the keyboard switch matrix, Table 8-4. For the remainder of this discussion refer to Figure 8-11, Manual Tuning Sense Circuit.

8-96. The manual tuning sense circuit is comprised of a rotary pulse generator (RPG), two D-type flip-flops (sense and enable, U8) and two NAND gates (increase and decrease, U7). The RPG is a two channel (A and B) rotary pulse generator which outputs TTL compatible square waves at a rate of 120 pulses per channel per revolution. The square waves from Channels A and B are produced with a phase difference of at least 45 degrees. The leading signal is determined by the direction of rotation of the MANUAL TUNE knob. For clockwise rotation, Signal A leads Signal B. Counterclockwise rotation results in Signal A lagging Signal B.

Table 8-4. Keyboard Switch Matrix.

Scan Lines	Controller Data Input Lines		
	PB7	PB6	PB5
DØ	Ø	RPG NAND GATE U7B (INCREASE)	RPG NAND GATE U7A (DECREASE)
D1	1	AMPTD INCR	STOP
D2	2	DISPLAY LAST ENTRY	
D3	3	SWEEP WIDTH	BACK SPACE
D4	4	FREQ INCR	Ø INCR
D5	5	FREQUENCY	NO CONN.
D6	6	AMPLITUDE	START AUTO
D7	7	RECALL	NO CONN.
D8	8	DISPLAY	NO CONN.
D9	9	STORE	MANUAL
D1Ø	INCR ↑	CLEAR	MANUAL TUNE ON/OFF
D11	INCR ↓	MHz - dBm	START SINGLE 10 SEC
D12	MANUAL TUNE ←	kHz + dBm	START SINGLE 10 SEC
D13	MANUAL TUNE →	Hz DEG	GO TO START FREQ

8-97. Channels A and B are applied to the sense and enable flip-flops, U8. Channel A drives the D input of the sense flip-flop. Channel B clocks both the sense and enable flip-flops. The D input to the enable flip-flop is transmitted by the annunciator latch under control of the controller. The outputs of the sense and enable flip-flops are applied to a pair of three-input NAND gates (U7). These gates develop the controller input signals to indicate the direction of manual tuning.

8-98. The increase and decrease NAND gates indicate the direction of manual tuning by pulling either controller data input line PB5 or PB6 low. This requires that all three inputs of a NAND gate be high. This condition is dependent on the Q output of the enable flip-flop and the uninverted DØ scan line. Both of these signals are applied simultaneously to each NAND gate. A NAND gate can only pull a data line low during a DØ scan interval and then only when the annunciator latch transmits a high through the enable flip-flop to enable both NAND gates.

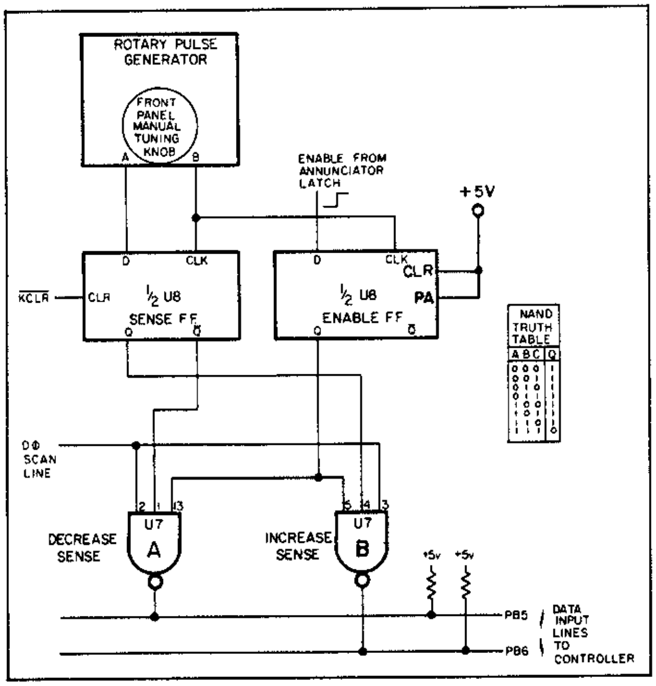


Figure 8-11. Manual Tuning Sense Circuit.

8-99. Prior to the DØ strobe, the sense flip-flop receives a $\overline{KCLR}$ pulse and a high is transmitted by the annunciator latch to the sense NAND gates; rotation of the front panel MANUAL TUNING knob does the following.

a. The first pulse generated by Channel B of the RPG clocks the high to the Q output of the enable flip-flop which enables the NAND gates.

b. The first pulse generated by Channel B also clocks the state of Channel A to the Q output of the sense flip-flop. If the MANUAL TUNE knob has been rotated clockwise, Channel A leads B and the Q output goes high ($\overline{Q}$ low). If the knob was rotated counterclockwise, Channel A lags B and the Q output remains low ($\overline{Q}$ high).

c. The Q output of the sense flip-flop is applied to one NAND gate, the $\overline{Q}$ output is applied to the other. Depending on the direction of rotation of the MANUAL TUNE knob, one of the NAND gates will pull a data input line low (Clockwise rotation, PB6 goes low; counterclockwise rotation, PB5 goes low).

The low signal transmitted to the controller over PB5 or PB6 during the DØ scan interval indicates manual tuning is occurring while the line it is transmitted over indicates the direction of tuning. This information is stored in a RAM location and recalled at the end of the present scan cycle to initiate the corresponding manual tune routine. When the Synthesizer is taken out of the manual tune mode of operation, the controller clears the sense flip-flop with Line $\overline{KCLR}$.

8-100. Keyboard Annunciator Latch.

8-101. The keyboard annunciator latch is a hex D-type flip-flop. Its purpose is to latch the information present on the six controller external data Lines (PA2 – PA7) whenever the latch is clocked by the controller Line ANN. The latched data bits provide steady state drive signals to:

a. Enable the RPG direction sense circuit.

b. Enable the front panel display "sweep mode" annunciator.

c. Enable any of the four keyboard annunciators associated with MANUAL TUNE ON/OFF, SWEEP MANUAL and START SINGLE keys.

8-102. The six controller external data lines (PA2 through PA7) which transmit the data bits to the annunciator latch, also transmit the seven-segment data to the numeric displays. If a key has been activated associated with a keyboard annunciator, display "sweep mode" annunciator or activates manual tuning, the controller stores this information in a RAM location, recalls this information at the end of the current scan cycle and initiates the key routines. This occurs during the time interval the high scan signal is shifted from Line D13 back to the D flip-flop. At this time all scan lines are inactive, therefore, no information can be transmitted to a numeric display. Because of this, the external data Lines PA2 through PA7 can be used to transmit the data required by the annunciator latch. The annunciator data corresponding to an activated key is placed on the external data lines. The data is latched when the controller clocks the latch (Line ANN). When the data is latched providing the steady-state drive signals required, the controller starts clocking the scan circuit again to begin the next scan cycle.

8-103. Display (Service Group A).

8-104. The front panel display contains eleven numeric displays, four groups of annunciators, eight segment drivers and the display digit drivers that scan the display (see Figure 8-A-2,Display Block Diagram). It indicates the value of a particular operating parameter. The parameter being displayed and the units of the parameter are identified by annunciator groups one, two and three. Annunciator group four indicates when the instrument is operating in the sweep mode, if the instrument is unable to lock to the reference signal applied and if the amplitude leveling is used.

8-105. The seven display segments and decimal point of

each numeric display and the annunciators are connected to the eight segment drivers in parallel. The output of each segment driver is identified with the numeric display pin number connected to that driver. Each annunciator is also identified with the number of the segment driver it is connected to. Note that the annunciators are grouped by association with one of three scan lines or the fourth group which is associated with steady-state drive lines. Refer to both the Display Block Diagram, Figure 8-A-2, and the Display Schematic, Figure 8-A-1, for the remainder of the display discussion.

8-106. The display is controlled entirely by the controller. Segment and annunciator data is transmitted to the segment drivers over the eight controller data lines PAØ through PA7. The data is displayed by the annunciator or numeric display scanned at that time. The scan signal originating at the keyboard scan circuit progresses through the display elements activating one annunciator or one numeric display at a time. The progression of the scan signal is controlled by the scan circuit clock signal (KCLK) generated by the controller. The controller then controls the data transmitted on the eight line display bus and it controls the length of time any one element displays data by control of the scan signal. The scan signal from the scan circuit is a high logic signal. It is inverted by the display digit drivers providing a logic low display scan signal applied to the digits. The display digit drivers also provide the current sink capability required to light all display segments of the numeric displays. When all numeric displays and the three scanned annunciator groups have been scanned, one "scan cycle" has occurred.

8-107. Throughout the display scan and the application of display data to the display bus, the process of interdigit blanking is used to prevent ghosting. (Low intensity image of the previously displayed digit appearing behind the next digit displayed.) The sequence of interdigit blanking in a display scan is as follows:

a. Data is removed from display data bus lines.

b. Scan signal progresses to next digit.

c. Data for digit is placed on display data bus lines and digit displayed.

d. Data is removed from display data bus lines.

e. Sequence repeats as in Step b through d.

8-108. The display provides a brightened digit when in the manual tune mode of operation. The brightened digit is selected with front panel manual tune keys. The controller controls which digit is brightened by extending the scan interval of that digit. An extended scan interval is obtained by retarding the scan circuit clock signal (KCLK). The three scanned annunciator groups also require an extended scan interval. A brightened digit is scanned or turned on approximately three times as long as a normally lit digit. The three scanned annunciator groups are scanned approximately five times as long as a normally lit digit. This is the reason the scan circuit clock signal (KCLK) is not a free running signal but generated by the controller.

8-109. The fourth annunciator group is not scanned by the scan circuit but driven by three steady-state lines. Two of the lines are transmitted from the annunciator latch. One of these lines (SWP) originates in the controller, the second (LOCK) originates at the out-of-lock detector in the Reference Section. The third drive line (UNLEV) originates in the Level Control Section.

8-110. Controller Interface (Service Group E).

8-111. The Controller Interface provides the interconnect between the controller section and the other sections of the instrument. Controller data is cabled from the Controller Interface to the mother board of the rf module containing the frequency synthesis and amplitude sections of the instrument. Additional data which is cabled to other parts of the instrument from the Controller Interface goes to the Attenuator and HP-IB Interface. Controller data is also coupled to the keyboard through a connector jack. This data contains the eight display data lines which are directly connected through the keyboard to the display section to drive the eight segment drivers.

8-112. The Controller Interface contains two mono-stable multivibrators and an attenuator data latch activated by control lines from the Controller Section. One monostable generates the keyboard clear signal ($\overline{\text{KCLR}}$), the other generates the attenuator enable signal ($\overline{\text{ATE}}$). The attenuator data latch is connected to the eight lines from the controller (PAØ to PA7) comprising the data bus. It is clocked by the controller line ATT to latch that data on the data bus which relates to the attenuator. The attenuator data latch outputs and the multivibrator line $\overline{\text{ATE}}$ control the introduction of the attenuator pads.

8-113. Reference Section (Service Group G & H).

8-114. A simplified block diagram of the reference section is shown in Figure 8-12. The master oscillator of the reference section (that from which all reference signals are driven) is a 40 MHz Voltage Controlled Crystal Oscillator (VCXO) phase-locked to a 10 MHz temperature stabilized oscillator or an external reference source that is a subharmonic of 40 MHz (40/N MHz). The master oscillator is phase-locked by a sampling detector which compares the phase of this oscillator to the phase of the temperature-stabilized or external reference. The 40 MHz master oscillator can be only as stable as the reference it is phase-locked to.

8-115. Temperature Stabilized Reference. The Model 3335A Synthesizer contains an internal temperature-stabilized reference which the 40 MHz master oscillator can be phase-locked to. An option 001 instrument contains a high-stability temperature-stabilized 10 MHz reference oscillator in place of the standard reference. In either standard or Option 001, the temperature-stabilized 10 MHz

reference signal is terminated at a rear panel connector labeled "10 MHz REF OVEN OUTPUT" (see Schematic Number G). It is applied to the rear panel "40/N MHz REF INPUT" (input must be a subharmonic of 40 MHz) to provide the reference signal the 40 MHz master oscillator is phase-locked to. If the user desires, the temperature-stabilized 10 MHz oscillator can be disconnected and any other external reference can be connected to the "40/N MHz REF INPUT" providing an alternative 40 MHz master oscillator phase-lock signal. An annunciator on the front panel, "UNLOCKED", will light until about 20 minutes after a proper reference signal is connected to the 40/N MHz REFerence INPUT.

8-116. Reference Signals. Five reference signals are generated by the Reference Section (40 MHz, 10 MHz, 2 MHz, 1 MHz and 100 kHz). Again refer to Figure 8-12, Simplified Block Diagram, Reference Section. The 40 MHz signal is transmitted to the Mixer Section where it is mixed with the synthesized signal of 40 MHz to 50 MHz to generate the output frequencies that are less than 10 MHz. The 100 kHz and 1 MHz signals are transmitted to the Frequency Synthesis Section where the 100 kHz provides the phase reference for the Frational N Loop and the 1 MHz provides the phase reference for the N Step Loop. The 2 MHz is transmitted to the Controller Section where it is divided by two to generate a 1 MHz clock for the microprocessor unit. The remaining reference output is a 10 MHz signal which is transmitted to a rear panel connector. This signal can be used as a reference for other instruments.

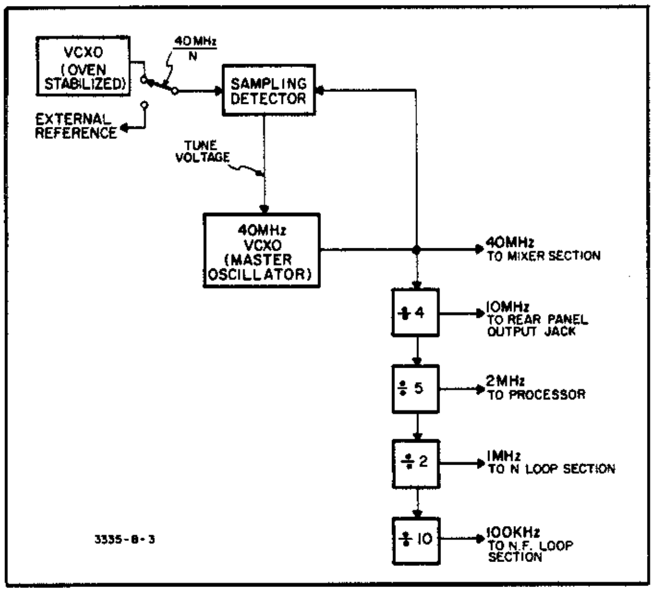


Figure 8-12. Simplified Block Diagram, Reference Section.

8-117. The Reference Section is functionally divided into two parts, a VCXO half and a digital half. See the Detailed Block Diagram, Figure 8-H-2, and the Reference Schematic Diagram, Figure 8-H-1. The VCXO half contains the 40 MHz master voltage controlled crystal oscillator (see Figure 8-12). This oscillator is phase-locked to the temperature-stabilized reference or to an external reference by a sampling detector. Whichever reference is used, it undergoes pre-amplification to drive a Schmitt trigger. (All logic levels in the Reference Section are TTL). A signal with a fast rise time is provided by the Schmitt trigger to drive the monostable multivibrator which in turn provides the sample signal to the sampling detector. The sample signal is a 5 to 6 nanosecond pulse derived by applying the Schmitt trigger output to both inputs of a NOR gate. One input is a direct connection from the Schmitt trigger, the other is applied through three successive NOR gates. When the Schmitt trigger makes a high-to-low transition, both inputs to the final NOR gate are low causing a high output for the time the signal requires to propagate through the three successive NOR gates. Once the signal has propagated through to the final NOR gate, the second NOR input goes high and the output goes low. The result at the final NOR output is a 5 to 6 nanosecond pulse (the propagation time) which initiates the sample to phase lock the VCXO.

8-118. The amplitude of an external reference signal is required to be between - 7 dBm (0.1 V) and + 7 dBm (0.5 V). It is monitored by an amplitude detector which enables the sampling multivibrator with a low logic level applied to the second successive NOR gate. If the amplitude of the external reference signal is not greater than - 7 dB, the amplitude detector output goes high which disables the sampling multivibrator and turns on the out-of-lock detector. A high level at one input port of the NOR gate does not allow the gates output to follow the signal at the second input port.

8-119. As previously described, the frequency of the external reference signal must be a subharmonic of 40 MHz. If something other than a subharmonic of 40 MHz is used, the VCXO will not be able to phase lock to the reference. This will cause an ac component to be present on the sampling detector's phase error voltage applied to the VCXO. The ac component causes the VCXO output to be frequency modulated. The tune voltage is monitored by an out-of-lock detector and if ac is present, a front panel indicator is illuminated to indicate the out-of-clock condition.

8-120. The VCXO half of the reference section develops the 40 MHz reference signal from which all other reference signals are derived. The output of the VCXO drives three high-isolation buffers to generate three separate 40 MHz outputs. The first output is returned to the sampling detector to form the phase-locked loop. The zero cross-over of this signal is sampled by the sampling detector (diode ring) when initiated by the 5 to 6 nanosecond pulse from the sampling multivibrator. A change in this sample voltage indicates a phase change by the VCXO. The sample voltage is held on capacitor C13 which follows the diode ring and is applied through the loop amplifier U4 to the VCXO as the tune voltage to keep the VCXO phase-locked to the reference. The VCXO cannot be more stable than the reference to which it is phase-locked. One of the two remaining VCXO outputs is applied to the digital half of the reference section to generate the other reference frequencies and the third output is transmitted to the Mixer Section.

8-121. Refer to Figure 8-13, VCXO, Master Oscillator. The VCXO contains a 39.998 MHz crystal but obtains its frequency stability by phase-locking to the external reference.

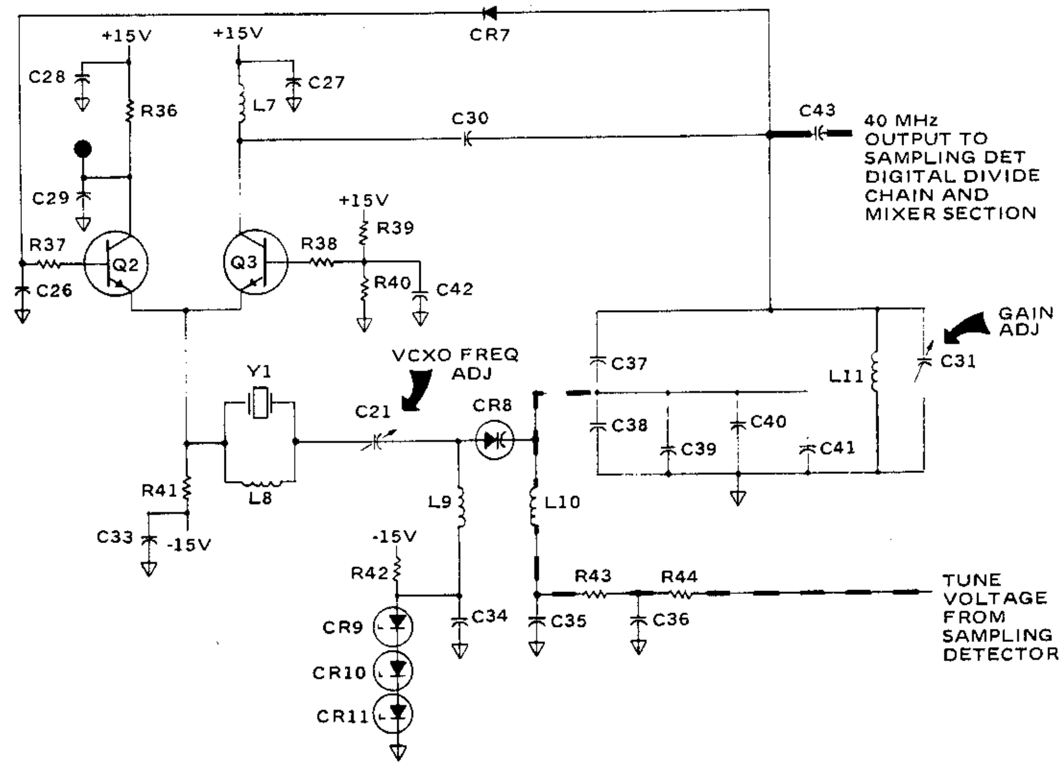


Figure 8-13. VCXO, Master Oscillator.

The load is the tank circuit consisting of C37 through C42 and L11. A connection between the parallel combination of C37 and C38 to C41 provides ac feedback to the varactor (CR8). DC feedback to the varactor comes from the sampling detector. The opposite side of the varactor is biased at approximately - 5 V by a low noise voltage source, CR9 – CR11. The combination of ac and dc feedback control the oscillating frequency of transistor Q3. Automatic gain control is provided by transistor Q2 and the detector circuit CR7 and C26.

8-122. The VCXO output is applied to three identical high isolation buffers. The output of the buffer transmitting to the sampling detector contains an inductor, L17, connected to ground. This inductance ensures the output is at zero volts dc in a steady-state condition so the sample voltage will not contain a dc component. The second buffer provides the 40 MHz signal to the digital half of the Reference Section. The buffer output is a sine wave transmitted through a sine wave-to-TTL converter to generate a 40 MHz square wave. This signal is applied to the digital half and divided to produce the other reference signals. The third buffer transmits a 40 MHz sine wave to the Mixer Section.

8-123. The digital half generates four output signals with frequencies of 10 MHz, 2 MHz, 1 MHz and 100 kHz. Their signals are derived from the 40 MHz signal transmitted by the sine wave-to-TTL converter. The 40 MHz signal is applied to a chain of dividers providing the different output frequencies at subsequent stages of the chain. The first stage is a divide-by-four which provides the 10 MHz signal. The signal is transmitted to a limiter (which removes noise from the signal), applied to a buffer and sine wave filter and transmitted to a rear panel output jack for external access. The 10 MHz signal is also applied to the second stage of the divide chain, a divide-by-five. The result is a 2 MHz signal which is transmitted through reverse isolation buffers to clock the controller. Reverse isolation prevents noise from the controller logic circuits from being introduced into the reference signals. The 2 MHz reference signal is also divided-by-two to generate the 1 MHz reference signal used as the phase reference in the N Step Loop. The 1 MHz signal is divided-by-ten to obtain the 100 kHz reference used by the Fractional N Loop.

8-124. The 1 MHz and 100 kHz frequency synthesis reference signals generated by the Reference Section are critical to the accuracy of the output frequency. Therefore, each signal is reclocked to eliminate propagation delay and to help noise and power supply immunity by rejustifying the edges. The edges of each signal are first rejustified to the 10 MHz signal and secondly, rejustified to the 40 MHz VCXO reference signal from the master oscillator. (Note that reclocking is performed by two flip-flops, the first clocked by 10 MHz, the second clocked by 40 MHz.)

8-125. The operation of the pulse gate indicates the importance of reclocking the drive signal. The two input signals to the pulse gate must be synchronized to insure there is no variation in the period between the pulse. Since the 100 kHz and 1 MHz drive signals are rejustified to the leading edge of the 40 MHz reference signal before driving

the pulse gate and the 40 MHz is the same signal clocking the second flip-flop of the pulse gate, the two signals are synchronized. Both the 100 kHz and 1 MHz pulse gate outputs are transmitted through ECL limiters which convert the TTL signal to an ECL signal which is required by the Frequency Synthesis Section because of speed requirements. The 100 kHz pulse gate output is the reference for the Fractional N Loop. The 1 MHz pulse gate output is the reference for the N Step Loop.

8-126. The reclocked 1 MHz signal performs two functions.

a. It drives the divide chain to develop a 100 kHz signal.

b. It drives the 1 MHz pulse gate to generate the 1 MHz reference signal.

The 100 kHz signal developed is used to drive a 100 kHz pulse gate. Each pulse gate produces narrow pulses at the rate of the drive signal (100 kHz or 1 MHz). The period of each pulse in both the 100 kHz and 1 MHz pulse is determined by a 40 MHz signal providing pulse widths of 25 microseconds.

8-127. Each pulse gate is comprised of two flip-flops (see Figure 8-14). The drive signal (100 kHz or 1 MHz) clocks the first flip-flop (A) while the second flip-flop (B), in both the 100 kHz or 1 MHz pulse gate, is clocked by a 40 MHz signal. The CLEAR line of flip-flop A is controlled $\overline{Q}$ of flip-flop B. Both flip-flops A and B are clocked by low-to-high transitions. When the Q output of A goes high, the next clock of B establishes a high at Q and low at $\overline{Q}$. The low of $\overline{Q}$ from B clears A (Q low). The next 40 MHz clock to B drops its Q output low and puts a high on CLEAR of A. The result is the output of the pulse gate (Q of flip-flop B) goes high at one 40 MHz low-to-high transition and goes low the next low-to-high transition creating a pulse the width of a 40 MHz cycle. The sequence of generating a pulse is repeated every low-to-high transition of the drive signal (100 kHz or 1 MHz) which clock flip-flop A.

8-128. Frequency Synthesis Section.

8-129. The Frequency Synthesis Section of the 3335A consists of three phase-locked loops.

a. N Step Loop
b. Fractional N Loop (N.F Loop)
c. Summation Loop

Figure 8-15 illustrates the relationship of the three loops in the frequency Synthesis Section.

8-130. The Frequency Synthesis output is developed by summing the N Step Loop signal and the N.F Loop signal. The N Step Loop signal ranges from 39 MHz to 79 MHz in 1 MHz steps. The N.F Loop output ranges from 20.000000000 MHz to 39.999999999 MHz. It is divided

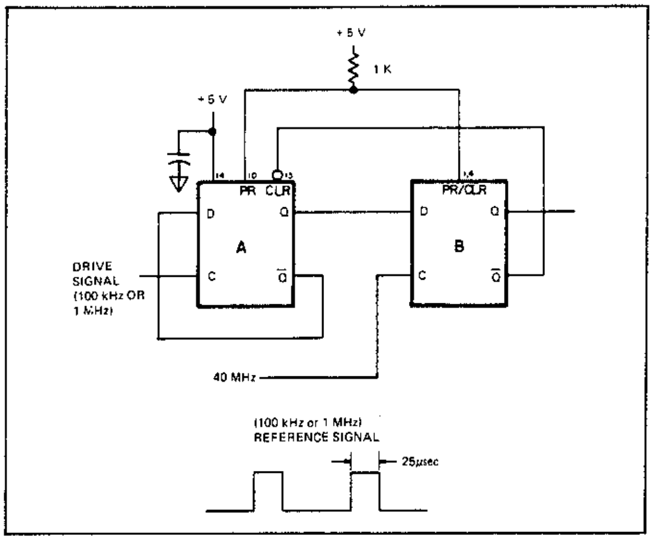


Figure 8-14. Pulse Gate.

by twenty to develop a signal ranging from 1.000000000 MHz to 1.999999999 MHz with .001 Hz resolution. The result from the Summation Loop is a signal ranging from 40 MHz to 80.999999999 MHz also with .001 Hz resolution.

8-131. The N.F Loop provides the changes in frequency less than 1 MHz. A frequency change equal to 1 MHz causes the N Step Loop to change by 1 MHz. A frequency change greater than 1 MHz is obtained by increasing the N Step Loop signal Frequency to the nearest MHz and obtaining the fraction of one MHz with the N.F Loop.

8-132. The N Step Loop and N.F Loop are referenced to signals generated by pulse gates in the Reference Section. The N Step Loop is phase-locked to a 1 MHz signal (resulting in 1 MHz output steps). The N.F Loop is phase-locked to a 100 kHz signal.

8-133. The description of the Frequency Synthesis Section describes each of the three loops separately. A basic description of a phase-locked loop and an N Step Loop is first presented. This is followed by the N Step Loop description, the N.F Loop description (modified N Step Loop) and the Summation Loop description.

8-134. Phase-Locked Loop, Basic Description.

8-135. A basic diagram of a phase-locked loop is shown in Figure 8-16. The phase-locked loop consists of a phase

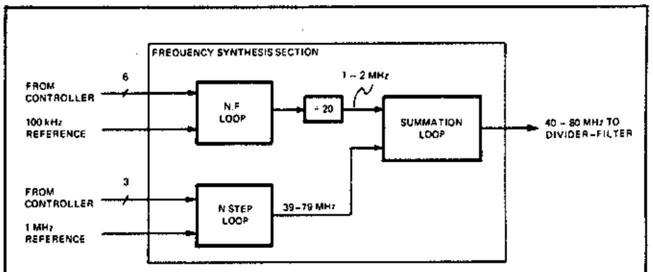


Figure 8-15. Frequency Synthesis Section, Block Diagram.

detector, a low-pass filter and a voltage-controlled oscillator (VCO). In a phase-locked loop the phase detector compares the VCO output to the reference signal. A voltage proportional to the difference in phase of the two inputs is generated by the phase detector (tune voltage). The tune voltage is passed through the low-pass filter to suppress noise and high frequency components. If the phase difference changes, a change in tune voltage is developed. The polarity of the change in tune voltage is such that it will pull the VCO frequency in a direction to phase-track the reference frequency. Figure 8-16 illustrates the phase detector output characteristic and the VCO tune voltage vs. frequency characteristic. These two characteristic curves describe how a change in phase changes the VCO tune voltage to correct the VCO frequency such that the VCO and reference signal are locked together.

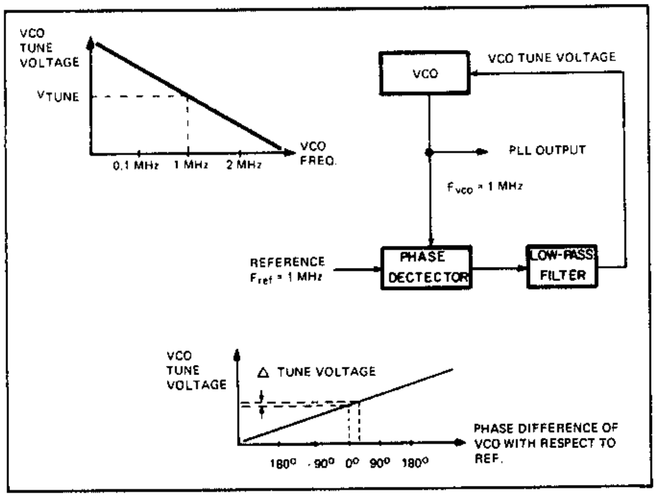


Figure 8-16. Basic Diagram, Phase Locked Loop.

8-136. A basic N Step Loop is shown in Figure 8-17. The operation of the N Step Loop is the same as that of a phase-locked loop. The difference between the two loops is that the VCO frequency is N times the reference frequency. It can be "stepped" to frequencies that are integer multiples of the reference. The output frequency of the programmable divide-by-"N" counter locks and tracks the phase of the reference signal. This method allows the VCO of an N Step Loop to be locked to integer multiples of the reference frequency.

8-137. N Step Loop (Service Group I).

8-138. The N Step Loop of the Frequency Synthesis Section has an operation range of 39 MHz to 79 MHz and is referenced to a 1 MHz signal from the Reference Section. The divide-by-"N" (÷ N) counter is programmable to provide a count from 39 to 79 which generates the output range of 39 MHz to 79 MHz in 1 MHz steps. The ÷ N counter is programmed by the instrument controller. For the remainder of the N Step Loop discussion, refer to Figure 8-I-2, Functional Block Diagram and Figure 8-I-1, N Step Loop Schematic Diagram.

8-139. A basic description of an N Step Loop was described previously. This description also applies to the

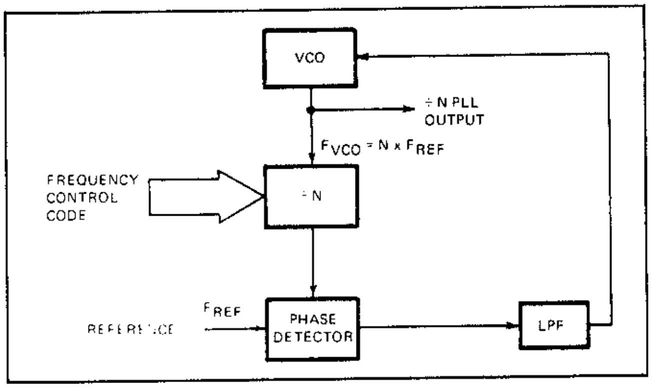


Figure 8-17. Basic Diagram, N Step Loop.

3335A N Step Loop which contains the elements shown in Figure 8-16, Basic Diagram, N Step Loop. These elements are the VCO, ÷ N counter, phase detector and low-pass filter. Additionally the 3335A N Step Loop contains isolation buffers at the output of the VCO. The description of the 3335A N Step Loop begins with the VCO and progresses around the phase-locked loop and ending with the development of the dc tune voltage required to operate the VCO at a particular frequency.

8-140. N Step Loop VCO. The VCO consists of the transistor pair Q11 and Q12, the tank circuit L7, L8, C46, CR3 and CR4 and the associated circuit. This includes a common base and emitter follower stage at the output which are coupled through capacitor C51. Positive feedback from the tank circuit to the base of Q12 is provided through capacitor C52.

8-141. Three adjustments are present in the VCO circuit. The variable inductor L8 tunes the VCO. Another variable inductor, L7, peaks the VCO signal. The third adjustment is a potentiometer at the base of Q12 used as a current adjustment to adjust the flatness of the transistor.

8-142. The frequency of the N Step Loop VCO signal is governed by the dc tune voltage applied to the varicaps CR3 and CR4 in the VCO tank circuit. The range of the tune voltage is approximately - 8.5 V dc to + 8.5 V dc. (These voltages are only limits and in actual circuit operation, they can fall anywhere within the range.) - 8.5 V corresponds to a VCO frequency of 80 MHz, + 8.5 V corresponds to a VCO frequency of 40 MHz and 0 V corresponds to 60 MHz. See Figure 8-18, VCO Tune Voltage vs. VCO Frequency. The VCO output is ac coupled through C51 to a common base amplifier Q13. This stage provides approxi-

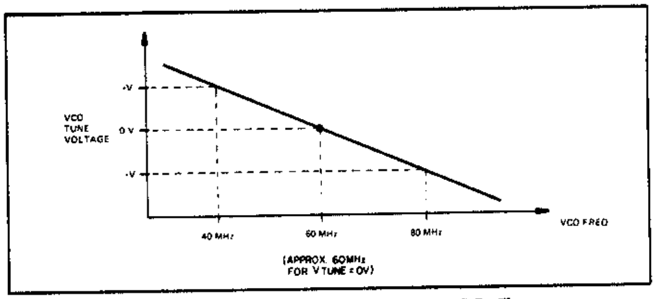


Figure 8-18. VCO Tune Voltage vs. VCO Frequency.

mately 20 dB of gain and drives an emitter follower stage Q14. Q14 is an impedance matching buffer which drives the isolation buffers that transmit to the summation loop, ÷ N counter and input to the Schmitt trigger (U5).

8-143. Isolation Buffers. The VCO signal is transmitted by three isolation buffers. Two buffers transmit the VCO signal to two separate locations in the summation loop, the third buffer transmits internal to the N Step Loop to complete the loop. The purpose of these buffers is to isolate the N Step Loop VCO from signals generated by the circuits being driven by the VCO. These buffers provide approximately 60 to 80 dB of isolation from unwanted signals.

8-144. The isolation buffers consist of three amplifier stages, a common emitter driving two common base stages. Resistive dividers and base by-pass capacitors couple unwanted signals to ground. Additional filtering is provided at the isolation buffer driving the summation loop mixer. This mixer generates many more extraneous signals than the circuits driven by the other two buffers. The filter, composed of L22 and C73, helps the isolation buffer to isolate these signals from the N Step Loop VCO.

8-145. Each isolation buffer is capacitive-coupled at both the input and output. The output of each buffer is a sine wave. This signal is converted to an ECL signal in the ÷ N counter portion of the N Step phase-locked loop, divided by the programmed number N and applied to the phase detector.

8-146. Divide-by-N (÷N) Counter. The ÷N counter is comprised of two binary presettable counters–a units counter and a tens counter (see Figure 8-19). An ECL line receiver used as a Schmitt trigger converts the VCO sine wave transmitted by the isolation buffer to an ECL signal which clocks the counters. Also included in the ÷N counter portion are a serial-to-parallel converter, an eight bit data latch and TTL-to-ECL converters. These components convert the TTL serial controller data to ECL parallel data which presets the units and tens counters.

8-147. Since the operating range of the N Step Loop VCO is 39 MHz to 79 MHz and is a function of the number N in the ÷N counter, the number N must vary from 39 to 79 (F VCO = N x F ref = N x 1 MHz). The units and tens counters are binary counters not BCD counters (counts 0 to 15 not 0 to 9). To obtain a count of 39 to 79, different binary numbers are preset into the units and tens counters for the number desired. This number is the divide-by-"N" number of the loop. the N Step Loop Schematic Diagram, Figure 8-I-1, contains a table indicating the binary number used to preset the counters to obtain a decimal divide-by-N number of 39 to 79.

8-148. Data to preset the ÷N counters is transmitted by the instrument controller in a serial transmission. This data is converted to an 8-bit binary parallel output which is applied to an octal D flip-flop data latch U2. The eight lines are weighted with numbers 0 through 7. The data is latched on command from the controller once it has transmitted all eight bits to the serial-to-parallel converter. The output of the data latch is converted from TTL to ECL before applied to the binary counters since the counters must be ECL to operate in the 39 to 79 MHz range. Lines weighted 0 through 3 pre-set the unit's counter while Lines 4 through 7 preset the ten's counter. Lines 0 and 4 represent the least significant bits while Lines 3 and 7 represent the most significant bits. Since the VCO signal clocks the ÷N counters, every N clock cycles the counter will provide one cycle.

8-149. The signal used to clock the ÷N counter is the VCO signal transmitted by one of the isolation buffers. Before being applied to the ÷N counter, the VCO signal (which is a sine wave) is converted to an ECL signal by line receiver, U5, here used as a Schmitt trigger. The VCO sine wave is applied to pin 4 with pin 5 being the other input of the first differential amplifier. These inputs are maintained at the ECL center switch point by the base bias supply transmitted from pin 11. Complimentary outputs at pins 2 and 3 drive the second differential amplifier at pins 13 and 12. One output of this amplifier at pin 14 provides an ECL signal the frequency of the VCO to clock the ÷N counters.

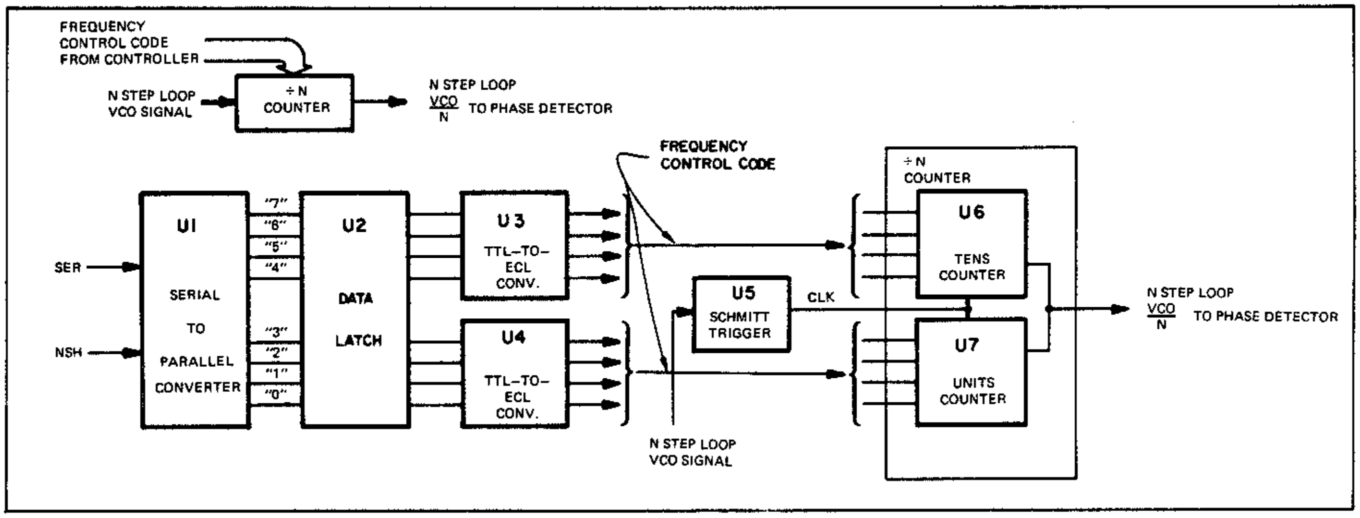


Figure 8-19. Divide-by-N Counter.

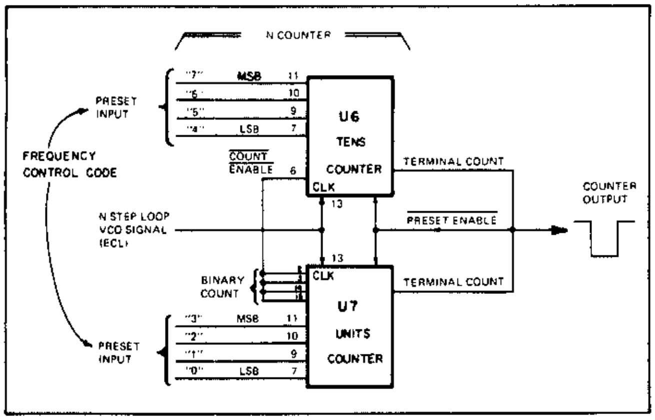


Figure 8-20. ÷N Counter.

8-150. The ÷N counter contains a unit's counter (U7) and a ten's counter (U6). Each counter accepts a four-bit binary code to preset (see Figure 8-20). Preset of the counters occurs when both the unit's and ten's counters reach terminal count. The preset enable line is connected to the terminal count lines. Both terminal count lines must go low simultaneously to cause the ÷N counter output (and preset enable) to go low. This occurs when the ÷N counter has received N VCO clock pulses. It then generates one output pulse and at the same time the output pulse presets the unit's and ten's counter from data on the preset input lines to re-establish the N number.

8-151. Since both the unit's and ten's counters are clocked by the N Step Loop VCO signal, the unit's counter enables the ten's counter each time the unit's counter reaches a binary zero. Enabling the ten's counter is performed using a low true count enable Line (pin 6). The binary outputs of the unit's counter (pins 2, 3, 14 and 15) are all tied to the count enable input of the ten's counter. All lines must be low to enable the ten's counter. Each time the unit's counter reaches a binary 15, the next clock it will go to 0 which enables the ten's counter. On the next clock the ten's counter increments one and is then disabled by the unit's counter also incrementing to a one.

8-152. The signal generated by the ÷N counter is a pulse train occurring at a 1 MHz rate. Each pulse has a period equal to the periof of the N Step Loop VCO and is negative going pulse. As the N Step Loop VCO frequency changes, so does the period of the pulse from the ÷N counter. The rising edges of the reference signal and ÷N signal are compared by the phase detector.

8-153. Phase Detector. The purpose of the phase detector is to generate a dc voltage proportional to the difference in phase of its two input signals, the 1 MHz reference and the ÷N counter 1 MHz signal. The phase detector consists of a phase-frequency detector (U7), a NOR gate with complimentary outputs (U8), and complimentary current sources with current switches and level shifting transistors. The current sources drive the input of the low-pass filter which is connected to an integrating capacitor. This capacitor integrates the current to develop the dc tune voltage required by the VCO (see Figure 8-21).

8-154. The method employed by the phase detector to develop the dc tune voltage is a current pulse cancellation scheme. The complimentary current sources are driving a current summation node, one driving current into the node, the other sinking current from the node. If the current entering the node is the same as the current leaving the node, no current flows through the LPF or through the integrating capacitor. The voltage on this capacitor remains unchanged providing an unchanging dc voltage which is applied to the VCO tank circuit as the tune voltage. This situation occurs when the VCO is locked to the reference signal (operating at N times the reference). When phase-locked, the current entering the summing node is cancelled by the current leaving the node and the tune voltage is a constant dc value.

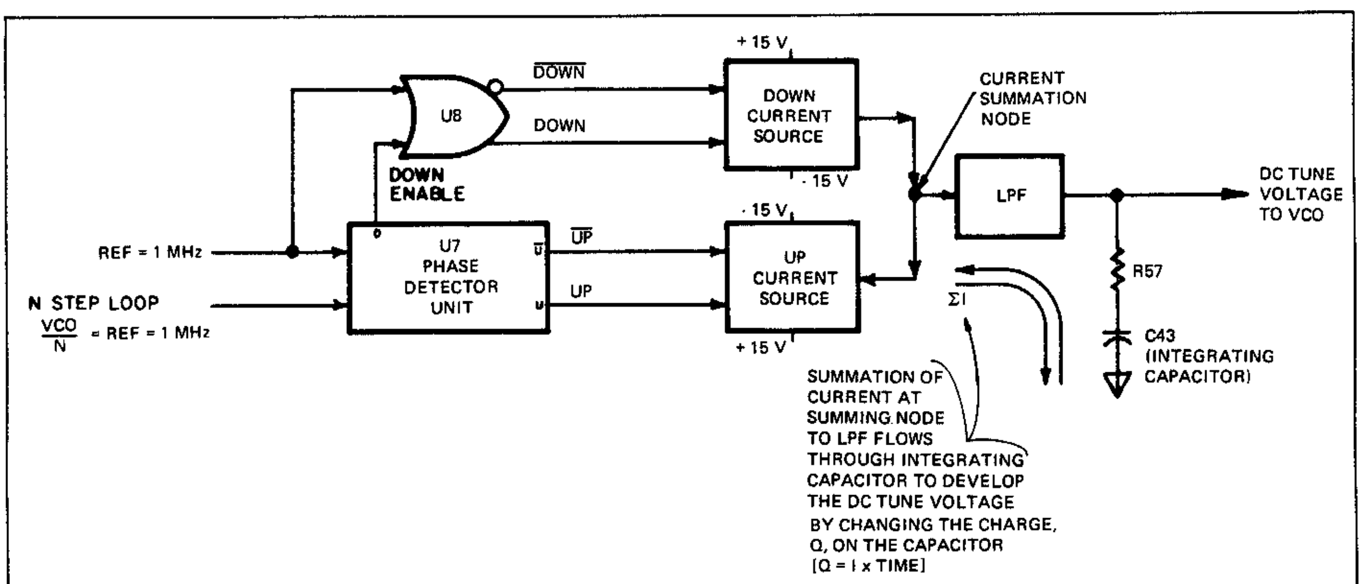


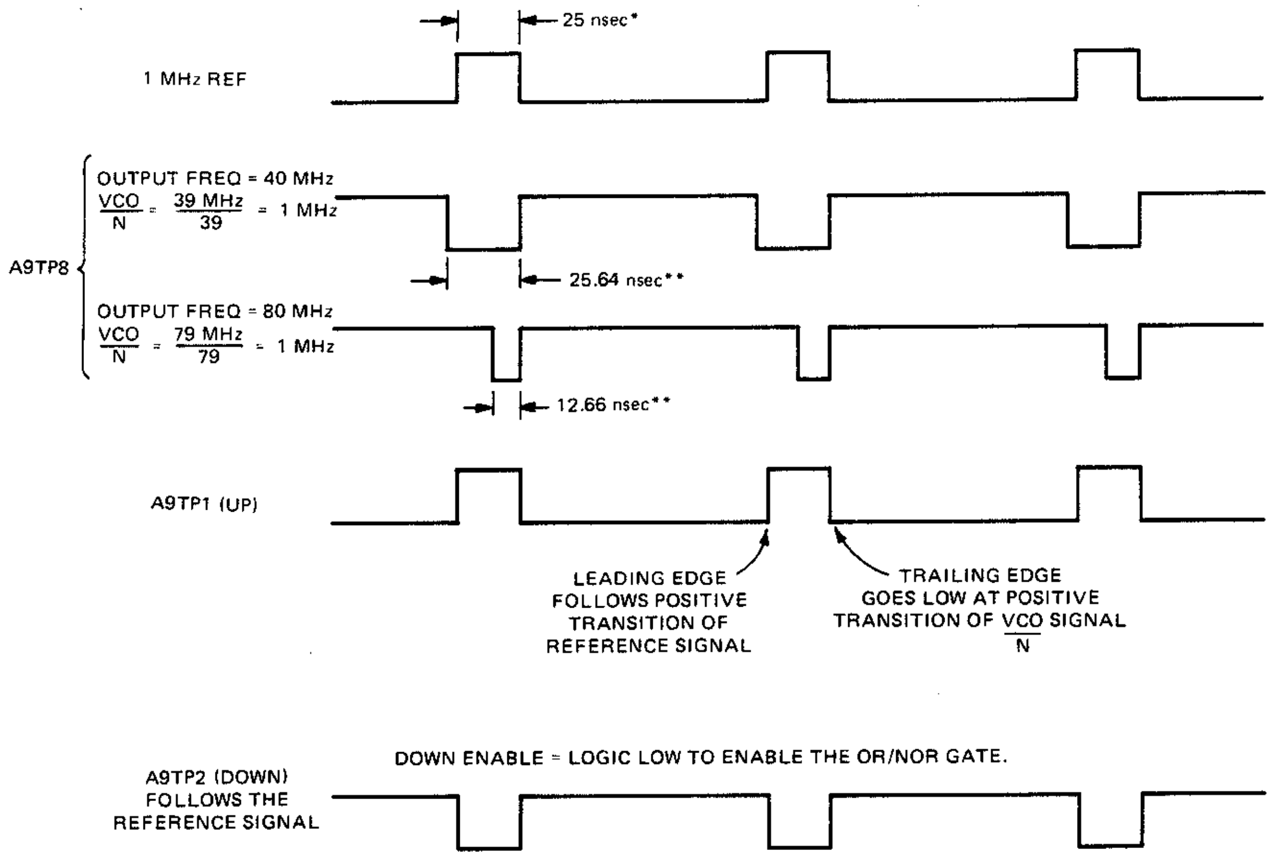
Figure 8-21. N Step Loop Phase Detector.

8-155. As indicated in Figure 8-17, N Step Loop VCO tune voltage vs. N Step Loop VCO frequency, the dc tune voltage must be variable from approximately + 8.5 V to - 8.5 V to tune the VCO over its operating range. The method used to change the tune voltage is to drive current into or out of the integrating capacitor C43. Current flowing through the integrating capacitor is regulated by complimentary pairs of UP and DOWN lines controlling the current sources. The UP lines control one current source while the DOWN lines control the other current source. These lines drive level shifting transistors (Q4–Q7) which convert ECL to the levels needed by the switching transistors (Q2, Q3, Q8 and Q9). If the signals on the UP and DOWN lines are symmetrical with respect to the area under each signal, the currents entering and leaving the current summing node are equal. No current flows into or out of the capacitor therefore the tune voltage (charge on the capacitor) remains constant and the loop is locked. If a new output frequency is programmed from the front panel that changes the N number in the ÷N counter, the tune voltage must be caused to change by a change in the summation of currents at the current summing node. The change in current drives current into or out of the integrating capacitor changing its voltage and this causes the VCO to operate at a different frequency. The VCO frequency is caused to change in a direction approaching N times the reference frequency. When N times the reference is reached, the loop is again phase-locked.

8-156. As described previously, the UP and DOWN lines control the current sources and therefore control whether current flows into or out of the integrating capacitor. They also dictate when there is no current flow to or from this capacitor. When phase-locked, the UP and DOWN lines have the same duty cycle and occur at the same time causing equal currents to flow from their respective current sources. This results in no current flowing into or out of the integrating capacitor. An OR/NOR gate (U8) is used in conjunction with the phase detector (U7) to develop equal signals on the UP and DOWN lines. Figure 8-22 illustrates UP and DOWN waveforms for a phase-locked loop.

8-157. The phase detector unit has two output modes.

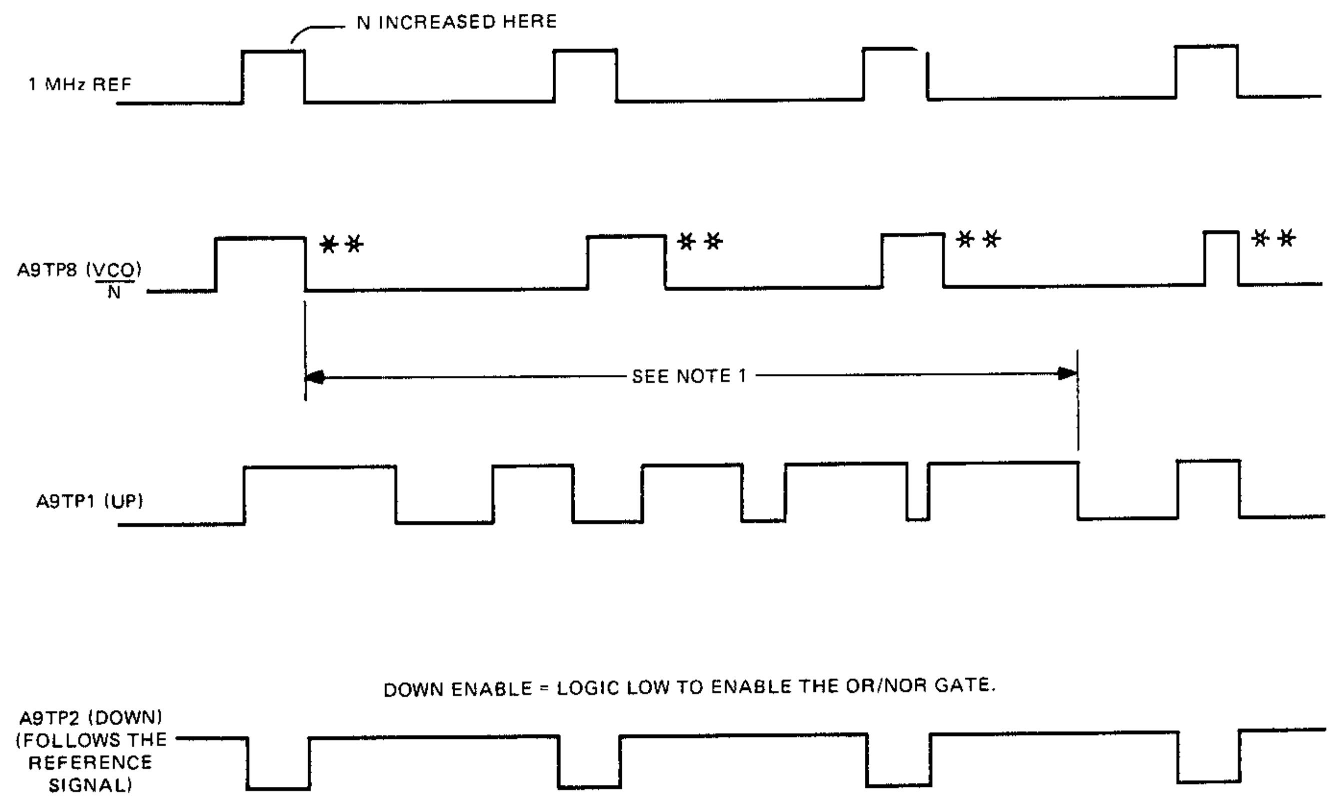
a. The DOWN ENABLE line is held low and the UP lines toggle with pulse widths equal to the phase difference when the VCO/N signal lags the reference signal.



* Period of 40 MHz; this 1 MHz signal with 25 nsec pulses is developed by the reference section pulse gate.

** Period of VCO frequency varies from 25.64 nsec at 39 MHz to 12.66 nsec at 79 MHz. When the terminal count of ÷ N counter is reached, line goes Low on the Low-to-High transition of VCO. On the next Low-to-High transition of the clock, the line goes back to the High state until the next terminal count. The difference in period to reach terminal count accounts for the variation in pulse width at A9TP8.

Figure 8-22. Phase Detector UP and DOWN Waveforms (Phase-Locked Condition).



NOTE

During this interval, $\frac{VCO}{N}$ lags REF due to an increase in the Divide-by-N number caused by an increase in the output frequency. The frequency of the VCO is increased to again phase-lock the loop by drawing current from the integrating capacitor to decrease the tune voltage (see Figure 8-18). This is accomplished by drawing more current from the summing node with the UP current source than is going into the node from the DOWN current source. (Note the UP pulses are wider than the down pulses for this interval.) Following this interval, the VCO is operating at N times the reference and the loop is again phase-locked as shown in Figure 8-22.

** Interval between pulses and pulse width decreases as VCO frequency increases.

Figure 8-23. Phase Detector UP and DOWN Waveforms to Increase VCO Frequency.

b. The UP line is held low and the DOWN ENABLE line toggles with pulse widths equal to the phase difference, when VCO/N leads the reference signal.

The reference signal is a positive-going pulse while the VCO/N signal is a negative-going pulse. The phase detector unit is triggered by the low-to-high transition of each pulse so in a phase locked condition, the phase detector unit is in an N Step Loop VCO/N lagging the reference mode (see Figure 8-22). The REF and VCO/N pulses occur at the same rate, but the phase detector responds only to the low-to-high transitions of each pulse. The UP line goes high at the positive transition of the reference signal and goes low at the positive transition of the N Step Loop VCO/N signal. To phase lock the N Step Loop VCO, the UP pulses must be the same width as the DOWN pulses if the current sources have exactly the same value. To accomplish this, the trailing edge (low-to-high transition) of the N Step Loop VCO/N signal is adjusted by the loop to generate an UP pulse the same width as the DOWN pulses. This is illustrated in Figure 8-22 by showing two VCO/N waveforms corresponding to N = 39 and N = 79 (the two operating extremes).

8-158. When the N number in the ÷N counter is changed, the current sources drive current into or out of the integrating capacitor to change the tune voltage. This is done under control of the UP and DOWN lines from the phase detector unit and OR/NOR gate. Figure 8-23 illustrates typical waveforms of the UP and DOWN lines to increase the N Step Loop VCO frequency when the N number is increased. Figure 8-24 illustrates typical waveforms of the UP and DOWN lines to decrease the N Step Loop VCO frequency when the N number is decreased.

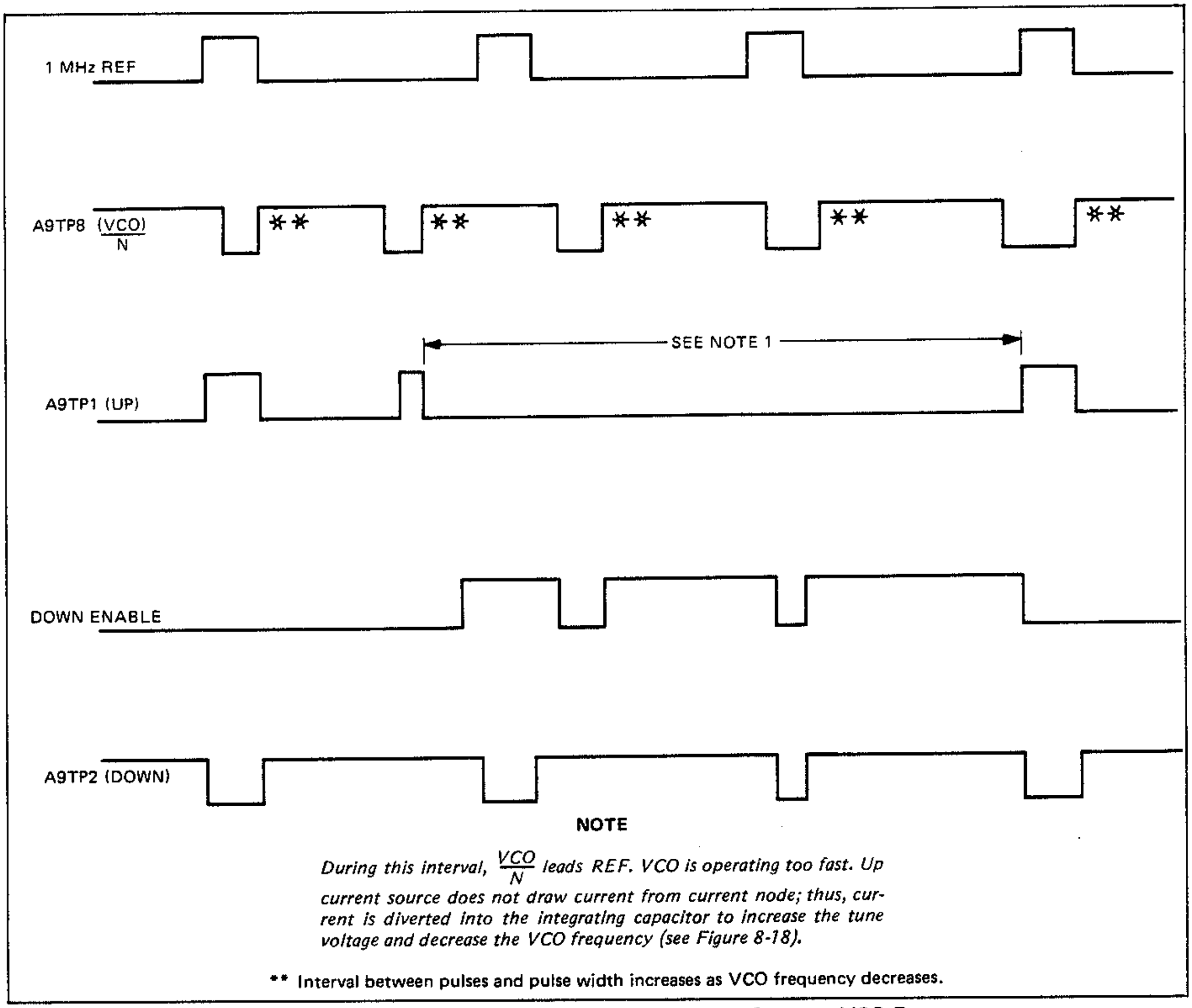


Figure 8-24. Phase Detector UP and DOWN Waveforms to Decrease VCO Frequency.

8-159. Low-Pass Filter (LPF). The LPF is present in the loop to suppress high frequency components on the tune voltage. Additionally, high-frequency by-pass capacitors C37 and C44 are present at each end of the LPF with the integrating capacitor between these capacitors. The result is a very clean dc tune voltage applied to the VCO tank circuit.

8-160. Fractional N Phase-Locked Loop (N.F Loop) (Service Group J).

8-161. The N.F Loop is a modified N Step Loop. A unique operating feature of the N.F Loop is that it can operate at fractional multiples of the reference signal instead of steps. In the fractional N Phase-Locked Loop abbreviation, "N.F Loop", N refers to the integer part and F the fractional part of the divide-by-N number. This number referred to the reference signal represents the loop frequency. The integer part is that of an N Step Loop (N x reference frequency). The fractional part F represents the offset frequency of the VCO with respect to the integer component of frequency.

8-162. The description of the N.F Loop is divided into three parts. The first part is a general discussion of the N.F Loop concept using example frequencies found in the 3335A N.F Loop. The second part describes the 3335A N.F Loop using simplified block diagrams. The third part is a detailed description of the more complex and unique parts of the Loop.

8-163. The Fractional N Phase-Locked Loop Concept.

8-164. Consider the N Step Loop phase detector output under an open loop condition. Assume a reference frequency of 100 kHz, N=10 and VCO frequency of 1.01 MHz (N=1.0 MHz; F=0.01 MHz). The VCO is operating at a fractional multiple (10.1) of the reference signal (10.1 x

0.1 MHz = 1.01 MHz). This configuration is shown in the block diagram of Figure 8-25. The phase detector compares the low-to-high transitions of the reference and divide-by-N signals. Since the VCO is not operating at N times the reference but operates with a fractional component (F=0.01 MHz), the signal from the divide-by-N block advances on the reference signal. Each time the divide-by-N signal makes a low-to-high transition, the phase detector compares it to that of the reference. The phase detector generates an output proportional to the period between the two low-to-high transitions. In the phase-locked condition of a N Step Loop this period remains constant. In this open loop example with the VCO containing a fractional component, the period between low-to-high transitions is continuously increasing, therefore, the phase detector output voltage consequently is increasing.

8-165. When analyzing the open loop N Step Loop, it is of interest to view the operation in terms of reference periods. A reference period is defined as the time required for the reference signal to complete one cycle. Each reference period the reference signal goes through one cycle while the VCO which is operating 10.1 times as fast, goes through 10.1 cycles. We can say the VCO has advanced one-tenth of a cycle of phase on the integer part N x fref (fref = reference freq) in one reference period. In two reference periods, the VCO has gone 20.2 cycles or advanced two-tenths of a cycle of phase on N x fref. When the VCO operates with a fractional offset (F), it continually advances phase on N x fref each reference period. From the example of Figure 8-25, in ten reference periods, the VCO signal will have gone 101 cycles or advanced one cycle of phase (360°) with respect to N x fref. Table 8-5 illustrates the phase relationship of N x fref and N.F. Just as the VCO signal advances phase on N x fref, the divide-by-N VCO signal applied to the phase detector advances phase on the reference frequency, fref.

8-166. In a N Step Loop, the VCO is phase-locked to a reference signal. With the introduction of the ÷ N block, the VCO operates at a multiple N of the reference frequency (N x fref). In a N.F Loop, the VCO operates at an integer-plus-fractional multiple of the reference frequency (N x fref + F = N.F). As previously illustrated in Figure 8-25, assume again the VCO operates at 1.01 MHz, the

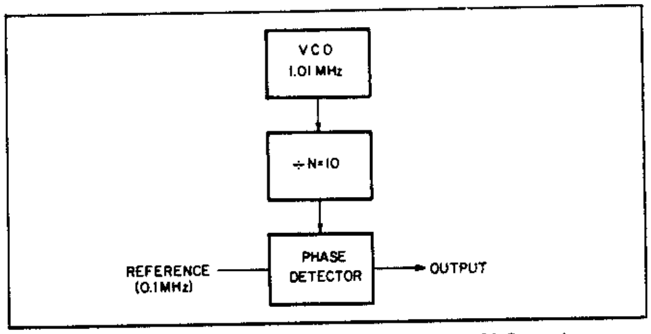


Figure 8-25. Basic Diagram, Open Loop N Step Loop.

reference is 0.1 MHz and N equals 10. Each time the reference signal goes through one cycle, the VCO goes through 10.1 cycles. After 10 reference cycles (10 reference periods) the VCO has gone 101 cycles. The VCO has advanced one full cycle of phase (360°) on N x fref. If a VCO cycle is removed from the VCO pulse train applied to the ÷ N block at the point a full VCO cycle has advanced, the phase advancement on the average is cancelled and the average frequency applied to the ÷ N block is N x fref or in this example 1 MHz.

8-167. Because of the continual removal of a VCO cycle (removal of one cycle of phase) at each point the VCO advances one cycle on N x fref, the phase detector output becomes a sawtooth waveform (See Figure 8-26, Phase Detector Sawtooth Output). The waveform increases linearly due to the advancing phase of the VCO until the VCO has advanced one cycle of VCO phase (360°). At this point a cycle is removed from the VCO pulse train cancelling the previous advancement of a cycle of phase. The phase detector responds to this sudden one cycle (360°) phase loss by returning to its initial output. The sequence is repetitive, generating the sawtooth waveform. The maximum amplitude reached represents one cycle of VCO phase. As the VCO frequency is increased, the time interval for the VCO to go through one cycle of phase is less, therefore, the maximum phase detector amplitude is decreased. The phase detector maximum amplitude is inversely proportional to the VCO frequency.

8-168. The necessity to remove one VCO cycle from the VCO output each time the output advances one cycle of

Table 8-5. Phase Relationship of N x fref and N.F.

No. of Ref. Periods (fref=100 kHz=0.1 MHz)	No. of Completed Cycles of		Phase Advancement of N.F on N x fref
	N x fref=1 MHz (N=10)	N.F=1.01 MHz	
1	10	10.1	0.1 cycle of phase
2	20	20.2	0.2 cycle of phase
3	30	30.3	0.3 cycle of phase
4	40	40.4	0.4 cycle of phase
.	.	.	.
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9	90	90.9	0.9 cycle of phase
10	100	101.0	1 full cycle of phase (360°)

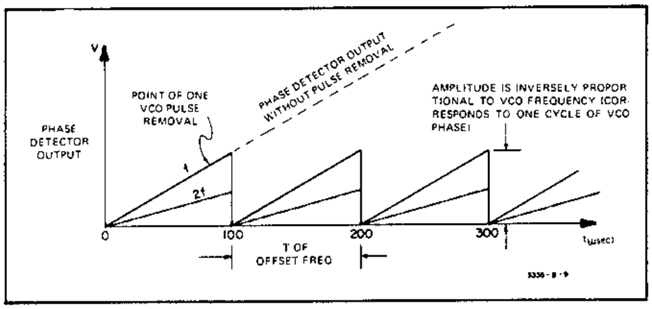


Figure 8-26. Phase Detector Sawtooth Output.

phase on N x fref requires we use a pulse remover block in the N Step Loop block diagram. See Figure 8-27. If a VCO pulse is removed each time the VCO advances one cycle of phase, the average frequency applied to the divide-by-N block is N x fref and the average frequency applied to the phase detector is fref. The relationship of the phase detector sawtooth output and the pulse trains shown in Figure 8-27 is illustrated in Figure 8-28. A method of determining when the VCO has advanced one cycle of phase is required. Such information can then be used to trigger the pulse remover block and a VCO cycle removed at the appropriate time.

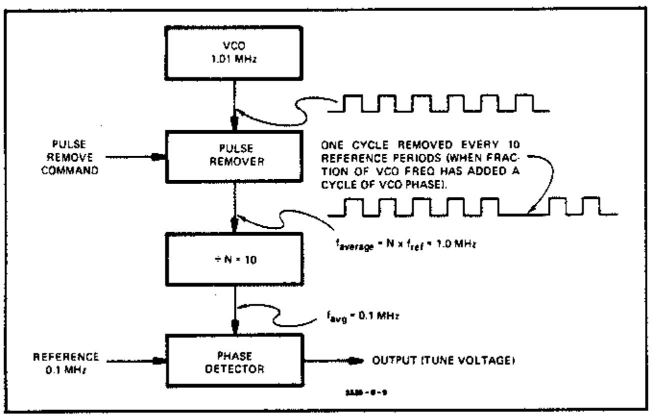


Figure 8-27. N Step Loop with Pulse Remover Block.

8-169. The fractional part of the VCO frequency determines the time required for the VCO to advance one cycle of phase on N x fref. The time required is the period of the fractional offset frequency and corresponds to a certain number of reference periods. If the fractional part of the VCO is stored in a fraction register and that quantity added to a second register each reference period, the second register will contain a running total of the fraction which is the fraction of a VCO cycle of phase advancement at any point in time. For this reason the second register is called the phase register and the entire configuration is called an accumulator (See Figure 8-29). The phase register will reach unity the same reference period the VCO has advanced one full cycle of phase. (Recall the preceeding example, in one reference period the VCO has gone 10.1 cycles, in two reference periods, the VCO has gone 20.2 cycles, etc. The summing register will contain .1 after one reference period, .2 after the second reference period, etc.) When unity is reached, the phase register overflows and transmits an overflow signal. The overflow signal corresponds to the point in time the VCO has advanced one cycle of phase on N x fref. The overflow signal can now be applied to the pulse remover block as a pulse remove signal.

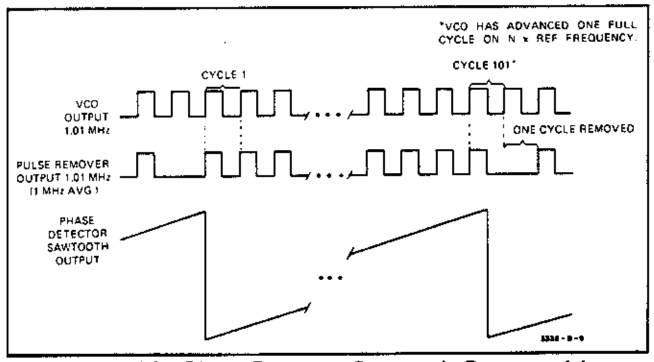


Figure 8-28. Phase Detector Sawtooth Output with Respect to Pulse Remover Output.

8-170. If the VCO operates with an offset frequency not evenly divisible into one (such as 0.03), a fractional overflow can result when the phase register reaches unity. For example, if the VCO operates at 1.03 MHz instead of 1.01 MHz, after one reference period it has gone 10.3 cycles, 20.6 after two, 30.9 after three and 41.2 after the fourth reference period. Prior to the fourth reference period, the phase register has accumulated 0.9. The fourth reference period 0.3 is added to the 0.9 from the phase register and results in 1.2. This causes an overflow as the pulse remove signal and the fractional overflow of 0.2 is loaded into the phase register and the next sequence phase begins to accumulate from 0.2 instead of zero.

8-171. Up to this point, the discussion has developed the N.F Loop to include the pulse remove command section. Figure 8-30 is a block diagram of the N.F Loop with the pulse remove command section. This structure provides a

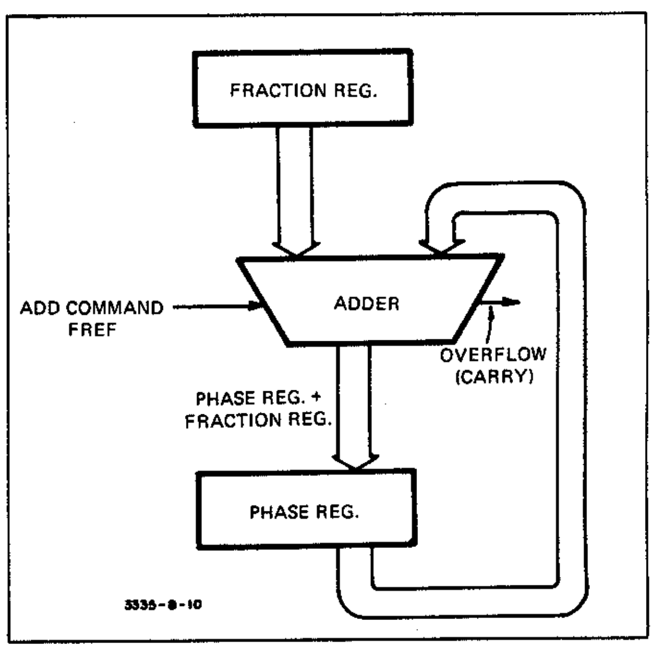


Figure 8-29. Accumulator.

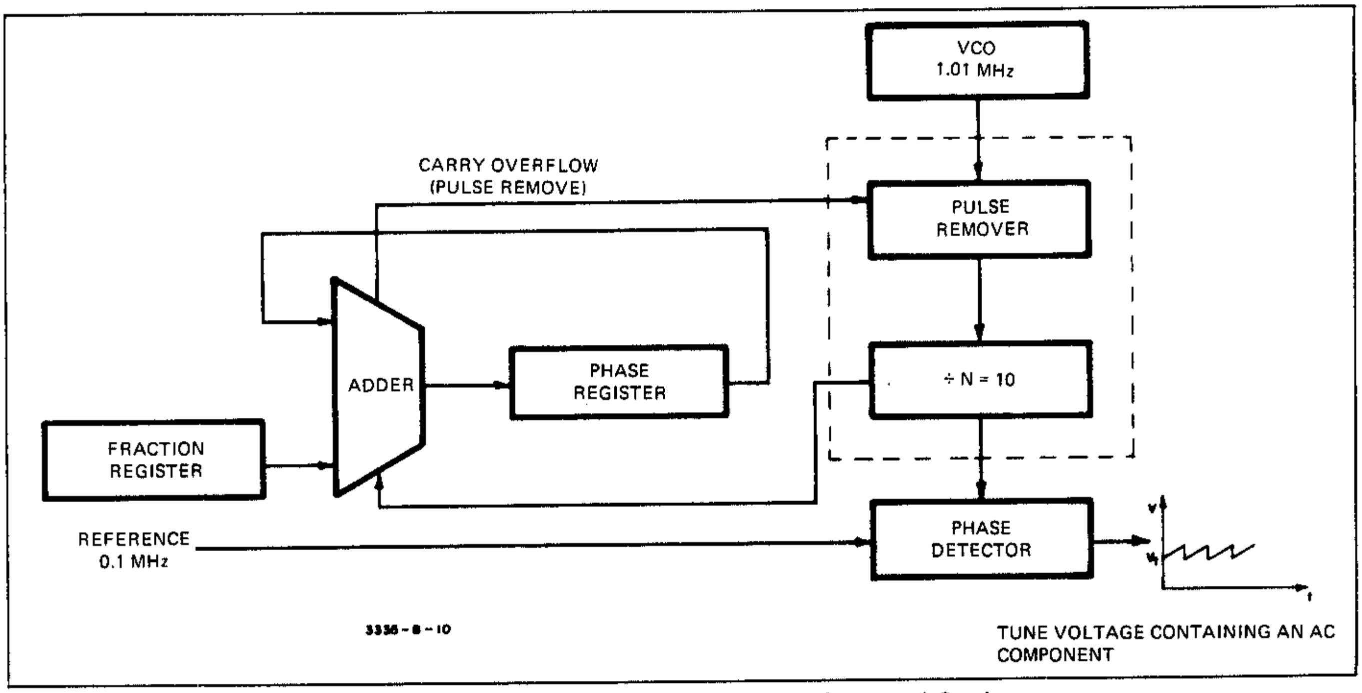


Figure 8-30. N.F Loop with Pulse Remove Command Section.

means of automatically removing a VCO cycle whenever the VCO advances one full cycle of phase on the frequency N x fref.

8-172. The open loop phase detector output of Figure 8-30 is a sawtooth waveform superimposed on a dc voltage. Only the dc voltage of this output is of interest. A VCO requires a dc tune voltage to maintain a stable output signal. A sawtooth ac signal superimposed on the dc VCO tune voltage would cause frequency modulation of the VCO signal. The ac sawtooth waveform of the phase detector output must be cancelled or removed leaving the dc component to tune the VCO to the proper frequency.

8-173. We know that the VCO output advances a fraction of a cycle of phase on N x fref each reference period. The fraction of a cycle of phase that the VCO is advanced at any one reference period is represented by the fractional sum in the phase register. (Recall that the phase register is incremented by the fractional VCO output each reference period). For the example of Figure 8-30, the contents of the phase register when viewed with respect to time is a staircase resetting to zero once unity is reached (See Figure 8-31). The staircase approximates a sawtooth waveform (See dotted lines). The "front edge" of each step represents the phase detector output for that reference period. (Recall the phase detector does not generate a ramp but samples the VCO with respect to the reference each reference period generating a staircase output.)

8-174. If the contents of the summing register are applied to a digital-to-analog converter (DAC), the DAC output will follow the steps of the summing register and approximate a sawtooth output. Applying the DAC output through an inverter and summing it with the phase detector output essentially cancels the ac component (sawtooth) of the phase detector output. This leaves the dc component required as a VCO control signal.

8-175. There are two requirements of the waveform generated by the DAC such that it will approximate the phase detector sawtooth output.

a. It must have a variable amplitude.

b. It must have a variable period.

The amplitude is inversely proportional to the frequency of the VCO and changes whenever the VCO frequency is changed. To demonstrate the amplitude dependence on the VCO frequency, refer to Figure 8-32.

8-176. In Figure 8-32 a reference of 0.1 MHz is used (horizontal axis plotted in reference periods) and plots of the phase detector output for VCO frequencies of 1.01 MHz and 2.01 MHz are shown. Note that each VCO frequency example contains a 0.01 MHz offset or fractional

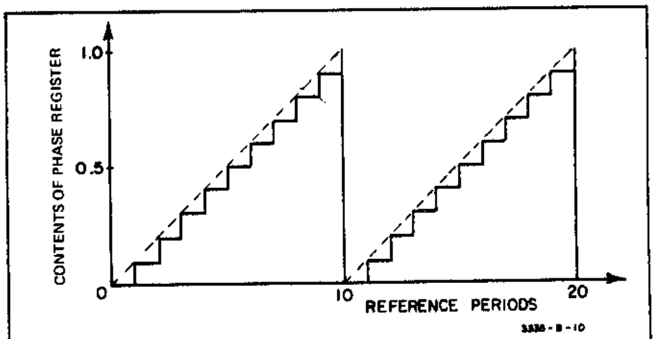


Figure 8-31. Phase Register Contents.

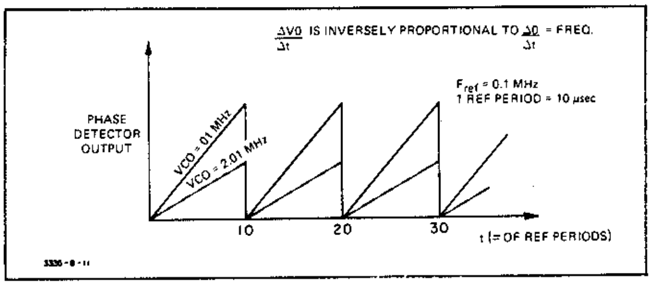


Figure 8-32. Phase Detector Output for Two VCO Frequencies with the Same Offset.

frequency. In terms of reference periods (10 μs), the period of the 0.01 MHz offset is ten reference periods. At this point the offset frequency has completed one cycle and added a cycle of phase to the VCO signal. Since the period of 2 MHz is half the interval of 1 MHz, the phase detector output representing one cycle of phase at 2 MHz is half the amplitude of the output representing one cycle of 1 MHz phase. When the VCO cycle is removed, a 360° phase loss is detected by the phase detector and it responds by returning to its initial output causing the high-to-low transition of the sawtooth. If the offset or fractional part of the VCO frequency is changed, the period of the sawtooth changes for these two periods are the same. The sawtooth generated by the DAC must change amplitude and period as the phase detector output changes and must be superimposed on zero volts dc. It can then be inverted and summed with the phase detector output to remove the sawtooth from the tune voltage applied to the VCO.

8-177. A general block diagram of an N.F Loop is shown in Figure 8-33. The basic elements of an N Step Loop are present; the VCO, ÷ N counter, phase detector and low-pass filter. In addition to these, a fraction register, adder and phase register provide the "bookkeeping system" to keep a record of the phase advancement from reference period to reference period. This system is known as a phase interpolator and in conjunction with a digital-to-analog converter (DAC), the system is referred to as an analog phase interpolator (API). Each reference period it generates an analog voltage equal and opposite in polarity to the phase advancement voltage generated by the phase detector. The voltage applied to the LPF is then a dc voltage constituting the VCO tune voltage. Since the "bookkeeping system" must update each reference period (the phase detector output changes each reference period after the VCO/N and reference signal comparison), the system receives its add command (update command) at a VCO/N rate.

8-178. N.F Loop, Simplified Theory.

8-179. The N.F Loop is a modified N Step Loop. It contains all the basic elements of the N Step Loop with the addition of several other sections. Figure 8-34 illustrates the additions made to the "loop". These additions are a sequencer, an N counter that can be changed to an (N + 1) counter and an integrator and sample/hold which are used to develop the tune voltage. Compare this diagram to Figure 8-33, General Block Diagram, N.F Loop.

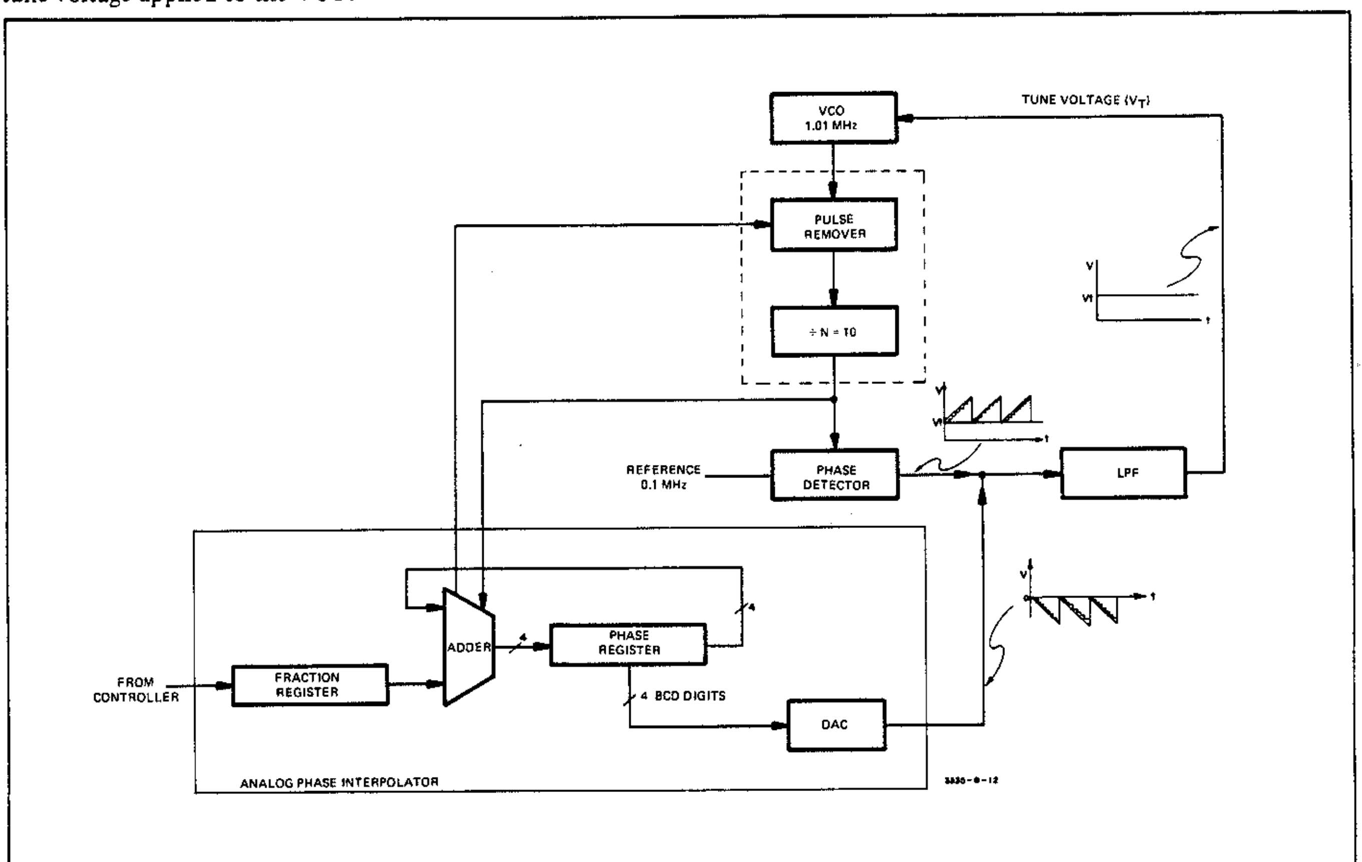


Figure 8-33. General Block Diagram, N.F Loop.

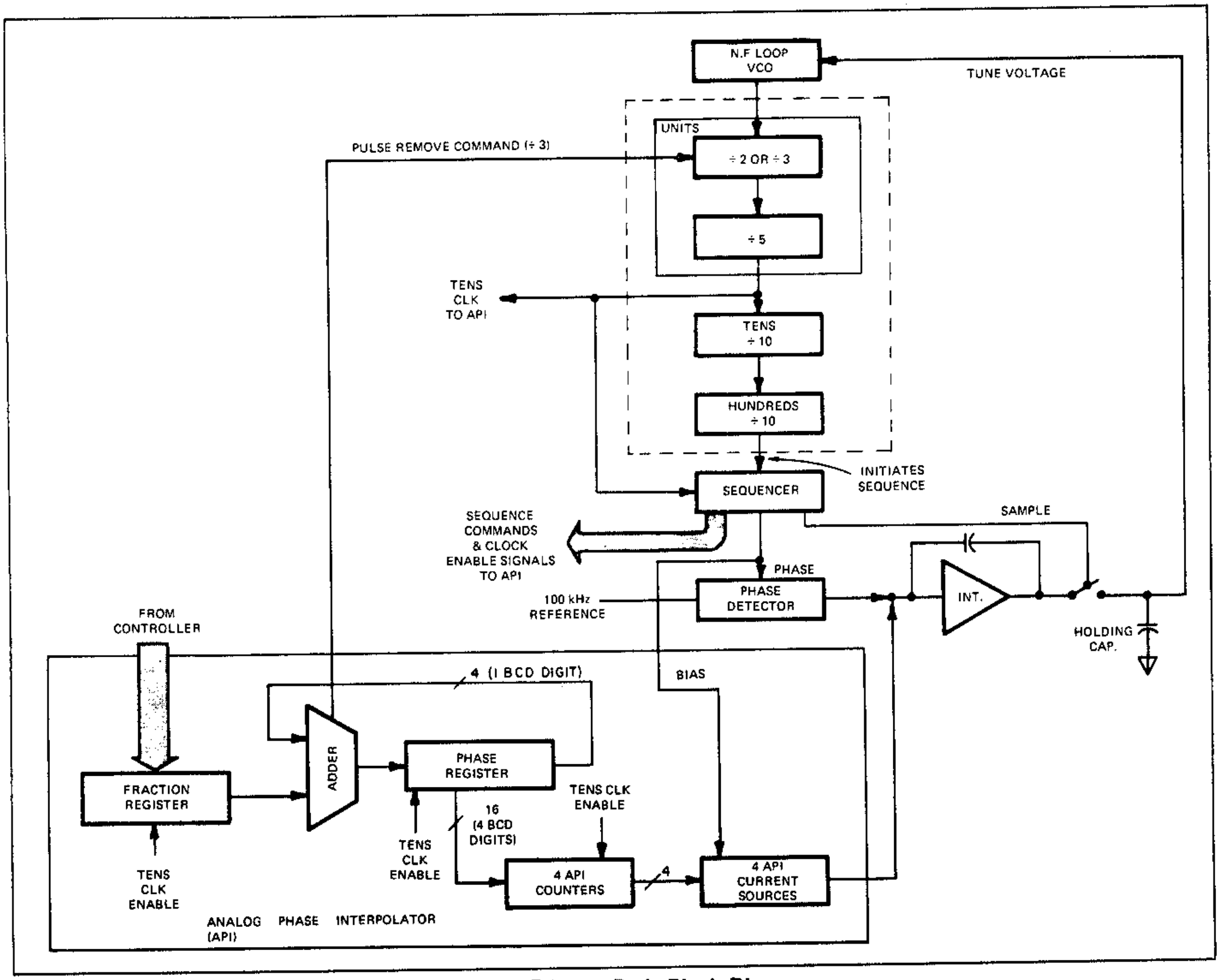


Figure 8-34. N.F Loop, Basic Block Diagram.

8-180. The N.F Loop operates according to an established sequence of events which occur once each reference period. The sequence is initiated at a rate equal to the VCO/N signal. This is accomplished by initiating each sequence of events with the N counter output. The sequencer generates a number of enable and command signals which are summarized here.

a. API TENS CLOCK ENABLE SIGNALS: These signals enable the TENS CLOCK to update the data in the API registers (bookkeeping system).

b. API COUNTER TENS CLOCK ENABLE: This signal enables the TENS CLOCK to clock the four API counters. These counters are preset each reference period by the four most significant digits of the phase register which keeps a running total of the phase advancement.

c. BIAS COMMAND: This signal turns on the four API current sources to establish a current reference point.

d. PHASE COMMAND: This signal is the Bias command reclocked to TENS CLK and again reclocked to the N.F Loop VCO. It is the signal compared to the reference each reference period by the phase detector.

e. SAMPLE COMMAND: This signal initiates the sample of the integrator output each reference period. Once the integrator has settled following the summation of the phase detector and API signals, the integrator voltage is transferred to the holding capacitor.

8-181. The rate the sequence of events occurs is determined by TENS CLOCK which is the N.F Loop VCO divided by ten. The sequence of events is initiated once each reference period but once initiated, the events occur at a rate determined by the VCO frequency.

8-182. N.F Loop, Simplified Block Diagram.

8-183. Refer to Figure 8-J-5, N.F Loop, Simplified Block Diagram. This diagram illustrates the loop by a heavy line and shows the division between the digital and analog halves of the loop. The basic structure of the loop is shown in Figure 8-35. The major sections of the loop structure are

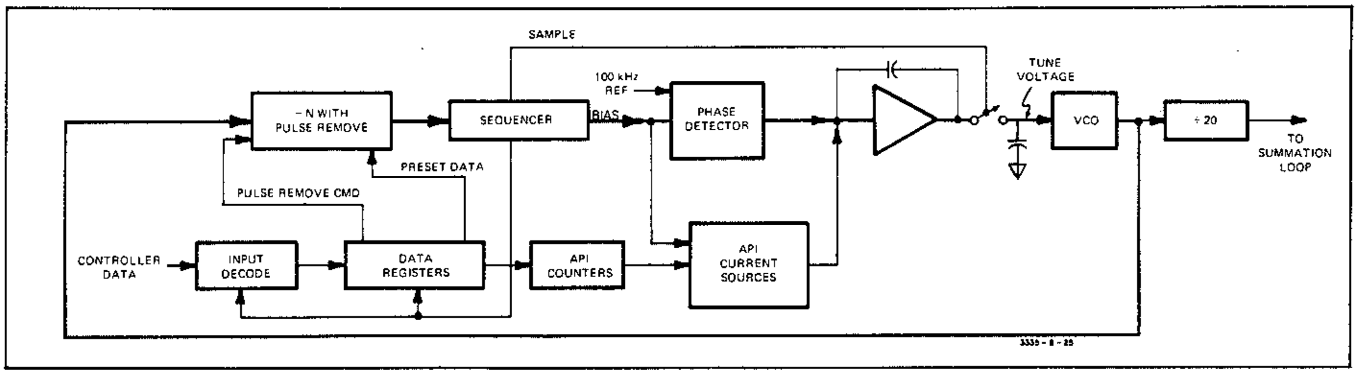


Figure 8-35. N.F Loop, Basic Structure

input decode and data registers, Divide-by-N with pulse remove, sequencer, phase detector, API, integrator, sample/hold and VCO.

8-184. Input Decode. The input decode section interfaces the loop with the data transmitted by the controller. This data includes loop frequency data and instructions which set up the operating modes of the data registers in the phase interpolator. Data register operation is controlled by a steering section.

8-185. Data Registers. The data registers comprise the "bookkeeping" scheme of the phase interpolator. There are three data registers.

a. f_1 frequency register.

b. f_2 frequency register.

c. Phase register.

Only one of the frequency registers is active at a time. The frequency register will always contain the current frequency of operation and this data will be circulated (output connected to input and the data shifted until starting state is reached) once each reference period. The other frequency register will contain the previous frequency of operation and be sitting idle but enabled to accept new data when a new output is programmed.

8-186. The data steering logic controls the operating modes of the f_1 and f_2 frequency registers. The LOAD DATA command enables the idle frequency register to be clocked by the controller line FDC (LOAD DATA CLOCK) to enter a new frequency. During this time the operation of the loop is not interrupted because the circulating frequency register continues operation while data is being loaded. Once the data is entered, the SET FREQ command interchanges the functions of the f_1 and f_2 registers and the new data now circulates to operate the loop at the new frequency.

8-187. Frequency data in the f_1 or f_2 register consists of 16 BCD digits which are loaded least significant digit first. The twelve least significant digits represent the fractional portion of the frequency while the next three digits contain the integer or N portion of the frequency. This accounts for fifteen of the sixteen digits in the f_1 or f_2 register. The sixteenth digit which is the last digit loaded, is not required and therefore is always loaded as a zero. During circulation of the data in the f_1 or f_2 register, this digit is truncated and therefore does not affect the operation of the Loop.

8-188. Each reference period the Divide-By-N counter initiates a sequence of events by triggering the sequencer. Part of the sequence is the enabling of the f_1 or f_2 register clock, the phase register clock and the N register clock. The phase register is clocked for the first twelve digits circulated by the f_1 or f_2 register, the N register for the next three. When the sixteenth digit is circulated by the f_1 or f_2 register, neither phase register or N register is clocked therefore this digit has no affect on the Loop operation. As a result of the sequence of clocking the registers and N register, the phase register quantity has been increased by the fractional component of the f_1 or f_2 register. The N register contains the three N number digits used to preset the Divide-By-N counter.

8-189. The phase register serves two purposes.

a. Records the total phase advancement of the VCO with respect to each reference period.

b. Causes the adder to overflow in the reference period the VCO has advanced a full cycle of phase.

The record of total phase advancement is used each reference period to drive the API section. The four most significant digits of the twelve digits in the phase register are used to preset four API counters. When these counters are clocked by the API clock, they generate an output pulse inversely proportional to the preset number. These four counter outputs drive the API section which develops a signal that counteracts the changing phase detector signal resulting in an unchanging tune voltage. The overflow of the adder indicates the reference period the N.F Loop VCO has advanced a full cycle of VCO phase. The overflow decode triggers the units counter during the pulse remove enable interval of the loop sequence to divide by three for one output pulse of the first stage. Since this stage has been providing an output for every two pulses input (divide-by-

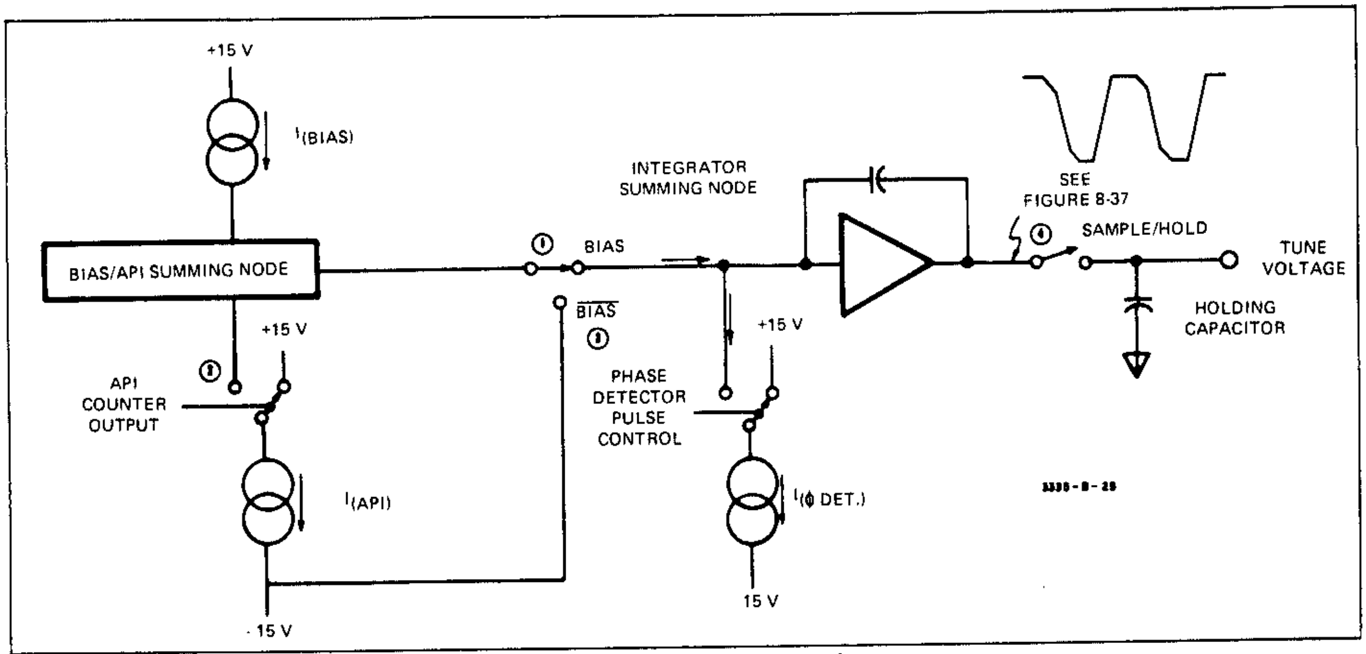


Figure 8-36. N.F Loop Integrated Currents.

two) it effectively has removed a VCO cycle by dividing by three for one output pulse. The cycle of phase the N.F Loop VCO has advanced has been removed and the phase relationship of the N.F Loop VCO and N times the reference is reset.

8-190. Analog Phase Interpolator (API). The API section consists of two parts.

a. The API counters.

b. The API current sources.

All API current sources are turned on by the BIAS command each reference period. The four most significant digits of the phase register preset the API counters which control when each of the four API current sources turn off. The smaller the phase register digits, the longer the API current sources are on.

8-191. Phase Detector. The phase detector compares the sequencer output "BIAS" with a 100 kHz reference signal. The BIAS signal is first reclocked to TENS CLOCK (VCO/10) and then to the N.F Loop VCO signal itself. If the N.F Loop VCO is operating with a fractional component, the reclocked BIAS signal applied to the phase detector gains phase each reference period with respect to the reference signal. The output applied to the integrator is an increasing voltage. The purpose of the API section is to negate the effects of the increase in the phase detector output.

8-192. Tune Voltage Generation. The method used to generate the N.F Loop VCO tune voltage is similar to that used in the N Step Loop. Currents are integrated and the integrated voltage is transferred to a holding capacitor.

8-193. A block diagram of the currents integrated by the N.F Loop in a phase-locked condition is shown in Figure 8-36. Figure 8-37 illustrates the integrator waveform showing the contributions of the different currents. A constant current source, I (BIAS), supplies current at all times to the BIAS/API summing node. The BIAS command from the sequencer goes high each reference period to connect this node to the integrator summing node. Following the BIAS command, the phase register data causes the API current source to draw current from the BIAS/API summing node and therefore keeps this current from being integrated. The amount of API current is determined by the magnitude of the phase register number. Larger numbers in the phase register cause the API current sources to be connected to the node for less time. Once the BIAS event has occurred and the BIAS/API summing node is disconnected from the integrator summing node, the phase detector pulse occurs and draws current out of the integrator summing node. When the Loop is phase-locked, the current entering the integrator node from the BIAS/API current sources is equal to the current drawn out

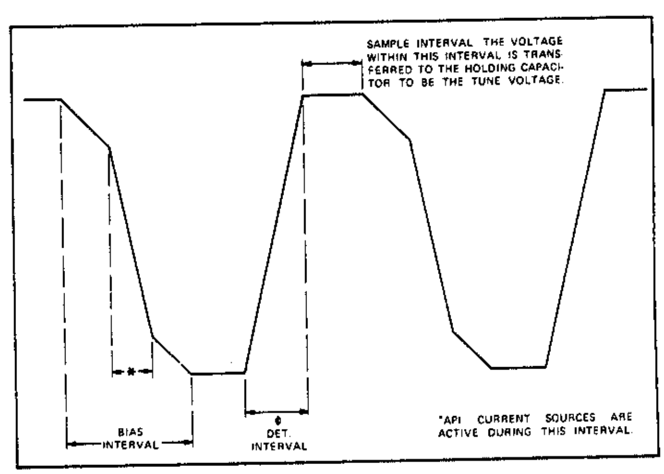


Figure 8-37. N.F Loop Integrated Currents.

by the phase detector current source and the integrated voltage remains a constant value. After integrating the two currents, the voltage is transferred to a holding capacitor and becomes the tune voltage.

Sequence of Events:

a. BIAS/API summing node is connected to the integrator and BIAS current integrated.

b. API current source is connected to BIAS/API summing node decreasing the amount of BIAS current integrated.

c. BIAS/API summing node is disconnected and phase detector is connected to integrator. Phase detector current is integrated.

d. After the phase detector current has been integrated and the voltage settled, the voltage is transferred to a holding capacitor. This voltage is the N.F Loop VCO tune voltage.

NOTE

When phase-locked, the BIAS/API current is equal to the phase detector current. The API current tracks the increasing phase detector current cancelling the fractional component of VCO phase.

8-194. Refer again to Figure 8-J-5, N.F Loop, Simplified Block Diagram. Assume that the loop operates without a fractional component (data in the phase register remains constant). The loop can be viewed as just a N Step Loop with an elaborate method of developing the tune voltage. The data in the phase register is constant therefore, the API current sources are sinking the same amount of current from the BIAS/API summing node each reference period. Since the current entering the integrator from the BIAS/API summing node is always a constant value, the phase detector changes the tune voltage just as it does in the N Step Loop. A change in the phase relationship causes the phase detector pulse to change in duration which changes the amount of current the phase detector source draws from the integrator. The result is a change in the integrated voltage after this reference period and therefore the tune voltage has been changed. The direction of change is such that the N.F Loop VCO is pulled back into a phase-locked condition.

8-195. Sample/Hold. The SAMPLE command from the sequencer transfers the integrated voltage to the holding capacitor at the appropriate period of the integrator output. This period occurs after the BIAS/API summing interval and the phase detector interval have occurred and the integrator output has returned to an unchanging value. This value is the tune voltage.

8-196. Increase Frequency Current Source. The increase frequency current source is shown on the simplified block diagram, Figure 8-J-5. This current source is also connected to the integrator summing node and is responsible for rapidly changing the tune voltage if a large frequency increase in frequency is programmed, the phase detector connects this current source to the integrator in place of the phase detector current source. Instead of sinking current from the integrator, the current source drives current into the integrating node to add to that current already supplied by the BIAS/API interval. This causes the tune voltage to change quickly and change the N.F Loop VCO frequency rapidly. Once the newly programmed frequency had been reached, the phase detector again begins operation using the phase detector current source.

8-197. Divide-By-Twenty. The N.F Loop VCO signal is divided by twenty before it is applied to the Summation Loop. The purpose of operating the N.F Loop VCO at twenty times the required frequency is to aid in spur attenuation and reduce phase noise.

8-198. N.F Loop, Detailed Theory.

8-199. This section of the N.F Loop theory provides a detailed discussion of various parts of the loop. Parts from both the digital and analog sections are presented.

8-200. Input Decoding.

8-201. Input decoding consists of two latches (U16, U17) and three quad input NAND gates (U14, U15). See Figure 8-J-3, N.F Loop Digital Schematic Diagram. Controller data consists of either frequency data to load into a frequency register (U34, 35, 44, 45 or U54, 55, 64, 65) or op code data which establishes the operating mode of the frequency registers. When op code data is transmitted it is latched into U17 by controller command by Line FIV (Instruction Valid). During each sequence of operations by the loop, the second latch, U16, is clocked and data from U17 is again latched. This synchronizes any new op code with the loop sequencer. The four-line op code is decoded by NAND gates U14 and U15 to generate three instruction signals (PHASE BUMP, SET FREQ and LOAD DATA).

8-202. Data Steering.

8-203. The three instruction signals from input decoding drive the data steering section consisting of flip-flops U13 and U23 and NAND gates U24, U25 and U26. The steering outputs control the data flow into and out of the frequency registers. Recall that only one of these registers is active at any time. The steering allows TENS CLOCK to clock only the register containing the current frequency data during any sequence interval. The idle register can be clocked by the LOAD DATA CLOCK (FDC) when the steering gates receive the LOAD DATA signal indicating a new frequency is about to be entered. The controller clocks in all digits of the new frequency with line FDC. It then sends an op code which causes the SET FREQ instruction line to go high resulting in the following.

a. U23 Pin 3 is clocked causing the two frequency registers to interchange their operating roles. The TENS CLOCK now clocks the register containing the new data.

b. The register inputs (D_0 and D_1) change connections as they interchange roles. The register with new data connects to its circulating inputs, (D_0), the register idled connects to the input lines ready to accept the next data input (D_1).

c. The multiplexer connects the register circulating the new data to the adder.

8-204. The third instruction signal is PHASE BUMP and is activated when a phase increment is made. PHASE BUMP also causes the frequency registers to interchange roles but only for a fixed amount of time and they revert back to the original roles. The phase increment is introduced by changing the output frequency for the fixed period to a value that gives the desired phase increment when the registers revert to their original roles.

8-205. Phase Register.

8-206. The phase register is a 12 digit register comprised of U22, U32, U33, U42, U12 and U52. The four most significant digits are stored by discrete quad D flip-flops. The outputs of these four flip-flops are used to preset four decade counters (U11, U21, U31 and U41). The counters set the outputs of four RS flip-flops (U51, quad RS flip-flop). These flip-flops are reset at the same time, therefore, the counters determine the pulse width of the RS flip-flop output. These outputs are applied to the API Section of the loop.

8-207. The phase register circulates its data to a BCD adder (U43). This data is added to data from the frequency register and entered back into the phase register. A carry flip-flop (U62) driven by the adder allows decade expansion.

8-208. ÷ 2/÷ 3 (Pulse Remove) Counter.

8-209. The ÷ 2/÷ 3 counter is comprised of four JK flip-flops (See Figure 8-38). The counter normally divides by two. The last flip-flop (U76 Pins 1-3, 5) has the J input connected to + 5 V and normally the K input is also held high. The remaining three flip-flops normally are in a steady-state condition. If a pulse is to be removed, the counter is made to give an output for three input pulses instead of two and then reset to a normal divide-by-two.

8-210. Divide-by-two results since the final flip-flop is in a toggle mode when both J and K are high. Each high-to-low transition of the VCO signal, the counter output changes states. To trigger the counter, a high-to-low transition must clock the first flip-flop (U77 Pin 1). The resultant waveforms of the ÷ 2/÷ 3 counter and the "removal" of a pulse by ÷ 3 is shown in Figure 8-39.

8-211. Presettable ÷ 5 counter.

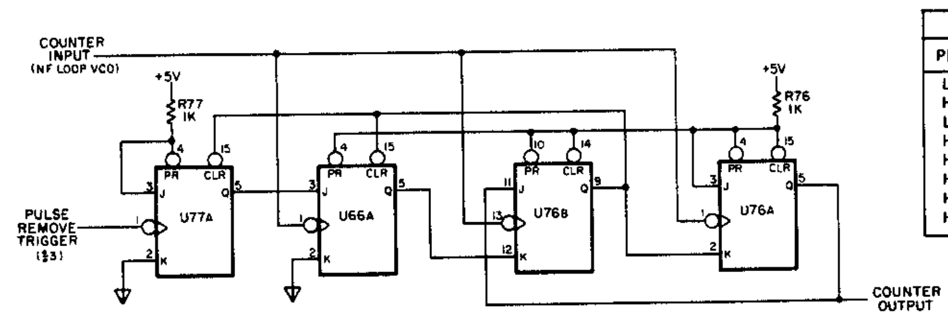
8-212. The presettable ÷ 5 counter works in conjunction with the ÷ 2/÷ 3 to provide the first decade. The ÷ 5 counter consists of JK flip-flops U86 and U96. It is preset by the 8, 4 and 2 - bits while the 1 - bit is applied to a NOR gate (U87B) which is part of the pulse remove trigger decode (See Figure 8-40). The pulse remove trigger causes the ÷ 2/÷ 3 counter to ÷ 3 for the next three input pulses and then revert back to a ÷ 2 counter.

8-213. The pulse remove trigger is initiated by a phase register overflow or by the preset signal of the ÷ 5 counter if the 1 - bit is low. The 1 - bit is low for odd N numbers since the 8, 4, 2 and 1 - bits are the nines compliment of the N number. When the 1 - bit is low (odd N number), the NOR gate it is applied to in the pulse remove trigger is enabled triggering a divide-by-three by the ÷ 2/÷ 3 counter reverts to a divide-by-two after three input pulses.

8-214. Summarizing the operation of the first decade, the combination ÷ 2/÷ 3 and ÷ 5 counters normally operate as ÷ 2 and ÷ 5 to provide a ÷ 10 (decade). If one VCO cycle is to be removed, the phase register overflow triggers the ÷ 2/÷ 3 counter to count three pulses for an output and then revert to a divide-by-two (See Figure 8-39). To obtain an odd modulus for the N counter, the ÷ 2/÷ 3 is triggered to count three pulses for the initial output of the counter then revert to a ÷ 2 counter thereby obtaining an odd count.

8-215. Sequencer.

8-216. The sequencer is comprised of two 10 - bit shift registers (U71 and U81), eight exclusive OR gates (U61 and



J-K FLIP-FLOP TRUTH TABLE

INPUTS					OUTPUTS	
PR	CLR	CLK	J	K	Q	$\overline{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H*	H*
H	H	↓	L	L	Q_0	$\overline{Q}_0$
H	H	↓	H	L	H	L
H	H	↓	L	H	L	H
H	H	↓	H	H	TOGGLE	
H	H	H	X	X	Q_0	$\overline{Q}_0$

* NOT A STABLE CONDITION
Q_0 = THE LEVEL OF Q BEFORE THE INDICATED INPUT CONDITIONS WERE ESTABLISHED.

Figure 8-38. ÷ 2/÷ 3 (Pulse Remove) Counter.

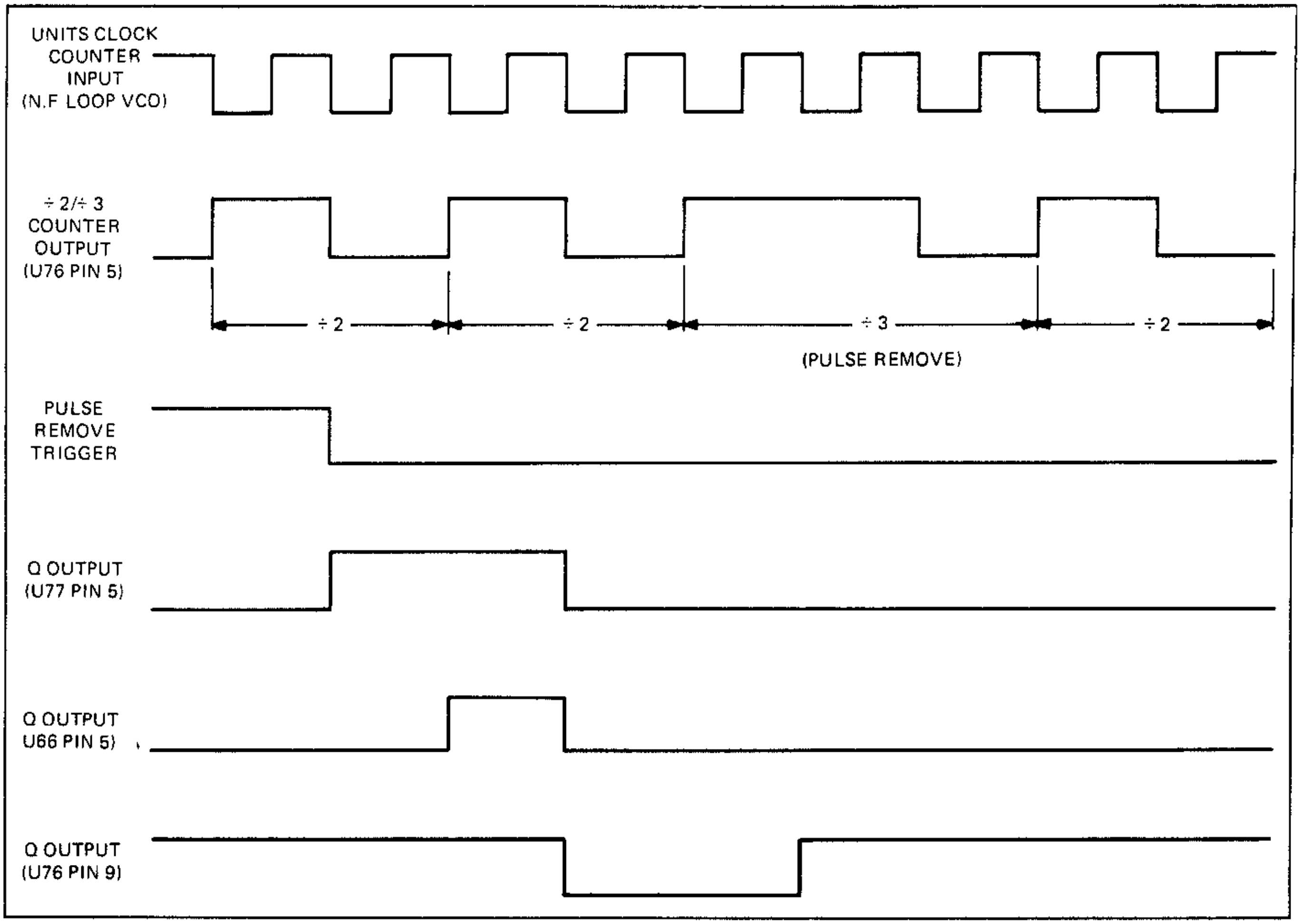


Figure 8-39. ÷2/÷3 (Pulse Remove) Counter Waveforms.

U72) and one OR gate (U93). Both 10 - bit shift registers are clocked by TENS CLOCK so the shift rate is dependent on the VCO frequency. The shift register outputs are set low by the RESET line. A high signal at the input to U81 (Pin 10) causes the high abate to shift through the registers changing all outputs to high. As the outputs fill with high states, the exclusive OR gates provide high outputs when their inputs are of opposite states. The next sequence the same events occur as the 10 - bit shift registers fill with lows.

8-217. N.F Loop VCO.

8-218. Refer to Figure 8-J-4, Fractional N Analog Schematic Diagram. The VCO is comprised of an oscillator, output buffers and an amplitude detector for automatic gain control. A tank circuit consisting of L7, C48, CR34 and CR35 determine the frequency of operation. CR34 and CR35 are varactors to which the tune voltage is applied. CR33 prevents forward biasing the varactors. The oscillator output is coupled by C49 to a source follower (Q55) which prevents loading of the tank circuit. Positive feedback is transmitted from Q55 through C54 to the emitter of Q54.

8-219. The N.F VCO Loop output is buffered by transistors Q57 - Q60. The collector of Q58 transmits a rf signal to the base of Q61 which comprises an amplitude detector. The amplitude detector controls the bias of the oscillator transistor Q54 and provides automatic gain control. This helps to level the oscillator output signal.

8-220. After the oscillator output is transmitted through the buffers, it is preamplified and transmitted to two locations. First it is converted to TTL and applied to the divide-by-N counter section on the digital assembly to complete the loop. Secondly, the N.F Loop VCO output is applied to a divide-by-twenty and transmitted to the Summation Loop. Because the N.F Loop VCO operates at twenty times the output transmitted to the Summation Loop, less phase noise is present and greater spur attention is acheived.

8-221. The oscillator, buffers and amplitude detector are powered from a private + 10 V power source (U5 and Q53) to reduce noise in the N.F Loop VCO output. The + 10 V supply voltage is derived from the + 15 V regulated output of the power supply section.

8-222. Phase Detector.

8-223. The phase detector section consists of a phase detector unit (U3) and the UP (Q3, 4, 6 and 7) and DOWN

(Q5) drive circuits. The phase detector unit operates as described in the N Step Loop discussion. It compares the N.F Loop VCO divided-by-N.F to a 100 kHz reference transmitted by the Reference Section. In a phase-locked condition, the UP drive circuit is active while the DOWN circuit is inactive. The UP circuit is connected to the phase detector/API 1 current source (U2 Pins 1, 3 and 5) through CR11 following the BIAS interval (the source of current is the + 15 V supply through Q6 and CR27 before the phase interval).

8-224. As the phase detector unit generates a pulse each reference period, it causes a low-going pulse at the emitter of Q6 which reverse-biases CR11 for the period of the pulse. When CR11 is reverse-biased, CR12 is forward biased connecting the phase detector/API 1 current source to the integrator summing node. For the period of the phase detector unit's pulse, the API 1 current source sinks current from the integrator summing node causing the integrator output to ramp up. In a phase-locked condition with no fractional component of frequency, the amount of current drawn from the integrator summing node is equal to the current driven into the node during the bias interval.

8-225. If the N.F Loop VCO frequency is required to increase a large amount, the DOWN drive circuit becomes active driving current into the integrator summing node during the phase detector unit's pulsing of the DOWN outputs. Both this current and the bias current enter the integrator summing node causing the integrator output to ramp down rapidly. The decrease in voltage increases the N.F Loop VCO frequency. Once the N.F Loop VCO frequency has reached the approximate programmed frequency of operation, the DOWN outputs of the phase detector unit become inactive and the UP outputs control the UP drive circuit to phase-lock the loop.

8-226. API (Analog Phase Interpolator).

8-227. The API Section consists of five current sources; BIAS, I, I/10, I/100 and I/1000 (See Figure 8-41). On the N.F Loop Analog Schematic Diagram Figure 8- , these current sources are Q14 and Q16, comprising the BIAS and I/1000 current sources and an integrated circuit, U2, comprising the I/100, I/10 and I current sources. The current sources except for BIAS, are controlled by API Lines 1 through 4. API 1 controls the I source, API 2 the I/10, API 3 the I/100 and API 4 the I/1000 source.

8-228. The BIAS current source draws current from a "current mirror" comprised of Q11 and Q12. A current mirror has the characteristic that the current drawn from one port (Q11) is duplicated by the other port (Q12). Therefore, the BIAS current source (Q14) established the current from Q12 of the current mirror entering the BIAS/API current summing node. The BIAS current is a fixed magnitude of 0.25 mA.

8-229. The BIAS current entering the BIAS/API current summing node has two paths to leave the node. One is through Q24 which acts as a source follower. The second path is the four API current sources. The current through Q24 equals the BIAS current except when the API current sources are connected to the summing node by the API 1 through API 4 logic. The current through Q24 then equals the BIAS current less the current drawn by the API current sources. During the BIAS current less the current drawn by the API current sources. During the BIAS interval (which includes the period the API current sources are connected to the summing node), the output of Q24 is connected to the integrator summing node. The API current sources reduce the amount of current entering the integrator summing node. This cancels the effects of the enlarging phase detector pulse when the N.F Loop VCO operates with a fractional component of frequency.

8-230. Each reference period Q24 is connected to the integrator summing node through CR8. When CR8 is on during the interval of the bias pulse, Q27 is enabled by Q26. The bias pulse from the digital assembly causes Q26 to enable Q27. This allows the API 1 current source to be connected to the BIAS/API current summing node when the API 1 line is pulsed by the digital assembly. Also the bias pulse causes Q25 to reverse-bias CR20. This leaves only the CR8 path and the current from Q24 must enter the integrator summing node.

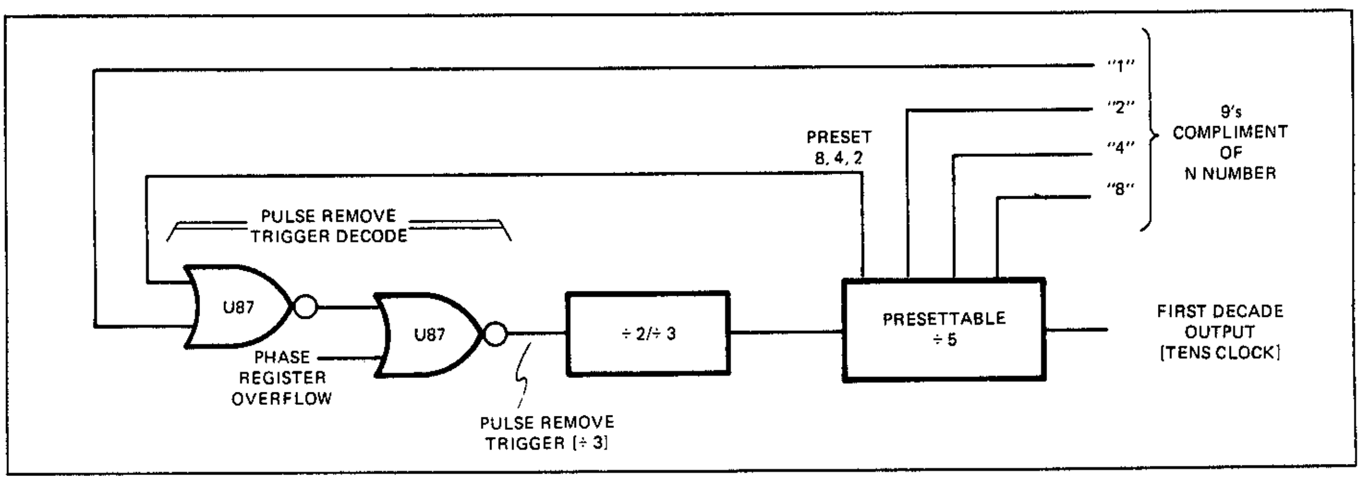


Figure 8-40. First Decade (Units) Counter with Pulse Remove Trigger Decode.

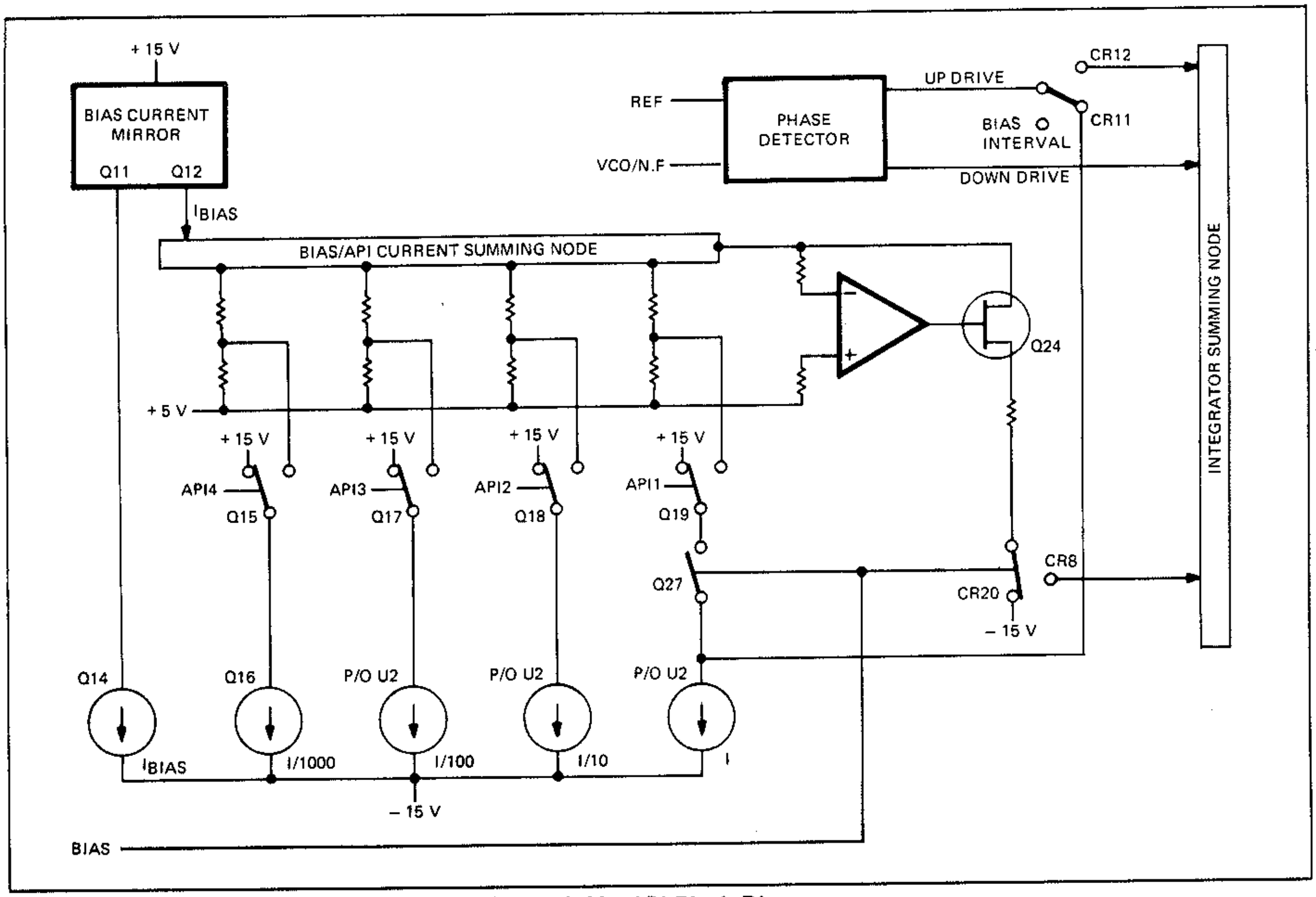


Figure 8-41. API Block Diagram.

8-231. After the bias pulse has occurred (BIAS line goes low), Q25 forward-biases CR20 and reverse biases CR8 connecting Q24 to the - 15 V supply. Q26 turns off Q27 which forward-biases CR11 connecting the API 1 current source to the integrator summing node for the duration of the pulse. For this interval, current is drawn from the integrator summing node. In a phase-locked condition, the current drawn from the integrator summing node through CR12 equals that driven into the node through CR8.

8-232. Integrator.

8-233. The integrator is a discrete component operational amplifier consisting of Q35 through Q43. The integrating capacitor is C26. The integrator sums the BIAS/API current and the phase detector current to generate the time voltage.

8-234. Sample and Hold.

8-235. The purpose of the Sample and Hold circuit is to transfer the integrator voltage present after the summation of currents has occurred, to the holding capacitor. This dc voltage is then applied to the N.F Loop VCO as the time voltage. The Sample and Hold section consists of transistors Q44 through Q52. Q46 and Q47 are the switching FET's turned on for the sample period. Capacitors C30 and C31 are the holding capacitors. Two holding capacitors are used with the sampling transistors being switched simultaneously to provide better isolation. The switching of Q46 is controlled by Q44 and Q45 while Q47 is controlled by Q49 and Q50. Transistor Q48 provides the current for Q47, 49 and 50 and also generates the voltage for the guard trace surrounding C30, C31 and R117. The transistor pair Q51 and Q52 provide the drive signals for switching during the sample interval. This pair is controlled by the SAMPLE logic line from the N. F Loop Digital Assembly.

8-236. Following the second holding capacitor is a unity gain voltage follower (U4). This stage provides isolation and a low output impedance. The output of this amplifier is the tune voltage applied to the N.F Loop VCO. Feedback from this output is applied to the integrator summing node through C25 and R91 for loop stabilization.

8-237. Summation Loop (Service Group K).

8-238. The final operation of the frequency synthesis section is the summing of the N Step Loop and N.F Loop outputs. This summation generates a signal of 40 to 80 MHz which is transmitted to the Divider-Filter Section. Refer to the Summation Loop Block Diagram, Figure 8-K-2, and the Schematic Diagram, Figure 8-K-1.

8-239. Since the Summation Loop VCO operates at a sum of two frequencies, a distinct characteristic of this VCO is that it always be operating at a higher frequency than the

N.F Loop and the N Step Loop VCO's. Because the ranges of the three phase-locked loops of the Frequency Synthesis Section are 1-2 MHz for the N.F Loop, 39-79 MHz for the N Step Loop and 40-80 MHz for the Summation Loop, the only concern is that the Summation Loop VCO operate at a higher frequency than the N Step Loop VCO since these have nearly the same operating range. A fall out of having nearly the same operating range is the two phase-locked loop designs are similar. A comparison of the block diagrams and schematic diagrams for the N Step Loop and Summation Loop reveals the only difference in the two loops is in the phase detector sections. The discussion presented in the N Step Loop description for components other than the phase detector, also applies to the Summation Loop. Because of this similarity, the remainder of the Summation Loop discussion is concentrated on the phase detector section and the development of the Summation Loop VCO tune voltage.

8-240. The Summation Loop is comprised of a VCO, three isolation buffers, the phase detector and current sources and a low-pass filter. Each section is as described in the N Step Loop discussion except the phase detector. The discussion of this portion of the Summation Loop follows.

8-241. The part of the phase detector which drives the complimentary current sources is shown in Figure 8-42. It consists of a mixer (U1), low-pass filter (C5, C6 and L4), amplifier (Q24), a signal squarer (U4), phase detector (U5), peak detector (U4), rate detector (U2, U3, U6 and U7) and gates (U8 and U9) to generate the UP and DOWN signals controlling the complimentary current sources.

8-242. Two separate VCO signals are transmitted to complete the Summation Loop. One signal is applied to the mixer, the other is applied to the rate detector. The mixer mixes the Summation Loop VCO signal with the N Step Loop VCO signal and the difference is transmitted to a 4 MHz low-pass filter. Since the Summation Loop VCO operates at the sum of the N Step Loop and N.F Loop VCO's, the difference signal from the mixer is equal to the N.F PLL signal. The difference signal is passed through the LPF and amplified by Q24. It is then coupled through C6 to two stages of signal squaring (U4). The complimentary outputs of the second stage of signal squaring are applied to the phase detector and the peak detector. The squared difference signal is equal in frequency to the N.F Loop signal and the two are compared by the phase detector. When the loop is phase-locked, the peak detector and rate detector enable the UP/DOWN gates and the phase detector outputs control the current sources much like the N Step Loop phase detector.

8-243. When the N number of the N Step Loop is changed, the peak detector (CR1, CR2 and U4) and rate detector (U2, 3, 6 and 7) establish fixed states on the UP/DOWN lines. Holding fixed states on the UP/DOWN line causes the Summation Loop VCO frequency to change rapidly in a direction approaching the frequency of the N Step Loop plus N.F Loop. The Summation Loop responds to changes in the N Step Loop output by action of the peak and rate detectors.

8-244. The rate detector compares the VCO frequency to the N Step Loop VCO output to ensure the VCO is faster than the N Step Loop. If the N number of the N Step Loop is increased, the N Step Loop output is increased and is greater than the Summation Loop VCO. The rate detector output which is normally low to enable the OR/NOR gates, now goes high and fixes the output of the gates. This operates the current sources in such a way to draw current out of the integrating capacitor (C45) and decrease the tune voltage. A decrease in tune voltage increases the VCO frequency (See Figure 8-18). This action takes place until the VCO reaches a frequency faster than the N Step Loop. Here the rate detector again enables the OR/NOR gates and the phase detector controls the tune voltage in a phase-locked condition.

8-245. The rate detector consists of dual differential amplifiers (U2), two D master slave flip-flops (U3), a phase

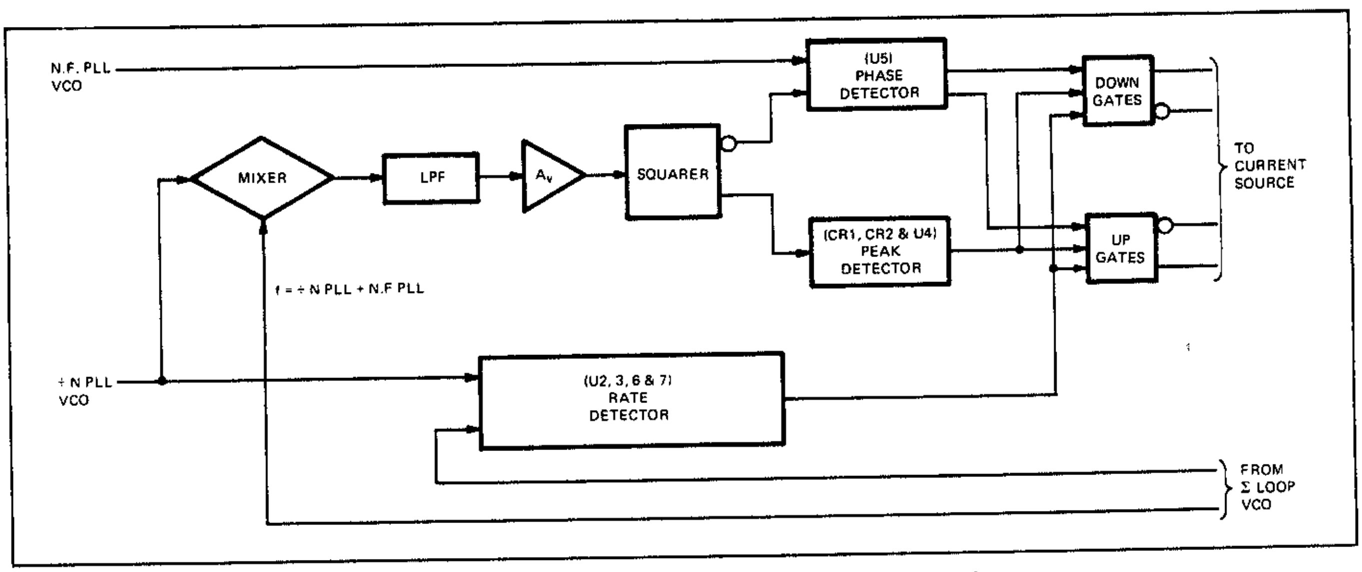


Figure 8-42. Phase Detector Current Source Control.

detector (U6) and two set - reset flip-flops (U7). The amplifiers clock the D flip-flops which drive the two inputs of the phase detector (R and V). When the V input leads the R input, the U output is low and the D output toggles to establish a low state at the output of the dual R - S flip-flops. This enables the OR/NOR gates controlling the current sources. If the R input begins to lead the V input of the phase detector, the D output goes low and the U output toggles to establish a high at the output of the R - S flip-flops. This fixes the output states of the OR/NOR gates controlling the current sources which change the tune voltage to increase the VCO frequency. Once the VCO is increased enough for the V input to lead the R input again, the R - S flip-flop state changes to enable the OR/NOR gates and the loop is phase-locked.

8-246. The peak detector also provides fixed outputs of the OR/NOR gates but are opposite of those fixed by the rate detector slowing the Summation Loop VCO down. This action is required when the N number of the N Step Loop is decreased by a large amount. When this happens the N Step Loop frequency decreases and the output of the Summation Loop Mixer (the difference signal) exceeds the cut-off frequency of the low-pass filter. There is no signal output from the filter to the amplifier and signal squarer. The absence of a signal at the peak detector causes its output to change from a low to a high which disables the OR/NOR gates fixing the outputs. This fixes current flow by the current sources to drive current into the integrating capacitor and increase the tune voltage. As a result, the Summation Loop VCO output decreases in frequency. When the signal comes within range to pass a signal through the LPF, the peak detector output goes back to a low state enabling the OR/NOR gates. The loop is then phase-locked by the outputs of the phase detector.

8-247. The OR/NOR outputs drive level shifting transistors to convert ECL to the levels needed by the switching transistors which control the action of the current sources. Current flow at the summing node to the LPF is routed through the integrating capacitor, C45, as described for the N Step Loop.

₰-248. Divider-Filter and Mixer Sections (Service Group L).

8-249. The Divider-Filter and Mixer Sections work in conjunction with each other to develop the 200 Hz to 80 MHz signal that is transmitted to the Output Amplifier Section. Only one of the two sections transmit at any time dependent on the frequency selected. The Mixer, activated by Divider-Filter logic, transmits the hand of frequencies from 200 Hz to less than 10 MHz. The Divider-Filter transmits the band of frequencies from 200 Hz to less than 10 MHz. The Divider-Filter transmits the band of frequencies from 10 MHz to 80 MHz. When in this high frequency band, the Divider-Filter logic deactivates the Mixer Section.

8-250. Divider-Filter Section (Service Group L).

8-251. The Divider-Filter Section performs four major functions.

a. It routes the 40 - 80 MHz signal generated by the frequency synthesis section to the required divider or to the Mixer Section dependent on the output frequency selected.

b. It divides the 40 - 80 MHz synthesized signal if an output between 10 MHz and 40 MHz is selected.

c. When the Divider-Filter Section is transmitting to the Output Amplifier, it controls the amplitude of the transmitted signal according to a level control signal.

d. It activates one of six low-pass filters (LPF) and provides additional 80 MHz low-pass filtering.

8-252. The Divider-Filter is comprised of a preamp, divider gating, a three-to-seven line decoder, TTL-to-ECL translator, two dividers, modulator, low-pass filter bank and an 80 MHz low-pass filter. The decoder provides seven instruction lines from three Controller Data lines. Six of the seven instruction lines control the low-pass filters, activating the filter corresponding to the selected frequency of operation. The seventh instruction line activates the modulator in the Mixer Section. All seven lines are again decoded by quad NOR gates to generate four TTL enable lines. One of there lines activates the modulator of the Divider-Filter. Each of the four TTL enable lines are converted to ECL to perform two functions.

a. Activate the mixer of the Mixer Section when the output is between 200 Hz and 10 MHz.

b. Controls the routing of the 40 - 80 MHz synthesized signal by enabling the appropriate divider gate.

8-253. The 40 MHz to 80 MHz signal from the Frequency Synthesis Section is preamplified by U6 (See Figure 8-L-1 Divider-Filter Schematic). This amplifier contains a single-ended coupled input. It isolates the noise generated by the divider gate (U7) from the Frequency Synthesis Section. The preamplified ECL signal is transmitted to the divider gate which consists of four NOR gates. The input of each NOR gate is connected in parallel to the preamplified signal. These gates control the routing of the synthesized signal routing it to the appropriate divider or to the Mixer Section dependent on the output frequency selected.

8-254. Activation of the NOR gates in the divider gate, U7, is accomplished by use of four ECL enable lines. At any one point in time, only one NOR gate is activated and the remaining three gates are disabled. Each of the four NOR gates operate over a particular frequency range, < 10 MHz, 10 MHz to < 20 MHz, 20 MHz to < 40 MHz and 40 MHz to 80 MHz. The enable signal is developed from a three-line processor instruction (FS1, FS2 and FS3). The three line code is TTL and is converted to a seven-line TTL instruction. The seven lines are buffered to provide the drive capability necessary to drive the TTL-to-ECL converter and the switches of the low-pass filter bank. The four ECL lines produced comprised the enable signals for the

divide gate. When NOR gate D of the divider gate is enabled routing the signal to the Mixer Section, the Divider-Filter modulator is turned off by the DIV-FIL Modulator control.

8-255. Each gate (A, B, C or D) in the divider gate is activated for a particular band of frequencies. A 40 MHz to 80 MHz selected output causes the synthesized signal to be routed through gate A (top NOR gate of U7) and is transmitted directly to the Divider-Filter modulator. A selected output of 20 MHz to < 40 MHz routes the synthesized signal through gate B (second NOR gate from top of U7) to a divide-by-two which provides the selected frequency to the Divider-Filter modulator. A selected output of 10 MHz to < 20 MHz routes the synthesized signal through gate C (third NOR gate from top of U7) to a divide-by-four which provides the selected frequency to the Divider-Filter modulator. The last situation is a selected output less than 10 MHz. The Divider-Filter Section does not generate signals less than 10 MHz but routes the synthesized 40 to 50 MHz signal to the Mixer Section through gate D (bottom NOR gate of U7). For a selected output less than 10 MHz, the Mixer Section is activated and the Divider-Filter modulator deactivated. The Mixer mixes the 40 to 50 MHz signal routed from the Divider-Filter with the 40 MHz signal transmitted from the Reference Section. The resulting difference is the desired signal less than 10 MHz.

8-256. For signals greater than 10 MHz, the Mixer is deactivated and the Divider-Filter generates the signal transmitted to the output amplifier. From the dividers, the synthesized signal is applied to the Divider-Filter modulator, differential pair Q2 and Q3. The supply voltage for the differential pair is derived from the combination of U11 and Q1. The amplitude of signals at the modulator output is regulated by a current source consisting of transistor Q6. The level of current is controlled by controlling the base current with Q5, all dependent on the level control voltage of the leveling loop. By controlling the current source, the level control voltage controls the output amplitude of the modulator. The gain slope of the modulator is adjusted by potentiometer R37 (MOD LEVEL ADJ) in the base circuit of the current source. Another gain slope adjustment is present in the mixer modulator (A7R24). The adjustments provide a means to obtain identical gain slopes in both the Mixer and Divider-Filter modulators. Since the same level control signal is applied to both modulators, each modulator responds in the same manner to the signal. Active control of the Divider-Filter modulator (ON/OFF) is accomplished by deactivating the current source. This is done by switching transistor Q4 under control of the DIV-FIL MODULATOR CONTROL line from the Decoder (U4).

8-257. The Divider-Filter modulator output is ac coupled to a low-pass filter (LPF) bank and a final 80 MHz low-pass filter. The input to the LPF bank is maintained at zero volts dc by inductor L4 from TP1 to ground. Only one of the low-pass filters of the LPF bank is activated at a time. Each filter operates over a particular range of frequencies which is indicated on the block diagram and above each filter on the schematic. For the 56 MHz to 80 MHz range, the signal is switched through and filtered by the final 80 MHz LPF. To control the activation of the bank, each filter contains an electronic switch controlled by one of six TTL lines (LPF 14, 20, 28, 40, 56 and 80) from the three line-to-seven-line decoder (U1). The seventh line MIXER MODULATOR CONTROL activates or deactivates the mixer modulator.

8-258. Each low-pass filter in the LPF bank is activated or deactivated by series switching diodes which are present at both ends of each filter. When these diodes are reversed biased, the filter is inactive. When the diodes are forward biased, the filter is active.

8-259. The bias of the switching diodes is controlled by a current source. Each switching circuit contains three transistors: a current source, a drive transistor and a switching transistor. All filter bank switching transistors are on but one. This is determined from the logic lines of buffers U2 and U3 (See Figure 8-43). When a switching transistor is off it turns the drive transistor on which activates the current source. The current source has two

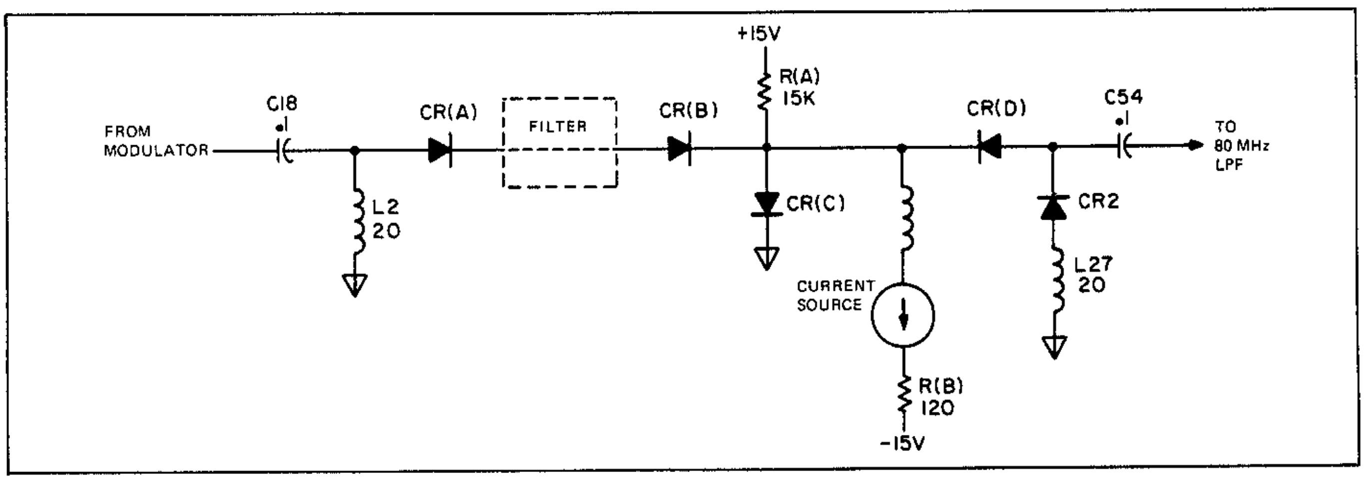


Figure 8-43. LPF Bank Switching.

states, off or full on (approx. 80 mA). It is these states which activate or deactivate the filter.

8-260. Each switch in the LPF bank operates alike. The following discussion describes how these switches operate. Refer to Figure 8-43, LPF Bank Switching. This figure illustrates the dc paths of the filter and associated components. The filter itself contains three series inductors between the switching diodes CR(A) and CR(B). Inductors L4 and L36 and diodes CR(A) and CR(B) represent a short to dc. When the current source is off, diode CR(C) is forward biased while all others are reversed biased. The bias voltage of CR(C) at the junction of CR(B) and CR(D) reverse biases all other diodes. Since diodes CR(A) and CR(B) are not conducting, the synthesized signal coupled through C22 is not transmitted through the filter.

8-261. When the current source is turned on, it operates at approximately 80 mA. This fixes the dc voltage at the junction of CR(B) and CR(D) at approximately two diode drops plus the inductor voltage which reverse biases CR(C) and forward biases all other diodes. The synthesized signal is now transmitted through the filter and coupled through C75 to a final 80 MHz low-pass filter before it is transmitted to the output amplifier. Note the balance at each end of the switch, CR(A), CR(B) and L4 are balanced by CR(D), CR43 and L36.

8-262. Mixer (Service Group L).

8-263. The Mixer performs two major functions.

a. It mixes the 40 MHz to < 50 MHz signal routed from the Divider-Filter with a 40 MHz reference signal. This develops a signal in the frequency band of 200 Hz to < 10 MHz which is transmitted to the output amplifier.

b. It provides dc level control to ensure the output amplifier signal applied to the attenuator has no dc component.

8-264. The Mixer Section is controlled by two logic lines from the Divider-Filter assembly, a MIXER MODULATOR CONTROL line and a MIXER CONTROL line. Both control lines activate or deactivate their associated component (the modulator or mixer). Both the mixer and mixer modulator in the Mixer Section are turned off when the Divider-Filter is providing the 10 to 80 MHz signal to the output amplifier. When a signal less than 10 MHz is selected, the mixer and mixer modulator of the Mixer Section are activated. At the same time the Divider-Filter modulator is deactivated. The Mixer Section now generates the sinusoidal signal which is applied to the output amplifier.

8-265. The signal generated by the Mixer Section is the difference of two mixed signals. One signal is a stable 40 MHz signal from the Reference Section. The signal it is mixed with is the 40 to 50 MHz signal routed by the divider gate in the Divider-Filter Section. This signal is the preamplified, synthesized signal originating from the Frequency Synthesis Section. It is routed through mixer control gates before being applied to the mixer.

8-266. The 40 MHz reference signal is first applied to the Mixer modulator. This modulator consists of a differential pair (Q6 and Q7) whose output amplitude is controlled by a current source (Q8) in the emitter circuit. The Mixer modulator in essence, is the same as the Divider-Filter modulator (A2Q2, Q3 and Q6). The Mixer modulator has a gain slope adjustment (R24) in the base circuit of the current source. Switching transistor Q4 turns the current source ON or OFF based on logic from the MIXER MODULATOR CONTROL line of the Divider-Filter Section. The Mixer modulator is responsible for establishing the amplitude of the 40 MHz reference signal dependent on the level control signal.

8-267. The Mixer modulator drives an emitter-follower (Q9) which in turn drives a 40 MHz band-pass filter. The emitter-follower provides a stage of buffering and is allowed to operate linearly at different bias levels by using a fixed bias stage in its emitter circuit. The band-pass filter removes harmonics and unwanted signal components of the 40 MHz reference signal. It is then transformer-coupled to the mixer (U2) through T1.

8-268. The mixer (U2) provides complementary outputs on Pins 1 and 16. These outputs contain both a balanced dc and ac load (See Figure 8-44). A dc load of 550 ohms at each output is connected to a stable + 5 V. The ac load following the filter (C40 and R77) is balanced at the complementary output by the ac load consisting of C34 and R64. Transistor Q11 and IC U3 comprise a + 5 V supply by the emitter-follower Q11.

8-269. The output of the mixer is filtered by a 10 MHz LPF and applied to a preamplifier consisting of Q12, Q13 and Q15. Transistor Q12 is a differential pair which drives

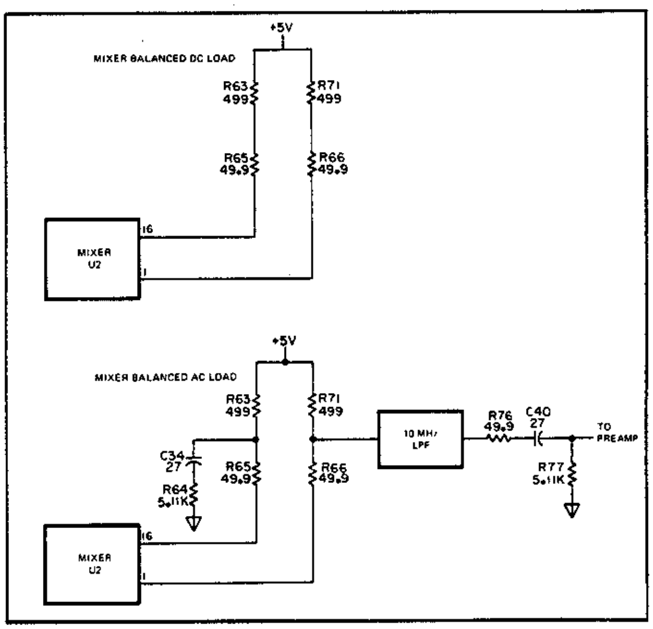


Figure 8-44. Mixer DC and AC Balanced Loads.

Q13. The output of the preamp provides ac feedback to the differential input of Q12 through R85. The preamplifier output is transmitted to the Output Amplifier Section.

8-270. The output of the preamplifier is monitored by a dc level control circuit consisting of op amp U4 and transistors Q14 and Q16. This circuit maintains the filtered and pre-amplified mixer signal at a fixed dc voltage. It remains active even when the Divider-Filter is generating the signal to ensure the signal output by the Output Amplifier does not contain a dc component. The 0 V dc at the Output Amplifier output is maintained by the dc level control circuit using dc feedback. The dc component of the signal is applied to the holding capacitor (C50) at the positive input port of the op amp U4. It is compared to the input at the negative input port and the output of U4 is applied to Q14 which drives Q16. Transistors Q14 and Q16 are biased by a diode stack and the + 15 V supply. Due to possible dc offsets in the Output Amplifier, the dc voltage at the output of the dc level control circuit may not be 0 V dc. It will be some dc value that counteracts the offsets to obtain 0 V dc at the Output Amplifier output.

8-271. Output Amplifier (Service Group M).

8-272. The output amplifier amplifies the signal generated by either the Mixer or Divider-Filter Section. It contains two stages of amplification.Refer to Figure 8-M-1 and 8-M-2 Output Amplifier Block Diagram and Schematic Diagram. The first stage of amplification contains seperate inputs and seperate amplifiers required to amplify the frequency band from 200 Hz to 80 MHz. One input receives the Mixer Section signal of less than 10 MHz while the second input receives the Divider-Filter Section signal of 10 MHz to 80 MHz.

8-273. The signal of less than 10 MHz from the Mixer Section is first transmitted through a 10 MHz low-pass filter. The first stage of amplification of this signal contains two amplifiers.

a. A low frequency amplifier for signals between dc and 1 kHz.

b. A 1 kHz to 10 MHz medium frequency amplifier coupled by a 1 kHz cross-over network.

8-274. The low frequency amplifier is active for all signals up to 1 kHz. At all times it amplifies and transmits the dc level control voltage developed in the Mixer Section. The low frequency amplifier is a composite amplifier comprised of an operational amplifier, U1, and a booster amplifier made up of transistors Q9 thru Q12. The booster amplifier increases the current drive capability of op amp U1. It is a complementary unity-gain amplifier consisting of complementary current sources and emitter-followers. The current sources are Q9 and Q10, the emitter-followers Q11 and Q12. Cross-over distortion is eliminated in the booster amp by biasing the current sources and emitter-followers at turn-on with CR1, CR2, R56, R57, R63 and R64 and by use of feedback. The output of this amplifier is applied to the second stage of the output amplifier.

8-275. The medium frequency amplifier operates from 1 kHz to 10 MHz. It receives the Mixer signal through a 1 kHz cross-over network. The amplifier is a push-pull amplifier transmitting the signal to the second stage of the output amplifier.

8-276. A signal between 10 MHz and 80 MHz is transmitted by the Divider-Filter Section. The first stage of amplification by the output amplifier is a high frequency amplifier, Q1 and Q4. It is a push-pull amplifier which transmits to the second stage in the output amp. A voltage divider network R3 and R4 at the input to the amplifier decreases the power supply sensitivity of the amplifier. In operation, this amplifier and the medium frequency amplifier are alike.

8-277. The second stage of the Output Amplifier Section sums the level control voltage and the signal. It consists of a dc stability amplifier, U2, and a complementary push-pull high frequency amplifier, Q13 thru Q16. The dc stability amplifier transmits the dc level control voltage originating in the Mixer Section to maintain the output at 0 V dc. The dc stability amplifier transmits to the bases of the complimentary output pair Q15 and Q16. For signals less than 200 Hz, this pair operates as a common-emitter amplifier with C52 and C53 acting as base coupling capacitors. Signals greater than 200 Hz are rejected by the low-pass filter R93 and C47 preceding the dc stability amp but are coupled through to the composite high frequency amplifier. The complimentary drive transistors Q13 and A14 drive the emitters of the output pair Q15 and Q16. For high frequency signals, C52 and C53 act as base by-pass capacitors and the output pair operate as common-base amplifiers. This pair has a bias adjustment in the bias circuit of Q15 to balance the output. Negative feedback of the composite amplifier is provided through R25 which establishes the gain.

8-278. Level Control (Service Group M).

8-279. The Level Control Section comprises a closed-loop system from the output of the output amplifier to the modulators of the Divider/Filter and Mixer Sections. See Figure 8-45, Level Control Loop and Figure 8-O-2, Functional Block Diagram. The main components of the Level Control Section comprising the loop are:

a. Ac-to-dc converter.

b. Digital-to-analog converter (DAC).

c. Amplitude reference.

d. Comparator.

e. Modulator driver.

The remaining components of the Level Control Section are the positive and negative peak detectors with their respec-

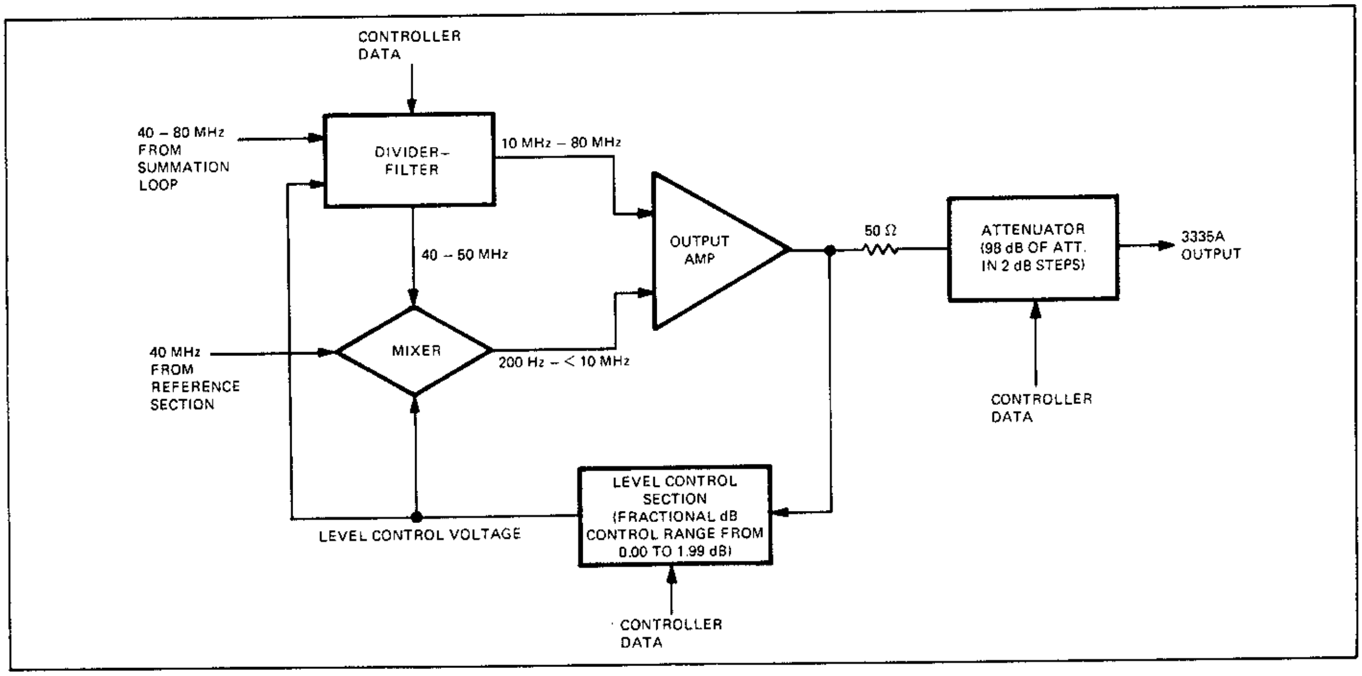


Figure 8-45. Level Control Loop.

tive over-voltage amplifiers and an external leveling amplifier allowing the user to provide an external source of level control. The immediate discussion of the Level Control Section will describe the operation of the leveling loop. Following this discussion, the peak detectors, over-voltage protection amplifiers and the external leveling amplifier will be described.

8-280. The level control loop (leveling loop) begins at the output of the output amplifier and extends back to the amplitude modulators in the Divider/Filter and Mixer Sections. This loop serves two purposes.

a. To maintain constant the amplitude of the output amplifier.

b. To vary the amplitude by 1.99 dB.

If an output is selected that is an integer multiple of 2 dB, the output amplifier provides maximum output which is attenuated by the 2 dB/step attenuator. If an amplitude is selected containing a fractional part of 2 dB, the leveled output amplifier signal (normally maximum output) is varied from 0.00 to 1.99 dB with .01 dB resolution to provide the fractional dB of attenuation. The 2 dB/step attenuator provides the full 2 dB steps of attenuation and in conjunction, the leveling loop varies the output amplifier to provide any fraction of a dB of attenuation.

8-281. The elements of the leveling loop are the ac-to-dc converter, a digital-to-analog converter, an amplitude reference, a comparator and the modulator driver. The ac-to-dc converter monitors three amplitude of the output amplifier and transmits to the comparator, a dc voltage equivalent to thermal value of the monitored voltage. The comparator compares this voltage to the amplitude reference. The difference is applied to the modulator driver and transmitted to the modulators in the Divider/Filter and Mixer Sections. This changes the output amplitude of the section that is active (recall that only the Divider-Filter or Mixer section is active at any one time). The change in amplitude by either section is reflected through the output amplifier correcting its output amplitude.

8-282. The first element of the leveling loop is the ac-to-dc converter. It consists of a thermal converter, U5, and an error amplifier comprised of U4, Q17 and Q18. The ac-to-dc converter monitors the amplitude of the output amplifier. This signal heats the sample half of the thermal converter (U5 Pins 2, 7, 8, 12 and 13) to a level determined by its rms power. The thermal converter reference half (U5 Pins 1, 6, 9, 10 and 14) is driven by the error amplifier with a dc voltage to put the reference and sample halves in equilibrium (the power going into the two resistors within the thermal converter is equal). This dc voltage is then equivalent to the rms value of the signal applied to the sample half. The system comprised of the thermal converter and the error amplifier continuously seek equilibrium.

8-283. The dc output of the error amplifier, in addition to heating the thermal converter reference half, is applied to a comparator and compared to the amplitude reference voltage. The reference voltage is comprised of two components; a fixed - 10 V reference voltage and a variable component from the DAC. The two components are summed by a summing amplifier (U10C) and applied to the comparator (U3 and Q19).

8-284. The amplitude reference is a stable - 10 V. It is regulated by the voltage source U10D. A zener, CR7, provides the voltage reference for amplifier (U10) and is biased on by the - 10 V output voltage. A zener turn-on circuit consisting of CR6, R140 and R141 initially estab-

lishes the zener bias until the - 10 V amplitude reference reaches sufficient amplitude to provide the bias. Once sufficient amplitude is reached, CR6 is reverse-biased removing the turn-on circuit.

8-285. The DAC output is the variable component of the reference voltage and is variable from + 10 V to 0 V. The output is established from processor data that is serially input into shift registers. The shift register output data is continuously applied to the DAC in a parallel transmission. For maximum output by the output amplifier, the summation of the amplitude reference and the DAC output is zero. This implies a DAC output of + 10 V. By decreasing the DAC output, the amplitude reference applied to the comparator can be varied. This provides a means of attenuating the output amplifier signal by as much as 1.99 dB dependent on the DAC output. A summing amplifier transmits the reference voltage to the comparator causing the leveling loop to be more responsive to small changes in the DAC output. The end result is a reference voltage set by the controller that is able to vary the amplitude of the output amplifier from 0.00 to 1.99 dB with .01 dB resolution.

8-286. The comparator compares the dc voltage applied to the thermal converter reference half (equivalent to the rms amplitude of the output amplifier) to the amplitude reference voltage (the sum of the - 10 V reference and DAC Outputs). Any difference in the two dc levels is applied to the modulator driver which transmits that voltage to the modulators in the Divider/Filter and Mixer Sections. Each modulator is adjusted to have identical gain characteristics resulting in the same change in amplitude by either the Divider/Filter or the Mixer for a given level control voltage. This amplitude change is reflected through the output amplifier and corrects the output amplitude monitored by the thermal converter. This completes the loop. The action of the leveling loop continues until the amplitude is stabilized on the amplitude required to provide that programmed from the front panel.

8-287. Overvoltage Protection.

8-288. Overvoltage protection is provided to keep the output from attaining an excessive voltage. The amplitude of the output amplifier is monitored by a positive and a negative peak detector. If the leveling loop cannot stabilize the output, the amplitude can reach a point that will activate the detectors. The overvoltage amplifiers turn-on and clamp the modulator driver input signal to a low value. The lowest voltage applied to the modulator driver controls the level control loop. This overrides the main leveling loop signal from the comparator and allows the level control loop to regain control of the amplitude.

8-289. External Leveling.

8-290. A rear panel switch and connector provide the control of the external leveling circuit allowing the user to control the amplitude externally. The switch activates the external leveling amplifier while the connector provides the external input to the circuit. + 15 V is applied through the rear panel external leveling switch to the amplifier output which holds the amplifier inactive and reverse biases CR18. When activated, the external leveling amplifier output is lower than the internal leveling loop. The external leveling amplifier overrides the internal loop signal and provides control of the amplitude.

8-291. Attenuator (Service Group N).

8-292. The attenuator can provide up to 98 dB of attenuation. This is obtained from seven attenuator pads of 40, 20, 20, 10, 4, 2 and 2 dB (See Figure 8-N-1).The introduction of an attenuator pad is controlled by relay contacts. There are eight relays contained on four relay driver assemblies (2 relays per assembly). Seven of the relays switch the attenuator pads while the eight relay switches the output impedance.

8-293. Each relay contains two windings, one operating the relay in one direction while the second winding operates the relay in the opposite direction. Only one winding is energized at any time. Once the relay has been operated in either direction, the energized winding is de-energized and the relay armature held by a permanent magnet.

8-294. The energizing circuits for each winding are identical consisting of two series transistors powered from the + 8 V raw voltage supply which is applied to the attenuator even in the power STBY mode (See Figure 8-46). The transistor pairs are driven by NOR gates whose output is determined by an attenuator control line (AT0 through AT7) and the attenuator enable line (ATE). The ATE line is the output of a monostable multivibrator which generates a negative pulse when triggered. When ATE is high, both transistor pairs are off de-energizing both relay windings. The relay armature, which moves the contacts, is held in the last operated position by a permanent magnet.

8-295. If the A' winding was the last winding energized and the relay contacts are to be switched, the control line AT0 is latched low at the controller interface assembly which applies a low to the NOR gate. When AT0 is latched, the

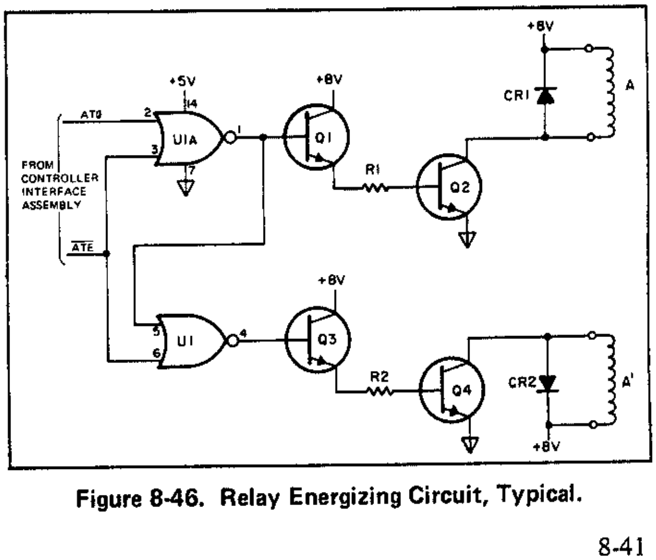


Figure 8-46. Relay Energizing Circuit, Typical.

monostable multivibrator on the controller interface is triggered, generating the ATE low-going pulse. U1 Pin 1 goes high to forward bias the transistor pair energizing relay winding A and switches the relay contacts. Following the ATE pulse, the high on ATE turns off both transister pairs de-energizing winding A. The switched contacts are held by a permanent magnet.

8-296. Hewlett-Packard Interface Bus (HP-IB) Interface Circuit (Service Group C).

8-297. The HP-IB Interface Circuit can be divided into three parts:

a. HP-IB Routine Trigger (IRQ).

b. Address Recognition and Control.

c. Data Input (acceptor) Handshake Control.

The HP-IB routine trigger causes the controller to access the HP-IB routine and service HP-IB data. The 3335A must first be addressed to listen before it will accept data. The address recognition and control circuit acknowledges the 3335A address and allows HP-IB data to be applied to the controller. Once data is applied to the controller, the handshake control circuit acknowledges receipt of the data.

8-298. All HP-IB signals are applied to optical isolators on the interface circuit (See Figures 8-C-2 and 8-C-1, HP-IB Interface Block Diagram and Schematic Diagram). The optical couplers isolate the HP-IB from the instrument. While the instrument side of the optical couplers is powered by the + 5 V supply, the HP-IB side of the optical couplers is powered by a seperate ungrounded transformer winding. A bridge rectifier (CR1) and voltage regulator (VR1) to convert the ac signal from the transformer to the isolated + 5 V are located on the HP-IB Interface assembly.

8-299. HP-IB Routine Trigger (IRQ).

8-300. The 3335A controller is interrupted to service data from the HP-IB by an HP-IB routine trigger (INTERRUPT REQUEST). HP-IB data is placed on the eight controller input data lines H0 through H7 (see Figure 8-C-1, HP-IB Schematic Diagram). These lines are terminated in tri-state buffers A13U11 on the Controller assembly, A13. When an HP-IB routine trigger occurs (IRQ goes true), the tri-state buffers are enabled by controller microprocessor address line A2 and an enable line from the controller address decoder. Enabled, they allow the data on lines H0 through H7 to be transferred from the HP-IB to the 3335A microprocessor unit of the controller.

8-301. The HP-IB routine trigger, IRQ (See Figure 8-47), is initiated each time the DAV line is pulled low (true) by the HP-IB system controller to indicate that valid data is on the bus providing one of the two following conditions exist when IFC is high.

a. The HP-IB is in the Command mode (ATN is low).

b. The 3335A has been addressed to listen (ATL is set low by the interface circuit "addressed to listen" R - S flip-flop).

In both cases the HP-IB system controller must not set IFC (Interface Clear) low. IFC low causes all instruments on the bus to cease responding.

8-302. Each time IRQ is pulled low, the controller accepts the data from the HP-IB processes it and clears the IRQ D flip-flop (U5A) which generates the IRQ transition. The controller goes back to servicing the instrument until IRQ is again pulled low and the HP-IB routine is accessed.

8-303. Address Recognition and Control.

8-304. When the HP-IB is in the command mode (ATN= LOW), the system controller is addressing the devices on the bus. The HP-IB routine trigger circuit is enabled by the state of ATN. When the address is placed on the bus by the system controller, DAV goes LOW to indicate valid data and this triggers the HP-IB routine. The 3335A controller stores the address in RAM then sets the "data select" flip-flop by transmitting control signals through the con-

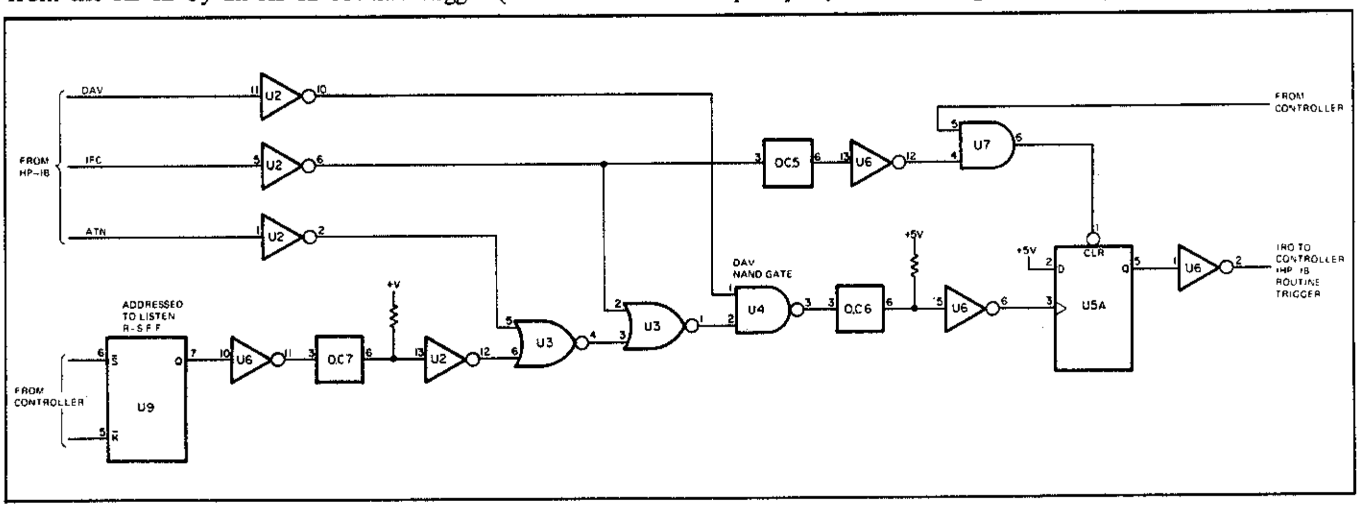


Figure 8-47. HP-IB Routine Trigger.

troller PIA which is decoded by the HP-IB Interface 3-to-8 line decoder (U10). The address set by the address select switches is transmitted to the controller and compared to that stored in RAM. If the address transmitted was the 3335A address, control signals from the PIA are decoded to set the "addressed" RS flip-flop and enable the DAV NAND gate of the routine trigger circuit. This causes IRQ to be pulled low each time DAV goes low. Once the controller processes the data controller signals are decoded to clear the IRQ flip-flop and prepare it for the next trigger.

8-305. Instruction signals from the controller PIA are transmitted over lines PB0 through PB4 and CB2. They are decoded by the HP-IB Interface circuit 3-to-8 line decoder (U10) to generate control signals. These signals are applied to the gates and RS flip-flops to control the operation of the interface circuit.

8-306. Data Input Handshake Control.

8-307. Two signals are transmitted to the bus by the 3335A in the acceptor handshake operation. These signals are NRFD (Not Ready for Data) and NDAC (Not Data Accepted) which are both low true signals. They are set by the decoded controller instruction. When the controller clears the IRQ flip-flop to prepare it for the next trigger by DAV, it also sets NRFD high indicating to the HP-IB system controller that it is ready for data.

8-308. Power Supply (Service Group F).

8-309. The power supply consists of a rectifier and filter section and four regulating circuits (See Figure 8-48, Power Supply Block Diagram). The rectifiers and filters develop unregulated output voltage of + 20 V, - 20 V, + 8 V and - 8 V. These unregulated voltages are applied to voltage regulators to generate regulated output voltages of + 15 V, - 15 V, + 5 V and - 5.2 V. The + 20 V unregulated output is also applied to the crystal oven reference. As long as the power cable is connected to a power source, the oven temperature is maintained by the application of + 20 V in either the STBY or ON mode. When the instrument is put in the STBY mode, the + 15 V regulator reference is connected to ground turning off the + 15 V output. Since all other regulators are referenced to the + 15 V output, they too are turned off.

8-310. The regulating circuits consist of two operational amplifiers, a reference amplifier and a current limiting amplifier. (See Figure 8-F-1, Power Supply Schematic.) The reference amplifier monitors the output voltage through a voltage divider network. The output voltage is connected by a sense line to the voltage divider network and a variant voltage is transmitted to the reference amplifier. The variant is compared to a reference applied to the second input port of the reference amplifier. In the - 15 V and - 5.2 V supplies, the reference is ground. If the

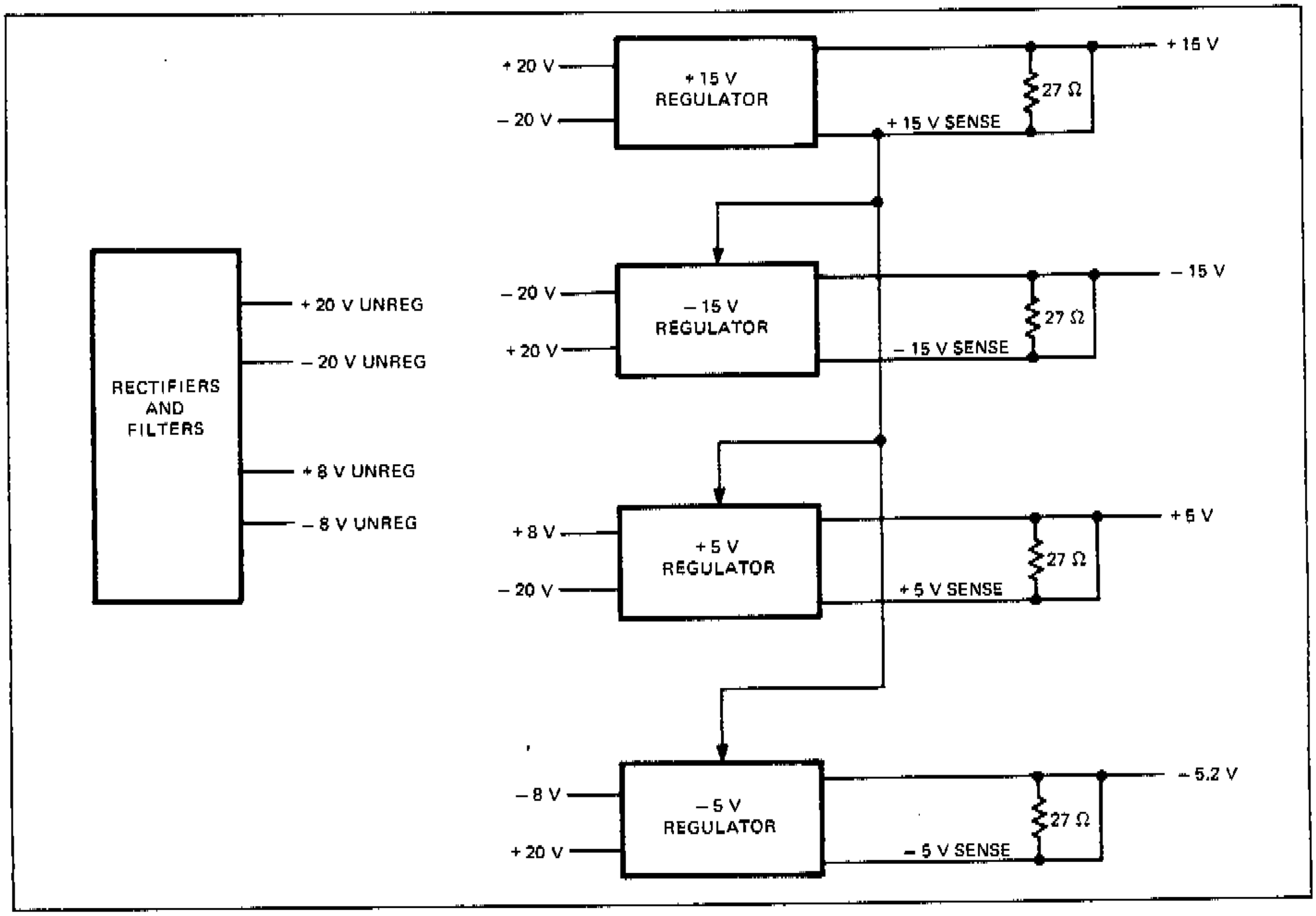


Figure 8-48. Power Supply, Block Diagram.

output voltage changes, the reference amplifier detects the change by the variant voltage and drives the series pass transistor to correct the output. In the - 15 V, + 5 V and - 5.2 V regulators, the variant voltage is referenced to the + 15 V sense. In these regulators, a voltage divider string is connected to the + 15 V sense line and if the + 15 V supply fails, these supplies are affected and will turn off.

8-311. The second operational amplifier in each regulator functions as a current limiter. This amplifier is identified by the series resistors of 4.7 K preceding each input port. A loop from one input port to the other is formed through a 100 ohm resistor and a board trace resistance formed by zig-zagging the trace a fixed distance. The amplifier and loop provide a means of providing protection by initiating current foldback under excessive loading conditions. The amplifier monitors the voltage present in the loop (the voltage across the 100 ohm and board trace resistor). An unregulated 20 V and a voltage divider establish the voltage across the 100 ohm resistor under full output. The output current establishes the voltage across the board trace resistance. Excessive loading occurs when the voltage across board trace resistance (due to the output current) exceeds the fixed voltage on the 100 ohm resistor causing a change of polarity at the input ports of the amplifier. Because of this, the amplifier output changes in a way that takes base drive from the series-pass transistor which decreases the output voltage and output current of the regulator. It is this output voltage in conjunction with the voltage divider, which establishes the voltage across the 100 ohm resistor determining the point where current foldback begins. Since the output voltage has decreased, less output current will cause enough of voltage drop across the board trace resistance to maintain the current foldback mode of operation. Current foldback continues as long as the output is being excessively loaded.

8-312. TROUBLESHOOTING INFORMATION.

8-313. This portion of Section VIII, SERVICE, contains troubleshooting information provided to aid in isolating an instrument malfunction first to the assembly level and further to the component level. This information is for *qualified personnel only.*

WARNING

Line voltage is exposed within the instrument even when the POWER switch is in the STBY position.

8-314. Service Groups; What They Are and How to Use Them.

8-315. The troubleshooting information presented in this section is sectionalized into service groups. A service group is an arrangement of information pertaining to a particular circuit or mechanical assembly. The objective of the service group is to integrate the servicing information into a single location. Each service group contains schematic diagrams, block diagrams, troubleshooting data, component parts lists and component locators for the circuit assemblies contained in the group. The service groups are structured so that the troubleshooting data and component parts lists lay over the apron page of the unfolded schematic of the service group. The block diagram of the service group follows the schematic so it too can be unfolded and referred to at any time simply by lifting the schematic. After reference to the block diagram has been made, the schematic can again lay over it. With this structure, both diagrams can be unfolded and easily worked with along with the troubleshooting data.

8-316. As an added convenience, the last service group is the functional block diagram and sectional level troubleshooting. This service group is used first to isolate the fault to a particular section. Once the faulty section is identified and the schematic and block diagram of its respective service group has been unfolded, the functional block diagram can remain unfolded for continued reference. This allows easy access to not only the schematic and block diagram of a particular service group, but also the instrument's functional block diagram for an overview of any section with respect to the rest of the instrument.

8-317. Service Groups; How to Identify Them.

8-318. Each service group is designated with a letter. The page numbers, figure and table numbers in each group contain the service group letter. Table 8-6 is a list of service groups and provides the assembly title, assembly designation and assembly part numbers of each assembly in a service group.

8-319. Safety Considerations.

8-320. To ensure the safety of the operating and maintenance personnel and retain the safe operating condition of the Synthesizer, this manual contains information, cautions and warnings which must be adhered to. Service and adjustments should be referred to qualified personnel.

WARNING

Any interruption of the protective ground conductor (inside or outside the instrument) or disconnection of the protective earth terminal can place the Synthesizer chassis at a potential other than ground. This potential difference can be large causing an operator hazard. Verify the continuity of this conductor to the chassis before servicing or operating the Synthesizer.

8-321. Any replacement of fuses must be made with fuses of the correct current rating and of the specified type (Fast blow, voltage rating, etc.). Fuse data is obtainable from the replaceable parts list of Section VI.

Table 8-6. Service Groups.

Service Group	Assembly	Assembly Designator	-hp- Part No.
A	Display	A12	03335-66509
B	Keyboard	A11	03335-66510
C	HP-IB Interface	A16	03335-66513
D	Controller	A13	03335-66511
E	Controller Interface	A10	03335-66512
F	Power Supply	A14	03335-66514
F	Pass Transistor	A15	03335-66516
G	Temp.-Stabilized Osc. (Std)	A17	03335-66522
	Temp.-Stabilized Osc. (Opt. 001)	A18	03335-66517
H	Reference	A3	03335-66505
I	N Step Loop	A9	03335-66501
J	Fractional-N Loop		
	Digital	A4	03335-66503
	Analog	A5	03335-66504
K	Summation Loop	A8	03335-66502
L	Divider-Filter	A2	03335-66506
	Mixer	A7	03335-66507
M	Output Amplifier/Level Control	A6	03335-66508
N	Attenuator	A25	5060-9596
	Option 002/004	A19	03335-66519
	Option 003 Interface	A20	03335-66521
O	Functional Block Diagram		
	Section Level Troubleshooting		
	Mother Board	A1	03335-66515

8-322. Service Aids.

8-323. This paragraph summarizes the various items incorporated into the instrument and service section of the manual as an aid to troubleshooting.

a. Parts Location Aids. The location of individual components on a printed circuit board is provided in each service group. The reference designator for a component

called out in troubleshooting information is referred to by assembly designation and component designation. For instance, R15 on the A3 assembly is referred to as A3R15. For specific component description or part number for replacement, refer to the replaceable parts list in each service group. Miscellaneous Parts, Mechanical Parts and Cables are located in Section VI.

b. Additional Parts Location Aids. Certain PC assemblies identify various components contained on the assembly. These assemblies contain the component designation etched into the PC board next to the component.

c. PC Assembly Test Point and Adjustment Callouts. Test points and adjustments contained on a PC assembly are identified by an etched callout. Test points can take three different forms.

1. A vertical pin
2. A small jumper
3. A coax connector.

NOTE

All coax connector test points are located on the large mother board for the module. They are accessible by removing the module from the instrument.

d. Module Assemblies and Adjustment Identification. Assembly designations for the eight PC assemblies which plug into the module are silkscreened on the assembly extrusion. Also, silkscreened are titles of those adjustments accessible through the extrusion.

e. Chassis Mounted Component Identification. All chassis mounted components (power transformer, diode bridge, etc.) are designated by a 100 series of numbers; e.g., the power transformer is T100, the two bridge diodes, are CR100 and CR200, etc. All of these components are listed at the end of Table 6-3 under the heading "CHASSIS MOUNTED COMPONENTS".

f. Mechanical Parts Exploded Views. To aid in identifying mechanical parts, exploded views are provided in Section VI along with the mechanical parts listing of Table 6-3.

g. Cable Identification. Identification of cables within the 3335A is made by a pictorial located with the cable parts listing of Section VI.

h. Service Kit. A service kit is provided with the Model 3335A to aid in servicing. The service kit contains special cables and a connector which allows easy interface of test equipment to the modules rf test points and connectors. Also contained in the service kit are the necessary extender boards to service the assemblies in the module and two extender boards for servicing the controller assembly. Service items are illustrated and described in Figure 8-49.

i. As a service aid to maintenance personnel, the troubleshooting information in each service group is provided with a wide margin. The margin is useful for recording troubleshooting notes developed by the user.

8-324. Controller Mnemonics.

8-325. The outputs from the Controller assembly, A13 (both control and data outputs), are each labeled by a mnemonic. To aid in identifying, locating the source and describing the function of each Controller output line, a mnemonic dictionary is provided in the Controller service group (Service Group D).

8-326. Adjustments Affected by Repairs.

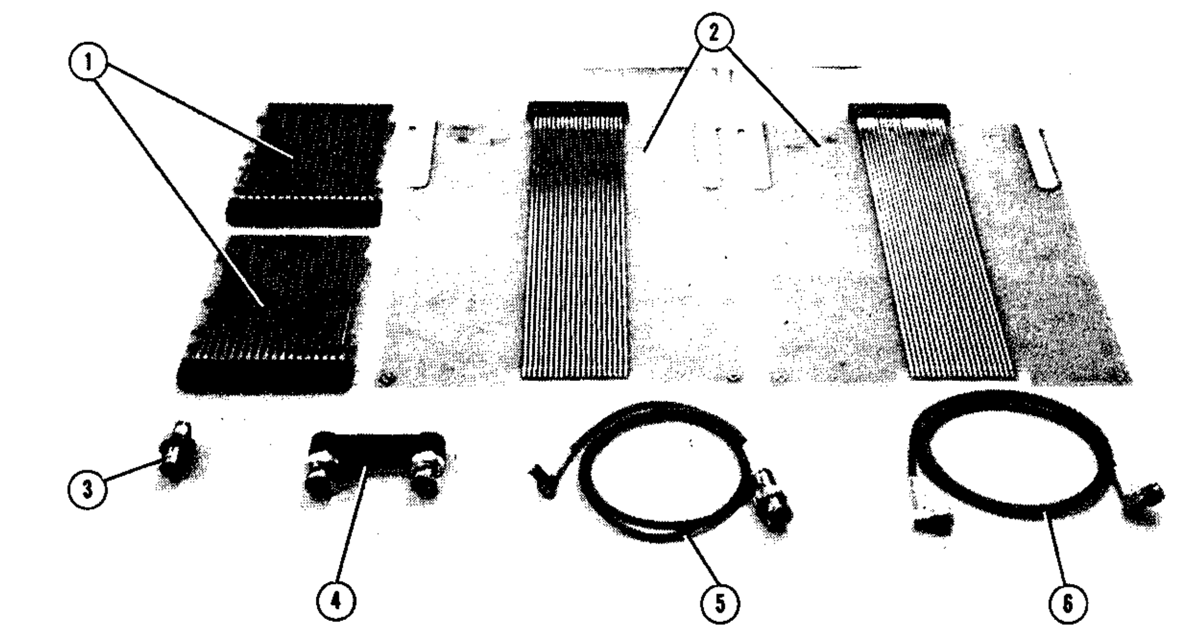
8-327. Repairs to certain assemblies affect the calibration of the instrument and certain adjustments must be performed. Table 8-7 is a list of the assemblies in the 3335A and what adjustments are affected by a repair to each assembly.

Table 8-7. Adjustments Required After Repair.

If a Repair Is Made to This Assembly		Perform the Following Adjustments After Repair
A1	Mother Board	None
A2	Divider-Filter	1. Filter Adjustments as required 2. Output Amplifier Adjustments 3. Level Control Loop Adjustments
A3	Reference	Reference VCXO Adjustments
A4	N.F Loop, Digital	None
A5	N.F Loop, Analog	Fractional N (N.F) Loop Analog Adjustments
A6	Output Amp/Level Control	1. Output Amplifier Adjustments 2. Level Control Loop Adjustments
A7	Mixer	1. Filter Adjustments as required 2. Output Amplifier Adjustments 3. Level Control Loop Adjustments
A8	Summation Loop	Summation Loop VCO Adjustments
A9	N Step Loop	N Step Loop VCO Adjustments
A10	Controller Interface	None
A11	Keyboard	None
A12	Display	None
A13	Controller	None
A14	Power Supply	Power Supply Adjustment
A15	Pass Transistor Assembly	Power Supply Adjustment
A16	HP-IB Interface	None
A17	Oscillator Interface (Std)	Temperature-Stabilized Oscillator Adjustments
A18	Oscillator Interface (Opt. 001)	Temperature-Stabilized Oscillator Adjustments
A19	75 Ω, 124 Ω, 135 Ω (Opt. 002)	None
A20	75 Ω, 150 Ω (Opt. 003)	None
A25	Attenuator	None

CAUTION

Do not subject the 3335A to any moisture-type cleaning process or attenuator performance will be degraded.



(1) EXTENDER BOARD (2). Used to place the Controller Assembly in position for servicing.

(2) EXTENDER BOARD. (2) Used in servicing assemblies in the module.

(3) SMA-to-BNC ADAPTER. Used to obtain a BNC connection at the module output (A6J1).

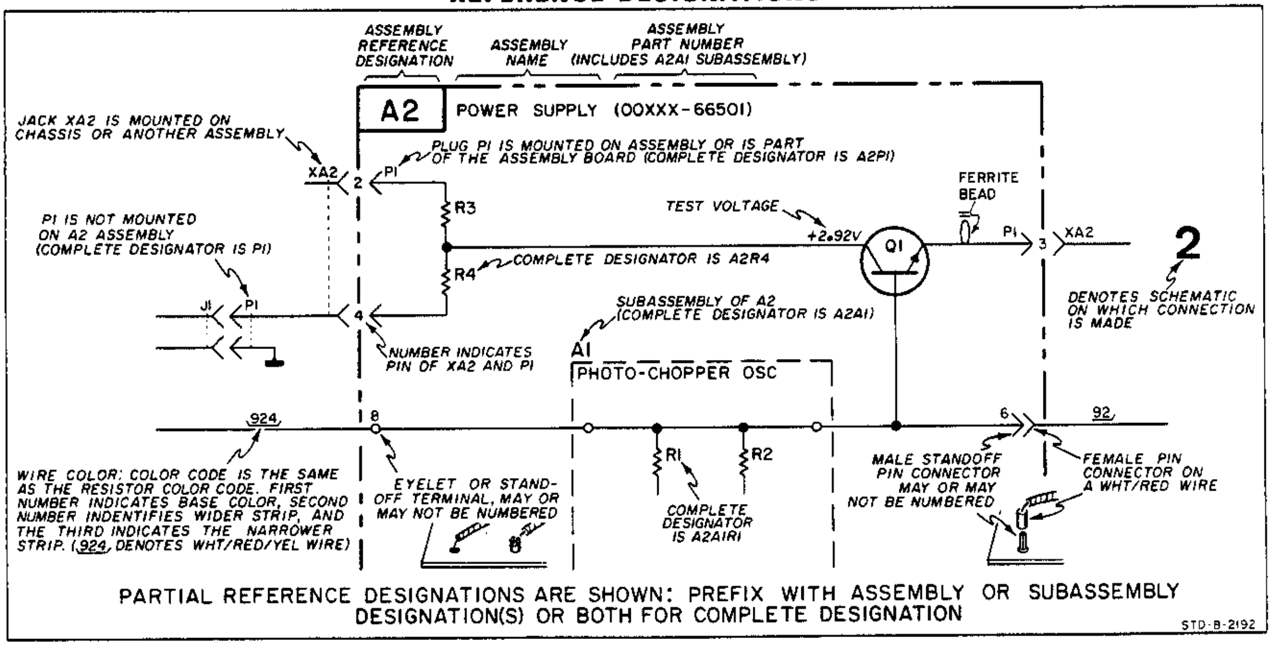
(4) BNC JUMPER. Used to interconnect the rear panel "10 MHz REF OVEN OUTPUT" to the "40/N MHz REF INPUT".

(5) CABLE W1. BNC-to-PUSH-ON SELECTOR. Used to obtain a BNC connection to the module for servicing.

(6) CABLE W2. SMA-to-SMA. Used to replace the semi-rigid coax between module and attenuator when the module is removed for servicing.

Figure 8-49. Service Items.

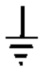
REFERENCE DESIGNATIONS



GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED.
   RESISTANCE IN OHMS
   CAPACITANCE IN MICROFARADS
   INDUCTANCE IN MILLIHENRYS

3.  DENOTES EARTH GROUND. USED FOR TERMINALS WITH NO LESS THAN A NO. 18 GAUGE WIRE CONNECTED BETWEEN TERMINAL AND EARTH GROUND TERMINAL OR AC POWER RECEPTACLE.

4.  DENOTES FRAME GROUND. USED FOR TERMINALS WHICH ARE PERMANENTLY CONNECTED WITHIN APPROXIMATELY 0.1 OHM OF EARTH GROUND.

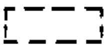
5.  DENOTES GROUND ON PRINTED CIRCUIT ASSEMBLY. (PERMANENTLY CONNECTED TO FRAME GROUND).

6. DENOTES ASSEMBLY.

7. DENOTES MAIN SIGNAL PATH.

9. DENOTES FEEDBACK PATH.

10.  DENOTES FRONT PANEL MARKING.

11.  DENOTES REAR PANEL MARKING.

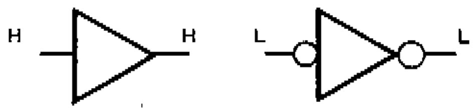
12.  DENOTES SCREWDRIVER ADJUST.

13. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY. THE VALUE OF THESE COMPONENTS MAY VARY FROM ONE INSTRUMENT TO ANOTHER. THE METHOD OF SELECTING THESE COMPONENTS IS DESCRIBED IN SECTION V OF THIS MANUAL.

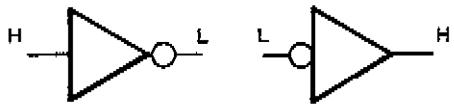
14.  DENOTES SECOND APPEARANCE OF A CONNECTOR PIN.

15. \924/ DENOTES WIRE COLOR: COLOR CODE SAME AS RESISTOR COLOR CODE. FIRST NUMBER IDENTIFIES BASE COLOR, SECOND NUMBER IDENTIFIES WIDER STRIP, THIRD NUMBER IDENTIFIES NARROWER STRIP. (e.g. \924/ = WHITE, RED, YELLOW.)

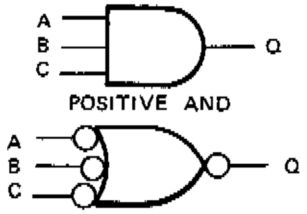
17. ALL RELAYS ARE SHOWN DEENERGIZED.



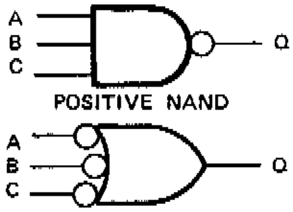
DENOTES BUFFER



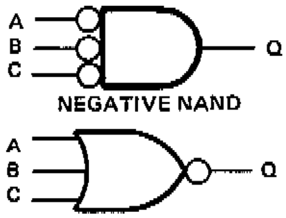
DENOTES INVERTER



A	B	C	Q
L	L	L	L
L	L	H	L
L	H	L	L
L	H	H	L
H	L	L	L
H	L	H	L
H	H	L	L
H	H	H	H



A	B	C	Q
L	L	L	H
L	L	H	H
L	H	L	H
L	H	H	H
H	L	L	H
H	L	H	H
H	H	L	H
H	H	H	L



A	B	C	Q
L	L	L	H
L	L	H	L
L	H	L	L
L	H	H	L
H	L	L	L
H	L	H	L
H	H	L	L
H	H	H	L

EXCLUSIVE OR GATE

A	B	Q
L	L	L
L	H	H
H	L	H
H	H	L

SERVICE GROUP INDEX

Service Group	Assembly	Assembly Designator	-hp- Part Number
A	Display	A12	03335-66509
B	Keyboard	A11	03335-66510
C	HP–IB Interface	A16	03335-66513
D	Controller	A13	03335-66511
E	Controller Interface	A10	03335-66512
F	Power Supply	A14	03335-66514
F	Pass Transistor	A15	03335-66516
G	Temp. Stabilized Osc. (Std)	A17	03335-66522
	Temp. Stabilized Osc. (Option 001)	A18	03335-66517
H	Reference	A3	03335-66505
I	N Step Loop	A9	03335-66501
J	Fractional–N Loop		
	Digital	A4	03335-66503
	Analog	A5	03335-66504
K	Summation Loop	A8	03335-66532
L	Divider–Filter	A2	03335-66536
	Mixer	A7	03335-66507
M	Output Amplifier/Level Control	A6	03335-66538
N	Attenuator	A25	5060-9596
	Option 002/004 Interface	A19	03335-66519
	Option 003 Interface,.	A20	03335-66521
O	Functional Block Diagram		
	Section Level Troubleshooting		
	Mother Board	A1	03335-66515

SERVICE GROUP A

DISPLAY

ADJUSTMENTS

NONE

TROUBLESHOOTING DATA

The Display assembly plugs into and is mounted on the Keyboard assembly. Display data for the 7-segment displays and annunciators (Lines PAØ through PA7) is generated by the Controller and is applied to the display segment drivers through the Keyboard. All 7-segment displays are connected in parallel to the eight data lines PAØ through PA7. The annunciators are also connected to the eight data lines. The display data turns on the 7-segment display or annunciator group activated by the display digit driver scan. The scan signal (Lines DØ through D13) originates at the scan circuit located on Keyboard assembly.

Display Self–Test

The display self test illuminates all segments and decimal points of the display. It also illuminates all annunciators except UNLOCKED and UNLEVELED. This allows a check of most display elements. If all display elements of a display bus line are bad, it is likely the segment driver associated with the bus line is defective.

To set up the display self test, perform the following steps:

1. Turn the 3335A on.

2. Ground pins A, B, and C on the A13 assembly.

3. Temporarily ground pin I on the A13 test connector.

4. Verify all display segments and decimal points are lit (display should indicate eights).

5. Verify all annunciators (except UNLOCKED and UNLEVELED) are lit.

NOTE

At this point verification of the Keyboard Assembly can be easily performed as follows:

1. Pressing each key (except POWER and LOCAL) extinguishes the display (except SWEEPING) and displays the switch number assigned to the key on the schematic and parts locator.

2. *Rotating the MANUAL TUNE knob continuously to the right will display the number 40. Rotation to the left displays the number 41.*

If all keys and the MANUAL TUNE knob display the correct number, the Keyboard Assembly is functioning properly.

To exit the Display and Keyboard Self–Test, temporarily ground the RESET (RST) pin on the A13 Controller Assembly or turn the instrument off and on again.

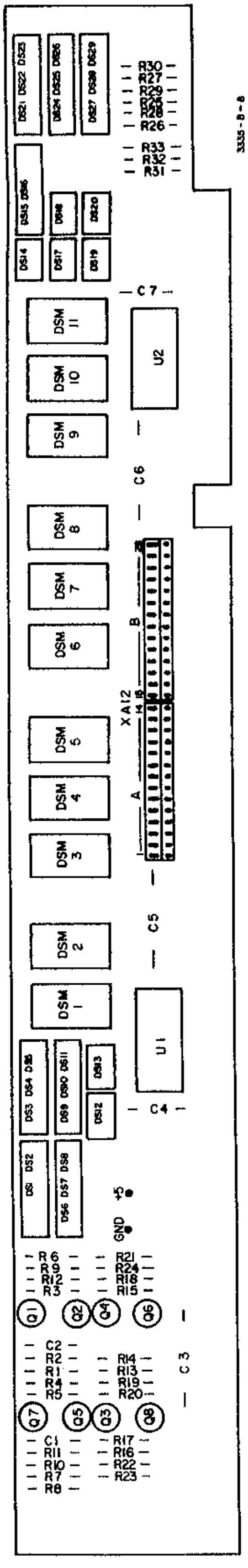
Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A12	03335-66509	1	PC ASSEMBLY, DISPLAY	28480	03335-66509
A12C1	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A12C2	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A12C3	0180-0106	3	CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X000682
A12C4	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A12C5	0180-0106		CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X000682
A12C6	0180-0106		CAPACITOR-FXD 60UF+-20% 6VDC TA	56289	150D606X000682
A12C7	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A12DS1	1990-0486	29	LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40006	7	*LED ANN GD	28480	08505-40006
	4040-1001	7	*STRIP, PLASTIC	28480	4040-1001
A12DS2	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40006		*LED ANN GD	28480	08505-40006
	4040-1001		*STRIP, PLASTIC	28480	4040-1001
A12DS3	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40006		*LED ANN GD	28480	08505-40006
	4040-1001		*STRIP, PLASTIC	28480	4040-1001
A12DS4	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40006		*LED ANN GD	28480	08505-40006
	4040-1001		*STRIP, PLASTIC	28480	4040-1001
A12DS5	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40006		*LED ANN GD	28480	08505-40006
	4040-1001		*STRIP, PLASTIC	28480	4040-1001
A12DS6	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40006		*LED ANN GD	28480	08505-40006
	4040-1001		*STRIP, PLASTIC	28480	4040-1001
A12DS7	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40006		*LED ANN GD	28480	08505-40006
	4040-1001		*STRIP, PLASTIC	28480	4040-1001
A12DS8	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40007	8	*LED ANN GD	28480	08505-40007
	4040-1002	8	STRIP, PLASTIC	28480	4040-1002
A12DS9	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40007		*LED ANN GD	28480	08505-40007
	4040-1002		STRIP, PLASTIC	28480	4040-1002
A12DS10	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40007		*LED ANN GD	28480	08505-40007
	4040-1002		STRIP, PLASTIC	28480	4040-1002
A12DS11	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40007		*LED ANN GD	28480	08505-40007
	4040-1002		STRIP, PLASTIC	28480	4040-1002
A12DS12	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40007		*LED ANN GD	28480	08505-40007
	4040-1002		STRIP, PLASTIC	28480	4040-1002
A12DS13	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40007		*LED ANN GD	28480	08505-40007
	4040-1002		STPIP, PLASTIC	28480	4040-1002
A12DS14	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40007		*LED ANN GD	28480	08505-40007
	4040-1002		STRIP, PLASTIC	28480	4040-1002
A12DS15	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
	08505-40007		*LED ANN GD	28480	08505-40007
	4040-1002		STRIP, PLASTIC	28480	4040-1002
A12DS16	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
A12DS17	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A12DS18	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
A12DS19	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
A12DS20	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
A12DS21	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
A12DS22	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
A12DS23	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
A12DS24	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
A12DS25	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
A12DS26	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
A12DS27	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
A12DS28	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
A12DS29	1990-0486		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0486
A12DSM1	1990-0592	11	*HPA 5082-7653	28480	1990-0592
A12DSM2	1990-0592		*HPA 5082-7653	28480	1990-0592
A12DSM3	1990-0592		*HPA 5082-7653	28480	1990-0592
A12DSM4	1990-0592		*HPA 5082-7653	28480	1990-0592
A12DSM5	1990-0592		*HPA 5082-7653	28480	1990-0592
A12DSM6	1990-0592		*HPA 5082-7653	28480	1990-0592
A12DSM7	1990-0592		*HPA 5082-7653	28480	1990-0592
A12DSM8	1990-0592		*HPA 5082-7653	28480	1990-0592
A12DSM9	1990-0592		*HPA 5082-7653	28480	1990-0592
A12DSM10	1990-0592		*HPA 5082-7653	28480	1990-0592
A12DSM11	1990-0592		*HPA 5082-7653	28480	1990-0592
A12Q1	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A12Q2	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A12Q3	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A12Q4	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A12Q5	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A12Q6	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A12Q7	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A12Q8	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A12R1	0683-6215	8	RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A12R2	0683-8215	8	RESISTOR 820 5% .25W FC TC=-400/+600	01121	CB8215
A12R3	0683-2005	8	RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A12R4	0683-6215		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A12R5	0683-8215		RESISTOR 820 5% .25W FC TC=-400/+600	01121	CB8215
A12R6	0683-2005		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A12R7	0683-6215		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A12R8	0683-8215		RESISTOR 820 5% .25W FC TC=-400/+600	01121	CB8215
A12R9	0683-2005		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A12R10	0683-6215		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A12R11	0683-8215		RESISTOR 820 5% .25W FC TC=-400/+600	01121	CB8215
A12R12	0683-2005		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A12R13	0683-6215		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A12R14	0683-8215		RESISTOR 820 5% .25W FC TC=-400/+600	01121	CB8215
A12R15	0683-2005		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A12R16	0683-6215		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A12R17	0683-8215		RESISTOR 820 5% .25W FC TC=-400/+600	01121	CB8215
A12R18	0683-2005		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A12R19	0683-6215		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A12R20	0683-8215		RESISTOR 820 5% .25W FC TC=-400/+600	01121	CB8215
A12R21	0683-2005		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A12R22	0683-6215		RESISTOR 620 5% .25W FC TC=-400/+600	01121	CB6215
A12R23	0683-8215		RESISTOR 820 5% .25W FC TC=-400/+600	01121	CB8215
A12R24	0683-2005		RESISTOR 20 5% .25W FC TC=-400/+500	01121	CB2005
A12R25	0683-1015	10	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A12R26	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A12R27	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A12R28	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A12R29	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A12R30	0683-1015		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A12R31	0683-1815		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A12R32	0683-1815		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A12R33	0683-1815		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A12U1	1820-1740	2	IC-DIGITAL DS8863N MOS* DSPL DRVR	27014	DS8863N
A12U2	1820-1740		IC-DIGITAL DS8863N MOS* DSPL DRVR	27014	DS8863N
A12XA12A, B	1251-4481	2	MOLEX, 12-14-2141		
A12XDS1	1200-0474	11	SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474
A12XDS2	1200-0474		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474
A12XDS3	1200-0474		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474
A12XDS4	1200-0474		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474
A12XDS5	1200-0474		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474
A12XDS6	1200-0474		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474
A12XDS7	1200-0474		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474
A12XDS8	1200-0474		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474
A12XDS9	1200-0474		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474
A12XDS10	1200-0474		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474
A12XDS11	1200-0474		SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474

Fig 8-A-1
Sht 1 of 4



A12
-hp- Part No. 03335-66509

Fig 8-A-1 Sht 2 of 4

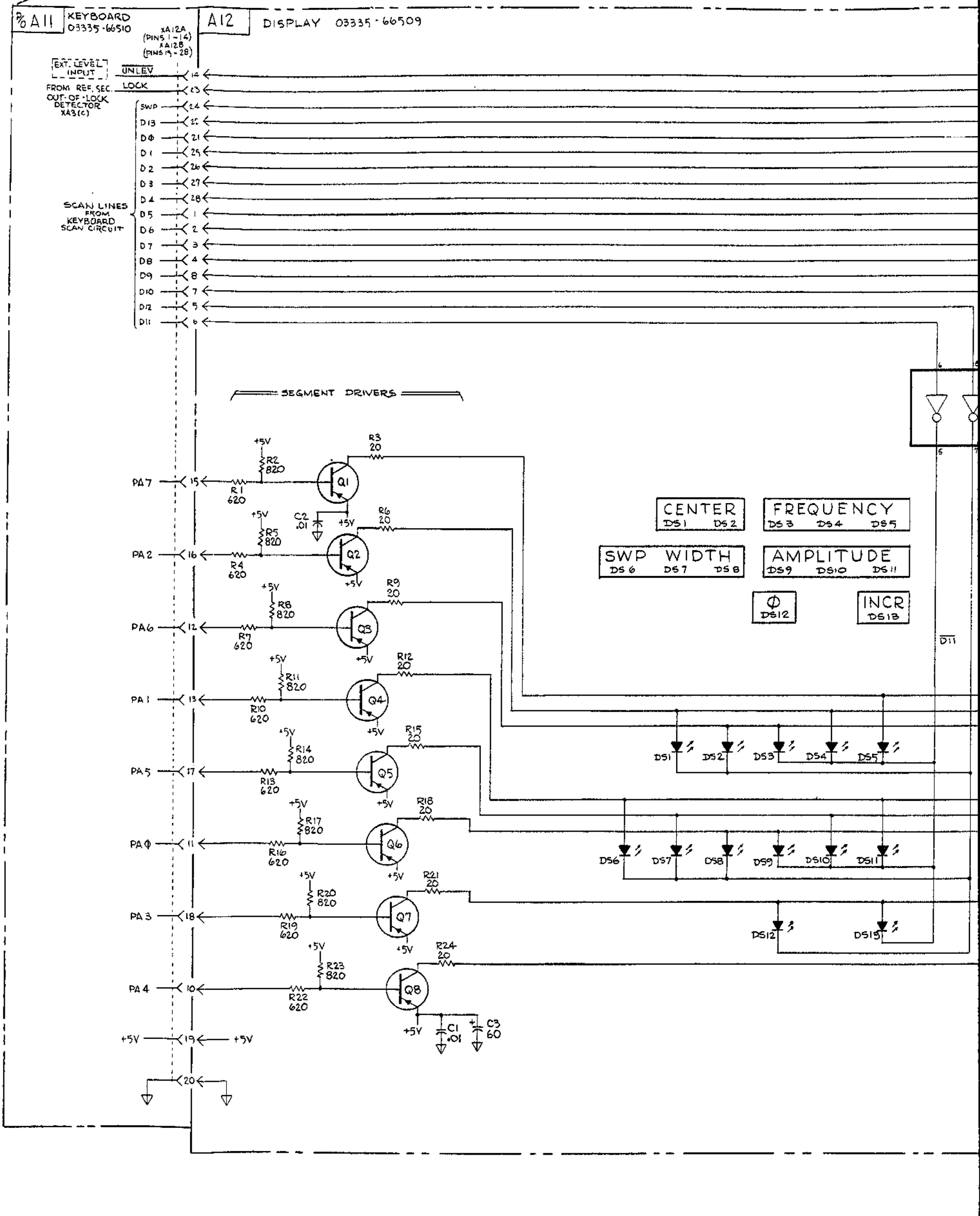


Fig 8-A-1 Sht 3 of 4

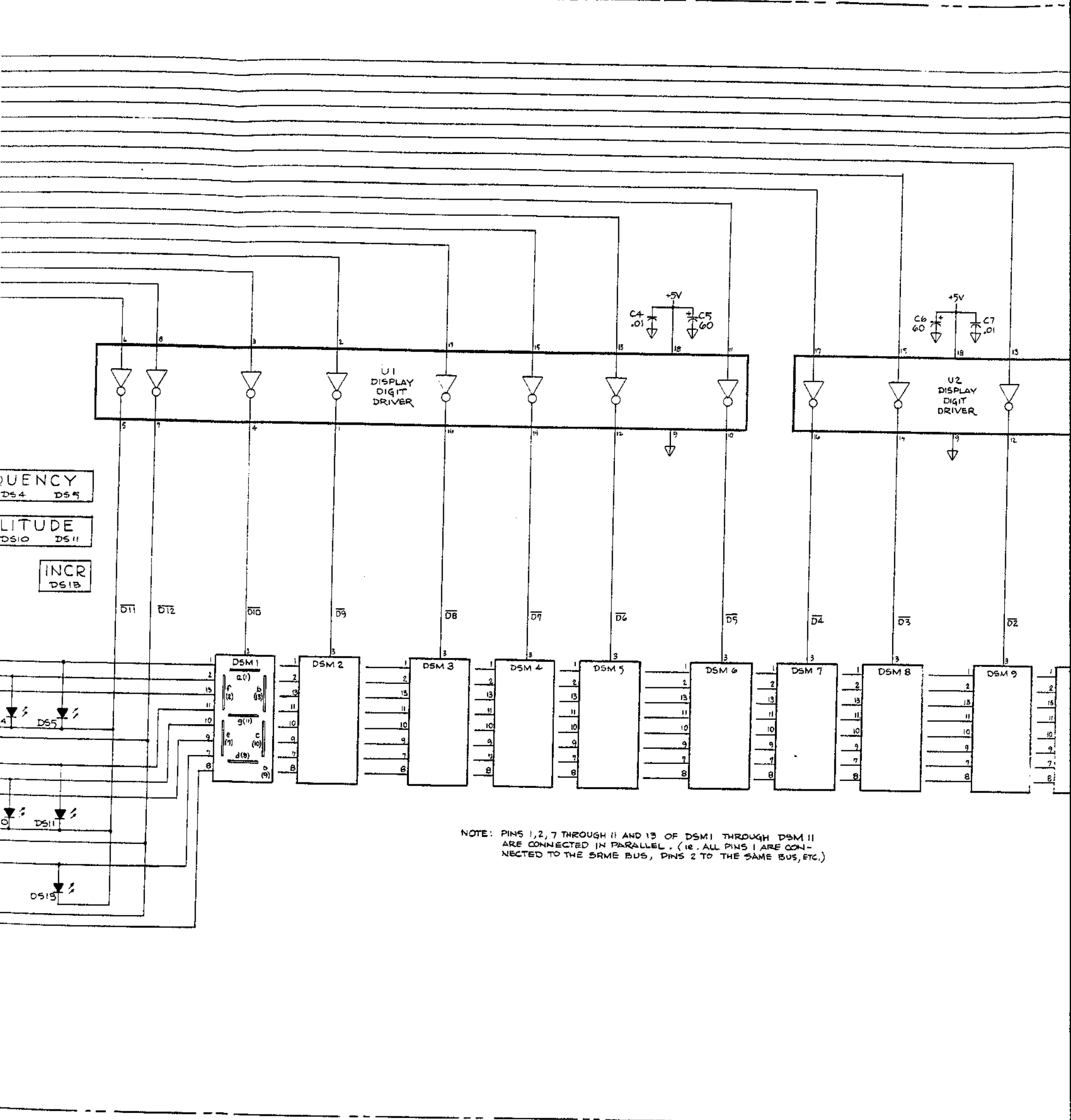
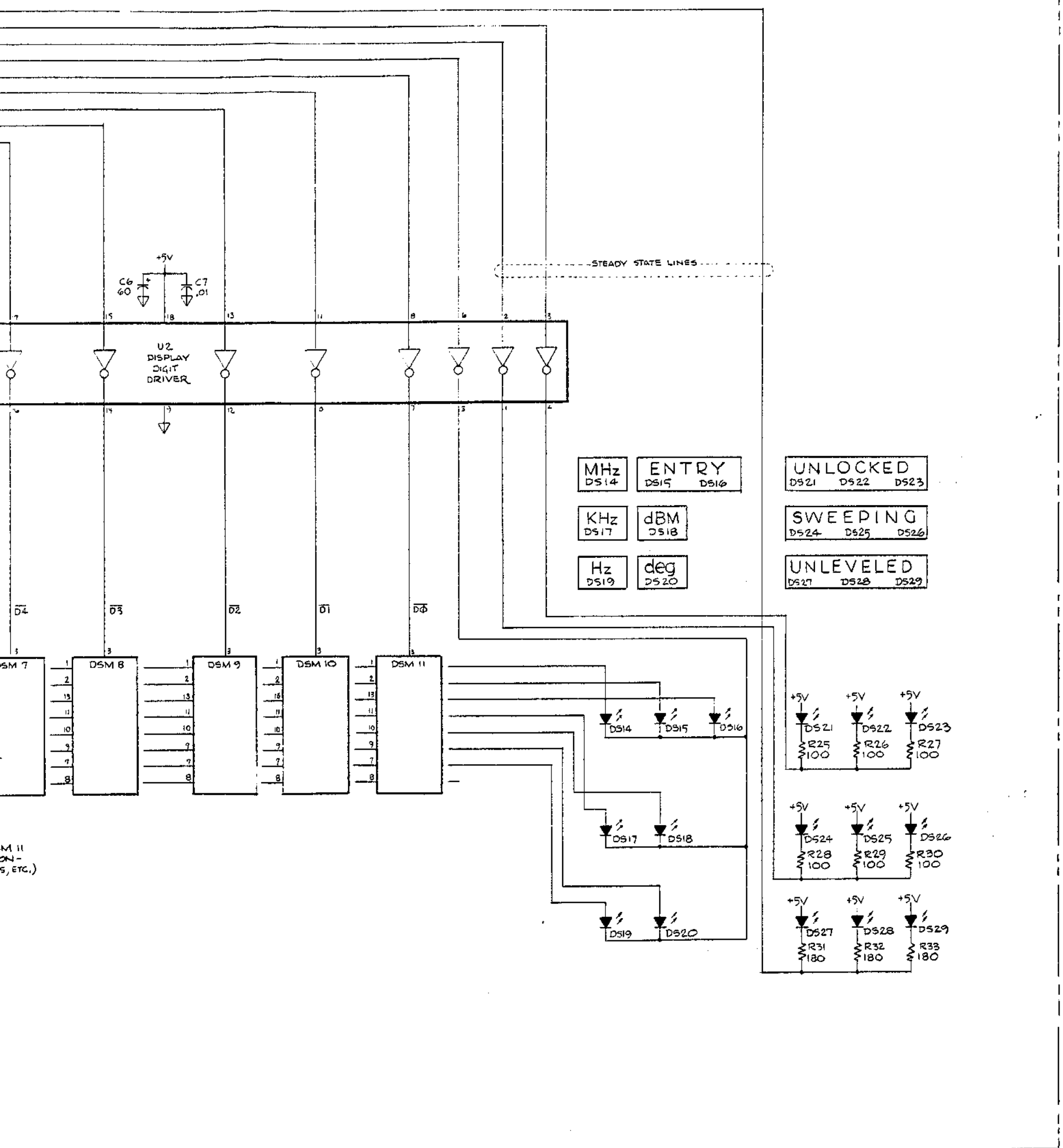


Fig 8-A-1 Sht 4 of 4

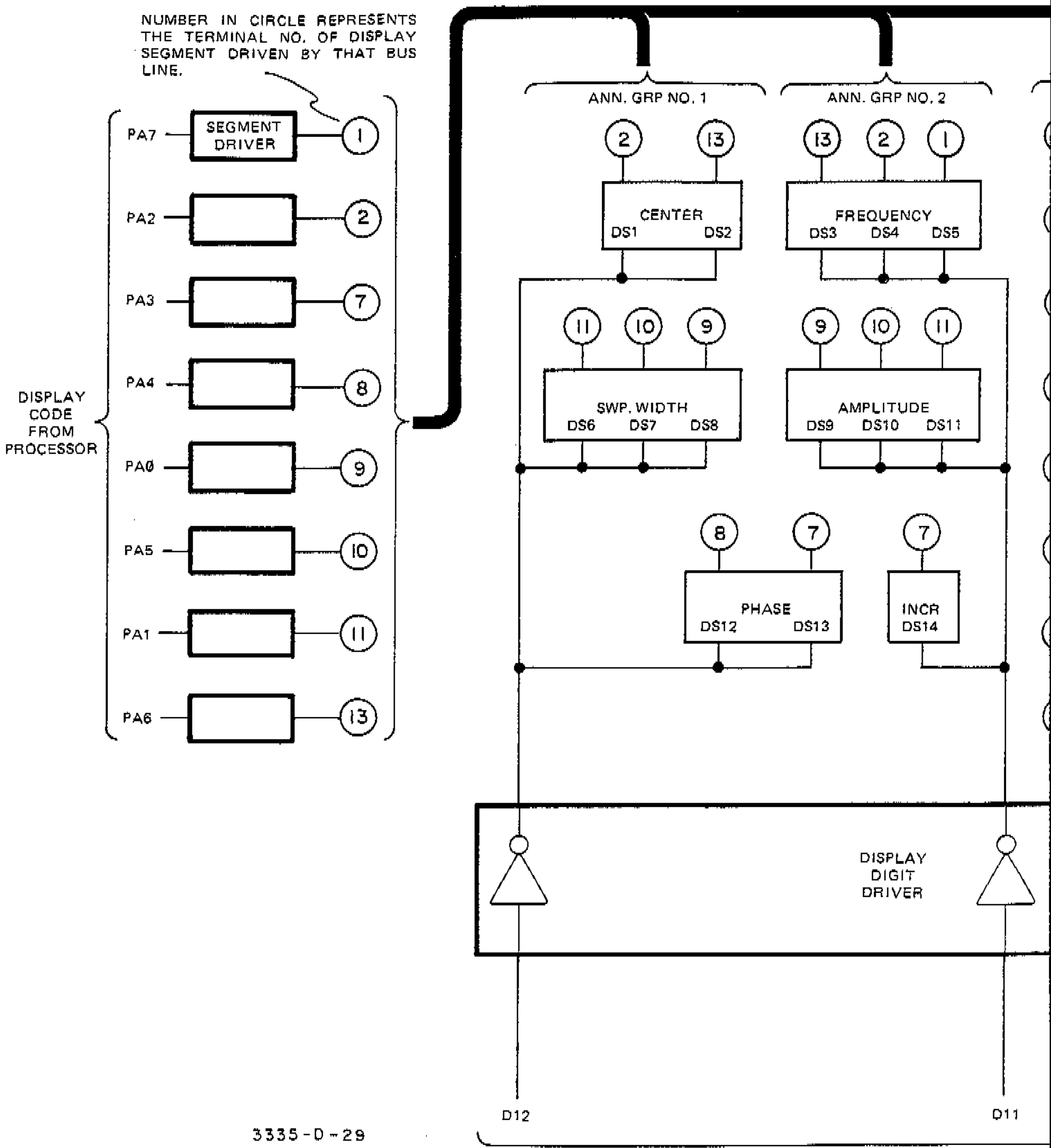


3335-E-34

A

Figure 8-A-1. Schematic Diagram Display (03335-66509) A12.

Fig 8 A-2
Sht 1 of 3



3335-D-29

Fig 8-A-2
Sht 2 of 3

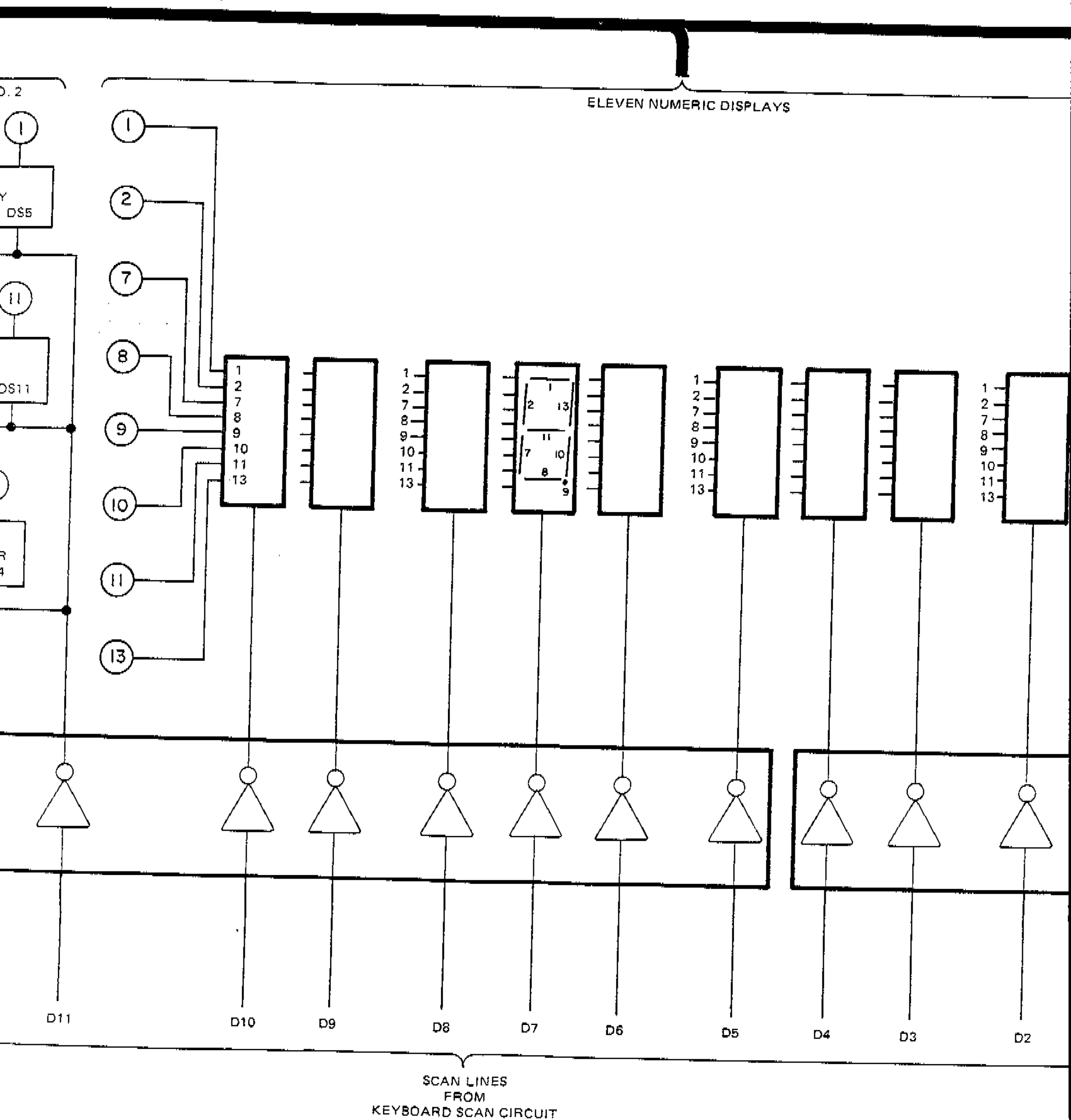


Fig 8-A-2
Sht 3 of 3

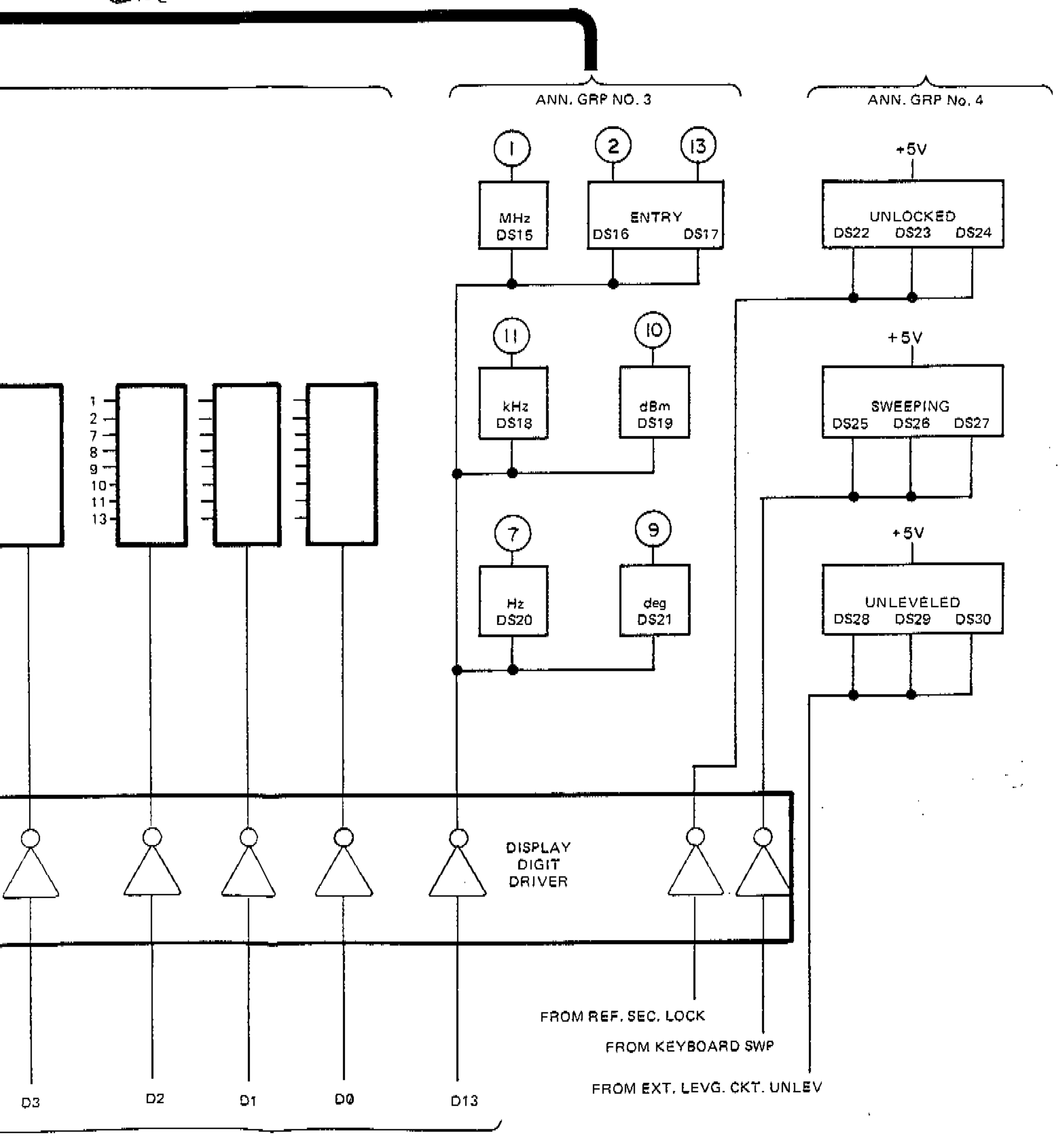


Figure 8-A-2. Block Diagram,Display (03335-66509) A12.

SERVICE GROUP B

KEYBOARD

ADJUSTMENTS

NONE

TROUBLESHOOTING DATA

The Keyboard assembly contains:

1. POWER switch and LOCAL key
2. All parameter/operation keys
3. HP-IB and function annunciator LED's
4. Annunciator latch
5. Scan circuit
6. Manual Tune RPG interface

All parameter/operation keys are scanned by the signal generated by the scan circuit. Data is transmitted to the Controller by lines PB5, PB6 and PB7. The Controller identifies an activated key by associating the low PB5, 6 or 7 with the active scan line (DØ through D13). Table 8-B-1 lists each key and the controller data input line and scan line it is associated with. The Keyboard assembly also contains two D flip-flops and two NOR gates which interface the Manual Tune RPG to their respective data lines, PB5 and PB6.

An excellent procedure for troubleshooting the keyboard is to trigger an oscilloscope on TP DØ and check the DB lines for the key being pressed (see Table 8-B-1).

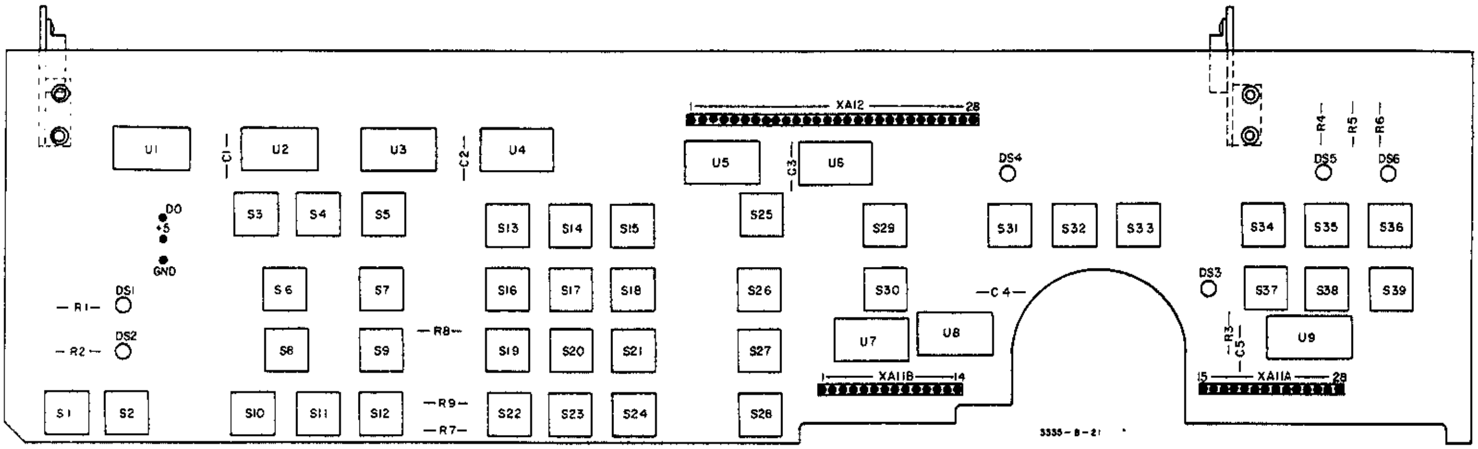
Table 8-B-1. Keyboard Switch Matrix.

Scan Lines	Controller Data Input Lines		
	PB7	PB6	PB5
DØ	Ø	RPG NAND GATE U7B (INCREASE)	RPG NAND GATE U7A (DECREASE)
D1	1	AMPTD INCR	STOP
D2	2	DISPLAY LAST ENTRY	
D3	3	SWEEP WIDTH	BACK SPACE
D4	4	FREQ INCR	Ø INCR
D5	5	FREQUENCY	NO CONN.
D6	6	AMPLITUDE	START AUTO
D7	7	RECALL	NO CONN.
D8	8	DISPLAY	NO CONN.
D9	9	STORE	MANUAL
D1Ø	INCR ↑	CLEAR	MANUAL TUNE ON/OFF
D11	INCR ↓	MHz - dBm	START SINGLE 10 SEC
D12	MANUAL TUNE ←	kHz + dBm	START SINGLE 10 SEC
D13	MANUAL TUNE →	Hz DEG	GO TO START FREQ

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A11	03335-66510	1	P.C. ASSEMBLY, KEYBOARD	28480	03335-66510
A11C1	0160-3847		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A11C2	0160-3847		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A11C3	0160-3847		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A11C4	0160-3847		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A11C5	0160-3847		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A11DS1	1990-0487	6	LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0487
A11DS2	1990-0487		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0487
A11DS3	1990-0487		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0487
A11DS4	1990-0487		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0487
A11DS5	1990-0487		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0487
A11DS6	1990-0487		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	1990-0487
A11MP1	03335-01209	1	PROCESSOR BOARD BRACKET	28480	03335-01209
A11MP2	03335-01210	1	P.C. BRACKET	28480	03335-01210
A11MP3	0380-0339	3	STANDOFF-RVT-ON .25LG 4-40THD .250D BRS	28480	0380-0339
A11MP4	0380-0339		STANDOFF-RVT-ON .25LG 4-40THD .250D BRS	28480	0380-0339
A11MP5	0380-0339		STANDOFF-RVT-ON .25LG 4-40THD .250D BRS	28480	0380-0339
A11R1	0683-1515	6	RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A11R2	0683-1515		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A11R3	0683-1515		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A11R4	0683-1515		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A11R5	0683-1515		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A11R6	0683-1515		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A11R7	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A11R8	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A11R9	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A11S1	3101-2124	1	*SWITCH, DPDT, POWER	28480	3101-2124
A11S2	3101-2123	38	*SWITCH, SPST, LOCAL	28480	3101-2123
A11S3	3101-2123		*SWITCH, SPST, STORE	28480	3101-2123
A11S4	3101-2123		*SWITCH, SPST, DISPLAY	28480	3101-2123
A11S5	3101-2123		*SWITCH, SPST, RECALL	28480	3101-2123
A11S6	3101-2123		*SWITCH, SPST, FREQUENCY	28480	3101-2123
A11S7	3101-2123		*SWITCH, SPST, FREQ INCR	28480	3101-2123
A11S8	3101-2123		*SWITCH, SPST, AMPLITUDE	28480	3101-2123
A11S9	3101-2123		*SWITCH, SPST, AMPTD INCR	28480	3101-2123
A11S10	3101-2123		*SWITCH, SPST, DISPLAY LAST ENTRY	28480	3101-2123
A11S11	3101-2123		*SWITCH, SPST, SWEEP WIDTH	28480	3101-2123
A11S12	3101-2123		*SWITCH, SPST, φ INCR	28480	3101-2123
A11S13	3101-2123		*SWITCH, SPST, 7	28480	3101-2123
A11S14	3101-2123		*SWITCH, SPST, 8	28480	3101-2123
A11S15	3101-2123		*SWITCH, SPST, 9	28480	3101-2123
A11S16	3101-2123		*SWITCH, SPST, 4	28480	3101-2123
A11S17	3101-2123		*SWITCH, SPST, 5	28480	3101-2123
A11S18	3101-2123		*SWITCH, SPST, 6	28480	3101-2123
A11S19	3101-2123		*SWITCH, SPST, 1	28480	3101-2123
A11S20	3101-2123		*SWITCH, SPST, 2	28480	3101-2123
A11S21	3101-2123		*SWITCH, SPST, 3	28480	3101-2123
A11S22	3101-2123		*SWITCH, SPST, 0	28480	3101-2123
A11S23	3101-2123		*SWITCH, SPST, .	28480	3101-2123
A11S24	3101-2123		*SWITCH, SPST, BACKSPACE	28480	3101-2123
A11S25	3101-2123		*SWITCH, SPST, CLEAR	28480	3101-2123
A11S26	3101-2123		*SWITCH, SPST, MHZ, – DBM	28480	3101-2123
A11S27	3101-2123		*SWITCH, SPST, KHZ, + DBM	28480	3101-2123
A11S28	3101-2123		*SWITCH, SPST, HZ, DEG	28480	3101-2123
A11S29	3101-2123		*SWITCH, SPST, INCR↑	28480	3101-2123
A11S30	3101-2123		*SWITCH, SPST, INCR↓	28480	3101-2123
A11S31	3101-2123		*SWITCH, SPST, ON/OFF	28480	3101-2123
A11S32	3101-2123		*SWITCH, SPST, MANUAL TUNE ←	28480	3101-2123
A11S33	3101-2123		*SWITCH, SPST, MANUAL TUNE →	28480	3101-2123
A11S34	3101-2123		*SWITCH, SPST, GO TO START FREQ	28480	3101-2123
A11S35	3101-2123		*SWITCH, SPST, START SINGLE 10 SEC	28480	3101-2123
A11S36	3101-2123		*SWITCH, SPST, START SINGLE 50 SEC	28480	3101-2123
A11S37	3101-2123		*SWITCH, SPST, MANUAL	28480	3101-2123
A11S38	3101-2123		*SWITCH, SPST, START AUTO	28480	3101-2123
A11S39	3101-2123		*SWITCH, SPST, STOP	28480	3101-2123
A11U1	1820-1200	4	IC-DIGITAL SN74LS05N TTL LS HEX 1	01295	SN74LS05N
A11U2	1820-1433	2	IC-DIGITAL SN74LS164N TTL LS R-S	01295	SN74LS164N
A11U3	1820-1200		IC-DIGITAL SN74LS05N TTL LS HEX 1	01295	SN74LS05N
A11U4	1820-1433		IC-DIGITAL SN74LS164N TTL LS R-S	01295	SN74LS164N
A11U5	1820-1200		IC-DIGITAL SN74LS05N TTL LS HEX 1	01295	SN74LS05N
A11U6	1820-1112		IC-DIGITAL SN74LS74N TTL LS DUAL	01295	SN74LS74N
A11U7	1820-1414	1	IC-DIGITAL SN74LS12N TTL LS TPL 3 NAND	01295	SN74LS12N
A11U8	1820-1112		IC-DIGITAL SN74LS74N TTL LS DUAL	01295	SN74LS74N
A11U9	1820-0786	1	IC-DIGITAL SN74174N TTL HEX D-TYPE	01295	SN74174N
A11XA11A	1251-4482	2	MOLEX, 22-02-2141	27264	OBD
A11XA11B	1251-4482		MOLEX, 22-02-2141	27264	OBD
A11XA12	1251-4496	1	MOLEX, 4030-28P	27264	OBD

Fig 8-B-1
Sht 1 of 5



A11
-hp- Part No. 03335-66510

Fig 8-B-1
Sht 2 of 5

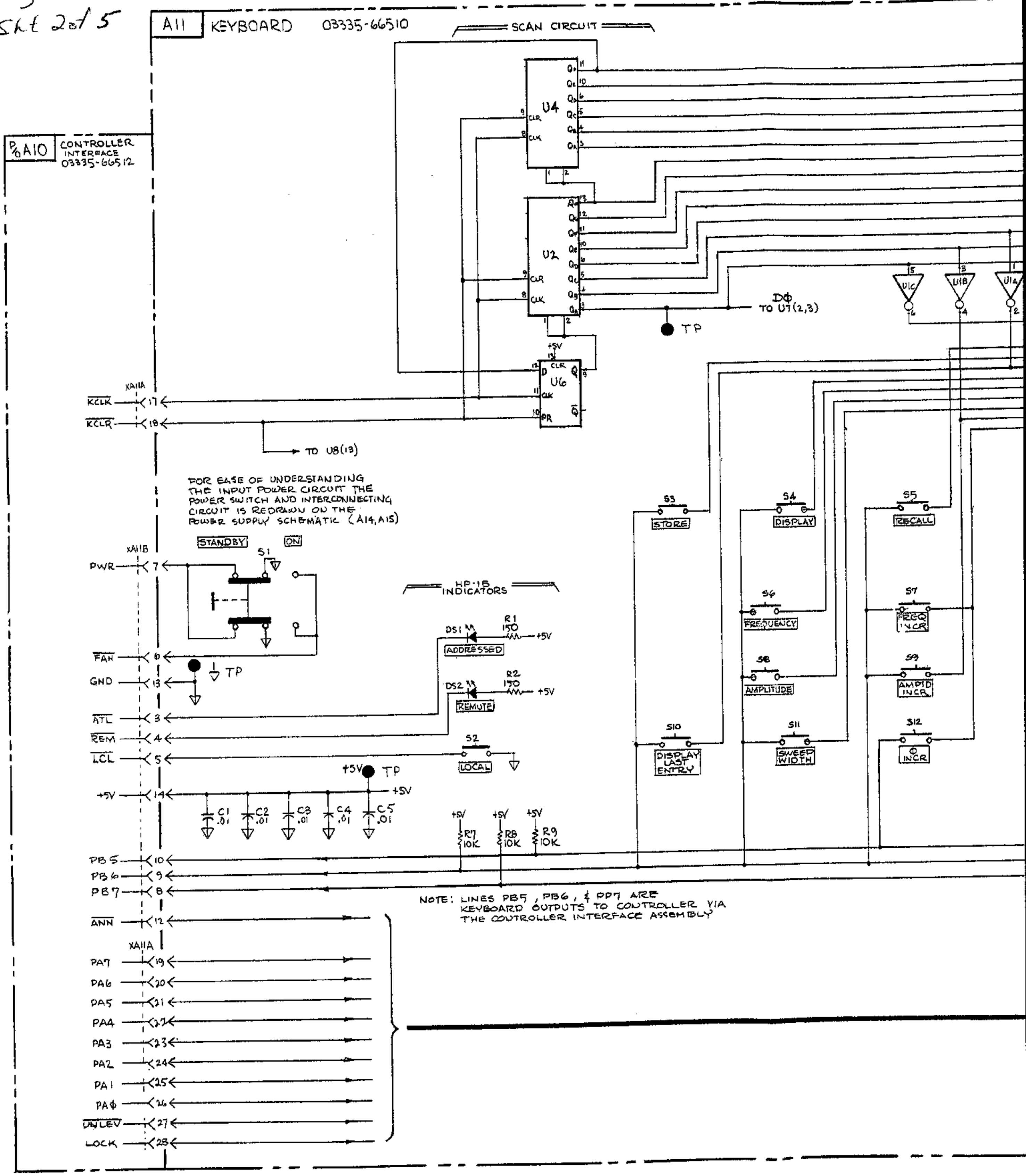


Fig 8-B-1
Sht 3 of 5

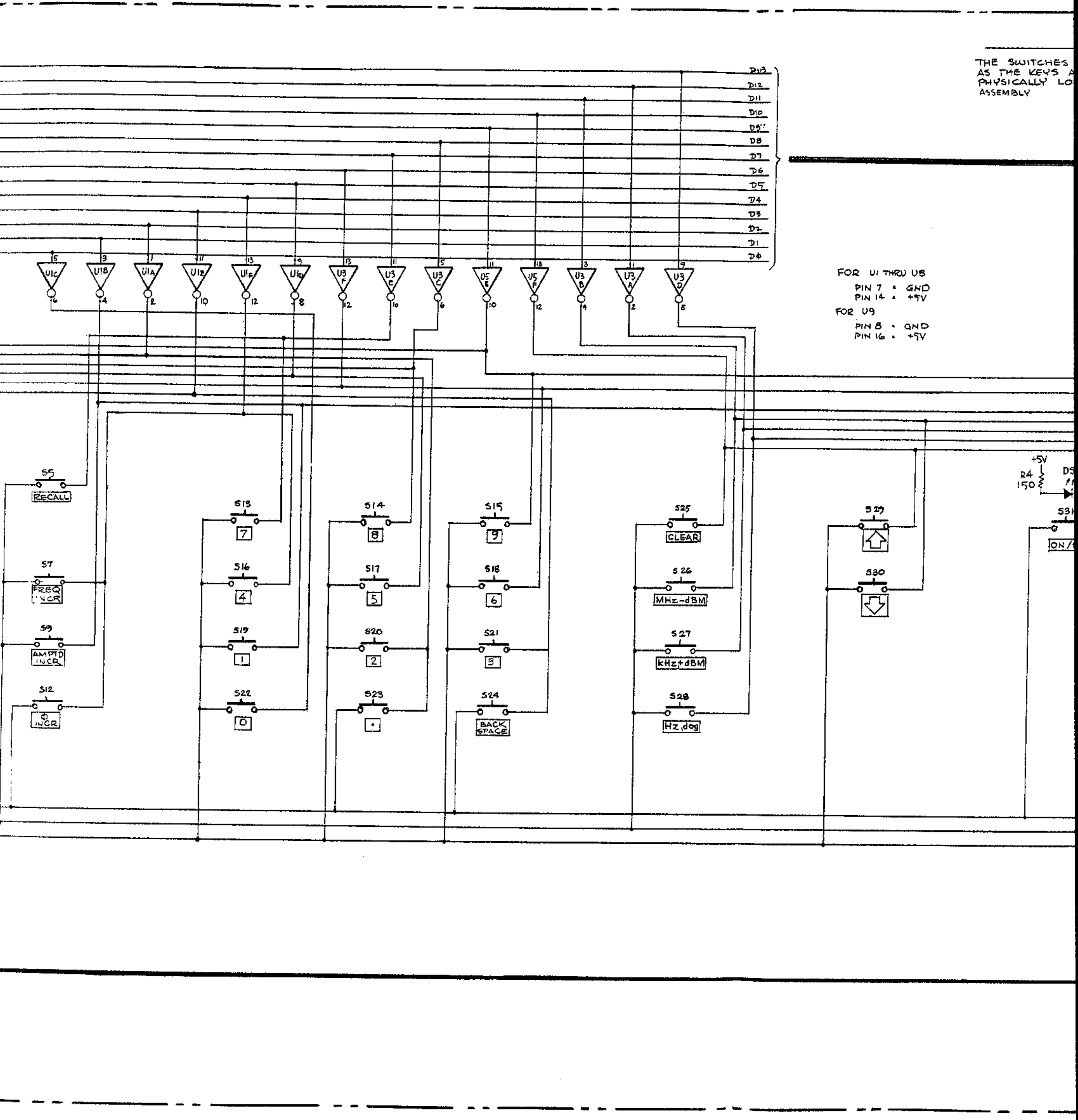


Fig 8-B-1
Sht 4 of 5

NOTE
THE SWITCHES AND LEDS ARE ORIENTED AS THE KEYS AND ANNUNCIATORS ARE PHYSICALLY LOCATED ON THE KEYBOARD ASSEMBLY

FOR U1 THRU U8
PIN 7 = GND
PIN 14 = +5V
FOR U9
PIN 8 = GND
PIN 16 = +5V

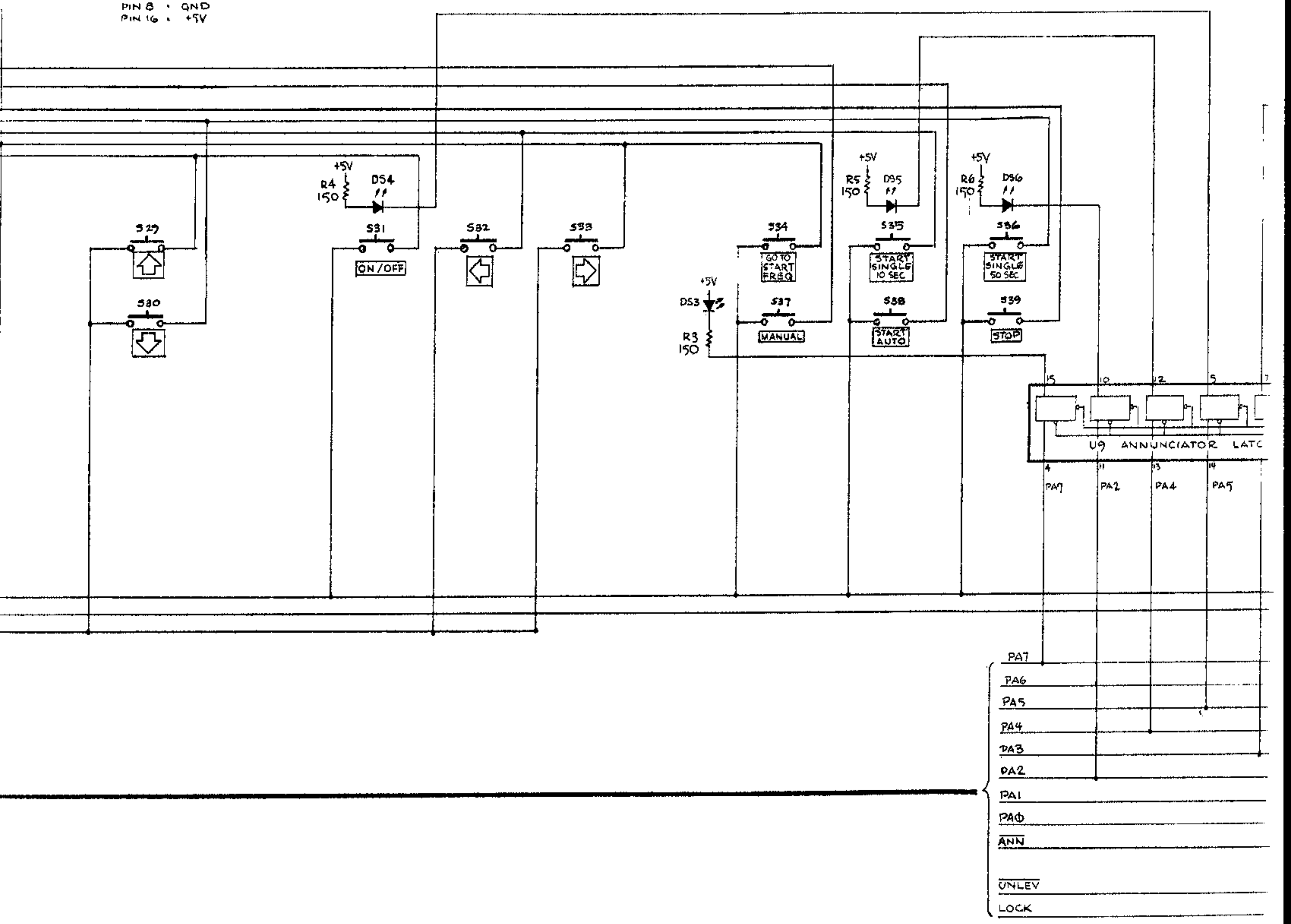
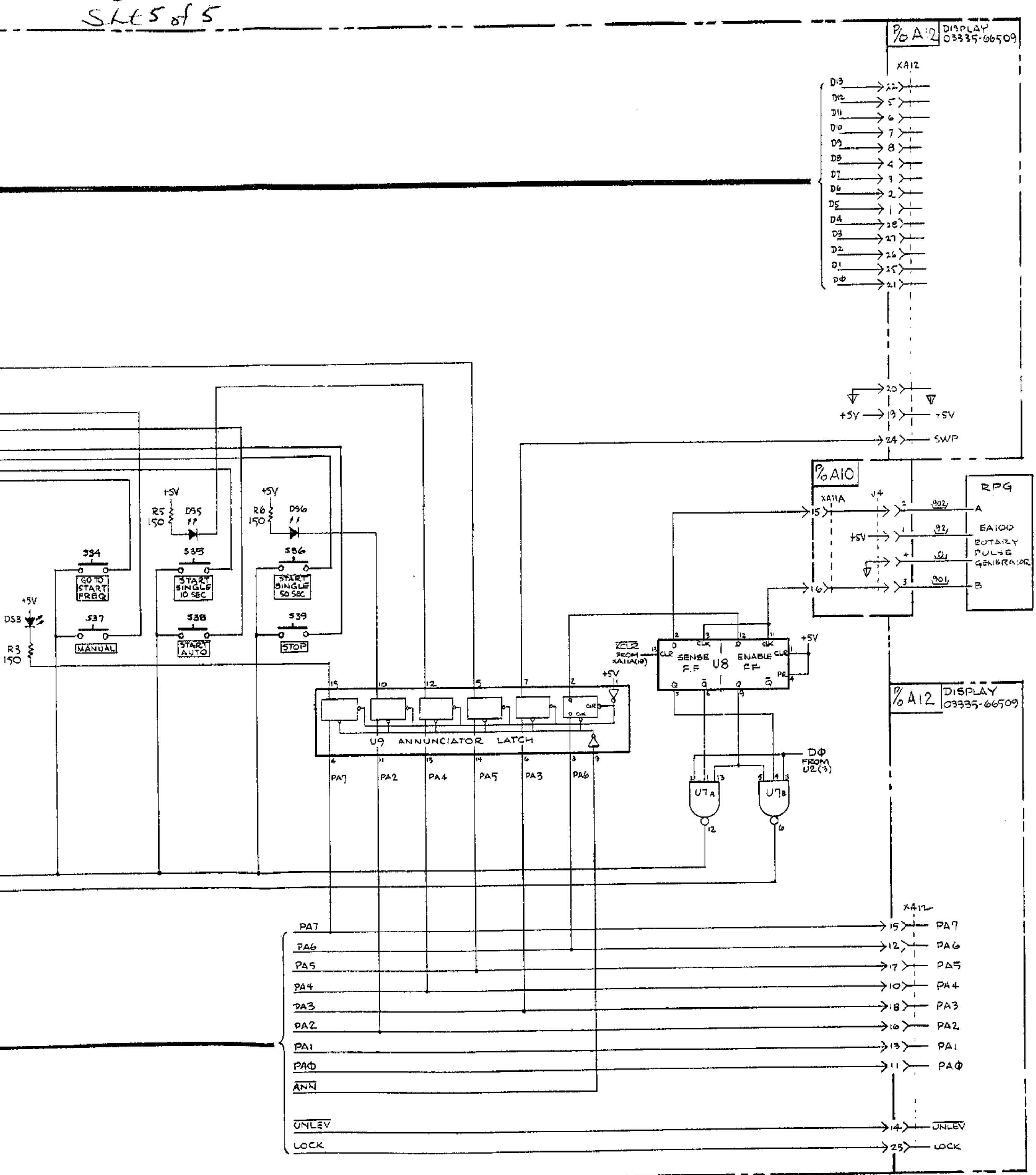


Fig 8-B-1
Sht 5 of 5



3335-E-35

B

Figure 8-B-1. Schematic Diagram Keyboard,(03335-66510) A11.

Fig 8-B-2
Sht 1 of 4

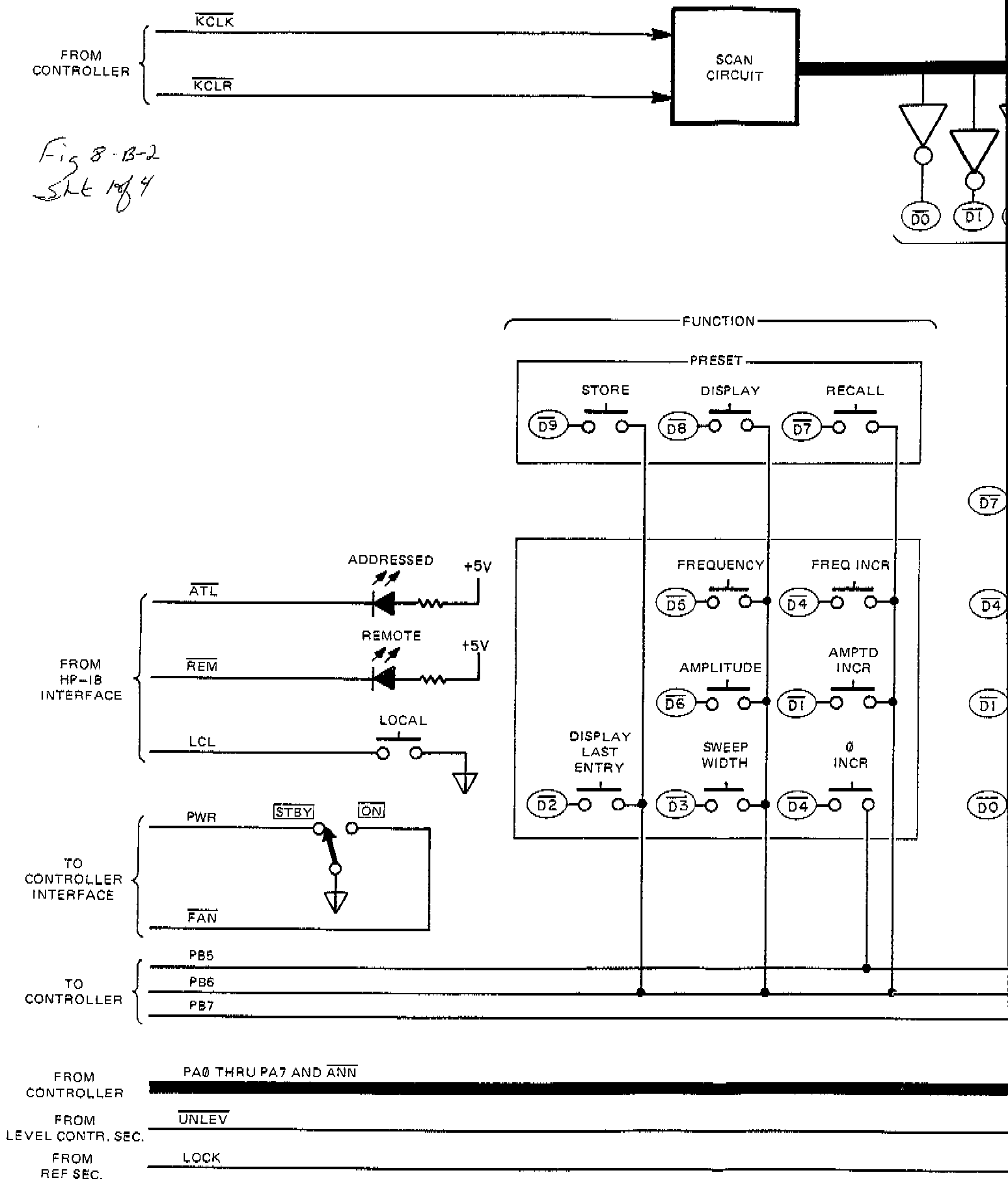


Fig 8 B-2
Sht 2 of 4

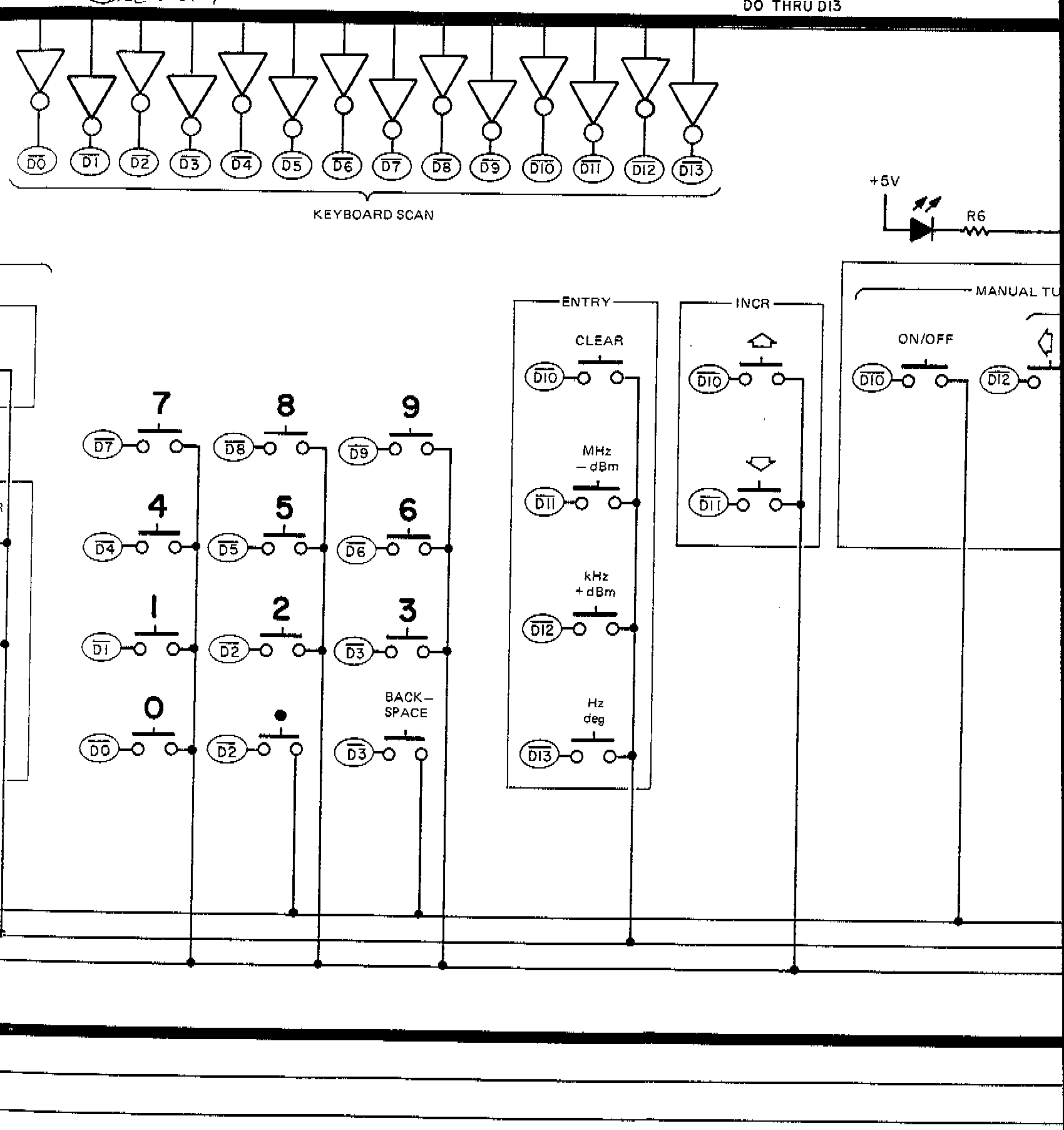


Fig 8-B-2
Sht 3 of 4

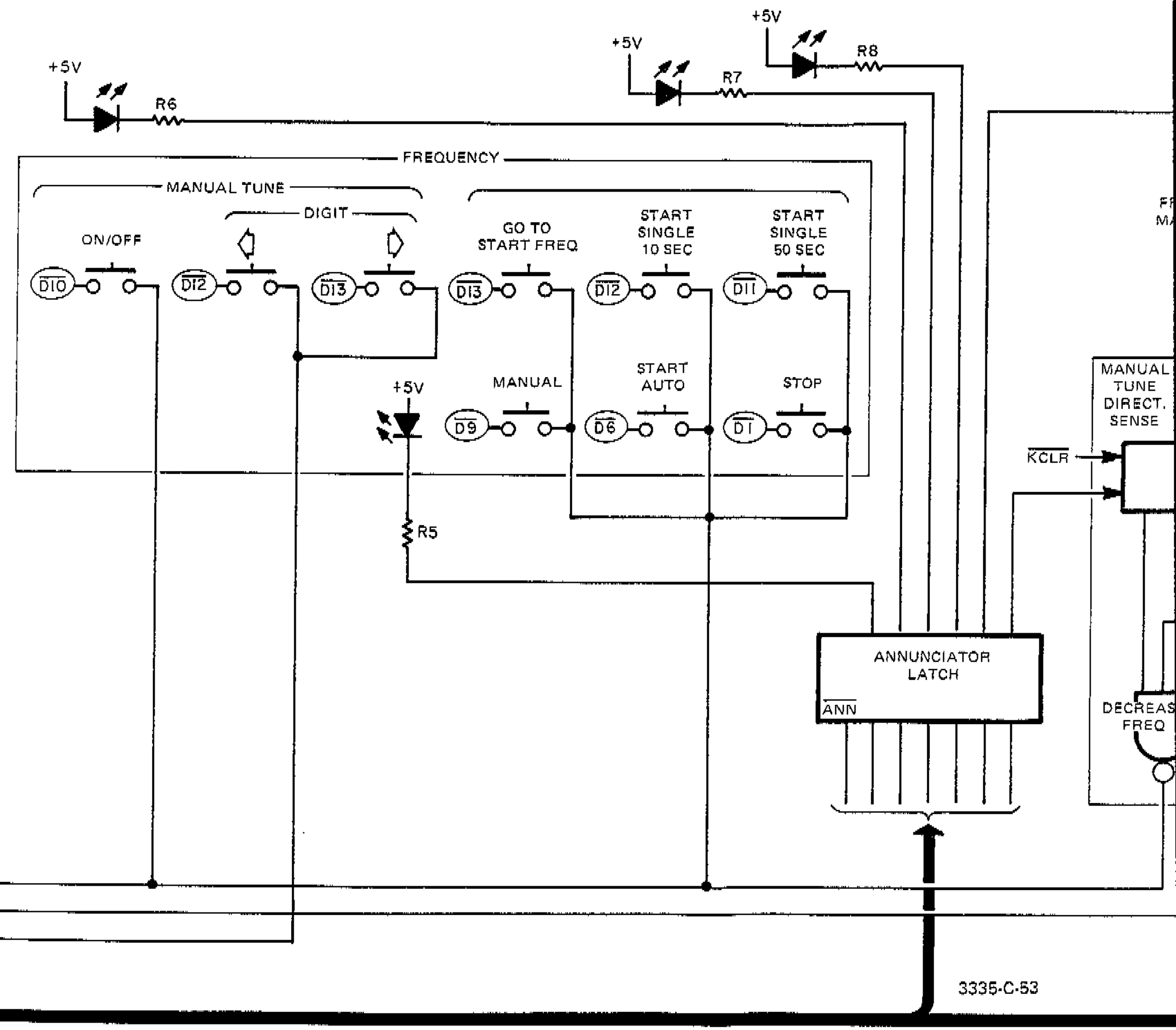


Figure 8-B-2. Blo

Fig 8 B-2 Sht 4 of 4

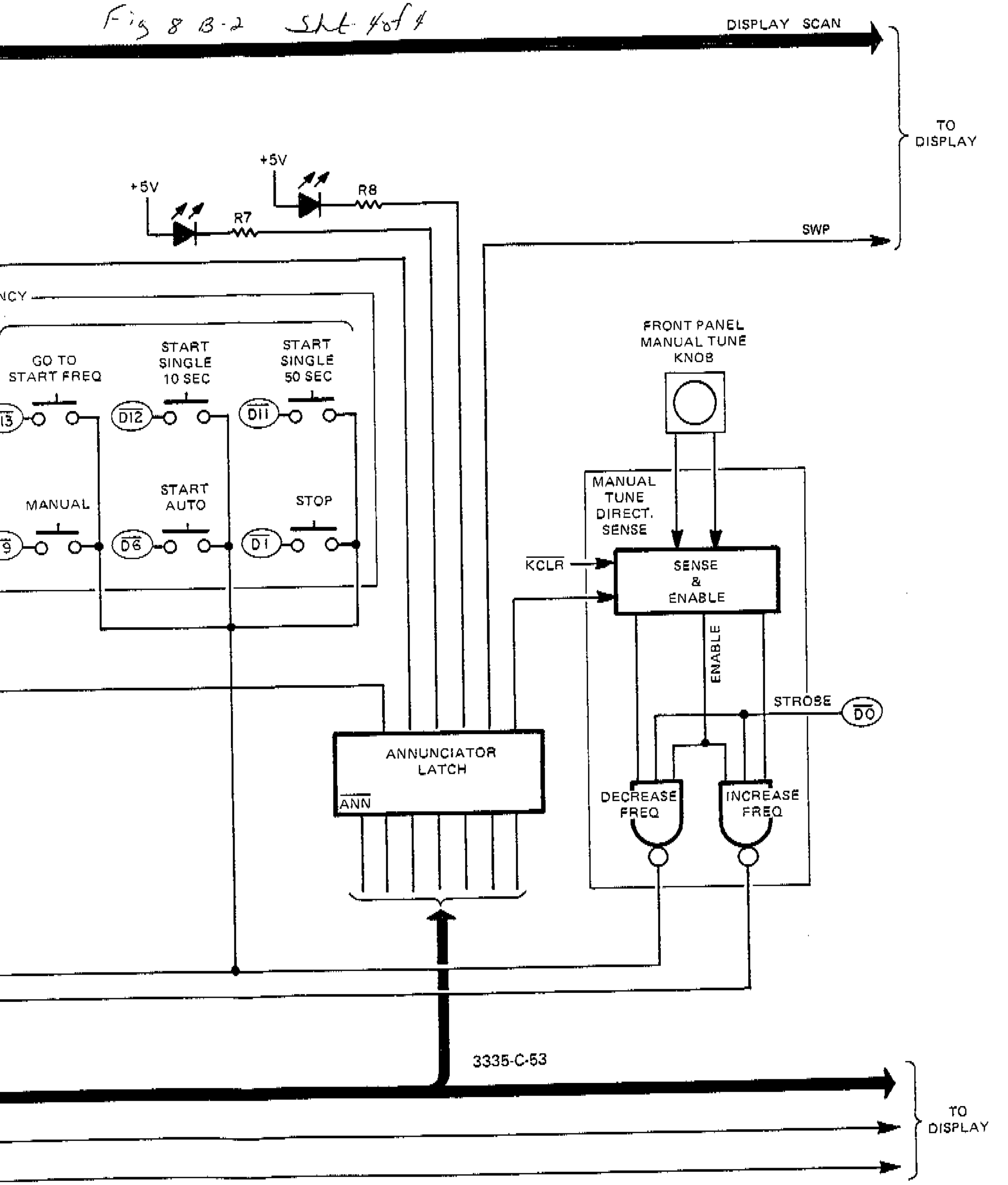


Figure 8-B-2. Block Diagram, Keyboard (03335-66510) A11.

SERVICE GROUP C

HP–IB INTERFACE

ADJUSTMENTS

NONE

TROUBLESHOOTING DATA

Troubleshooting of the HP–IB Interface assembly is by means of normal logic troubleshooting techniques. A general troubleshooting outline follows.

1. Verify the isolated and non-isolated + 5 V supplies.

2. Verify the operation of optical couplers OC1 through OC8.

3. Verify operation of Data Select IC's U11 and U12.

Table 8-C-1. U11/U12 Function Table

INPUTS			OUTPUTS
SELECT(S)	A	B	Y
L	L	X	L
L	H	X	H
H	X	L	L
H	X	H	H

H = HIGH, L = LOW, X = IRRELEVANT

4. Verify operation of the Decoder, U10.

Table 8-C-2. U10 Function Table.

INPUTS					OUTPUTS							
ENABLE		SELECT										
G1	G2*	C	B	A	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	H	H	H	H	H	L	H	H	H	H
H	L	H	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	H	L	H	H
H	L	H	H	L	H	H	H	H	H	H	L	H
H	L	H	H	H	H	H	H	H	H	H	H	L

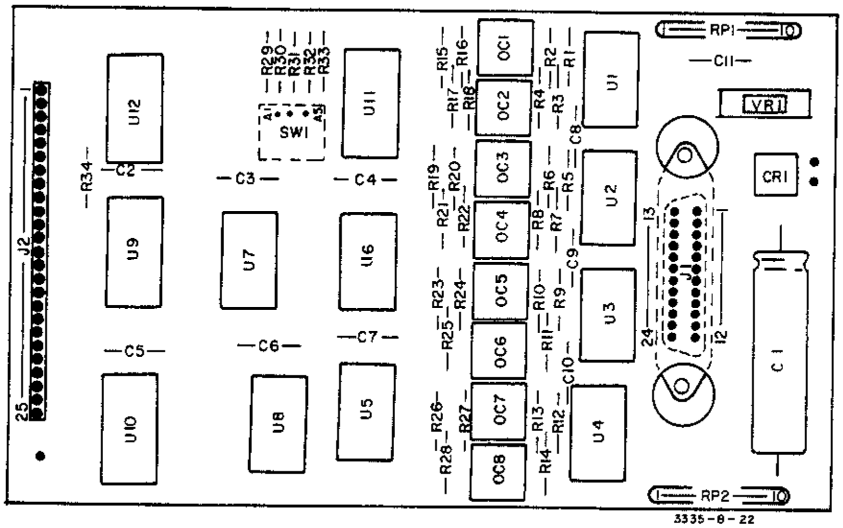
*G2 = G2A + G2B
H = high level, L = low level, X = irrelevant

5. Verify remaining logic using normal techniques.

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A16	03335-66513	1	PC ASSEMBLY, HP-IB INTERFACE	28480	03335-66513
A16C1	0180-0466	1	CAPACITOR-FXD 2200UF+100-10% 16VDC AL	28480	0180-0466
A16C2	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A16C3	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A16C4	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A16C5	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A16C6	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A16C7	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A16C8	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A16C9	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A16C10	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A16C11	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A16CR1	1901-0364	1	DIODE-FW BRDG 200V 1A	04713	SDA 10185-4
A16J1	1251-4040	1	CONNECTOR 24-PIN F MICRO RIBBON	90949	57-20240-8
A16J2	1251-4112		CONNECTOR 25-PIN M POST TYPE	27264	22-03-2251
A16OC1	1990-0594	5	OP-ISOLATOR 5082-4354	28480	1990-0594
A16OC2	1990-0594		OP-ISOLATOR 5082-4354	28480	1990-0594
A16OC3	1990-0594		OP-ISOLATOR 5082-4354	28480	1990-0594
A16OC4	1990-0594		OP-ISOLATOR 5082-4354	28480	1990-0594
A16OC5	1990-0594		OP-ISOLATOR 5082-4354	28480	1990-0594
A16OC6	1990-0455	2	OPTO-ISOLATOR LED-PDIO/XSTR IF=25MA-MAX	28480	1990-0455
A16OC7	1990-0455		OPTO-ISOLATOR LED-PDIO/XSTR IF=25MA-MAX	28480	1990-0455
A16R1	0683-2015	14	RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R2	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R3	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R4	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R5	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R6	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R7	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R8	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R9	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R10	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R11	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R12	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R13	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R14	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R15	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R16	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R17	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R18	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R19	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R20	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R21	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R22	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R23	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R24	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R25	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16R26	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R27	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R28	0683-2015		RESISTOR 200 5% .25W FC TC=-400/+600	01121	CB2015
A16R29	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A16R30	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A16R31	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A16R32	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A16R33	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A16R34	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A16RP1	1810-0136	2	NETWORK-RES 10-PIN-SIP .1-PIN-SPCG	28480	1810-0136
A16RP2	1810-0136		NETWORK-RES 10-PIN-SIP .1-PIN-SPCG	28480	1810-0136
A16S1	3101-1860	1	SWITCH-SL 5-1A-NS DIP-SLIDE-ASSY .1A	11237	206 TYPE
A16U1	1820-1053	3	IC-DIGITAL SN7414N TTL HEX 1	01295	SN7414N
A16U2	1820-1053		IC-DIGITAL SN7414N TTL HEX 1	01295	SN7414N
A16U3	1820-1144		IC-DIGITAL SN74LS02N TTL LS QUAD 2 NOR	01295	SN74LS02N
A16U4	1820-0621	1	IC-DIGITAL SN7438N TTL QUAD 2 NAND	01295	SN7438N
A16U5	1820-0077	1	IC-DIGITAL SN7474N TTL DUAL D-TYPE	01295	SN7474N
A16U6	1820-1053		IC-DIGITAL SN7414N TTL HEX 1	01295	SN7414N
A16U7	1820-1201		IC-DIGITAL SN74LS08N TTL LS QUAD 2 AND	01295	SN74LS08N
A16U8	1820-1197		IC-DIGITAL SN74LS00N TTL LS QUAD 2 NAND	01295	SN74LS00N
A16U9	1820-1089	1	IC-DIGITAL SN74279N TTL QUAD	01295	SN74279N
A16U10	1820-1216		IC-DIGITAL SN74LS138N TTL LS 3	01295	SN74LS138N
A16U11	1820-1470		IC-DIGITAL SN74LS157N TTL LS QUAD 2	01295	SN74LS157N
A16U12	1820-1470		IC-DIGITAL SN74LS157N TTL LS QUAD 2	01295	SN74LS157N
A16VR1	1826-0122	1	IC 7805C V RGLTR	07263	7805UC

Fig 8-C-1
Sht 1 of 4



A16
-hp- Part No. 03335-66513

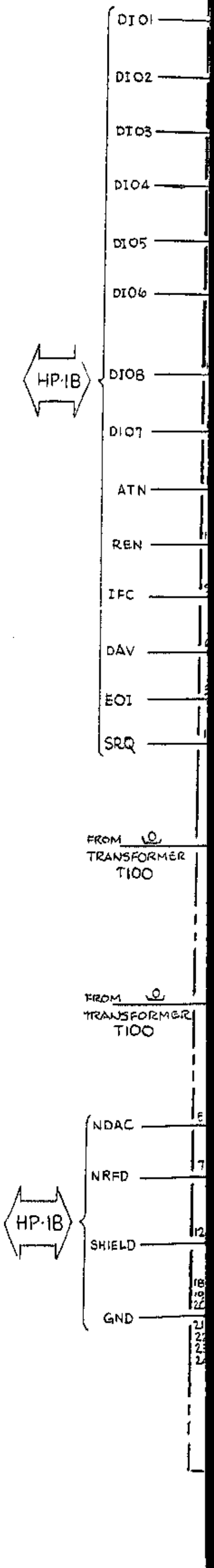


Fig 8-C-1 Sht 2 of 4

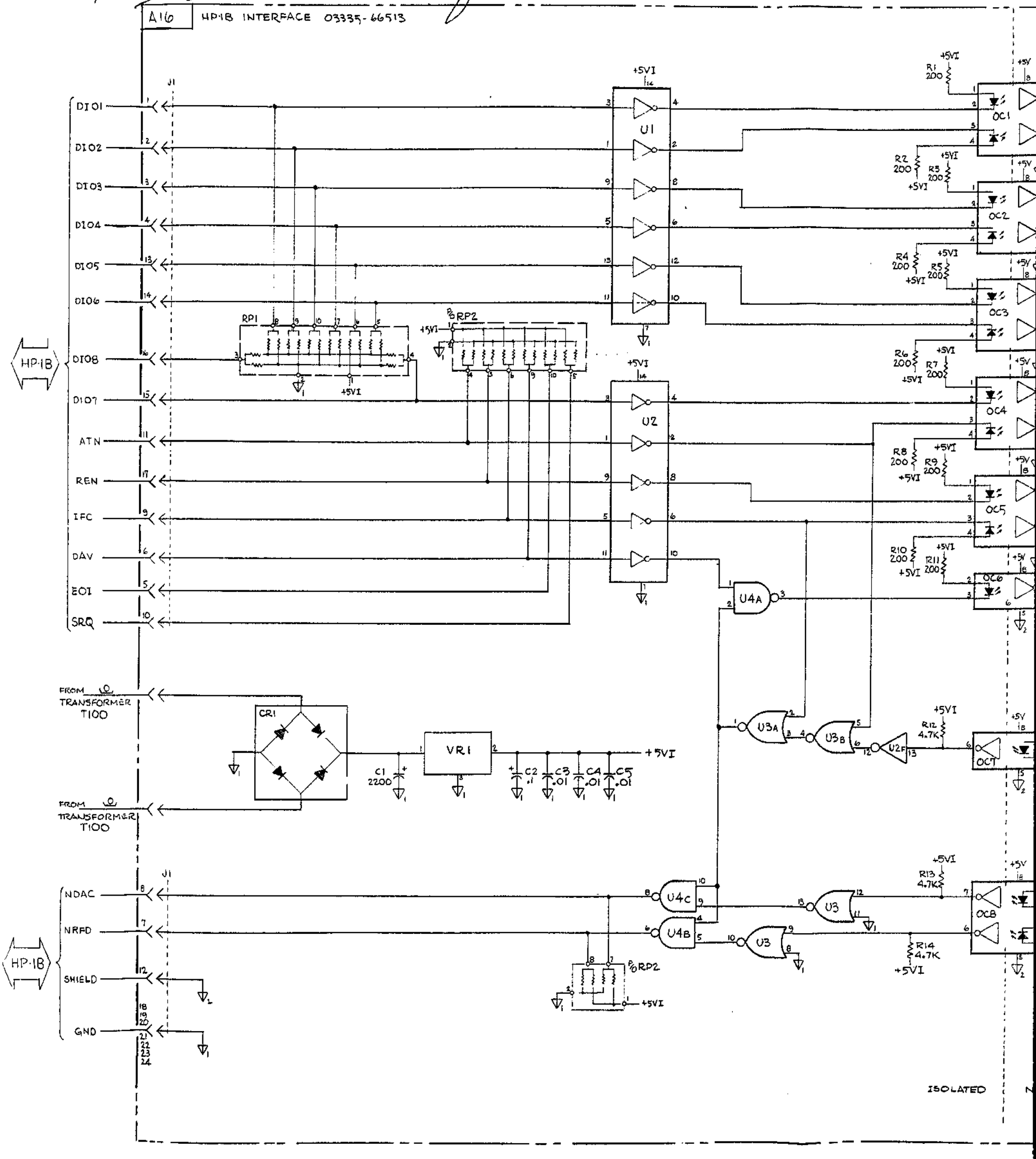
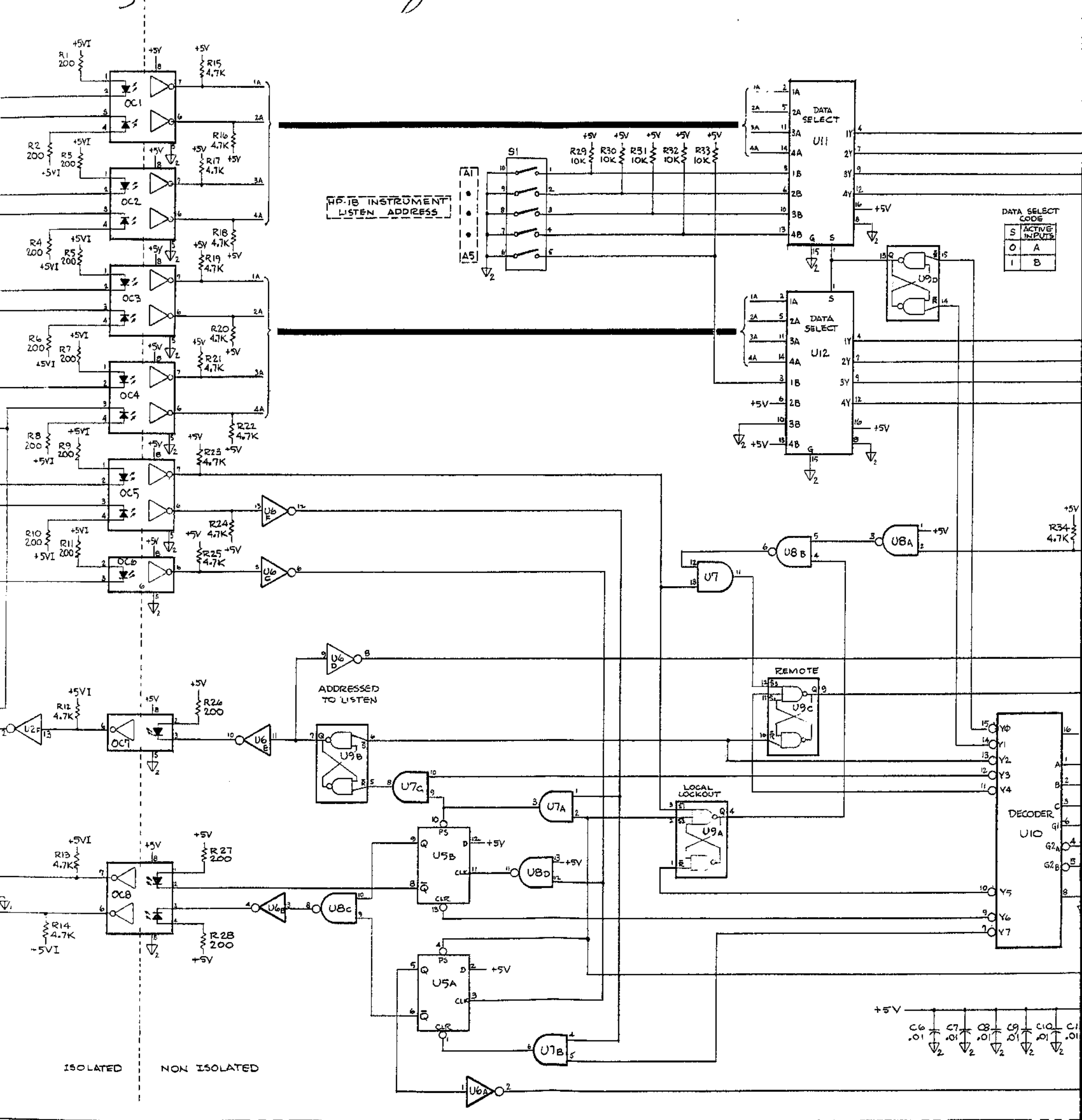
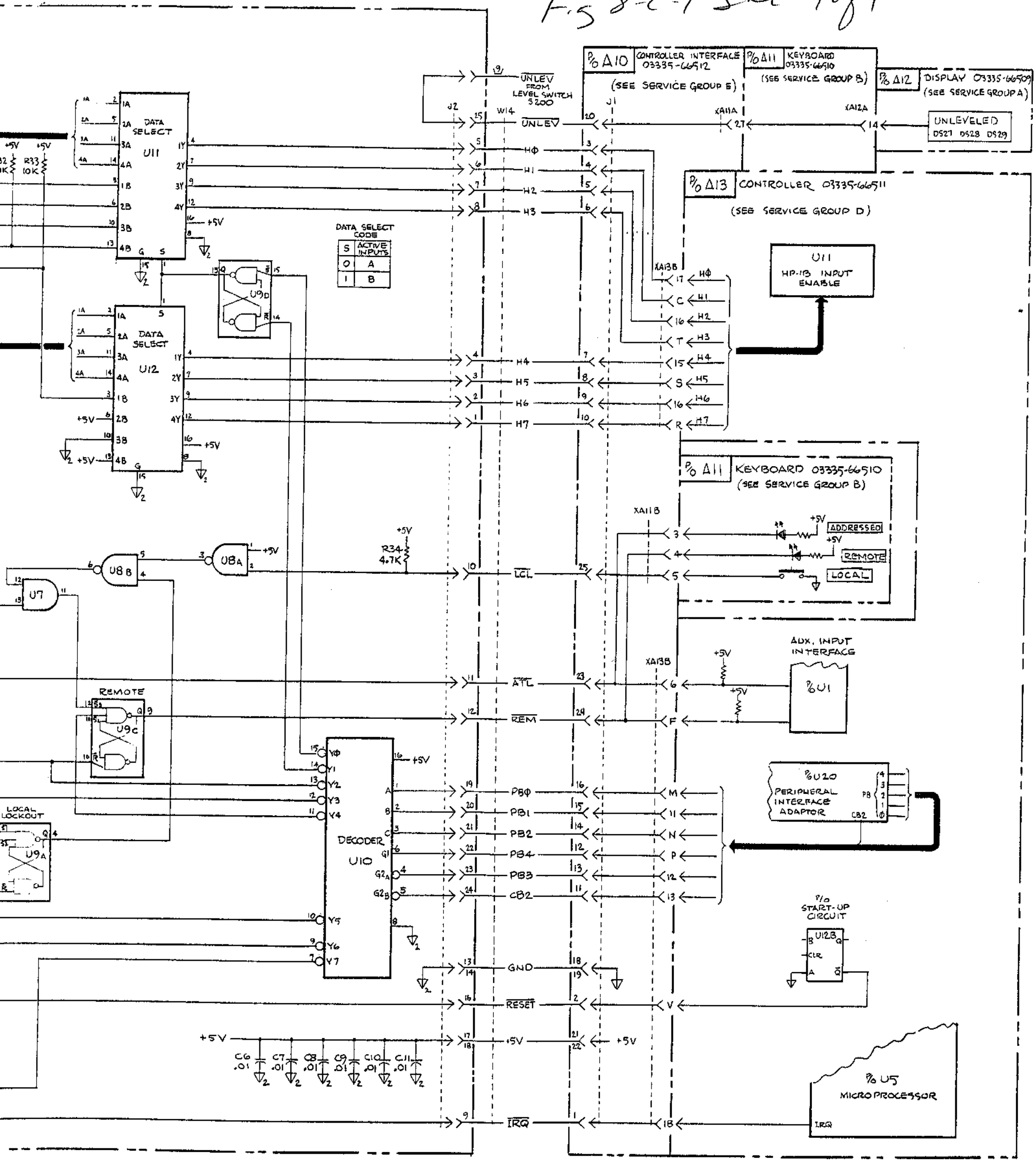


Fig 8-C-1 Sht 3 of 4



 3335-E-54

Fig 8-C-1 Sht 4 of 4



C

Figure 8-C-1. Schematic Diagram, HP–IB Interface (03335-66513) A16.

SERVICE GROUP D

CONTROLLER

ADJUSTMENTS

NONE

TROUBLESHOOTING DATA

NOTE

A general understanding of how the controller section operates is required before troubleshooting of this section can be effective.

The controller generates the data required to establish the programmed frequency and amplitude. The data is generated by the data interface section of the controller. It is held by latches in the controller, the controller interface or the assembly to which the data is transferred. The latching of data is on command of clock lines from the control line decoder of the controller.

The Keyboard and Display sections are operated by a scan circuit located on the Keyboard. The scan circuit synchronizes the display data with the correct display element and is used by the controller to identify an activated key. The controller activates the scan circuit using control lines $\overline{KCLK}$ and $\overline{KCLR}$ from the control line decoder. With this interconnection, the controller has direct control of the scan rate to control the display.

Controller troubleshooting should begin at "turn-on". The turn-on routine transfers data to the various sections of the instrument establishing the turn-on parameters (Frequency = 1 MHz, Amplitude = - 86.98 dBm for 50 ohms or - 88.74 dBm for 75 ohms). Following turn-on, the display should indicate 1 000 000.0 Hz. All controller section output lines should not be changing except $\overline{KCLK}$, CB2 and data lines PAØ, PA2 - PA7. Data line PA1 does not change because the digits displayed to not require the center horizontal segment of the display.

The control lines and the data lines of the controller section are each identified by a mnemonic. Table 8-D-1 is a mnemonic dictionary listing these lines and defining and describing the function of each line.

The firmware, or the routines associated with controller operation, is fixed in ROM's U2, U3 and U4. The routines associated with each ROM are listed in Table 8-D-2.

Signature Analysis (SA).

CAUTION

Before performing an SA test, disconnect the attenuator. Failure to do so can result in damage to the attenuator. The SA tests cause the switches internal to the attenuator to continuously be opened and closed for the duration of the test.

The 3335A controller contains a troubleshooting technique called Signature Analysis (SA). SA is a nodal troubleshooting technique based on the fact that each node has a unique signature when the circuit is stimulated by a repetitive routine. A signature consists of four alphanumeric characters, and if an incorrect signature is obtained at a particular node, this is an indication that the node is defective. This analysis does not identify a faulty component but only indicates a defective node. By checking all signa-

Table 8-D-1. 3335A Mnemonic Dictionary.

Mnemonic	Description/Comments	Source
$\overline{\text{LCL}}$	Return to Local Command	A11S2 (Keyboard LOCAL Key)
$\overline{\text{REM}}$	$\overline{\text{REMOTE}}$, Controls Keyboard HP-IB REMOTE annunciator	
$\overline{\text{ATL}}$	$\overline{\text{ADDRESSED (to Listen)}}$, Controls Keyboard HP–IB ADDRESSED annunciator	A16U9C (9)
$\overline{\text{IRQ}}$	$\overline{\text{INTERRUPT REQUEST}}$, interrupts micro-processor to initiate the HP-IB routine.	A16U6A (2)
H0	HP-IB data lines from the HP-IB Interface (A16) to the Controller (A13)	A16U11 (4)
H1		(7)
H2		(9)
H3		(12)
H4		A16U12 (4)
H5		(7)
H6		(9)
H7		(12)
PB0	HP-IB control lines from the Controller PIA (A13U20) to the HP-IB DECODER (A16U10)	A13U20 (10)
PB1		(11)
PB2		(12)
PB3		(13)
PB4		(14)
CB2		(19)
PB5	Data input lines from the Keyboard (A11) to the Controller PIA (A13U20) (PIA Input terminals are shown in Source column). For key relationship to these lines see keyboard switch matrix table in Service Group B.	A13U20 (15)
PB6		(16)
PB7		(17)
NSH	N Step Loop (A9) Shift Register Clock. Shifts eight data bits via the SER line into a serial-to-parallel converter (A9U1).	A13U29 (12)
LSH	Level Control Loop (A6) shift Register Clock. Shifts ten data bits via the SER line into a shift register (A6U7, U8).	A13U29 (8)
SER	SERIAL Data line to N Step Loop and Level Control Loop: a. N Step Loop serial data occurs as one load of A13U28 (Controller) with all eight bits shifted to the N Step Loop least significant digit first. b. Level Control Loop serial data occurs as two loads of A13U28 (Controller). The first load shifts only two bits while the second load shifts all eight bits for a total of ten bits. Data is shifted most significant bit first. The selected amplitude versus bit code is shown in Service Group M.	A13U28 (9)
NLCH	N Step Loop Latch. Latches the data output from the serial-to-parallel converter (A9U1) into the data latch (A9U2) both on the N Step Loop Assembly.	A13U29 (10)
NF8	Fractional-N Data lines (comprises the BCD frequency data and loop instructions). Frequency data consists of 16 BCD digits transferred least significant digit first. An instruction consists of one BCD digit (4 bits).	A13U27 (3)
NF4		A13U27 (11)
NF2		A13U27 (6)
NF1		A13U27 (8)
FDC	Fractional-N Data Clock, Clocks the 16 BCD digits, least significant digit first, into one of the two frequency registers of the N.F Loop.	A13U29 (2)
FIV	Fractional-N Instruction Valid clocks the one BCD digit instruction into the N.F Loop op code latch, A4U17.	A13U29 (4)

Table 8-D-1. 3335A Mnemonic Dictionary (Cont'd).

Mnemonic	Description/Comments	Source
FS3 FS2 FS1	Filter Select Lines (and Dif-Fil and Mixer modulator control). Filter Select Data is latched on the Controller by A13U26. A table of filter select codes is located in Service Group L.	A13U26 (11) A13U26 (10) A13U26 (2)
$\overline{\text{RESET}}$	Turn-on Signal	A13U12B (12)
$\overline{\text{KCLR}}$	Clears Scan Shift Registers	A13U25 (14)
$\overline{\text{KCLK}}$	Clocks Scan Shift Register (not free running, clocks on the low-to-high transition)	A13U25 (15)
$\overline{\text{ANN}}$	Annunciator Latch, latches data which controls the Keyboard Sweep annunciators	A13U25 (11)
$\overline{\text{ATT}}$	Attenuator latch and enable trigger	A13U25 (10)
PA0 PA1 PA2 PA3 PA4 PA5 PA6 PA7	External Data Bus	A13U20 (2) (3) (4) (5) (6) (7) (8) (9)
D/A	Analog Output to BNC on Front panel (Sweep Output: 0 - +2 V)	A13U21 (14)
A15	Not Used	A13U5 (25)
A14	Not Used	A13U5 (24)
A13 A12 A11 A10 A9 A8 A7 A6 A5 A4 A3 A2 A1 A0	Address Bus	A13U5 (23) (22) (20) (19) (18) (17) (16) (15) (14) (13) (12) (11) (10) (9)
$\overline{\text{ENA}}$	Enable Line to Address Decoder	A13U18A (12)
D7 D6 D5 D4 D3 D2 D1 D0	Internal Data	A13U5 (26) (27) (28) (29) (30) (31) (32) (33)
R/$\overline{\text{W}}$	Read/$\overline{\text{Write}}$	A13U5 (34)
DBE	Data Bus Enable	A13U15A (3)
$\phi 1$ $\phi 2$	Micro-processor (A13U5) two-phase clocks (C1 & C2)	A13U15 (6) (8)
S1	Impedance selection control from Impedance switch S100	Impedance Switch S100

Table 8-D-2. Firmware Routines and Associated ROM's.

ROM A (U2)	ROM B (U3)	ROM C (U4)
-hp- Part No. 1818-0284 Vendor Part No. C-27027 Routines: Preset Keys and Routines Decimal Point Key Back Key Entry Key Increment Keys Phase Increment Routine Output Frequency Routine Output Amplitude Routine	-hp- Part No. 1818-0285 Vendor Part No. C-27028 Routines: Leveling Loop Loop—Up Table RPG Keys and Knob Routines Sweep Keys and Routines Impedance Switch Routine Minus Sign HP—IB Routines HP—IB Code Table Attenuator Test Routine	-hp- Part No. 1818-0286 Vendor Part No. C-27029 Routines: Start—Up Routine Function Keys Clear Key Numerical Entry Keys Start—Up and Interrupt Vectors Key Return (Display Formatting) 7-Segment Display Code Table, Scan Display and Keyboard, Key Code Tables, Signature Analysis, SA Key Number Table

tures associated with components common to the defective node, the component causing the fault can be more readily identified. Normal logic troubleshooting may be required at this point to make a positive identification.

A question that might arise is "why does a particular node indicate the same signature each time it is tested?" Signature Analysis (SA) clocks a fixed bit pattern (which is part of the firmware) between a start and stop signal generated by the instrument under test. Each time the start signal occurs, the bit pattern is repeated. At conclusion of the bit pattern, the stop signal occurs. The start and stop signals are applied to the signature reading instrument (-hp- Signature Analyzer Model 5004A) which converts the nodal bit pattern to the alphanumeric display.

The fixed bit pattern, which is part of the firmware, is designed for the particular circuits of the instrument and is unique to the instrument under test. Maintaining a constant signature at circuit nodes requires that the controller:

1. Keep repeating the SA bit pattern.

2. Ignore all incoming information (e.g., keyboard input data).

A third requirement for maintaining a signature is that the circuit under test cannot loop back on itself.

The Signature Analyzer (-hp- Model 5004A), when connected to a node with the appropriate clock, start and stop connections, monitors the number of clock pulses and their occurrence in relation to the number of clock pulses. This combination results in an unchanging signature if the circuit operates properly. An important note concerning signatures is that the signature is dependent on:

1. The model of Signature Analyzer.

2. The part number of the ROM containing the SA routine. (If the SA bit pattern changes, the ROM part number will change.)

3. The part number and revision of the PC board being tested. Circuit modifications can cause a change in signatures.

3335A Signature Analysis Tests.

The 3335A has built into its controller eight SA tests. The suspected problem concerning the controller should determine which test is chosen to begin troubleshooting. If undecided about which test to begin with, testing should begin with Test 1 and progress sequentially through test 8. If any test does not appear to start correctly, proceed to the next test.

CAUTION

Before performing an SA test, disconnect the attenuator. Failure to do so can result in damage to the attenuator. The SA tests cause the switches internal to the attenuator to continuously be opened and closed for the duration of the test.

Table 8-D-3 is an index of the SA tests and a brief description of each test.

Table 8-D-3. SA Test Index.

SA Test	Description
1	Checks the PIA and output circuits
2	Checks the bit pattern of ROM C
3	Checks the bit pattern of ROM B
4	Checks the bit pattern of ROM A
5	Checks RAM pair A
6	Checks RAM pair B
7	Checks the HP–IB section of the controller and part of the HP–IB Interface Assembly (A16–Service Group C)
8	Checks the Display and Keyboard Assemblies

NOTES

1. *An incorrect signature does not identify a faulty component but does indicate a defective circuit node. By checking all signatures associated with components common to the defective node, the component causing the fault can be more readily identified.*

2. *Each SA test can be expedited by first checking the RED signatures followed by a RED bar. These signatures are test verification signatures and if all are correct, it is an indication that circuits tested by the SA test operate properly. The remaining signatures are troubleshooting signatures; some are red without a bar while others are black. The red signatures indicate driving circuit nodes, the black are general troubleshooting signatures.*

3. *If the instrument fails to go into an SA test when initialized, check Table 8-D-4 for possible causes. If during an SA test the instrument drops out of the test, reinitiate the test by turning the 3335A POWER switch to STBY and back to ON then momentarily ground pin I (NMI) on the A13 Controller test pins.*

Table 8-D-4. Possible SA Test Failure Causes.

Item	Possible Cause
1	Read/Write line inoperative
2	An address line on the address Bus is inoperative
3	A data line on the Data Bus is inoperative
4	Address Decoder is defective

NOTE: *Inadvertantly shorting pins together can cause the instrument to drop out of the SA test routine.*

SA TEST 1 (PIA–A13U20)

Test Requirements

Signatures associated with this test are dependent on the following:

1. -hp- Model 5004A Signature Analyzer.

2. Controller Assembly (A13) -hp- Part No. 03335-66511 Rev. B.

3. ROM C, A13U4, -hp- Part No. 1818-0286

NOTE

A continuously depressed key or a stuck key will generate signatures other than that shown.

Test Capability.

Access of SA Test 1 is indicated by flashing ones on the display. Flashing decimal points indicate two of the six PIA (A13U20) internal registers function properly. Additionally this test verifies:

1. Peripheral Data Bus A
2. Peripheral Data Bus B
3. Control Line Decoder
4. Data Interface
5. Sweep Digital-to-Analog Converter (Digital)

The test verification signatures (red with a red bar) for SA TEST 1 are all associated with the edge connectors XA13A and XA13B. If these signatures are correct, circuits tested by SA TEST 1 are operating properly.

-hp- Signature Analyzer Set-Up

Connect the Signature Analyzer as follows:

1. CLOCK input to A13U15 pin 1
2. CLOCK switch to _|‾ position
3. START and STOP inputs to address line A15 on the Controller test pins
4. START switch to _|‾ position
5. STOP switch to ‾|_ position
6. GND input to the A13 GND pin
7. HOLD switch out

Initializing SA TEST 1

1. Turn the 3335A on.

2. Check that no grounds are connected to the A13 Controller test pins A, B or C. Temporarily remove the jumpers if any of the pins are grounded.

3. Momentarily ground pin I (NMI) on the A13 Controller test pins.

4. Check the display for an indication of flashing ones and decimal points. Some annunciators also flash but are not important in analyzing SA TEST 1. If the 3335A fails to go into SA TEST 1, check Tables 8-D-4 and 8-D-5 for possible causes.

5. Verify that the ground and + 5 V signatures are correct.

a. With the Signature Analyzer probe grounded, the Signature Analyzer display should indicate 0000.

b. With the Signature Analyzer probe touching + 5 V, the Signature Analyzer display should read F824. If unable to obtain the display reading, reinitiate the test and check Table 8-D-4.

6. Signatures for SA TEST 1 are illustrated in Table 8-D-6.

NOTE

Orientation of the IC's and pin out with signatures is illustrated in a format developed for ease of reading. This format does not necessarily agree with the actual physical component or pin orientation. A component side and circuit side component locator is provided in this service group to identify the component and pin under test.

Table 8-D-5. SA TEST 1 Failures.

Symptom	Service Action or Comment
Incorrect signature on XA13B pin E	Any problem on Peripheral Bus A or B will change the signature.
SA TEST 1 will not function	Check A13U20 (PIA) for defective output (shorted or grounded output lines between U19 and U20). The PIA reads the last byte that is output to locate the next ROM address.
Most signatures are incorrect	Probable defective A13U20 (PIA).

Table 8-D-6. SA TEST 1 Signatures.

CAUTION
20 V on pin 3

XA13A				XA13B			
	1	A		■ P21C	1	A	9CC9 ■
	2	B		■ A428	2	B	C024 ■
	3	C		■ 9U10	3	C	50UC ■
	4	D		■ 83A2	4	D	3260 ■
	5	E		9A11	5	E	6UC5 ■
	6	F	F834 ■	F824	6	F	
	7	H			7	H	
	8	J			8	J	
AU71	9	K	4FP1 ■		9	K	
UAHA	10	L	HH19		10	L	
77UA	11	M	3A14	OF2A	11	M	OF87
F377	12	N	F3HH	U7AC	12	N	P55U
803A	13	P	5362	2P5F	13	P	0000
F824	14	R			14	R	
■f F824	15	S			15	S	
F824	16	T	F824 f■		16	T	
■ 99HC	17	U	7P80 ■		17	U	
■ 5FC2	18	V	A6U9 ■		18	V	

NOTES

F824 f, 0000 f = *Indicates Signature Analyzer's probe tip flashes on signatures associated with + 5 V and ground. If "f" is not present on the F824 (+ 5 V) or 0000 (ground) signatures, the probe tip lamp should not flash.*

XXXX = *Driving node signature*

XXXX ■ = *Test Verification Signature*

**** = *Unstable signature*

Table 8-D-6. SA TEST 1 Signatures (Cont'd).

U5

	1	40	F824
F824	2	39	
f 0000	3	38	
F824	4	37	F824 f
2811	5	36	F824 f
F824	6	35	
0000	7	34	5A95
F824	8	33	03A1
8975	9	32	HHPP
OUO5	10	31	C7F4
136A	11	30	4281
7CC1	12	29	H3FF
AU90	13	28	APP1
H326	14	27	3236
FUAA	15	26	F11H
f 0000	16	25	F824 f
64C8	17	24	64C8
64C8	18	23	64C8
64C8	19	22	64C8
64C8	20	21	

U6

F824	1	14	
0000	2	13	H326
7CC1	3	12	2C98
2C98	4	11	FUAA
AU90	5	10	2C98
2C98	6	9	0000 f
	7	8	2C98

U13

F824	1	14	
f F824	2	13	052H
f F824	3	12	F824
	4	11	
f 0000	5	10	6U10
f F824	6	9	7CU2
	7	8	

U16

	1	14	
	2	13	64C8
	3	12	AF9F
	4	11	
	5	10	
	6	9	64C8
	7	8	AF9F

U17

AF9F	1	16	
64C8	2	15	P484
64C8	3	14	64C8
f F824	4	13	AF9F
F824	5	12	
F824	6	11	F824
AF9F	7	10	P484
	8	9	F824

U18

64C8	1	14	
f F824	2	13	5A95
2811	3	12	AF9F
AF9F	4	11	AF9F
f F824	5	10	AF9F
P484	6	9	2C98
	7	8	64C8

U19

	1	20	
AU71	2	19	
AU71	3	18	77UA
HH19	4	17	77UA
HH19	5	16	3A14
F3HH	6	15	3A14
F3HH	7	14	F377
UAHA	8	13	F377
UAHA	9	12	5362
	10	11	5362

U20

0000	1	40	F824
AU71	2	39	F824
HH19	3	38	F824
F3HH	4	37	F824 f
UAHA	5	36	OU05
77UA	6	35	8975
3A14	7	34	F824
F377	8	33	03A1
5362	9	32	HHPP
OF87	10	31	C7F4
OF2A	11	30	4281
P55U	12	29	H3FF
U7AC	13	28	APP1
0000	14	27	3236
F824	15	26	F11H
F824	16	25	F824 f
F824	17	24	136A
f F824	18	23	P484
2P5F	19	22	136A
F824	20	21	5A95

U22

0000	1	16	0000
0000	2	15	F824
	3	14	
A1H6	4	13	U9H8
H8P3	5	12	C49P
P9H8	6	11	7U86
490F	7	10	F1A3
4U19	8	9	8H8U

U23

F824	1	20	
C49P	2	19	U9H8
HH19	3	18	AU71
F3HH	4	17	UAHA
7U86	5	16	F1A3
4U19	6	15	8H8U
3A14	7	14	77UA
F377	8	13	5362
490F	9	12	P9H8
	10	11	9A20

Table 8-D-6. SA TEST 1 Signatures (Cont'd).

U24

	1	14	
HH19	2	13	9A20
U96F	3	12	U96F
F824	4	11	4FP1
A1H6	5	10	
	6	9	H8P3
	7	8	

U29

6F0F	1	14	
A428	2	13	4C86
7800	3	12	83A2
C024	4	11	UA44
U7AC	5	10	3260
3U8U	6	9	C6A4
	7	8	7P80

U25

0F87	1	16	
0F2A	2	15	F824 f
P55U	3	14	F824 f
0000	4	13	P126
2P5F	5	12	5080
3U8U	6	11	8A46
6U10	7	10	F834
	8	9	052F

U30

0F87	1	16	
0F2A	2	15	89F4
P55U	3	14	9A11
0000	4	13	7800
2P5F	5	12	6F0F
U7AC	6	11	UA44
C6A4	7	10	4C86
	8	9	6C6H

U26

	1	16	
A6U9	2	15	F824
HF40	3	14	
AU71	4	13	F3HH
UA44	5	12	290F
0000	6	11	99HC
HH19	7	10	5FC2
	8	9	9496

U27

7CU2	1	14	
UAHA	2	13	F3HH
9U10	3	12	7CU2
7CU2	4	11	50UC
HH19	5	10	AU71
P21C	6	9	7CU2
	7	8	9CC9

U28

89FA	1	16	
6C6H	2	15	0000
77UA	3	14	UAHA
3A14	4	13	F3HH
F377	5	12	HH19
5362	6	11	AU71
	7	10	0000
	8	9	6UC5

Controller Test Pins

AF9F	.E	
5A95	.R/W	
03A1	.0	DATA
HHPP	.1	
C7F4	.	
4281	.	
H3FF	.	
APP1	.	
3236	.	
F11H	.	
f F824	.15	ADDRESS
64C8	.	
64C8	.	
64C8	.	
64C8	.	
64C8	.	
64C8	.	
64C8	.	
f 0000	.	
FUAA	.	
H326	.	
AU90	.	
7CC1	.	
136A	.	
F824	.	
8975	.0	

SA TEST 2 (ROMC – A13U4)

Test Requirements

Signatures associated with this test are dependent on the following:

1. -hp- Model 5004A Signature Analyzer
2. Controller Assembly (A13) -hp- Part No. 03335-66511 Rev. B
3. ROM B, A13U3, -hp- Part No. 1818-0285
4. ROM C, A13U4, -hp- Part No. 1818-0286

NOTE

A continuously depressed key or a stuck key will generate signatures other than that shown.

Test Capability

Access of SA TEST 2 is indicated by flashing twos on the display. Flashing decimal points indicate that the check sum test of ROM C data has passed. If the decimal points are not present, the check sum test has failed.

-hp- Signature Analyzer Set-Up

Connect the Signature Analyzer as follows:

1. CLOCK input to A13U15 pin 1
2. CLOCK switch to _⌐ position
3. START and STOP inputs to address line A15 on the Controller test pins
4. START switch to _⌐ position
5. STOP switch to ¬_ position
6. GND input to the A13 GND pin
7. HOLD switch out

Initializing SA TEST 2

1. Turn the 3335A on.

2. Ground pin C on the A13 Controller Assembly test pins. Temporarily remove any ground connections to pins A or B.

3. Momentarily ground pin I (NMI) on the A13 Controller Test pins.

4. Check the display for an indication of flashing twos and decimal points. Some annunciators also flash but are not important in analyzing SA TEST 2. If the 3335A fails to go into SA TEST 2, check Table 8-D-4 for possible causes.

5. Verify that the ground and +5 V signatures are correct.

   a. With the Signature Analyzer probe grounded, the Signature Analyzer display should indicate 0000.

   b. With the Signature Analyzer probe touching +5 V, the Signature Analyzer–display should read 57U3. If unable to obtain the display reading, reinitiate the test and check Table 8-D-4.

6. If the 3335A display indicates twos with decimal points or the Signature Analyzer's ground and + 5 V signatures are correct, ROM C is good. If the decimal points are NOT present, the + 5 V signature should be 5UFU.

7. Signatures for SA TEST 2 are illustrated in Tables 8-D-7 and 8-D-8. The signatures of 8-D-7 apply to a good SA TEST 2 (i.e., + 5 V signature of 57U3 with decimal points present on the 3335A display). The signatures of Table 8-D-8 correspond to the results of a defective SA TEST 2 (i.e., + 5 V signature of 5UFU and no decimal points displayed on the 3335A display). Table 8-D-7 can be used to verify circuit operation and a good ROM C.

NOTE

Orientation of the IC's and pin out with signatures is illustrated in a format developed for ease of reading. This format does not necessarily agree with the actual physical component or pin•orientation. A component side and circuit side component locator is provided in this service group to identify the component and pin under test.

Table 8-D-7. SA TEST 2.

ROM C U4

0000	13	12	0000
0000	14	11	74P2
f 0000	15	10	247U
5U2H	16	9	6721
4474	17	8	096P
C94P	18	7	4490
FF78	19	6	F84P
6878	20	5	UF63
6AU0	21	4	U762
UFF4	22	3	068H
2497	23	2	1A28
57U3	24	1	200H

U6

	1	14	
	2	13	
096P	3	12	F9HP
F9HP	4	11	74P2
6721	5	10	F9HP
F9HP	6	9	200H
	7	8	F9HP

U16

	1	14	
	2	13	1A28
	3	12	4HHC
	4	11	
	5	10	
	6	9	57U3 f
	7	8	0000 f

U17

f 0000	1	16	
f 57U3	2	15	57U3 f
f 57U3	3	14	UF17
f 57U3	4	13	4HHC
57U3	5	12	
57U3	6	11	57U3
f 0000	7	10	57U3 f
	8	9	57U3

U18

f 57U3	1	14	
f 57U3	2	13	57U3 f
0324	3	12	0000 f
f 0000	4	11	4HHC
f 57U3	5	10	4HHC
f 57U3	6	9	F9HP
	7	8	UF17

U19

0000	1	20	57U3
0000	2	19	0000
0000	3	18	0000
0000	4	17	0000
0000	5	16	57U3
57U3	6	15	57U3
0000	7	14	0000
0000	8	13	0000
0000	9	12	0000
0000	10	11	0000

Controller Test Pins

0000	.GND	
57U3	.HLT	
57U3	.H	
f 57U3	.DBE CLK	
f 0000	.E	
f 57U3	.R/W	
■ 2497	.0	
■ UFF4	.	
■ 6AUO	.	D
■ 6878	.	A
■ FF78	.	T
■ C94P	.	A
■ 4474	.	
■ 5U2H	.	
f 57U3	.15	
f 57U3	.	
f 57U3	.	
f 57U3	.	A
f 57U3	.	D
U762	.	D
068H	.	R
1A28	.	E
200H	.	S
74P2	.	S
247U	.	
6721	.	
096P	.	
4490	.	
F84P	.	
UF63	.0	

Table 8-D-8. SA TEST 2 (Defective).

U6

	1	14	
	2	13	91UH
25CC	3	12	2778
2778	4	11	H38A
9F84	5	10	2778
2778	6	9	8034
	7	8	2778

U18

f 5UFU	1	14	
f 5UFU	2	13	5UFU f
0F90	3	12	0000 f
f 0000	4	11	376F
f 5UFU	5	10	376F
f 5UFU	6	9	2778
	7	8	U05U

U16

	1	14	
	2	13	68A3
	3	12	376F
	4	11	
	5	10	
	6	9	5UFU f
	7	8	0000 f

U17

f 0000	1	16	
f 5UFU	2	15	5UFU f
f 5UFU	3	14	U05U
f 5UFU	4	13	376F
5UFU	5	12	
5UFU	6	11	5UFU
f 0000	7	10	5UFU f
	8	9	5UFU

Controller Test Pins

Signature	Pin	
	.GND	
	.HLT	
	.H	
	.DBE CLK	
	.E	
	.R/W	
▮ 9253	.0	DATA
▮ U30A	.	DATA
▮ ACF7	.	DATA
▮ A1P6	.	DATA
▮ 31P5	.	DATA
▮ P52P	.	DATA
▮ 11HO	.	DATA
▮ 7FCO	.	DATA
▮ f 5UFU	.15	ADDRESS
▮ f 5UFU	.	ADDRESS
▮ f 5UFU	.	ADDRESS
▮ f 5UFU	.	ADDRESS
▮ f 5UFU	.	ADDRESS
▮ HH88	.	ADDRESS
▮ 1A37	.	ADDRESS
▮ 68A3	.	ADDRESS
▮ 8034	.	ADDRESS
▮ H38A	.	ADDRESS
▮ 91UH	.	ADDRESS
▮ 9F84	.	ADDRESS
▮ 25CC	.	ADDRESS
▮ 1252	.	ADDRESS
▮ 212P	.	ADDRESS
▮ U195	.0	ADDRESS
	.GND	

NOTES

57U3 f / *0000 f* } = *Indicates Signature Analyzer's probe tip flashes on signatures associated with + 5 V and ground. If "f" is not present on the F824 (+ 5 V) or 0000 (ground) signatures, the probe tip lamp should not flash.*

XXXX = *Driving node signature*

XXXX▮ = *Test Verification Signature*

**** = *Unstable signature*

SA TEST 3 (ROM B – A13U3)

Test Requirements

Signatures associated with this test are dependent on the following:

1. -hp- Model 5004A Signature Analyzer
2. Controller Assembly (A13) -hp- Part No. 03335-66511 Rev. B
3. ROM A, A13U2, -hp- Part No. 1818-0284
4. ROM B, A13U3, -hp- Part No. 1818-0285
5. ROM C, A13U4, -hp- Part No. 1818-0286

NOTE

A continuously depressed key or a stuck key will generate signatures other than that shown.

Test Capability

Access of SA TEST 3 is indicated by flashing threes on the display. Flashing decimal points indicate that the check sum test of ROM B data has passed. If the decimal points are not present, the check sum test has failed.

-hp- Signature Analyzer Set-Up

Connect the Signature Analyzer as follows:

1. CLOCK input to A13U15 pin 1
2. CLOCK switch to ⌐ position
3. START and STOP inputs to address line A15 on the Controller test pins
4. START switch to ⌐ position
5. STOP switch to ¬ position
6. GND input to the A13 GND pin
7. HOLD switch out

Initializing SA TEST 3

1. Turn the 3335A on.

2. Ground pin B on the A13 Controller Assembly test pins.

3. Momentarily ground pin I (NMI) on the A13 Controller Test pins.

4. Check the display for an indication of flashing threes and decimal points. Some annunciators also flash but are not important in analyzing SA TEST 3. If the 3335A fails to go into SA TEST 3, check Table 8-D-4 for possible causes.

5. Verify that the ground and + 5 V signatures are correct.

   a. With the Signature Analyzer probe grounded, the Signature Analyzer display should indicate 0000.

   b. With the Signature Analyzer probe touching + 5 V, the Signature Analyzer display should read 57U3. If unable to obtain the display reading, reinitiate the test and check Table 8-D-4.

6. If the 3335A display indicates threes with decimal points and the Signature Analyzer's ground and + 5 V signatures are correct, ROM B is good. If the decimal points are NOT present, the + 5 V signature should be 5UFU.

7. Signatures for SA TEST 3 are illustrated in Tables 8-D-9 and 8-D-10. The signatures of 8-D-9 apply to a good SA TEST 3 (i.e., + 5 V signature of 57U3 with

Table 8-D-9. SA TEST 3

ROM B U3

		Pin	Pin	
	0000	13	12	0000
	0000	14	11	451P
	AFUP	15	10	P88P
C45F or	3248	16	9	O4H7
309P	7F0P	17	8	19FF
519H	A4UC	18	7	UFFH
U6F4	H319	19	6	6749
67CP	PUAP	20	5	UF63
2U8A	U366	21	4	U762
7A97	HUH7	22	3	068H
A8P6	HH12	23	2	1A28
	57U3	24	1	200H

U18

	Pin	Pin	
f 57U3	1	14	
f 57U3	2	13	57U3 f
0324	3	12	0000 f
f 0000	4	11	4HHC
f 57U3	5	10	4HHC
f 57U3	6	9	F9HP
	7	8	U517

U19

	Pin	Pin	
0000	1	20	
0000	2	19	0000
0000	3	18	0000
0000	4	17	0000
0000	5	16	0000
57U3	6	15	0000
57U3	7	14	0000
57U3	8	13	0000
57U3	9	12	0000
	10	11	0000

U6

	Pin	Pin	
	1	14	
	2	13	P88P
19FF	3	12	F9HP
F9HP	4	11	451P
04H7	5	10	F9HP
F9HP	6	9	200H
	7	8	F9HP

U16

Pin	Pin	
1	14	
2	13	1A28
3	12	4HHC
4	11	
5	10	
6	9	57U3 f
7	8	0000 f

U17

Pin	Pin	
1	16	
2	15	57U3 f
3	14	UF17
4	13	4HHC
5	12	
6	11	
7	10	57U3 f
8	9	

Controller Test Pins

			Pin	
		0000	.GND	
		57U3	.HLT	
		57U3	.H	
		f 57U3	.DBE CLK	
		f 0000	.E	
		f 57U3	.T/W	
■ A8P6	or	■ HH12	.0	DATA
■ 7A97		■ HUH7	.	
■ 2U8A		■ U366	.	
■ 67CP		■ PUAP	.	
■ U6F4		■ H319	.	
■ 519H		■ A4UC	.	
■ 309P		■ 7F0P	.	
■ C45F		■ 32U8	.	
		f 57U3	.15	ADDRESS
		f 57U3	.	
		f 57U3	.	
		f 57U3	.	
		AFUP	.	
		A762	.	
		068H	.	
		1A28	.	
		200H	.	
		451P	.	
		P88P	.	
		04H7	.	
		19FF	.	
		UFFH	.	
		6749	.	
		UF63	.0	
			.GND	

NOTES

57U3 f / *0000 f* = *Indicates Signature Analyzer's probe tip flashes on signatures associated with + 5 V and ground. If "f" is not present on the F824 (+ 5 V) or 0000 (ground) signatures, the probe tip lamp should not flash.*

XXXX = *Driving node signature*

XXXX■ = *Test Verification Signature*

****** = *Unstable signature*

Table 8-D-10. SA TEST 3 (Defective)

ROM B U3

		0000	13	12	0000
C3U8	or	0000	14	11	147A
H174		C3U8	15	10	A23C
F27A		FCP7	16	9	135H
4660		U039	17	8	6733
HC17		93UC	18	7	U324
9PUF		4F63	19	6	9H31
CP2P		CPCF	20	5	U195
PA47		FH9F	21	4	HH88
A395		7U44	22	3	1A37
		7445	23	2	68A3
		5UFU	24	1	8034

U18

f 5UFU	1	14	
f 5UFU	2	13	5UFU f
0F90	3	12	0000 f
f 0000	4	11	376F
f 5UFU	5	10	376F
f 5UFU	6	9	2778
	7	8	U05U

U19

1	20
2	19
3	18
4	17
5	16
6	15
7	14
8	13
9	12
10	11

U6

	1	14	
	2	13	A23C
6733	3	12	
	4	11	147A
135H	5	10	
	6	9	8034
	7	8	

U16

	1	14	
	2	13	68A3
	3	12	376F
	4	11	
	5	10	
	6	9	5UFU f
	7	8	0000 f

U17

f 0000	1	16	
C3U8	2	15	5UFU f
f 5UFU	3	14	U05U
f 5UFU	4	13	376F
5UFU	5	12	
C3U8	6	11	5UFU
PF37	7	10	5UFU f
	8	9	5UFU

Controller Test Pins

			.GND	
			.HLT	
			.H	
			.DBE CLK	
			.E	
		f5UFU	.R/W	
A395	or	7445	.0	DATA
PA47		7U44	.	
CP2P		FH9F	.	
9PUF		CPCF	.	
HC17		4F63	.	
4660		93UC	.	
F27A		U039	.	
H174		FCP7	.	
		f 5UFU	.15	ADDRESS
		f 5UFU	.	
		f 5UFU	.	
		f 5UFU	.	
		C3U8	.	
		HH88	.	
		1A37	.	
		68A3	.	
		8034	.	
		147A	.	
		A23C	.	
		135H	.	
		6733	.	
		U324	.	
		9H31	.	
		U195	.0	

decimal points present on the 3335A display). The signatures of Table 8-D-10 correspond to the results of a defective SA TEST 3 (i.e.,+ 5 V signature of 5UFU and no decimal points displayed on the 3335A display). Table 8-D-10 can be used to verify circuit operation and a good ROM B.

NOTE

Orientation of the IC's and pin out with signatures is illustrated in a format developed for ease of reading. This format does not necessarily agree with the actual physical component or pin orientation. A component side and circuit side component locator is provided in this service group to identify the component and pin under test.

SA TEST 4 (ROM A – A13U2)

Signatures associated with this test are dependent on the following:

1. -hp- Model 5004A Signature Analyzer
2. Controller Assembly (A13) -hp- Part No. 03335-66511 Rev. B
3. ROM A, A13U2, -hp- Part No. 1818-0284
4. ROM C, A13U4, -hp- Part No. 1818-0286

NOTE

A continuously depressed key or a stuck key will generate signatures other than that shown.

Test Capability

Access of SA TEST 4 is indicated by flashing fours on the display. Flashing decimal points indicate that the check sum test of ROM A data has passed. If the decimal points are not present, the check sum test has failed.

-hp- Signature Analyzer Set-Up

Connect the Signature Analyzer as follows:

1. CLOCK input to A13U15 pin 1
2. CLOCK switch to _|‾ position
3. START and STOP inputs to address line A15 on the Controller test pins.
4. START switch to _|‾ position
5. STOP switch to ‾|_ position
6. GND input to the A13 GND pin.
7. HOLD switch out

Initializing SA TEST 4

1. Turn the 3335A on.

2. Ground pin A on the A13 Controller Assembly test pins. Temporarily remove any ground connections to pins B and C.

3. Momentarily ground pin I (NMI) on the A13 Controller test pins.

4. Check the display for an indication of flashing fours and decimal points. Some annunciators also flash but are not important in analyzing SA TEST 4. If the 3335A fails to go into SA TEST 4, check Table 8-D-4 for possible causes.

5. Verify that the ground and + 5 V signatures are correct.

   a. With the Signature Analyzer probe grounded, the Signature Analyzer display should indicate 0000.

   b. With the Signature Analyzer probe touching + 5 V, the Signature Analyzer display should read 57U3. If unable to obtain the display reading, reinitiate the test and check Table 8-D-4.

6. If the 3335A display indicates fours with decimal points and the Signature Analyzer's ground and + 5 V signatures are correct, ROM A is good. If the decimal points are NOT present, the + 5 V signature should be 5UFU.

7. Signatures for SA TEST 4 are illustrated in Tables 8-D-11 and 8-D-12. The signatures of 8-D-11 apply to a good SA TEST 4 (i.e., + 5 V signature of 57U3 with decimal points present on the 3335A display). The signatures of Table 8-D-12

correspond to the results of a defective SA TEST 4 (i.e., + 5 V signature of 5UFU and no decimal points displayed on the 3335A display). Table 8-D-11 can be used to verify circuit operation and a good ROM A.

NOTE

Orientation of the IC's and pin out with signatures is illustrated in a format developed for ease of reading. This format does not necessarily agree with the actual physical component or pin orientation. A component side and circuit side component locator is provided in this service group to identify the component and pin under test.

Table 8-D-11. SA TEST 4

ROM A U2

0000	13	12	0000
0000	14	11	HCP5
AFUP	15	10	7675
HUH8	16	9	A945
UPH4	17	8	H728
847H	18	7	PC97
HA13	19	6	F84P
2633	20	5	UF63
3P23	21	4	U762
UH94	22	3	068H
PC55	23	2	1A28
57U3	24	1	200H

U6

	1	14	
	2	13	7675
H728	3	12	F9HP
F9HP	4	11	HCP5
A945	5	10	F9HP
F9HP	6	9	200H
	7	8	F9HP

U16

	1	14	
	2	13	1A28
	3	12	4HHC
	4	11	
	5	10	
	6	9	57U3 f
	7	8	0000 f

U17

	1	16	
	2	15	57U3 f
	3	14	UF17
	4	13	4HHC
	5	12	
	6	11	
	7	10	57U3 f
	8	9	

U18

f 57U3	1	14	
f 57U3	2	13	57U3 f
0324	3	12	0000 f
f 0000	4	11	4HHC
f 57U3	5	10	4HHC
f 57U3	6	9	F9HP
	7	8	UF17

U19

0000	1	20	
0000	2	19	0000
0000	3	18	57U3
0000	4	17	57U3
0000	5	16	0000
0000	6	15	0000
0000	7	14	0000
57U3	8	13	0000
57U3	9	12	57U3
	10	11	57U3

Controller Test Pins

0000	.GND	
57U3	.HLT	
57U3	.H	
f 57U3	.DBE CLK	
f 0000	.E	
f 57U3	.T/W	
■ PC55	.0	DATA
■ UH94	.	
■ 3P23	.	
■ 2633	.	
■ HA13	.	
■ 847H	.	
■ UPH4	.	
■ HUH8	.	
f 57U3	.15	ADDRESS
f 57U3	.	
f 57U3	.	
AFUP	.	
f 57U3	.	
U762	.	
068H	.	
1A28	.	
200H	.	
HCP5	.	
7675	.	
A945	.	
H728	.	
PC97	.	
F84P	.	
UF63	.0	
	.GND	

Table 8-D-12. SA TEST 4 (Defective)

ROM A U2

Signature	Pin	Pin	Signature
0000	13	12	0000
0000	14	11	6U95
C3U8	15	10	H9H4
7U64	16	9	H517
UC50	17	8	5FA1
11P2	18	7	AP4H
684C	19	6	212P
98FA	20	5	U195
U888	21	4	HH88
U64A	22	3	1A37
AH5A	23	2	68A3
5UFU	24	1	8034

U18

Signature	Pin	Pin	Signature
f 5UFU	1	14	
f 5UFU	2	13	5UFU f
0F90	3	12	0000 f
f 0000	4	11	376F
f 5UFU	5	10	376F
f 5UFU	6	9	2778
	7	8	U05U

U19

Signature	Pin	Pin	Signature
	1	20	
	2	19	
	3	18	
	4	17	
	5	16	
	6	15	
	7	14	
	8	13	
	9	12	
	10	11	

U6

Signature	Pin	Pin	Signature
	1	14	
	2	13	H9H4
5FA1	3	12	2778
2778	4	11	6U95
A517	5	10	2778
2778	6	9	8034
	7	8	2778

U16

Signature	Pin	Pin	Signature
	1	14	
	2	13	68A3
	3	12	376F
	4	11	
	5	10	
	6	9	5UFU f
	7	8	0000 f

U17

Signature	Pin	Pin	Signature
f 0000	1	16	
f 5UFU	2	15	5UFU f
C3U8	3	14	U05U
f 5UFU	4	13	376F
C3U8	5	12	
5UFU	6	11	5UFU
PF37	7	10	5UFU f
	8	9	5UFU

Controller Test Pins

Signature	Pin	
0000	.GND	
5UFU	.HLT	
5UFU	.H	
f 5UFU	.DBE CLK	
f 0000	.E	
f 5UFU	.T/W	
■ AH5A	.0	DATA
■ U64A	.	
■ U888	.	
■ 98FA	.	
■ 684C	.	
■ 11P2	.	
■ UC50	.	
■ 7U64	.	
■ f 5UFU	.15	ADDRESS
■ f 5UFU	.	
■ f 5UFU	.	
■ C3U8	.	
■ f 5UFU	.	
■ HH88	.	
■ 1A37	.	
■ 68A3	.	
■ 8034	.	
■ 6U95	.	
■ H9H4	.	
■ A517	.	
■ 5FA1	.	
■ AP4H	.	
■ 212P	.	
■ U195	.0	
	.GND	

NOTES

57U3 f / *0000 f* = *Indicates Signature Analyzer's probe tip flashes on signatures associated with + 5 V and ground. If "f" is not present on the F824 (+ 5 V) or 0000 (ground) signatures, the probe tip lamp should not flash.*

XXXX = *Driving node signature*

XXXX ■ = *Test Verification Signature*

****** = *Unstable signature*

SA TEST 5 (RAM PAIR A – A13U7 AND U8)

Test Requirements

Signatures associated with this test are dependent on the following:

1. -hp- Model 5004A Signature Analyzer
2. Controller Assembly (A13) -hp- Part No. 03335-66511 Rev. B
3. ROM C, A13U4, -hp- Part No. 1818-0826

NOTE

A continuously depressed key or a stuck key will generate signatures other than that shown.

Test Capability

Access of SA TEST 5 is indicated by flashing fives (the frequency of flashing is slower than other SA tests). Flashing decimal points indicate that all storage locations within RAM pair A are good. If decimal points are not present, the storage location check has failed.

-hp- Signature Analyzer Set-Up

Connect the Signature Analyzer as follows:

1. CLOCK input to A13U15 pin 1
2. CLOCK switch to _|‾ position
3. START and STOP inputs to address line A15 on the Controller test pins
4. START switch to _|‾ position
5. STOP switch to ‾|_ position
6. GND input to the A13 GND pin
7. HOLD switch out

Initializing SA TEST 5

1. Turn the 3335A on.

2. Ground pins A and B on the A13 Controller Assembly test pins. Temporarily remove any ground connection to pin C.

3. Momentarily ground pin I (NMI) on the A13 Controller Test pins.

4. Check the display for an indication of flashing fives and decimal points. Some annunciators also flash but are not important in analyzing SA TEST 5. If the 3335A fails to go into SA TEST 5, check Table 8-D-4 for possible causes.

5. Verify that the ground and + 5 V signatures are correct.

   a. With the Signature Analyzer probe grounded, the Signature Analyzer display should indicate 0000.

   b. With the Signature Analyzer probe touching + 5 V., the Signature Analyzer display should read 332C for a good RAM pair. If unable to obtain the display reading, reinitiate the test and check Table 8-D-4.

6. Verify that the enable line for RAM pair A from the Address Decoder is functioning. The Signature Analyzer's probe tip lamp should flash when the probe is touching A13U17 pin 9 (RAM pair A enable line). This verifies that the line is able to toggle.

7. Verify that the Read/Write line is able to toggle. The Signature Analyzer's probe tip lamp should flash when the probe is touching A13U7 pin 14 or A13U8 pin 14.

SA TEST 6 (RAM PAIR B – A13U9 AND U10)

Test Requirements

Signatures associated with this test are dependent on the following:

1. -hp- Model 5004A Signature Analyzer
2. Controller Assembly (A13) -hp- Part No. 03335-66511 Rev. B
3. ROM C, A13U4, -hp- Part No. 1818-0826

NOTE

A continuously depressed key or a stuck key will generate signatures other than that shown.

Test Capability

Access of SA TEST 6 is indicated by flashing sixes (flashing frequency is the same as SA TEST 5). Flashing decimal points indicate that all storage locations within RAM pair B are good. If decimal points are not present, the storage location check has failed.

-hp- Signature Analyzer Set-UP

Connect the Signature Analyzer as follows:

1. CLOCK input to A13U15 pin 1
2. CLOCK switch to _⌐ position
3. START and STOP inputs to address line A15 on the Controller test pins
4. START switch to _⌐ position
5. STOP switch to ⌐_ position
6. GND input to the A13 GND pin
7. HOLD switch out

Initializing SA TEST 6

1. Turn the 3335A on.

2. Ground pins B and C on the A13 Controller Assembly test pins. Temporarily remove any ground connections to pin A.

3. Momentarily ground pin I (NMI) on the A13 Controller test pins.

4. Check the display for an indication of flashing sixes and decimal points. Some annunciators also flash but are not important in analyzing SA TEST 6. If the 3335A fails to go into SA TEST 6, check Table 8-D-4 for possible causes.

5. Verify that the ground and + 5 V signatures are correct.

   a. With the Signature Analyzer probe grounded, the Signature Analyzer display should indicate 0000.

   b. With the Signature Analyzer probe touching + 5 V, the Signature Analyzer display should read 3A92. If unable to obtain the display reading, reinitiate the test and check Table 8-D-4.

6. Verify that the enable line for RAM pair B from the Address Decoder is functioning. The Signature Analyzer's probe tip lamp should flash when the probe is touching A13U17 pin 11 (RAM pair B enable line). This verifies the line is able to toggle.

7. Verify that the Read/Write line is able to toggle. The Signature Analyzer's probe tip lamp should flash when the probe is touching A13U9 pin 14 or A13U10 pin 14.

SA TEST 7 (HP–IB INTERFACE – A16)

Test Requirements

Signatures associated with this test are dependent on the following:

1. -hp- Model 5004A Signature Analyzer
2. Controller Assembly (A13) -hp- Part No. 03335-66511 Rev. B
3. HP–IB Interface Assembly (A16) -hp- Part No. 03335-66513 Rev. A
4. ROM C, A13U4, -hp- Part No. 1818-0826

NOTE

A continuously depressed key or a stuck key will generate signatures other than that shown.

Test Capability

Access of SA TEST 7 is indicated by sevens displayed (not flashing). Decimal points do not have any significance.

-hp- Signature Analyzer Set-Up

Connect the Signature Analyzer as follows:

1. CLOCK input to A13U15 pin 1
2. CLOCK switch to _|‾ position
3. START and STOP inputs to address line A15 on the Controller test pins
4. START switch to _|‾ position
5. STOP switch to ‾|_ position
6. GND input to the A13 GND pin
7. HOLD switch out

Initializing SA TEST 7

1. Connect a jumper between the HP–IB Assembly electrolytic (A16C1) negative end and chassis ground. Turn the 3335A on.

2. Ground pins A and C on the A13 Controller test pins. Temporarily remove any ground connection to pin B.

3. Momentarily ground pin I (NMI) on the A13 Controller test pins.

4. Check the display for an indication of all sevens and decimal points (not flashing). Some annunciators are also on but are not important in analyzing SA TEST 7. If the 3335A fails to go into SA TEST 7, check Table 8-D-4 for possible causes.

5. Verify that the ground and + 5 V signatures are correct.

   a. With the Signature Analyzer probe grounded, the Signature Analyzer display should indicate 0000.

   b. With the Signature Analyzer probe touching + 5 V, the Signature Analyzer display should read APF1. If unable to obtain the display reading, reinitiate the test and check Table 8-D-4.

6. There are seven tables of signatures for SA TEST 7 (Tables 8-D-13 through 8-D-19). Testing begins with the use of Table 8-D-13. If the HP–IB Interface Assembly and the associated circuits in the Controller are operating properly, all signatures of Table 8-D-13 will be correct. This table contains two parts:

a. Input Line Verification
b. Address Switch Verification

7. Input Line Verification (top half of Table 8-D-13).

   a. All rear panel address switches (A1–A5) must be open (UP position) for the Input Line Verification Tests.

   b. If an Input Line Ungrounded Signature is incorrect, troubleshoot by use of Table 8-D-14.

   c. If an Input Line Grounded Signature is incorrect, troubleshoot according to the faulty line and its associated table as follows:

Faulty Line	Table
DIO1–DIO7 or ATN	8-D-15
REN	8-D-16
DAV	8-D-17
IFC	8-D-18

8. Address Switch Verification (bottom half of Table 8-D-13).

   a. All rear panel address switches (A1–A5) must be closed (down position) for the Address Switch Verification Test.

   b. If an Address Switch (closed) Signature is incorrect, troubleshoot by use of Table 8-D-19.

Table 8-D-13. HP–IB Interface Assembly Verification Signatures.

Part 1

Input Line Verification

Input Line	Signatures: Input Line Ungrounded	Signatures: Input Line Grounded	Verify Signature At Controller Test Pin
DIO1	7090	8P2U	D0
DIO2	5PPP	A051	D1
DIO3	8645	78UA	D2
DIO4	AF74	52FC	D3
DIO5	8850	76PU	D4
DIO6	23HA	HH65	D5
DIO7	93F1	6H7P	D6
ATN	A472	5AFH	D7
			XA13B pin
REN	APF1	85C4	F
DAV	APF1	FH71	18
			HP–IB Connector
IFC	C2AF	APF1	NRFD
ATN	C2AF	0000	NRFD

Part 2

Address Switch Verification

Address Switch S1	Closed Switch Signature	Verify Signature At Controller Test Pin
A1	1FPP	D0
A2	3290	D1
A3	PA3C	D2
A4	FOOC	D3
A5	P42P	D4

Fig 8-D-14
Sht 1 of 2

XA13A

0000	1	A	APF1 f
0000	2	B	0000
	3	C	APF1 f
APF1	4	D	APF1
0000	5	E	0000
APF1	6	F	APF1
961C	7	H	APF1
0000	8	J	0000
0000	9	K	APF1
APF1	10	L	APF1
APF1	11	M	0000
0000	12	N	APF1
f 0000	13	P	0000
APF1	14	R	APF1
f APF1	15	S	APF1
APF1	16	T	APF1 f
0000	17	U	0000
0000	18	V	0000

XA13B

0000	1	A	0000
0000	2	B	0000
0000	3	C	0000
0000	4	D	0000
APF1	5	E	0000
961C	6	F	APF1 ■
f 0000	7	H	0000 f
f 0000	8	J	0000 f
APF1	9	K	0000 f
13AU	10	L	0000 f
6P13	11	M	5951
0000	12	N	70HA
38FC	13	P	CH5H
0000	14	R	748C
748C	15	S	748C
748C	16	T	748C
748C	17	U	748C
■ APF1	18	V	APF1

U11

1015	1	20	APF1
748C	2	19	2P1H
A472	3	18	0000
748C	4	17	93F1
23HA	5	16	748C
748C	6	15	8850
AF74	7	14	748C
748C	8	13	8645
5PPP	9	12	748C
0000	10	11	7090

Controller Test Pins

	.GND	
	.HLT	
	.H	
	.DBE CLK	
P6UU	.E	
82H4	.R/W	
■ 7090	.0	DATA
■ 5PPP	.	
■ 8645	.	
■ AF74	.	
■ 8850	.	
■ 23HA	.	
■ 93F1	.	
■ A472	.	
f APf1	.15	ADDRESS
483P	.	
483P	.	
0112	.	
0112	.	
0112	.	
0112	.	
f 0000	.	
f 0000	.	
0112	.	
6C8U	.	
6A9H	.	
79PU	.	
2P1H	.	
3UP7	.	
4740	.0	
	.GND	

U12

748C	1	16	APF1
0000	2	15	0000
APF1	3	14	0000
748C	4	13	APF1
0000	5	12	748C
APF1	6	11	0000
748C	7	10	0000
0000	8	9	0000

SV

U9

H484	1	16	APF1
APF1	2	15	FH32
0000	3	14	03UF
APF1	4	13	748C
7FOP	5	12	0000
58C9	6	11	6676
38HA	7	10	58C9
0000	8	9	APF1

U7

APF1	1	14
APF1	2	13
APF1	3	12
APF1	4	11
8795	5	10
8795	6	9
0000	7	8

U10

5951	1	16	APF1
6P13	2	15	FH32
70HA	3	14	O3UF
0000	4	13	58C9
38FC	5	12	7FOP
CHGH	6	11	6676
8795	7	10	H484
0000	8	9	4914

U8

APF1	1	14
APF1	2	13
0000	3	12
APF1	4	11
0000	5	10
APF1	6	9
0000	7	8

Fig 8-D-14
Sht 2 of 2

SW1

A ● ● ● ● A5

U11

748C	1	16	APF1
0000	2	15	0000
APF1	3	14	0000
748C	4	13	APF1
0000	5	12	748C
APF1	6	11	0000
748C	7	10	APF1
0000	8	9	748C

U7

14	APF1
13	0000
12	APF1
11	0000
10	7FOP
9	APF1
8	7FOP

U6

0000	1	14	APF1
APF1	2	13	0000
APF1	3	12	APF1
0000	4	11	38HA
APF1	5	10	981C
0000	6	9	38HA
0000	7	8	981C

U8

14	APF1
13	APF1
12	0000
11	APF1
10	0000
9	APF1
8	APF1

U5

8795	1	14	APF1
APF1	2	13	4914
0000	3	12	APF1
APF1	4	11	APF1
0000	10		APF1
APF1	6	9	0000
0000	7	8	APF1

OC1

0000	5	4	APF1 f
0000	6	3	0000
0000	7	2	0000
APF1	8	1	APF1 f

OC2

0000	5	4	APF1 f
0000	6	3	0000
0000	7	2	0000
APF1	8	1	APF1 f

OC3

0000	5	4	APF1 f
0000	6	3	0000
0000	7	2	0000
APF1	8	1	APF1 f

OC4

0000	5	4	APF1 f
0000	6	3	0000
0000	7	2	0000
APF1	8	1	APF1 f

OC5

0000	5	4	APF1
APF1	6	3	APF1
0000	7	2	0000
APF1	8	1	APF1 f

OC6

0000	5	4	APF1
APF1	6	3	APF1
0000	7	2	APF1
APF1	8	1	APF1

OC7

APF1	1	8	APF1
APF1	2	7	0000
961C	3	6	C2AF
APF1	4	5	0000

OC8

APF1	1	8	APF1
APF1	2	7	APF1
0000	3	6	0000
APF1	4	5	0000

U1

APF1	1	14	APF1
0000	2	13	APF1
APF1	3	12	0000
0000	4	11	APF1
APF1	5	10	0000
0000	6	9	APF1
0000	7	8	0000

U2

APF1	1	14	APF1
0000	2	13	C2AF
APF1	3	12	FPA2
0000	4	11	APF1
APF1	5	10	0000
0000	6	9	APF1
0000	7	8	0000

U3

FPA2	1	14	APF1
0000	2	13	0000
6063	3	12	APF1
6063	4	11	0000
0000	5	10	APF1
FPA2	6	9	0000
0000	7	8	0000

U4

0000	1	14	APF1
FPA2	2	13	APF1 f
APF1	3	12	APF1 f
FPA2	4	11	0000
APF1	5	10	FPA2
6063	6	9	0000
0000	7	8	APF1

Table 8-D-14. SA TEST 7 Signatures (DIO1–7, ATN UNGROUNDED).

Fig 8-0-15
sht 1 of 2

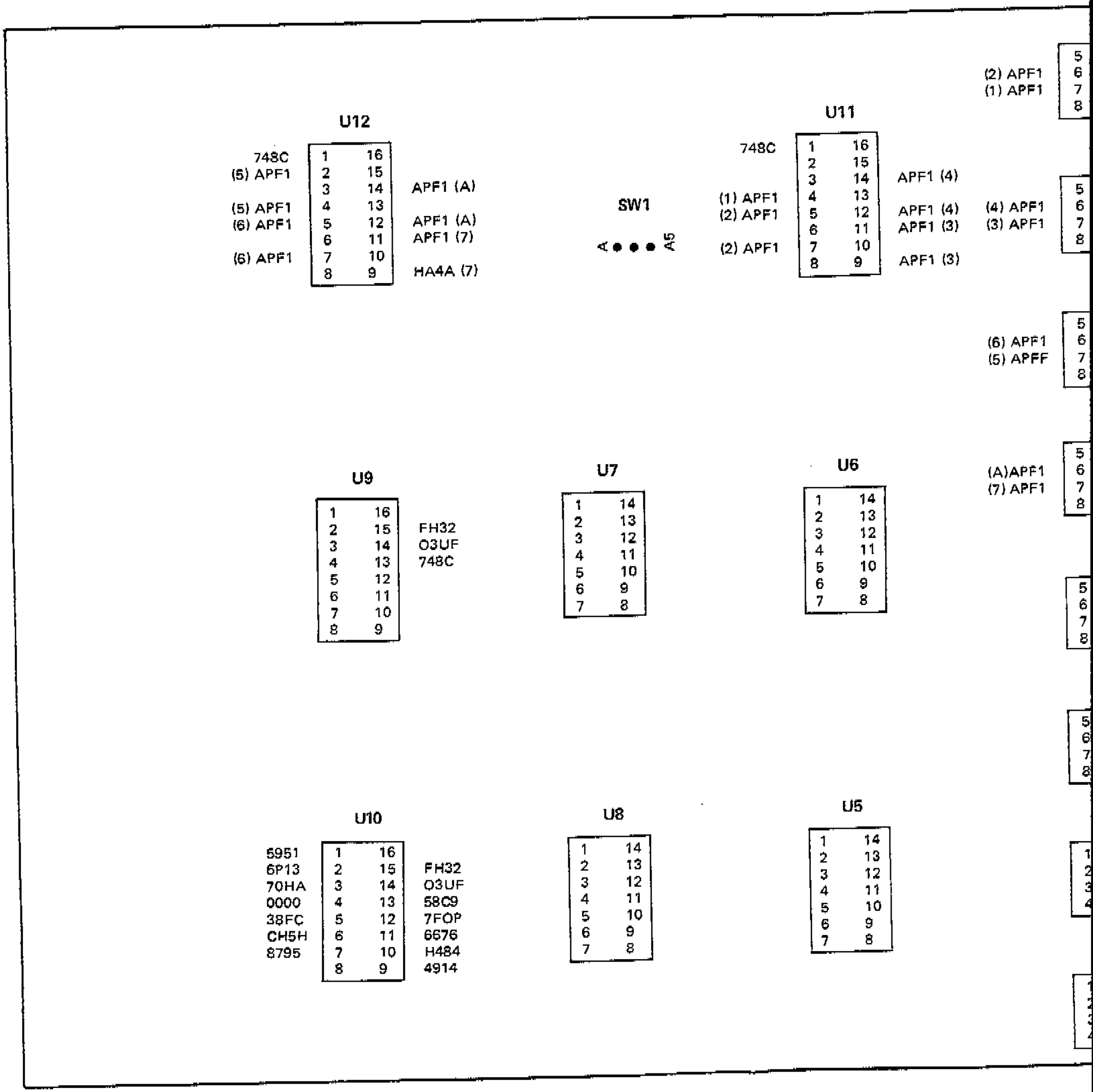


Fig 8-D-15
sht 2 of 2

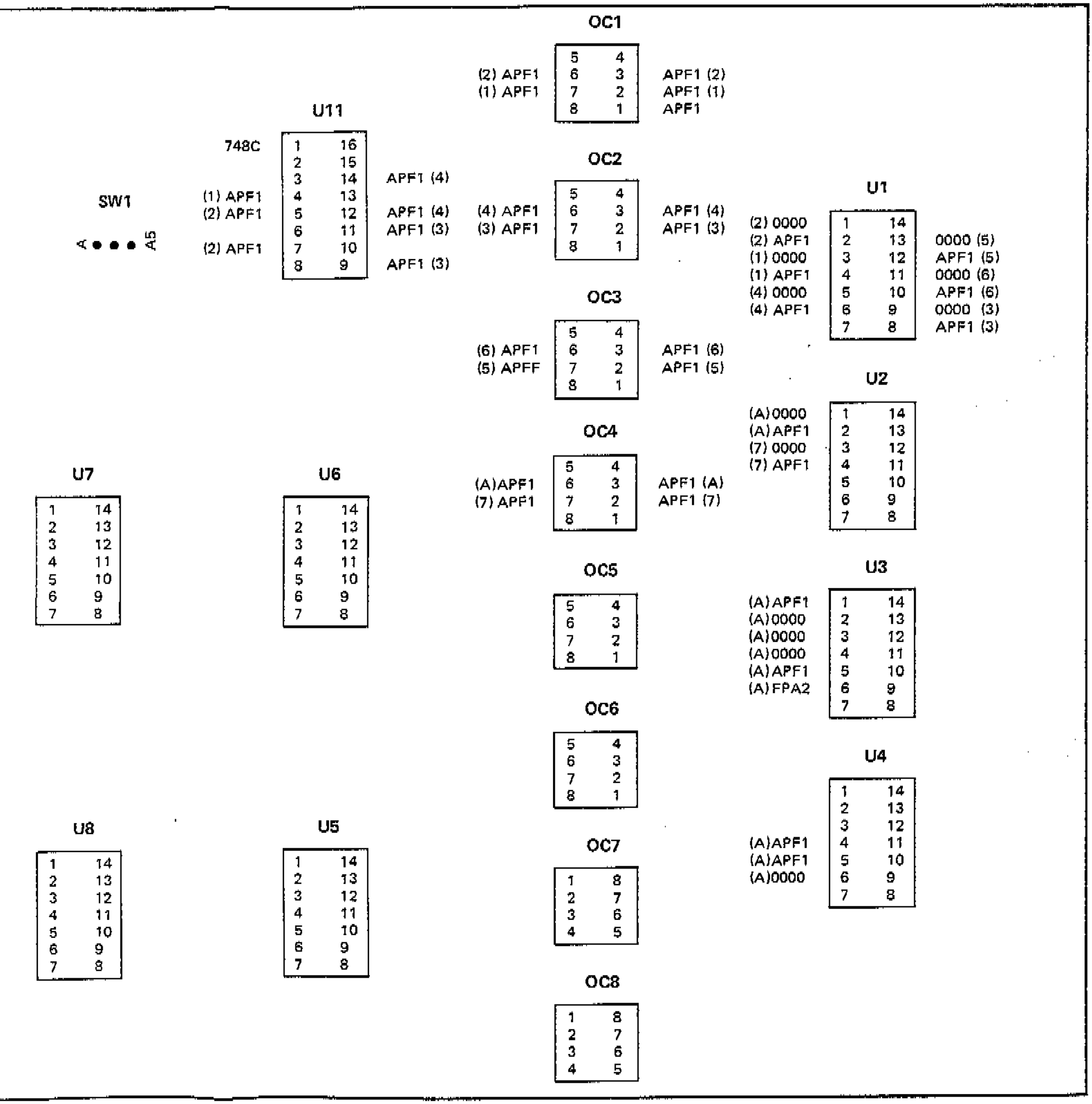


Table 8-D-15. SA TEST 7 Signatures (DIO1–7, ATN GROUNDED).

Table 8-D-16
Sht 1 of 2

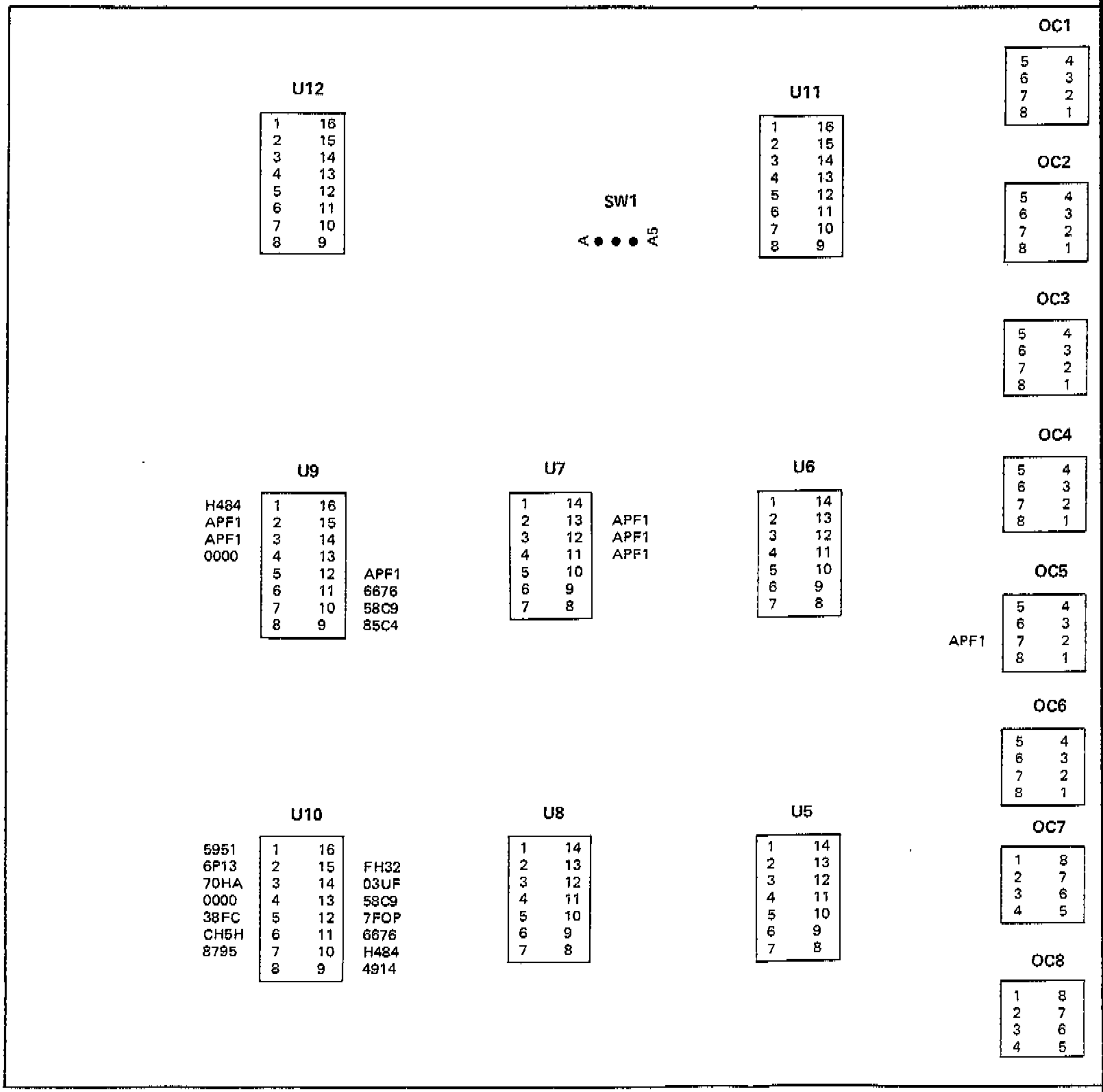


Table 8-D-16
sht 2 of 2

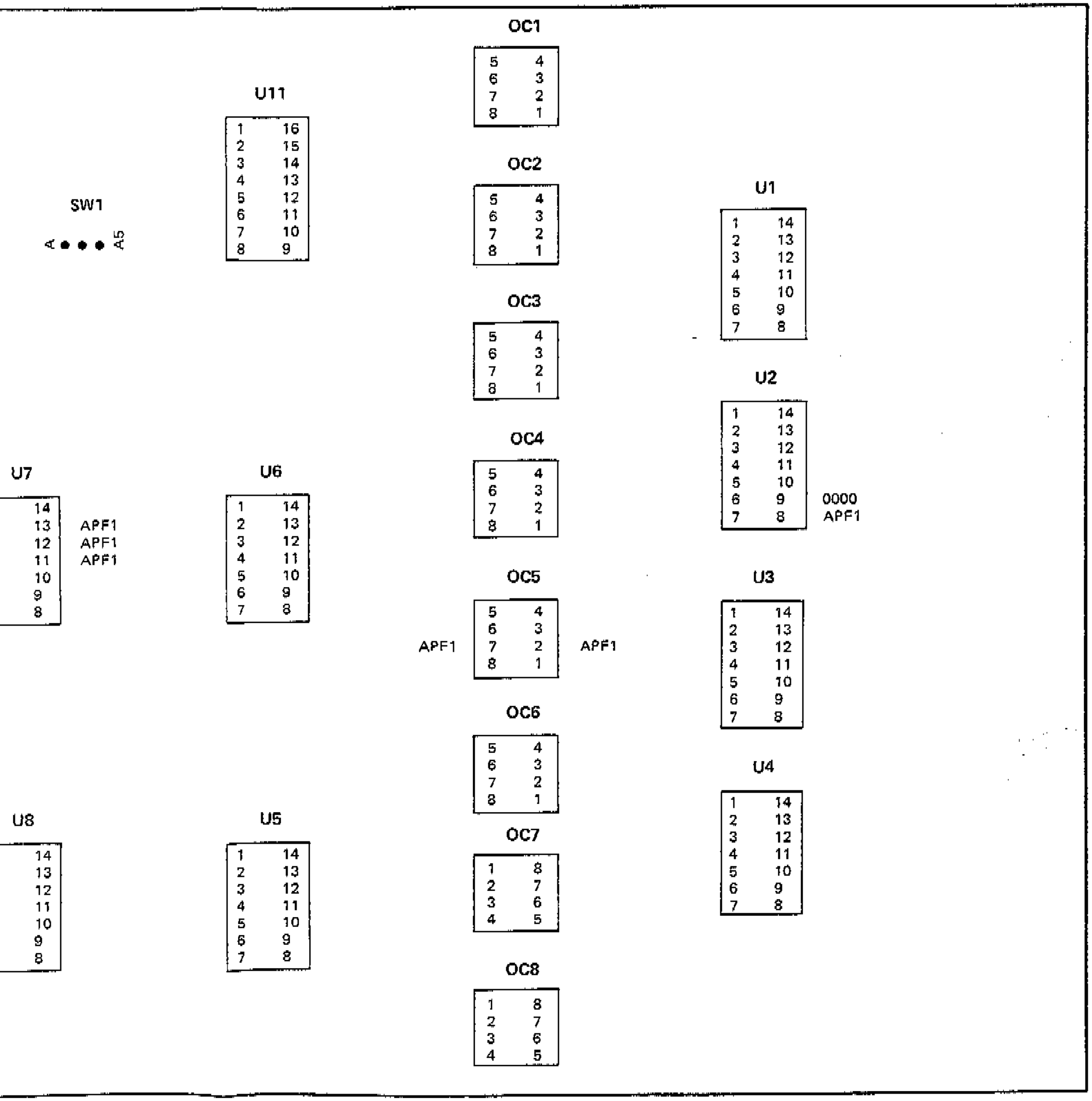


Table 8-D-16. SA TEST 7 Signatures (REN GROUNDED).

Table 8-12-17
Sht 1 of 2

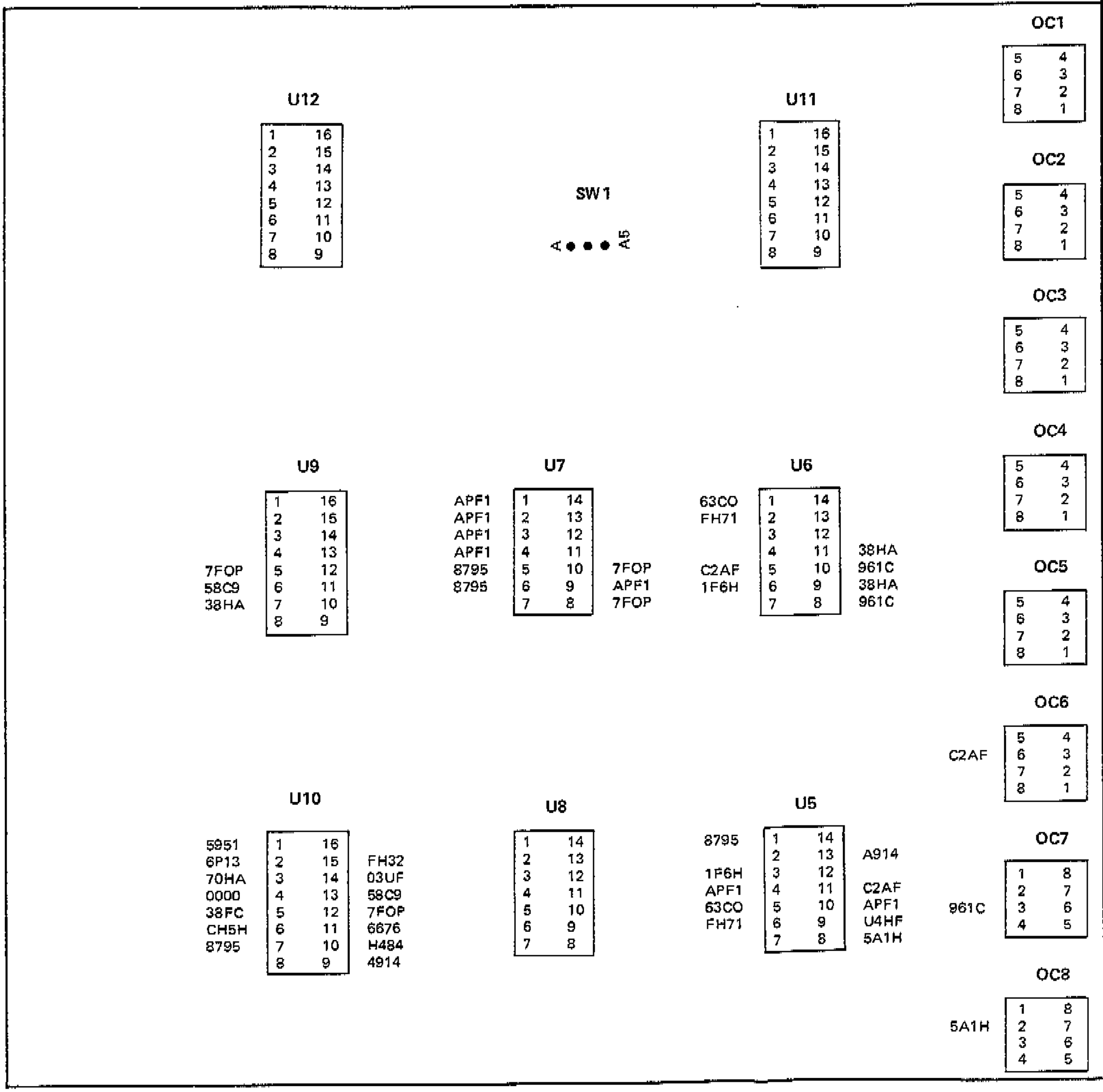


Table 8-D-17
Sht 2 of 2

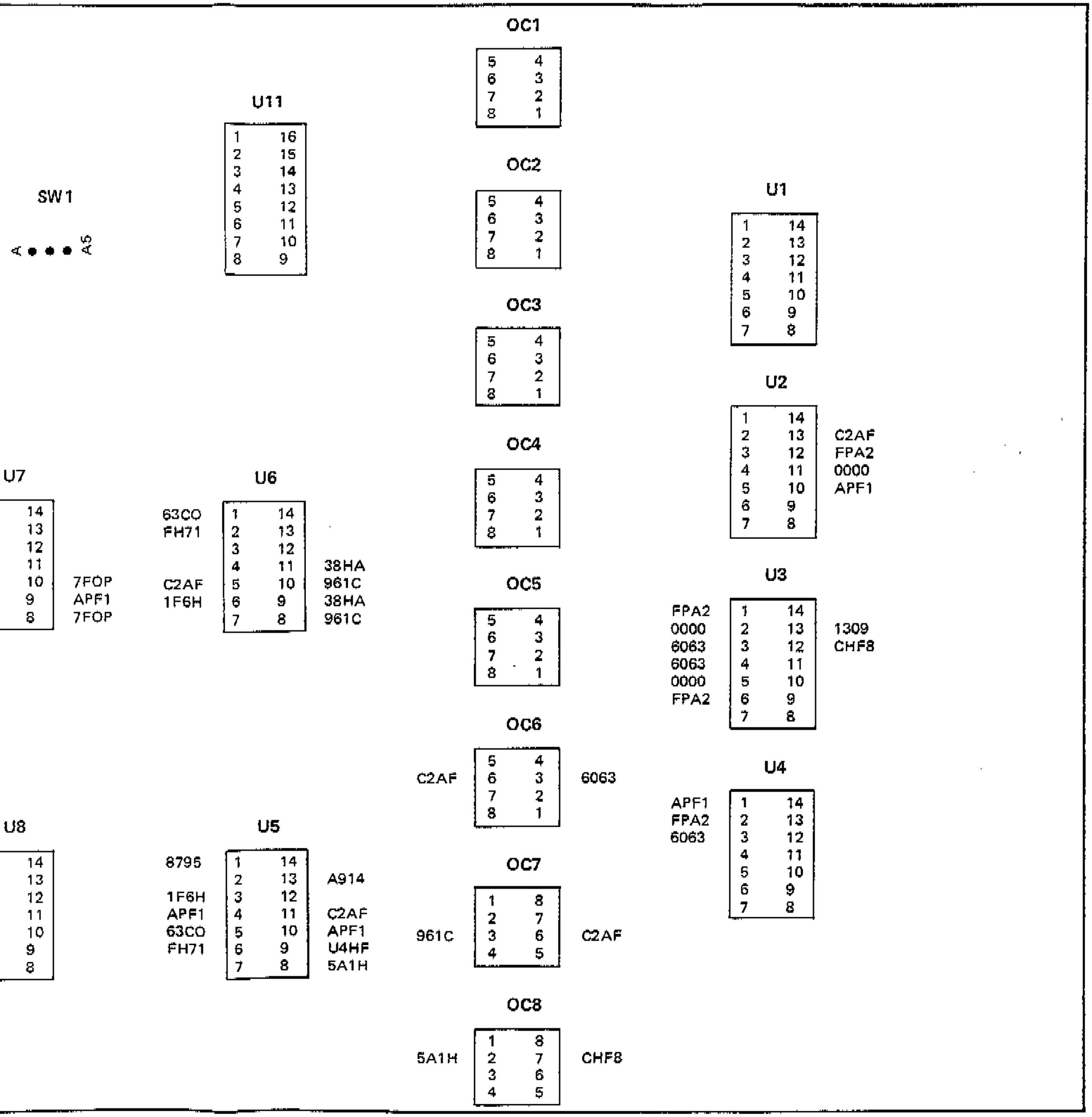


Table 8-D-17. SA TEST 7 Signatures (DAV GROUNDED).

Table 8-D-18
Sht 1 of 2

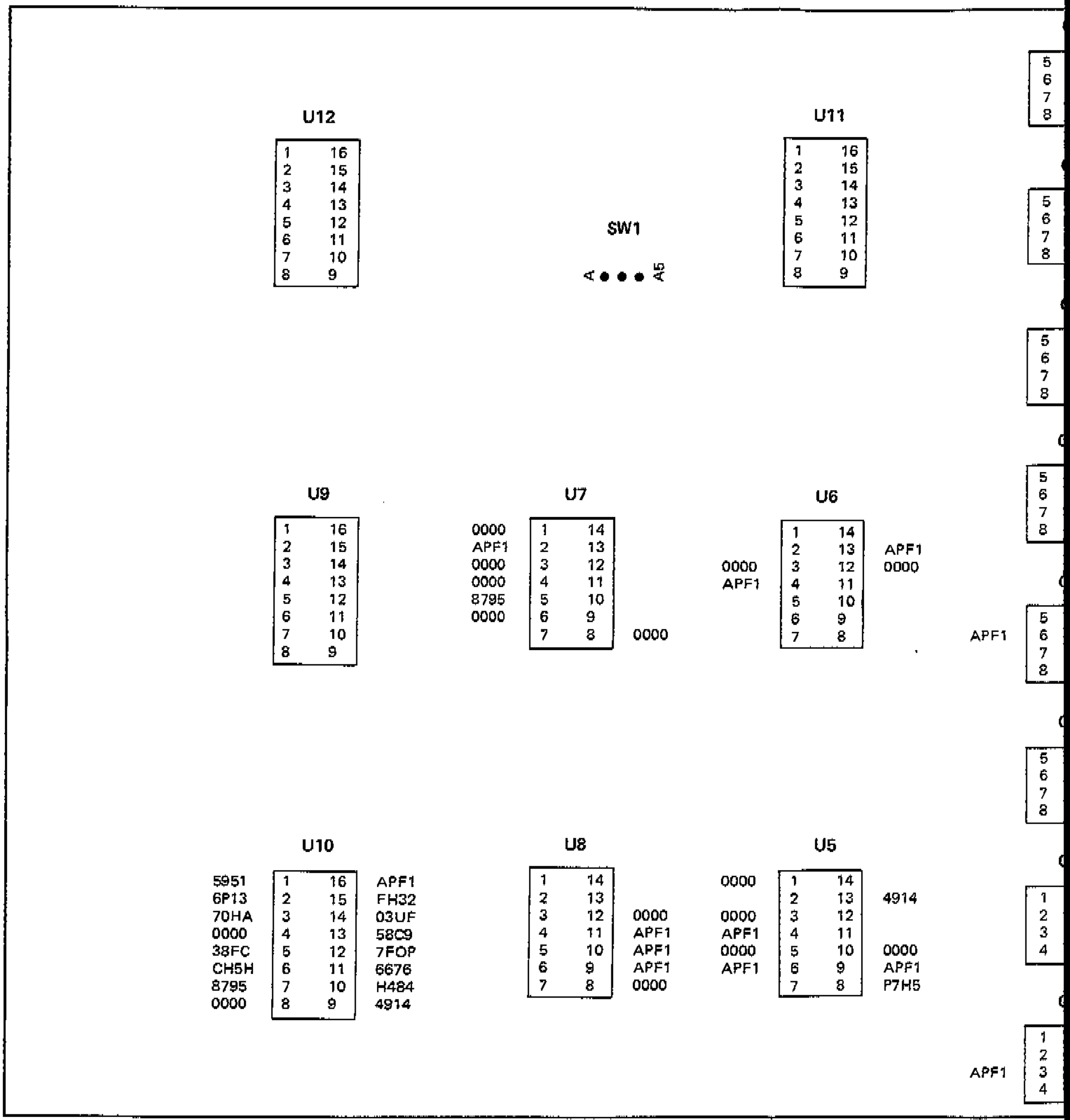


Table 8-D-18
Sht 2 of 2

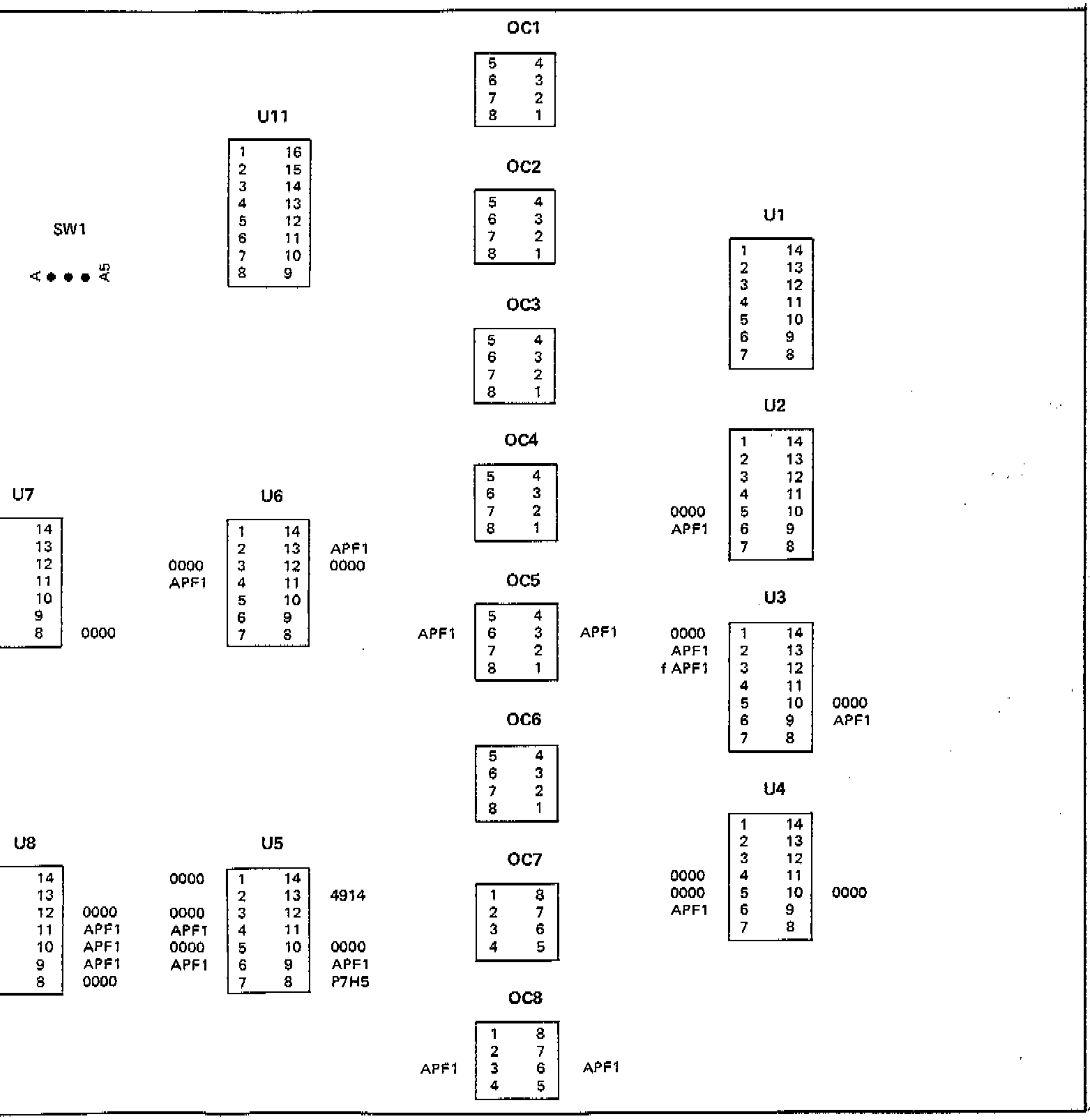
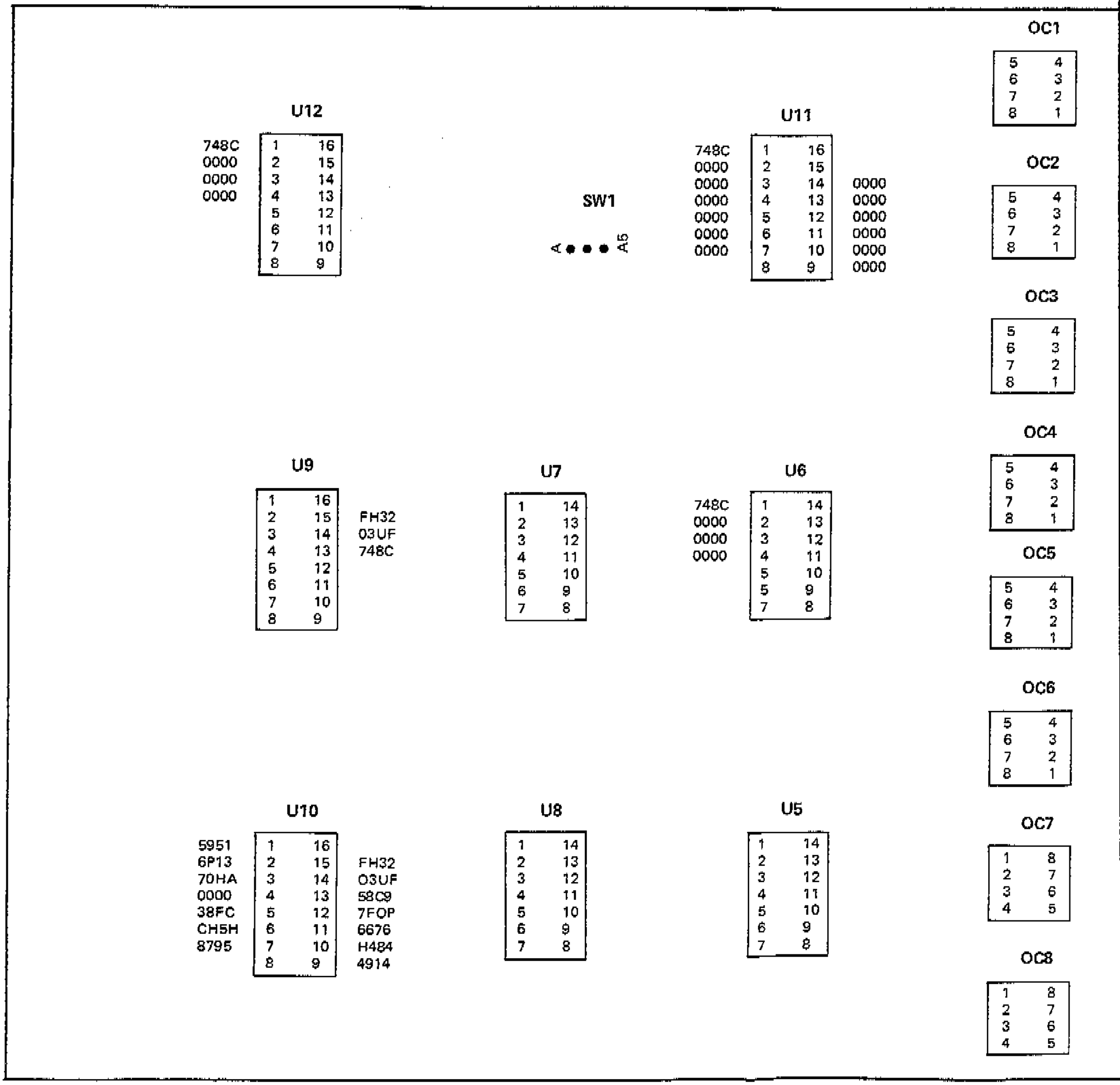


Table 8-D-18. SA TEST 7 Signatures (IFC GROUNDED).

Table 8-D79
Sht 1 of 2



Table

Table 8-D-19
Sht 2 of 2

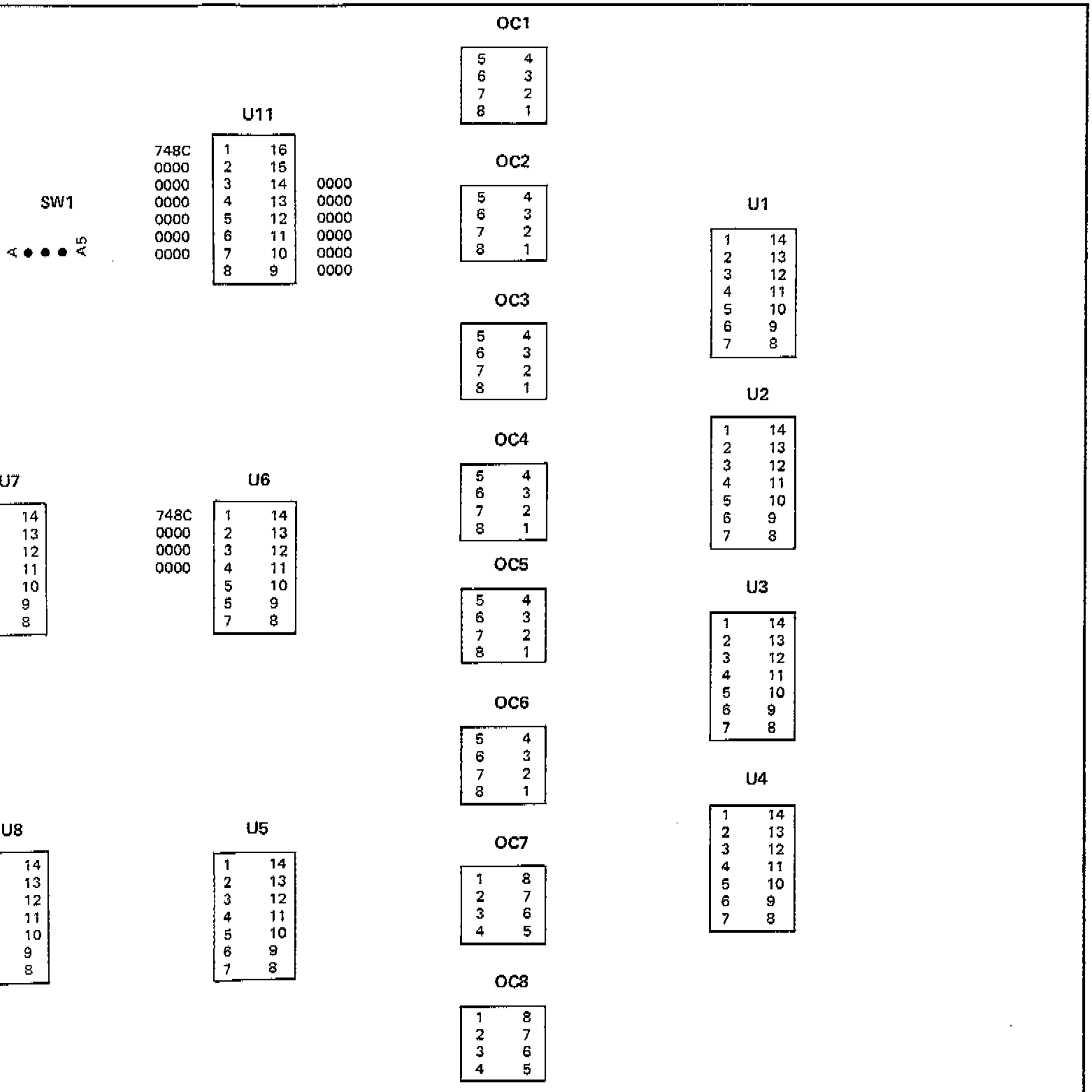


Table 8-D-19. SA TEST 7 Signatures (A11 Address Switches Closed).

SA TEST 8 (DISPLAY – A13 AND KEYBOARD – A11)

Test Requirements

Signatures associated with this test are dependent on the following:

1. -hp- Model 5004A Signature Analyzer
2. Controller Assembly (A13) -hp- Part No. 03335-66511 Rev. B
3. ROM C, A13U4, -hp- Part No. 1818-0826

NOTE

A continuously depressed key or a stuck key will generate signatures other than that shown.

Test Capability

Access of SA TEST 8 is indicated by eights displayed (not flashing). Decimal points do not have any significance.

-hp- Signature Analyzer Set-Up

Connect the Signature Analyzer as follows:

1. CLOCK input to A13U15 pin 1
2. CLOCK switch to position
3. START and STOP inputs to address line A15 on the controller test pins
4. START switch to position
5. STOP switch to position.
6. GND input to the A13 GND pin
7. HOLD switch out

Initializing SA TEST 8

1. Turn the 3335A on.

2. Ground pins A, B and C on the A13 Controller test pins.

3. Momentarily ground pin I (NMI) on the A13 Controller test pins.

4. Check the display for an indication of all eights and decimal points (not flashing). Some annunciators are also on but are not important in analyzing SA TEST 8. If the 3335A fails to go into SA TEST 8, check Table 8-D-4 for possible causes.

5. Verify that the ground and + 5 V signatures are correct.

   a. With the Signature Analyzer probe grounded, the Signature Analyzer display should indicate 0000.

   b. With the Signature Analyzer probe touching + 5 V, the Signature Analyzer display should read 9CA5. If unable to obtain the display reading, reinitiate the test and check Table 8-D-4.

6. Signatures for SA TEST 8 are divided into two parts:

   a. probed signatures
   b. non-probed signatures.

Probed signatures verify the display and keyboard circuits with no keys depressed. Non-probed signatures are those displayed when a key is depressed verifying the operation of each key switch.

7. The signatures of Table 8-D-20 correspond to part one of SA TEST 8 (probed signatures).

8. The signatures of Table 8-D-21 correspond to part two of SA TEST 8 (non-probed signatures). To obtain these signatures, the Signature Analyzer must first be displaying the + 5 V signature (9CA5). Depressing a front panel key causes the 3335A to display the switch designation associated with the depressed key. The Signature Analyzer display changes from 9CA5 to the signature indicated in Table 8-D-21.

Table 8-D-20. SA TEST 8 Probed Signatures.

U19

	1	20	
	2	19	
1073	3	18	
	4	17	0000
0000	5	16	
	6	15	0000
0000	7	14	
	8	13	1073
1073	9	12	
	10	11	0000

U25

	1	16	
	2	15	8272
	3	14	9CA5 f
	4	13	
	5	12	
	6	11	5780
	7	10	9CA5
	8	9	

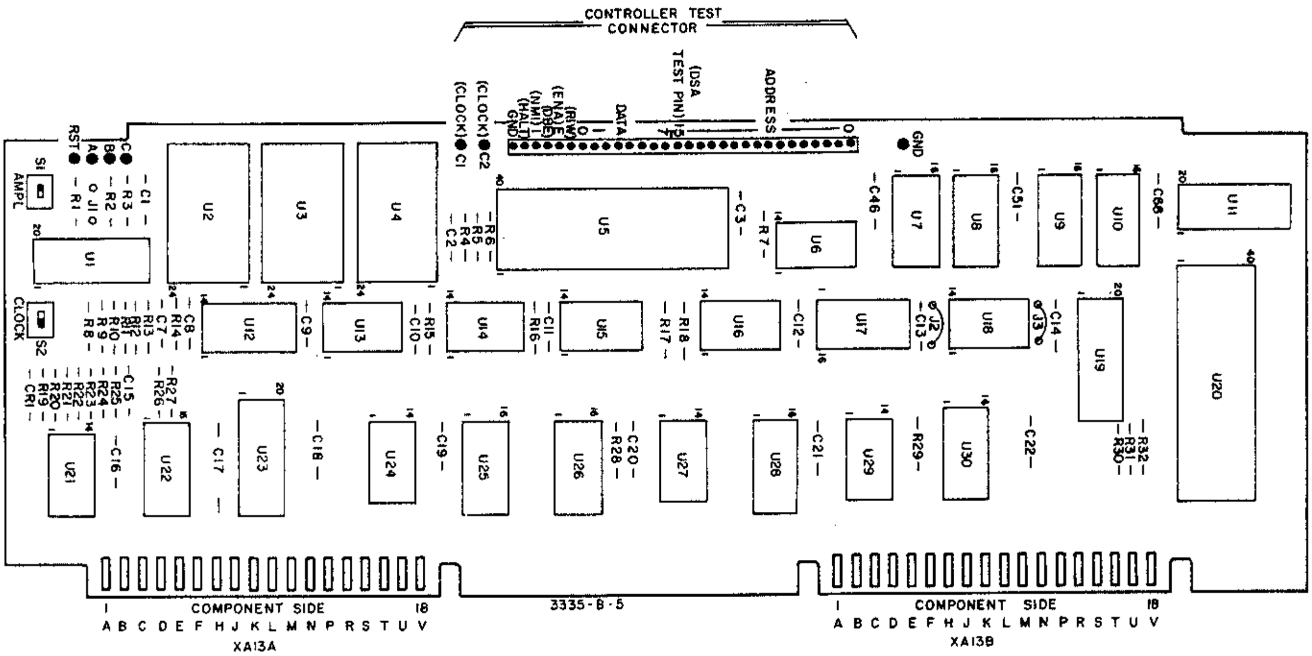
U20

	1	40	
	2	39	
	3	38	
	4	37	
	5	36	
	6	35	
	7	34	
	8	33	
	9	32	
	10	31	
	11	30	
	12	29	
	13	28	
	14	27	
9CA5	15	26	
9CA5	16	25	
9CA5	17	24	
	18	23	
	19	22	
	20	21	

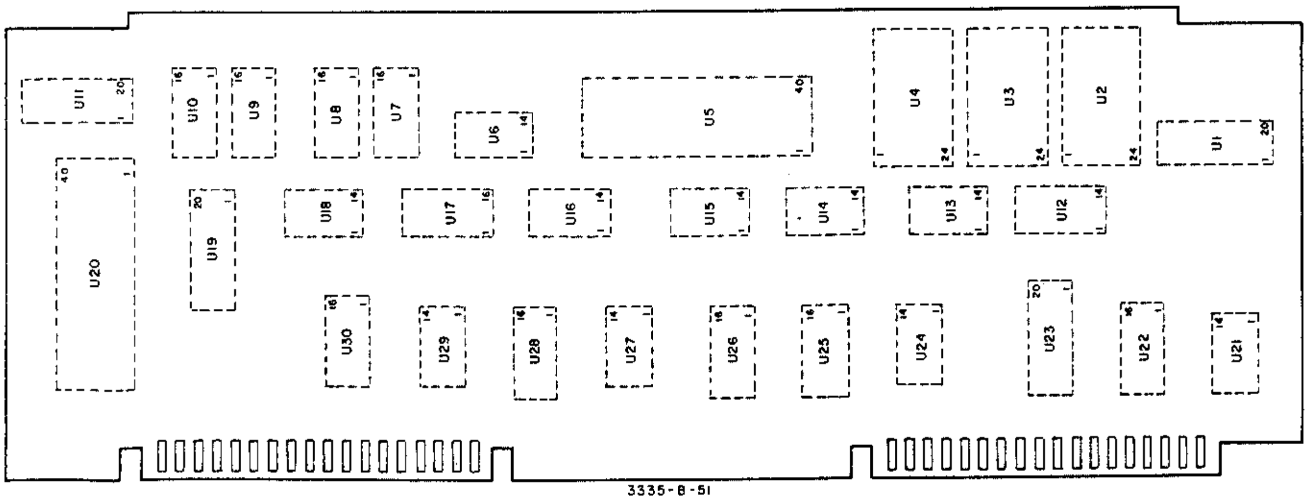
Table 8-D-21. SA TEST 8 Non-Probed Signatures.

Key	3335A Display	Signature
STORE	03	8543
DISPLAY	04	7UUF
RECALL	05	A3F5
FREQUENCY	06	C4A7
FREQ INCR	07	7FU8
AMPLITUDE	08	4U2F
AMPTD INCR	09	A14U
DISPLAY LAST ENTRY	10	8F00
SWEEP WIDTH	11	644A
Ø INCR	12	U3P3
7	13	6A3F
8	14	47UU
9	15	F854
4	16	77FU
5	17	OC4A
6	18	P4U2
1	19	8A14
2	20	98FO
3	21	9644
0	22	2A21
.	23	3002
BACK SPACE	24	9129
CLEAR	25	8H6U
MHz, −dBm	26	096U
kHz, +dBm	27	UCCP
Hz, deg	28	4CA7
⇧	29	48H6
⇩	30	6096
ON/OFF	31	35CU
⬅	32	4UCC
➡	33	P4CA
GO TO START FREQ	34	2P9P
START SINGLE 10 SEC	35	PPU8
START SINGLE 50 SEC	36	25CF
MANUAL	37	150F
START AUTO	38	3FC2
STOP	39	853H
MANUAL TUNE (RIGHT)	40	A212
MANUAL TUNE (LEFT)	41	8849

Fig 8-D-0
Sht 1 of 1



A13
-hp- Part No. 03335-66511



A13
Circuit Side

Figure 8-D-0. Controller Board (A-13) Component Locator.

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A13	03335-66511	1	PC ASSEMBLY, CONTROLLER	28480	03335-66511
A13C1	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C2	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C3	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C4	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C5	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C6	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C7	0160-0376		CAPACITOR-FXD 68PF +-5% 500WVDC MICA	28480	0160-0376
A13C8	0160-2220		CAPACITOR-FXD 1200PF +-5% 300WVDC MICA	28480	0160-2220
A13C9	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C10	0160-2009		CAPACITOR-FXD 820PF +-5% 300WVDC MICA	28480	0160-2009
A13C11	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C12	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C13	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C14	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C15	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A13C16	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C17	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X902082
A13C18	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C19	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C20	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C21	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13C22	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A13CR1	1902-0692	1	DIODE-ZNR 6.3V 1% DO-7 PD=.4W TC=+.001%	28480	1902-0692
A13J3	1251-4483	1	MOLEX, 22-03-2181	27264	08D
A13J4	1251-4132		CONNECTOR 12-PIN M POST TYPE	27264	22-03-2121
A13MP1	4040-0748	2	EXTRACTOR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
A13MP2	4040-0748		EXTRACTOR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
A13R1	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A13R2	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A13R3	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A13R4	0683-3325	6	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A13R5	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A13R6	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A13R7	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A13R8	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A13R9	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A13R10	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A13R11	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A13R12	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A13R13	0757-0449	2	RESISTOR 20K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2002-F
A13R14	0757-0449		RESISTOR 20K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2002-F
A13R15	0757-0411		RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-T0-332R-F
A13R16	0683-6815		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A13R17	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A13R18	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A13R19	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A13R20	0757-0457	1	RESISTOR 47.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4752-F
A13R21	0698-3540	1	RESISTOR 15.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1542-F
A13R22	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A13R23	0698-4020	1	RESISTOR 9.53K 1% .125W F TC=0+-100	24546	C4-1/8-T0-9531-F
A13R24	0698-4475	1	RESISTOR 9.76K 1% .125W F TC=0+-100	03888	PME55-1/8-T0-9761-F
A13R25	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A13R26	0698-4437	1	RESISTOR 2.94K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2941-F
A13R27	0698-4432		RESISTOR 2.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2101-F
A13R28	0683-4715		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A13R29	0683-4715		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A13R30	0683-2035	3	RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A13R31	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A13R32	0683-2035		RESISTOR 20K 5% .25W FC TC=-400/+800	01121	CB2035
A13S1, S2	3101-1341		SWITCH-SL SPDT-NS SUBMIN .5A 125VAC/DC	95146	SLS-120-1
A13U1	1820-1759	2	IC, DIGITAL TTL	28480	1820-1759
A13U2	1818-0284	1	IC-ROM C-27027	28480	1818-0284
A13U3	1818-0285	1	IC-ROM C-27028	28480	1818-0285
A13U4	1818-0286	1	IC-ROM C-27029	28480	1818-0286
A13U5	1820-1480	1	IC-DIGITAL MC6800L NMOS	04713	MC6800L
A13U6	1820-1200		IC-DIGITAL SN74LS05N TTL LS HEX 1	01295	SN74LS05N
A13U7	1818-0199	4	IC AM9112APC 1K RAM NMOS	34335	AM9112APC
A13U8	1818-0199		IC AM9112APC 1K RAM NMOS	34335	AM9112APC
A13U9	1818-0199		IC AM9112APC 1K RAM NMOS	34335	AM9112APC
A13U10	1818-0199		IC AM9112APC 1K RAM NMOS	34335	AM9112APC
A13U11	1820-1794	1	IC-DIGITAL 81LS95 TTL LS OCTL	27014	DM81LS95N
A13U12	1820-1423		IC-DIGITAL SN74LS123N TTL LS DUAL	01295	SN74LS123N
A13U13	1820-1112		IC-DIGITAL SN74LS74N TTL LS DUAL	01295	SN74LS74N

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A13U14	1820-1416	1	IC-DIGITAL SN74LS14N TTL LS HEX 1 INV	01295	SN74LS14N
A13U15	1820-1786	1	IC-DIGITAL 3459 NMOS QUAD LINE DRVR	04713	MC3459CP
A13U16	1820-1199		IC-DIGITAL SN74LS04N TTL LS HEX 1	01295	SN74LS04N
A13U17	1820-1281	1	IC-DIGITAL SN74LS139N TTL LS DUAL 2	01295	SN74LS139N
A13U18	1820-1202		IC-DIGITAL SN74LS10N TTL LS TPL 3 NAND	01295	SN74LS10N
A13U19	1820-1759		IC, DIGITAL TTL	28480	1820-1759
A13U20	1820-1481	1	IC-DIGITAL MC6820L NMOS	04713	MC6820L
A13U21	1826-0312		IC MC 3403 OP AMP	04713	MC3403P
A13U22	1820-1789	1	IC-DIGITAL AD7530 CMOS D/A	24355	AD7530JN
A13U23	1820-1730		IC-DIGITAL SN74LS273N TTL LS OCTL	01295	58039
A13U24	1820-1112		IC-DIGITAL SN74LS74N TTL LS DUAL	01295	SN74LS74N
A13U25	1820-1216	3	IC-DIGITAL SN74LS138N TTL LS 3	01295	SN74LS138N
A13U26	1820-0958	1	IC-DIGITAL CD4042AE CMOS QUAD D-TYPE	02735	CD4042AY
A13U27	1820-1201		IC-DIGITAL SN74LS08N TTL LS QUAD 2 AND	01295	SN74LS08N
A13U28	1820-1042	1	IC-DIGITAL SN74165N TTL R-S PRL-IN	01295	SN74165N
A13U29	1820-1199		IC-DIGITAL SN74LS04N TTL LS HEX 1	01295	SN74LS04N
A13U30	1820-1216		IC-DIGITAL SN74LS138N TTL LS 3	01295	SN74LS138N
	1200-0659	2	SOCKET-IC 40-CONT DIP-SLDR (FOR U5 & U20)	0011J	A-23-2030Y
	1200-0473	4	SOCKET-IC 16-CONT DIP-SLDR (FOR U7, 8, 9 & 10)	28480	1200-0473
	1200-0583	3	SOCKET-IC 24-CONT LSI DIP-SLDR (FOR U2, 3 & 4)	28480	1200-0583

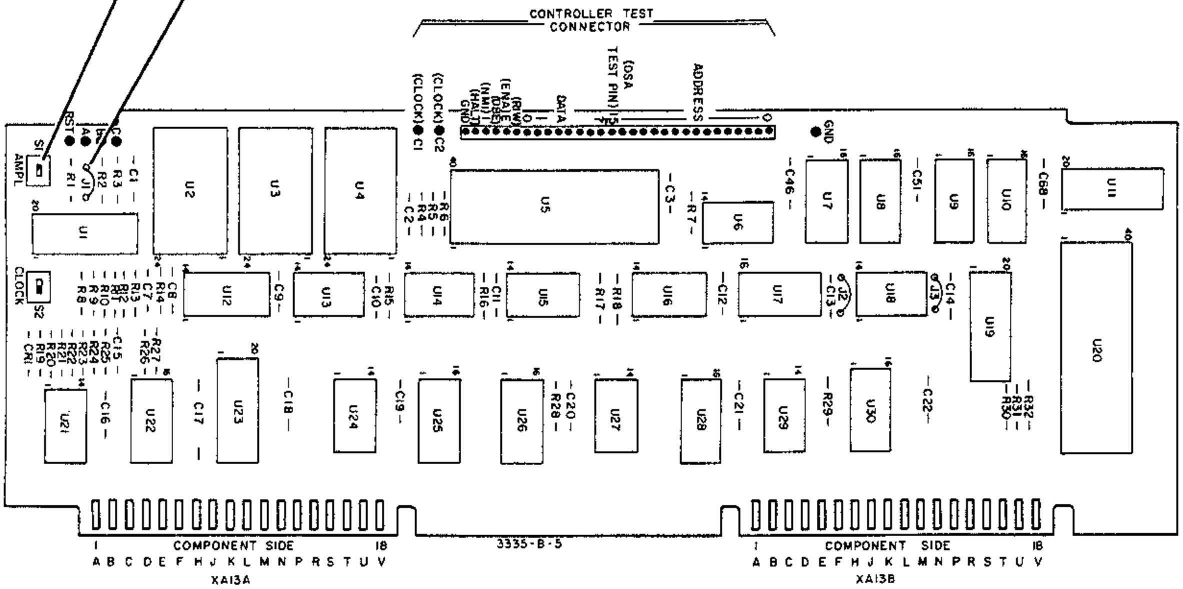
Fig 8-D-1
Sht 1 of 5

AMPLITUDE BLANKING SWITCH

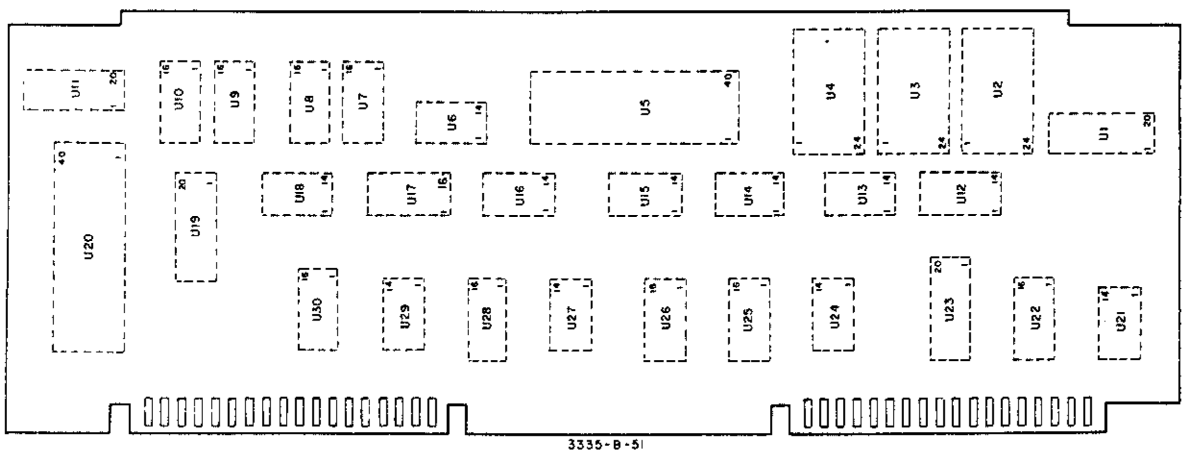
NORM POSITION: NORMAL OPERATION

BLANK POSITION: THE AMPLITUDE IS BLANKED FOR 20 MSEC WHENEVER A NEW FREQUENCY IS PROGRAMMED OR WHENEVER THE INCR ↑ OR INCR ↓ KEYS ARE ACTIVATED. FREQUENCY CHANGES INITIATED BY THE RPG OR SWEEP FUNCTIONS ARE NOT AFFECTED.

J1, SPECIAL SWEEP JUMPER: WHEN INSTALLED, AMPLITUDE IS BLANKED FOR 20 MSEC AT EACH STEP OF AN AUTO OR SINGLE SWEEP. IN AUTO SWEEP (100 STEPS) THE TIME BETWEEN STEPS IS APPROXIMATELY 4 SEC, THIS INCLUDES THE 20 MSEC BLANKING AND MAKES THE TOTAL SWEEP TIME APPROXIMATELY 400 SEC (6.7 MINUTES). IN SINGLE SWEEP (1000 STEPS) THE 20 MSEC IS ADDED TO EACH STEP WHICH INCREASES THE SINGLE SWEEP TIME BY 20 SEC. THEREFORE, THE 10 SEC SWEEP BECOMES APPROXIMATELY 30 SEC AND THE 50 SEC SWEEP BECOMES APPROXIMATELY 70 SEC. FREQUENCY CHANGES INITIATED BY THE RPG, INCR ↑, INCR ↓ OR INDIVIDUALLY PROGRAMMED FREQUENCIES DO NOT CAUSE AMPLTIUDE BLANKING.



A13
-hp- Part No. 03335-66511



A13
Circuit Side

Fig 8-D-1
Sht 2 of 5

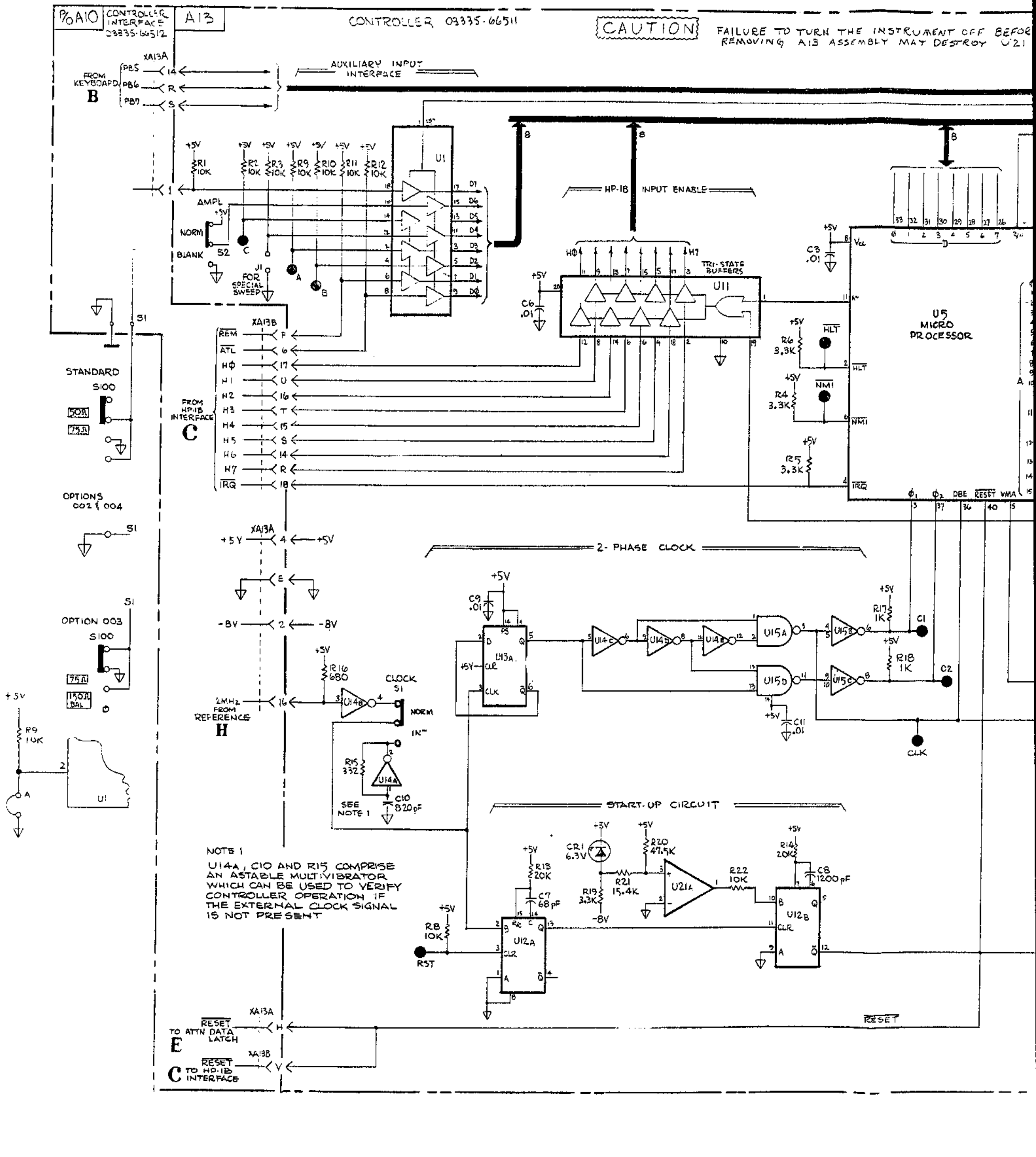


Fig 8-D-1
Sht 3 of 5

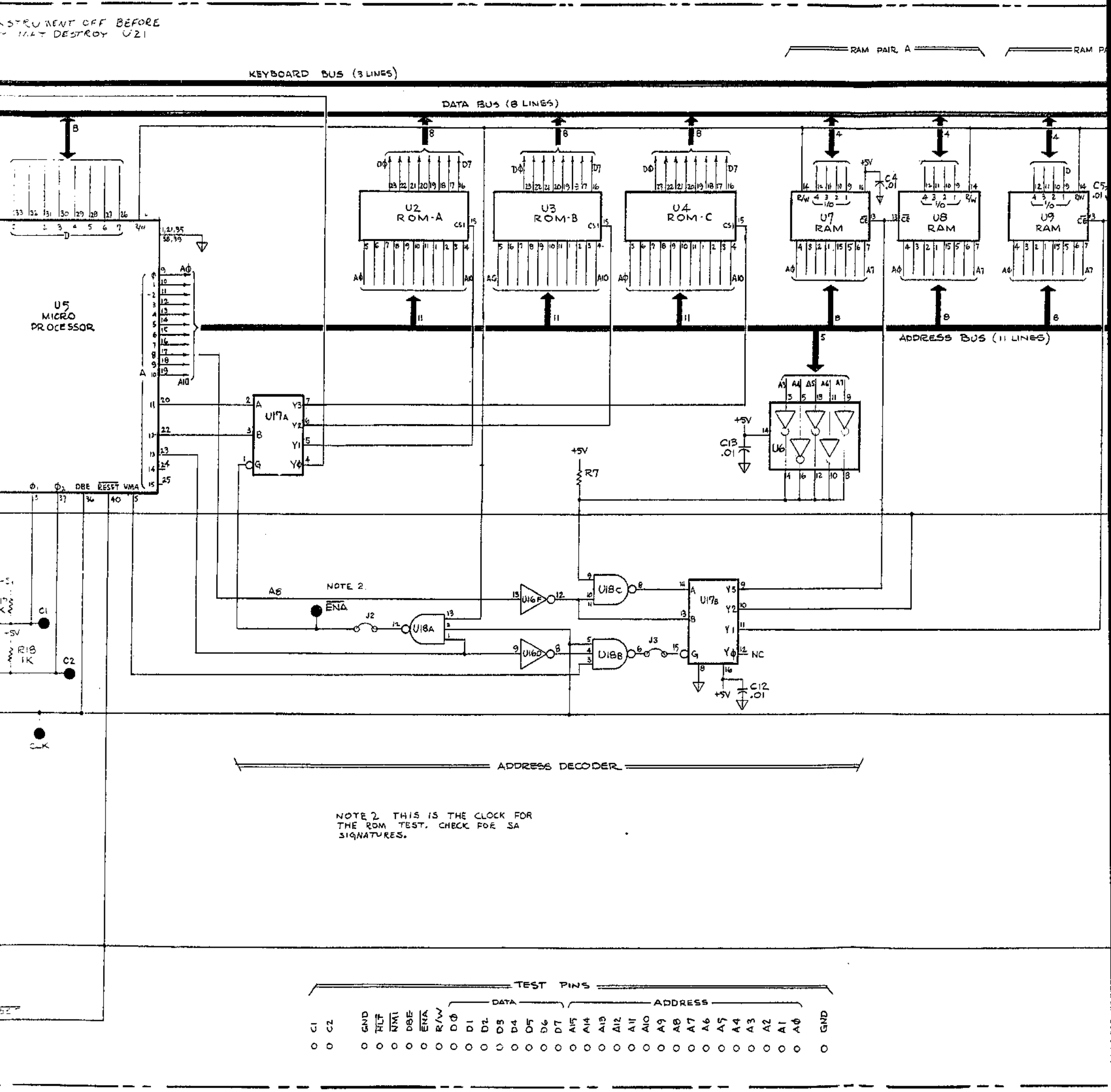
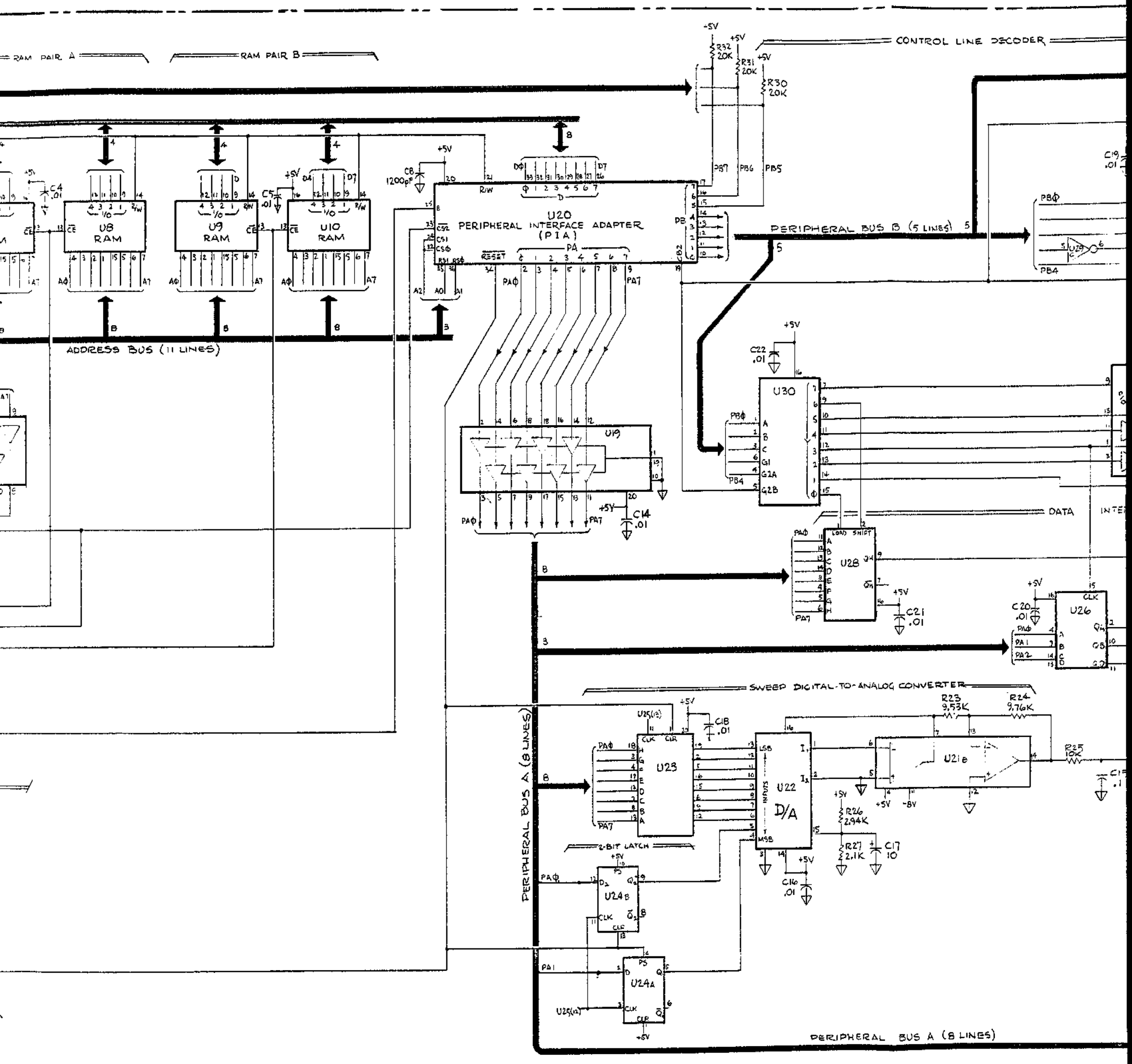
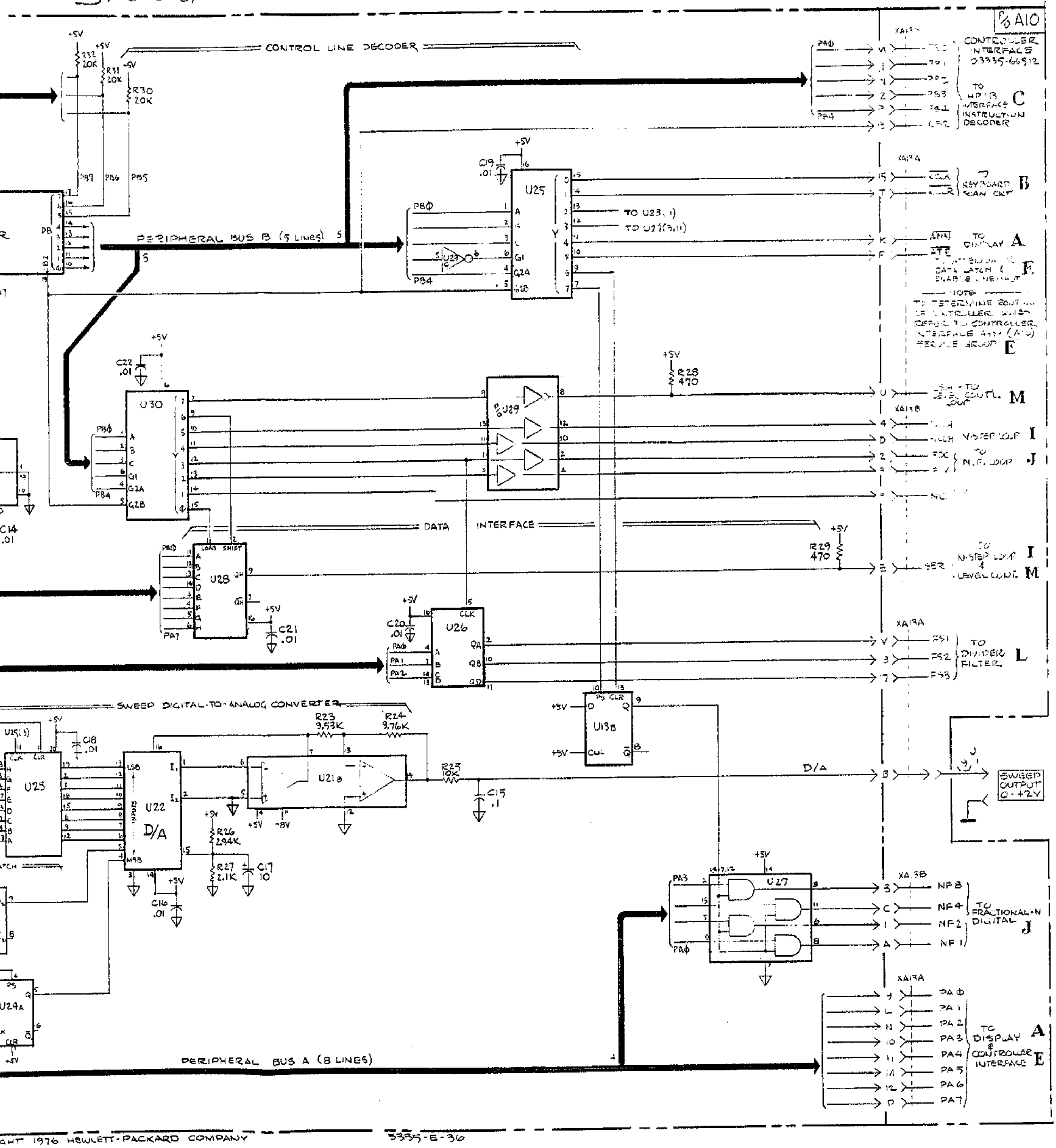


Fig 8-D-1
Sht 4 of 5



3335-E-36

Fig 8-D-1
Sht 5 of 5



D

Figure 8-D-1. Schematic Diagram, Controller (03335-66511) A13.

Fig -8-D-2
Sht 1 of 3

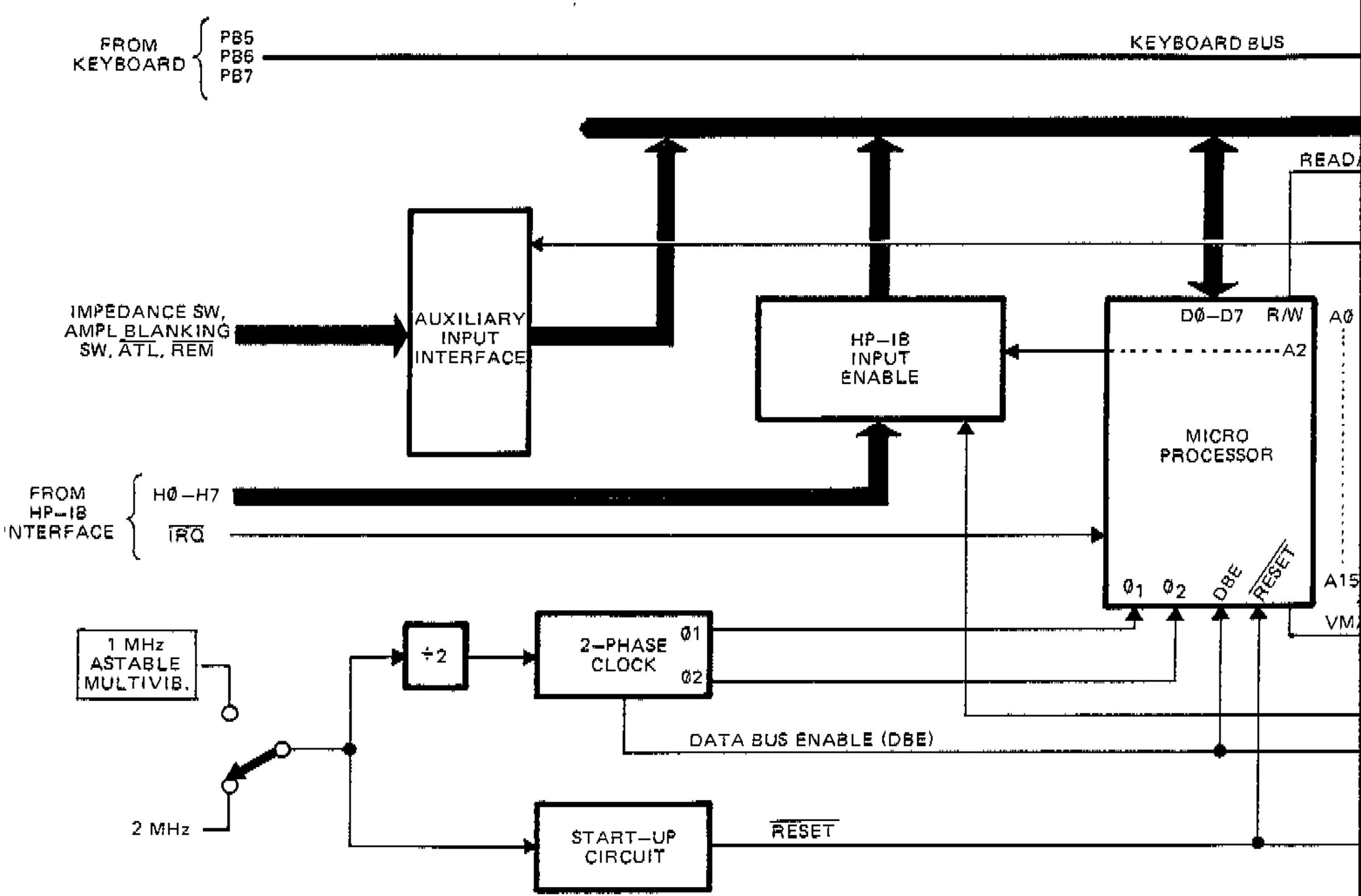


Fig 8-D-2
Sht 2 of 3

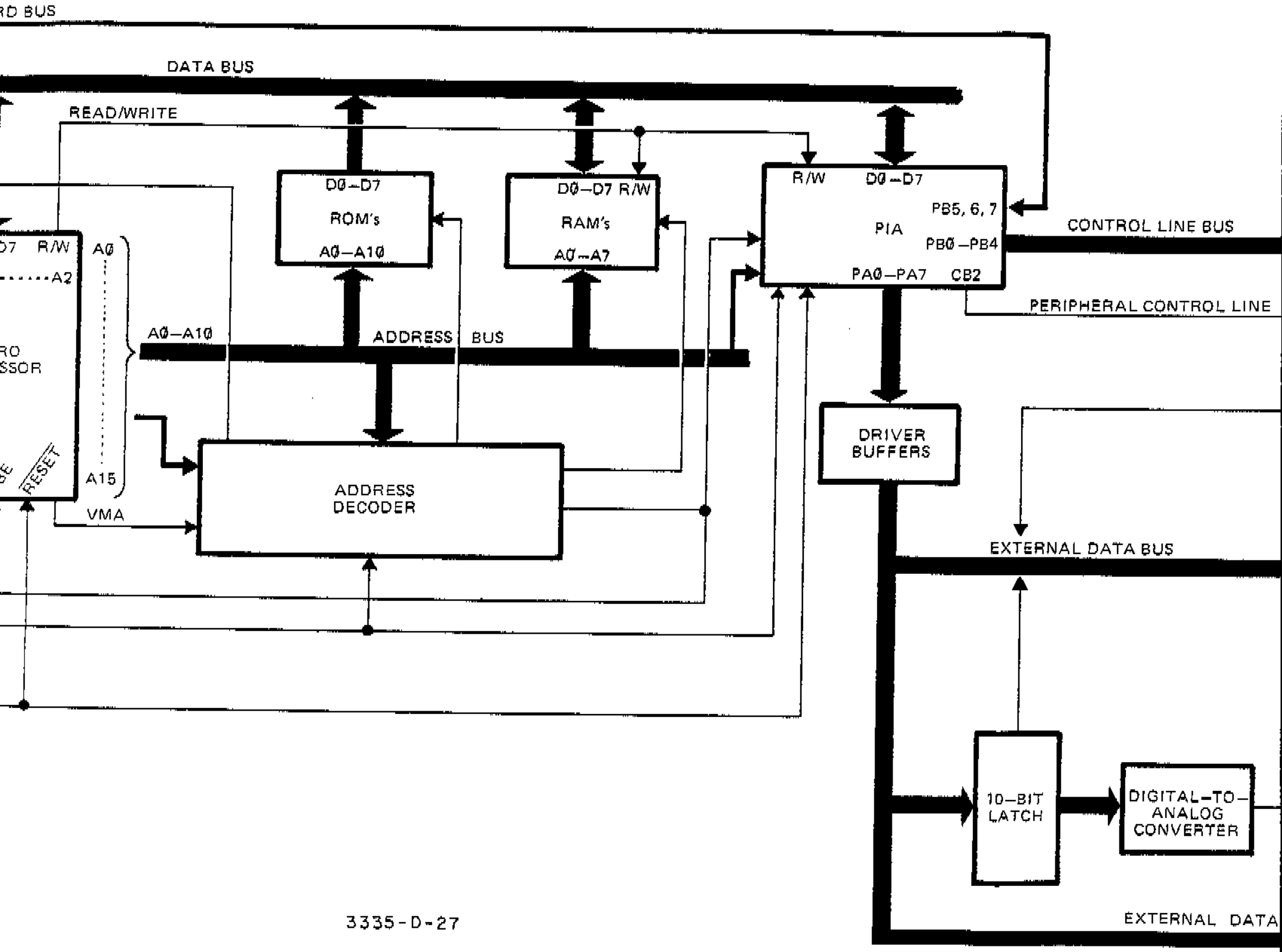


Fig 8-D-2
Sht 3 of 3

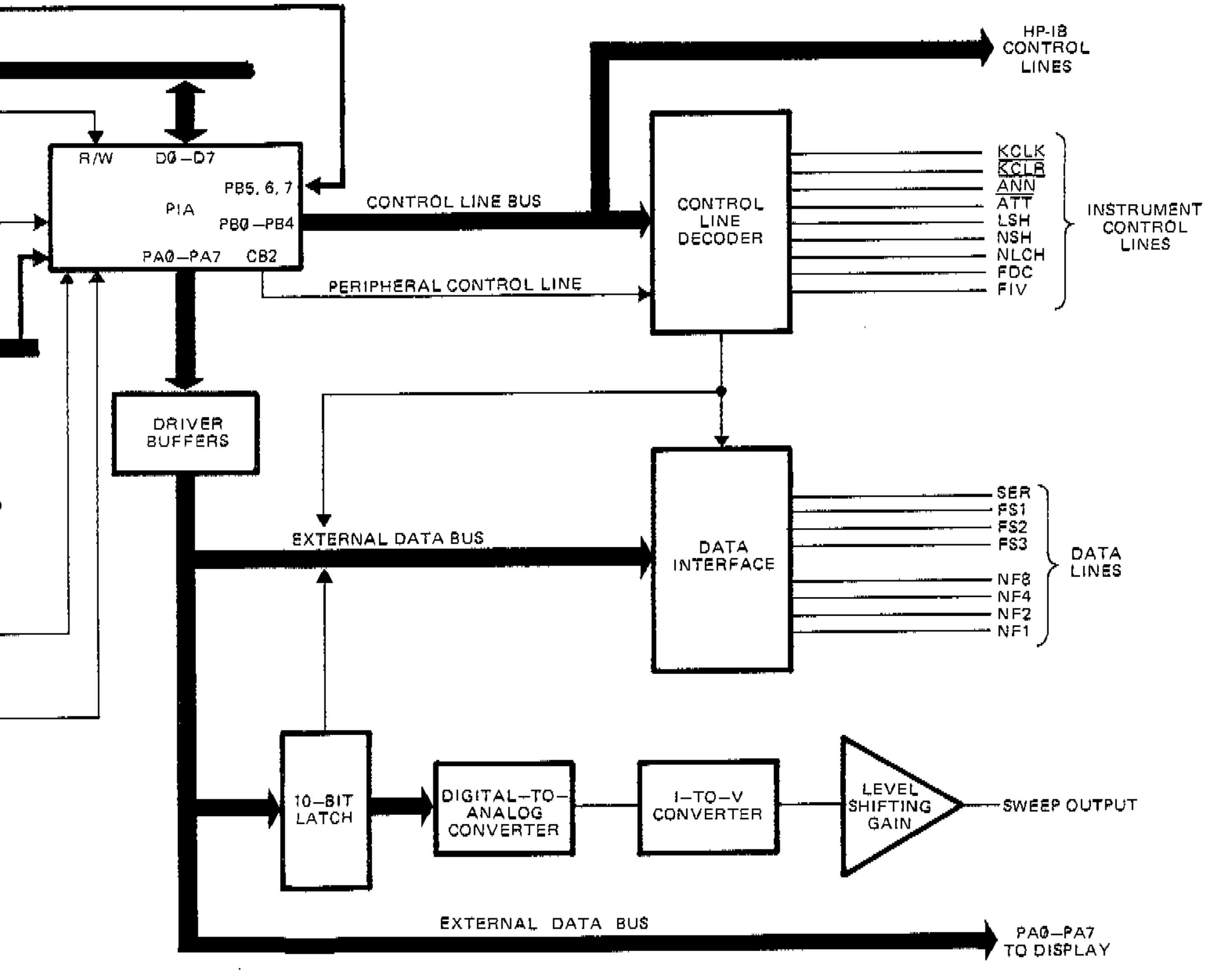


Figure 8-D-2. Block Diagram, Controller (03335-66511) A13.

SERVICE GROUP E

CONTROLLER INTERFACE

ADJUSTMENTS

NONE

TROUBLESHOOTING DATA

The Controller Interface Assembly (A10) is the interface between the Controller Assembly (A13) and the other sections. It also contains a data latch which latches data to operate the attenuator. This data is latched under control of the Controller line $\overline{ATT}$. A monostable multivibrator, also contained on the Controller Interface, generates the control line KCLR which is applied to the scan circuit of the Keyboard.

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A10	03335-66512	1	P.C. ASSEMBLY, CONTROLLER INTERFACE	28480	03335-66512
A10C1	0180-0137	1	CAPACITOR-FXD 100UF+-20% 10VDC TA	56289	150D107X0010R2
A10C2	0180-1735	3	CAPACITOR-FXD .22UF+-10% 35VDC TA	56289	150D224X9035A2
A10C3	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A10C3	0180-1743		CAPACITOR-FXD .1UF+-10% 35VDC TA	56289	150D104X9035A2
A10J1	1251-4112	2	CONNECTOR 25-PIN M POST TYPE	27264	22-03-2251
A10J2	1251-4620		MOLEX, 22-10-2181	27264	OBD
A10J3	1251-3638	2	CONNECTOR 6-PIN M POST TYPE	28480	1251-3638
A10J4	1251-4484	1	MOLEX, 22-03-2041	27264	OBD
A10J5	1251-4132	2	CONNECTOR 12-PIN M POST TYPE	27264	22-03-2121
A10R1	0698-4529	1	RESISTOR 226K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2263-F
A10R2	0698-4536	1	RESISTOR 340K 1% .125W F TC=0+-100	91637	CMF-55-1, T-1
A10U1	1820-1423	2	IC-DIGITAL SN74LS123N TTL LS DUAL	01295	SN74LS123N
A10U2	1820-1730		IC-DIGITAL SN74LS273N TTL LS OCTL	01295	58039
A10XA11A	1251-4485	2	CONNECTOR 14-PIN M POST TYPE	27264	22-05-2141
A10XA11B	1251-4485		CONNECTOR 14-PIN M POST TYPE	27264	22-05-2141
A10XA13A	1251-2026	2	CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	71785	252-18-30-300
A10XA13B	1251-2026		CONNECTOR-PC EDGE 18-CONT/ROW 2-ROWS	71785	252-18-30-300

Fig 8-F-1
Sht 3 of 4

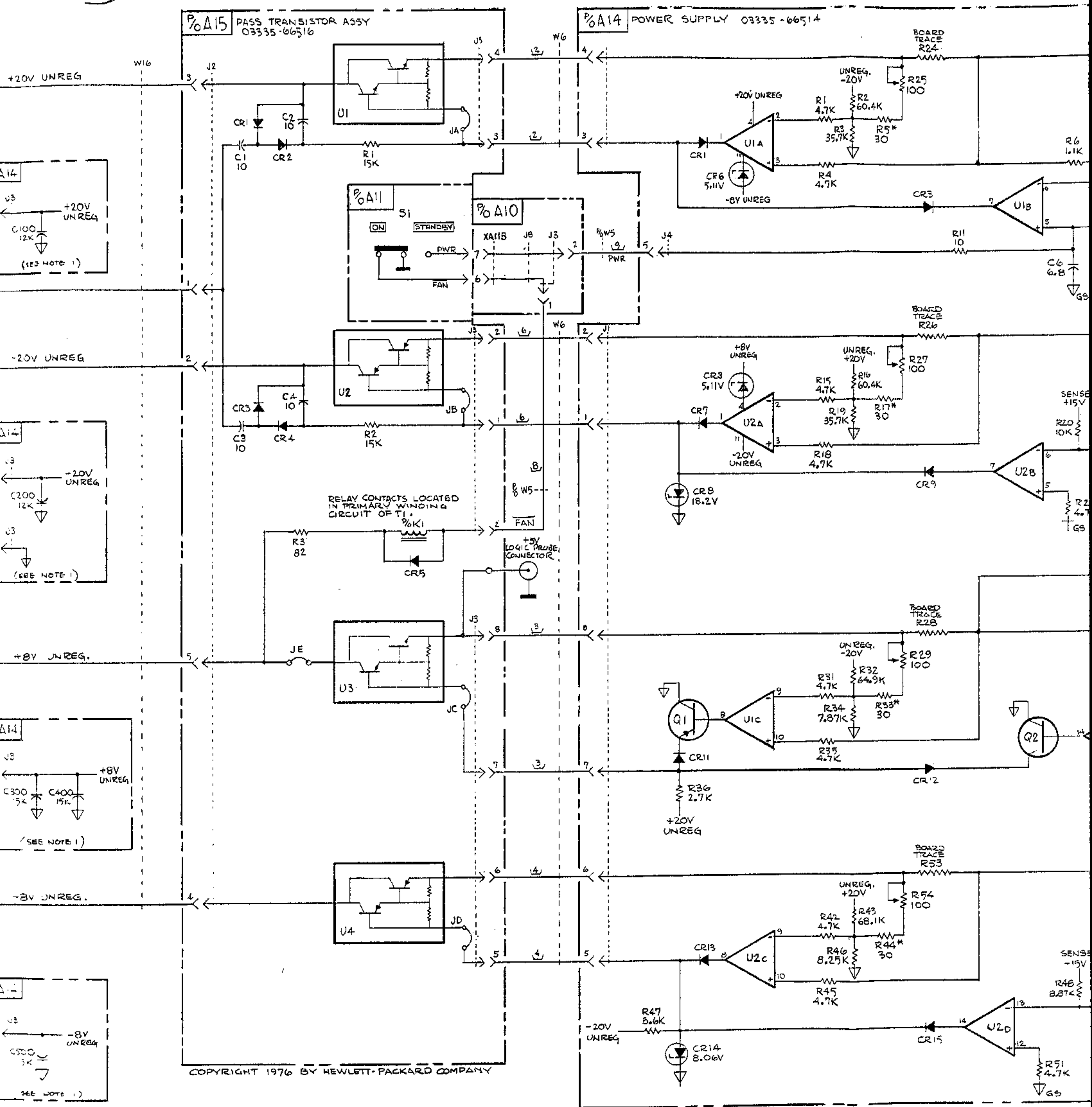


Fig 8-E-1
Sht 2 of 3

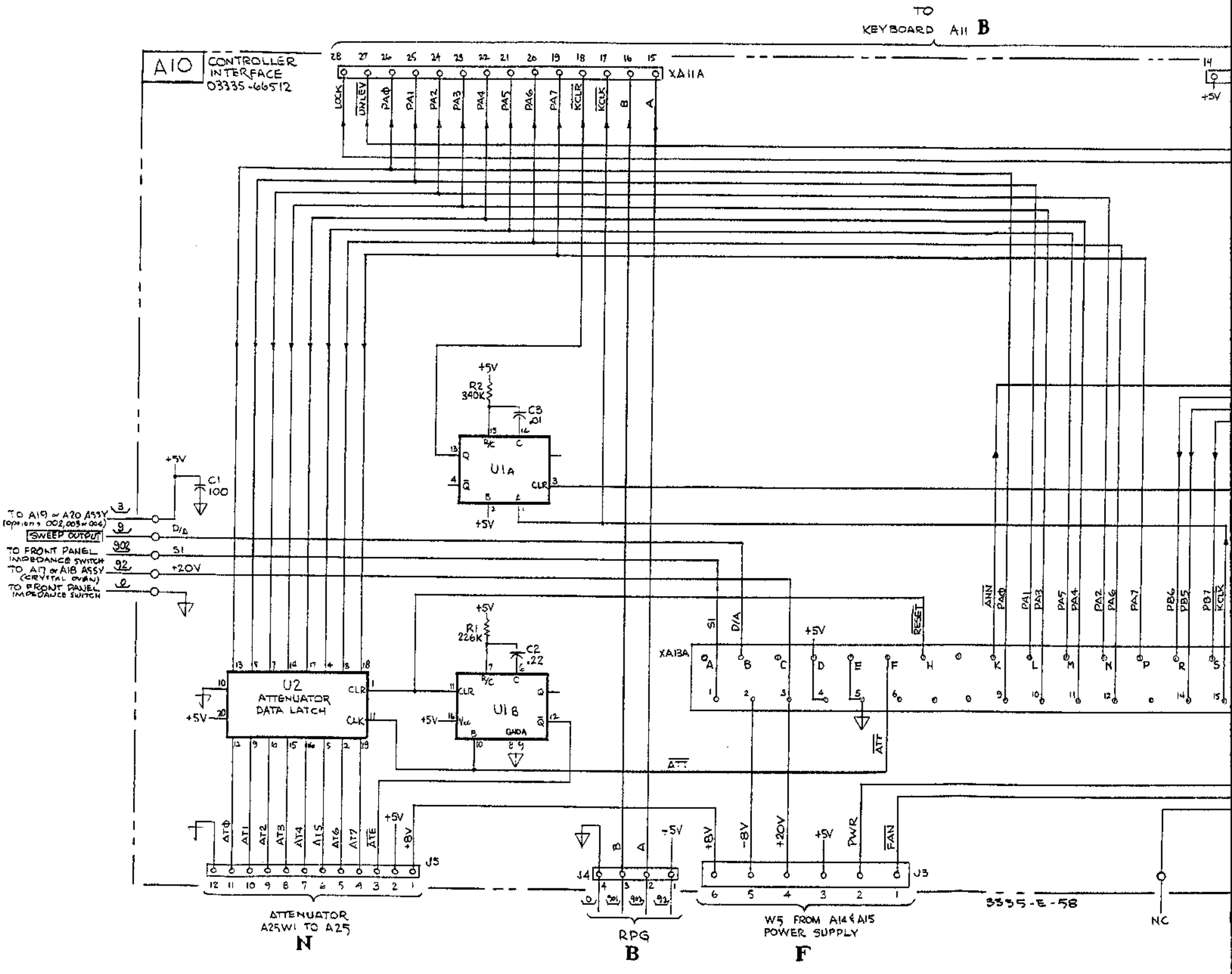
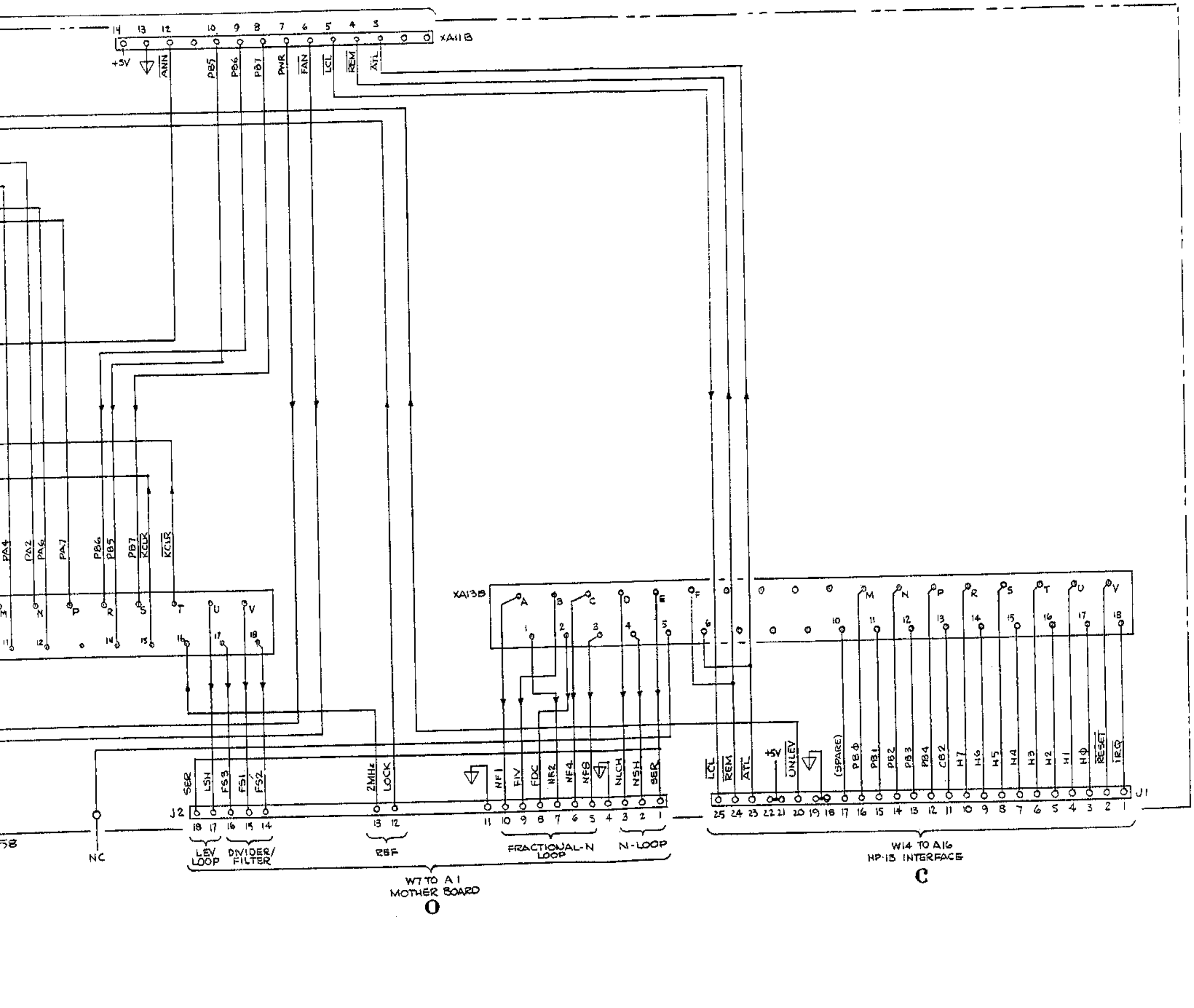


Fig 8-E-1
Sht 3 of 3



E

Figure 8-E-1. Schematic Diagram, Controller Interface (03335-66512) A10.

SERVICE GROUP F

POWER SUPPLY/PASS TRANSISTOR

ADJUSTMENTS

Designation	Adjustment Title	Adjustment Paragraph
A14R10	+ 15 V ADJ	5-9

TROUBLESHOOTING DATA

The Power Supply service group provides information to troubleshoot the Power Supply and Pass Transistor assemblies (A14 and A15) to the component level. It is assumed that one or more of the regulated power supply outputs (+ 15 V, - 15 V, + 5 V and - 5.2 V) is incorrect at the module Mother Board (A1) voltage test points to require power supply service. The four voltage test points on the A1 assembly are located at the top of the assembly between the two module halves.

1. If one or more of the regulated outputs are incorrect at the A1 assembly, verify that the unregulated voltages (+ 20 V, - 20 V, + 8 V and - 8 V) are present. These voltages are most easily measured at the "+" and "-" terminals of the bridge rectifiers CR100 and CR200 which are mounted above the power transformer, T100. A variation of ± 20% is acceptable for the unregulated output voltages.

2. If unregulated voltages are correct, verify the voltage doubler outputs on Pass Transistor assembly, A16, are approximately 55 V. These can be measured at the junction of R1 and CR2 and R2 and CR4. The voltages on Jumpers JA, JB, JC and JD are approximately:

   JA = + 13.7 V
   JB = - 13.7 V
   JC = + 3.7 V
   JD = - 3.9 V

3. The interfacing between the Power Supply and Pass Transistor assemblies (A14 and A15 is color coded according to the supply voltage. Interfacing associated with the +15 V supply is by red wires, −15 V by blue, +5 V by orange and −5.2 V by yellow.

4. If troubleshooting of the Power Supply Assembly, A14, is required, access to the components is obtained by removing the module from the cabinet with the cabling intact. A jumper connecting an A14 ground trace and the chassis must be made. This is required since the assembly obtains circuit ground through the mounting bracket attached to the chassis.

5. The - 15 V, + 5 V and - 5.2 V supplies are each referenced to the + 15 V output. When the power switch is in STBY, the zener reference (CR5) is shorted to ground causing the + 15 V supply output to go to 0 V. Since the other supplies are referenced to the + 15 V sense line, they too go to 0 V when the + 15 V output drops to 0 V.

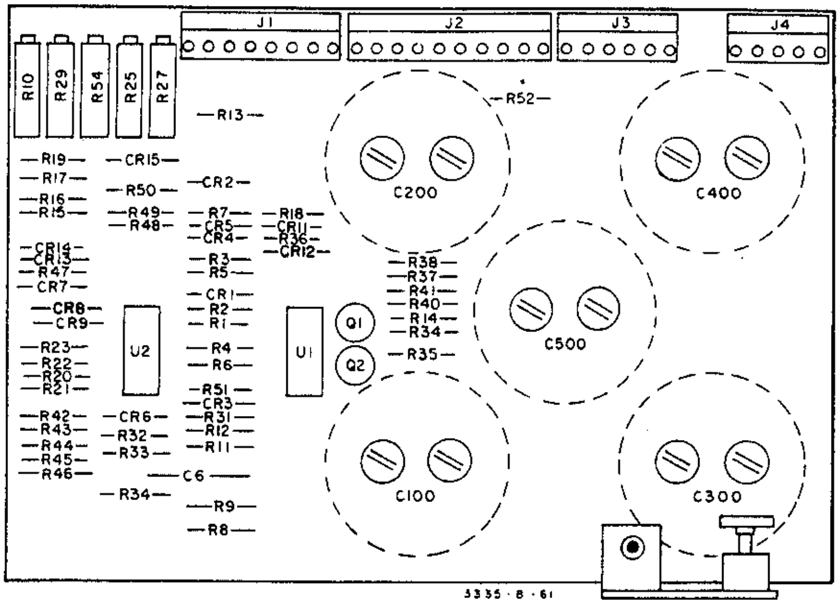
Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A14	03335-66514	1	P.C. ASSEMBLY, POWER SUPPLY	28480	03335-66514
A14C6	0180-0116	1	CAPACITOR-FXD 6.8UF+-10% 35VDC TA	56289	150D685X903582
A14CR1	1901-0025	17	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A14CR2	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	15818	CD 35622
A14CR3	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A14CR4	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A14CR5	1902-0777	1	DIODE-ZNR 1N825 6.2V 5% DO-7 PD=.25W	04713	1N825
A14CR6	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	15818	CD 35622
A14CR7	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A14CR8	1902-0766	1	DIODE-ZNR 18.2V 5% DO-7 PD=.4W TC=+.068%	04713	SZ 10939-257
A14CR9	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A14CR11	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A14CR12	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A14CR13	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A14CR14	1902-3136	1	DIODE-ZNR 8.06V 5% DO-7 PD=.4W TC=+.052%	04713	SZ 10939-155
A14CR15	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A14MP1	03335-01202	1	BRACKET, POWER SUPPLY	28480	03335-01202
A14J1	1251-3751	2	CONNECTOR 8-PIN M POST TYPE	27264	09-65-1081
A14J2	1251-3750	1	CONNECTOR 10-PIN M POST TYPE	27264	09-65-1101
A14J3	1251-3638		CONNECTOR 6-PIN M POST TYPE	28480	1251-3638
A14J4	1251-3825	1	CONNECTOR 5-PIN M POST TYPE	27264	09-65-1061
A14Q1	1853-0036	2	TRANSISTOR PNP 2N6053 S1 DARL TO-3	04713	2N6053
A14Q2	1853-0036		TRANSISTOR PNP S1 PD=310 MW FT=250MHZ	28480	1853-0036
A14R1	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A14R2	0698-3572	2	RESISTOR 60.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6042-F
A14R3	0698-4494	2	RESISTOR 35.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3572-F
A14R4	0683-4725		RESISTOR 4.7K 5% .25W FC TC=−400/+700	01121	CB4725
A14R5*	0757-0388	4	RESISTOR 30.1 1% .125W F TC=0+−100	03292	C4-1/8-TO−30 R-F
A14R6	0757-0424		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A14R7	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A14R8	0683-2705	4	RESISTOR 27 5% .25W FC TC=-400/+500	01121	CB2705
A14R9	0698-4474	1	RESISTOR 8.45K 1% .125W F TC=0+−100	24546	C4-1/8-TO-8451-F
A14R10	2100-3154	1	RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	03744	3006P-1-102
A14R11	0683-1005		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A14R12	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A14R13	0698-4445	1	RESISTOR 5.76K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5761-F
A14R14	0683-1005		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A14R15	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A14R16	0698-3572		RESISTOR 60.4K 1% .125W F TC=0+−100	24546	C4-1/8-TO-6042-F
A14R17*	0757-0388		RESISTOR 30.1 1% .125W F TC=0+−100	03292	C4-1/8-TO-30 R-F
A14R18	0683-4725		RESISTOR 4.7K 5% .25W FC TC=−400/+700	01121	CB4725
A14R19	0698-4494		RESISTOR 35.7K 1% .125W F TC=0+−100	24546	C4-1/8-TO-3572-F
A14R20	0698-6360	2	RESISTOR 10K .1% .125W F TC=0+−25	24546	NE55
A14R21	0698-6360		RESISTOR 10K .1% .125W F TC=0+−25	24546	NE55
A14R22	0683-4725		RESISTOR 4.7K 5% .25W FC TC=−400/+700	01121	CB4725
A14R23	0683-2705		RESISTOR 27 5% .25W FC TC=−400/+500	01121	CB2705
A14R25	2100-3122	4	RESISTOR-TRMR 100 10% C TOP-ADJ 15-TRN	03744	3006P-1-101
A14R27	2100-3122		RESISTOR-TRMR 100 10% C TOP-ADJ 15-TRN	03744	3006P-1-101
A14R29	2100-3122		RESISTOR-TRMR 100 10% C TOP-ADJ 15-TRN	03744	3006P-1-101
A14R31	0683-4725	1	RESISTOR 4.7K 5% .25W FC TC=−400/+700	01121	CB4725
A14R32	0698-4502	1	RESISTOR 64.9K 1% .125W F TC=0+−100	24546	C4-1/8-TO-6492-F
A14R33	0757-0388		RESISTOR 30.1 1% .125W F TC=0+−100	03292	C4-1/8-TO-30 R-F
A14R34	0698-3259		RESISTOR 7.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7871-F
A14R35	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A14R36	0683-2725	1	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A14R37	0683-3325		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A14R38	0683-2705		RESISTOR 27 5% .25W FC TC=-400/+500	01121	CB2705
A14R39	0698-8061	1	RESISTOR 8.25K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-8251-B
A14R40*	0757-0388	1	RESISTOR 30.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-30R1-F
A14R41	0698-8180	1	RESISTOR 4.22K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-4221-B
A14R42	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A14R43	0757-0461	1	RESISTOR 68.1K 1% .125W F TC=0+−100	24546	C4-1/8-TO-6812-F
A14R44*	0757-0388		RESISTOR 30.1 1% .125W F TC=0+−100	03292	C4-1/8-TO-30 R-F
A14R45	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A14R46	0757-0441		RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A14R47	0683-5625		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A14R48	0698-8039	1	RESISTOR 8.87K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-8871-B
A14R49*	0698-3437	1	RESISTOR 133 1% .125W F TC=0+-100	24546	C4-1/8-T0-133R-F
A14R50	0698-6348	1	RESISTOR 3K .1% .125W F TC=0+-25	24546	NE55
A14R51	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A14R52	0683-2705		RESISTOR 27 5% .25W FC TC=−400/+500	01121	CB2705
A14R54	2100-3122		RESISTOR-TRMR 100 10% C TOP-ADJ 15-TRN	03744	3006P-1-101
A14U1	1826-0312		IC MC 3403 OP AMP	04713	MC3403P
A14U2	1826-0312		IC MC 3403 OP AMP	04713	MC3403P

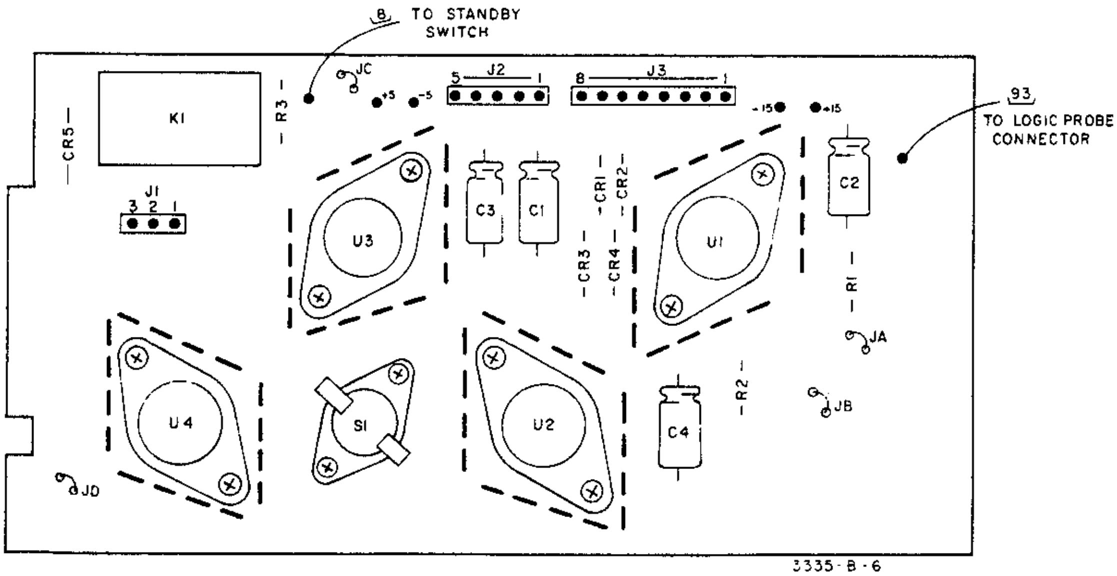
Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A15	03335-66516	1	PC ASSEMBLY, PASS TRAN	28480	03335-66516
A15C1	0180-0183	4	CAPACITOR-FXD 10UF+75-10% 50VDC AL	56289	30D106G050CB2
A15C2	0180-0183		CAPACITOR-FXD 10UF+75-10% 50VDC AL	56289	30D106G050CB2
A15C3	0180-0183		CAPACITOR-FXD 10UF+75-10% 50VDC AL	56289	30D106G050CB2
A15C4	0180-0183		CAPACITOR-FXD 10UF+75-10% 50VDC AL	56289	30D106G050CB2
A15CR1	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A15CR2	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A15CR3	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A15CR4	1901-0025		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A15F1	2110-0010	1	FUSE 5A 250V FAST-BLO 1.25X.25 UL IEC	75915	312005.
	2110-0269	1	FUSEHOLDER-CLIP TYPE .25FUSE	28480	2110-0269
A15J1	1251-4246		CONNECTOR 3-PIN M POST TYPE	27264	09-65-1031
A15J2	1251-3825		CONNECTOR 5-PIN M POST TYPE	27264	09-65-1061
A15J3	1251-3751		CONNECTOR 8-PIN M POST TYPE	27264	09-65-1081
A15K1	0490-0745	1	RELAY 1C 6VDC-COIL 2A 115VAC	09023	603-6
A15R1	0683-1535	2	RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A15R2	0683-1535		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A15R3	0683-8205	1	RESISTOR 82 5% .25W FC TC=-400/+500	01121	CB8205
A15S1	3103-0016	1	SWITCH-THRM FXD +90C 15A OPN ON RISE	14604	3450
A15U1	1854-0744	2	TRANSISTOR NPN SI DARL TO-3 PD=100W	28480	1854-0744
	1205-0289	4	HEAT SINK TO-3-PKG	28480	1205-0289
A15U2	1853-0415	2	TRANSISTOR PNP SI DARL TO-3 PD=100W	28480	1853-0415
	1205-0289		HEAT SINK TO-3-PKG	28480	1205-0289
A15U3	1854-0744		TRANSISTOR NPN SI DARL TO-3 PD=100W	28480	1854-0744
	1205-0289		HEAT SINK TO-3-PKG	28480	1205-0289
A15U4	1853-0415		TRANSISTOR PNP SI DARL TO-3 PD=100W	28480	1853-0415
	1205-0289		HEAT SINK TO-3-PKG	28480	1205-0289
		8	INSULATOR-XSTR RUBBER	8G464	7403-10-03
A15V6	0340-0583		INSULATOR-XSTR RUBBER	8G464	7403-10-03
A15V7	0340-0583		INSULATOR-XSTR RUBBER	8G464	7403-10-03
A15V8	0340-0583		INSULATOR-XSTR RUBBER	8G464	7403-10-03

Fig 8-F1
Sht 1of4

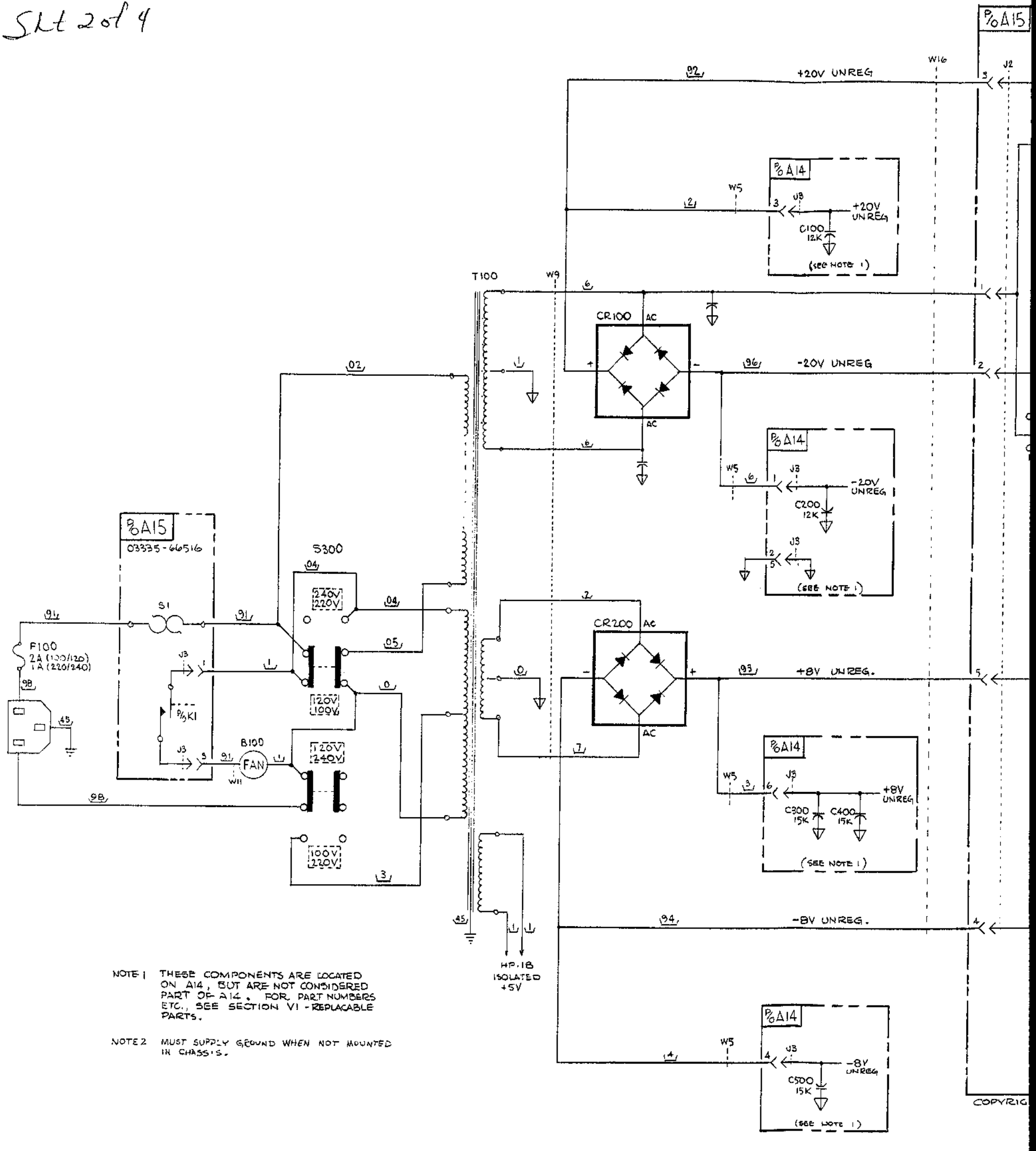


A14
-hp- Part No. 03335-66514



A15
-hp- Part No. 03335-66516

Fig 8-f-1
Sht 2 of 4



NOTE 1 THESE COMPONENTS ARE LOCATED ON A14, BUT ARE NOT CONSIDERED PART OF A14. FOR PART NUMBERS ETC., SEE SECTION VI - REPLACABLE PARTS.

NOTE 2 MUST SUPPLY GROUND WHEN NOT MOUNTED IN CHASSIS.

Fig 8-F-1
Sht 3 of 4

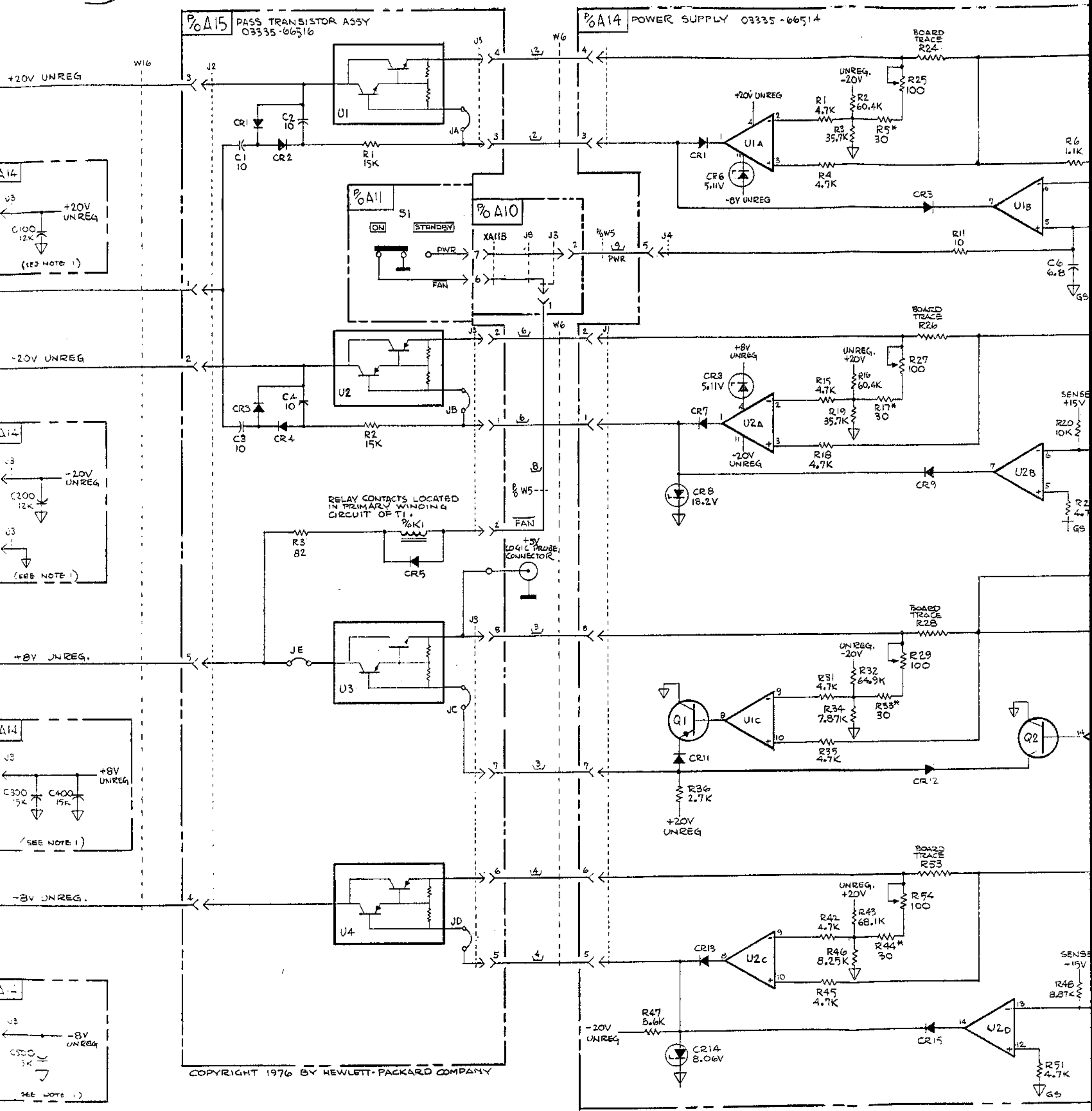
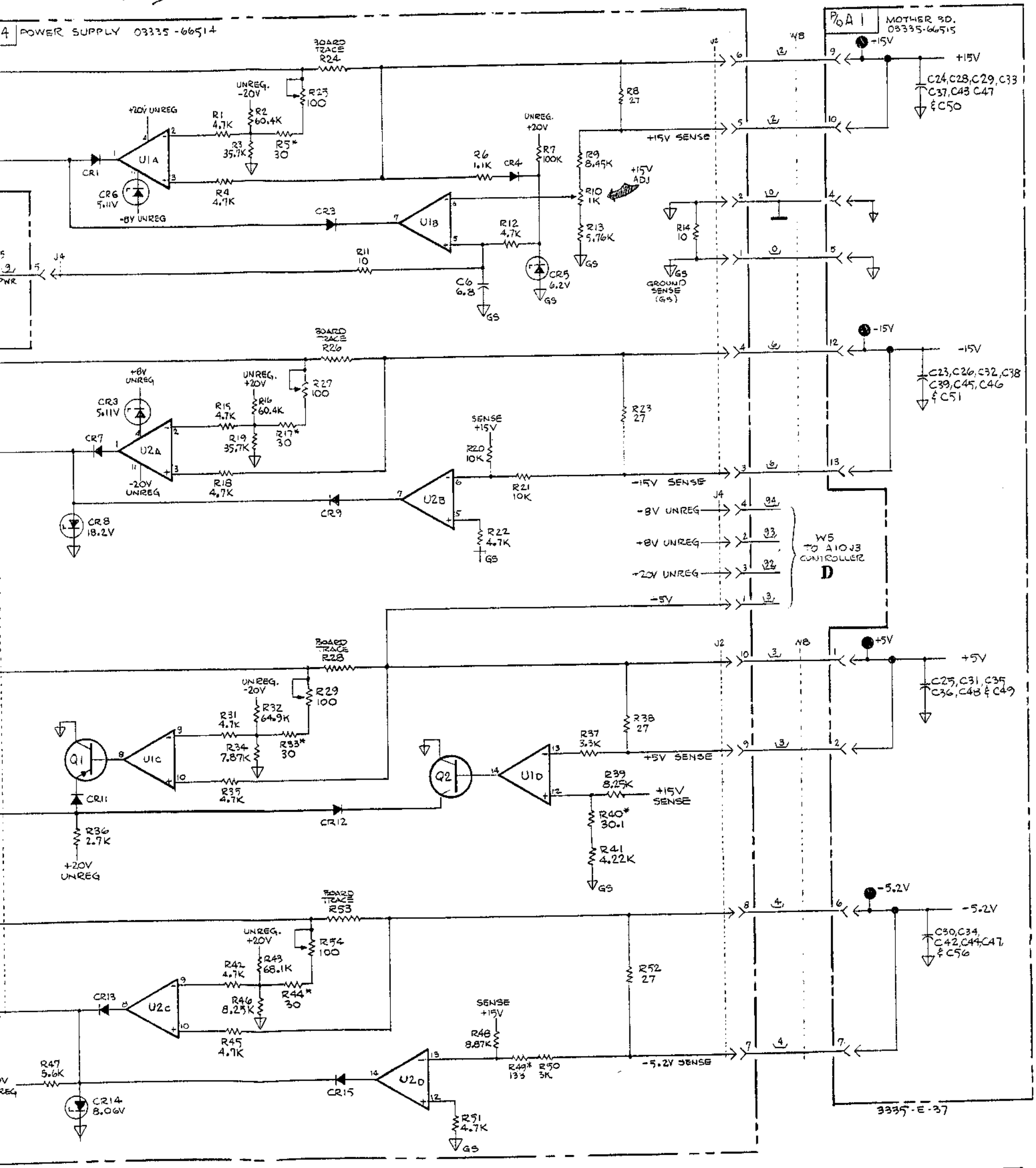


Fig 8-F-1 Sht 4 of 4



F

Figure 8-F-1. Schematic Diagram, Power Supply (03335-66514) A14, Pass Transistor (03335-66516) A15.

SERVICE GROUP G

TEMPERATURE STABILIZED OSCILLATOR

ADJUSTMENTS

Designation	Adjustment Title	Paragraph
Standard:		
A17A1	FREQ ADJ	5-12
A17R11	FINE FREQ ADJ	5-12
Option 001:		
A18A1	FREQ ADJ	5-13

TROUBLESHOOTING DATA

Verify that the voltage supplied to the oven is as follows:

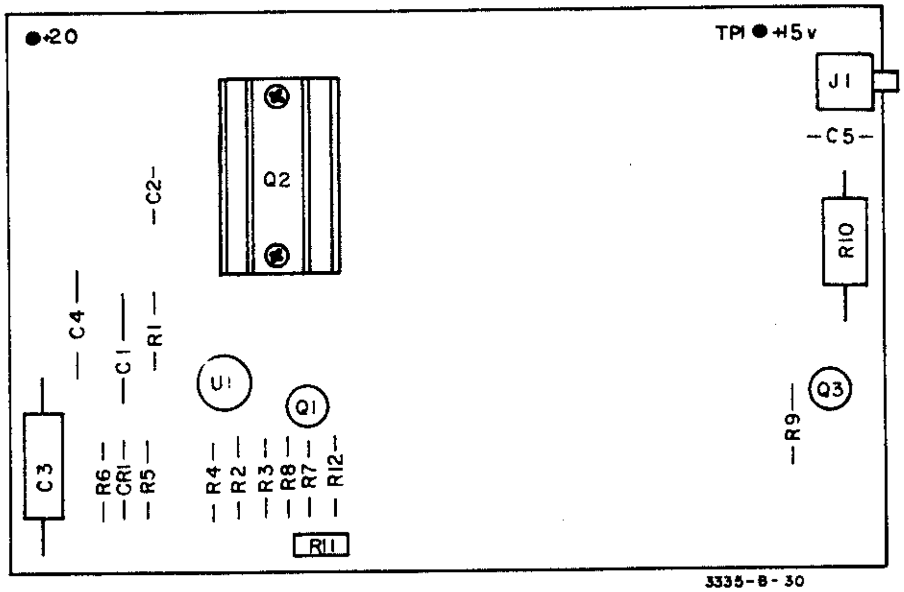
STANDARD: + 15 V ± 0.2 V
OPTION 001: + 12.6 V ± 0.2 V

If the voltage applied to the oven is present and the 10 MHz REF OUTPUT is not correct, replace the temperature-stabilized oscillator assembly A17A1 or A18A1.

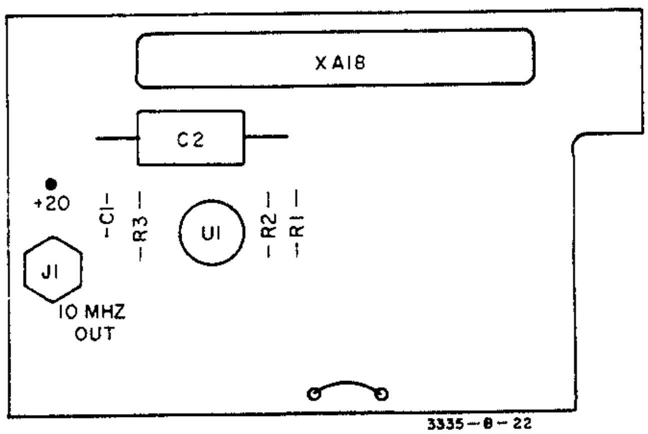
Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A17	03335-66522		PC ASSEMBLY, OSCILLATOR INTERFACE (STANDARD)	28480	03335-66522
A17A1	0960-0465		CRYSTAL OSCILLATOR	28480	0960-0465
A17C1	0180-0309		CAPACITOR-FXD 4.7UF +-20% 10VDC	56289	150D475X0010A2
A17C2	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC	28480	0160-3622
A17C3	0180-0097		CAPACITOR-FXD 47UF +-10% 35VDC	56289	150D476X9035S2
A17C4	0160-0301		CAPACITOR-FXD .012UF +-10% 200WVDC	56289	292P12392
A17C5	0160-0301		CAPACITOR-FXD .012UF +-10% 200WVDC	56289	292P12392
A17CR1	1902-0041		CIODE-ZNR 5.11 V 5%	04713	SZ 10939-98
A17J1	1250-0836		CONNECTOR-RF SMC MPC	2K497	CD-700141
A17Q1	1854-0053		TRANSISTOR NPN 2N2218	04713	2N2218
A17Q2	1853-0413		TRANSISTOR PNP 2N6049	28480	1853-0413
A17Q3	1853-0010		TRANSISTOR PNP SI SM4713	28480	1853-0010
A17R1	0698-4426		RESISTOR 1.58K 1% .125W	16299	C4-1/8-T0-1581-F
A17R2	0757-0273		RESISTOR 3.01K 1% .125W	24546	C4-1/8-T0-3011-F
A17R3	0757-0433		RESISTOR 3.32K 1% .125W	24546	C4-1/8-T0-3321-F
A17R4	0698-4460		RESISTOR 649 1% .125W	24546	C4-1/8-T0-649R-F
A17R5	0698-4460		RESISTOR 649 1% .125W	24546	C4-1/8-T0-649R-F
A17R6	0757-0420		RESISTOR 750 1% .125W	24546	C4-1/8-T0-751-F
A17R7	0683-5105		RESISTOR 51 5% .25W	01121	CB5105
A17R8	0757-0280		RESISTOR 1K 1% .125W	24546	C4-1/8-T0-1001-F
A17R9	0683-5105		RESISTOR 51 5% .25W	01121	CB5105
A17R10	0683-3633		RESISTOR 390 5% 2 W	24546	FP42-2-T0-390R-J
A17R11	2100-3207		RESISTOR TRMR 5K 10%	73138	72-145-0
A17R12	0683-1035		RESISTOR 10K 5% .25W	01121	CB1035
A17U1	1820-0196		IC VA 723C V RGLTR	07263	723HC
A18	03335-66517	1	PC ASSEMBLY, OSCILLATOR INTERFACE(OPTION 001)	28480	03335-66517
A18A1	10544B	1	*CRYSTAL OSCILLATOR	28480	10544A-H36
XA18A1	1251-1388	1	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	71785	252-15-30-008
A18C1	0180-0098		CAPACITOR-FXD 100UF+-20% 20VDC TA	56289	150D107X002082
A18C2	0160-0336		CAPACITOR-FXD 100PF +-1% 300WVDC MICA	28480	0160-0336
A18J1	1250-0835		CONNECTOR-RF SMC M PC 50-OHM	98291	50-051-0000
A18R1	0683-0825	1	RESISTOR 8.2 5% .25W FC TC=-400/+500	01121	CB82G5
A18R2	0698-4444	1	RESISTOR 4.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4871-F
A18R3	0757-0439		RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A18U1	1820-0196	1	IC UA 723C V RGLTR	07263	723HC

Fig 8-G-1
Sht 1 of 3

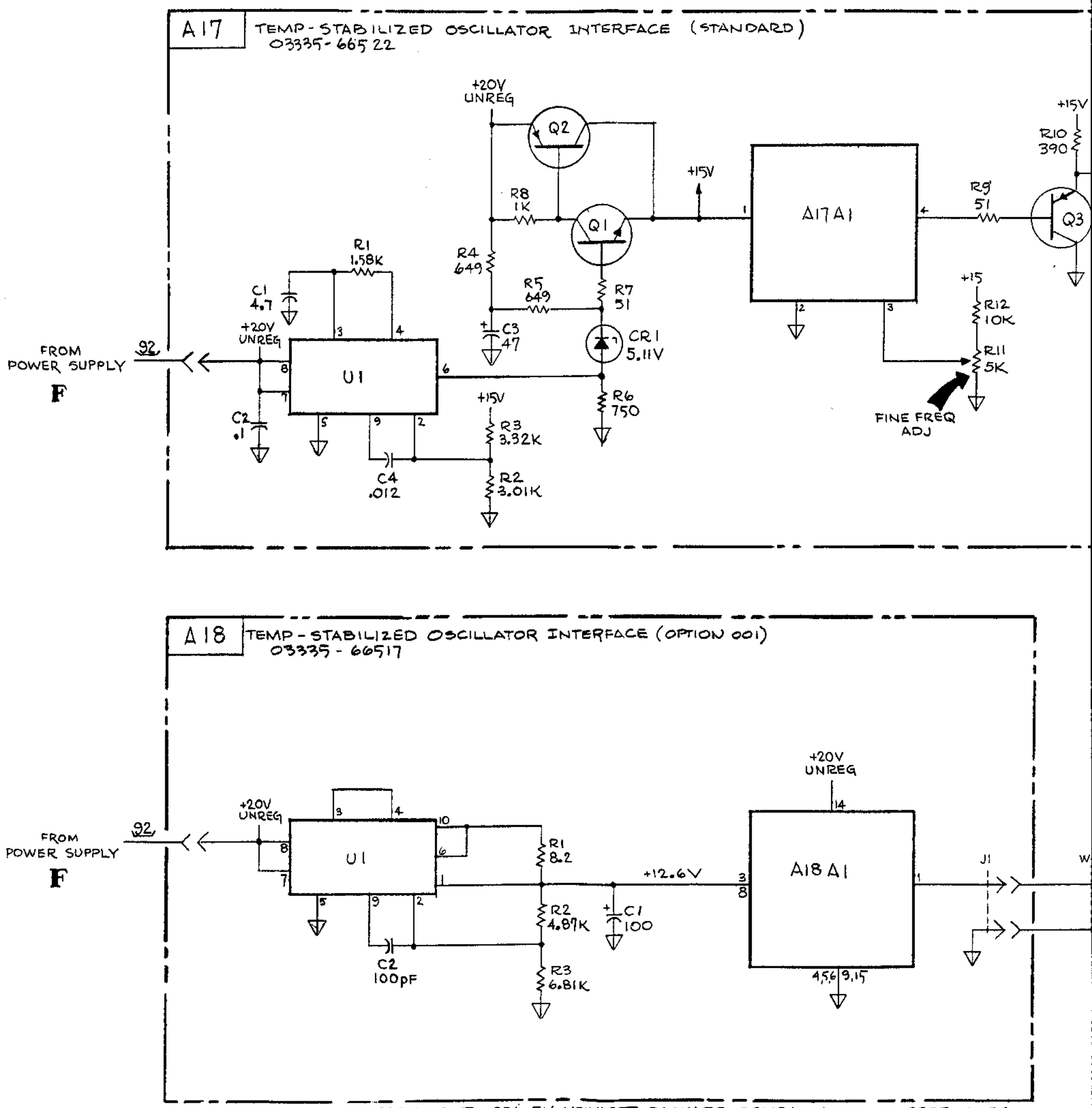


A17
-hp- Part No. 03335-66522



A18
-hp- Part No. 03335-66517

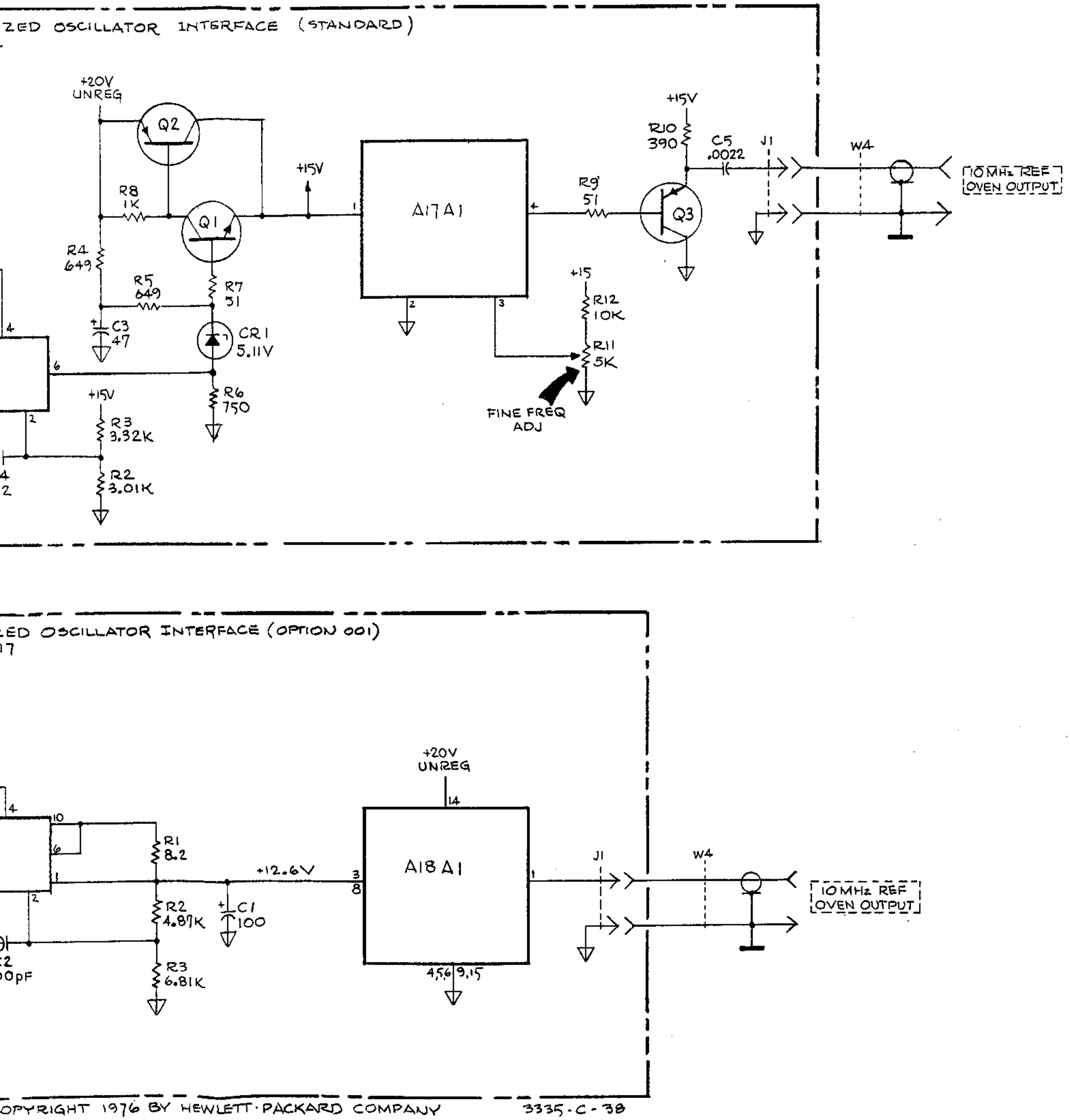
Fig 8-G-1
Sht 2 of 3



 3335-C-38

Figure 8-G-1. Schema
(03335-

Fig 8-G-1
Sht 3 of 3



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G

Figure 8-G-1. Schematic Diagram, Temperature Stabilized Oscillator (03335-66522, 03335-66517) A17, A18.

SERVICE GROUP H

REFERENCE

ADJUSTMENTS

Designation	Adjustment Title	Paragraph
A3C21	VCXO FREQ ADJ	5-14
A3C31	GAIN ADJ	5-14

TROUBLESHOOTING DATA

Reference service group provides information to aid in troubleshooting the Reference Assembly (A3, 03335-66505) to the component level. It is assumed that the 100 kHz reference signal was incorrect or not present at the .1 MHz test point on the module Mother Board (A1) to require service of the Reference section.

Symptom	Service Action	Notes
100 kHz signal at A1 test point .1 MHz is incorrect or not present.	Check master 40 MHz VCXO output at the emitter of A3Q4. If present, check the digital divide chain signals (10 MHz and 40 MHz must be present to reclock the signals, 40 MHz must be present at the pulse gates to generate the 100 kHz and 1 MHz signals).	
No master 40 MHz VCXO signal.	Adjust A3C31 (GAIN ADJ) to see if oscillator begins and check crystal Y1.	
Master 40 MHz signal is present but won't phase-lock.	Check 40N/ MHz REF INPUT. Must be a subharmonic of 40 MHz and ⩾ 1 MHz with amplitude of - 7 dBm (0.1 V to 0.5 V). If not, verify the reference oven assembly generates the correct oven supply voltage or check the external reference if used.	
No sampling pulses at secondary of A3T1.	A. Check U2 Pin 6 for a low ECL level (≈ - 1.6 V). B. Check U2 Pin 7 for the 40/N MHz input signal. C. Check U2 Pin 3 for the 40/N MHz signal. D. Check U2 Pin 9 and 15 for complementary output pulses at the 40/N MHz signal rate.	
Still no master 40 MHz VCXO signal.	A. If TP1 is less than + 13 V, Q2 is on too hard. B. Check base of A3Q3 for ≈ 0.4 V. C. Lift A3R44 to open the phase-locked loop. If oscillator operates open loop, U4 is bad. Verify by monitoring the output of U4 and adjusting A3C21 (VCXO FREQ ADJ), U4 output should change. If the oscillator does not operate open loop, the oscillator is bad.	

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3	03335-66505	1	P.C. ASSEMBLY, REFERENCE	28480	03335-66505
A3C1	0160-3622	63	CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C2	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C3	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C4	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C5	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C6	0160-0127	9	CAPACITOR-FXD 1UF + -20% 25WVDC CER	28480	0160-0127
A3C7	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C8	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C9	0160-2964	36	CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C10	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C11	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C12	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C13	0140-0198		CAPACITOR-FXD 200PF ±5% 3090WVDC MICA	72136	DM15F201J0300WVICR
A3C14	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C15	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C16, C17	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C21	0121-0500		CAPACITOR-V TRMR-MICA 7/100PF 175V	72136	D4203/0X
A3C26	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C27	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C28	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C29	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C30	0160-0945	2	CAPACITOR-FXD 910PF +-5% 100WVDC MICA	28480	0160-0945
A3C31	0121-0127	1	CAPACITOR-V TRMR-AIR 1.7/14.1PF 350V	74970	189-0505-005
A3C33	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C34	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C35	0160-0300	1	CAPACITOR-FXD 2700PF +-10% 200WVDC POLYE	56289	292P27292
A3C36	0170-0066	1	CAPACITOR-FXD .027UF +-10% 200WVDC POLYE	56289	292P27392
A3C37	0140-0205		CAPACITOR-FXD 62PF +-5% 300WVDC MICA	72136	DM15E620J0300WV1CR
A3C38	0140-0198		CAPACITOR-FXD 200PF +-5% 300WVDC MICA	72136	DM15F201J0300WV1CR
A3C39	0140-0198		CAPACITOR-FXD 200PF +-5% 300WVDC MICA	72136	DM15F201J0300WV1CR
A3C40	0140-0198		CAPACITOR-FXD 200PF +-5% 300WVDC MICA	72136	DM15F201J0300WV1CR
A3C41	0140-0198		CAPACITOR-FXD 200PF +-5% 300WVDC MICA	72136	DM15F201J0300WV1CR
A3C42	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C43	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C50	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C51	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C52	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C53	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C54	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C55	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C56	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C57	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C58	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C60	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C61	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C62	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C63	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C64	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C71	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C72	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A3C73	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C74	0180-0309	2	CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A3C75	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C76	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C77	0180-0309		CAPACITOR-FXD 4.7UF+-20% 10VDC TA	56289	150D475X0010A2
A3C78	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C79	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A3C80	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C81	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C82	0180-0098	2	CAPACITOR-FXD 100UF+-20% 20VDC TA	56289	150D107X0020S2
A3C83	0140-0207	1	CAPACITOR-FXD 330PF +-5% 500WVDC MICA	72136	DM15F331J0500WV1CR
A3C84	0160-2009	3	CAPACITOR-FXD 820PF +-5% 300WVDC MICA	28480	0160-2009
A3C85	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C86	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C88	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C89	0160-0763		CAPACITOR-FXD 5PF +-10% 500WVDC MICA	28480	0160-0763
A3C90	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C91	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A3C92	0160-0763		CAPACITOR-FXD 5PF +-10% 500WVDC MICA	28480	0160-0763
A3C93	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C94	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C95	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C96	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3C97	0140-0198		CAPACITOR-FXD 200PF +-5% 300WVDC MICA	72136	DM15F201J0300WV1CR
A3C101	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C102	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C103	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C104	0140-0198		CAPACITOR-FXD 200PF +-5% 300WVDC MICA	72136	DM15F201J0300WV1CR
A3C105	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A3C111	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A3C112	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A3C113	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A3C114	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A3C115	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A3C116	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A3CR1	1906-0082	4	DIODE-MATCHED 15V 5MV	28480	1906-0082
A3CR2	1906-0082		DIODE-MATCHED 15V 5MV	28480	1906-0082
A3CR3	1906-0082		DIODE-MATCHED 15V 5MV	28480	1906-0082
A3CR4	1906-0082		DIODE-MATCHED 15V 5MV	28480	1906-0082
A3CR5	1902-3073	1	DIODE-ZNR 4.32V 5% DO-7 PD=.4W TC=-.035%	04713	SZ 10939-77
A3CR6	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR7	1901-0347	17	DIODE-SCHOTTKY 8V	28480	1901-0347
A3CR8	0122-0059	3	DIODE:VOLTAGE VARIABLE CAPACITANCE	28480	0122-0059
A3CR9	1902-0126	1	DIODE-ZNR 2.61V 5% DO-7 PD=.4W TC=-.073%	04713	SZ 10939-14
A3CR10	1902-3002	6	DIODE-ZNR 2.37V 5% DO-7 PD=.4W TC=-.074%	15818	CD 35526
A3CR11	1902-3002		DIODE-ZNR 2.37V 5% DO-7 PD=.4W TC=-.074%	15818	CD 35526
A3CR12	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A3CR13	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A3CR14	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A3CR15	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A3CR16	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR17	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR18	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR19	1902-3085	12	DIODE-ZNR 4.75V 5% DO-7 PD=.4W TC=-.019%	15818	CD 35613
A3CR26	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A3CR27	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A3CR28	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A3CR29	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A3CR30	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A3CR31	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A3L1	9100-3334		COIL 25UH 10% .30X.5LG SRF=14MHZ	28480	9100-3334
A3L2	9100-3334		COIL 25UH 10% .30X.5LG SRF=14MHZ	28480	9100-3334
A3L3	9100-0541	18	COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A3L4	9100-3334		COIL 25UH 10% .30X.5LG SRF=14MHZ	28480	9100-3334
A3L5	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A3L6	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A3L7	9100-3315	2	COIL-MLD 820NH 5% .155DX.375LG	24226	9403
A3L8	9100-2543	1	COIL-MLD 2.7UH 10% Q=44 .156DX.375LG	06560	158-2R7K
A3L9	9100-3912	2	COIL-MLD 15UH 5% Q=65 .155DX.375LG	28480	9100-3912
A3L10	9100-3912		COIL-MLD 15UH 5% Q=65 .155DX.375LG	28480	9100-3912
A3L11	9100-3911	1	COIL-MLD 220NH 5% Q=50 .155DX.375LG	28480	9100-3911
A3L16	9170-0894	45	CORE-SHIELDING BEAD	02114	56-590-65/4A6
A3L17	9100-3551	3	COIL-MLD 1UH 5% Q=50 .155DX.375LG	24226	9493
A3L18	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A3L19	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A3L20	9100-3913	1	COIL-MLD 3.3UH 5% Q=33 .155DX.375LG	28480	9100-3913
A3L21	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A3L22	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A3L23	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A3L24	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A3L25	9100-3551		COIL-MLD 1UH 5% Q=50 .155DX.375LG	24226	9493
A3MP1	03335-61205	1	EXTRUSION ASSEMBLY	28480	03335-61205
A3Q1	1854-0345	15	TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A3Q2	1854-0215	23	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A3Q3	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A3Q4	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A3Q5	1854-0233	27	TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A3Q6	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A3Q7	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A3Q8	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A3Q9	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A3Q10	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A3Q11, Q12 △	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	02037	SPS 3611
A3Q13	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A3Q14	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A3Q15	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866

△For Serial Numbers 1640A00201 and lower, see parts list on Figure 8-H-1.

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3Q17	1855-0062	1	TRANSISTOR J-FET N-CHAN D-MODE SI	28480	1855-0062
A3Q18	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A3Q19	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A3Q20	1853-0020	10	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A3Q21	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A3Q22	1853-0203	5	TRANSISTOR PNP SI TO-18 PD=360MW	28480	1853-0203
A3Q23	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A3Q24	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A3Q25	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A3Q26	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A3Q27	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A3R1	0683-5105	32	RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R2	0683-2025	10	RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A3R3	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A3R4	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R5	0683-5115	32	RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A3R6	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A3R7	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R8	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R9	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A3R10	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R11	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R12	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A3R13	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A3R14	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A3R15	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A3R16	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A3R17	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A3R18	0683-2715	3	RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A3R19	0683-2715		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A3R20	0683-4745	2	RESISTOR 470K 5% .25W FC TC=-800/+900	01121	CB4745
A3R21	0683-4735	3	RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A3R22	0683-4735		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A3R23	0683-4745		RESISTOR 470K 5% .25W FC TC=-800/+900	01121	CB4745
A3R24	0757-0434	1	RESISTOR 3.65K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3651-F
A3R25	0757-0379	1	RESISTOR 12.1 1% .125W F TC=0+-100	19701	MF4C1/8-T0-12R1-F
A3R26	0698-3279		RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A3R27	0683-3625	1	RESISTOR 3.6K 5% .25W FC TC=-400/+700	01121	CB3625
A3R28	0683-4725	28	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R29	0683-9115		RESISTOR 910 5% .25W FC TC=-400/+600	01121	CB9115
A3R36	0683-4715	12	RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A3R37	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R38	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R39	0698-3264	3	RESISTOR 11.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1182-F
A3R40	0757-0415	1	RESISTOR 475 1% .125W F TC=0+-100	24546	C4-1/8-T0-475R-F
A3R41	0698-3225	2	RESISTOR 1.43K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1431-F
A3R42	0683-5125	5	RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A3R43	0683-1035	21	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R44	0683-1025	34	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R45	0698-3136	1	RESISTOR 17.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1782-F
A3R46	0757-0444	4	RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A3R47	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R48	0683-4715		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A3R49	0698-4403	6	RESISTOR 102 1% .125W F TC=0+-100	24546	C4-1/8-T0-102R-F
A3R50	0698-4403		RESISTOR 102 1% .125W F TC=0+-100	24546	C4-1/8-T0-102R-F
A3R51	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R52	0683-1525	8	RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A3R53	0683-1525		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A3R54	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R55	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A3R56	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A3R61	0683-7535	2	RESISTOR 75K 5% .25W FC TC=-400/+800	01121	CB7535
A3R62	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A3R63	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A3R65	0683-7535		RESISTOR 75K 5% .25W FC TC=-400/+800	01121	CB7535
A3R65	0683-1045	9	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A3R66	0683-1055	1	RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A3R67	0683-4735		RESISTOR 47K 5% .25W FC TC=-400/+800		CB4735
A3R68	0683-2745	1	RESISTOR 270K 5% .25W FC TC=-800/+900	01121	CB2745
A3R69	0683-9115		RESISTOR 910 5% .25W FC TC=-400/+600	01121	CB9115
A3R70	0683-7525	4	RESISTOR 7.5K 5% .25W FC TC=-400/+700	01121	CB7525
A3R71	0683-4725		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R76	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R77Δ	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	03292	C4-1/8-T0-499R-F
A3R78Δ	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	03292	C4-1/8-T0-101-F

ΔFor Serial Numbers 1640A00201 and lower, see parts list on Figure 8-H-1.

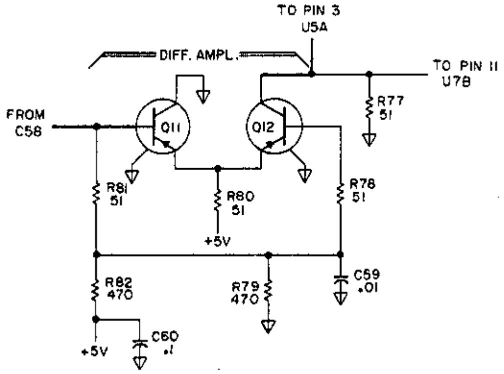
Replaceable Parts

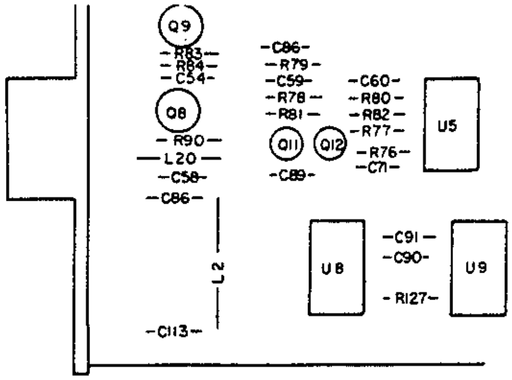
Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3R80Δ	0698-3447		RESISTOR 422 1% .125W F TC=0+-100	03292	C4-1/8-T0-422R-F
A3R81Δ	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	03292	C4-1/8-T0-101-F
A3R83	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A3R84	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R85	0683-1525		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A3R86	0683-1525		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A3R87	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R88	0698-4403		RESISTOR 102 1% .125W F TC=0+-100	24546	C4-1/8-T0-102R-F
A3R89Δ	0698-3262		RESISTOR 40.2 1% .125W F TC=0+-100	03292	C4-1/8-T0-4022-F
A3R90	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A3R91	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A3R92	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R93	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A3R94	0683-1525		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A3R95	0683-1525		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A3R96	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R97	0698-4403		RESISTOR 102 1% .125W F TC=0+-100	24546	C4-1/8-T0-102R-F
A3R98	0698-4403		RESISTOR 102 1% .125W F TC=0+-100	24546	C4-1/8-T0-102R-F
A3R106	0683-1005	8	RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A3R107	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R108	0683-3315	3	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A3R109	0683-1005		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A3R110	0757-1094	1	RESISTOR 1.47K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1471-F
A3R111	0683-7525		RESISTOR 7.5K 5% .25W FC TC=-400/+700	01121	CB7525
A3R112	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R113	0683-5125		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A3R114	0683-5125		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A3R115	0683-5125		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A3R116	0683-4705	7	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A3R117	0683-4705		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A3R118	0698-3488	1	RESISTOR 442 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A3R119	0698-4399	1	RESISTOR 88.7 1% .125W F TC=0+-100	24546	C4-1/8-T0-88R7-F
A3R120	0698-3444	1	RESISTOR 316 1% .125W F TC=0+-100	24546	C4-1/8-T0-316R-F
A3R126	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R127	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R128	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R129	0698-4449	6	RESISTOR 309 1% .125W F TC=0+-100	24546	C4-1/8-T0-309R-F
A3R130	0698-4449		RESISTOR 309 1% .125W F TC=0+-100	24546	C4-1/8-T0-309R-F
A3R131	0683-1005		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A3R132	0683-1005		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A3R133	0683-1525		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A3R134	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R135	0757-0398	3	RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A3R136	0698-4413	3	RESISTOR 154 1% .125W F TC=0+-100	24546	C4-1/8-T0-154R-F
A3R137	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R138	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R139	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A3R140Δ	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	03292	C4-1/8-T0-499R-F
A3R141	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R142	0683-1005		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A3R143	0698-4449		RESISTOR 309 1% .125W F TC=0+-100	24546	C4-1/8-T0-309R-F
A3R144	0698-4449		RESISTOR 309 1% .125W F TC=0+-100	24546	C4-1/8-T0-309R-F
A3R145	0757-0398		RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A3R146	0698-4413		RESISTOR 154 1% .125W F TC=0+-100	24546	C4-1/8-T0-154R-F
A3R147	0683-1005		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A3R148	0683-1525		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A3R149	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3T1	08553-6012	1	*TRANSFORMER	28480	08553-6012
A3U1	1820-0809	3	IC-DIGITAL MC10115P ECL QUAD 2 LINE RCVR	04713	MC10115P
A3U2	1820-0802		IC-DIGITAL MC10102P ECL QUAD 2 NOR	04713	MC10102P
A3U3	1826-0043		IC LM 307 OP AMP	27014	LM307H
A3U4	1826-0043		IC LM 307 OP AMP	27014	LM307H
A3U5	1820-0693	5	IC-DIGITAL SN74S74N TTL S DUAL	01295	SN74S74N
A3U6	1820-1490	2	IC-DIGITAL SN74LS90N TTL LS DECD	01295	SN74LS90N
A3U7	1820-0693		IC-DIGITAL SN74S74N TTL S DUAL	01295	SN74S74N
A3U8	1820-1490		IC-DIGITAL SN74LS90N TTL LS DECD	01295	SN74LS90N
A3U9	1820-0693		IC-DIGITAL SN74S74N TTL S DUAL	01295	SN74S74N
A3U10	1820-0693		IC-DIGITAL SN74S74N TTL S DUAL	01295	SN74S74N
A3U11	1820-1199	4	IC-DIGITAL SN74LS04N TTL LS HEX 1	01295	SN74LS04N
A3U12	1820-0693		IC-DIGITAL SN74S74N TTL S DUAL	01295	SN74S74N
A3Y1	0410-0680	1	CRYSTAL, QUARTZ	28480	0410-0680

ΔFor Serial Numbers 1640A00201 and lower, see parts list on Figure 8-H-1.

Fig 8-H-1 Sht 1 of 5

ΔFOR SERIAL NUMBERS 1640A00201 AND LOWER





REF DES	—HP— PART NUMBER	DESCRIPTION	MFR CODE	MFR PART NO.
A3C59	0160—2964	CAP—FXD .01UF +80—20% 25WVCR	28480	0160—2964
A3Q11,12	1853—0018	TSTR PNP SI TO—72 PD=200MW F+=1GHZ	28480	1853—0018
A3R77,78	0683—5105	RES 51 OHM 5% .25W FC TC=—400/+500	01121	CB5105
A3R79	0683—4715	RES 470 OHM 5% .25W FC TC=—400/+600	01121	CB4715
A3R80,81	0683—5105	RES 51 OHM 5% .25W FC TC=—400/+500	01121	CB5105
A3R82	0683—4715	RES 470 OHM 5% .25W FC TC=—400/+600	01121	CB4715
A3R89	0698—4403	RES 102 OHM 1% .125W F TC=0+—100	24546	C4—1/8—T0—102R—F

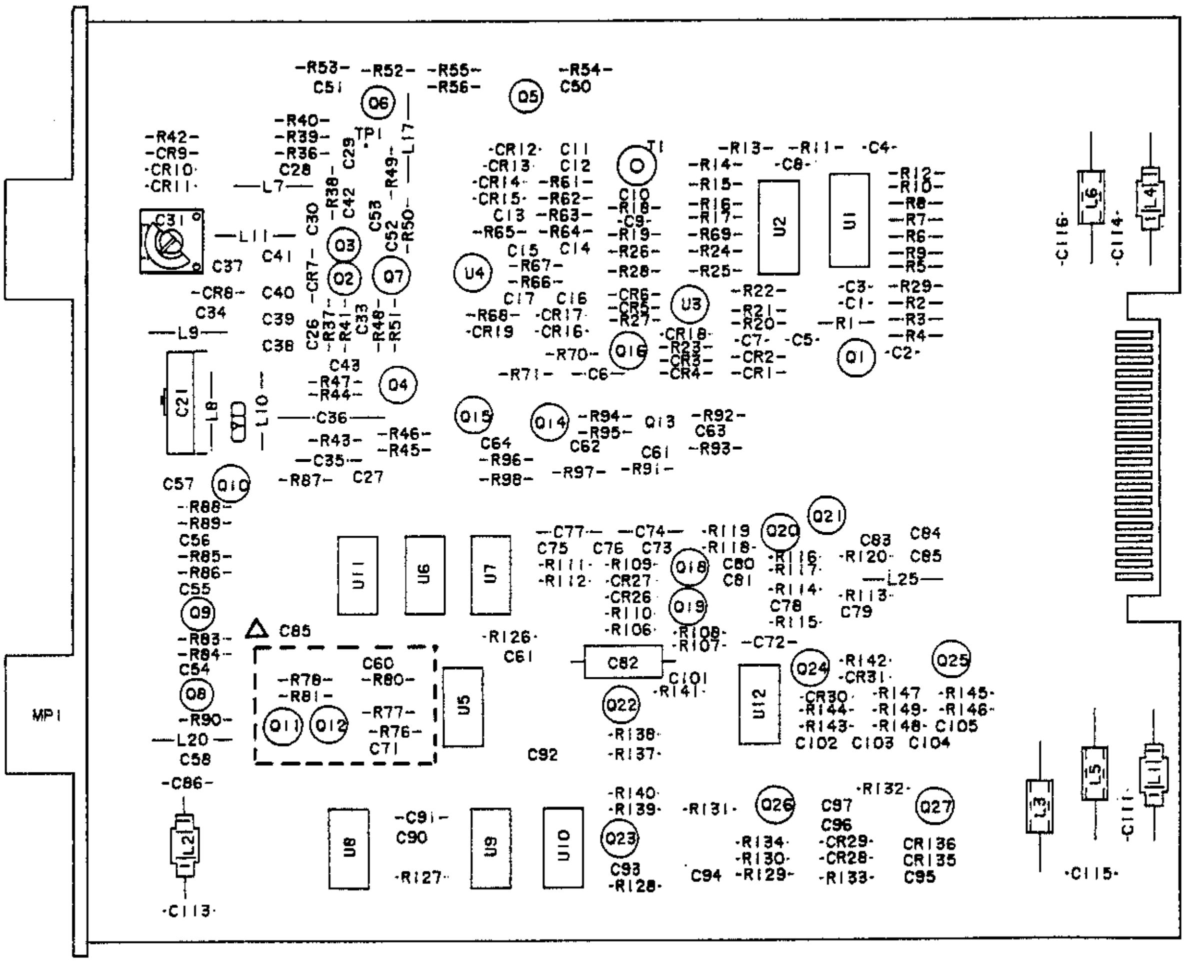


Fig 8-H-1
Sht 2 of 5

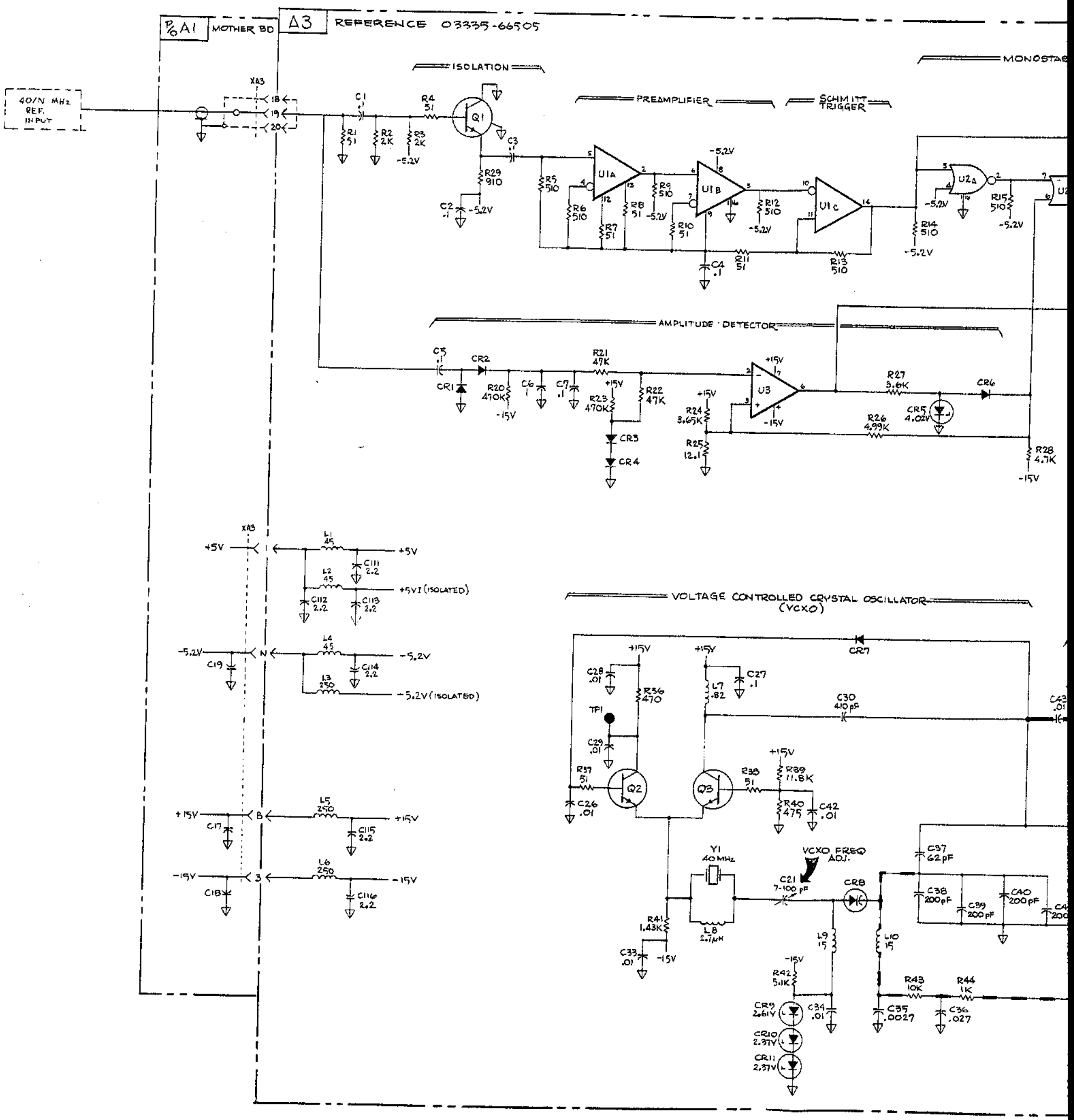


Fig 8-H-1
Sht 3 of 5

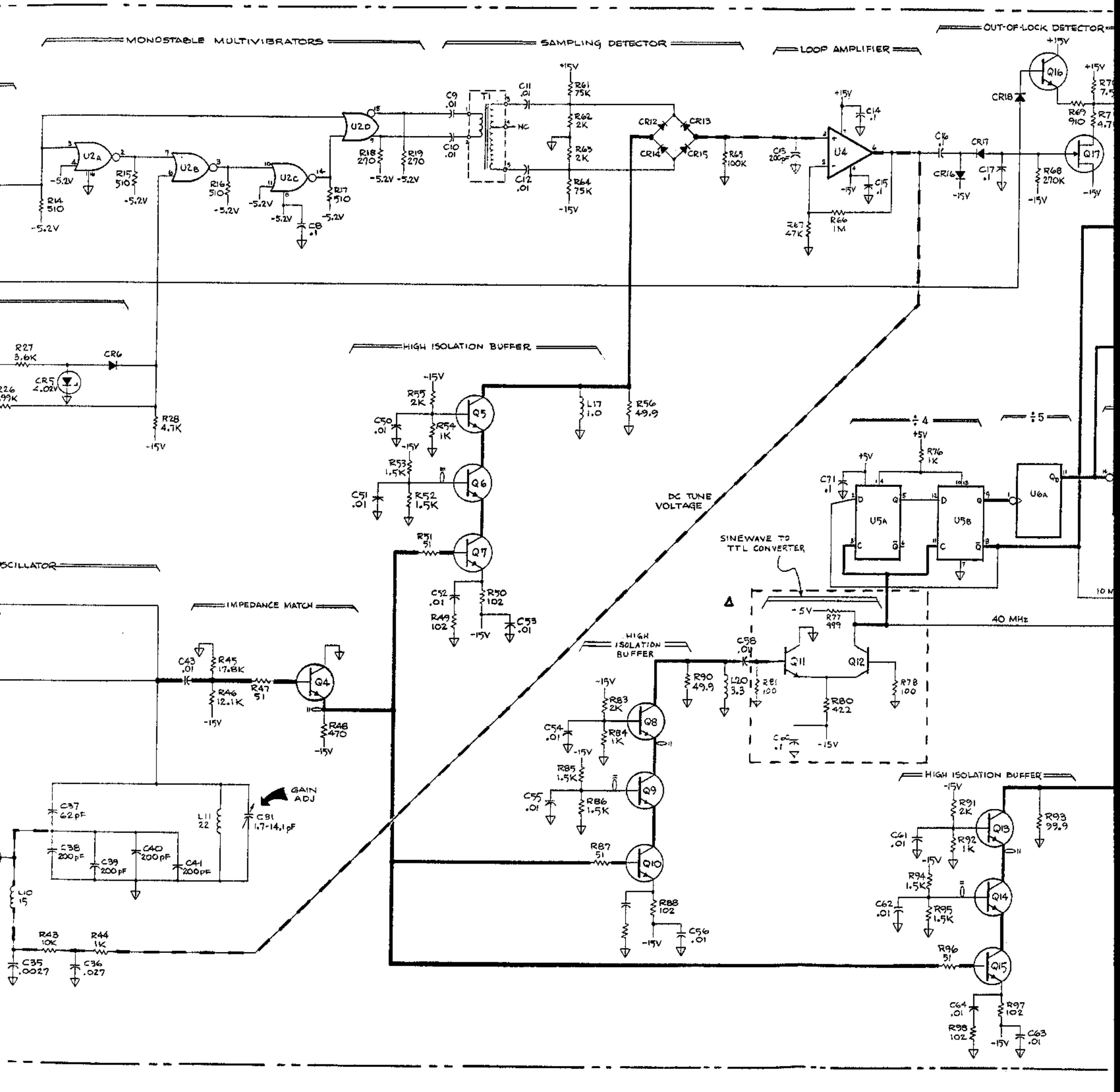


Fig 8-H-1
Sht 4 of 5

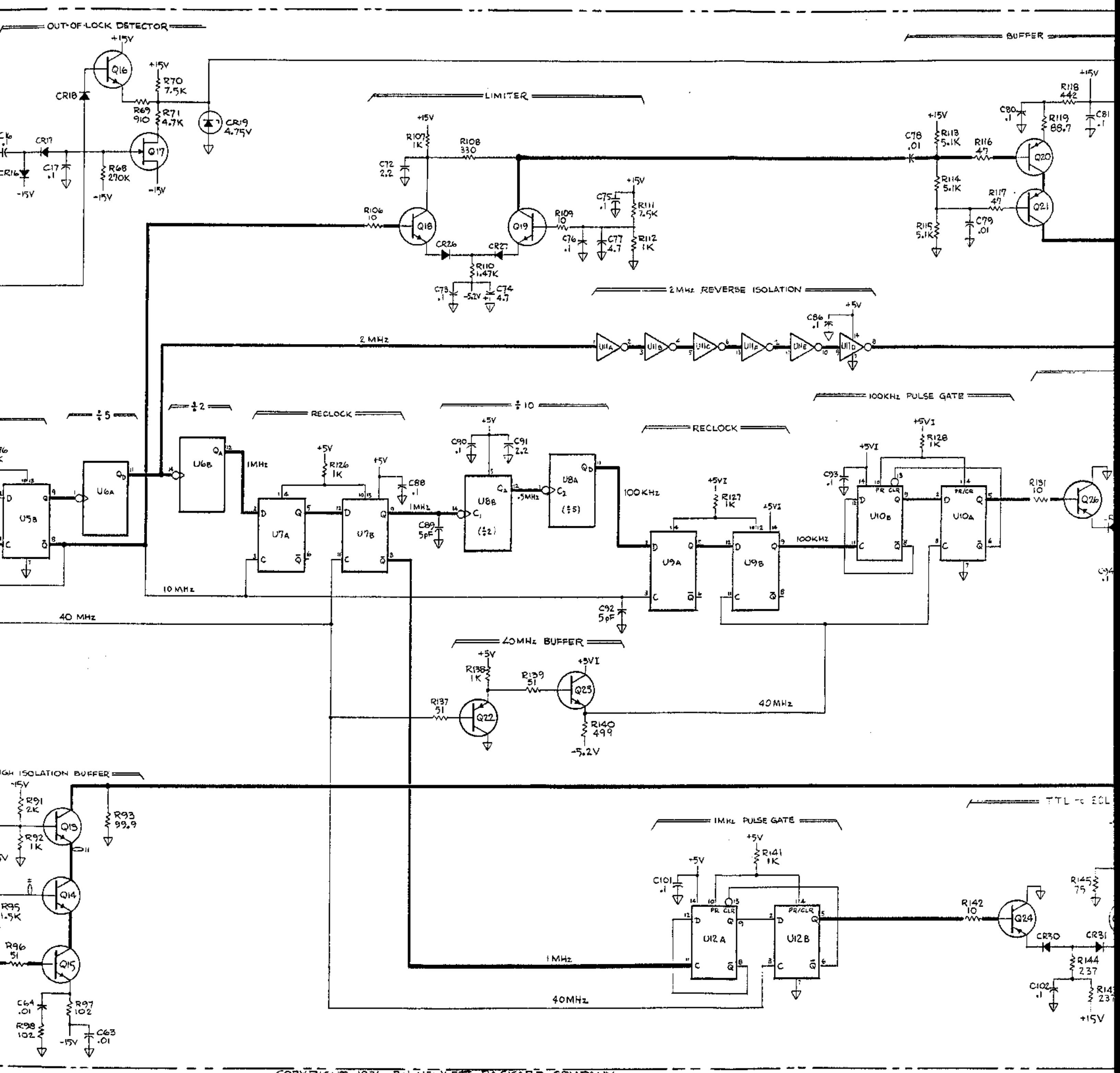
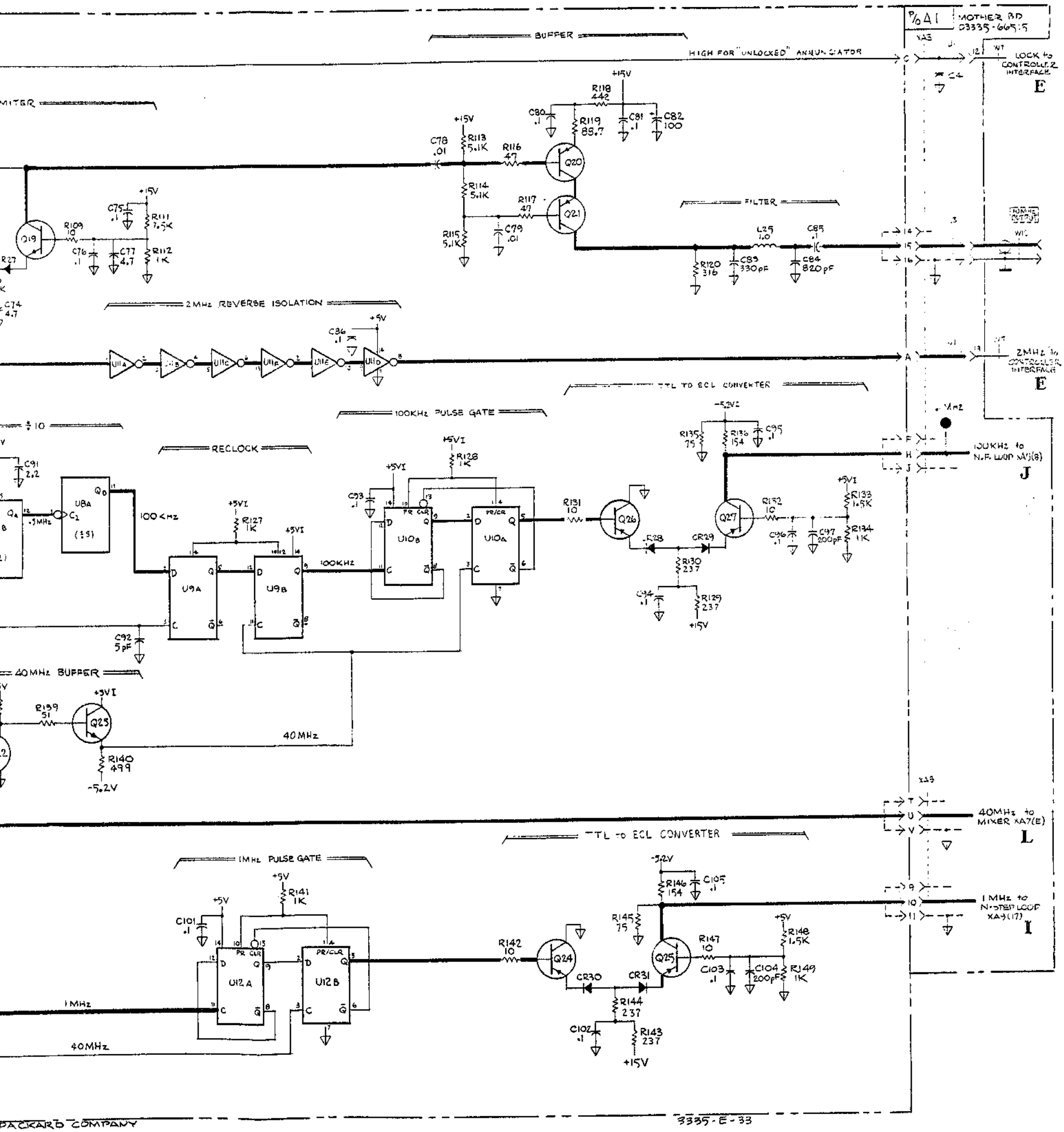


Figure 8-H-1.

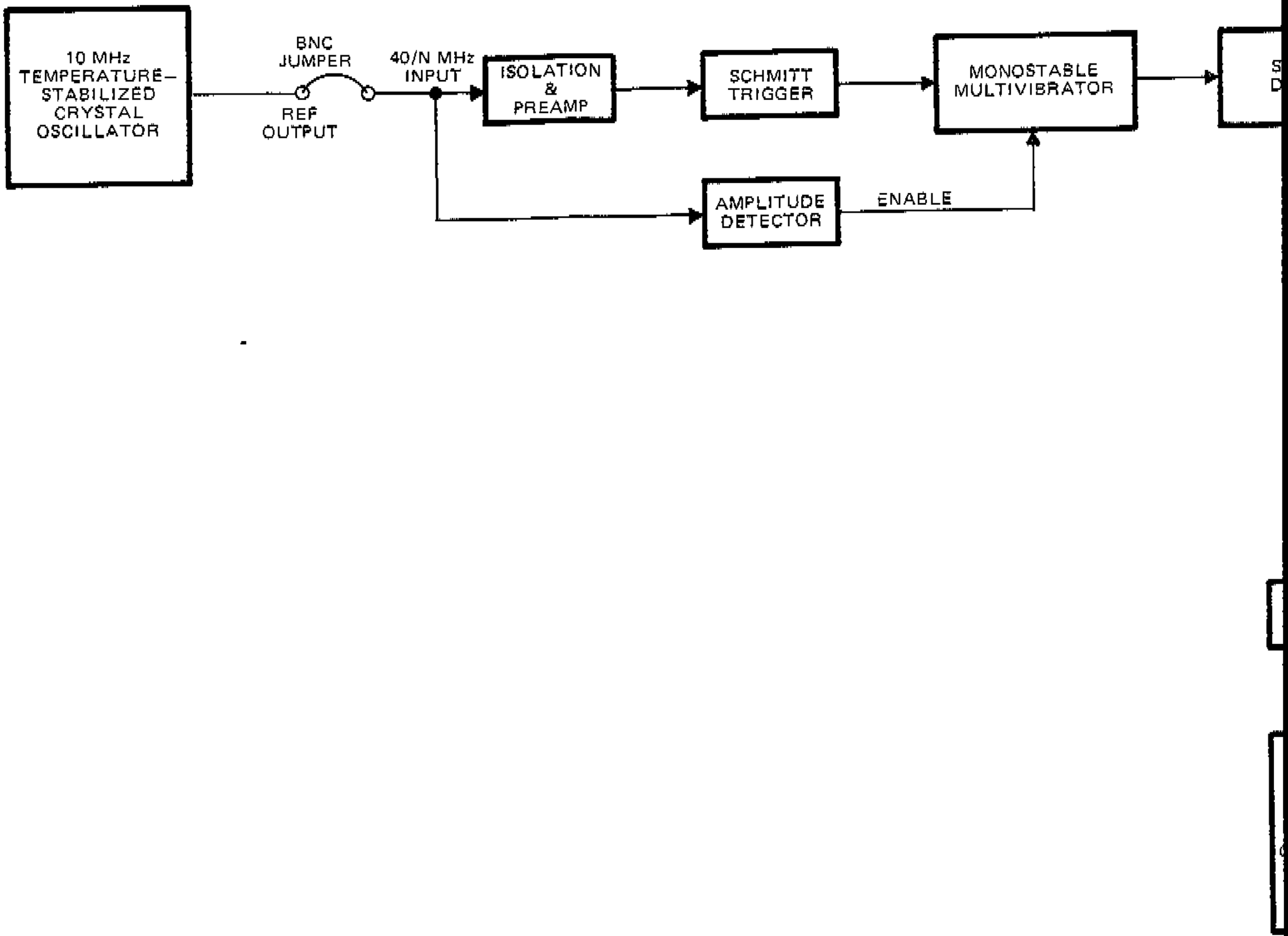
Fig 8-H-1
Sht 5 of 5



H

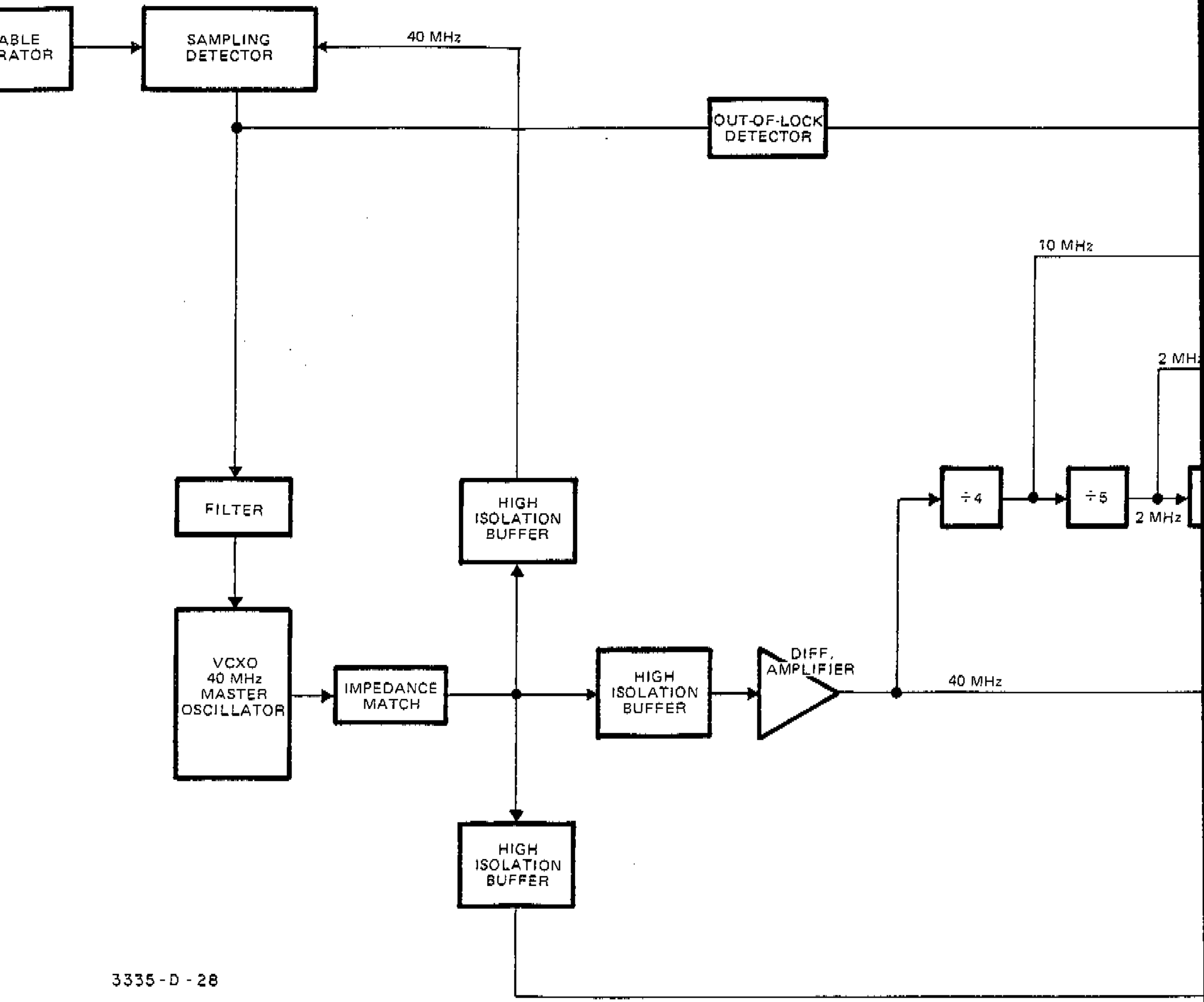
Figure 8-H-1. Schematic Diagram, Reference (03335-66505) A3.

Fig 8-H-2
Sht 1 of 3



3335-D

Fig 8-H-2
Sht 2 of 3



3335-D-28

Fig 8-H-2
Sht 3 of 3

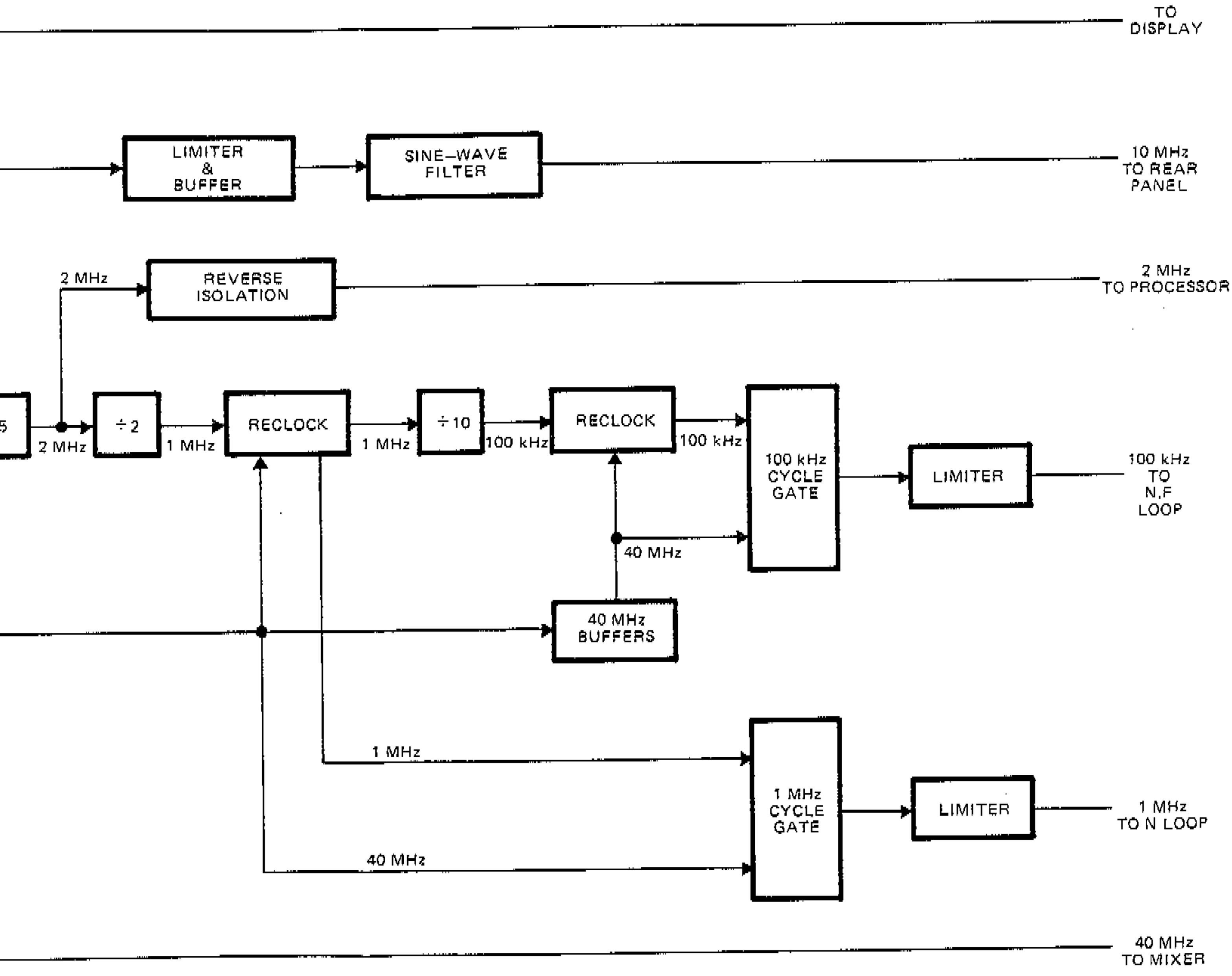


Figure 8-H-2. Block Diagram, Reference (03335-66505) A3.

SERVICE GROUP I

N STEP LOOP

ADJUSTMENTS

Designation	Adjustment Title	Paragraph
A9L7	(VCO TANK)	5-16
A9L8	(VCO TANK)	5-16
A9R66	FLATNESS ADJ	5-16

TROUBLESHOOTING DATA

The N Step Loop service group provides information to aid in troubleshooting the N Step Loop assembly (A9, 03335-66501) to the component level. It is assumed the 39–79 MHz signal measured at the module Mother Board test point was not present or was incorrect for the frequency selected.

Symptom	Service Action	Notes
No VCO output (no signal at A9TP4).	A. Disconnect the jumper TP3 from the side labeled B and connect ground to Side A. If an approximate 60 MHz signal is not present at A9TP4, then the probable cause is A9Q11, Q13 or Q14. B. If there is no signal at the emitter of A9Q13, the probable cause is a defective A9Q11.	Disconnecting the jumper at TP3 and grounding point A opens the loop and reduces the affect of the faulty circuits on the good circuits. The circuitry on this board is very similar to the circuitry on the Summation Loop board (Service Group K). This allows comparisons between measurements made on working and faulty circuits.
VCO signal is present at 39–79 MHz test point on A1 but is not of correct frequency to generate programmed output (i.e., Program 1 MHz, 39–79 Hz TP should be 40 MHz).	A. VERIFY VCO OPERATION: Ground A9TP3 at Side A with Side B disconnected. Verify at TP4 the VCO operates at approximately 60 MHz. Leave Side A connected to ground for the remaining steps. B. VERIFY ISOLATION BUFFER OPERATION: Verify the VCO signal appears at TP5, TP6 and TP7. C. VERIFY SCHMITT TRIGGER OPERATION: Verify the VCO signal at Pin 13 of both A9U6 and A9U7. D. VERIFY ÷N COUNTER OPERATION: Program a frequency of 1 MHz and FREQ INCR of 1 MHz and monitor the signal at TP8 (output of counter). Use the ⇧ INCR key to increase the output frequency in 1 MHz steps. Since the 39–79 MHz signal is fixed at approximately 60 MHz, increasing the frequency in 1 MHz steps increments the counter modulus by one each step. With a dual trace oscilloscope, the 39–79 MHz N Step Loop output and the counter output can be viewed simultaneously to verify the counter operation. Table 8-I-1 lists the counter modulus (N) for each output frequency being a multiple of 1 MHz.	
÷N Counter does not generate the correct count.	A. VERIFY DATA BITS "0" THROUGH "7" ARE CORRECT: Program Frequency of 57 MHz and verify the data bits for a decimal number of 56. Refer to the preset number table on the N Step Loop schematic. Change frequency to 73 MHz and verify the data bits as before for a decimal number of 72.	

Symptom	Service Action	Notes
	These two verifications check that all bits (except "7" which is always high) are capable of changing states. **NOTE** *Logic levels prior to the TTL-to-ECL converter are TTL. ECL levels are applied to the counters.* B. If the data bits applied to the counters are incorrect, verify the data from serial-to-parallel converter and data latch is correct. When not in a sweep mode, the serial-to-parallel converter output remains constant and is the same data latched.	
VCO operates at 60 MHz with TP3 grounded and counter functions properly.	A. VERIFY PHASE DETECTOR. First verify operation of the Phase Detector Unit, U7. Program a FREQUENCY of 70 MHz. The signal at A9TP1 should be changing states between an ECL high (- 0.8 V) and ECL low (- 1.6 V). The signal at U7 Pin 3 (PHASE DETECTOR UNIT) should also change states between an ECL high and low. The signal at U7 Pin 11 should be an ECL low (- 1.6 V). Comment: The VCO is locked at 60 MHz by grounding TP3. When 70 MHz is programmed, the VCO running at 60 MHz is slow and the phase detector UP Lines (U7 Pins 3 and 4) are activated to change the tune voltage and speed up the VCO. The DOWN Line (U7 Pin 11) is not active and remain at an ECL low. Program a FREQUENCY of 50 MHz. The signal at A9TP1 should be an ECL low (- 1.6 V). The signal at U7 Pin 3 should be an ECL high (- 0.8 V). The signal at the DOWN Line, U7 Pin 11, should be changing states between an ECL high and low (- 0.8 V to - 1.6 V). Comment: The VCO is locked at 60 MHz because of ground at TP3. When 50 MHz is programmed, the VCO is running too fast at 60 MHz. The Phase Detector Unit Down Line (U7 Pin 11) is activated to change the tune voltage and slow down the VCO. The UP Lines (U7 Pin 3 and 4) are not active. B. VERIFY OR/NOR GATE U8. With FREQUENCY at 50 MHz, verify that the signal at A9TP2 changes states between an ECL high and low. Verify that U1 Pin 9 also changes states between an ECL high and low. C. VERIFY CURRENT SOURCE OPERATION of TP3 and reconnect Sides A and B. Verify ECL pulses at TP1 and TP2 (high-going at TP1, low-going at TP2). Measure the differential voltage across A9R13 and R50. The voltage across each resistor should be 1.3 V ± 0.3 V. This verifies that the current sources are operating within the required current range. If current sources check good, verify that the signals at TP1 and TP2 appear at the base of Q6 and Q4 respectively. Verify that the inversion of signals at TP1 and TP2 appear at the base of Q7 and Q5 respectively. Verify that an inversion of the signal at the base of Q4, Q5, Q6 and Q7 appears at the base of Q2, Q3, Q8 and Q9 respectively. Monitor A9TP3 with a DVM. Program 40 MHz. TP3 should be approximately +8.5 V. Program 80 MHz. TP3 should be approximately - 8.5 V.	

Table 8-I-1. Counter Modulus (N).

Output Freq (MHz)	N Step Loop		Output Freq (MHz)	N Step Loop	
	N	Freq (MHz)		N	Freq (MHz)
40	39	Same as N number	61	60	Same as N number
41	40		62	61	
42	41		63	62	
43	42		64	63	
44	43		65	64	
45	44		66	65	
46	45		67	66	
47	46		68	67	
48	47		69	68	
49	48		70	69	
50	49		71	70	
51	50		72	71	
52	51		73	72	
53	52		74	73	
54	53		75	74	
55	54		76	75	
56	55		77	76	
57	56		78	77	
58	57		79	78	
59	58		80	79	
60	59				

Any Freq < 1 MHz; N = 39

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A9	03335-66501	1	P.C. ASSEMBLY, N-STEP LOOP (DOES NOT INCLUDE SCREW-ON SHIELDS, SEE MECHANICAL PARTS LIST—MP36 THROUGH MP41, MP48 AND MP49)	28480	03335-66501
A9C1, C2	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X902082
A9C3	0180-1861		CAPACITOR-FXD 27UF+-10% 10VDC TA	56289	150D276X901082
A9C4	0180-1861		CAPACITOR-FXD 27UF+-10% 10VDC TA	56289	150D276X901082
A9C5	0180-1861		CAPACITOR-FXD 27UF+-10% 10VDC TA	56289	150D276X901082
A9C6	0180-1861		CAPACITOR-FXD 27UF+-10% 10VDC TA	56289	150D276X901082
A9C7	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C8	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C9	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C10	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C11	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C12	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C13	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C14	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C15	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C16	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C17	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C18	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C19	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C20	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C21	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C22	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C23	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C24	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C25	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C26	0150-0050		CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A9C27	0160-2201		CAPACITOR-FXD 51PF +-5% 300WVDC MICA	28480	0160-2201
A9C31	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A9C32	0160-2201		CAPACITOR-FXD 51PF +-5% 300WVDC MICA	28480	0160-2201
A9C33	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C34	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C35	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A9C36	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C37	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A9C38	0160-2009		CAPACITOR-FXD 820PF +-5% 300WVDC MICA	28480	0160-2009
A9C39	0160-0136	1	CAPACITOR-FXD 2500PF +-1% 300WVDC MICA	28480	0160-0136
A9C40	0140-0170	1	CAPACITOR-FXD 5600PF +-5% 300WVDC MICA	72136	DM20F562J0300WV1CR
A9C41	0140-0172	1	CAPACITOR-FXD 3000PF +-1% 100WVDC MICA	72136	DM19F302F0100WV1CR
A9C42	0160-0944	1	CAPACITOR-FXD 1800PF +-5% 500WVDC MICA	28480	0160-0944
A9C43	0160-2290	1	CAPACITOR-FXD .15UF +-10% 80WVDC POLYE	56289	292P15498
A9C44	0140-0220		CAPACITOR-FXD 200PF +-1% 300WVDC MICA	72136	DM15F201F0300WV1CR
A9C45	0150-0050		CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A9C46	0140-0220		CAPACITOR-FXD 200PF +-1% 300WVDC MICA	72136	DM15F201F0300WV1CR
A9C47	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A9C48	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A9C49	01 0-0127		CAPACITOR-FXD 1UF +-20% 25WVDC CER	28480	0160-0127
A9C50	01 0-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A9C51	0160-2198		CAPACITOR-FXD 20PF +-5% 300WVDC MICA	28480	0160-2198
A9C52	0160-2203		CAPACITOR-FXD 91PF +-5% 300WVDC MICA	28480	0160-2203
A9C53	0160-0127		CAPACITOR-FXD 1UF +-20% 25WVDC CER	28480	0160-0127
A9C54	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A9C55	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A9C56	0150-0050		CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A9C61	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C62	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X902082
A9C63	0160-0127		CAPACITOR-FXD 1UF +-20% 25WVDC CER	28480	0160-0127
A9C64	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C65	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C66	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C67	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C68	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C69	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C70	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C71	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C72	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C73	0160-2201		CAPACITOR-FXD 51PF +-5% 300WVDC MICA	28480	0160-2201
A9C74	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C75	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C76	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C77	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C78	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9C79	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A9CR1	1902-3002		DIODE-ZNR 2.37V 5% DO-7 PD=.4W TC=-.074%	15818	CD 35526
A9CR2	1902-3002		DIODE-ZNR 2.37V 5% DO-7 PD=.4W TC=-.074%	15818	CD 35526
A9CR3	0122-0089		DIODE-VVC 29PF 10% C3/C25-MIN=5 BVR=30V	04713	MV109
A9CR4	0122-0089		DIODE-VVC 29PF 10% C3/C25-MIN=5 BVR=30V	04713	MV109
A9CR5	1902-3085		DIODE-ZNR 4.75V 5% DO-7 PD=.4W TC=-.019%	15818	CD 35613

Replaceable Parts

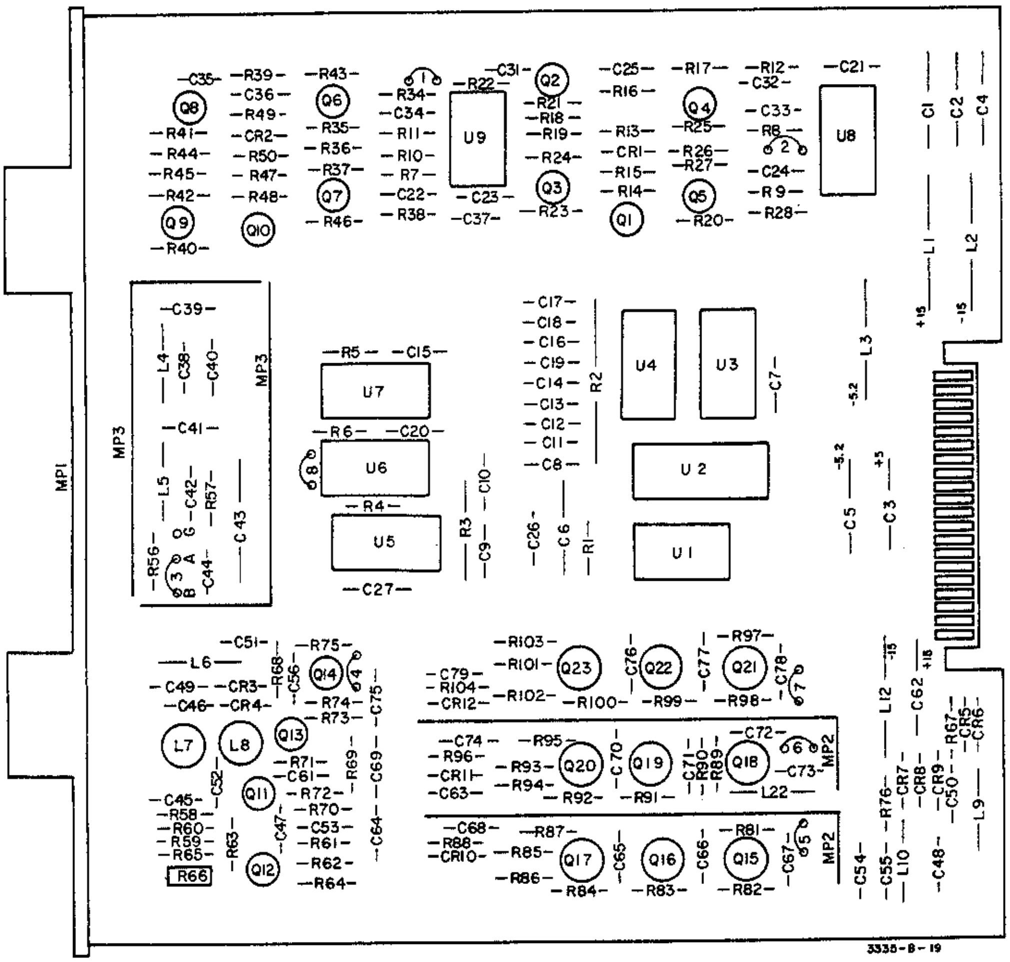
Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A9CR6	1902-3085		DIODE-ZNR 4.75V 5% DO-7 PD=.4W TC=-.019%	15818	CD 35613
A9CR7	1902-3085		DIODE-ZNR 4.75V 5% DO-7 PD=.4W TC=-.019%	15818	CD 35613
A9CR8	1902-3085		DIODE-ZNR 4.75V 5% DO-7 PD=.4W TC=-.019%	15818	CD 35613
A9CR9	1902-3085		DIODE-ZNR 4.75V 5% DO-7 PD=.4W TC=-.019%	15818	CD 35613
A9CR10	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR11	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9CR12	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A9L1	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A9L2	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A9L3	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A9L4	9100-1628	1	COIL-MLD 43UH 5% Q=60 .155DX.375LG	24226	15/432
A9L5	9100-1629	1	COIL-MLD 47UH 5% Q=55 .155DX.375LG	24226	15/472
A9L6	9100-1622		COIL-MLD 24UH 5% Q=60 .155DX.375LG	24226	15/242
A9L7	9100-0699		COIL	28480	9100-0699
A9L8	9100-0700		COIL	28480	9100-0700
A9L9	9140-0183		COIL-MLD 20UH 10% Q=80 .156DX.375LG	06560	4445-6K
A9L10	9140-0183		COIL-MLD 20UH 10% Q=80 .156DX.375LG	06560	4445-6K
A9L11	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A9L12	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A9L13	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A9L14	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A9L15	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A9L16	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A9L17	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A9L18	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A9L19	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A9L20	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A9L21	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A9L22	9100-3807		COIL-MLD 110NH 5% Q=50 .1550X.375LG	24226	9572
A9MP1	03335-61201	1	EXTRUSION ASSEMBLY	28480	03335-61201
A9MP2	8160-0265	2	PC SHIELD	28480	8160-0265
A9MP3	8160-0260	2	PC SHIELD	28480	8160-0260
A9Q1	1853-0018		TRANSISTOR PNP SI TO-72 PD=200MW FT=1GHZ	28480	1853-0018
A9Q2	1853-0036		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A9Q3	1853-0036		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A9Q4	1854-0220		TRANSISTOR NPN 2N3959 SI TO-18 PD=400MW	04713	2N3959
A9Q5	1854-0220		TRANSISTOR NPN 2N3959 SI TO-18 PD=400MW	04713	2N3959
A9Q6	1853-0018		TRANSISTOR PNP SI TO-72 PD=200MW FT=1GHZ	28480	1853-0018
A9Q7	1853-0018		TRANSISTOR PNP SI TO-72 PD=200MW FT=1GHZ	28480	1853-0018
A9Q8	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A9Q9	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A9Q10	1854-0354		TRANSISTOR NPN SI TO-52 PD=360MW	28480	1854-0354
A9Q11	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A9Q12	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A9Q13	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A9Q14	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A9Q15	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A9Q16	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A9Q17	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A9Q18	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A9Q19	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A9Q20	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A9Q21	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A9Q22	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A9Q23	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A9R1	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A9R2	1810-0142		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0142
A9R3	1810-0167		NETWORK-RES 8-PIN-SIP .1-PIN-SPCG	28480	1810-0167
A9R4	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A9R5	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A9R6	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A9R7	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A9R8	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A9R9	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A9R10	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A9R11	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A9R12	0698-4382		RESISTOR 52.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-52R3-F
A9R13	0757-0276		RESISTOR 61.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A9R14	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A9R15	0698-4423		RESISTOR 1.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1371-F
A9R16	0757-0411		RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-T0-332R-F
A9R17	0698-4396		RESISTOR 80.6 1% .125W F TC=0+-100	24546	C4-1/8-T0-80R6-F
A9R18	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A9R19	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A9R20	0698-4396		RESISTOR 80.6 1% .125W F TC=0+-100	24546	C4-1/8-T0-80R6-F
A9R21	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A9R22	0698-3442	2	RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A9R23	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A9R24	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A9R25	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A9R26	0698-4423		RESISTOR 1.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1371-F
A9R27	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A9R28	0698-4382		RESISTOR 52.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-52R3-F
A9R34	0698-4382		RESISTOR 52.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-52R3-F
A9R35	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A9R36	0698-4427		RESISTOR 1.65K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1651-F
A9R37	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A9R38	0698-4382		RESISTOR 52.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-52R3-F
A9R39	0698-3442		RESISTOR 237 1% .125W F TC=0+-100	24546	C4-1/8-T0-237R-F
A9R40	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A9R41	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A9R42	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A9R43	0698-4396		RESISTOR 80.6 1% .125W F TC=0+-100	24546	C4-1/8-T0-80R6-F
A9R44	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A9R45	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A9R46	0698-4396		RESISTOR 80.6 1% .125W F TC=0+-100	24546	C4-1/8-T0-80R6-F
A9R47	0698-4423		RESISTOR 1.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1371-F
A9R48	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A9R49	0757-0411		RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-T0-332R-F
A9R50	0757-0276		RESISTOR 61.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A9R56	0757-0407	1	RESISTOR 200 1% .125W F TC=0+-100	24546	C4-1/8-T0-201-F
A9R57	0757-0284	1	RESISTOR 150 1% .125W F TC=0+-100	24546	C4-1/8-T0-151-F
A9R58	0698-3259		RESISTOR 7.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7871-F
A9R59	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A9R60	0698-3558		RESISTOR 4.02K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4021-F
A9R61	0757-0123		RESISTOR 34.8K 1% .125W F TC=0+-100	24546	C4, T-0
A9R62	0698-4472		RESISTOR 7.68K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7681-F
A9R63	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A9R64	0698-3558		RESISTOR 4.02K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4021-F
A9R65	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A9R66	2100-3353		RESISTOR-TRMR 20K 10% C SIDE-ADJ 1-TRN	32997	3386X-Y46-203
A9R67	0698-3444		RESISTOR 316 1% .125W F TC=0+-100	16299	C4-1/8-T0-316R-F
A9R68	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A9R69	0757-0420		RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A9R70	0698-3518		RESISTOR 7.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7321-F
A9R71	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A9R72	0698-0063		RESISTOR 5.23K 1% .125W F TC=0+-100	91637	CMF-1/8-T1-5231-F
A9R73	0698-3511		RESISTOR 665 1% .125W F TC=0+-100	24546	C4-1/8-T0-665R-F
A9R74	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A9R75	0698-3122		RESISTOR 412 1% .125W F TC=0+-100	03888	PME55-1/8-T0-4120-F
A9R76	0757-0276		RESISTOR 61.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A9R81	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A9R82	0698-3512		RESISTOR 1.18K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1181-F
A9R83	0757-0424		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A9R84	0757-0274		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1213-F
A9R85	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A9R86	0757-0411		RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-T0-332R-F
A9R87	0757-0381		RESISTOR 15 1% .125W F TC=0+-100	19701	MF4C1/8-T0-15R0-F
A9R88	0757-0383		RESISTOR 18.2 1% .125W F TC=0+-100	19701	MF4C1/8-T0-18R2-F
A9R89	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A9R90	0698-3512		RESISTOR 1.18K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1181-F
A9R91	0757-0424		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A9R92	0757-0274		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1213-F
A9R93	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A9R94	0757-0411		RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-T0-332R-F
A9R95	0757-0381		RESISTOR 15 1% .125W F TC=0+-100	19701	MF4C1/8-T0-15R0-F
A9R96	0757-0383		RESISTOR 18.2 1% .125W F TC=0+-100	19701	MF4C1/8-T0-18R2-F
A9R97	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A9R98	0698-3512		RESISTOR 1.18K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1181-F
A9R99	0757-0424		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A9R100	0757-0274		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1213-F
A9R101	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A9R102	0757-0411		RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-T0-332R-F
A9R103	0757-0381		RESISTOR 15 1% .125W F TC=0+-100	19701	MF4C1/8-T0-15R0-F
A9R104	0757-0383		RESISTOR 18.2 1% .125W F TC=0+-100	19701	MF4C1/8-T0-18R2-F
A9U1	1820-1559	1	IC-DIGITAL MM74C164N CMOS D-TYPE	27014	MM74C164N
A9U2	1820-1730	3	IC-DIGITAL SN74LS273N TTL LS OCTL	01295	58039
A9U3	1820-1173		IC-DIGITAL MC10124L TTL/ECL QUAD 2	04713	MC10124L
A9U4	1820-1173		IC-DIGITAL MC10124L TTL/ECL QUAD 2	04713	MC10124L
A9U5	1820-0810		IC-DIGITAL MC10116P ECL TPL 2 LINE RCVR	04713	MC10116P
A9U6	1820-1788	2	IC-DIGITAL F10016 ECL BIN SYNCHRO	07263	F10016DC
A9U7	1820-1788		IC-DIGITAL F10016 ECL BIN SYNCHRO	07263	F10016DC
A9U8	1820-0802		IC-DIGITAL MC10102P ECL QUAD 2 NOR	04713	MC10102P
A9U9	1820-1344		IC MC 12040 PL LOOP	04713	MC12040L

Fig 8-I-1

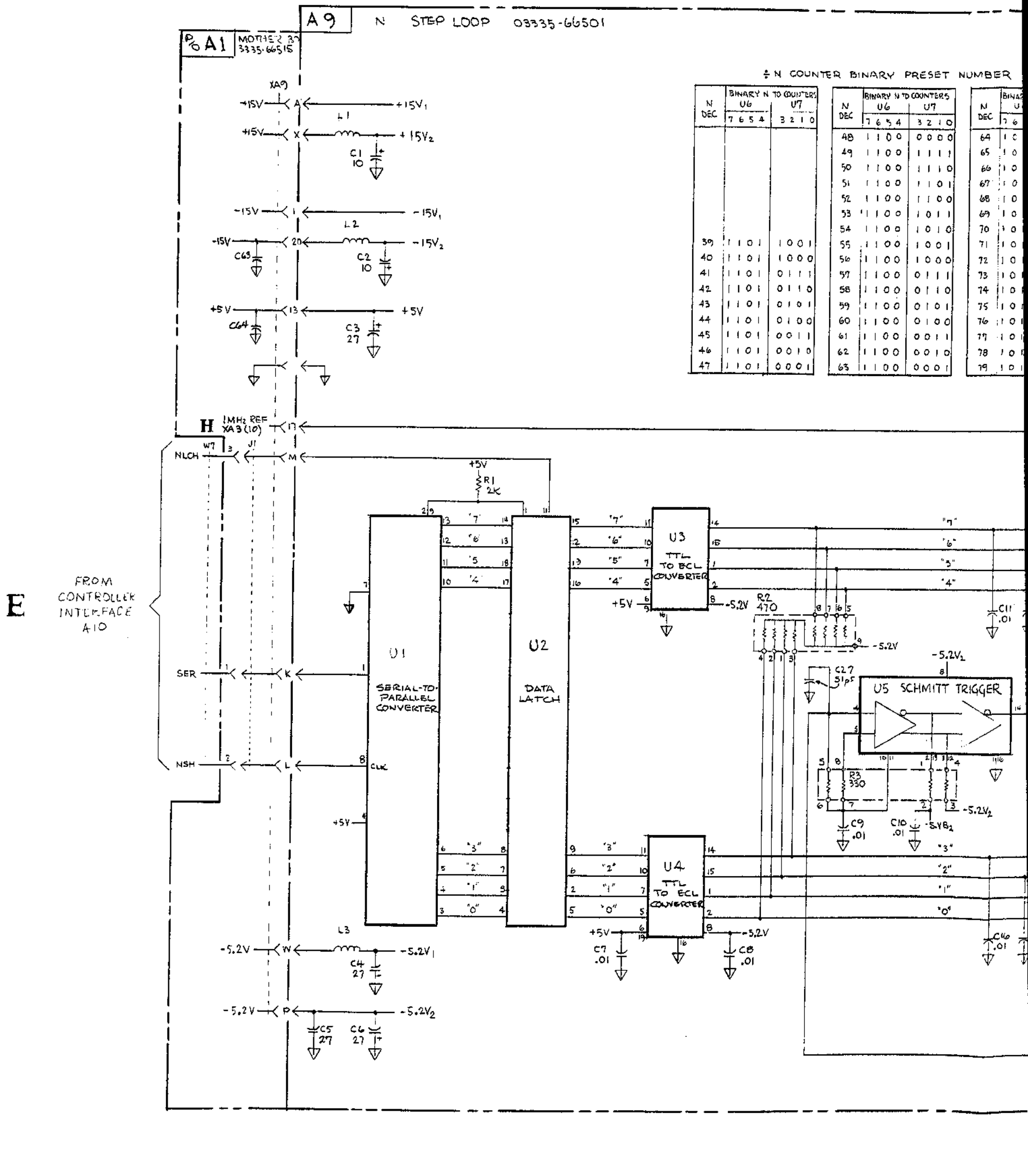
Sht 1 of 5



A9

-hp- Part No. 03335-66501

Fig 8-I-1
Sht 2 of 5



÷N COUNTER BINARY PRESET NUMBER

N DEC	BINARY N TO COUNTERS U6 7 6 5 4	U7 3 2 1 0
39	1 1 0 1	1 0 0 1
40	1 1 0 1	1 0 0 0
41	1 1 0 1	0 1 1 1
42	1 1 0 1	0 1 1 0
43	1 1 0 1	0 1 0 1
44	1 1 0 1	0 1 0 0
45	1 1 0 1	0 0 1 1
46	1 1 0 1	0 0 1 0
47	1 1 0 1	0 0 0 1

N DEC	BINARY N TO COUNTERS U6 7 6 5 4	U7 3 2 1 0
48	1 1 0 0	0 0 0 0
49	1 1 0 0	1 1 1 1
50	1 1 0 0	1 1 1 0
51	1 1 0 0	1 1 0 1
52	1 1 0 0	1 1 0 0
53	1 1 0 0	1 0 1 1
54	1 1 0 0	1 0 1 0
55	1 1 0 0	1 0 0 1
56	1 1 0 0	1 0 0 0
57	1 1 0 0	0 1 1 1
58	1 1 0 0	0 1 1 0
59	1 1 0 0	0 1 0 1
60	1 1 0 0	0 1 0 0
61	1 1 0 0	0 0 1 1
62	1 1 0 0	0 0 1 0
63	1 1 0 0	0 0 0 1

N DEC	BINA[illegible] U[illegible] 7 6
64	1 0
65	1 0
66	1 0
67	1 0
68	1 0
69	1 0
70	1 0
71	1 0
72	1 0
73	1 0
74	1 0
75	1 0
76	1 0
77	1 0
78	1 0
79	1 0

Fig 8 I-1
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PRESET NUMBER

COUNTERS U7 3	2	1	0
0	0	0	0
1	1	1	1
1	1	1	0
1	1	0	1
1	1	0	0
1	0	1	1
1	0	1	0
1	0	0	1
1	0	0	0
0	1	1	1
0	1	1	0
0	1	0	1
0	1	0	0
0	0	1	1
0	0	1	0
0	0	0	1

N DEC	BINARY N TO COUNTERS U6				U7			
	7	6	5	4	3	2	1	0
64	1	0	1	1	0	0	0	0
65	1	0	1	1	1	1	1	1
66	1	0	1	1	1	1	1	0
67	1	0	1	1	1	1	0	1
68	1	0	1	1	1	1	0	0
69	1	0	1	1	1	0	1	1
70	1	0	1	1	1	0	1	0
71	1	0	1	1	1	0	0	1
72	1	0	1	1	1	0	0	0
73	1	0	1	1	0	1	1	1
74	1	0	1	1	0	1	1	0
75	1	0	1	1	0	1	0	1
76	1	0	1	1	0	1	0	0
77	1	0	1	1	0	0	1	1
78	1	0	1	1	0	0	1	0
79	1	0	1	1	0	0	0	1

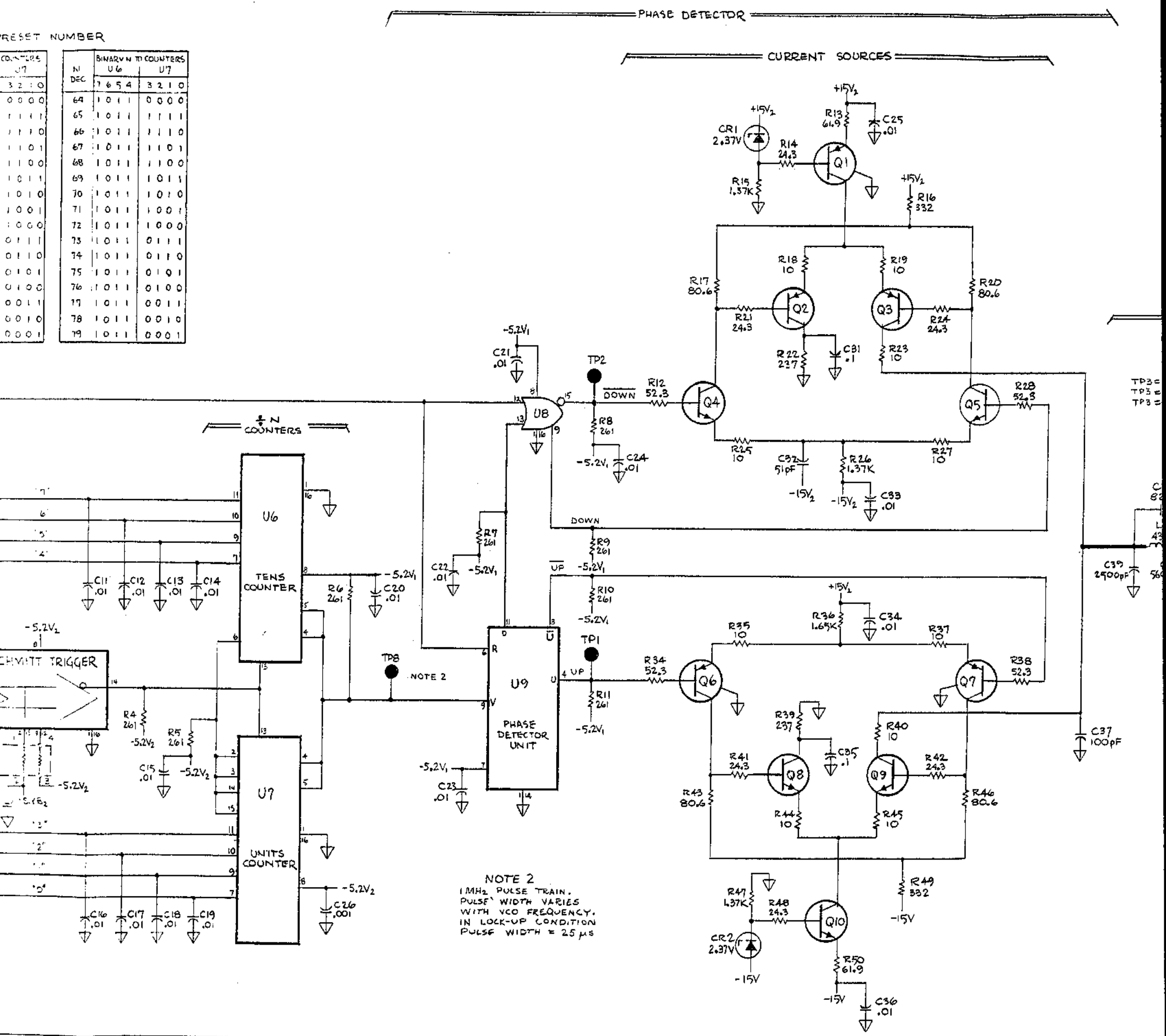
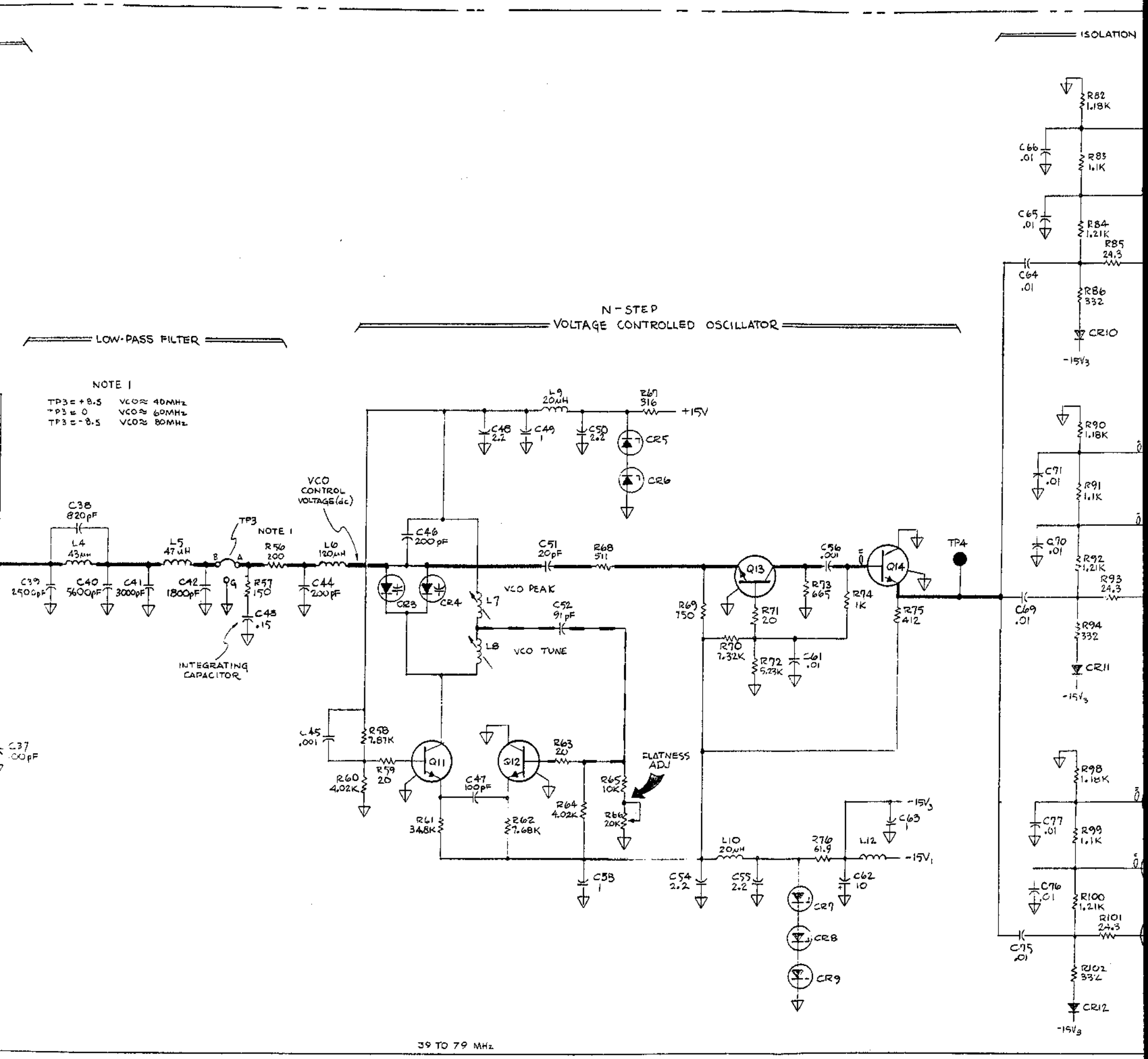


Fig 8-I-1
Sht 4 of 5



3335-E-39

Figure 8-I-1

Fig 8-I-1
Sht 5 of 5

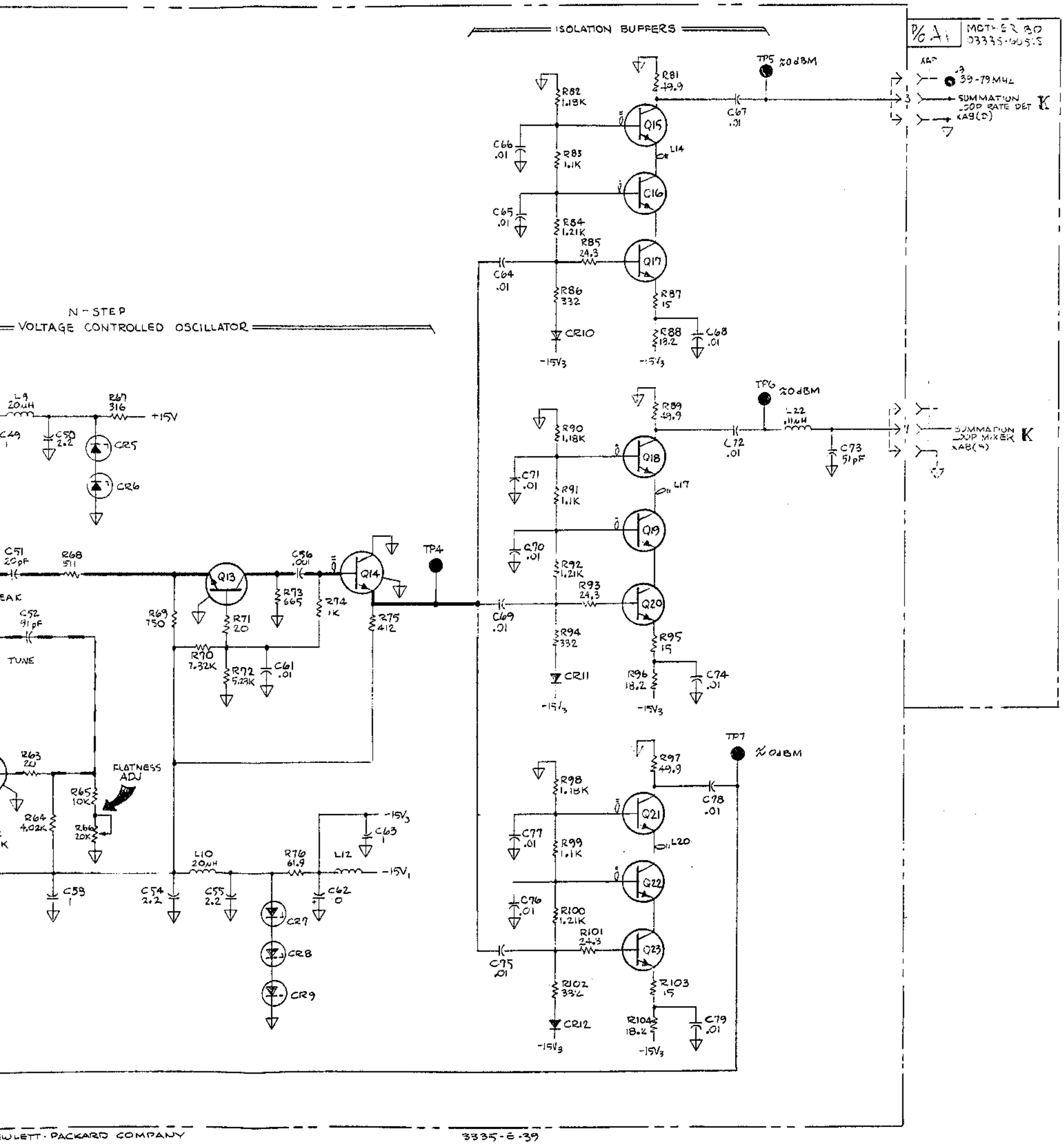


Figure 8-I-1. Schematic Diagram, N Step Loop (03335-66501) A9.

Fig 8-I-2
Sht 1 of 3

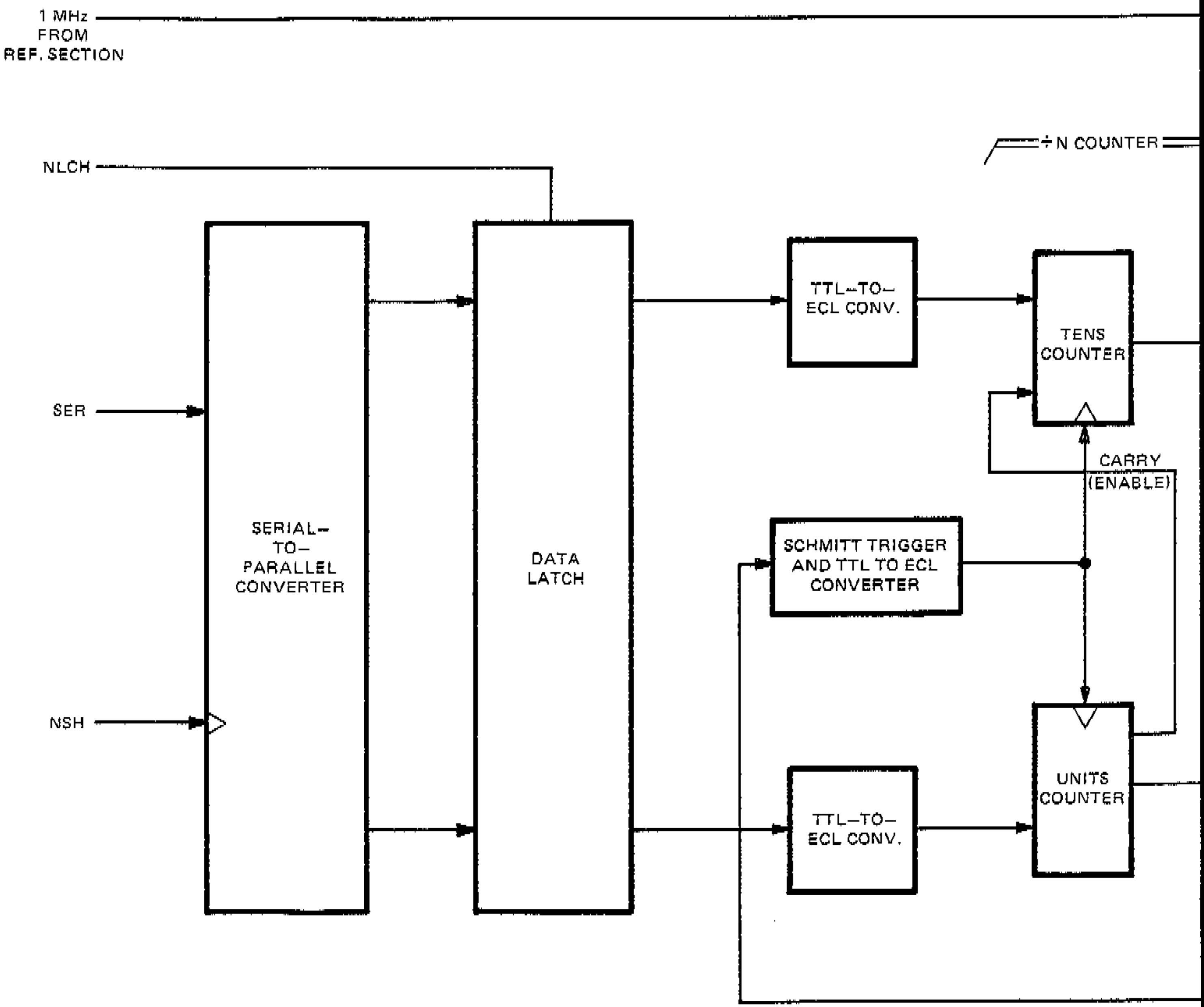


Fig 8-I-2
sht 2 of 3

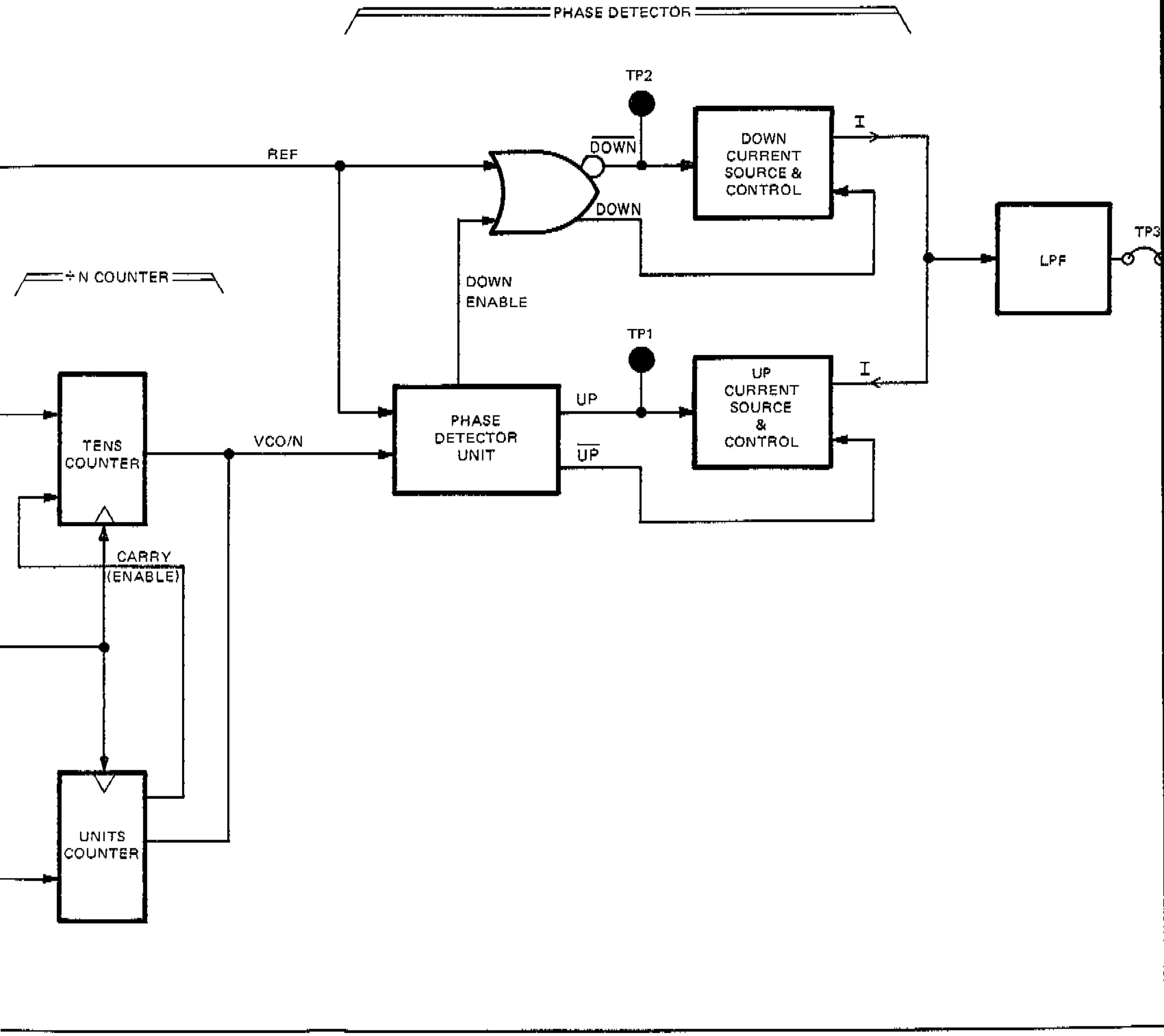


Fig 8-I-2
Sht 3 of 3

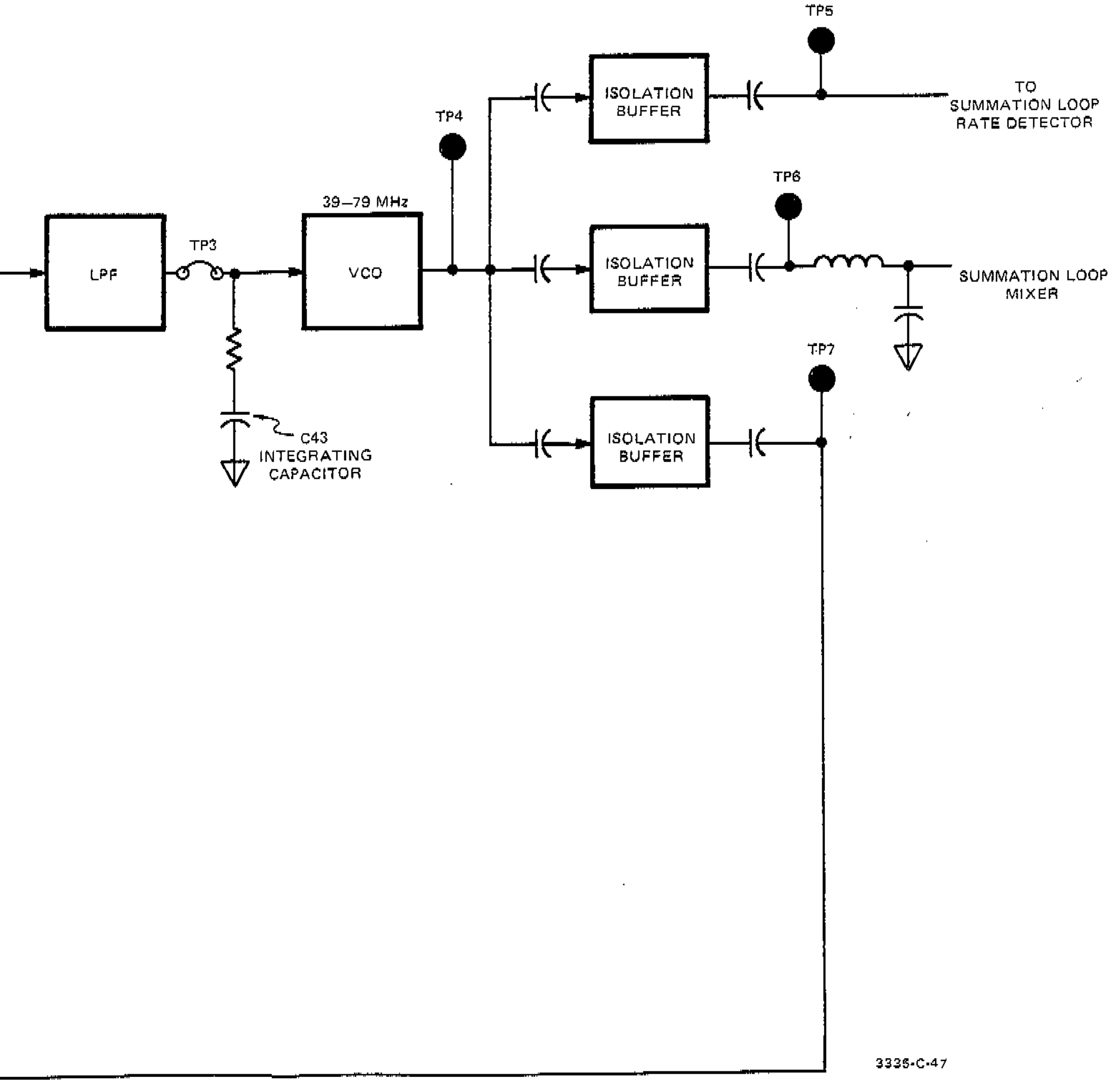


Figure 8-I-2. Block Diagram, N Step Loop (03335-66501) A9.

SERVICE GROUP J

FRACTIONAL–N LOOP

ADJUSTMENTS

Designation	Adjustment Title	Paragraph
A5R43	API-2 ADJ	5-18
A5R45	API-1 ADJ	5-18
A5L7	(VCO TANK)	5-18

TROUBLESHOOTING DATA

The Fractional N (N.F) Loop service group provides information to aid in troubleshooting the N.F Loop (A4, 03335-66503 and A5, 03335-66504) to the component level. It is assumed the 1–2 MHz signal measured at the module Mother Board (A1) test point was not present or incorrect for the frequency selected.

INTRODUCTION

The N.F Loop is comprised of two printed circuit board assemblies, A4 and A5 (digital and analog assemblies respectively). The first step in troubleshooting the "loop" is to isolate the fault to either the digital or analog assembly. To do this, a half-split method is employed where data from the first troubleshooting point (integrator output) indicates which half of the loop is faulty.

The N.F Loop is a typical divide-by-N phase lock loop with some additional circuitry. A simplified block diagram is shown in Figure 8-J-1. If CR8 is removed, the effect of the API's is eliminated and the loop functions as a typical phase locked loop.

The N.F Loop VCO operates over the range of 20 MHz to 40 MHz. This signal is divided by twenty to obtain the 1–2 MHz signal applied to the Summation Loop. The N.F Loop VCO frequency is set by the N.F BCD number loaded into the ÷ N.F counter. On the schematic this is the f1 or f2 register. The BCD number is loaded least significant digit first. A total of 16 digits are loaded since the f1 and f2 registers consist of two eight-bit registers. For an N.F Loop VCO frequency of 20 MHz, the following 16 digit number is loaded into the f1 or f2 register. A further breakdown of this number indicates the function of each digit.

$$\underset{\substack{\text{this digit}\\ \text{is not used}\\ \text{and is truncated}}}{0}\ \underbrace{200}_{\text{N digits}}\ \underbrace{00000000}_{\text{.F digits}}\ \underbrace{0000}_{\substack{\text{Always Zero}\\ \text{to complete}\\ \text{16 digits}}}$$

NOTE

Digits are loaded least significant digits first. N digits range from 200 to 400.

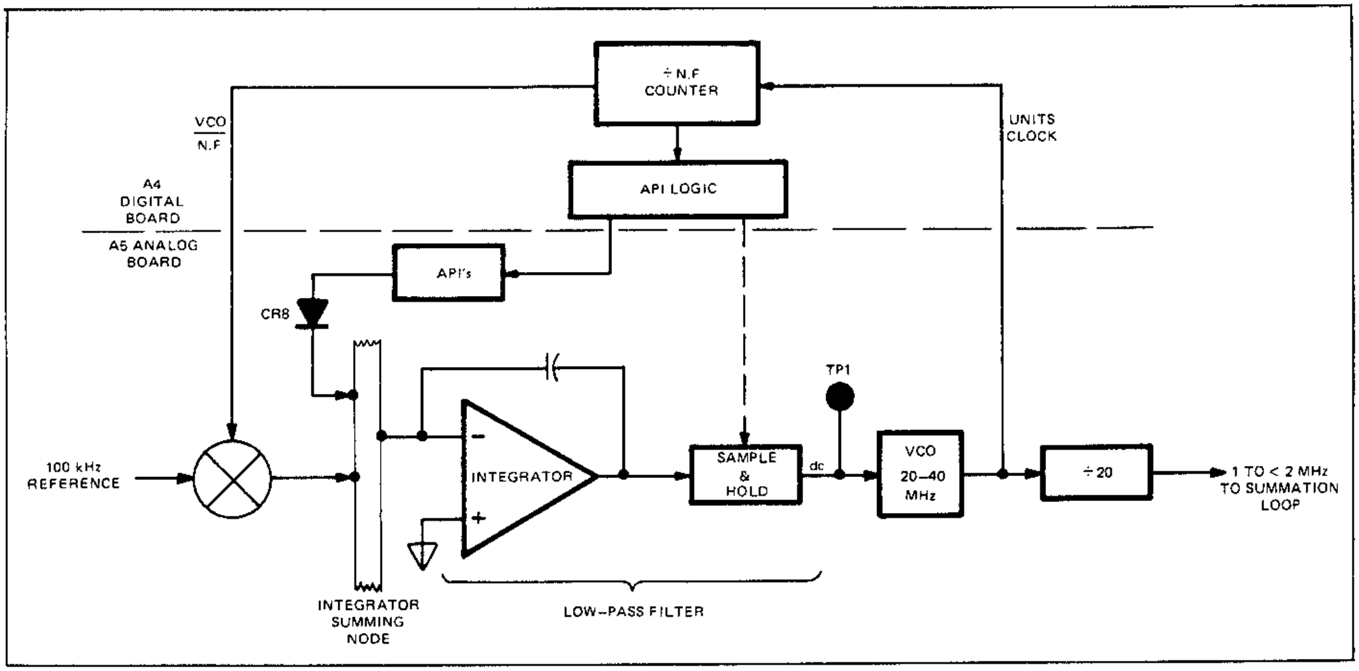


Figure 8-J-1. Simplified Block Diagram.

The previous discussion briefly summarized the digital counter activity. To isolate the problem to either the digital half or analog half of the N.F Loop, the integrator output waveform is analyzed. The fault isolation procedure follows.

GENERAL N.F LOOP FAULT ISOLATION

1. Place the N.F Analog board on an extender and set instrument frequency to 1 MHz.

2. Monitor the instrument output frequency with a spectrum analyzer.

3. Check integrator output waveform (see Figure 8-J-2) for the following:

   a. Period of 10 μsec. If period is not 10 μsec, check the 100 K pps reference input from the Reference assembly (Service Group B).

   b. The top pedestal of waveform is a constant dc level. If there is jitter from pedestal to pedestal, check the API circuits.

   c. A stable dc waveform indicates that the integrator output is at one of its end limits. The waveform voltage limits are approximately 2 volts below the + 15 V dc or - 15 V dc supplied to the integrator.

4. If vertical jitter is present or waveform is a constant dc, disconnect A5CR8. This separates the API's and their associated circuits as a probable cause. The phase register and the API counters on the digital assembly, A4, do not affect the circuit and the loop operates as a typical phase-locked loop.

5. With CR8 removed, the integrator waveform should be a steady dc. DC level for phase lock is + 10 V dc for VCO equal to 20 MHz to a not to exceed - 12 V dc for 40 MHz. Circuit component values and the varicaps (CR34 and CR35) determine the voltage required for a locked condition at 40 MHz. DC level for an out-of-lock condition is approximately + 13 V dc or - 13 V dc measured at the integrator output.

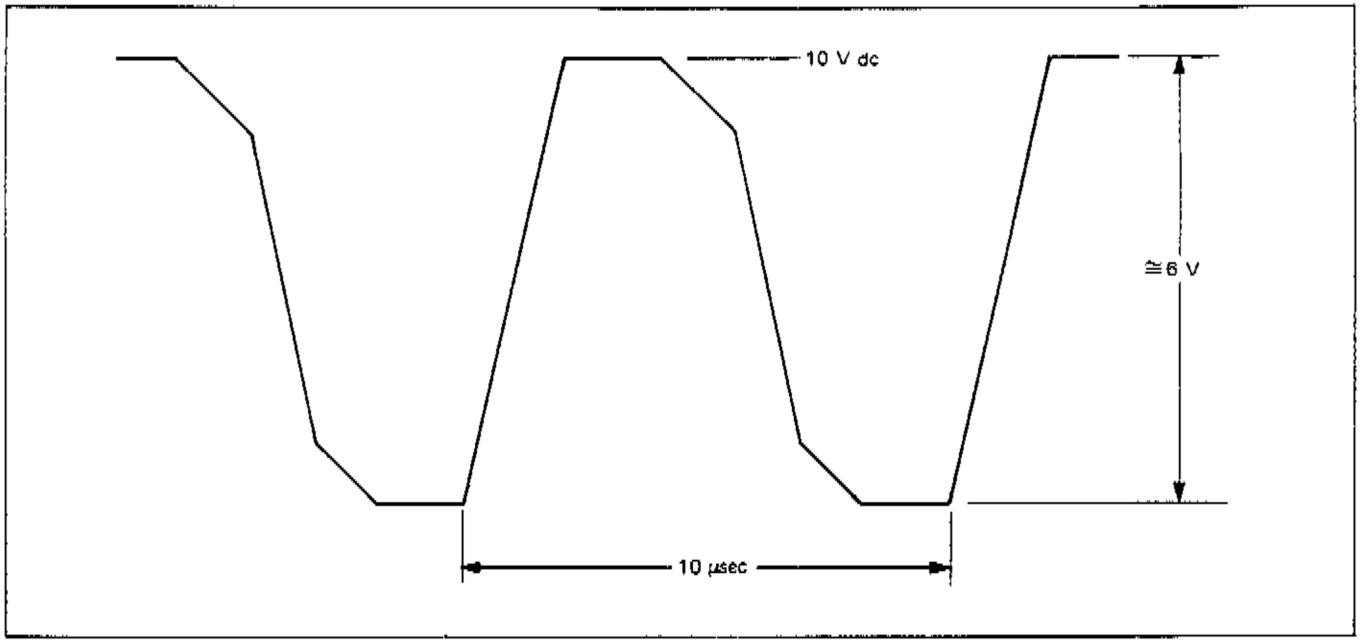


Figure 8-J-2. A5L7 Adjustment Waveform.

NOTE

With the front panel set to 1 MHz and FREQ. INCR set to 5 kHz, the dc level should step evenly for each + 5 kHz increment until the N.F VCO output is 40 MHz. The next + 5 kHz increment will cause the dc level to reset to + 10 V dc which is an N.F VCO output of 20 MHz.

6. Phase Detector Check. If the loop is locked, this implies that the phase detector and integrator are operating correctly. The problem is with the API and phase register circuits. Troubleshooting of the API's start at Step 23. If the circuit is not locked then troubleshoot the circuit as a typical divide-by-N phase locked loop.

7. If the loop is not locked, proceed with loop troubleshooting and ground the VCO control voltage by connecting a short between the two pins which are TP1. Monitor output of N.F board and adjust A5L7 (N.F VCO TUNE) for an output frequency approximately 1.5 MHz.

NOTE

The N.F loop is broken by grounding TP1.

8. Check the phase detector for a stable 100 K pps from the Reference Assembly, A3.

9. Make sure that the front panel display is set to 1 MHz and FREQ INCR is set to 5 kHz. Check that 5 kHz increments will change period and duty cycle of the phase input from the N.F digital board. The frequency of this waveform is $\frac{\text{VCO}}{\text{N.F}}$. Continue to INCR the frequency UP until one INCR causes the duty cycle and period to change by an approximate factor of 2. If the phase input signal does not respond correctly then a problem is in the N.F digital board. Refer to Step 13.

10. The phase detector can be tested by varying the frequency through the cross-over point, where the phase input and the reference input approach one another.

The cross-over point causes the phase detector outputs to change state by one being active and the other inactive, dependent on which of the two inputs is changing phase faster. If the phase detector output is correct, then the problem is between the phase detector and the sample and hold output. If the output is not correct, then the problem is in the phase detector.

11. The integrator is an FET input discrete component op amp. Ground the dc control voltage to the VCO and adjust A5L7 for an N.F output frequency of approximately 1.5 MHz. Also set the display to 1 MHz and the FREQ INCR to 1 Hz. Monitor the integrator output voltage and increment the frequency down by 1 Hz and then up by 1 Hz. The integrator output voltage will reach the typical op amp stops which are $> \pm$ 10 V dc.

    If this test does not work, then the problem lies between the phase detector and integrator output. If the test works, check the sample and hold circuit. Apply normal troubleshooting techniques to these circuits.

12. ÷ N Digital Troubleshooting. Improper phase input to the phase detector from the N.F digital board implies a problem with the digital section. Insert the N.F Analog board into the module with the VCO dc input (TP1) grounded and the output frequency adjusted by A5L7 to 1.5 MHz. Place the N.F Digital board on an extender. Program the 3335A for a frequency of 1 MHz.

13. Ground A4TP7(Pin 1 of U84). This insures a constant N input to the ÷ N latches.

14. The frequency set to 1 MHz implies that the fractional or Phase component of the digital signal loaded into the N.F Digital f1 or f2 register is all zeros. It also insures the N number is constant and the VCO frequency is fixed. With the above inputs fixed, the positive pulse at A4TP1 (U61D pin 11) should have a stable period. A stable period indicates that the sequencer is working and the ÷ N counter is partially working correctly for a constant input number of zero. The ÷ N latches of the ÷ N counter should not be tested until after verifying the Multiplexer, f1/f2 Registers and Data Steering circuits. If the pulse was stable, then check the output of the MUX U53 Step 18.

15. If the pulse at A4TP1 (U61D pin 11) is not correct, then check A4TP8 (U94 pin 8) for a negative pulse with a stable period. If the correct pulse is present the sequencer circuit is probably defective. If the proper pulse is not present, the problem is probably in the ÷ N counter.

16. ÷ N Counter. Check for the TENS CLOCK U56A Pin 6. If the TENS CLOCK is present, check the divide-by-ten presettable counters U83 and U73 for proper operation. Ten input pulses should give a single output pulse for each. The output on U73 Pin 7 should occur one clock pulse before the ripple output and remain present until the counter receives a new load command. If the TENS CLOCK is not present, check the units counter of the ÷ N counter.

NOTE

The TENS CLOCK period depends on N.F VCO frequency. This frequency is stable since A5TP1 is grounded.

17. Unit Counter. Apply normal troubleshooting procedures to the Units Counter with A4TP7 grounded which loads Ø into the ÷ 5 counter.

NOTE

The signal on U87C pin 10 is to change the ÷ 2 counter to a ÷ 3 counter for three VCO units clock pulses.

18. Multiplexer U53 and f1/f2 Register Test. Set front panel display frequency to 1.435 MHz and FREQ INC to Ø Hz. Monitor the state of U53 pin 1. Push INC key once and see if U53 Pin 1 changed state. If Pin 1 changes state then registers f1 and f2 can be selected. Also the correct set frequency code was received by U15A. If Pin 1 did not change state then a problem will be in the Data Steering circuit or the circuits which feed the Data Steering section. Apply normal troubleshooting procedures to these circuits.

19. Check the multiplexer output (U53 pins 4, 7, 9, and 12) for pulse indications. Increment the frequency once and recheck the output pins for pulse indications. This test checks the multiplexer and registers f1 and f2. The data is recirculating and pulses present indicate that data is being shifted through the registers and multiplexer U53.

20. If one of the output pins does not indicate pulses present, then the multiplexer U53, f1/f2 registers or the data input to the registers is defective. Each increment of the frequency attenuates the register selected for recirculating data to the multiplexer. Which register selected can be determined by checking the state of U53 pin 1. The f registers are checked in Step 21. If pulses are present, check the ÷ N latches in Step 22.

21. Check the f registers by seeing if the f register being used is receiving clock bursts of 16 pulses on Pin 9 which indicates proper operation. If the clock pulses are not correct, check the relationship between the TENS CLOCK and R/F enable gate from the sequences. (16 TENS CLOCK pulses should occur during the R/F register enable gate.) If the 16 pulses are present, the multiplexer U53, f register or data input to the f registers could be defective. Apply normal troubleshooting procedures to these circuits.

22. ÷ N Latches. With A4TP7 grounded (U84A Pin 1) check the 9's complement IC U63 to see that the output lines are changing state indicating U63 is good. Now remove ground from A4TP7 (U84A Pin 1) and check for a stable waveform at A4TP1 (U61D Pin 11). If waveform is unstable or missing, then *U84* and *U74* are the probable cause.

23. API. When CR8 was removed, the integrator output waveform indicated the circuit came into phase lock. The probable cause is the API Analog or Digital circuits. Check the API input pulse to the analog board. If the pulses are a constant high or have an unstable period (with frequency set to 1 MHz), then a problem exists in the API digital circuitry. If the API input control lines are correct, the API analog circuit is defective. Normal troubleshooting procedures should be applied to the circuits. A good place to start is to check CR4—CR7 for proper switching.

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4	03335-66503	1	PC ASSEMBLY, FRACTIONAL-N DIGITAL		
A4C1	0140-0206		CAPACITOR-FXD 270PF +-5% 500WVDC MICA	72136	DM15F271J0500WV1CR
A4C2	0180-0374	15	CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X902082
A4C12	0160-3847	126	CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C13	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C15	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C16	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C17	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C21	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C27	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C31	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C32	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C34	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C36	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C44	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C45	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C46	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C56	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C61	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C64	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C67	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C76	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C77	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C81	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C83	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C84	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C85	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C86	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C87	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C88	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C95	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4C96	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A4L1	9100-3334		COIL 25UH 10% .3DX.5LG SRF=14MHZ	28480	9100-3334
A4L2	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A4MP1	03335-61203	1	EXTRUSION ASSEMBLY	28480	03335-61203
A4R1	0683-3315		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A4R2	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A4R3	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A4R4	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A4R5	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A4R6	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A4R7	0683-1045		RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A4R12	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R13	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R25	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R26	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R41	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R46	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R56	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R62	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R64	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R73	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R76	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R77	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R84	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R94	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4R96	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A4U11	1820-1279	6	IC-DIGITAL SN74LS190N TTL LS DECD	01295	SN74LS190N
A4U12	1820-0709	10	IC-DIGITAL 93L28DC TTL L R-S	07263	93L28DC
A4U13	1820-1112	8	IC-DIGITAL SN74LS74N TTL LS DUAL	01295	SN74LS74N
A4U14	1820-1205	2	IC-DIGITAL SN74LS21N TTL LS DUAL 4 AND	01295	SN74LS21N
A4U15	1820-1205		IC-DIGITAL SN74LS21N TTL LS DUAL 4 AND	01295	SN74LS21N
A4U16	1820-1195	6	IC-DIGITAL SN74LS175N TTL LS QUAD	01295	SN74LS175N
A4U17	1820-1195		IC-DIGITAL SN74LS175N TTL LS QUAD	01295	SN74LS175N
A4U21	1820-1279		IC-DIGITAL SN74LS190N TTL LS DECD	01295	SN74LS190N
A4U22	1820-1195		IC-DIGITAL SN74LS175N TTL LS QUAD	01295	SN74LS175N
A4U23	1820-1112		IC-DIGITAL SN74LS74N TTL LS DUAL	01295	SN74LS74N
A4U24	1820-1202	3	IC-DIGITAL SN74LS10N TTL LS TPL 3 NAND	01295	SN74LS10N
A4U25	1820-1197	2	IC-DIGITAL SN74LS00N TTL LS QUAD 2 NAND	01295	SN74LS00N
A4U26	1820-1202		IC-DIGITAL SN74LS10N TTL LS TPL 3 NAND	01295	SN74LS10N
A4U27	1820-1146		IC-DIGITAL CD4050AE CMOS HEX 1 NON-INV	02735	CD4050AY
A4U31	1820-1279		IC-DIGITAL SN74LS190N TTL LS DECD	01295	SN74LS190N

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A4U32	1820-1195		IC-DIGITAL SN74LS175N TTL LS QUAD	01295	SN74LS175N
A4U33	1820-1195		IC-DIGITAL SN74LS175N TTL LS QUAD	01295	SN74LS175N
A4U34	1820-0709		IC-DIGITAL 93L28DC TTL L R-S	07263	93L28DC
A4U35	1820-0709		IC-DIGITAL 93L28DC TTL L R-S	07263	93L28DC
A4U36	1820-1144		IC-DIGITAL SN74LS02N TTL LS QUAD 2 NOR	01295	SN74LS02N
A4U41	1820-1279		IC-DIGITAL SN74LS190N TTL LS DECD	01295	SN74LS190N
A4U42	1820-1195		IC-DIGITAL SN74LS175N TTL LS QUAD	01295	SN74LS175N
A4U43	1820-1467	1	IC-DIGITAL N82S83B TTL S BCD ADDER	18324	N82S83B
A4U44	1820-0709		IC-DIGITAL 93L28DC TTL L R-S	07263	93L28DC
A4U45	1820-0709		IC-DIGITAL 93L28DC TTL L R-S	07263	93L28DC
A4U46	1820-1196	3	IC-DIGITAL SN74LS174N TTL LS HEX	01295	SN74LS174N
A4U51	1820-1440	1	IC-DIGITAL SN74LS279N TTL LS QUAD	01295	SN74LS279N
A4U52	1820-0709		IC-DIGITAL 93L28DC TTL L R-S	07263	93L28DC
A4U53	1820-1470	3	IC-DIGITAL SN74LS157N TTL LS QUAD 2	01295	SN74LS157N
A4U54	1820-0709		IC-DIGITAL 93L28DC TTL L R-S	07263	93L28DC
A4U55	1820-0709		IC-DIGITAL 93L28DC TTL L R-S	07263	93L28DC
A4U56	1820-0629	6	IC-DIGITAL SN74S112N TTL S DUAL J-K	01295	SN74S112N
A4U61	1820-1211	2	IC-DIGITAL SN74LS86N TTL LS QUAD 2	01295	SN74LS86N
A4U62	1820-1112		IC-DIGITAL SN74LS74N TTL LS DUAL	01295	SN74LS74N
A4U63	1820-1267	1	IC-DIGITAL SN74184N TTL BCD-TO-BIN	01295	SN74184N
A4U64	1820-0709		IC-DIGITAL 93L28DC TTL L R-S	07263	93L28DC
A4U65	1820-0709		IC-DIGITAL 93L28DC TTL L R-S	07263	93L28DC
A4U66	1820-0629		IC-DIGITAL SN74S112N TTL S DUAL J-K	01295	SN74S112N
A4U71	1820-1045	2	IC-DIGITAL N8273B TTL D-TYPE	18324	N8273B
A4U72	1820-1211		IC-DIGITAL SN74LS86N TTL LS QUAD 2	01295	SN74LS86N
A4U73	1820-1279		IC-DIGITAL SN74LS190N TTL LS DECD	01295	SN74LS190N
A4U74	1820-1196		IC-DIGITAL SN74LS174N TTL LS HEX	01295	SN74LS174N
A4U75	1820-1199		IC-DIGITAL SN74LS04N TTL LS HEX 1	01295	SN74LS04N
A4U76	1820-0629		IC-DIGITAL SN74S112N TTL S DUAL J-K	01295	SN74S112N
A4U77	1820-0629		IC-DIGITAL SN74S112N TTL S DUAL J-K	01295	SN74S112N
A4U81	1820-1045		IC-DIGITAL N8273B TTL D-TYPE	18324	N8273B
A4U82	1820-1201	3	IC-DIGITAL SN74LS08N TTL LS QUAD 2 AND	01295	SN74LS08N
A4U83	1820-1279		IC-DIGITAL SN74LS190N TTL LS DECD	01295	SN74LS190N
A4U84	1820-1196		IC-DIGITAL SN74LS174N TTL LS HEX	01295	SN74LS174N
A4U85	1820-0681	3	IC-DIGITAL SN74S00N TTL S QUAD 2 NAND	01295	SN74S00N
A4U86	1820-0629		IC-DIGITAL SN74S112N TTL S DUAL J-K	01295	SN74S112N
A4U87	1820-1322	1	IC-DIGITAL SN74S02N TTL S QUAD 2 NOR	01295	SN74S02N
A4U93	1820-1208	1	IC-DIGITAL SN74LS32N TTL LS QUAD 2 OR	01295	SN74LS32N
A4U94	1820-1112		IC-DIGITAL SN74LS74N TTL LS DUAL	01295	SN74LS74N
A4U95	1820-0681		IC-DIGITAL SN74S00N TTL S QUAD 2 NAND	01295	SN74S00N
A4U96	1820-0629		IC-DIGITAL SN74S112N TTL S DUAL J-K	01295	SN74S112N
A4U97	1820-0681		IC-DIGITAL SN74S00N TTL S QUAD 2 NAND	01295	SN74S00N
A4U106	1820-0629	1	IC FF TTL S J-K NEG-EDGE-TRIG	01698	SN74S112N
A4U107	1820-0693	1	IC FF TTL J D-TYPE POS-EDGE-TRIG	01698	SN74S74N
A5	03335-66504	1	PC ASSEMBLY, FRACTIONAL-N ANALOG		
A5C1	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C2	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X902082
A5C3	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C4	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C5	0180-1714	1	CAPACITOR-FXD 330UF+-10% 6VDC TA	56289	150D337X900682
A5C6	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C7	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C8	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X902082
A5C9	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C10	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A5C11	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C12	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X902082
A5C13	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C14	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A5C15	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C16	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C17	0160-2202		CAPACITOR-FXD 75PF +-5% 300WVDC MICA	28480	0160-2202
A5C18	0160-0205		CAPACITOR-FXD 10PF +-5% 500WVDC MICA	28480	0160-0205
A5C19	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C20	0160-0134		CAPACITOR-FXD 220PF +-5% 300WVDC MICA	28480	0160-0134
A5C21	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C22	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C23	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A5C24	0160-2306		CAPACITOR-FXD 27PF +-5% 300WVDC MICA	28480	0160-2306
A5C25	0160-3829	2	CAPACITOR-FXD .47UF +-10% 50WVDC MET	28480	0160-3829
A5C26	0160-4461	1	CAPACITOR-FXD 150PF +-2.5% 160WVDC POLYP	28480	0160-4461
A5C27	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C28	0140-0204	1	CAPACITOR-FXD 47PF +-5% 500WVDC MICA	72136	DM15E470J0500WV1CR
A5C29	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C30	0160-0336		CAPACITOR-FXD 100PF +-1% 300WVDC MICA	28480	0160-0336
A5C31	0140-0149	1	CAPACITOR-FXD 470PF +-5% 300WVDC MICA	72136	DM15F471J0300WV1CR

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5C33	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C34	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C35	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C37	0140-0193		CAPACITOR-FXD 82PF + -5% 300WVDC MICA	72136	DM15E820J0300WV1CR
A5C38	0180-0374		CAPACITOR-FXD 10UF + -10% 20VDC TA	56289	150D106X9020B2
A5C39	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C40	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A5C46	0160-3829		CAPACITOR-FXD .47UF + -10% 50WVDC MET	28480	0160-3829
A5C47	0160-0938	2	CAPACITOR-FXD 1000PF + -5% 100WVDC MICA	28480	0160-0938
A5C48	0160-2207	3	CAPACITOR-FXD 300PF + -5% 300WVDC MICA	28480	0160-2207
A5C49	0140-0193		CAPACITOR-FXD 82PF + -5% 300WVDC MICA	72136	DM15E820J0300WV1CR
A5C50	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C51	0160-2206		CAPACITOR-FXD 160PF + -5% 300WVDC MICA	28480	0160-2206
A5C52	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C53	0160-0376	2	CAPACITOR-FXD 68PF + -5% 500WVDC MICA	28480	0160-0376
A5C54	0160-0336		CAPACITOR-FXD 100PF + -1% 300WVDC MICA	28480	0160-0336
A5C55	0160-2206		CAPACITOR-FXD 160PF + -5% 300WVDC MICA	28480	0160-2206
A5C56	0160-2206		CAPACITOR-FXD 160PF + -5% 300WVDC MICA	28480	0160-2206
A5C57	0160-0938		CAPACITOR-FXD 1000PF +-5% 100WVDC MICA	28480	0160-0938
A5C58	0160-0336		CAPACITOR-FXD 100PF +-1% 300WVDC MICA	28480	0160-0336
A5C59	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A5C60	0160-2207		CAPACITOR-FXD 300PF +-5% 300WVDC MICA	28480	0160-2207
A5C61	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A5C62	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C63	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A5C64	0160-2207		CAPACITOR-FXD 300PF +-5% 300WVDC MICA	28480	0160-2207
A5C65	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A5C66	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A5C67	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A5C68	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A5CR1	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A5CR2	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A5CR4	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A5CR5	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A5CR6	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR7	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR8	1901-0518	11	DIODE-SCHOTTKY	28480	1901-0518
A5CR9	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A5CR10	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A5CR11	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A5CR12	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A5CR13	1902-0041	5	DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	15818	CD 35622
A5CR14	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	15818	CD 35622
A5CR15	1902-0041		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	15818	CD 35622
A5CR16	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A5CR17	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A5CR18	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A5CR19	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A5CR20	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A5CR21	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A5CR22	1902-3036	5	DIODE-ZNR 3.16V 5% DO-7 PD=.4W TC=-.064%	04713	SZ 10939-38
A5CR23	1902-3036		DIODE-ZNR 3.16V 5% DO-7 PD=.4W TC=-.064%	04713	SZ 10939-38
A5CR24	1902-3036		DIODE-ZNR 3.16V 5% DO-7 PD=.4W TC=-.064%	04713	SZ 10939-38
A5CR25	1902-3036		DIODE-ZNR 3.16V 5% DO-7 PD=.4W TC=-.064%	04713	SZ 10939-38
A5CR26	1902-0064	2	DIODE-ZNR 7.5V 5% DO-7 PD=.4W TC=+.05%	28480	1902-0064
A5CR27	1902-0064		DIODE-ZNR 7.5V 5% DO-7 PD=.4W TC=+.05%	28480	1902-0064
A5CR31	1902-3054	1	DIODE-ZNR 3.65V 5% DO-7 PD=.4W TC=-.055%	04713	SZ 10939-56
A5CR32	1902-3036		DIODE-ZNR 3.16V 5% DO-7 PD=.4W TC=-.064%	04713	SZ 10939-38
A5CR33	1901-0518		DIODE-SCHOTTKY	28480	1901-0518
A5CR34	0122-0059		DIODE:VOLTAGE VARIABLE CAPACITANCE	28480	0122-0059
A5CR35	0122-0059		DIODE:VOLTAGE VARIABLE CAPACITANCE	28480	0122-0059
A5L1	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A5L2	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A5L3	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A5L4	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A5L5	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A5L6	9100-3345	2	COIL-MLD 2UH 5% .155DX.375LG	24226	9406
A5L7	9100-3312	1	COIL-VAR 900NH/1.1UH Q=150 PC MTG	02113	Q1-1.0
A5L8	9100-0539	3	COIL-MLD 10UH 5% Q=55 .155DX.375LG	24226	15/102-5%
A5L9	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A5L10	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A5L11	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A5L12	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A5L13	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A5L14	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A5MP1	03335-61204	1	EXTRUSION ASSEMBLY	28480	03335-61204

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5Q1	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A5Q2	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A5Q3	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A5Q4	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A5Q5	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A5Q6	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A5Q7	1853-0089	18	TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q8	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A5Q9	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A5Q10	1854-0351	1	TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0351
A5Q11	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q12	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q13	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q14	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A5Q15	1854-0215	16	TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A5Q16	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A5Q17	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHz	04713	SPS 3611
A5Q18	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHz	04713	SPS 3611
A5Q19	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHz	04713	SPS 3611
A5Q20	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q21	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q22	1854-0296		TRANSISTOR NPN SI TO-92 PD=310MW	28480	1854-0296
A5Q23	1853-0020		TRANSISTOR PNP SI PD=300MW FT=150MHz	28480	1853-0020
A5Q24	1855-0082	1	TRANSISTOR MOSFET P-CHAN D-MODE SI	28480	1855-0082
A5Q25	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q26	1853-0020		TRANSISTOR PNP PNP SI PD=300MW FT=150MHz	28480	1853-0020
A5Q27	1855-0081	4	TRANSISTOR J-FET 2N5245 N-CHAN D-MODE SI	01295	2N5245
A5Q28	1855-0081		TRANSISTOR J-FET 2N5245 N-CHAN D-MODE SI	01295	2N5245
A5Q29	1854-0296		TRANSISTOR NPN SI TO-92 PD=310MW	28480	1854-0296
A5Q35	1855-0308	1	TRANSISTOR-JFET DUAL N-CHAN D-MODE SI	28480	1855-0308
A5Q36	1854-0296		TRANSISTOR NPN SI TO-92 PD=310MW	28480	1854-0296
A5Q37	1854-0296		TRANSISTOR NPN SI TO-92 PD=310MW	28480	1854-0296
A5Q38	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q39	1854-0296		TRANSISTOR NPN SI TO-92 PD=310MW	28480	1854-0296
A5Q40	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q41	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHz	04713	SPS 3611
A5Q42	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHz	04713	SPS 3611
A5Q43	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q44	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A5Q45	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A5Q46	1855-0081		TRANSISTOR J-FET 2N5245 N-CHAN D-MODE SI	01295	2N5245
A5Q47	1855-0332	1	TRANSISTOR MOSFET 3N138 N-CHAN D-MODE	02735	3N138
A5Q48	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A5Q49	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHz	04713	SPS 3611
A5Q50	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHz	04713	SPS 3611
A5Q51	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q52	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q53	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A5Q54	1854-0296		TRANSISTOR NPN SI TO-92 PD=310MW	28480	1854-0296
A5Q55	1855-0081		TRANSISTOR J-FET 2N5245 N-CHAN D-MODE SI	01295	2N5245
A5Q56	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q57	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q58	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q59	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q60	1853-0089		TRANSISTOR PNP 2N4917 SI PD=200MW	07263	2N4917
A5Q61	1854-0296		TRANSISTOR NPN SI TO-92 PD=310MW	28480	1854-0296
A5R1	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A5R2	0698-4449		RESISTOR 309 1% .125W F TC=0+-100	24546	C4-1/8-T0-309R-F
A5R3	0698-4449		RESISTOR 309 1% .125W F TC=0+-100	24546	C4-1/8-T0-309R-F
A5R4	0698-4413		RESISTOR 154 1% .125W F TC=0+-100	24546	C4-1/8-T0-154R-F
A5R5	0757-0398		RESISTOR 75 1% .125W F TC=0+-100	24546	C4-1/8-T0-75R0-F
A5R6	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-TO-10 R0-F
A5R7	0698-3444		RESISTOR 316 1% .125W F TC=0+-100	03292	C4-1/8-TO-316 R-F
A5R8	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R9	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R10	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R11	0683-4705		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A5R12	0757-0405	1	RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-T0-162R-F
A5R13	0683-4705		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A5R14	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A5R15	0683-3025	1	RESISTOR 3K 5% .25W FC TC=-400/+700	01121	CB3025
A5R16	0683-4715		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A5R17	0698-4424	2	RESISTOR 1.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1401-F
A5R18	0757-0401	4	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A5R19	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R20	0683-4705		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A5R21	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R22	0683-4705		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A5R23	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F

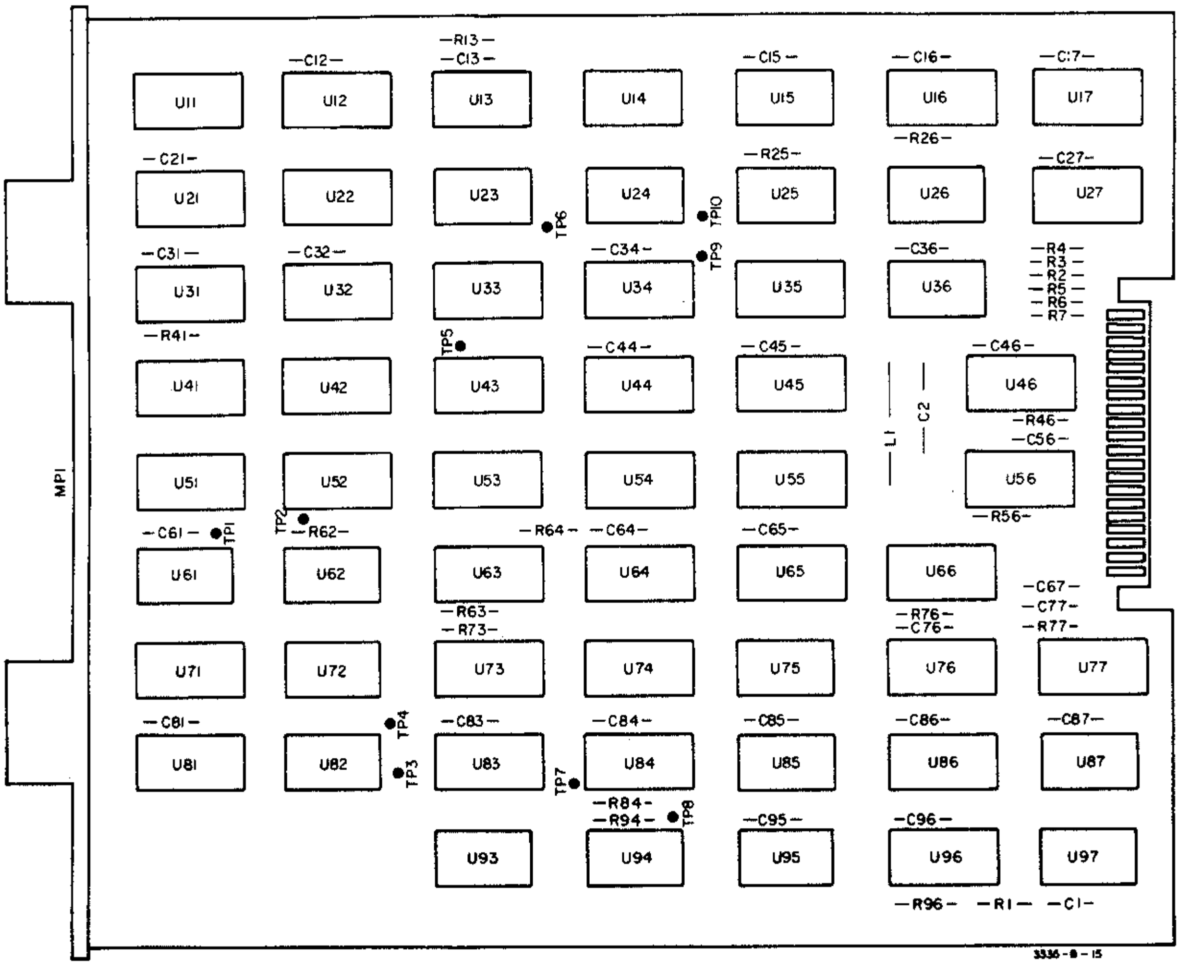
Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5 R24	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-TO-10 R0-F
A5 R25	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01607	CR5105
A5 R26	0757-0405		RESISTOR 162 1% .125W F TC=0+-100	03292	C4-1/8-TO-162 R-F
A5R31	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A5R32	0757-0431	2	RESISTOR 2.43K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2431-F
A5R33	0698-4429	2	RESISTOR 1.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1871-F
A5R34	0757-0431		RESISTOR 2.43K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2431-F
A5R35	0683-4715		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A5R36	0698-4429		RESISTOR 1.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1871-F
A5R37	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R38	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R39	0698-3228	3	RESISTOR 49.9K 1% .125W F TC=0+-100	24546	C-4, T-0
A5R40	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A5R41	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R42	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A5R43	2100-3154	1	RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	32997	3006P-1-102
A5R44	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R45	2100-3054	2	RESISTOR-TRMR 50K 10% C SIDE-ADJ 17-TRN	32997	3006P-1-503
A5R46	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A5R47	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R48	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R49	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R50	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A5R51	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A5R56	0757-0427	6	RESISTOR 1.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1501-F
A5R57	0683-6815		RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A5R58	0757-0427		RESISTOR 1.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1501-F
A5R59	0683-4705		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A5R60	0757-0433		RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3321-F
A5R61	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A5R62	0698-3156	1	RESISTOR 23.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2372-F
A5R63	0757-0435	6	RESISTOR 3.92K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3921-F
A5R64	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R65	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R66	0757-0435		RESISTOR 3.92K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3921-F
A5R67	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R68	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R69	0698-4434	1	RESISTOR 2.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2321-F
A5R70	0757-0435		RESISTOR 3.92K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3921-F
A5R71	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R72	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R73	0757-0435		RESISTOR 3.92K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3921-F
A5R74	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R75	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R76	0757-0444		RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A5R77	0757-0429	1	RESISTOR 1.82K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1821-F
A5R78	0698-3496	1	RESISTOR 3.57K 1% .125W F TC=0+-100	24546	C4-1/8-T0-357R-F
A5R79	0757-0438	5	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A5R80	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A5R81	0698-3259	4	RESISTOR 7.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7871-F
A5R82	0757-0161	1	RESISTOR 604 1% .125W F TC=0+-100	24546	C4-1/8-T0-604R-F
A5R83	0683-4715		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A5R84	1810-0294	1	5330A F.L. PACKAGE	28480	1810-0294
A5R91	0757-0459	1	RESISTOR 56.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5622-F
A5R92	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R93	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A5R94	0698-3279		RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A5R95	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R96	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A5R97	0757-0440	1	RESISTOR 7.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7501-F
A5R98	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A5R99	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A5R100	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A5R101	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A5R102	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A5R103	0757-0273		RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A5R104	0757-0273		RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A5R105	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A5R111	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R112	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R113	0757-0421	4	RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A5R114	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A5R115	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R116	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R117	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R118	0757-0421		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A5R119	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R120	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R121	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R122	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A5R123	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F

Replaceable Parts

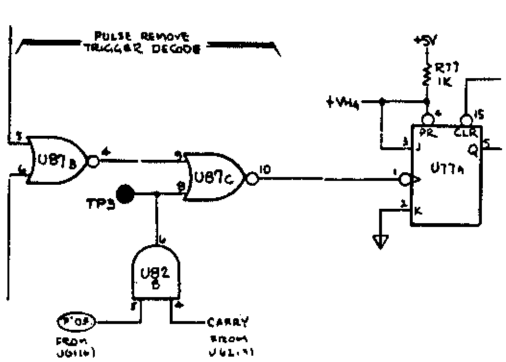
Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5R124	0698-4479	3	RESISTOR 14K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1402-F
A5R125	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R130	0757-0427		RESISTOR 1.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1501-F
A5R131	0757-0317	1	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1331-F
A5R132	0698-4432	2	RESISTOR 2.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2101-F
A5R133	0698-4470	2	RESISTOR 6.98K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6981-F
A5R134	0683-1835	1	RESISTOR 18K 5% .25W FC TC=-400/+800	01121	CB1835
A5R135	0757-0273		RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A5R136	0757-0401		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A5R137	0757-0444		RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A5R138	0683-3315		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A5R139	0683-4335	1	RESISTOR 43K 5% .25W FC TC=-400/+800	01121	CB4335
A5R140	0757-0445	1	RESISTOR 13K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1302-F
A5R141	0757-0427		RESISTOR 1.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1501-F
A5R142	0757-0427		RESISTOR 1.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1501-F
A5R143	0757-0273	6	RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A5R144	0683-5125		RESISTOR 5.1K 5% .25W FC TC=-400/+700	01121	CB5125
A5R145	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A5R146	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A5R147	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A5R148	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A5R149	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A5R150	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A5R151	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A5R152	0683-1325	1	RESISTOR 1.3K 5% .25W FC TC=-400/+700	01121	CB1325
A5R153	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A5R154	0757-0444		RESISTOR 12.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1212-F
A5R155	0698-3279		RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A5R156	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A5R157	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R158	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R159	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R160	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R161	0757-0446		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A5R162	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A5R163	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R164	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A5R170	0683-1625	1	RESISTOR 1.6K 5% .25W FC TC=-400/+700	01121	CB1625
A5R171	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A5R172	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R173	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R174	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R175	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A5R176	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A5R177	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R178	0757-0397	1	RESISTOR 68.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-68R1-F
A5R179	0757-0406	1	RESISTOR 182 1% .125W F TC=0+-100	24546	C4-1/8-T0-182R-F
A5R180	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A5R181	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R182	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R183	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R184	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R185	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R186	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R187	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R188	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R189	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R190	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R191	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R192	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R193	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R194	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R195	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A5R196	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A5U2	1821-0001	1	TRANSISTOR ARRAY DIP	02735	CA3046
A5U3	1820-1344	4	IC MC 12040 PL LOOP	04713	MC12040L
A5U4	1826-0021	1	IC LM 310 OP AMP	27014	LM310H
A5U5	1820-0203	1	IC, AMPL. OPERATIONAL	15818	741CE009
A5U6	1820-0809		IC-DIGITAL MC10115P ECL QUAD 2 LINE RCVR	04713	MC10115P
A5U7	1820-0683	1	IC-DIGITAL SN74S04N TTL S HEX 1	01295	SN74S04N
A5U8	1820-0809		IC-DIGITAL MC10115P ECL QUAD 2 LINE RCVR	04713	MC10115P
A5U9	1820-0817	5	IC-DIGITAL MC10131P ECL DUAL D-M/S	04713	MC10131P
A5U10	1820-0817		IC-DIGITAL MC10131P ECL DUAL D-M/S	04713	MC10131P
A5U11	1820-0817		IC-DIGITAL MC10131P ECL DUAL D-M/S	04713	MC10131P
A5U12	1820-0804	1	IC-DIGITAL MC10106P ECL TPL NOR	04713	MC10106P
A5U13	1820-0817		IC-DIGITAL MC10131P ECL DUAL D-M/S	04713	MC10131P
A5W1	03335-61612	1	CABLE 100 KHZ REFERENCE SIGNAL	28480	03335-61612

ΔA For Serial Numbers 1640A00261 and lower



A4
-hp- Part No. 03335-66503

ΔA For Serial Numbers 1640A00261 and lower



ΔB For Serial Numbers 1640A00261 and lower

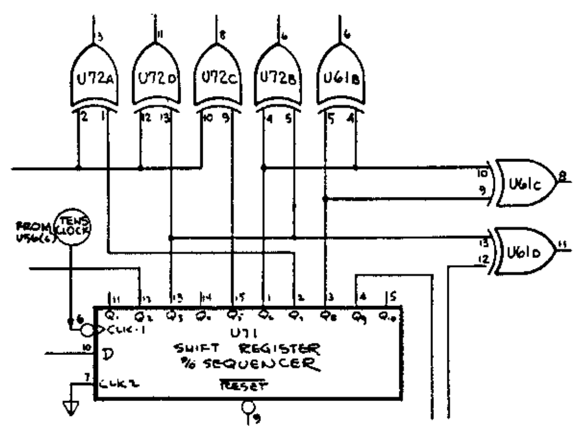
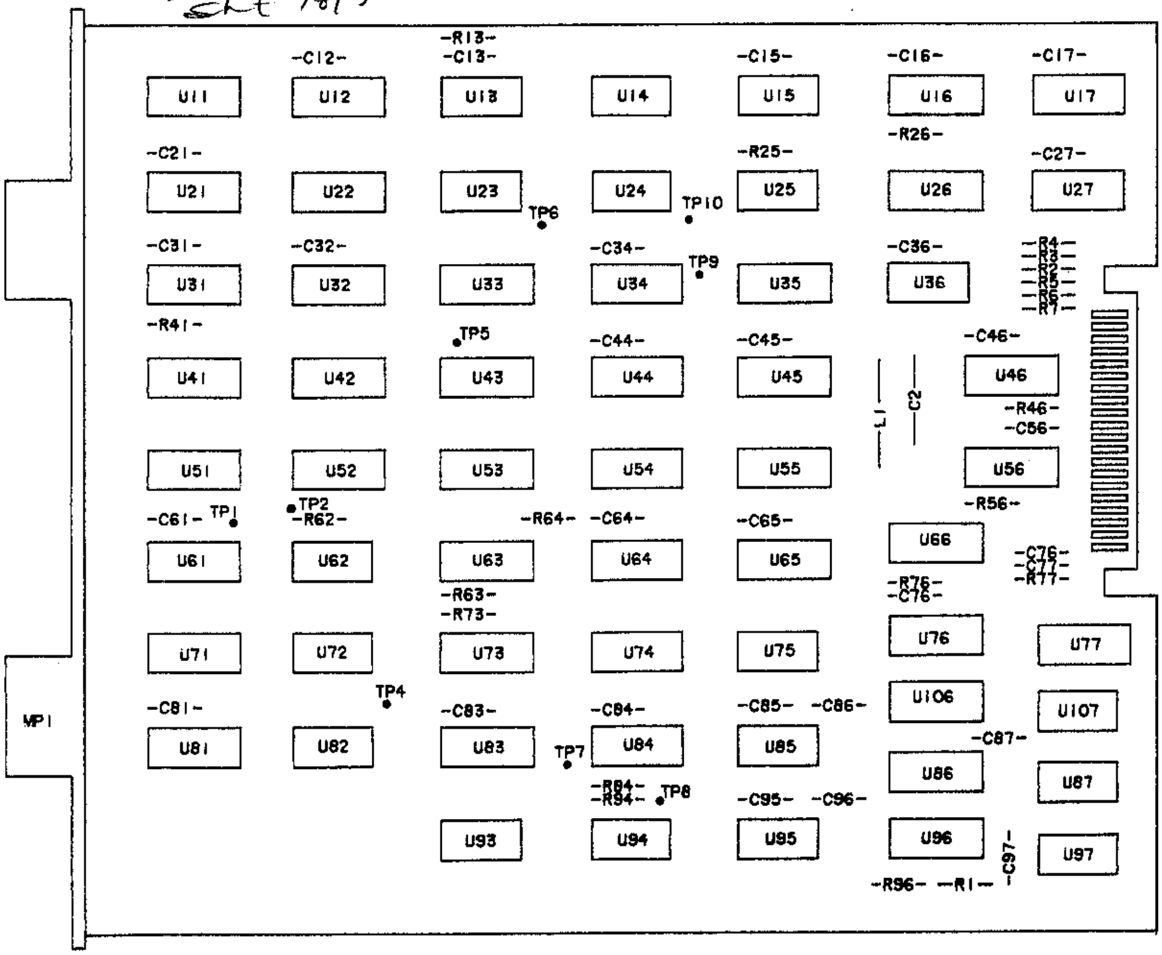


Fig 8-J-3
sht 1 of 5



A4
-hp- Part No. 03335-66503
Rev. C

Table 8-J-1. A4 IC Power Connections and Associated Capacitors.

A4 IC Number	VCC Connection	Associated PS Capacitor	↓ Connection	A4 IC Number	VCC Connection	Associated PS Capacitor	↓ Connection
11	16		8	55	16		8
12	16	C12	8	56	16	C56	8
13	14	C13	7	61	14	C61	7
14	14		7	62	14		7
15	14	C15	7	63	16		8
16	16	C16	8	64	16	C64	8
17	16	C17	8	65	16	C65	8
21	16	C21	8	66	16		8
22	16		8	71	16		8
23	14		7	72	14		7
24	14		7	73	16		8
25	14		7	74	16		8
26	14		7	75	16		8
27	16	C27	8	76	16		8
31	16	C31	8	77	16		8
32	16	C32	8	81	16	C81	8
33	16		8	82	14		7
34	16	C34	8	83	16	C83	8
35	16		8	84	16	C84	8
36	14	C36	7	85	14	C85	7
41	16		8	86	16	C86	8
42	16		8	87	14	C87	7
43	16		8	93	14		7
44	16	C44	8	94	14		7
45	16	C45	8	95	14	C95	7
46	16	C46	8	96	16	C96	8
51	16		8	97	14	C97	7
52	16		8	106	16		8
53	16		8	107	14		7
54	16		8				

Fig 8-J-3
Sht 2 of 5

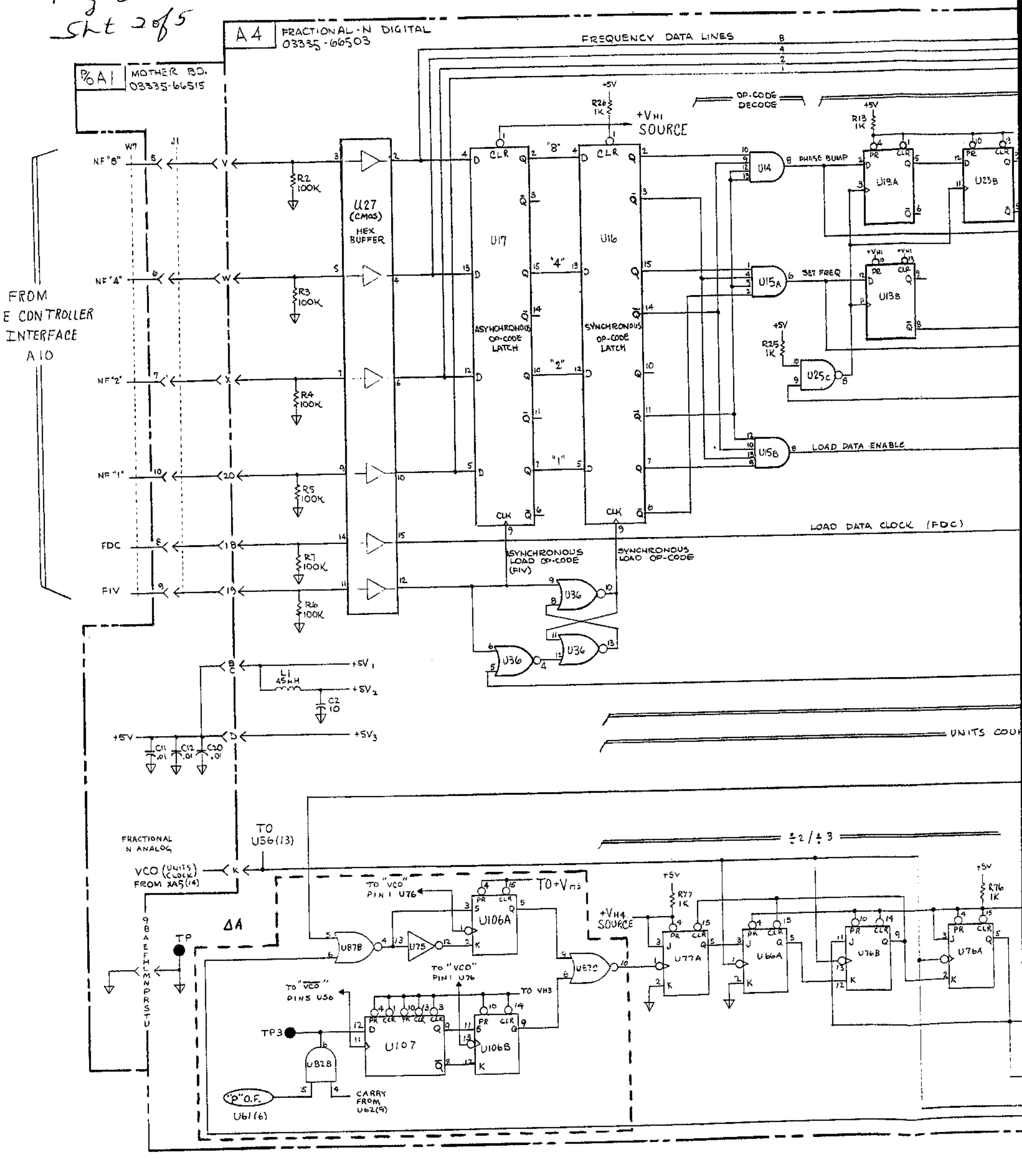


Fig 8-J-3 sht 3 of 5

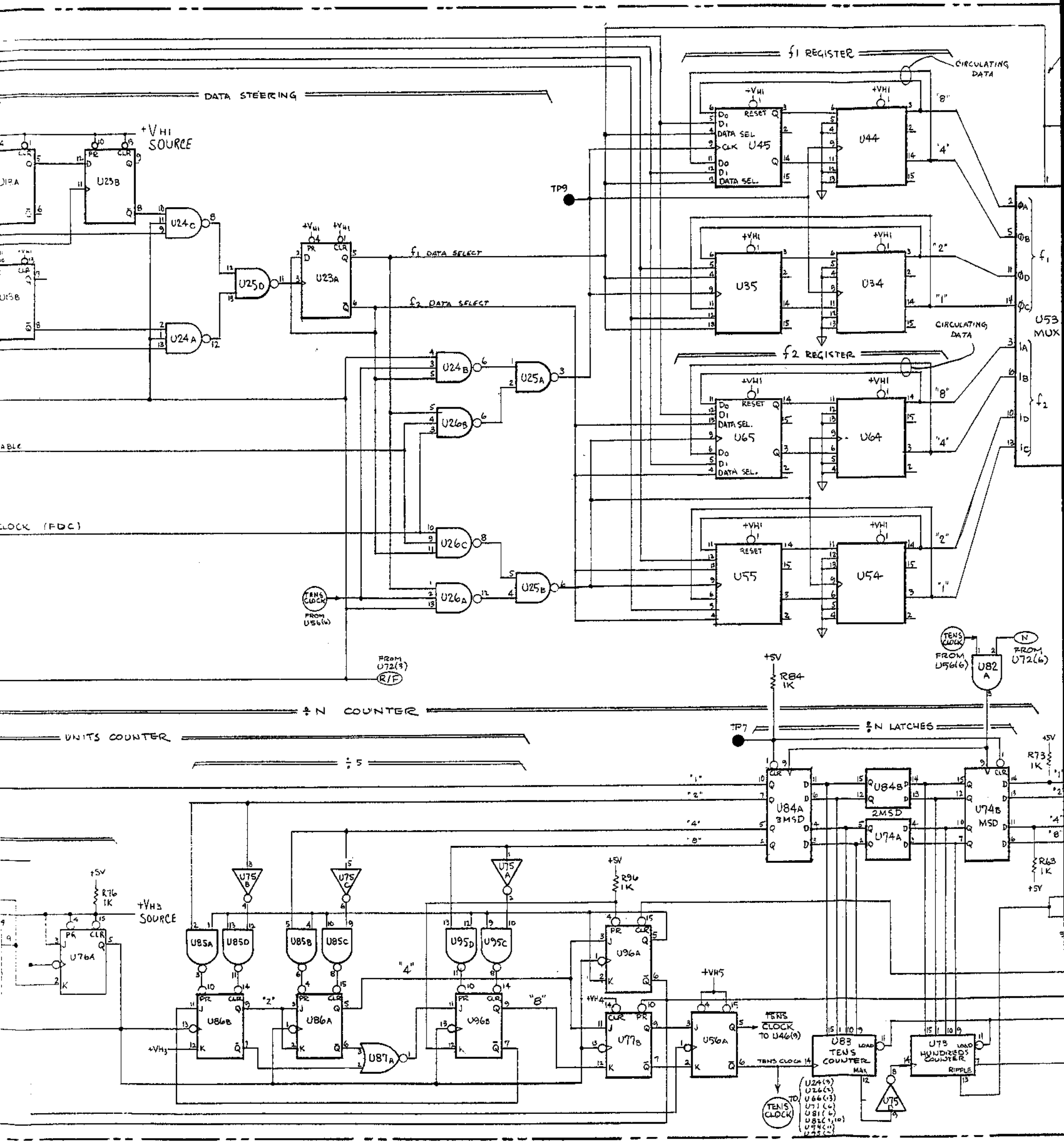


Fig 8-J-3 Sht 4 of 5

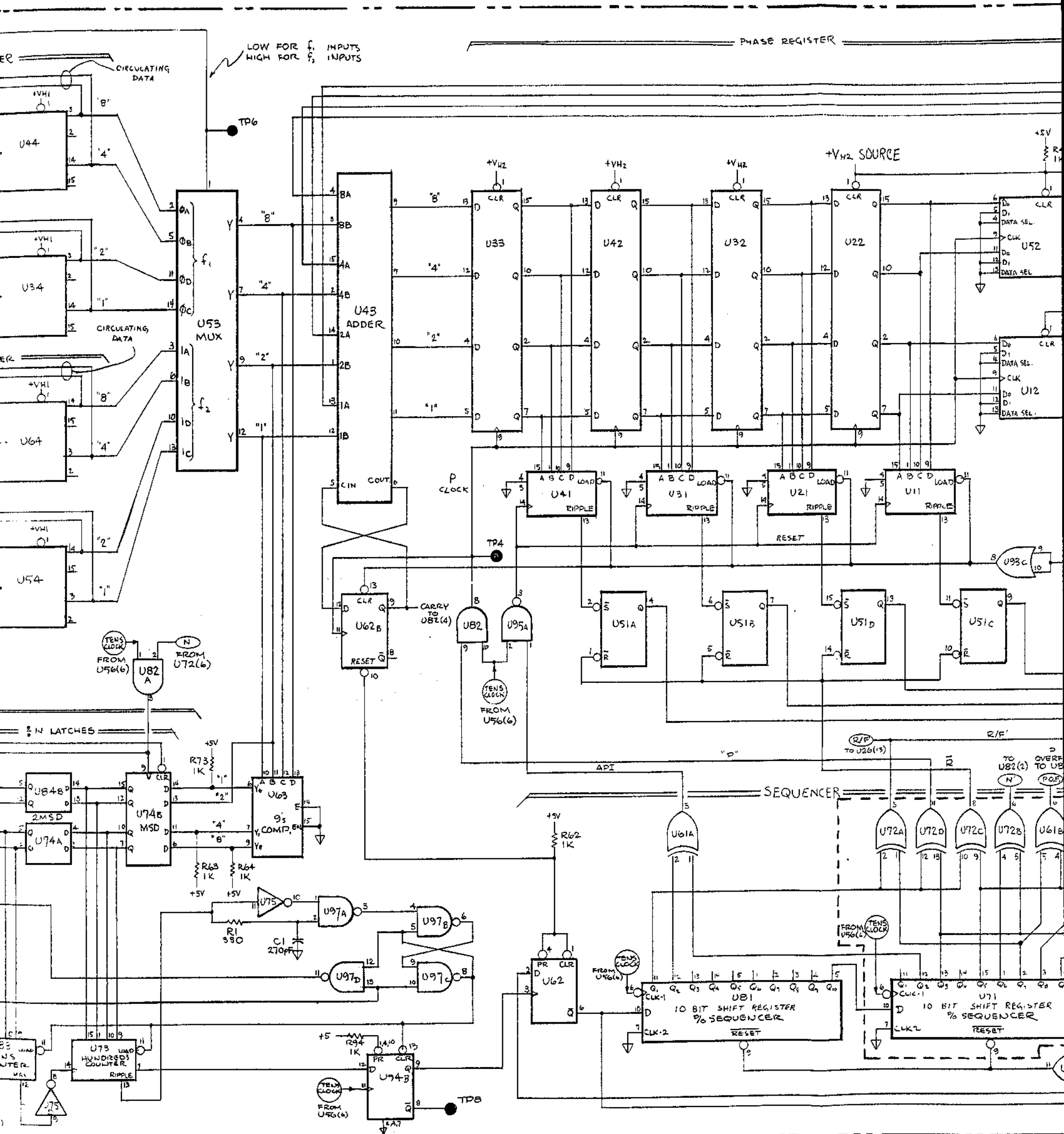


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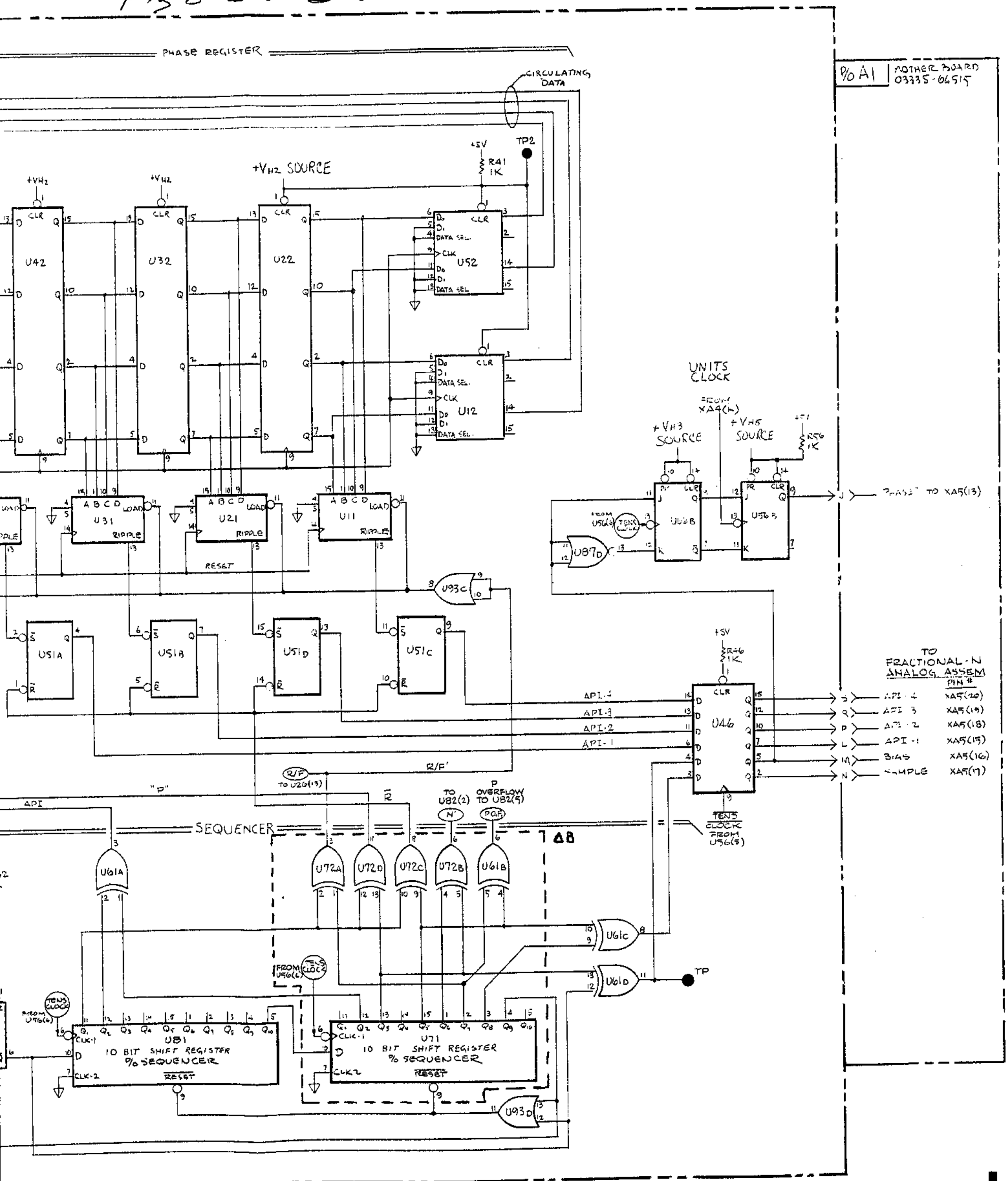
Figure

Fig 8-J-3 Sht 5 of 5

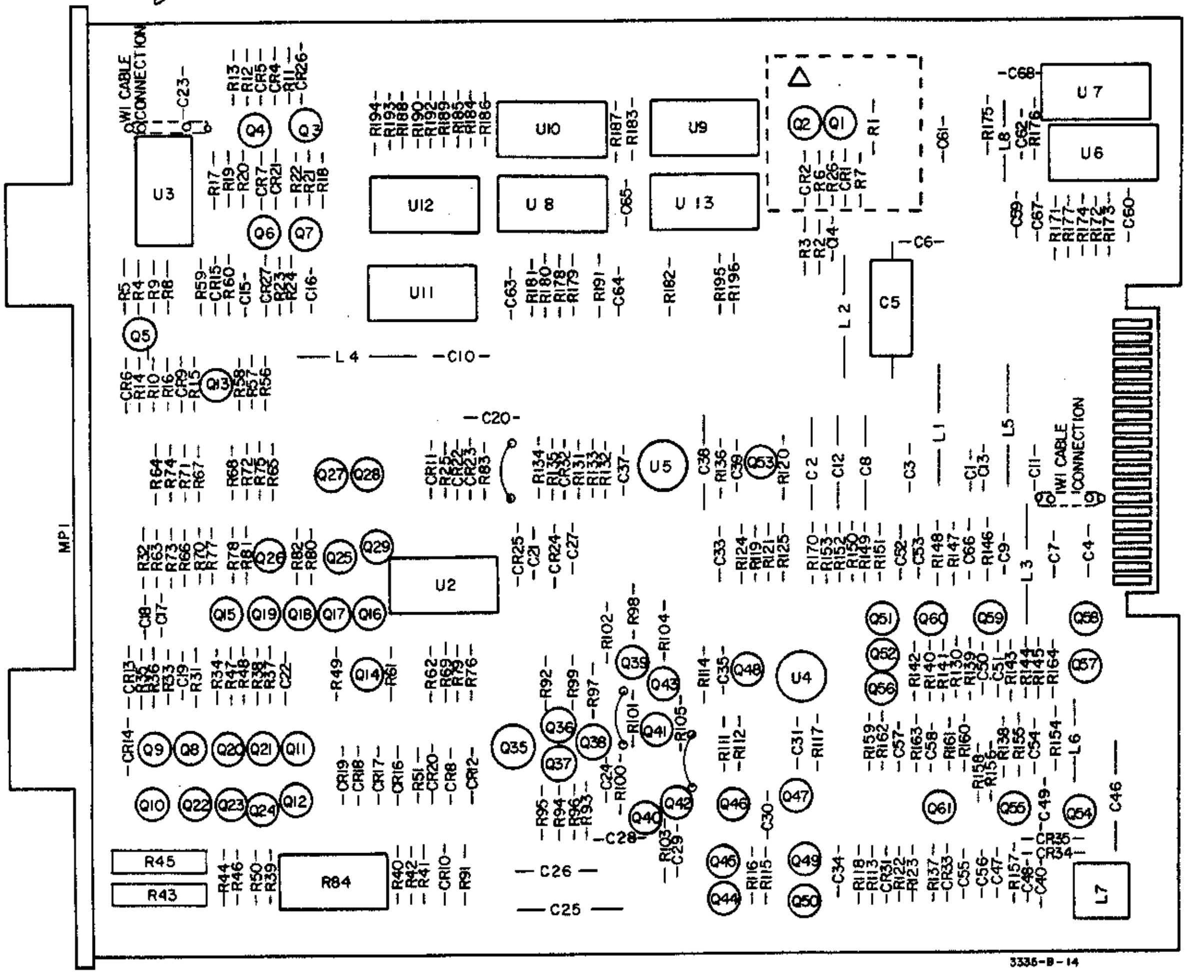


3335-E-40

J

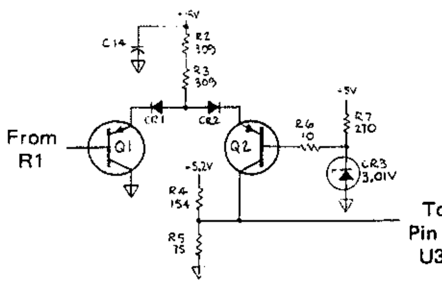
Figure 8-J-3. Schematic Diagram, Fractional-N Digital (03335-66503) A4.

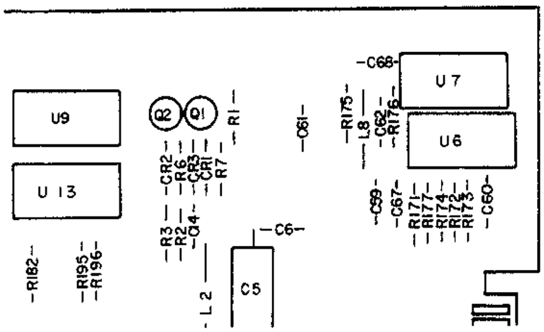
Fig 8-5-4
Sht 1 of 5



A5
-hp- Part No. 03335-66504

Δ For Serial Numbers 1640A00300 and lower.





Ref. Des.	-hp- Part Number	Description	Mfr. Code	Mis. Part Numbers
R7	0683-2715	Res 270 52 .23 W FC TC = -400/1600	01121	CB 2715
CR3	1902-3030	Diode-Znr 3.01 V 5% D0-7 PO=.4W TC= - .067%	04713	SZ 10959-52

Fig 8-5-4
Sht 2 of 5

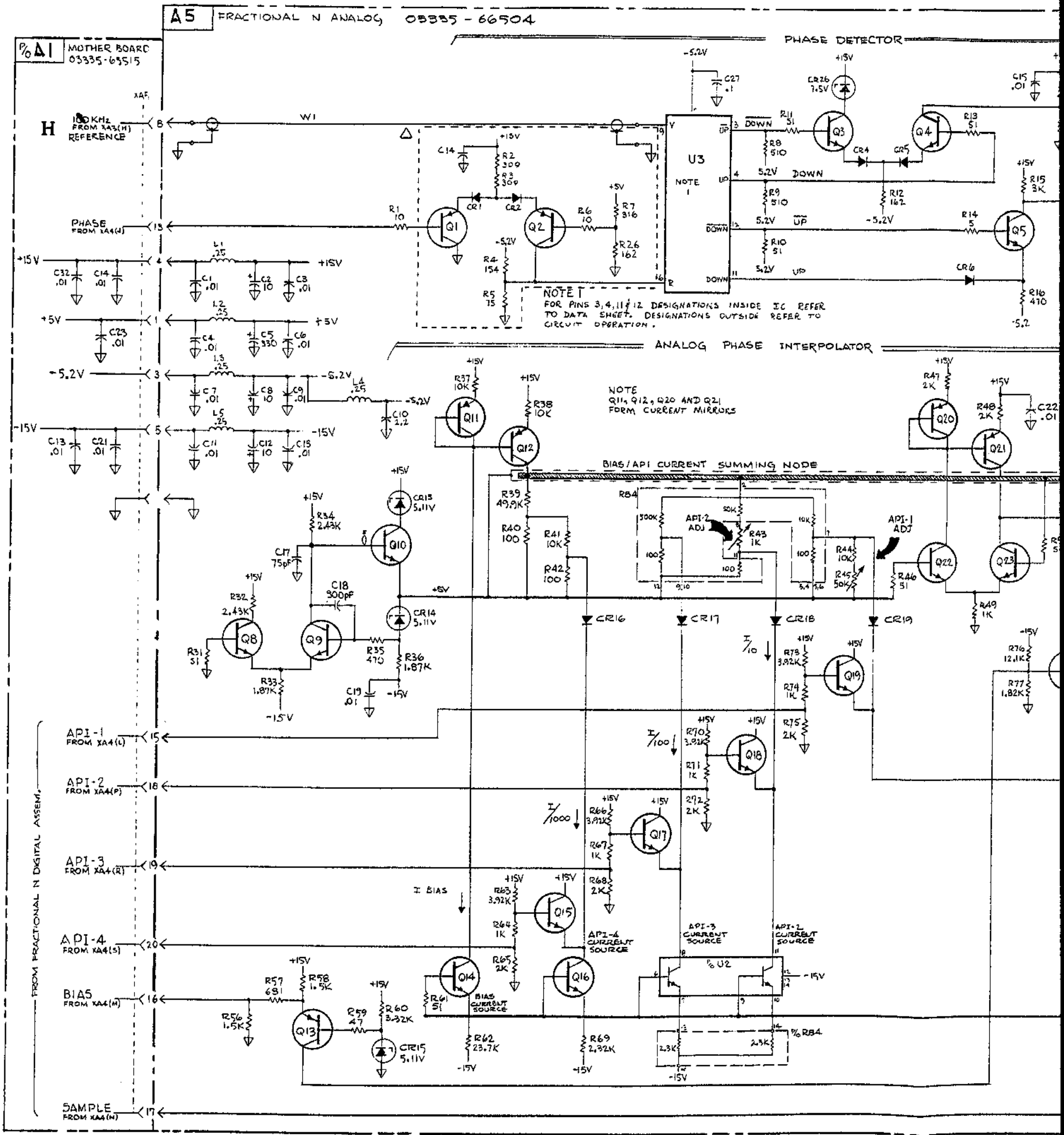


Fig 8-5-4
Sht 3 of 5

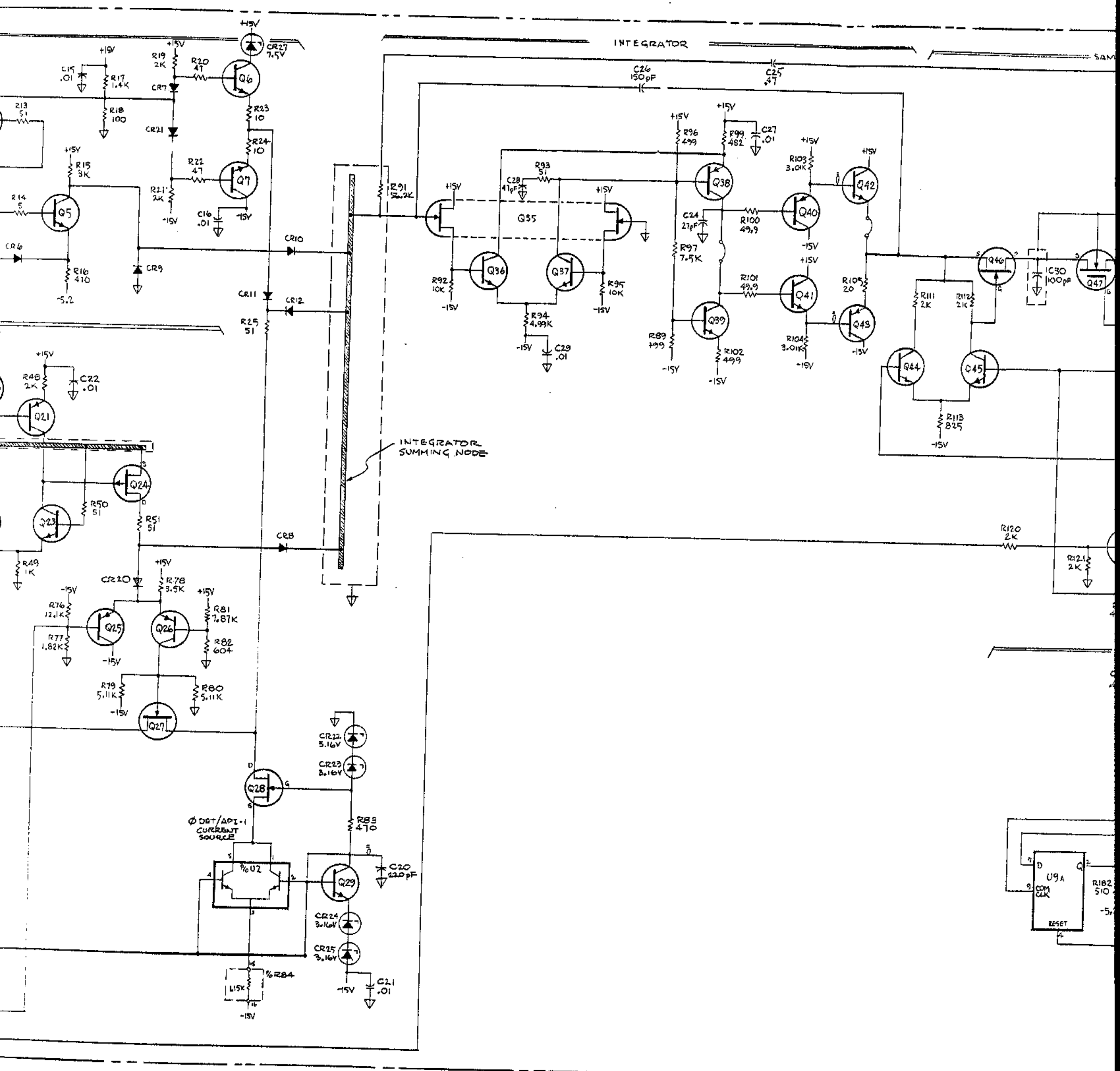
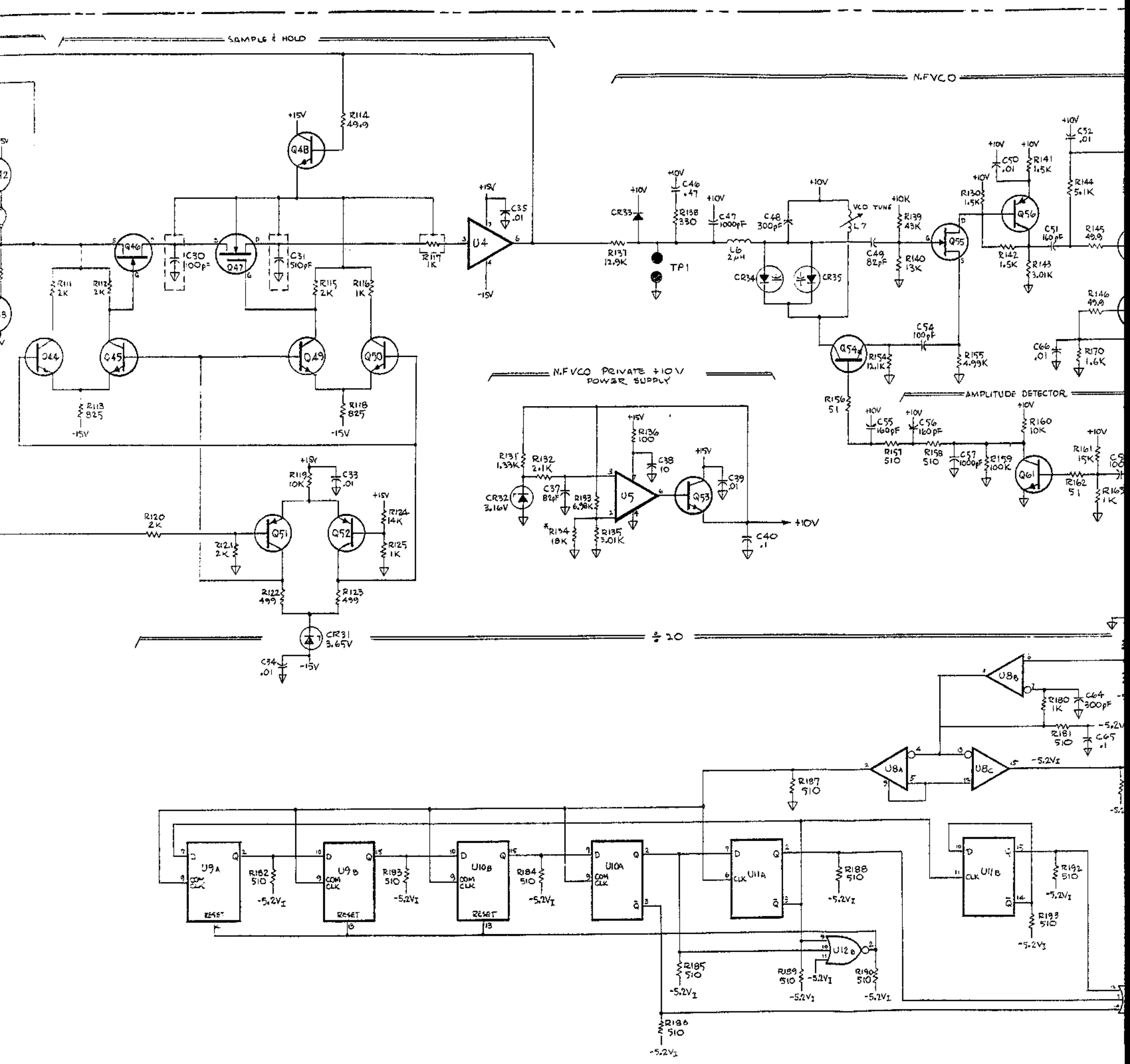
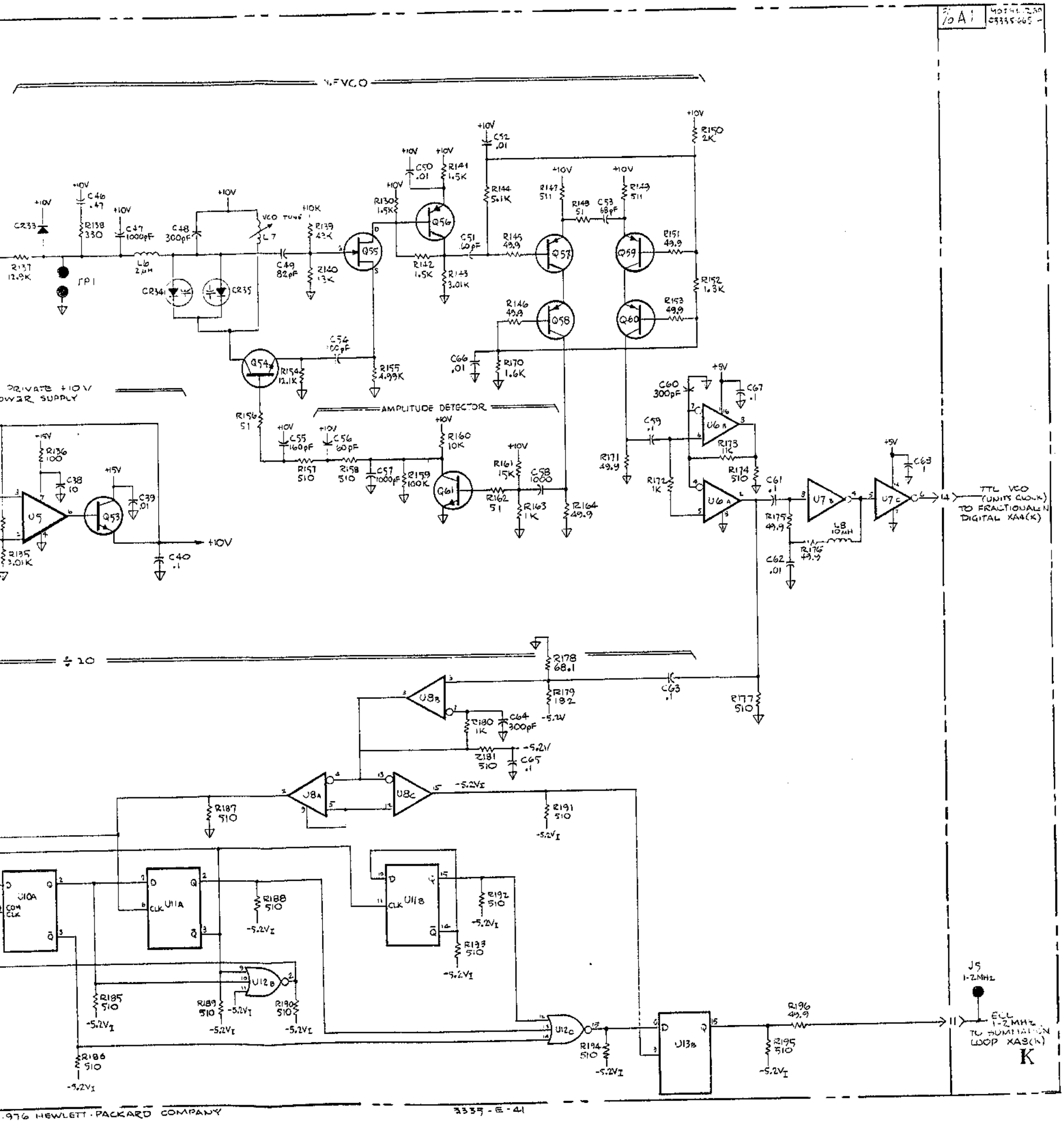


Fig 8-5-4
Sht 4 of 5



3335-E-41

Fig 8-J-4
Sht 5 of 5



J

Figure 8-J-4. Schematic Diagram, Fractional-N Analog (03335-66504) A5.

Fig 8-J-5
Sht 1 of 4

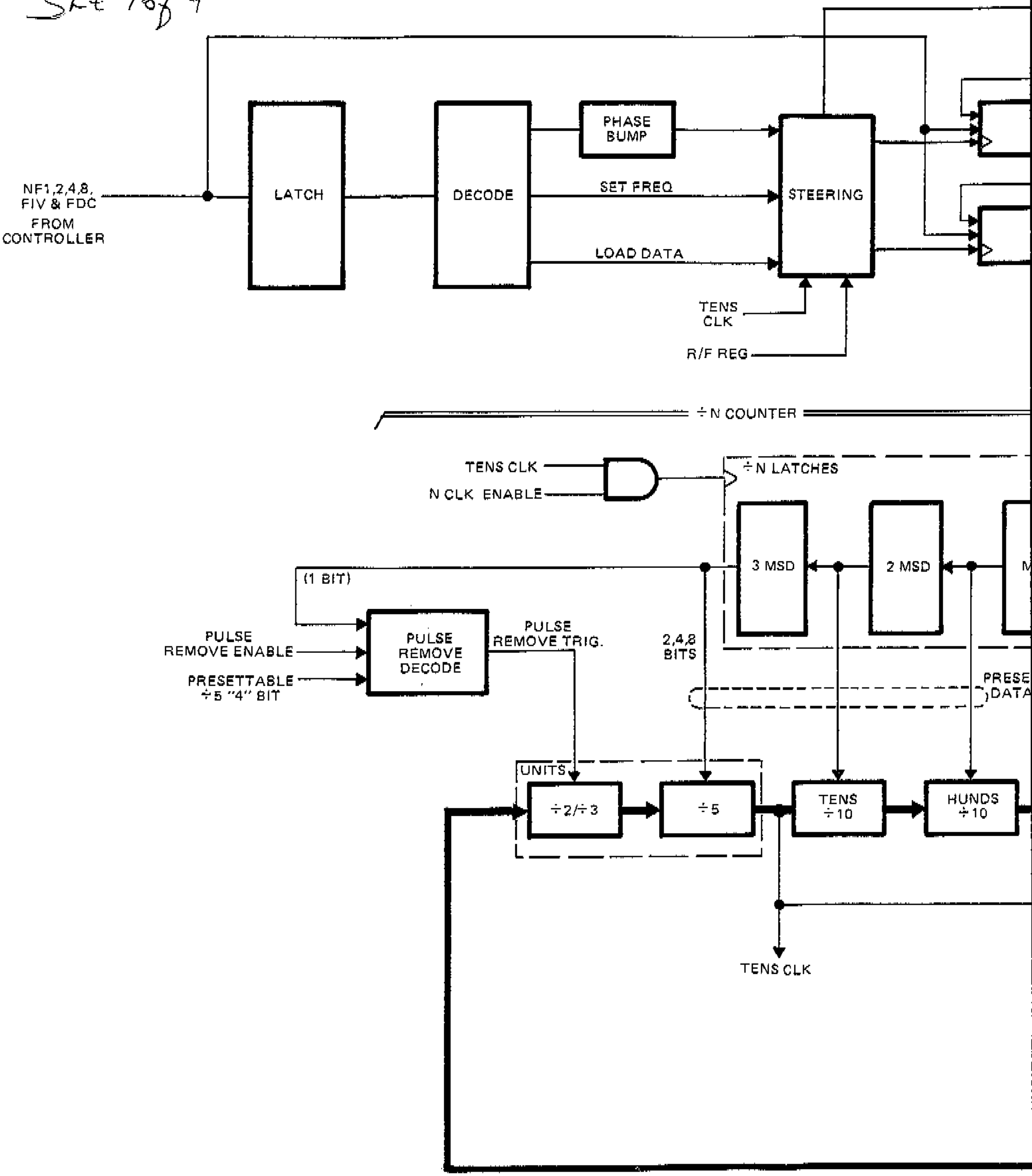


Fig 8-3-5

Sht 2 of 4

FRACTIONAL –N DI

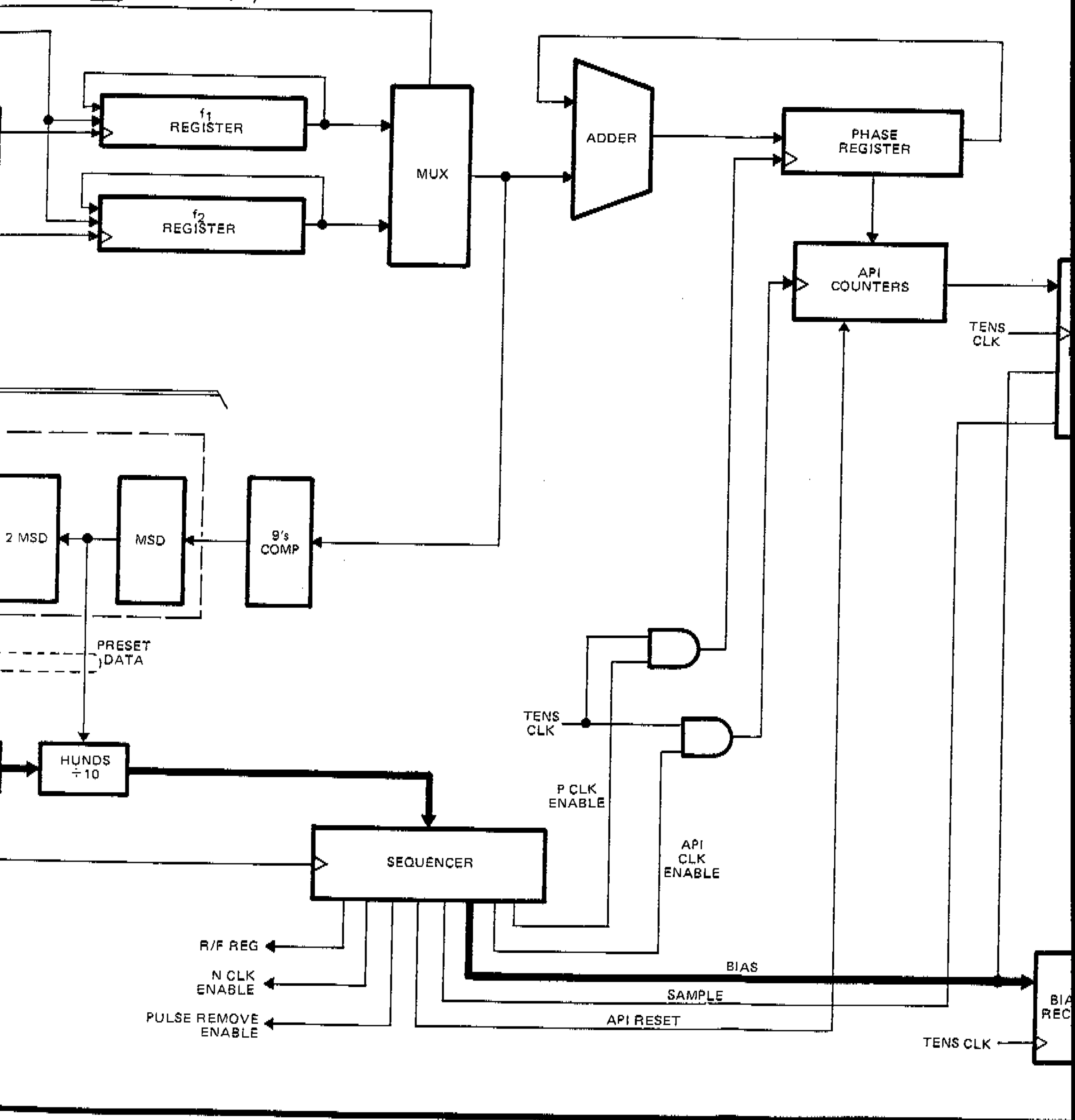


Fig 8 5-5 Sht 3 of 4

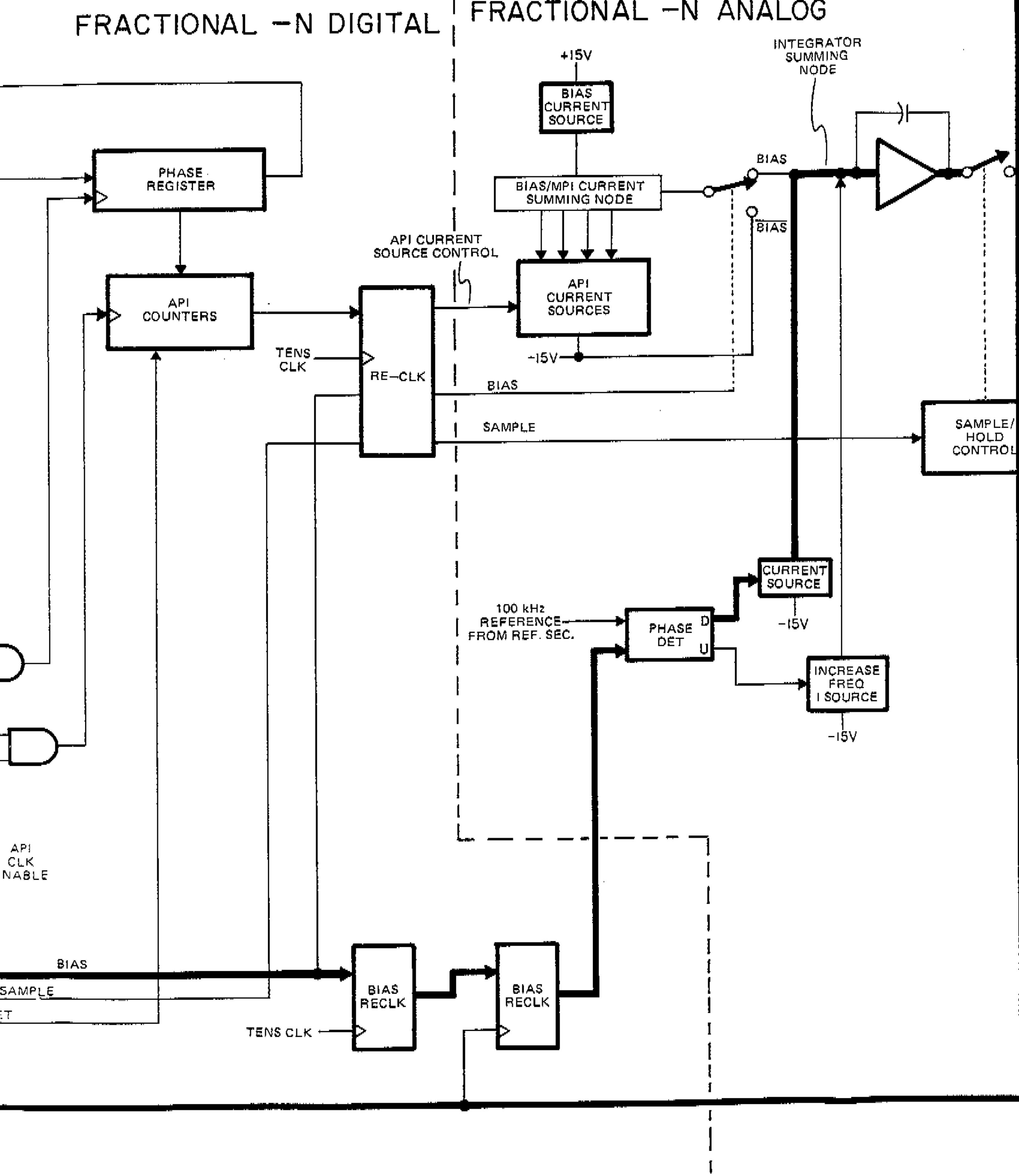


Fig 8-5-5
Sht 4 of 4

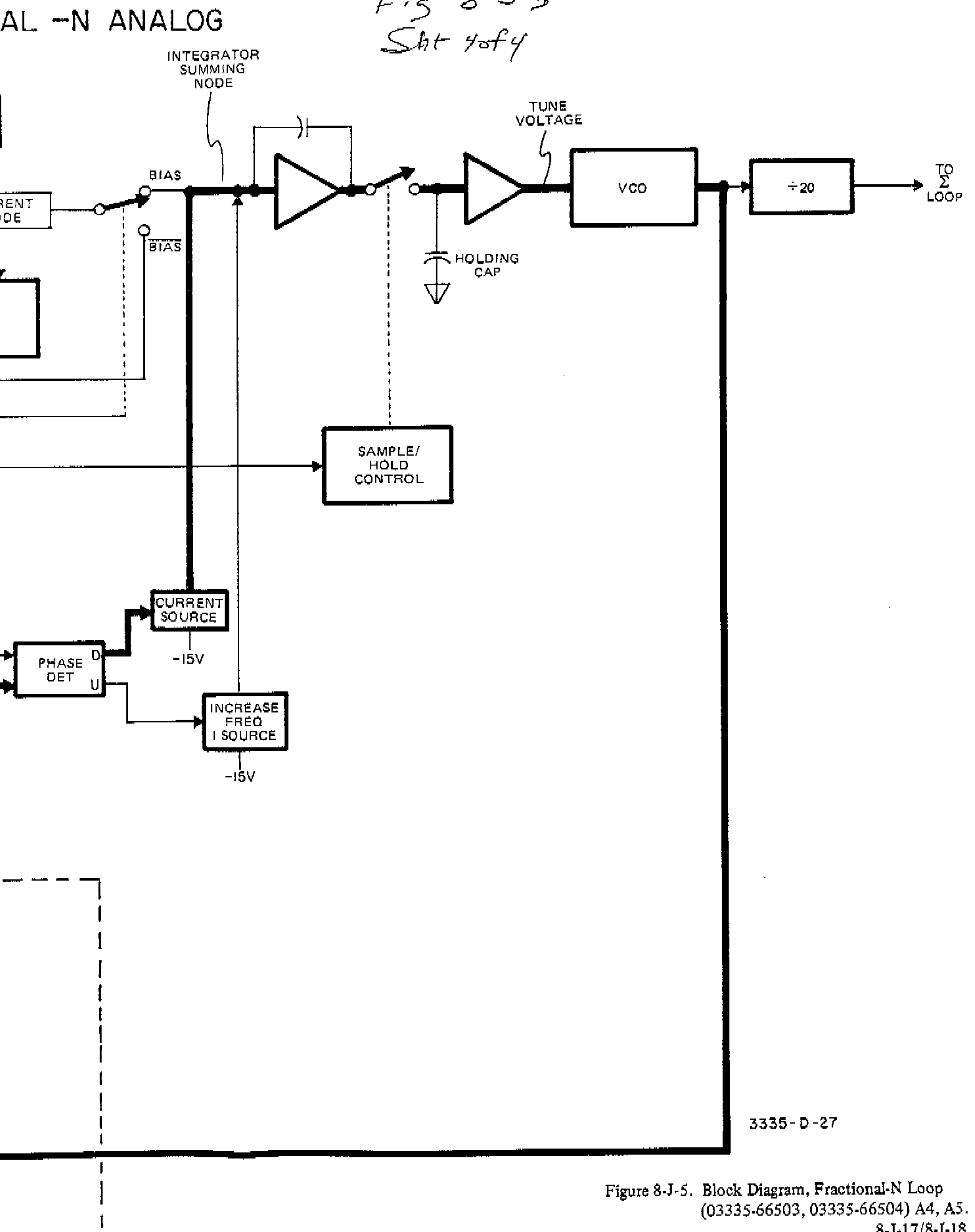


Figure 8-J-5. Block Diagram, Fractional-N Loop (03335-66503, 03335-66504) A4, A5.

SERVICE GROUP K

SUMMATION LOOP

ADJUSTMENTS

Designation	Adjustment Title	Paragraph
A8L15	(VCO TANK)	5-20
A8L16	(VCO TANK)	5-20
A8R76	FLATNESS ADJ	5-20

The Summation Loop service group provide information to aid in troubleshooting the Summation Loop assembly (A8, 03335-66502) to the component level. It is assumed that the 39–79 MHz from the N Step Loop has been verified and the 1-2 MHz from the N.F Loop has been verified. With these two inputs verified, it is assumed the 40–80 MHz Summation Loop output was not present or is not the correct frequency at the module Mother Board, A1, test point to require service of the Summation Loop.

NOTE

When placing the A8 assembly on an extender, the extender containing the rf connectors must be used.

Symptom	Service Action	Notes
No VCO output (no signal at A8TP4).	A. Disconnect the jumper TP3 from the side labeled B and connect ground to Side A. If an approximate 60 MHz signal is not present at A8TP4, then the probable cause is A8Q11, Q13 or Q14. Troubleshoot by using voltages shown on schematic.	Disconnecting the jumper at TP3 and grounding point A opens the loop and reduces the effect of the faulty circuits on the good circuits.
	B. If there is no signal at the emitter of A8Q13, the probable cause is a defective A8Q11.	The circuitry on this board is very similar to the circuitry on the N Step Loop board (Service Group I). This allows comparisons between measurements made on working and faulty circuits.
VCO signal is present at the 40–80 MHz test point on A1 but is not of correct frequency to generate the programmed output. (i.e., program 40 MHz, the 40–80 MHz test point should be 40 MHz.	A. VERIFY VCO OPERATION: Ground A8TP3 at Side A with Side B disconnected. Verify at TP4 the VCO operates at approximately 60 MHz. Leave Side A connected to ground for the remaining steps. B. VERIFY ISOLATION BUFFER OPERATION: Check that the VCO signal appears at TP5, TP6 and TP7. C. VERIFY RATE DETECTOR OPERATION: The Summation Loop VCO must always be operating faster than the N Step Loop VCO. When this is true, A8TP9 is an ECL low ($\approx$ - 1.6 V), if false TP9 is an ECL high ($\approx$ - 0.8 V). The Summation Loop VCO is fixed at $\approx$ 60 MHz, operating the N Step Loop VCO above and below will cause TP9 to change states. Program 40 MHz; A8TP9 should be an ECL low. Program 80 MHz; A8TP9 should be an ECL high.	

Symptom	Service Action	Notes
	If the levels at TP9 are correct, the rate detector functions properly and Steps D and E can be omitted. D. CHECK PHASE DETECTOR UNIT, U6. Program 40 MHz, U6 Pin 11 changes states between an ECL high and ECL low while Pin 4 remains at an ECL low. Program 80 MHz, U6 Pin 11 remains an ECL low while Pin 4 changes states between an ECL high and ECL low. E. CHECK FIRST STAGE OF U7. Output Freq. / U7 Pin 2 Logic Level: 40 MHz — ECL low 80 MHz — ECL high F. VERIFY MIXER AND GAIN STAGE OPERATION: The LPF is a 6 MHz low pass filter. The output of the N Step Loop (39–79 MHz) must be within 6 MHz of the Summation Loop VCO for a signal to appear at A8TP8. Program 60 MHz and FREQ INCR of 1 MHz. Step frequency about 60 MHz to obtain a signal at TP8 if not present when 60 MHz was programmed. If a signal at TP8 cannot be obtained and both the Summation Loop VCO and 39–79 MHz signals have been verified, isolate the fault to the gain stage, filter or mixer. G. VERIFY SCHMITT TRIGGER OPERATION: If a signal is present at A8TP8, verify ECL levels at U4 Pins 2 and 3 which change state at the rate of the TP8 signal. H. VERIFY PEAK DETECTOR OPERATION: With a signal verified at U4 Pins 2 and 3, A8TP10 should be an ECL low. Program 20 MHz. The signal at TP8 no longer exists and TP10 is an ECL high. I. VERIFY PHASE DETECTOR UNIT, U5, OPERATION: Remove ground from Side A of TP3 and install jumper between A and B. U5 Pin 3 (U) should be low-going pulses changing states between ECL high and low. U5 Pin 11 (D) should be an ECL low. J. VERIFY OR/NOR GATES (U8 & U9) OPERATION: Verify an ECL low at TP9 and TP10. This enables gates U8 and U9 to pass signals to TP1 and TP2. At TP1 there should be high-going pulses between ECL low and high levels. At TP2 there should be low-going pulses between ECL high and low levels. K. VERIFY CURRENT SOURCE OPERATION. Verify ECL pulses at TP1 and TP2 (high-going at TP1, low-going at TP2). Measure the differential voltage across A8R26 and R57. The voltage across each resistor should be 1.3 V ± 0.3 V. This verifies that the current sources are operating within the required current range. If the current sources check good, verify that the signals at TP1 and TP2 appear at the base of Q6 and Q4 respectively. Verify that the inverse of signals at TP1 and TP2 appear at the base of Q7 and Q5 respectively. Verify that an inversion of the signal at the base of Q4, Q5, Q6 and Q7 appears at the base of Q2, Q3, Q8 and Q9 respectively. Monitor A8TP3 with a DVM. Program 40 MHz, TP3 should be approximately + 8.5 V. Program 80 MHz, TP3 should be approximately - 8.5 V.	

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A8	03335-66532	1	P.C. ASSEMBLY, SUMMATION LOOP (DOES NOT INCLUDE SCREW-ON SHIELDS, SEE MECHANICAL PARTS LIST—MP42 THROUGH MP49)	28480	03335-66532
A8C1, C2	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A8C3	0180-1861		CAPACITOR-FXD 27UF+-10% 10VDC TA	56289	150D276X9010B2
A8C4	0180-1861		CAPACITOR-FXD 27UF+-10% 10VDC TA	56289	150D276X9010B2
A8C5	0160-2220	4	CAPACITOR-FXD 1200PF +-5% 300WVDC MICA	28480	0160-2220
A8C6	0160-2220		CAPACITOR-FXD 1200PF +-5% 300WVDC MICA	28480	0160-2220
A8C7	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C8	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C9	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C10	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C11	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A8C12	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C13	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C14	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C15	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C19, C20	0140-0149	2	CAPACITOR—FXD 470PF +—5% 300WVDC MICA	72136	DM15F471J0300WV1CR
A8C21	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C22	0160-0155	1	CAPACITOR-FXD 3300PF +-10% 200WVDC POLYE	56289	292P33292
A8C23	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C24	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C25	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C26	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C27	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C28	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C29	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C30	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C31	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C32	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A8C33	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A8C41	0160-2220		CAPACITOR-FXD 1200PF +-5% 300WVDC MICA	28480	0160-2220
A8C42	0160-0939		CAPACITOR-FXD 430PF +-5% 300WVDC MICA	28480	0160-0939
A8C43	0160-2222	1	CAPACITOR-FXD 1500PF +-5% 300WVDC MICA	28480	0160-2222
A8C44	0160-0945		CAPACITOR-FXD 910PF +-5% 100WVDC MICA	28480	0160-0945
A8C45	0160-3405	1	CAPACITOR-FXD 2UF +-10% 50WVDC MET POLYC	28480	0160-3405
A8C46	0150-0050		CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A8C47	0160-0127		CAPACITOR-FXD 1UF +-20% 25WVDC CER	28480	0160-0127
A8C48	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A8C49	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A8C50	0140-0220	3	CAPACITOR-FXD 200PF +-1% 300WVDC MICA	72136	DM15F201F0300WV1CR
A8C51	0160-2198		CAPACITOR-FXD 20PF +-5% 300WVDC MICA	28480	0160-2198
A8C52	0160-2203		CAPACITOR-FXD 91PF +-5% 300WVDC MICA	28480	0160-2203
A8C53	0160-2204		CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A8C54	0160-0127		CAPACITOR-FXD 1UF +-20% 25WVDC CER	28480	0160-0127
A8C55	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A8C56	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A8C57	0150-0050		CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A8C58	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C59	0180-1861		CAPACITOR-FXD 27UF+-10% 10VDC TA	56289	150D276X9010B2
A8C60	0160-0127		CAPACITOR-FXD 1UF +-20% 25WVDC CER	28480	0160-0127
A8C66	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C67	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C68	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C69	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C70	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C71	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C72	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C73	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C74	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C75	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C76	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C77	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C78	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C79	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8C80	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A8CR1	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A8CR2	1901-0347		DIODE-SCHOTTKY 8V	28480	1901-0347
A8CR4	1902-3002		DIODE-ZNR 2.37V 5% DO-7 PD=.4W TC=-.074%	15818	CD 35526
A8CR6	1902-3002		DIODE-ZNR 2.37V 5% DO-7 PD=.4W TC=-.074%	15818	CD 35526
A8CR7	1902-3085		DIODE-ZNR 4.75V 5% DO-7 PD=.4W TC=-.019%	15818	CD 35613
A8CR8	1902-3085		DIODE-ZNR 4.75V 5% DO-7 PD=.4W TC=-.019%	15818	CD 35613
A8CR9	0122-0089	4	DIODE-VVC 29PF 10% C3/C25-MIN=5 BVR=30V	04713	MV109
A8CR10	0122-0089		DIODE-VVC 29PF 10% C3/C25-MIN=5 BVR=30V	04713	MV109
A8CR11	1902-3085		DIODE-ZNR 4.75V 5% DO-7 PD=.4W TC=-.019%	15818	CD 35613
A8CR12	1902-3085		DIODE-ZNR 4.75V 5% DO-7 PD=.4W TC=-.019%	15818	CD 35613
A8CR13	1902-3085		DIODE-ZNR 4.75V 5% DO-7 PD=.4W TC=-.019%	15818	CD 35613
A8CR14	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A8CR15	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A8CR16	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040

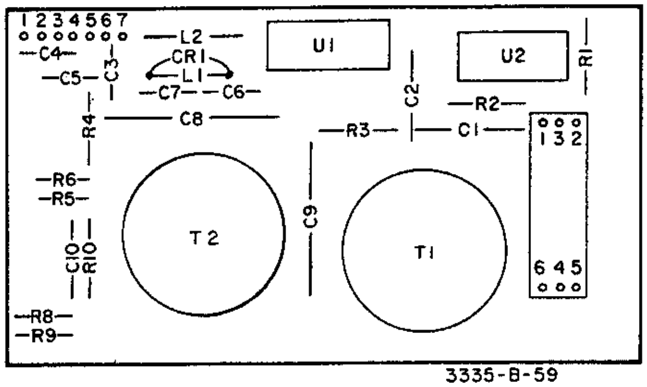
Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A8FL1	9135-0002	5	FILTER-LP SOLDER-TERMS	28480	9135-0002
A8FL2	9135-0002		FILTER-LP SOLDER-TERMS	28480	9135-0002
A8FL3	9135-0002		FILTER-LP SOLDER-TERMS	28480	9135-0002
A8FL4	9135-0002		FILTER-LP SOLDER-TERMS	28480	9135-0002
A8FL5	9135-0002		FILTER-LP SOLDER-TERMS	28480	9135-0002
A8L1	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A8L2	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A8L3	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A8L4	9100-3345		COIL-MLD 2UH 5% .155DX.375LG	24226	9406
A8L11	9140-0238	1	COIL-MLD 82UH 5% Q=50 .155DX.375LG	24226	15/822
A8L12	9100-1635	1	COIL-MLD 91UH 5% Q=50 .155DX.375LG	28480	9100-1635
A8L13	9100-1622	2	COIL-MLD 24UH 5% Q=60 .155DX.375LG	24226	15/242
A8L14	9140-0183		COIL-MLD 20UH 10% Q=80 .156DX.375LG	06560	4445-6K
A8L15	9100-0699	2	COIL	28480	9100-0699
A8L16	9100-0700	2	COIL	28480	9100-0700
A8L17	9140-0183		COIL-MLD 20UH 10% Q=80 .156DX.375LG	06560	4445-6K
A8L18	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A8L19	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A8L20	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A8L21	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A8L22	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A8L23	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A8L24	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A8L25	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A8L26	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A8L27	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A8L28	9170-0894		CORE-SHIELDING BEAD	02114	56-590-65/4A6
A8MP1	03335-61202	1	EXTRUSION ASSEMBLY	28480	03335-61202
A8MP2	8160-0265	2	P.C. SHIELD	28480	8160-0265
A8MP3	8160-0258	1	P.C. SHIELD	28480	8160-0258
A8MP4	8160-0259	2	P.C. SHIELD	28480	8160-0259
A8MP5	8160-0263	1	P.C. SHIELD	28480	8160-0263
A8MP6	8160-0262	2	P.C. SHIELD	28480	8160-0262
A8MP7	8160-0299	2	P.C. SHIELD	28480	8160-0299
A8Q1	1853-0018		TRANSISTOR PNP SI TO-72 PD=200MW FT=1GHZ	28480	1853-0018
A8Q2	1853-0036	4	TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A8Q3	1853-0036		TRANSISTOR PNP SI PD=310MW FT=250MHZ	28480	1853-0036
A8Q4	1854-0220	4	TRANSISTOR NPN 2N3959 SI TO-18 PD=400MW	04713	2N3959
A8Q5	1854-0220		TRANSISTOR NPN 2N3959 SI TO-18 PD=400MW	04713	2N3959
A8Q6	1853-0018		TRANSISTOR PNP SI TO-72 PD=200MW FT=1GHZ	28480	1853-0018
A8Q7	1853-0018		TRANSISTOR PNP SI TO-72 PD=200MW FT=1GHZ	28480	1853-0018
A8Q8	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A8Q9	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A8Q10	1854-0354	2	TRANSISTOR NPN SI TO-52 PD=360MW	28480	1854-0354
A8Q11	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A8Q12	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A8Q13	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A8Q14	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A8Q15	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A8Q16	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A8Q17	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A8Q18	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A8Q19	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A8Q20	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A8Q21	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A8Q22	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A8Q23	1854-0233		TRANSISTOR NPN 2N3866 SI TO-39 PD=1W	02735	2N3866
A8Q24	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A8R1	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A8R2	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R3	0698-3279		RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A8R4	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A8R5	0757-0346	1	RESISTOR 10 1% .125W F TC=0+-100	03292	C4-1/8-T0-10R0-F
A8R6	0698-4125	1	RESISTOR 953 1% .125W F TC=0+-100	24546	C4-1/8-T0-953R-F
A8R7	1810-0167	2	NETWORK-RES 8-PIN-SIP .1-PIN-SPCG	28480	1810-0167
A8R8	1810-0142	4	NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0142
A8R9	0698-3498	1	RESISTOR 8.66K 1% .125W F TC=0+-100	24546	C4-1/8-T0-866R-F
A8R10	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A8R11	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A8R12	1810-0142		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0142
A8R13	1810-0142		NETWORK-RES 9-PIN-SIP .15-PIN-SPCG	28480	1810-0142
A8R14	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A8R15	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R16	0757-0200	1	RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A8R17	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A8R18	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A8R19	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A8R20	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A8R21	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	16299	C4-1/8-T0-499R-F

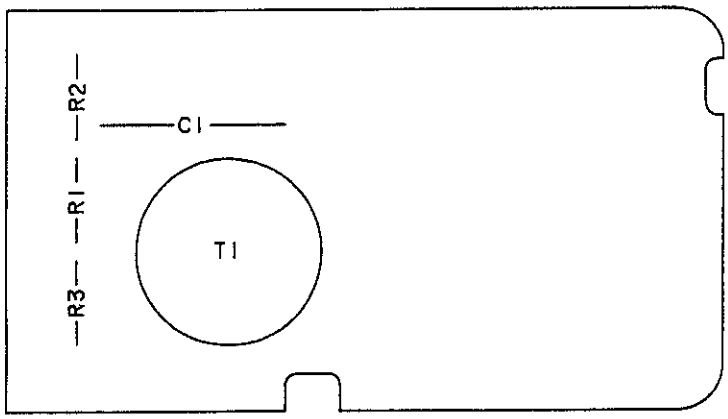
Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A8R20	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A8R21	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	16299	C4-1/8-T0-499R-F
A8R26	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A8R27	0757-0386	18	RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A8R28	0698-4423	6	RESISTOR 1.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1371-F
A8R29	0757-0411	11	RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-T0-332R-F
A8R30	0698-4396	8	RESISTOR 80.6 1% .125W F TC=0+-100	24546	C4-1/8-T0-80R6-F
A8R31	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A8R32	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R33	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R34	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R35	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A8R36	0698-4396		RESISTOR 80.6 1% .125W F TC=0+-100	24546	C4-1/8-T0-80R6-F
A8R37	0698-4382	8	RESISTOR 52.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-52R3-F
A8R38	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R39	0698-4423		RESISTOR 1.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1371-F
A8R40	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R41	0698-4382		RESISTOR 52.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-52R3-F
A8R42	0698-4427	2	RESISTOR 1.65K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1651-F
A8R43	0698-4382		RESISTOR 52.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-52R3-F
A8R44	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R45	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R46	0698-4382		RESISTOR 52.3 1% .125W F TC=0+-100	24546	C4-1/8-T0-52R3-F
A8R47	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R48	0698-4396		RESISTOR 80.6 1% .125W F TC=0+-100	24546	C4-1/8-T0-80R6-F
A8R49	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A8R50	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R51	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R52	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A8R53	0698-4396		RESISTOR 80.6 1% .125W F TC=0+-100	24546	C4-1/8-T0-80R6-F
A8R54	0757-0411		RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-T0-332R-F
A8R55	0698-4423		RESISTOR 1.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1371-F
A8R56	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A8R57	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A8R66	0698-3443	1	RESISTOR 287 1% .125W F TC=0+-100	24546	C4-1/8-T0-287R-F
A8R67	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A8R68	0698-3259		RESISTOR 7.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7871-F
A8R69	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A8R70	0698-3558		RESISTOR 4.02K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4021-F
A8R71	0757-0123	2	RESISTOR 34.8K 1% .125W F TC=0+-100	24546	C4, T-0
A8R72	0698-4472	2	RESISTOR 7.68K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7681-F
A8R73	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A8R74	0698-3558		RESISTOR 4.02K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4021-F
A8R75	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A8R76	2100-3353		RESISTOR-TRMR 20K 10% C SIDE-ADJ 1-TRN	32997	3386X-Y46-203
A8R77	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A8R78	0757-0409	2	RESISTOR 274 1% .125W F TC=0+-100	24546	C4-1/8-T0-274R-F
A8R79	0757-0420	2	RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A8R80	0698-3518	2	RESISTOR 7.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7321-F
A8R81	0698-0063	2	RESISTOR 5.23K 1% .125W F TC=0+-100	91637	CMF-1/8-T1-5231-F
A8R82	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A8R83	0698-3511	2	RESISTOR 665 1% .125W F TC=0+-100	24546	C4-1/8-T0-665R-F
A8R84	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A8R85	0698-3122	2	RESISTOR 412 1% .125W F TC=0+-100	03888	PME55-1/8-T0-4120-F
A8R86	0757-0276	4	RESISTOR 61.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-6192-F
A8R91	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A8R92	0698-3512	6	RESISTOR 1.18K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1181-F
A8R93	0757-0424	7	RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A8R94	0757-0274		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1213-F
A8R95	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A8R96	0757-0411		RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-T0-332R-F
A8R97	0757-0381	6	RESISTOR 15 1% .125W F TC=0+-100	19701	MF4C1/8-T0-15R0-F
A8R98	0757-0383		RESISTOR 18.2 1% .125W F TC=0+-100	19701	MF4C1/8-T0-18R2-F
A8R99	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A8R100	0698-3512		RESISTOR 1.18K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1181-F
A8R101	0757-0424		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A8R102	0757-0274		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1213-F
A8R103	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A8R104	0757-0411		RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-T0-332R-F
A8R105	0757-0381		RESISTOR 15 1% .125W F TC=0+-100	19701	MF4C1/8-T0-15R0-F
A8R106	0757-0383		RESISTOR 18.2 1% .125W F TC=0+-100	19701	MF4C1/8-T0-18R2-F
A8R107	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A8R108	0698-3512		RESISTOR 1.18K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1181-F
A8R109	0757-0424		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A8R110	0757-0274		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1213-F
A8R111	0757-0386		RESISTOR 24.3 1% .125W F TC=0+-100	19701	MF4C1/8-T0-24R3-F
A8R112	0757-0411		RESISTOR 332 1% .125W F TC=0+-100	24546	C4-1/8-T0-332R-F
A8R113	0757-0381		RESISTOR 15 1% .125W F TC=0+-100	19701	MF4C1/8-T0-15R0-F

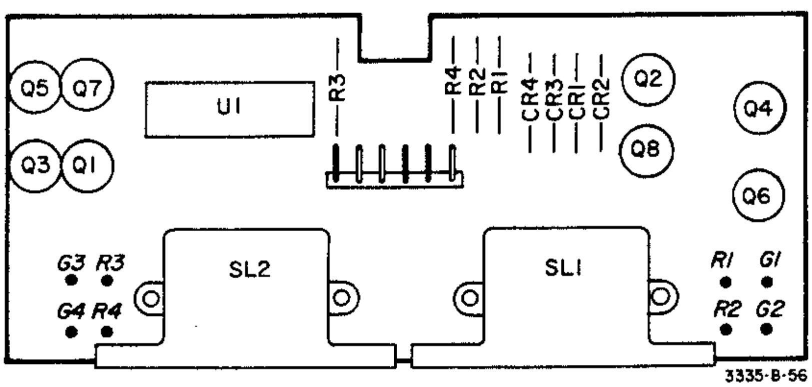
Fig 8-N-15
Sht 1 of 5



A19
-hp- Part No. 03335-66519

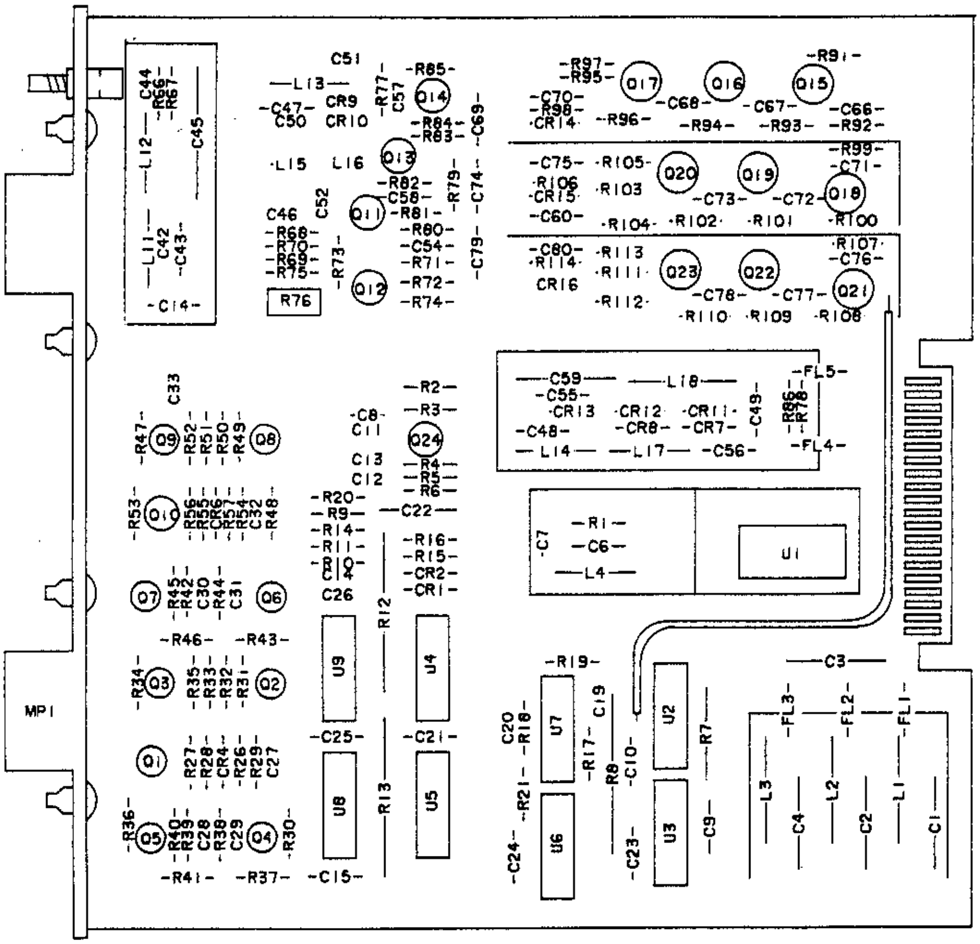


A20
-hp- Part No. 03335-66521



A25
-hp- Part No. 5060-9597

Fig 8-K-1
Sht 1 of 5



A8
-hp- Part No. 03335-66532

Fig 8-K-1
Sht 2 of 5

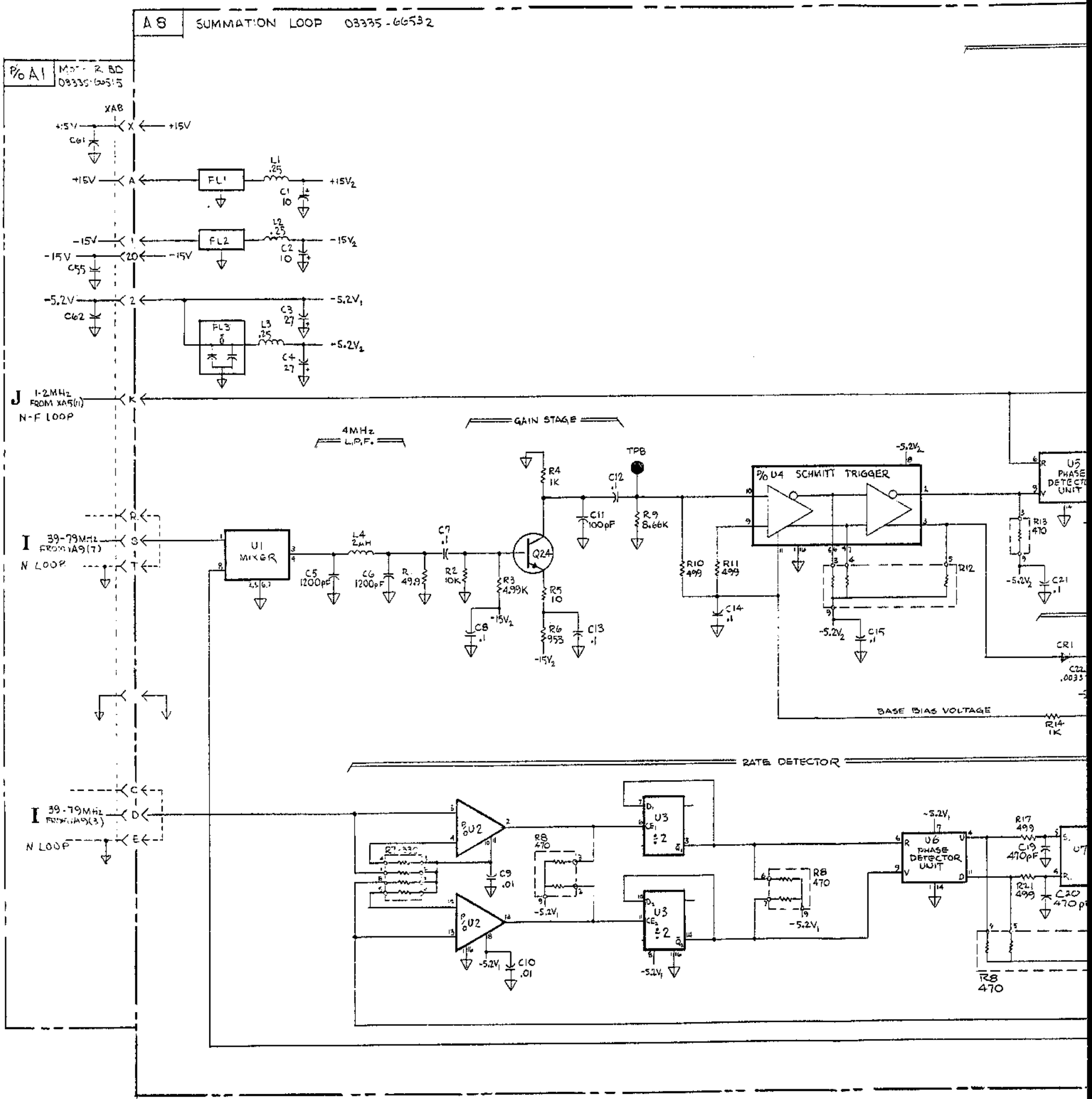


Fig 8-K-1

Sht 3 of 5

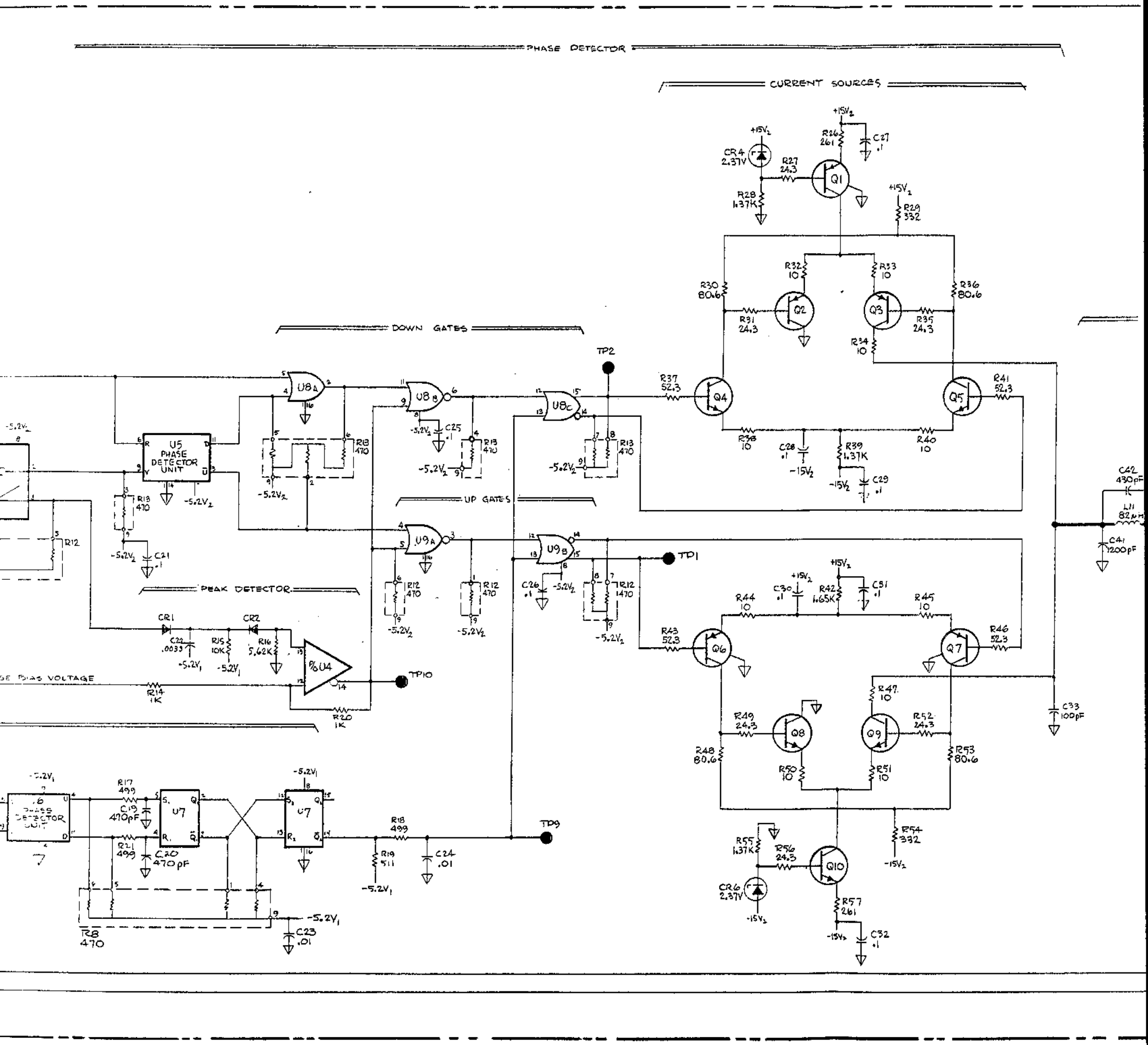
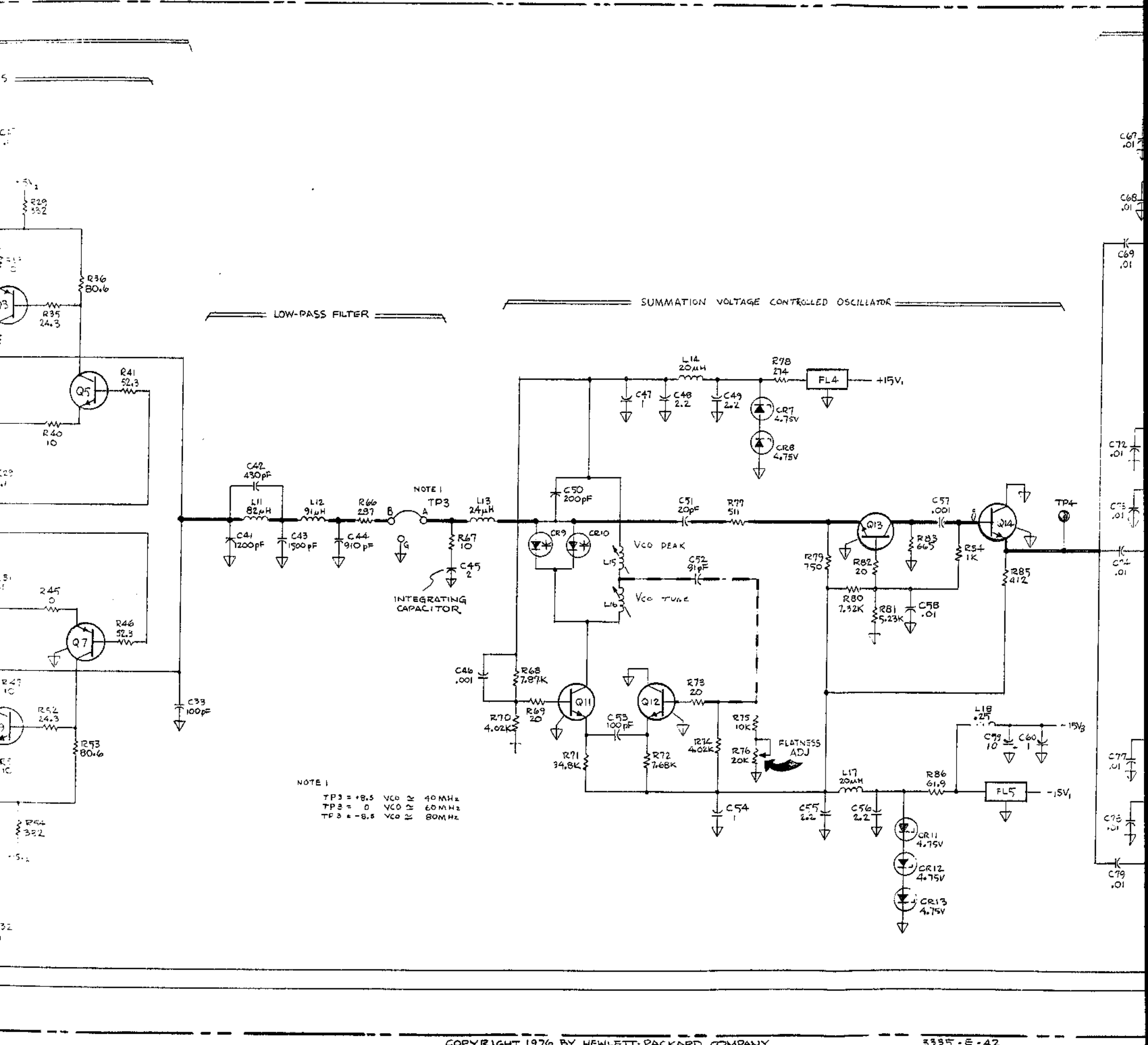


Fig 8-K-1
Sht 4 of 5



3335-E-42

Fig 8-K-1
Sht 5 of 5

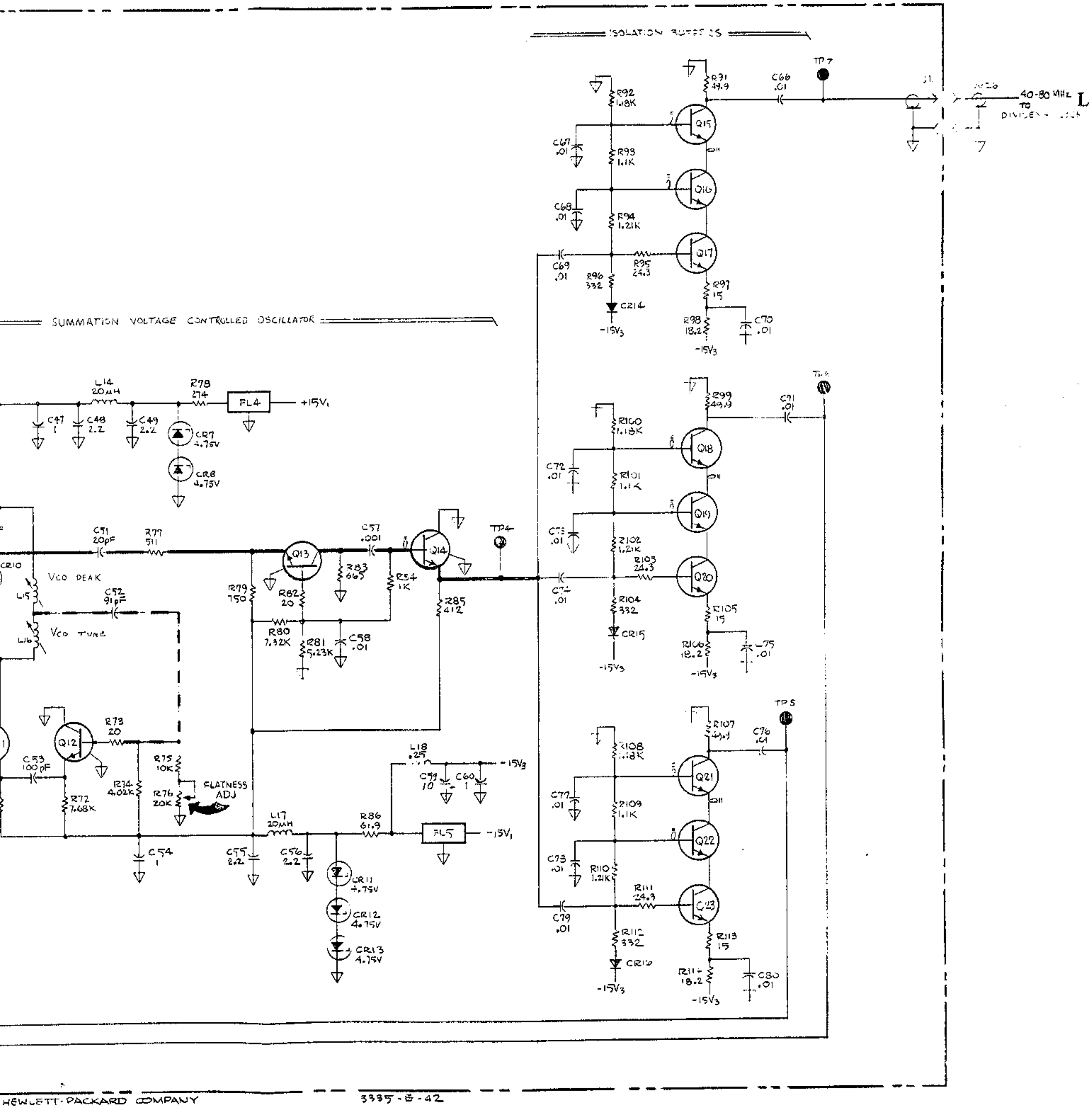
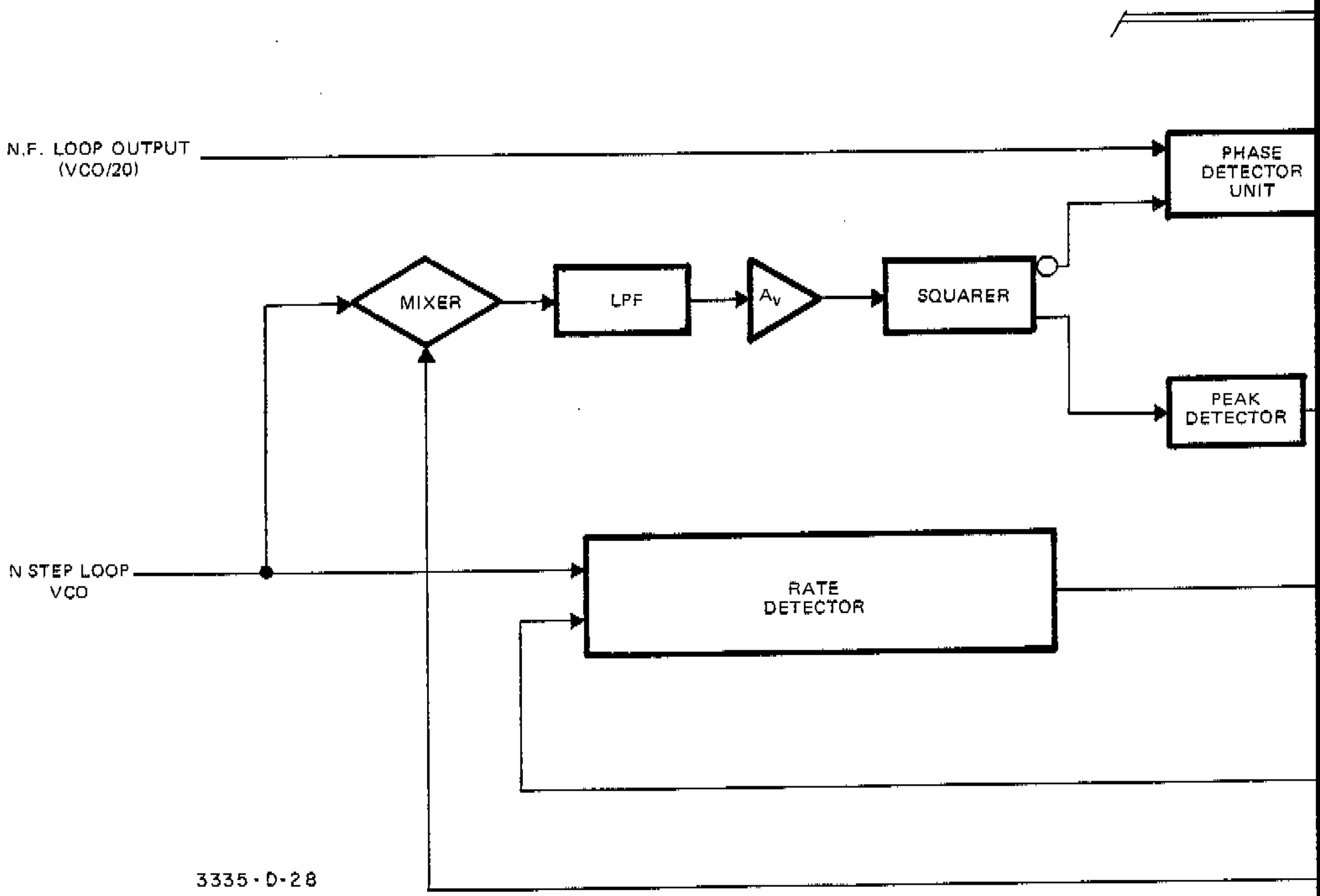


Figure 8-K-1. Schematic Diagram, Summation Loop (03335-66532) A8.

Fig 8-K-2
Sht 1 of 3



3335-D-28

Fig 8-K-2
Sht 2 of 3

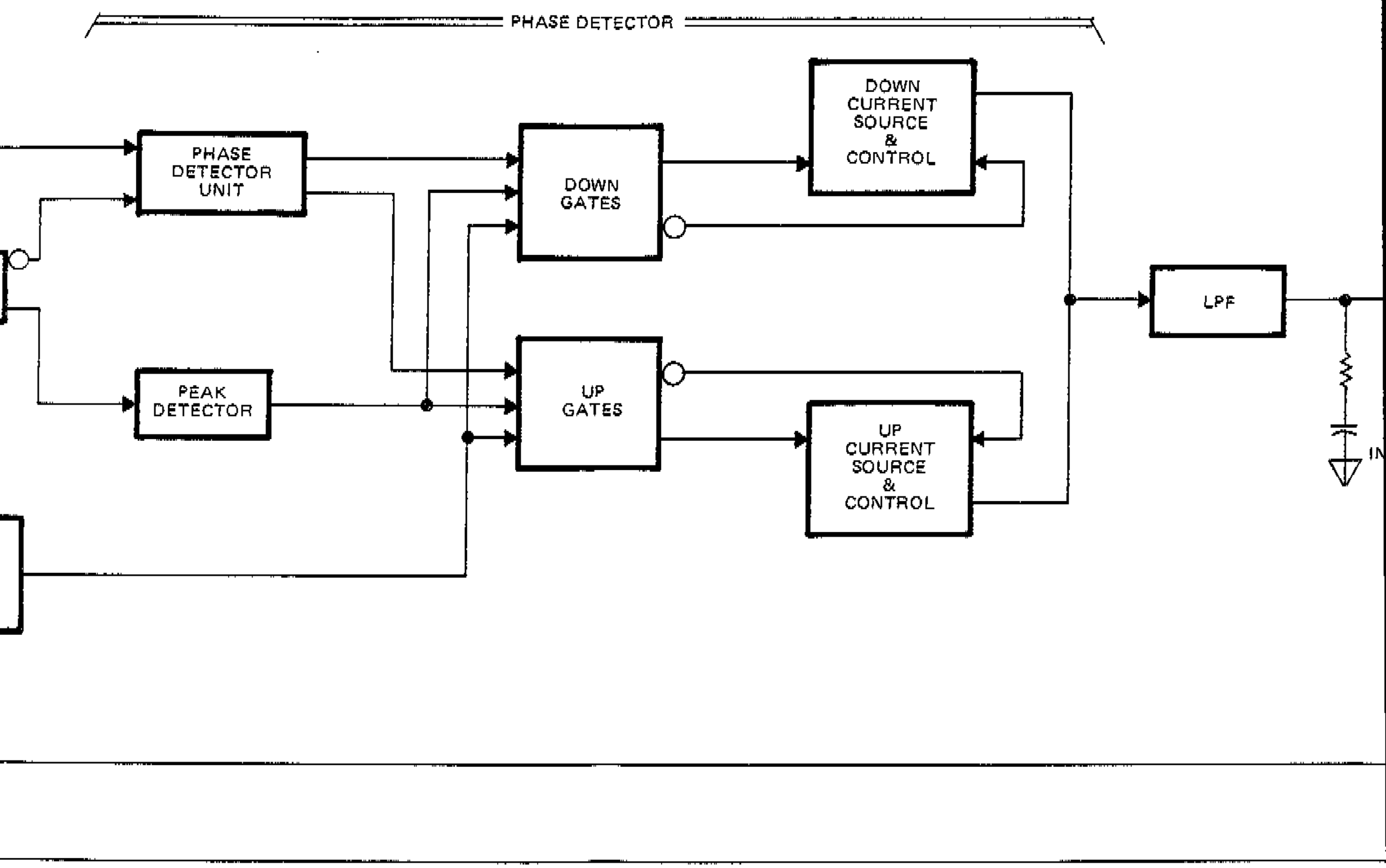


Fig 8-K-2
Sht 3 of 3

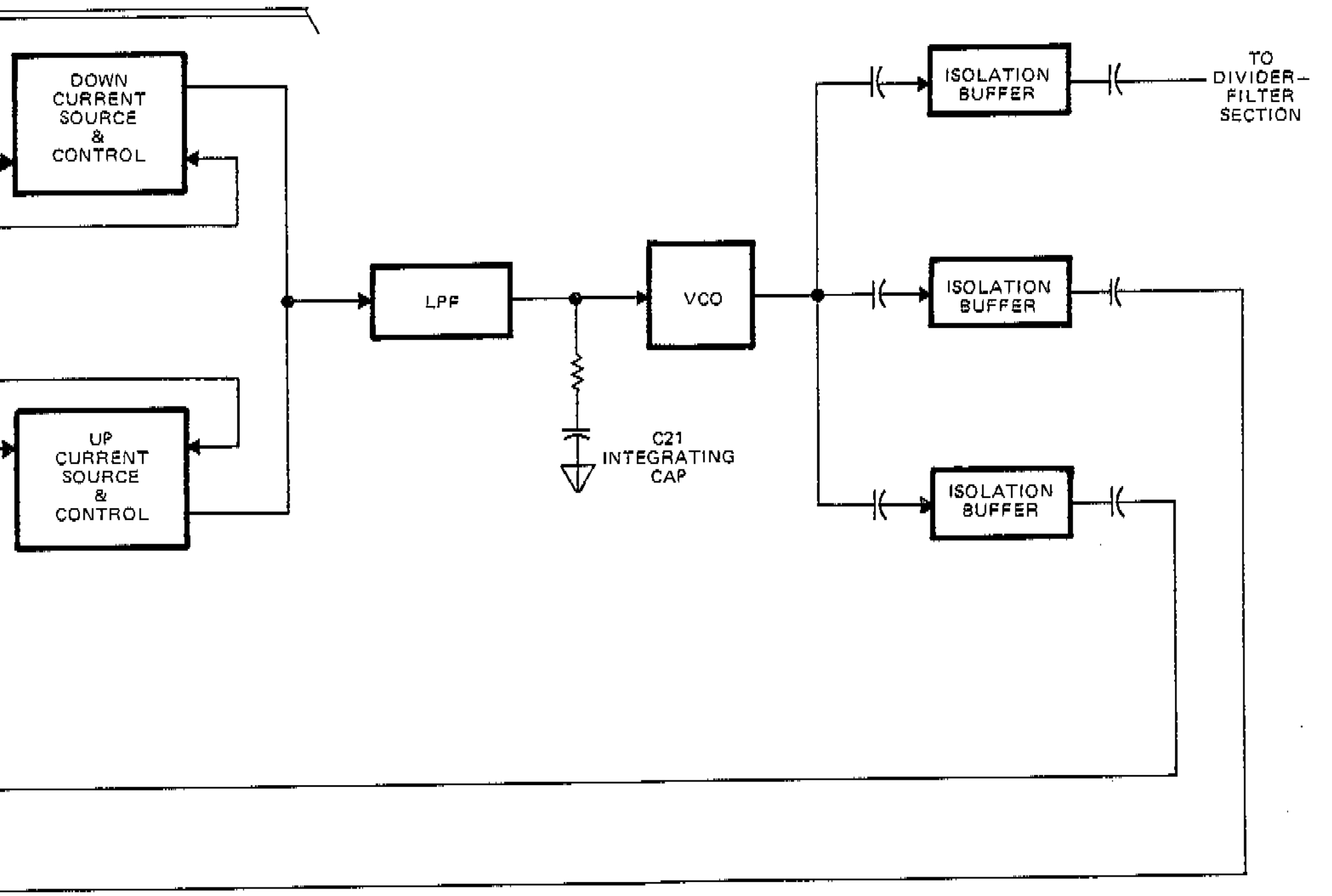


Figure 8-K-2. Block Diagram, Summation Loop (03335-66532) A8.

SERVICE GROUP L

DIVIDER–FILTER/MIXER

DIVIDER–FILTER ADJUSTMENTS

Designation	Adjustment Title	Paragraph
A2R37	MOD. LEVEL ADJ	5-30
A2L12–L14	56 MHz LPF	5-22
A2L16–L18	40 MHz LPF	5-22
A2L20–L22	28 MHz LPF	5-22
A2L24–L26	20 MHz LPF	5-22
A2L28–L30	14 MHz LPF	5-22
A2L37–L39	80 MHz LPF	5-22

MIXER ADJUSTMENTS

Designation	Adjustment Title	Paragraph
A7R24	MOD. LEVEL ADJ	5-30
A7R68	CARRIER BAL	5-24
A7R90	FLATNESS ADJ	5-26
A7R92	DC NULL ADJ	5-28
A7L9	40 MHz BANDPASS FILTER	5-24
A7L10	40 MHz BANDPASS FILTER	5-24

The Divider-Filter service group provides information to aid in troubleshooting the Divider-Filter assembly (A2, 03335-66506) to the component level. It is assumed that the 10–80 MHz Divider-Filter signal was incorrect or not present for certain output frequency ranges at the Divider-Filter Output connector on the front extrusion to require service of the Divider-Filter section.

Symptom	Service Action	Notes
10–80 MHz signal at Divider-Filter Output is incorrect, noncontinuous or absent.	A. Remove the A6 assembly, Output Amplifier/Level Control from the rf module. With the Divider-Filter assembly on an extender, connect test point LC to test point LCT. This sets the Divider-Filter output at 0 dBm (0.224 V) into 50 Ω. B. Verify the signal is present and correct at TP1 for each of the three active ranges (10 - < 20 MHz, 20 - < 40 MHz and 40–80 MHz). C. If the correct signals were present at TP1 from the previous step, the logic decoding and level translation is probably good. To further verify the logic decoding, monitor the 0 dBm (50 Ω) output signal at the front extrusion output connector (recall this signal is there only for frequencies of 10 MHz and greater) and program a frequency mid-range of each low-pass filter. If the logic switches the filters of the LPF bank correctly, the 0 dBm signal will always be present. D. Correct logic decoding and translation can also be verified by checking the divider gate enable lines. Only one will be low at any time and will correspond to the frequency programmed as labeled on the enable lines. The levels are ECL: High = ≈ - 0.8 V, Low = ≈ - 1.6 V. E. If the decoded logic is not correct, verify the controller filter select data lines (FS1, FS2 and FS3) have the correct logic levels for the frequency range programmed. Table 8-L-1 indicates the level of the FS controller lines for each frequency range.	

Table 8-L-1. Filter Select Controller Data.

Freq Range	Controller Filter Select Data Line FS3	FS2	FS1
0 - < 10 MHz	0	0	0
10 - < 14 MHz	0	0	1
14 - < 20 MHz	0	1	0
20 - < 28 MHz	0	1	1
28 - < 40 MHz	1	0	0
40 - < 56 MHz	1	0	1
56 - 80 MHz	1	1	0

Symptom	Service Action	Notes
No signal at TP1 for any output programmed ⩾ 10 MHz.	F. If no signals are detected at TP1, verify a 40–80 MHz signal (from the Summation Loop) is present at the input to the divider gates. G. Verify correct divider operation for each frequency range. H. Verify + 10 V dc at the emitter of Q1. I. Verify the modulator control line from U4 Pin 10 activates the modulator for frequencies programmed ⩾ 10 MHz.	

The Mixer service group provides information to aid in troubleshooting the Mixer assembly (A7, 03335-66507) to the component level. It is assumed the 0–10 MHz signal from the Mixer to the Output Amplifier was incorrect or not present for programmed output frequencies less than 10 MHz to require service of the Mixer Section.

Symptom	Service Action	Notes
Incorrect or absent output from Mixer section.	A. Remove the A6 assembly, Output Amplifier/Level Control from the rf module. With the Mixer assembly on an extender, connect test point LC to LCT. This establishes the Mixer output level at 0 dBm (0.224 V) into 50 Ω.	

Symptom	Service Action	Notes
40–50 MHz and 40 MHz inputs to mixer U2 are good but no output from assembly.	B. Program an output frequency of 5 MHz and verify the 40–50 MHz signal from the Divider-Filter section is 45 MHz at the 40–50 MHz test point on Mother Board A1. Verify that this 45 MHz signal appears at U1 Pin 3 with complementary appearance at U1 Pins 14 and 15 (Pins 4 and 3 of the mixer U2). C. Verify the 40 MHz Reference signal is present at the mixer (U2 Pins 12 and 13). If not, verify that the 40 MHz signal appears at the connector XA7 Pin E on Mother Board A1. D. If the 40 MHz signal appears at XA7 Pin E, verify the modulator operation by checking for the signal at the collector of Q10. Verify the - 15 V_3 supply which powers the mixer U2. Also verify that U3 and Q11 generate + 10 V at the emitter of Q11 (U3 Pin 2). Verify the dc level of the Mixer section output is 0 V at the connection of A7W2 and L15.	

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2	03335-66536	1	P.C. ASSEMBLY, DIVIDER/FILTER	28480	03335-66536
A2C1	0160-2307	2	CAPACITOR-FXD 47PF +-5% 300WVDC MICA	28480	0160-2307
A2C2	0140-0193	4	CAPACITOR-FXD 82PF +-5% 300WVDC MICA	72136	DM15E820J0300WV1CR
A2C3	0160-2307		CAPACITOR-FXD 47PF +-5% 300WVDC MICA	28480	0160-2307
A2C4	0150-0084	16	CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C5	0160-0128	33	CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A2C6	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A2C7	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C8	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C9	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C10	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C11	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C12	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C13	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C14	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C15	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A2C16	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A2C17	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C18	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C19	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C20	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C21	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C22	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C31	0150-0047	1	CAPACITOR-FXD 6.8PF +-10% 500WVDC TI	95121	TYPE QC
A2C32	0160-2308	2	CAPACITOR-FXD 36PF +-5% 300WVDC MICA	28480	0160-2308
A2C33	0160-2306	4	CAPACITOR-FXD 27PF +-5% 300WVDC MICA	28480	0160-2306
A2C34	0160-2202	6	CAPACITOR-FXD 75PF +-5% 300WVDC MICA	28480	0160-2202
A2C35	0160-2203	3	CAPACITOR-FXD 91PF +-5% 300WVDC MICA	28480	0160-2203
A2C36	0140-0193		CAPACITOR-FXD 82PF +-5% 300WVDC MICA	72136	DM15E820J0300WV1CR
A2C37	0140-0191	2	CAPACITOR-FXD 56PF +-5% 300WVDC MICA	72136	DM15E560J0300WV1CR
A2C38	0160-0205	3	CAPACITOR-FXD 10PF +-5% 500WVDC MICA	28480	0160-0205
A2C39	0160-2201	6	CAPACITOR-FXD 51PF +-5% 300WVDC MICA	28480	0160-2201
A2C40	0160-2308		CAPACITOR-FXD 36PF +-5% 300WVDC MICA	28480	0160-2308
A2C41	0160-0336	8	CAPACITOR-FXD 100PF +-1% 300WVDC MICA	28480	0160-0336
A2C42	0140-0195	2	CAPACITOR-FXD 130PF +-5% 300WVDC MICA	72136	DM15F131J0300WV1CR
A2C43	0140-0194	2	CAPACITOR-FXD 110PF +-5% 300WVDC MICA	72136	DM15F111J0300WV1CR
A2C44	0140-0215	1	CAPACITOR-FXD 80PF +-2% 300WVDC MICA	72136	DM15E800G0300WV1CR
A2C45	0140-0202	1	CAPACITOR-FXD 15PF +-5% 500WVDC MICA	72136	DM15C150J0500WV1CR
A2C46	0160-2202		CAPACITOR-FXD 75PF +-5% 300WVDC MICA	28480	0160-2202
A2C47	0160-2201		CAPACITOR-FXD 51PF +-5% 300WVDC MICA	28480	0160-2201
A2C48	0140-0217	1	CAPACITOR-FXD 140PF +-2% 300WVDC MICA	72136	DM15F141G0300WV1CR
A2C49	0140-0197	1	CAPACITOR-FXD 180PF +-5% 300WVDC MICA	72136	DM15F181J0300WV1CR
A2C50	0160-2206	5	CAPACITOR-FXD 160PF +-5% 300WVDC MICA	28480	0160-2206
A2C51	0140-0194		CAPACITOR-FXD 110PF +-5% 300WVDC MICA	72136	DM15F111J0300WV1CR
A2C61	0160-2198	3	CAPACITOR-FXD 20PF +-5% 300WVDC MICA	28480	0160-2198
A2C62	0160-0336		CAPACITOR-FXD 100PF +-1% 300WVDC MICA	28480	0160-0336
A2C63	0160-2202		CAPACITOR-FXD 75PF +-5% 300WVDC MICA	28480	0160-2202
A2C64	0140-0198	14	CAPACITOR-FXD 200PF +-5% 300WVDC MICA	72136	DM15F201J0300WV1CR
A2C65	0140-0223	1	CAPACITOR-FXD 260PF +-1% 300WVDC MICA	72136	DM15F261F0300WV1C
A2C66	0160-0134	5	CAPACITOR-FXD 220PF +-5% 300WVDC MICA	28480	0160-0134
A2C67	0160-2206		CAPACITOR-FXD 160PF +-5% 300WVDC MICA	28480	0160-2206
A2C68	0160-2199	2	CAPACITOR-FXD 30PF +-5% 300WVDC MICA	28480	0160-2199
A2C69	0140-0196	3	CAPACITOR-FXD 150PF +-5% 300WVDC MICA	72136	DM15F151J0300WV1CR
A2C70	0160-0336		CAPACITOR-FXD 100PF +-1% 300WVDC MICA	28480	0160-0336
A2C71	0140-0206	3	CAPACITOR-FXD 270PF +-5% 500WVDC MICA	72136	DM15F271J0500WV1CR
A2C72	0160-2209	1	CAPACITOR-FXD 360PF +-5% 300WVDC MICA	28480	0160-2209
A2C73	0140-0226	1	CAPACITOR-FXD 320PF +-1% 300WVDC MICA	72136	DM15F321F0300WV1C
A2C74	0160-0134		CAPACITOR-FXD 220PF +-5% 300WVDC MICA	28480	0160-0134
A2C75	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2C76	0160-0763	4	CAPACITOR-FXD 5PF +-10% 500WVDC MICA	28480	0160-0763
A2C77	0160-2306		CAPACITOR-FXD 27PF +-5% 300WVDC MICA	28480	0160-2306

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2C78	0160-0356	1	CAPACITOR-FXD 18PF +-5% 300WVDC MICA	28480	0160-0356
A2C79	0160-2201		CAPACITOR-FXD 51PF +-5% 300WVDC MICA	28480	0160-2201
A2C80	0140-0205	2	CAPACITOR-FXD 62PF +-5% 300WVDC MICA	72136	DM15E620J0300WV1CR
A2C81	0140-0191		CAPACITOR-FXD 56PF +-5% 300WVDC MICA	72136	DM15E560J0300WV1CR
A2C82	0140-0190	1	CAPACITOR-FXD 39PF +-5% 300WVDC MICA	72136	DM15E390J0300WV1CR
A2C83	0180-1846	2	CAPACITOR-FXD 2.2UF+-10% 35VDC TA	56289	150D225X9035B2
A2C84	0180-0197	4	CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A2C85	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A2C86	0180-1846		CAPACITOR-FXD 2.2UF+-10% 35VDC TA	56289	150D225X9035B2
A2C87	0150-0084		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0150-0084
A2CR1	1901-0040	37	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR2	1901-0050	25	DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR3	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR4	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR5	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR6	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR7	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR8	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR9	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR10	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR11	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR12	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR13	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR16	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR17	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR18	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR19	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR20	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR21	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR22	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR23	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR24	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR25	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR26	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR27	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR31	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR32	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR33	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR34	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR35	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR36	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR37	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR38	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR39	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR40	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2CR41	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR42	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR43	1901-0050		DIODE-SWITCHING 80V 200MA 2NS DO-7	28480	1901-0050
A2J1	1250-0826	2	CONNECTOR, RF, SMC M SGL HOLE	98229	50-027-0000
A2J2	1250-0826		CONNECTOR, RF, SMC M SGL HOLE	98229	50-027-0000
	1251-4548	1	MOLEX, 22-03-2021, FILTER PINS	27264	OBD
A2L1	9100-3919	2	COIL-MLD .13UH 5% Q=50 .155DX.375LG	28480	9135-0002
A2L2	9100-3919		COIL-MLD .13UH 5% Q=50 .155DX.375LG	28480	9135-0002
A2L3	9140-0183	13	COIL-MLD 20UH 10% Q=80 .156DX.375LG	06560	4445-6K
A2L4	9140-0163		COIL-MLD 20UH 10% Q=80 .156DX.375LG	06560	4445-6K
A2L11	9140-0183		COIL-MLD 20UH 10% Q=80 .156DX.375LG	06560	4445-6K
A2L12	9100-0682	3	COIL .156DX.625LG	28480	9100-0682
A2L13	9100-0682		COIL .156DX.625LG	28480	9100-0682
A2L14	9100-0682		COIL .156DX.625LG	28480	9100-0682
A2L15	9140-0183		COIL-MLD 20UH 10% Q=80 .156DX.375LG	06560	4445-6K
A2L16	9100-0684	3	COIL .156DX.625LG	28480	9100-0684
A2L17	9100-0689	2	COIL .156DX.625LG	28480	9100-0689
A2L18	9100-0689		COIL .156DX.625LG	28480	9100-0689
A2L19	9140-0183		COIL-MLD 20UH 10% Q=80 .156DX.375LG	06560	4445-6K
A2L20	9100-0683	1	COIL .156DX.625LG	28480	9100-0683
A2L21	9100-0684		COIL .156DX.625LG	28480	9100-0684
A2L22	9100-0684		COIL .156DX.625LG	28480	9100-0684
A2L23	9140-0183		COIL-MLD 20UH 10% Q=80 .156DX.375LG	06560	4445-6K
A2L24	9100-0686	3	COIL .156DX.625LG	28480	9100-0686
A2L25	9100-0686		COIL .156DX.625LG	28480	9100-0686
A2L26	9100-0696		COIL .156DX.625LG	28480	9100-0686
A2L27	9140-0183		COIL-MLD 20UH 10% Q=80 .156DX.375LG	06560	4445-6K
A2L28	9100-0685	1	COIL .156DX.625LG	28480	9100-0685
A2L29	9100-0690	1	COIL .156DX.625LG	28480	9100-0690
A2L30	9100-0687	1	COIL .156DX.625LG	28480	9100-0687
A2L31	9140-0183		COIL-MLD 20UH 10% Q=80 .156DX.375LG	06560	4445-6K

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2L36	9140-0183		COIL-MLD 20UH 10% Q=80 .156DX.375LG	06560	4445-6K
A2L37	9100-0688	3	COIL .156DX.625LG	28480	9100-0688
A2L38	9100-0688		COIL .156DX.625LG	28480	9100-0688
A2L39	9100-0688		COIL .156DX.625LG	28480	9100-0688
A2L40	9100-2558	2	COIL-MLD 47UH 10% Q=50 .156DX.375LG	06560	15S-470K
A2L41	9100-2558		COIL-MLD 47UH 10% Q=50 .156DX.375LG	06560	15S-470K
A2L42	9100-3334	5	COIL 25UH 10% .30X.5LG SRF=14MHZ	28480	9100-3334
A2L43	9100-2556	4	COIL-MLD 33UH 10% Q=45 .156DX.375LG	06560	15S-330K
A2MP1	03335-61212	1	EXTRUSION ASSEMBLY	28480	03335-61212
A2MP2	8160-0264	6	P.C. SHIELD	28480	8160-0264
A2Q1	1854-0053	7	TRANSISTOR NPN 2N2218 SI TO-5 PD=800MW	04713	2N2218
A2Q2	1854-0378	4	TRANSISTOR NPN 2N5109 SI TO-39 PD=800MW	02735	2N5109
A2Q3	1854-0378		TRANSISTOR NPN 2N5109 SI TO-39 PD=800MW	02735	2N5109
A2Q4	1853-0016	22	TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q5	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q6	1854-0745	1	TRANSISTOR NPN SI TO-5 PD=3W FT=250MHZ	28480	1854-0745
A2Q7	1854-0053		TRANSISTOR NPN 2N2218 SI TO-5 PD=800MW	04713	2N2218
A2Q8	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q9	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q10	1854-0053		TRANSISTOR NPN 2N2218 SI TO-5 PD=800MW	04713	2N2218
A2Q11	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q12	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q13	1854-0053		TRANSISTOR NPN 2N2218 SI TO-5 PD=800MW	04713	2N2218
A2Q14	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q15	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q16	1854-0053		TRANSISTOR NPN 2N2218 SI TO-5 PD=800MW	04713	2N2218
A2Q17	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q18	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q19	1854-0053		TRANSISTOR NPN 2N2218 SI TO-5 PD=800MW	04713	2N2218
A2Q20	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q21	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q22	1854-0053		TRANSISTOR NPN 2N2218 SI TO-5 PD=800MW	04713	2N2218
A2Q23	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2Q24	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A2R1	0757-0416	11	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A2R2	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A2R3	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A2R4	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A2R5	0757-0277	51	RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A2R6	0698-4123	18	RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A2R7	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A2R8	0698-3132	26	RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A2R9	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A2R10	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A2R11	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A2R12	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A2R13	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A2R14	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A2R15	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A2R16	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A2R17	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A2R18	0757-0416		RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A2R19	0683-6815	3	RESISTOR 680 5% .25W FC TC=-400/+600	01121	CB6815
A2R20	0683-9115	3	RESISTOR 910 5% .25W FC TC=-400/+600	01121	CB9115
A2R26	0698-3279	8	RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A2R27	0757-0442	31	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R28	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A2R29	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A2R30	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A2R31	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A2R32	0757-0280	27	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R33	0757-0446	9	RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A2R34	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A2R35	0757-0283	17	RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A2R36	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A2R37	2100-3252	1	RESISTOR-TRMR 5K 10% C TOP-ADJ 1-TRN	32997	3386P-Y46-502
A2R38	0757-0420	1	RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A2R39	0757-1001	1	RESISTOR 56.2 1% .5W F TC=0+-100	19701	MF7C1/2-T0-56R2-F
A2R40	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A2R41	0757-0346	34	RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A2R42	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A2R43	0757-0384	20	RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A2R44	0757-0180	1	RESISTOR 31.6 1% .125W F TC=0+-100	24546	C4, T-0
A2R45	0757-0383	7	RESISTOR 18.2 1% .125W F TC=0+-100	19701	MF4C1/8-T0-18R2-F

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2R46	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-49R9-F
A2R56	0757-0446		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A2R57	0698-3622	6	RESISTOR 120 5% 2W MO TC=0+-200	11502	RG42
A2R58	0757-0433	7	RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3321-F
A2R59	0698-4439	8	RESISTOR 3.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3241-F
A2R60	0698-3223	6	RESISTOR 1.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1241-F
A2R61	0698-3557	6	RESISTOR 806 1% .125W F TC=0+-100	24546	C4-1/8-T0-806R-F
A2R62	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R63	0757-0446		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A2R64	0698-3622		RESISTOR 120 5% 2W MO TC=0+-200	11502	RG42
A2R65	0757-0433		RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3321-F
A2R66	0698-4439		RESISTOR 3.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3241-F
A2R67	0698-3223		RESISTOR 1.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1241-F
A2R68	0698-3557		RESISTOR 806 1% .125W F TC=0+-100	24546	C4-1/8-T0-806R-F
A2R69	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R70	0757-0446		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A2R71	0698-3622		RESISTOR 120 5% 2W MO TC=0+-200	11502	RG42
A2R72	0757-0433		RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3321-F
A2R73	0698-4439		RESISTOR 3.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3241-F
A2R74	0698-3223		RESISTOR 1.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1241-F
A2R75	0698-3557		RESISTOR 806 1% .125W F TC=0+-100	24546	C4-1/8-T0-806R-F
A2R76	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R81	0757-0446		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A2R82	0698-3622		RESISTOR 120 5% 2W MO TC=0+-200	11502	RG42
A2R83	0757-0433		RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3321-F
A2R84	0698-4439		RESISTOR 3.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3241-F
A2R85	0698-3223		RESISTOR 1.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1241-F
A2R86	0698-3557		RESISTOR 806 1% .125W F TC=0+-100	24546	C4-1/8-T0-806R-F
A2R87	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R88	0757-0446		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A2R89	0698-3622		RESISTOR 120 5% 2W MO TC=0+-200	11502	RG42
A2R90	0757-0433		RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3321-F
A2R91	0698-4439		RESISTOR 3.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3241-F
A2R92	0698-3223		RESISTOR 1.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1241-F
A2R93	0698-3557		RESISTOR 806 1% .125W F TC=0+-100	24546	C4-1/8-T0-806R-F
A2R94	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2R95	0757-0446		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A2R96	0698-3622		RESISTOR 120 5% 2W MO TC=0+-200	11502	RG42
A2R97	0757-0433		RESISTOR 3.32K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3321-F
A2R98	0698-4439		RESISTOR 3.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3241-F
A2R99	0698-3223		RESISTOR 1.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1241-F
A2R100	0698-3557		RESISTOR 806 1% .125W F TC=0+-100	24546	C4-1/8-T0-806R-F
A2R101	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A2U1	1820-0927	1	IC-DIGITAL CD4028AE CMOS BCD-TO-DEC	02735	CD4028AY
A2U2	1820-1146	3	IC-DIGITAL CD4050AE CMOS HEX 1 NON-INV	02735	CD4050AY
A2U3	1820-1146		IC-DIGITAL CD4050AE CMOS HEX 1 NON-INV	02735	CD4050AY
A2U4	1820-1144	4	IC-DIGITAL SN74LS02N TTL LS QUAD 2 NOR	01295	SN74LS02N
A2U5	1820-1173	3	IC-DIGITAL MC10124L TTL/ECL QUAD 2	04713	MC10124L
A2U6	1820-0810	4	IC-DIGITAL MC10116P ECL TPL 2 LINE RCVR	04713	MC10116P
A2U7	1820-0802	3	IC-DIGITAL MC10102P ECL QUAD 2 NOR	04713	MC10102P
A2U8	1820-0820	3	IC-DIGITAL MC10135L ECL DUAL J-KBAR	04713	MC10135L
A2U9	1820-0820		IC-DIGITAL MC10135L ECL DUAL J-KBAR	04713	MC10135L
A2U10	1820-0806	2	IC-DIGITAL MC10109P ECL DUAL 4-5 OR-NOR	04713	MC10109P
A2U11	1826-0043	6	IC LM 307 OP AMP	27014	LM307H
A2W1	03335-61629	2	CABLE, COAX, OUTPUT	28480	03335-61629
A2W2	03335-61629		CABLE, COAX, OUTPUT	28480	03335-61629
A7	03335-66507	1	P.C. ASSEMBLY, MIXER	28480	03335-66507
A7C1	0180-1779		CAPACITOR-FXD 18UF+-10% 35VDC TA	56289	150D186X9035R2
A7C2	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A7C3	0180-1746	2	CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A7C4	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A7C5	0180-1779		CAPACITOR-FXD 18UF+-10% 35VDC TA	56289	150D186X9035R2
A7C6	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A7C7	0150-0121	2	CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A7C8	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A7C9	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A7C10	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A7C11	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A7C12	0180-0197		CAPACITOR-FXD 2.2UF+-10% 20VDC TA	56289	150D225X9020A2
A7C13	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A7C14	0150-0121		CAPACITOR-FXD .1UF +80-20% 50WVDC CER	28480	0150-0121
A7C15	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A7C16	0160-2202		CAPACITOR-FXD 75PF +-5% 300WVDC MICA	28480	0160-2202
A7C17	0150-0022	1	CAPACITOR-FXD 3.3PF +-10% 500WVDC TI	95121	TYPE QC
A7C18	0160-2202		CAPACITOR-FXD 75PF +-5% 300WVDC MICA	28480	0160-2202
A7C19	0160-2257	1	CAPACITOR-FXD 10PF +-5% 500WVDC CER	28480	0160-2257
A7C20	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093

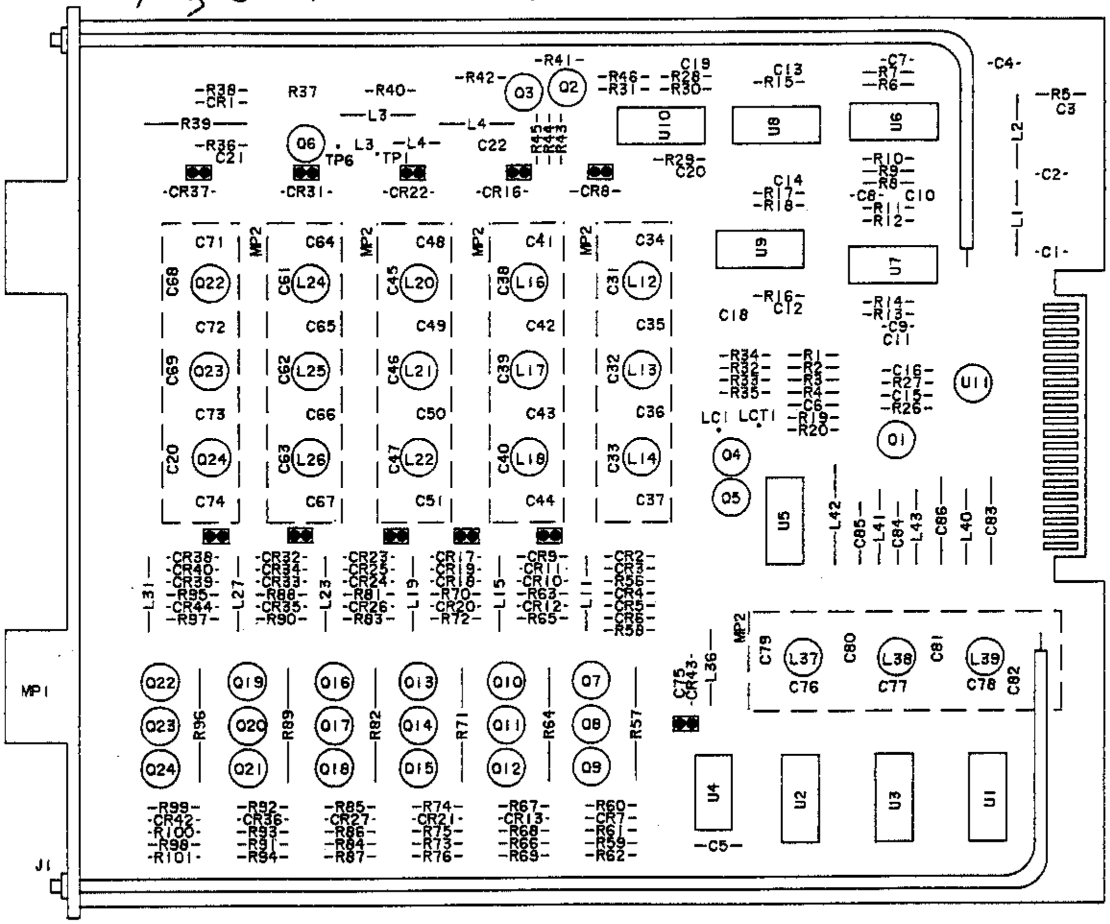
Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A7C27	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A7C28	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A7C29	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A7C30	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A7C31	0160-3847		CAPACITOR-FXD .01UF +100-0% 50WVDC CER	28480	0160-3847
A7C32	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A7C33	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A7C34	0180-1861	10	CAPACITOR-FXD 27UF+-10% 10VDC TA	56289	150D276X9010B2
A7C35	0160-2248	1	CAPACITOR-FXD 4.3PF +-.25PF 500WVDC CER	28480	0160-2248
A7C36	0160-2256	1	CAPACITOR-FXD 9.1PF +-.25PF 500WVDC CER	28480	0160-2256
A7C37	0150-0029	1	CAPACITOR-FXD 1PF +-10% 500WVDC TI DIOX	95121	TYPE QC
A7C38	0121-0046	1	CAPACITOR-V TRMR-CER 9/35PF 200V PC-MTG	00865	304322 9/35PF N650
A7C39	0121-0060	1	CAPACITOR-V TRMR-CER 2/8PF 350V PC-MTG	00865	304322 2/8PF NPO
A7C40	0180-1861		CAPACITOR-FXD 27UF+-10% 10VDC TA	56289	150D276X9010B2
A7C46	0140-0198		CAPACITOR-FXD 200PF +-5% 300WVDC MICA	72136	DM15F201J0300WV1CR
A7C47	0180-1746		CAPACITOR-FXD 15UF+-10% 20VDC TA	56289	150D156X9020B2
A7C48	0160-0174	1	CAPACITOR-FXD .47UF +80-20% 25WVDC CER	28480	0160-0174
A7C49	0160-3563	2	CAPACITOR-FXD 10UF +-5% 50WVDC MET POLYC	28480	0160-3563
A7C50	0160-3563		CAPACITOR-FXD 10UF +-5% 50WVDC MET POLYC	28480	0160-3563
A7C51	0140-0198		CAPACITOR-FXD 200PF +-5% 300WVDC MICA	72136	DM15F201J0300WV1CR
A7C52	0180-0291	3	CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A7C53	0180-1861		CAPACITOR-FXD 27UF+-10% 10VDC TA	56289	150D276X9010B2
A7C54	0180-0291		CAPACITOR-FXD 1UF+-10% 35VDC TA	56289	150D105X9035A2
A7C55	0160-2265	1	CAPACITOR-FXD 22PF +-5% 500WVDC CER	28480	0160-2265
A7C56	0160-0134		CAPACITOR-FXD 220PF +-5% 300WVDC MICA	28480	0160-0134
A7C57	0160-0134		CAPACITOR-FXD 220PF +-5% 300WVDC MICA	28480	0160-0134
A7CR3	1901-0044		DIODE-SWITCHING 50V 50MA 6NS	28480	1901-0044
A7CR4	1901-0044		DIODE-SWITCHING 50V 50MA 6NS	28480	1901-0044
A7CR6	1901-0044		DIODE-SWITCHING 50V 50MA 6NS	28480	1901-0044
A7L1	9100-2556		COIL-MLD 33UH 10% Q=45 .156DX.375LG	06560	15S-330K
A7L2	9100-1623	3	COIL-MLD 27UH 5% Q=60 .155DX.375LG	24226	15/272
A7L3	9100-2556		COIL-MLD 33UH 10% Q=45 .156DX.375LG	06560	15S-330K
A7L4	9100-1623		COIL-MLD 27UH 5% Q=60 .155DX.375LG	24226	15/272
A7L5	9100-2556		COIL-MLD 33UH 10% Q=45 .156DX.375LG	06560	15S-330K
A7L6	9100-0539		COIL-MLD 10UH 5% Q=55 .155DX.375LG	24226	15/102-5%
A7L7	9100-1623		COIL-MLD 27UH 5% Q=60 .155DX.375LG	24226	15/272
A7L8	9100-0539		COIL-MLD 10UH 5% Q=55 .155DX.375LG	24226	15/102-5%
A7L9	9100-0691	1	COIL .156DX.625LG	28480	9100-0691
A7L10	9100-0692	1	COIL .156DX.625LG	28480	9100-0692
A7L11	9100-3316	1	COIL-MLD 5.6UH 2% .155DX.375LG	24226	9327
A7L12	9100-3311	1	COIL-MLD 6UH 2% .155DX.375LG	24226	9332
A7L13	9100-3807	2	COIL-MLD 110NH 5% Q=50 .155DX.375LG	24226	9572
A7L15	9100-3318	1	COIL-MLD 580NH 2% .155DX.375LG	24226	9414
A7MP1	03335-61207	1	EXTRUSION ASSEMBLY	28480	03335-61207
A7MP2	8160-0266		PC SHIELD, MIXER 40MHZ BANDPASS FILTER	28480	8160-0266
A7MP3	1600-0617	1	PC SHIELD, MIXER OUTPUT FILTER	28480	1600-0617
A7Q1	1853-0010	2	TRANSISTOR PNP SI TO-18 PD=360MW	28480	1853-0010
A7Q2	1853-0010		TRANSISTOR PNP SI TO-18 PD=360MW	28480	1853-0010
A7Q4	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A7Q5	1853-0016		TRANSISTOR PNP SI TO-92 PD=300MW	28480	1853-0016
A7Q6	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A7Q7	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A7Q8	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A7Q9	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A7Q10	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A7Q11	1854-0404	1	TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0404
A7Q12	1854-0457	1	TRANSISTOR-DUAL NPN PD=400MW	28480	1854-0457
A7Q13	1853-0203		TRANSISTOR PNP SI TO-18 PD=360MW	28480	1853-0203
A7Q14	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A7Q15	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A7Q16	1853-0203		TRANSISTOR PNP SI TO-18 PD=360MW	28480	1853-0203
A7R1	0757-0453	3	RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3012-F
A7R2	0683-1805	2	RESISTOR 18 5% .25W FC TC=-400/+500	01121	CB1805
A7R4	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R5	0683-1805		RESISTOR 18 5% .25W FC TC=-400/+500	01121	CB1805
A7R8	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A7R9	0683-4715		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A7R10	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R11	0757-0446		RESISTOR 15K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1502-F
A7R12	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R13	0757-0283		RESISTOR 2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2001-F
A7R21	0698-3445	2	RESISTOR 348 1% .125W F TC=0+-100	24546	C4-1/8-T0-348R-F
A7R22	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R23	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R24	2100-0567	2	RESISTOR-TRMR 2K 10% C TOP-ADJ	73138	72-106-0
A7R25	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F

Replaceable Parts

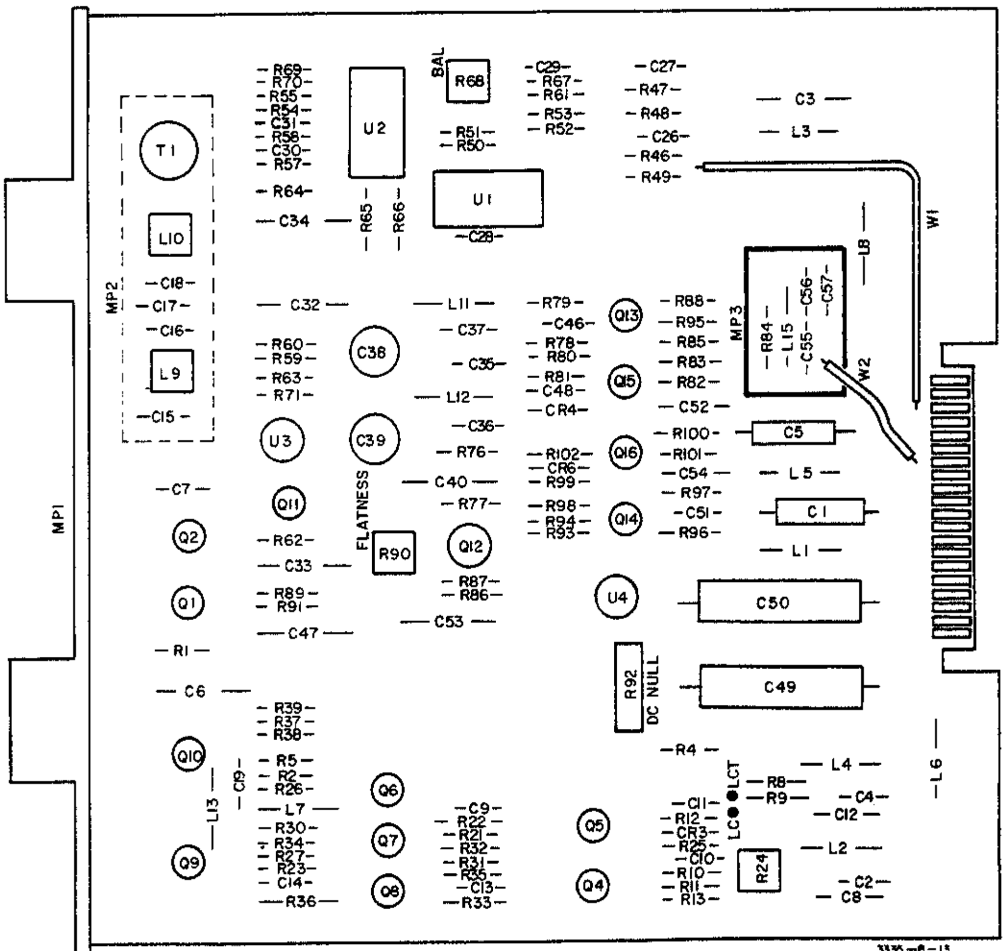
Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A7R26	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A7R27	0757-0417	1	RESISTOR 562 1% .125W F TC=0+-100	24546	C4-1/8-T0-562R-F
A7R30	0698-4453		RESISTOR 402 1% .125W F TC=0+-100	24546	C4-1/8-T0-402R-F
A7R31	0698-4424		RESISTOR 1.4K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1401-F
A7R32	0757-0428	1	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A7R33	0698-3445		RESISTOR 348 1% .125W F TC=0+-100	24546	C4-1/8-T0-348R-F
A7R34	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R35	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R36	0687-6811	1	RESISTOR 680 10% .5W CC TC=0+529	01121	EB6811
A7R37	0698-4439		RESISTOR 3.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3241-F
A7R38	0698-3152	1	RESISTOR 3.48K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3481-F
A7R39	0683-3915	1	RESISTOR 390 5% .25W FC TC=-400/+600	01121	CB3915
A7R46	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R47	0698-4441	1	RESISTOR 3.74K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3741-F
A7R48	0757-0274		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1213-F
A7R49	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A7R50	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A7R51	0698-3132		RESISTOR 261 1% .125W F TC=0+-100	24546	C4-1/8-T0-2610-F
A7R52	0757-0439	2	RESISTOR 6.81K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6811-F
A7R53	0757-0441	2	RESISTOR 8.25K 1% .125W F TC=0+-100	24546	C4-1/8-T0-8251-F
A7R54	0698-4479		RESISTOR 14K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1402-F
A7R55	0757-0435		RESISTOR 3.92K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3921-F
A7R57	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A7R58	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A7R59	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A7R60	0698-3279		RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A7R61	0698-3225		RESISTOR 1.43K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1431-F
A7R62	0684-3911	1	RESISTOR 390 10% .25W FC TC=-400/+600	01121	CB3911
A7R63	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A7R64	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R65	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R66	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R67	0757-0419	1	RESISTOR 681 1% .125W F TC=0+-100	24546	C4-1/8-T0-681R-F
A7R68	2100-0567		RESISTOR-TRMR 2K 10% C TOP-ADJ	73138	72-106-0
A7R69	0698-4479		RESISTOR 14K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1402-F
A7R70	0757-0435		RESISTOR 3.92K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3921-F
A7R71	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A7R76	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R77	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R78	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A7R79	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R80	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A7R81	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R82	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A7R83	0698-3262	2	RESISTOR 40.2 1% .125W F TC=0+-100	24546	C4-1/8-T0-4022-F
A7R84	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R85	0698-4439		RESISTOR 3.24K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3241-F
A7R86	0698-4457	1	RESISTOR 576 1% .125W F TC=0+-100	24546	C4-1/8-T0-576R-F
A7R87	0757-0438		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R88	0698-4451	1	RESISTOR 340 1% .125W F TC=0+-100	24546	C4-1/8-T0-340R-F
A7R89	0698-3151	2	RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A7R90	2100-3212	1	RESISTOR-TRMR 200 10% C TOP-ADJ 1-TRN	73138	72-103-0
A7R91	0698-3151		RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A7R92	2100-3054		RESISTOR-TRMR 50K 10% C SIDE-ADJ 17-TRN	32997	3006P-1-503
A7R93	0683-2055	1	RESISTOR 2M 5% .25W FC TC=-900/+1100	01121	CB2055
A7R94	0757-0453		RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3012-F
A7R95	0757-0453		RESISTOR 30.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3012-F
A7R96	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R97	0698-4452	1	RESISTOR 374 1% .125W F TC=0+-100	24546	C4-1/8-T0-374R-F
A7R98	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A7R99	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A7R100	0698-3262		RESISTOR 40.2 1% .125W F TC=0+-100	24546	C4-1/8-T0-4022-F
A7R101	0698-4123		RESISTOR 499 1% .125W F TC=0+-100	24546	C4-1/8-T0-499R-F
A7R102	0757-0405		RESISTOR 162 1% .125W F TC=0+-100	24546	C4-1/8-T0-162R-F
A7T1	9100-1393	1	TRANSFORMER:TOROID	28480	9100-1393
A7U1	1820-0806		IC-DIGITAL MC10109P ECL DUAL 4-5 OR-NOR	04713	MC10109P
A7U2	1826-0062	1	IC:MIXER CIRCUIT	28480	1826-0062
A7U3	1826-0043		IC LM 307 OP AMP	27014	LM307H
A7U4	1826-0043		IC LM 307 OP AMP	27014	LM307H
A7W1	03335-61625	1	CABLE ASSEMBLY, SEMI RIGID, COAX	28480	03335-61625
A7W2	03335-61626	1	CABLE ASSEMBLY, SEMI RIGID, COAX	28480	03335-61626

Fig 8-L-1 Sht 1of 5



E

A2
-hp- Part No. 03335-66536



A7
-hp- Part No. 03335-66507

Fig 8-L-1
Sht 2 of 5

66536

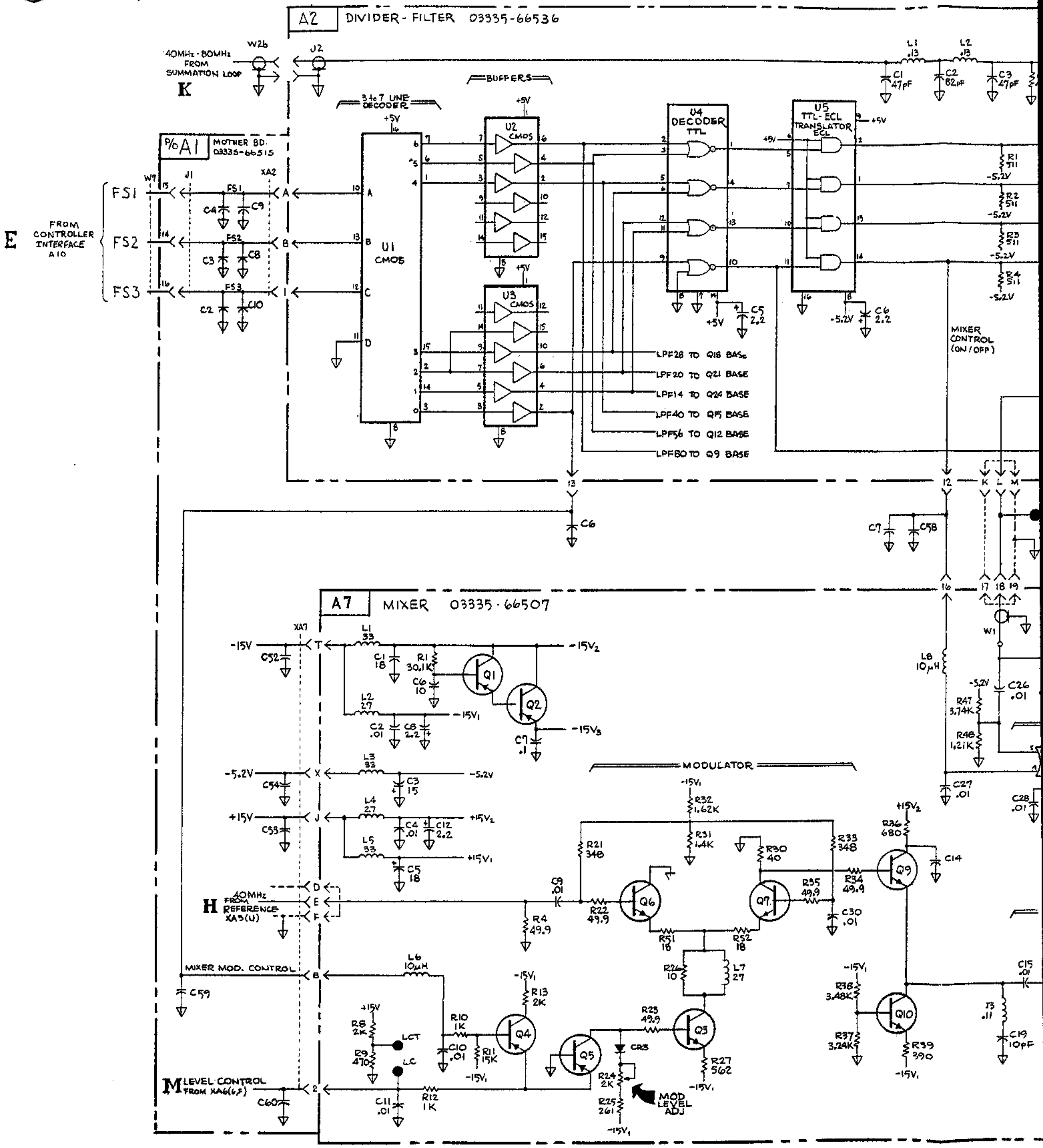


Fig 8-L-1 Sht 3 of 5

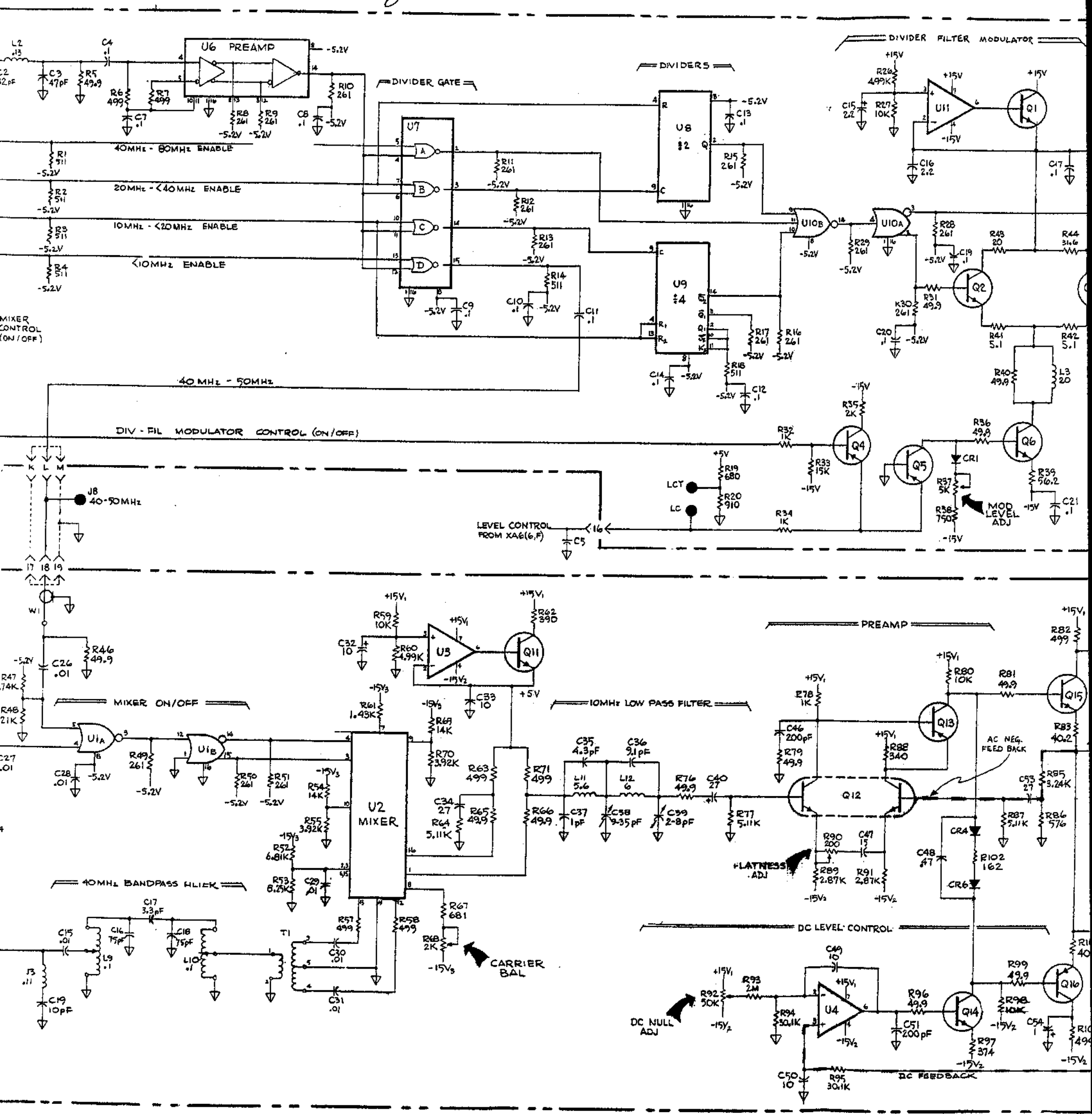


Fig 8-2-1 Sht 4 of 5

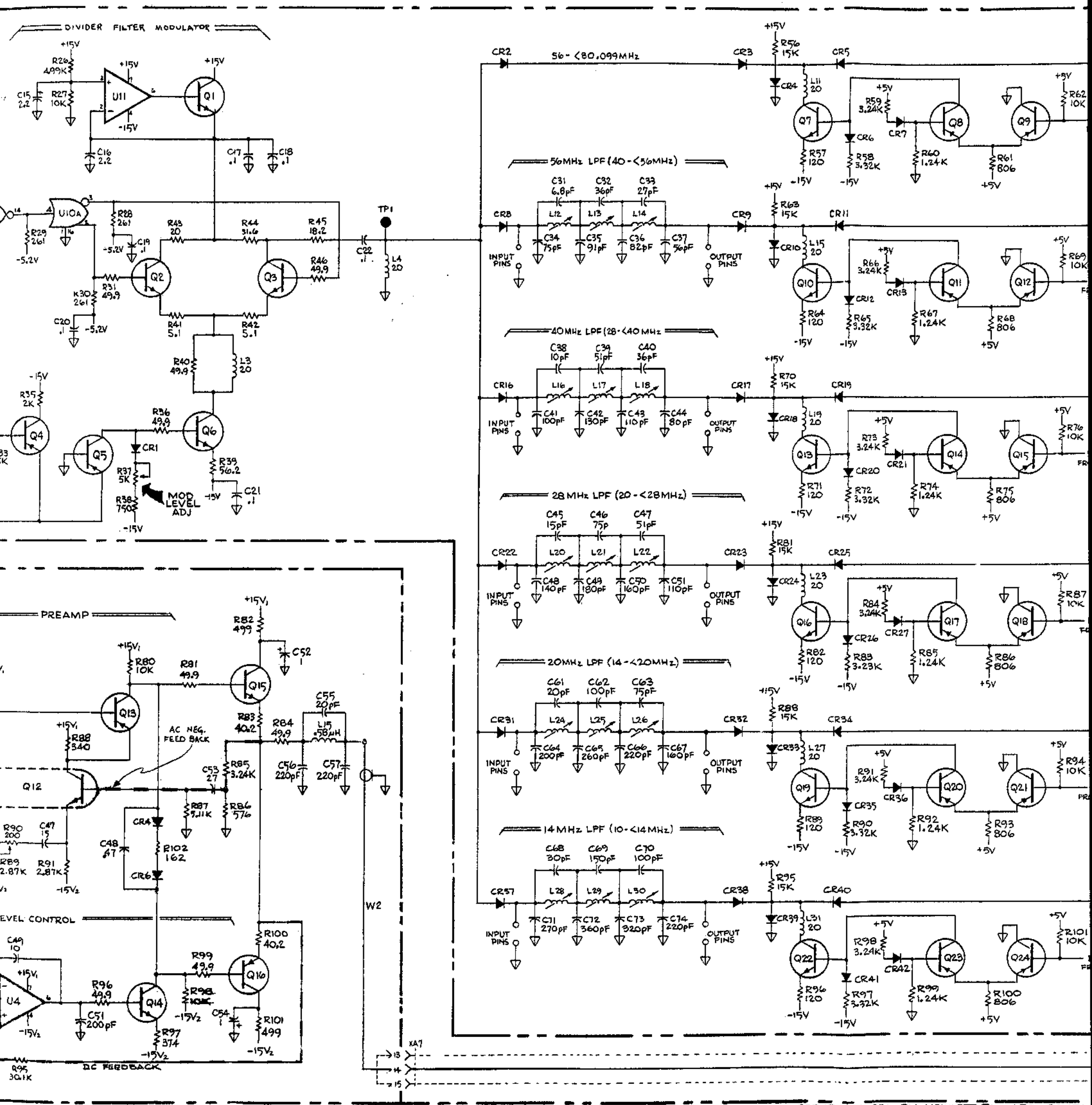
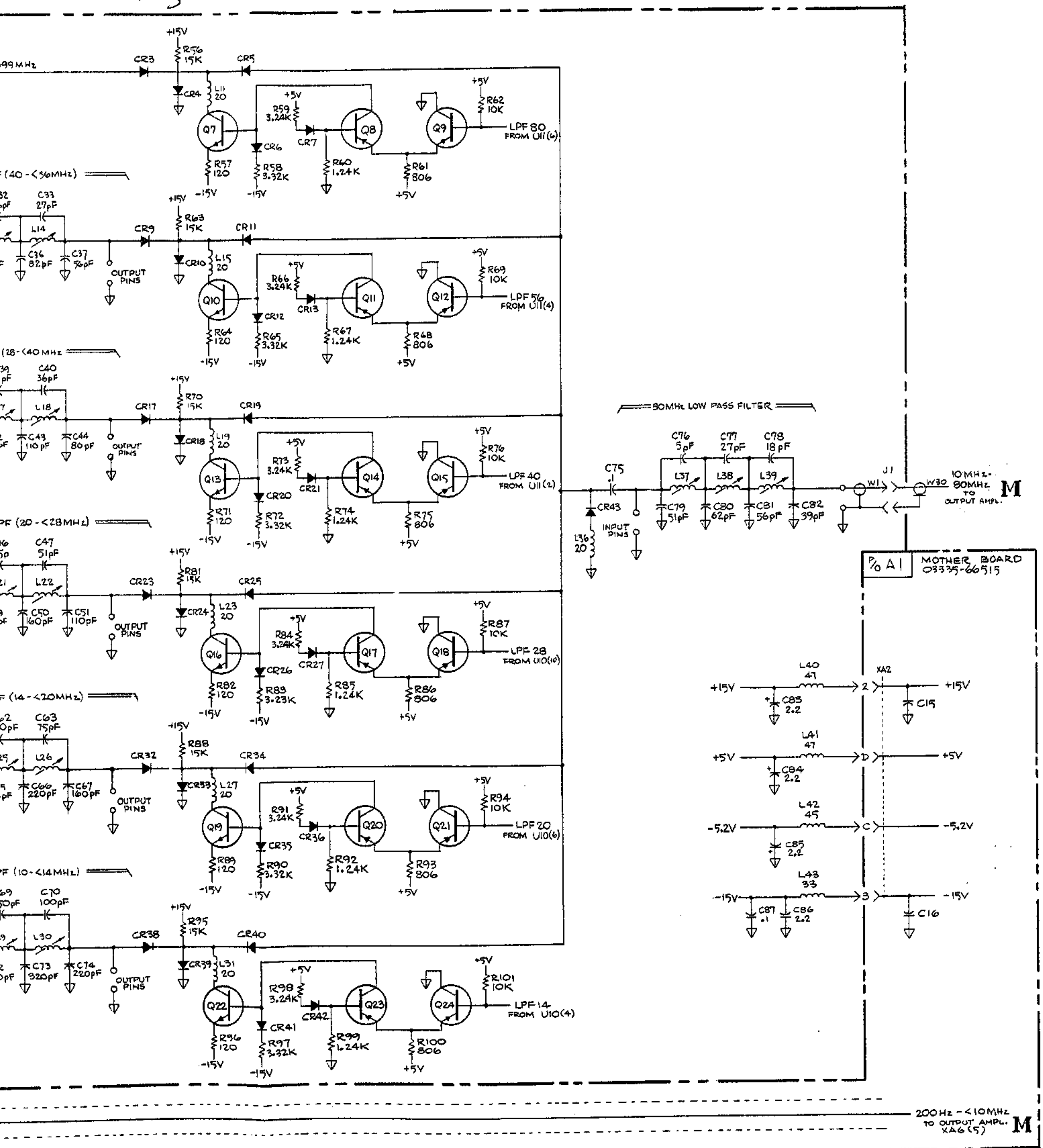


Fig 8-L-1 Sht 5 of 5



L

Figure 8-L-1. Schematic Diagram, Divider-Filter (03335-66536) A2 Mixer (03335-66507) A7.

Fig 8-2
Sht 1 of 3

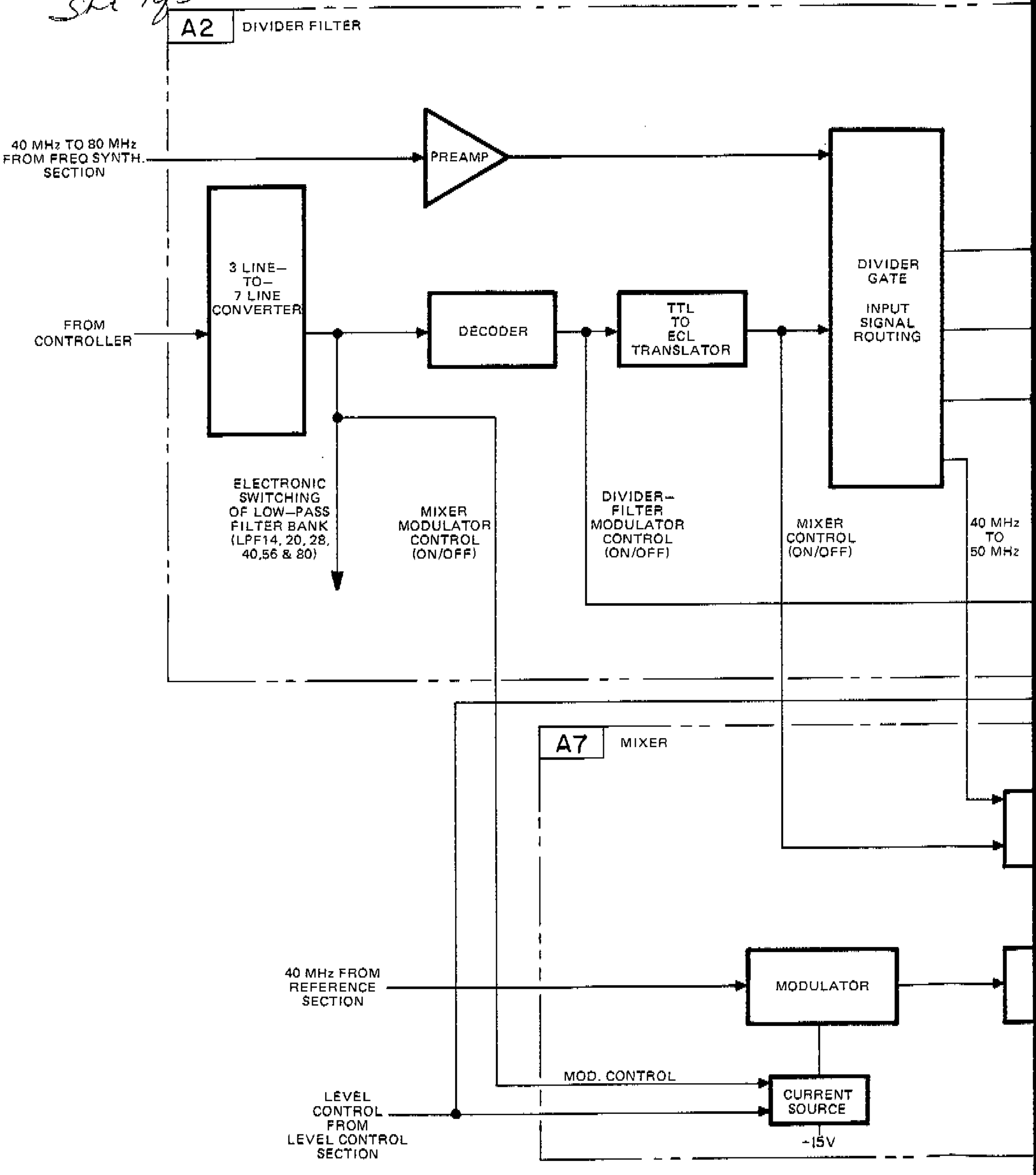


Fig 8-L-2 Sht 2 of 3

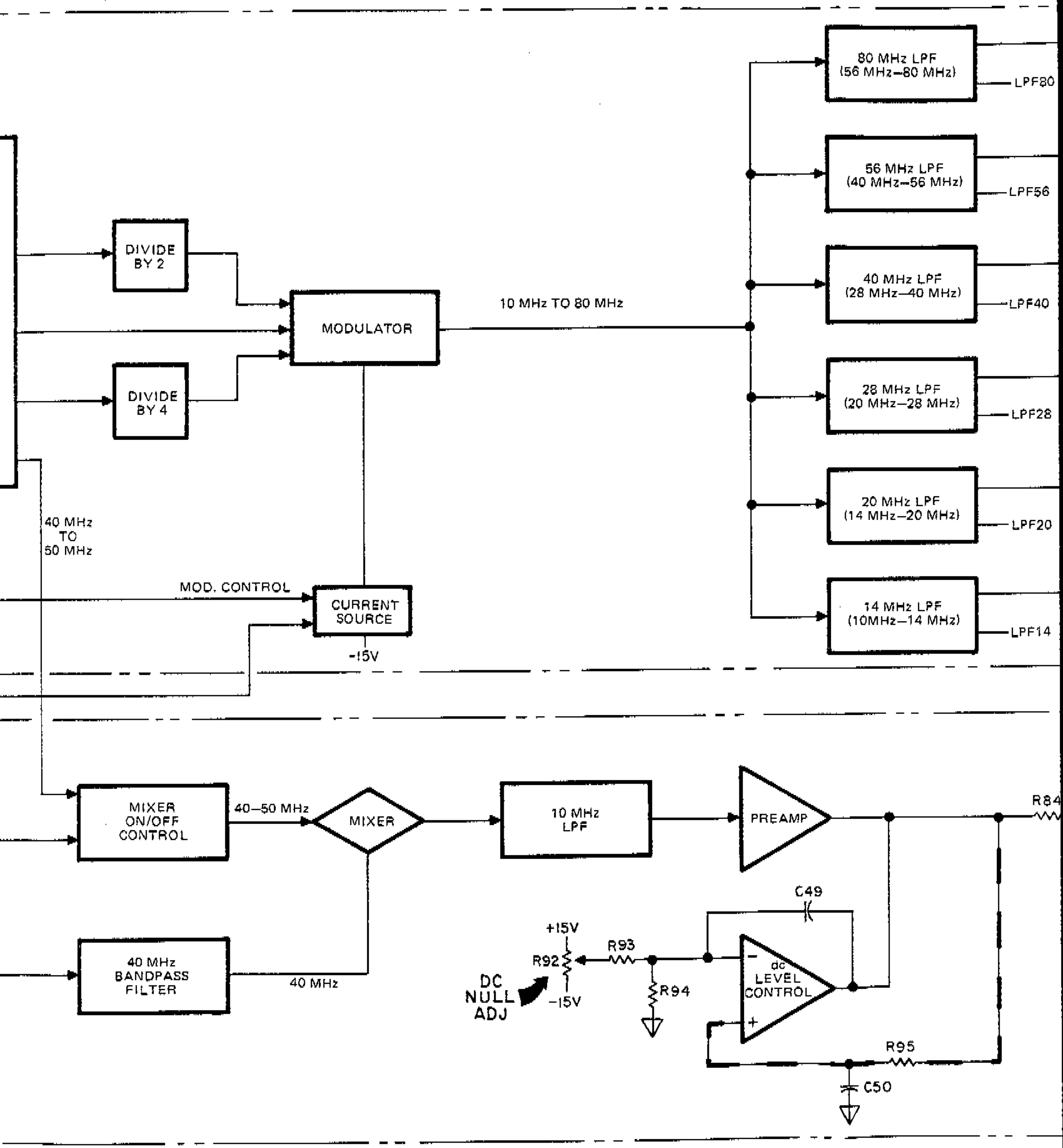


Fig 8-L-2 Sht 3 of 3

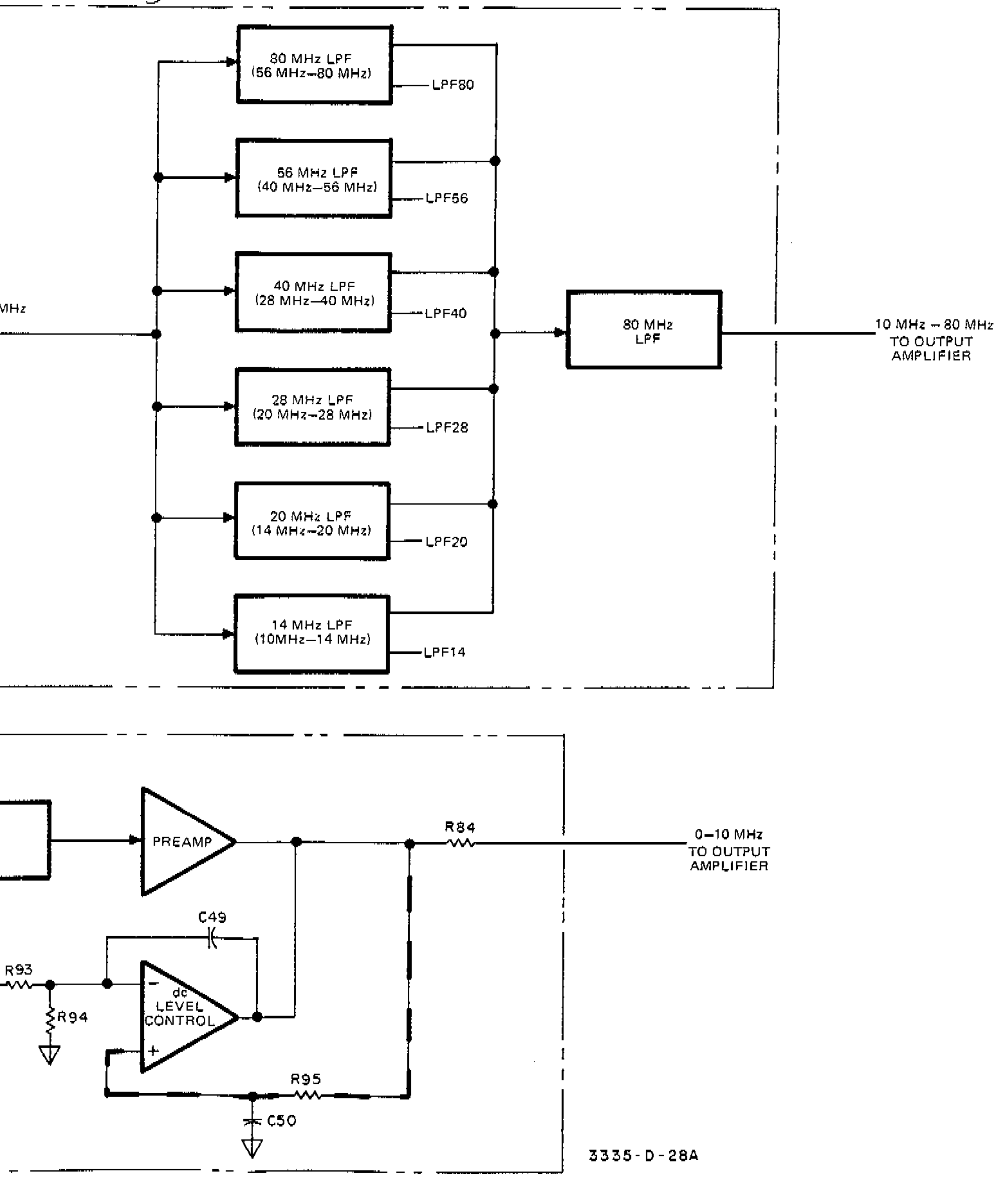


Figure 8-L-2. Block Diagram, Divider-Filter (03335-66536) A2 Mixer (03335-66507) A7.

SERVICE GROUP M

OUTPUT AMP/LEVEL CONTROL

OUTPUT AMP ADJUSTMENTS

Designation	Adjustment Title	Paragraph
A6R85	BIAS ADJ	5-28

LEVEL CONTROL ADJUSTMENTS

Designation	Adjustment Title	Paragraph
A6R122	THERM CONV BAL ADJ	5-30
A6R144	- 10 V ADJ	5-30
A6R147	+ 13.01 dBm ADJ	5-30
A6R150	+ 11.02 dBm ADJ	5-30
A6R164	EXT. LEVEL ADJ	5-30

The Output Amplifier service group provides information to aid in troubleshooting the Output Amplifier section of the A6 assembly (03335-66508). It is assumed that the Divider-Filter and Mixer sections outputs have been verified at the test points of Mother Board A1 and the output from the Output Amplifier is bad to require service of this assembly.

Symptom	Service Action	Notes
No output greater than 10 MHz.	Verify the operation of the 10–80 MHz High Frequency Amplifier. If inoperative, troubleshoot using normal troubleshooting techniques.	
No output between 1 kHz and 10 MHz.	Verify the operation of the 1 kHz - 10 MHz Medium Frequency Amplifier. If inoperative, troubleshoot using normal troubleshooting techniques.	
No output less than 1 kHz.	Verify the operation of the dc - 1 kHz Low Frequency Amplifier. If inoperative, troubleshoot using normal troubleshooting techniques.	
No output signal on any frequency.	A. Verify a signal at the junction of R66 and R67 for a programmed output less than 1 kHz, less than 10 MHz and greater than 10 MHz. This verifies that the Low, Medium and High frequency amplifiers are all providing a signal to the final amplification stage. B. If a signal exists at the input to the final amplification stage but does not provide an output, troubleshoot the final stage using normal troubleshooting techniques.	

The Level Control service group provides information to aid in troubleshooting the Level Control section of the A6 assembly (03335-66508). It is assumed the Level Control section has been determined bad by verifying the modulators of the Divider-Filter and Mixer sections are working properly. This is done by removing the Output Amplifier/Level control assembly, A6, from the module, connecting TP LC to TP LCT on both the Divider-Filter and Mixer assemblies and verifying an approximate 0 dBm signal at their output when each section is active.

<table>
<tr><th>Symptom</th><th>Service Action</th><th>Notes</th></tr>
<tr><td></td><td>
A. Verify limits of Level Control at TP level: Program + 13.01 dBm, note LEVEL reading (the reading should be between 0 and + 4 V dc). Program + 11.02 dBm, LEVEL should be approximately 0.2 V less than the + 13.01 dBm reading.

B. Short the test points of TP1. Connect an oscilloscope to A6TP2. Perform Steps g and h of the Level Control Loop Adjustments. If the adjustment can be made, the ac-dc converter functions properly. If not, troubleshoot the ac-dc converter using normal troubleshooting techniques.

C. Verify the dc level at U10 Pin 8 decreases approximately 0.3 V from a programmed amplitude of + 13.01 dBm to + 11.02 dBm.

D. Verify the dc level at the emitter of Q18 decreases approximately 0.3 V from a programmed amplitude of + 13.01 dBm to + 11.02 dBm.

E. Verify A6TP3 is - 10 V dc.

F. Monitor A6TP4; program + 13.01 dBm and check TP4 for 0 V. Program + 11.02 dBm and check TP4 for + 10 V dc.
</td><td></td></tr>
<tr><td>TP4 does not give correct output at + 13.01 dBm or + 11.02 dBm.</td><td>
Verify the logic applied to the digital-to-analog converter is correct for the amplitude programmed.

A. Program + 2.5 dBm; the logic on the inputs to U9 should be:
<table>
<tr><td>U9 Pins</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td></tr>
<tr><td></td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
</table>
B. Program + 11.62 dBm; the logic on the inputs to U9 should be:
<table>
<tr><td>U9 Pins</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td></tr>
<tr><td></td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td></tr>
</table>
C. Program + 11.11 dBm; the logic on the inputs to U9 should be:
<table>
<tr><td>U9 Pins</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td></tr>
<tr><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
</table>
This verifies all logic inputs to the DAC are capable of changing state and that they provide the correct data.

The logic inputs to U5 for a particular output amplitude can be determined by using Table 8-M-1 and Table 8-M-2 with the following procedure.

EXAMPLE 1:

Displayed amplitude is + 6.12 dBm (50 Ω).

1. Locate amplitude range in Table 8-M-1 (+ 7.01 → + 5.02).
</td><td></td></tr>
</table>

Table 8-M-1. Amplitude Range (50 Ω and 75 Ω).

50 Ω	75 Ω	50 Ω	75 Ω
dBm	dBm	dBm	dBm
+ 13.01 → + 11.02	+ 11.25 → + 9.26	- 36.99 → - 38.98	- 38.75 → - 40.74
+ 11.01 → + 9.02	+ 9.25 → + 7.26	- 38.99 → - 40.98	- 40.75 → - 42.74
+ 9.01 → + 7.02	+ 7.25 → + 5.26	- 40.99 → - 42.98	- 42.75 → - 44.74
+ 7.01 → + 5.02	+ 5.25 → + 3.26	- 42.99 → - 44.98	- 44.75 → - 46.74
+ 5.01 → + 3.02	+ 3.25 → + 1.26	- 44.99 → - 46.98	- 46.75 → - 48.74
+ 3.01 → + 1.02	+ 1.25 → - 0.74	- 46.99 → - 48.98	- 48.75 → - 50.74
+ 1.01 → - 0.98	- 0.75 → - 2.74	- 48.99 → - 50.98	- 50.75 → - 52.74
- 0.99 → - 2.98	- 2.75 → - 4.74	- 50.99 → - 52.98	- 52.75 → - 54.74
- 2.99 → - 4.98	- 4.75 → - 6.74	- 52.99 → - 54.98	- 54.75 → - 56.74
- 4.99 → - 6.98	- 6.75 → - 8.74	- 54.99 → - 56.98	- 56.75 → - 58.74
- 6.99 → - 8.98	- 8.75 → - 10.74	- 56.99 → - 58.98	- 58.75 → - 60.74
- 8.99 → - 10.98	- 10.75 → - 12.74	- 58.99 → - 60.98	- 60.75 → - 62.74
- 10.99 → - 12.98	- 12.75 → - 12.74	- 60.99 → - 62.98	- 62.75 → - 64.74
- 12.99 → - 14.98	- 14.75 → - 16.74	- 62.99 → - 64.98	- 64.75 → - 66.74
- 14.99 → - 16.98	- 16.75 → - 18.74	- 64.99 → - 66.98	- 66.75 → - 68.74
- 16.99 → - 18.98	- 18.75 → - 20.74	- 66.99 → - 68.98	- 68.75 → - 70.74
- 18.99 → - 20.98	- 20.75 → - 22.74	- 68.99 → - 70.98	- 70.75 → - 72.74
- 20.99 → - 22.98	- 22.75 → - 24.74	- 70.99 → - 72.98	- 72.75 → - 74.74
- 22.99 → - 24.98	- 24.75 → - 26.74	- 72.99 → - 74.98	- 74.75 → - 76.74
- 24.99 → - 26.98	- 26.75 → - 28.74	- 74.99 → - 76.98	- 76.75 → - 78.74
- 26.99 → - 28.98	- 28.75 → - 30.74	- 76.99 → - 78.98	- 78.75 → - 80.74
- 28.99 → - 30.98	- 30.75 → - 32.74	- 78.99 → - 80.98	- 80.75 → - 82.74
- 30.99 → - 32.98	- 32.75 → - 34.74	- 80.99 → - 82.98	- 82.75 → - 84.74
- 32.99 → - 34.98	- 34.75 → - 36.74	- 82.99 → - 84.98	- 84.75 → - 86.74
- 34.99 → - 36.98	- 36.75 → - 38.74	- 84.99 → - 86.98	- 86.75 → - 88.74

Symptom	Service Action	Notes

2. Subtract lower limit of amplitude range from the displayed amplitude:

   + 6.12 dBm (Displayed)
   - (+ 5.02) dBm (Lower Limit of range)

   + 1.10

3. Locate + 1.10 in Table 8-M-2 and obtain DAC input code.

   + 1.10 = 1030 (octal)

   Octal 1030 is applied to the DAC U9 as follows:

U9 Pins	13	12	11	10	9	8	7	6	5	4
	1	0	0	0	0	1	1	0	0	0

EXAMPLE 2:

Displayed amplitude is - 72.05 dBm (50 Ω).

1. Locate amplitude range in Table 8-M-1 (- 70.99 → 72.98).

2. Subtract the lower limit of amplitude range from the displayed amplitude:

   - 72.05 dBm (Displayed)
   - (- 72.98) dBm (Lower limit of range)

   +0.93 dBm

3. Locate + 0.93 in Table 8-M-2 and obtain DAC input code.

   +0.93 = 0701 (octal)

Symptom	Service Action	Notes
	Octal 0701 is applied to the DAC U9 as follows: U9 Pins: 13 12 11 10 9 8 7 6 5 4 0 1 1 1 0 0 0 0 0 1 To obtain the DAC input code for a 75 ohm output impedance, locate the amplitude range in the 75 Ω column of Table 8-M-1 and proceed as in Examples 1 and 2.	

Table 8-M-2. DAC Input Code (In Octal) for Fractional Part of Amplitude.

	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0	5	11	16	22	27	34	40	45	51
0.1	56	63	67	74	101	105	112	117	123	130
0.2	135	141	146	153	157	164	171	175	202	207
0.3	214	220	225	232	237	243	250	255	262	266
0.4	273	300	305	312	316	323	330	335	342	347
0.5	353	360	365	372	377	404	411	415	422	427
0.6	434	441	446	453	460	465	472	477	504	511
0.7	515	522	527	534	541	546	553	560	565	572
0.8	577	604	611	616	623	630	636	643	650	655
0.9	662	667	674	701	706	713	720	725	733	740
1.0	745	752	757	764	771	777	1004	1011	1016	1023
1.1	1030	1036	1043	1050	1055	1062	1070	1075	1102	1107
1.2	1115	1122	1127	1134	1142	1147	1154	1162	1167	1174
1.3	1201	1207	1214	1221	1227	1234	1241	1247	1254	1262
1.4	1267	1274	1302	1307	1314	1322	1327	1335	1342	1350
1.5	1355	1362	1370	1375	1403	1410	1416	1423	1431	1436
1.6	1444	1451	1457	1464	1472	1477	1505	1512	1520	1525
1.7	1533	1541	1546	1554	1561	1567	1574	1602	1610	1615
1.8	1623	1631	1636	1644	1651	1657	1665	1672	1700	1706
1.9	1713	1721	1727	1735	1742	1750	1756	1764	1771	1777

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A6	03335-66538	1	PC ASSEMBLY, OUTPUT AMP/LEVEL CONTROL	28480	03335-66538
A6C4	0160-0205		CAPACITOR-FXD 10PF +-5% 500WVDC MICA	28480	0160-0205
A6C5	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A6C6	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A6C8	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A6C9	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A6C11	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A6C12	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A6C13	0160-2306		CAPACITOR-FXD 27PF +-5% 300WVDC MICA	28480	0160-2306
A6C14	0140-0195		CAPACITOR-FXD 130PF +-5% 300WVDC MICA	72136	DM15F131J0300WV1CR
A6C15	0160-2204	6	CAPACITOR-FXD 100PF +-5% 300WVDC MICA	28480	0160-2204
A6C16	0140-0206		CAPACITOR-FXD 270PF +-5% 500WVDC MICA	72136	DM15F271J0500WV1CR
A6C17	0160-0939	2	CAPACITOR-FXD 430PF +-5% 300WVDC MICA	28480	0160-0939
A6C18	0140-0200	1	CAPACITOR-FXD 390PF +-5% 300WVDC MICA	72136	DM15F391J0300WV1CR
A6C19	0140-0199	1	CAPACITOR-FXD 240PF +-5% 300WVDC MICA	72136	DM15F241J0300WV1CR
A6C20	0150-0096	1	CAPACITOR-FXD .05UF +80-20% 100WVDC CER	28480	0150-0096
A6C22	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A6C23	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A6C24	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A6C25	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A6C26	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A6C27	0180-1779	4	CAPACITOR-FXD 18UF+-10% 35VDC TA	56289	150D186X9035R2
A6C28	0180-1779		CAPACITOR-FXD 18UF+-10% 35VDC TA	56289	150D186X9035R2
A6C36	0160-0160	1	CAPACITOR-FXD 8200PF +-10% 200WVDC POLYE	56289	292P82292
A6C37	0160-2150	1	CAPACITOR-FXD 33PF +-5% 300WVDC MICA	28480	0160-2150
A6C38	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A6C39	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A6C40	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A6C41	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A6C42	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A6C43	0180-1794	2	CAPACITOR-FXD 22 UF +-10% 35VDC TA	04200	150D226X9035R2
A6C44	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A6C45	0180-1794		CAPACITOR-FXD 22 UF +-10% 35VDC TA	04200	150D226X9035R2
A6C46	0160-0128		CAPACITOR-FXD 2.2UF +-20% 50WVDC CER	28480	0160-0128
A6C47	0160-0166	1	CAPACITOR-FXD .068UF +-10% 200WVDC POLYE	56289	292P68392
A6C48	0160-0336		CAPACITOR-FXD 100PF +-1% 300WVDC MICA	28480	0160-0336
A6C49	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A6C50	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A6C51	0160-0763		CAPACITOR-FXD 5PF +-10% 500WVDC MICA	28480	0160-0763
A6C52, C53	0160-0127		CAPACITOR-FXD 1UF +-20% 25WVDC CER	28480	0160-0127
A6C54	0150-0050	6	CAPACITOR-FXD 1000PF +80-20% 1000WVDC	28480	0150-0050
A6C55, C56	0180-1794		CAPACITOR-FXD 22UF +-10% 35WVDC	56289	150D226X9035R2
A6C59	0160-2237		CAPACITOR-FXD 1.2PF +-.25PF 500WVDC CER	28480	0160-2237
A6C60	0150-0059	1	CAPACITOR-FXD 3.3 PF +-.25PF 500WVDC CER	28480	0150-0059
A6C61	0140-0198		CAPACITOR-FXD 200PF +-5% 300WVDC MICA	72136	DM15F201J0300WV1CR
A6C62	0140-0234	1	CAPACITOR-FXD 500PF +-1% 300WVDC MICA	72136	DM15F501F0300WV1C
A6C63	0140-0198		CAPACITOR-FXD 200PF +-5% 300WVDC MICA	72136	DM15F201J0300WV1CR
A6C64	0160-0298	1	CAPACITOR-FXD 1500PF +-10% 200WVDC POLYE	56289	292P15292
A6C65	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A6C66	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A6C67	0180-0374		CAPACITOR-FXD 10UF+-10% 20VDC TA	56289	150D106X9020B2
A6C68	0160-0576	2	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A6C69	0160-0576		CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-0576
A6C70	0140-0196		CAPACITOR-FXD 150PF +-5% 300WVDC MICA	72136	DM15F151J0300WV1CR
A6C71	0160-0194	2	CAPACITOR-FXD .015UF +-10% 200WVDC POLYE	56289	292P15392
A6C72	0140-0196		CAPACITOR-FXD 150PF +-5% 300WVDC MICA	72136	DM15F151J0300WV1CR
A6C73	0160-2199		CAPACITOR-FXD 30PF +-5% 300WVDC MICA	28480	0160-2199
A6C74	0160-0194		CAPACITOR-FXD .015UF +-10% 200WVDC POLYE	56289	292P15392
A6C75	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A6C76	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A6C81	0160-3622		CAPACITOR-FXD .1UF +80-20% 100WVDC CER	28480	0160-3622
A6C82	0160-2611	2	CAPACITOR-FXD 1UF +-10% 50WVDC MET POLYE	28480	0160-2611
A6C83	0160-2611		CAPACITOR-FXD 1UF +-10% 50WVDC MET POLYE	28480	0160-2611
A6C84	0160-2964		CAPACITOR-FXD .01UF +80-20% 25WVDC CER	28480	0160-2964
A6CR1	1901-0044	6	DIODE-SWITCHING 50V 50MA 6NS	28480	1901-0044
A6CR2	1901-0044		DIODE-SWITCHING 50V 50MA 6NS	28480	1901-0044
A6CR3	1901-0535	2	DIODE-SCHOTTKY	28480	1901-0535
A6CR4	1901-0535		DIODE-SCHOTTKY	28480	1901-0535
A6CR5	1902-0025	1	DIODE-ZNR 10V 5% DO-7 PD=.4W TC=+.06%	28480	1902-0025
A6C85 – A6C92	0180-1779	8	CAPACITOR-FXD 18UF +-10% 35VDC TA	04200	150D186X9035R2
A6C93	0150-0091	1	CAPACITOR-FXD 1.5PF +-.25PF 500VDC CER	28480	0150-0091
A6CR1	1901-0044	6	DIODE-SWITCHING 50V 50MA 6NS	28480	1901-0044
A6CR2	1901-0044		DIODE-SWITCHING 50V 50MA 6NS	28480	1901-0044
A6CR3	1901-0535	2	DIODE-SCHOTTKY	28480	1901-0535
A6CR4	1901-0535		DIODE-SCHOTTKY	28480	1901-0535
A6CR5	1902-0025	1	DIODE-ZNR 10V 5% DO-7 PD=.4W TC=+.06%	28480	1902-0025

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A6CR6	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR7	1902-0680	1	DIODE-ZNR 1N827 6.2V 5% DO-7 PD=.25W	03877	1N827
A6CR8	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR9	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR10	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR11	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR12	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR13	1902-3085		DIODE-ZNR 4.75V 5% DO-7 PO=.4W TC=.019%	15818	CD 35613
A6CR14	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR15	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR16	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR17	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6CR18	1901-0040		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A6J1	1250–1591		CONNECTOR,RF SMC M SGL-HOLE-RR 50-OHM OUTPUT	28480	1250–
A6J2	1250–0826		CONNECTOR, RF, SMC M SGL HOLE, INPUT	98291	50 027–0000
A6L2, L3	9100-0541		COIL-FXD MOLDED RF CHOKE 250UH 10%	28480	9100-0541
A6L4	9100-3551		COIL-MLD 1UH 5% Q=50 .155DX.375LG	24226	9493
A6L5	9100-3315		COIL-MLD 820NH 5% .155DX.375LG	24226	9403
A6L6	9140-0094	1	COIL-MLD 680NH 10% Q=50 .155DX.375LG	24226	15/680
A6MP1	03335-61213	1	EXTRUSION ASSEMBLY	28480	03335-61213
A6MP2	8160–0304	2	R.F. SHIELD	28480	8160–0304
A6MP3	03335-00627	1	P.C. SHIELD	28480	03335-00627
A6Q1	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
	1205-0037	4	HEAT SINK TO-36-PKG	28480	1205-0037
A6Q2	1853–0203		TRANSISTOR PNP SI TO–18 PD=360MW	28480	1853–0203
	1205-0037		HEAT SINK TO-36-PKG	28480	1205-0037
A6Q3	1853–0203		TRANSISTOR PNP SI TO–18 PD=360MW	28480	1853–0203
	1205-0037		HEAT SINK TO-36-PKG	28480	1205-0037
A6Q4	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
	1205-0037		HEAT SINK TO-36-PKG	28480	1205-0037
A6Q5	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A6Q6	1853-0018		TRANSISTOR PNP SI TO-72 PD=200MW FT=1GHZ	28480	1853-0018
A6Q7	1853-0018		TRANSISTOR PNP SI TO-72 PD=200MW FT=1GHZ	28480	1853-0018
A6Q8	1854-0345		TRANSISTOR NPN 2N5179 SI TO-72 PD=200MW	04713	2N5179
A6Q9	1853-0203		TRANSISTOR PNP SI TO-18 PD=360MW	28480	1853-0203
A6Q10	1854-0019	4	TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A6Q11	1854-0019		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A6Q12	1853-0203		TRANSISTOR PNP SI TO-18 PD=360MW	28480	1853-0203
A6Q13	1854-0378		TRANSISTOR NPN 2N5109 SI TO-39 PD=800MW	02735	2N5109
	1205-0011	4	HEAT SINK TO-5/TO-39-PKG	28480	1205-0011
A6Q14	1853-0293	2	TRANSISTOR PNP 2N5583 SI TO-39 PD=1W	04713	2N5583
	1205-0011		HEAT SINK TO-5/TO-39-PKG	28480	1205-0011
A6Q15	1853-0293		TRANSISTOR PNP 2N5583 SI TO-39 PD=1W	04713	2N5583
	1205-0011		HEAT SINK TO-5/TO-39-PKG	28480	1205-0011
A6Q16	1854-0378		TRANSISTOR NPN 2N5109 SI TO-39 PD=800MW	02735	2N5109
	1205-0011		HEAT SINK TO-5/TO-39-PKG	28480	1205-0011
A6Q17	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A6Q18	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A6Q19	1853-0264	1	TRANSISTOR PNP SI PD=310MW FT=100MHZ	04713	SPS6793
A6Q20	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A6Q21	1854-0215		TRANSISTOR NPN SI PD=350MW FT=300MHZ	04713	SPS 3611
A6R1	0698-4411	5	RESISTOR 140 1% .125W F TC=0+-100	24546	C4-1/8-T0-140R-F
A6R2	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A6R3	0757-0273		RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A6R4	0757-0273		RESISTOR 3.01K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3011-F
A6R5	0757-0421		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A6R6	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A6R7	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A6R8	0757-0421		RESISTOR 825 1% .125W F TC=0+-100	24546	C4-1/8-T0-825R-F
A6R9	0698-4453	3	RESISTOR 402 1% .125W F TC=0+-100	24546	C4-1/8-T0-402R-F
A6R10	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A6R11	0698–4610	2	RESISTOR 866 1% .125W F TC=0+-100	03412	C5–1/4–T0–866R–F
A6R12	0698–4610		RESISTOR 866 1% .125W F TC=0+-100	03412	C5–1/4–T0–866R–F
A6R13	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A6R14	0698-4453		RESISTOR 402 1% .125W F TC=0+-100	24546	C4-1/8-T0-402R-F
A6R15	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A6R16	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A6R17	0698-4421	2	RESISTOR 249 1% .125W F TC=0+-100	24546	C4-1/8-T0-249R-F
A6R18	0698-4421		RESISTOR 249 1% .125W F TC=0+-100	24546	C4-1/8-T0-249R-F
A6R19	0698-3558	6	RESISTOR 4.02K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4021-F
A6R26	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A6R27	0757-0403	1	RESISTOR 121 1% .125W F TC=0+-100	24546	C4-1/8-T0-121R-F
A6R28	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R29	0757-0422	3	RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A6R30	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A6R31	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F

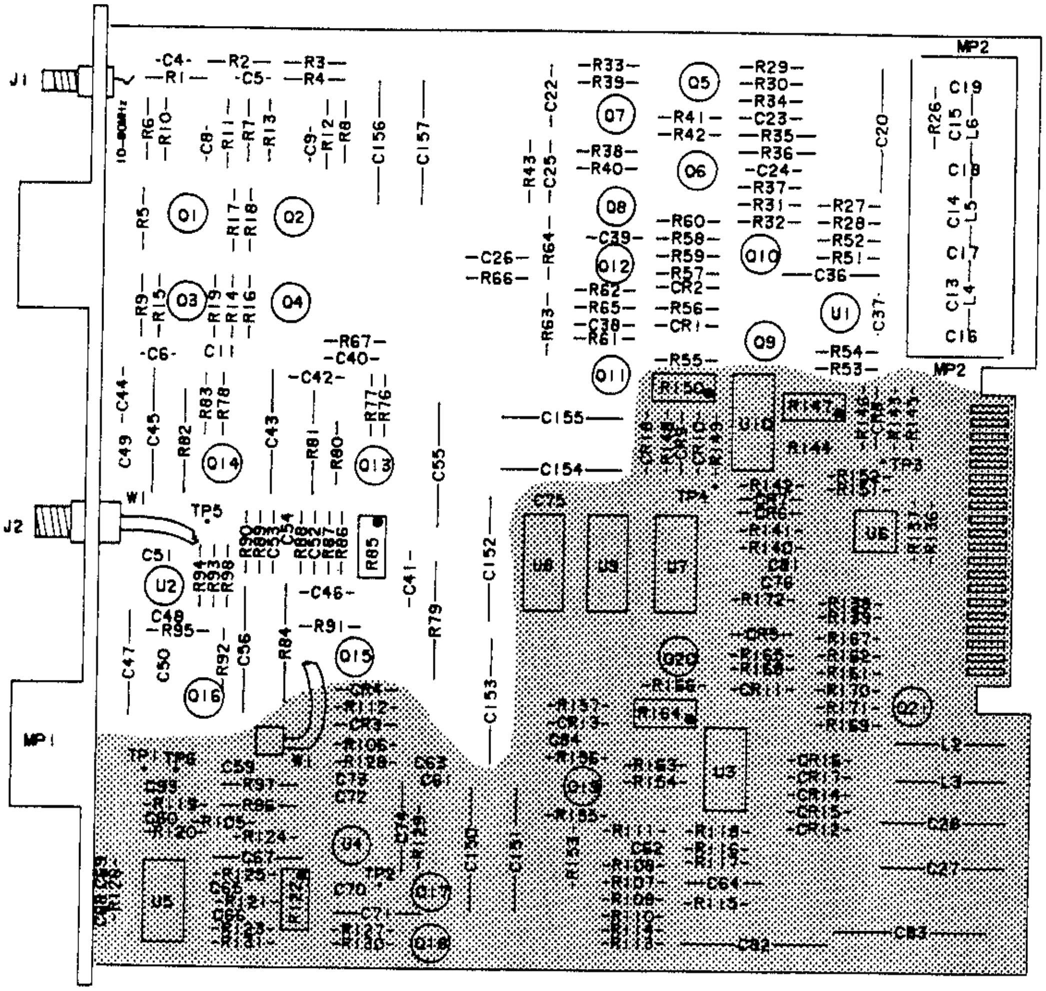
Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A6R32	0757-0422		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A6R33	0698-4456	2	RESISTOR 549 1% .125W F TC=0+-100	24546	C4-1/8-T0-549R-F
A6R34	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A6R35	0757-0734	9	RESISTOR 1.21K 1% .25W F TC=0+-100	03412	C5-1/4-T0-1211-F
A6R36	0757-0734		RESISTOR 1.21K 1% .25W F TC=0+-100	03412	C5-1/4-T0-1211-F
A6R37	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A6R38	0698-4456		RESISTOR 549 1% .125W F TC=0+-100	24546	C4-1/8-T0-549R-F
A6R39	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A6R40	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A6R41	0757-0410	2	RESISTOR 301 1% .125W F TC=0+-100	24546	C4-1/8-T0-301R-F
A6R42	0757-0410		RESISTOR 301 1% .125W F TC=0+-100	24546	C4-1/8-T0-301R-F
A6R43	0698-3558		RESISTOR 4.02K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4021-F
A6R51	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R52	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R53	0698-3154	2	RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A6R54	0698-3264		RESISTOR 11.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1182-F
A6R55	0698-4454	2	RESISTOR 523 1% .125W F TC=0+-100	24546	C4-1/8-T0-523R-F
A6R56	0698-4411		RESISTOR 140 1% .125W F TC=0+-100	24546	C4-1/8-T0-140R-F
A6R57	0698-4411		RESISTOR 140 1% .125W F TC=0+-100	24546	C4-1/8-T0-140R-F
A6R58	0698-3264		RESISTOR 11.8K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1182-F
A6R59	0698-3154		RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A6R60	0698-4454		RESISTOR 523 1% .125W F TC=0+-100	24546	C4-1/8-T0-523R-F
A6R61	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A6R62	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A6R63	0698-4411		RESISTOR 140 1% .125W F TC=0+-100	24546	C4-1/8-T0-140R-F
A6R64	0698-4411		RESISTOR 140 1% .125W F TC=0+-100	24546	C4-1/8-T0-140R-F
A6R65	0698-4508	1	RESISTOR 78.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-7872-F
A6R66	0757-0422		RESISTOR 909 1% .125W F TC=0+-100	24546	C4-1/8-T0-909R-F
A6R67	0698-4406	1	RESISTOR 115 1% .125W F TC=0+-100	24546	C4-1/8-T0-115R-F
A6R76	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R77	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A6R78	0757-0384		RESISTOR 20 1% .125W F TC=0+-100	19701	MF4C1/8-T0-20R0-F
A6R79	0698-3180	2	RESISTOR 68 2% 2W MO TC=0+-200	11502	RG42
A6R80	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A6R81	0760-0022	2	RESISTOR 330 2% 1W MO TC=0+-200	11502	RG32
A6R82	0760-0022		RESISTOR 330 2% 1W MO TC=0+-200	11502	RG32
A6R83	0757-0346		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A6R84	0698-3180		RESISTOR 68 2% 2W MO TC=0+-200	11502	RG42
A6R85	2100-3089	1	RESISTOR-TRMR 5K 10% C TOP-ADJ 17-TRN	03744	3292W-1-502
A6R86	0698-0084	1	RESISTOR 2.15K 1% .125W F TC=0+-200	24546	C4-1/8-T0-2151-F
A6R87	0698-4433	1	RESISTOR 2.26K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2261-F
A6R88	0698-4468	2	RESISTOR 1.13K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1131-F
A6R89	0698-4468		RESISTOR 1.13K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1131-F
A6R90	0698-4425	1	RESISTOR 1.54K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1541-F
A6R91	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A6R92	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A6R93	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R94	0698-7332	2	RESISTOR 1M 1% .125W F TC=0+-100	19701	MF5C1/8-T0-1004-F
A6R95	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R96	0698-7448	2	RESISTOR 100 .1% .25W F TC=0+-25	19701	MF52C1/4-T9-100R-B
A6R97	0698-7448		RESISTOR 100 .1% .25W F TC=0+-25	19701	MF52C1/4-T9-100R-B
A6R98	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R105	0757-0430	1	RESISTOR 2.21 K 1% .125W F TC=0+-100	03292	C4-1/8-T0-2211-F
A6R106	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A6R107	0698-3455	1	RESISTOR 261K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2613-F
A6R108	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R109	0757-0455	1	RESISTOR 36.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3652-F
A6R110	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R111	0757-0469	1	RESISTOR 150K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1503-F
A6R112	0757-0277		RESISTOR 49.9 1% .125W F TC=0+-100	24546	C4-1/8-T0-4992-F
A6R113	0698-3228		RESISTOR 49.9K 1% .125W F TC=0+-100	24546	C-4, T=0
A6R114	0698-3359	1	RESISTOR 12.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1272-F
A6R115	0698-3228		RESISTOR 49.9K 1% .125W F TC=0+-100	24546	C-4, T=0
A6R116	0698-3499	1	RESISTOR 40.2K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4022-F
A6R117	0757-0289	1	RESISTOR 13.3K 1% .125W F TC=0+-100	19701	MF4C1/8-T0-1332-F
A6R118	0698-4519	1	RESISTOR 140K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1403-F
A6R119	0698-3147	1	RESISTOR 191 1% .125W F TC=0+-100	24546	C4-1/8-T0-1910-F
A6R120	0698-4450	1	RESISTOR 324 1% .125W F TC=0+-100	24546	C4-1/8-T0-324R-F
A6R121	0698-7332		RESISTOR 1M 1% .125W F TC=0+-100	19701	MF5C1/8-T0-1004-F
A6R122	2100-3659	2	RESISTOR-TRMR 20K 10% C TOP-ADJ 17-TRN		
A6R123	0698-7956	2	RESISTOR 99K 1% .125W F TC=0+-25	19701	MF4C1/8-T9-9902-F
A6R124	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A6R125	0698-7956		RESISTOR 99K 1% .125W F TC=0+-25	19701	MF4C1/8-T9-9902-F
A6R126	0698-3452	1	RESISTOR 147K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1473-F
A6R127	0683-4755	2	RESISTOR 4.7M 5% .25W FC TC=-900/+1100	01121	CB4755
A6R128	0683-4755		RESISTOR 4.7M 5% .25W FC TC=-900/+1100	01121	CB4755

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A6R129	0683-2235	1	RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A6R130	0757-0427		RESISTOR 1.5K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1501-F
A6R131	0698-4407	1	RESISTOR 118 1% .125W F TC=0+-100	24546	C4-1/8-T0-118R-F
A6R136	0683-1815	5	RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A6R137	0683-1815		RESISTOR 180 5% .25W FC TC=-400/+600	01121	CB1815
A6R138	0683-4715		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A6R139	0683-4715		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A6R140	0683-1845	1	RESISTOR 180K 5% .25W FC TC=-800/+900	01121	CB1845
A6R141	0683-4735		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A6R142	0683-5115		RESISTOR 510 5% .25W FC TC=-400/+600	01121	CB5115
A6R143	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A6R144	2100-3083	1	RESISTOR-TRMR 500 10% C TOP-ADJ 17-TRN	03744	3292W-1-501
A6R145	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A6R146	0698-4470		RESISTOR 6.98K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6981-F
A6R147	2100-3286	1	RESISTOR-TRMR 10K 10% C TOP-ADJ 17-TRN	03744	3292W-1-103
A6R148	0757-0437	1	RESISTOR 4.75K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4751-F
A6R149	0698-3449	1	RESISTOR 28.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2872-F
A6R150	2100-3096		RESISTOR-TRMR 50K 10% C TOP-ADJ 17-TRN	03744	3292W-1- 03
A6R151	0757-0280		RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A6R152	0698-4465	1	RESISTOR 931 1% .125W F TC=0+-100	24546	C4-1/8-T0-931R-F
A6R153	0698-4486	2	RESISTOR 24.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2492-F
A6R154	0698-4486		RESISTOR 24.9K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2492-F
A6R155	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A6R156	0683-1025		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A6R157	0683-7525		RESISTOR 7.5K 5% .25W FC TC=-400/+700	01121	CB7525
A6R161	0698-3279		RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A6R162	0698-3279		RESISTOR 4.99K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4991-F
A6R163	0698-4307	1	RESISTOR 14.3K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1432-F
A6R164	2100-3659	2	RESISTOR-TRMR 20K 10% C TOP-ADJ 1-TRN	03744	3292W-I-203
A6R165	0683-2025		RESISTOR 2K 5% .25W FC TC=-400/+700	01121	CB2025
A6R166	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A6R167	0683-1035		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A6R168	0757-0442		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A6R169	0683-8225	1	RESISTOR 8.2K 5% .25W FC TC=-400/+700	01121	CB8225
A6R170	0683-5625	2	RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A6R171	0683-5105		RESISTOR 51 5% .25W FC TC=-400/+500	01121	CB5105
A6R172	0683-7525		RESISTOR 7.5K 5% .25W FC TC=-400/+700	01121	CB7525
A6U1	1820-0223	2	IC LM 301A OP AMP	27014	LM301AH
A6U2	1820-0223		IC LM 301A OP AMP	27014	LM301AH
A6U3	1826-0312	5	IC MC 3403 OP AMP	04713	MC3403P
A6U4	1826-0043		IC LM 307 OP AMP	27014	LM307H
A6U5	5080-9069	1	THERMISTOR/CONVERTER	28480	5080-9069
A6U6	1990-0461	1	OPTO-ISOLATOR LED-IC GATE IF=10MA-MAX	28480	1990-0461
A6U7	1820-0976	2	IC-DIGITAL CD4015AE CMOS DUAL D-TYPE	02735	CD4015AY
A6U8	1820-0976		IC-DIGITAL CD4015AE CMOS DUAL D-TYPE	02735	CD4015AY
A6U9	1826-0197	1	IC-DIGITAL DAC100CCT1 TTL* D/A	06665	DAC100CCT1
A6U10	1826-0312		IC MC 3403 OP AMP	04713	MC3403P
A6W1	03335-61641	1	CABLE, OUTPUT	28480	03335-61641
		1			

Fig 8-M-1
Sht 1of4



A6
-hp- Part No. 03335-66538
Output Amplifier

Fig 8-M-1
Sht 2 of 4

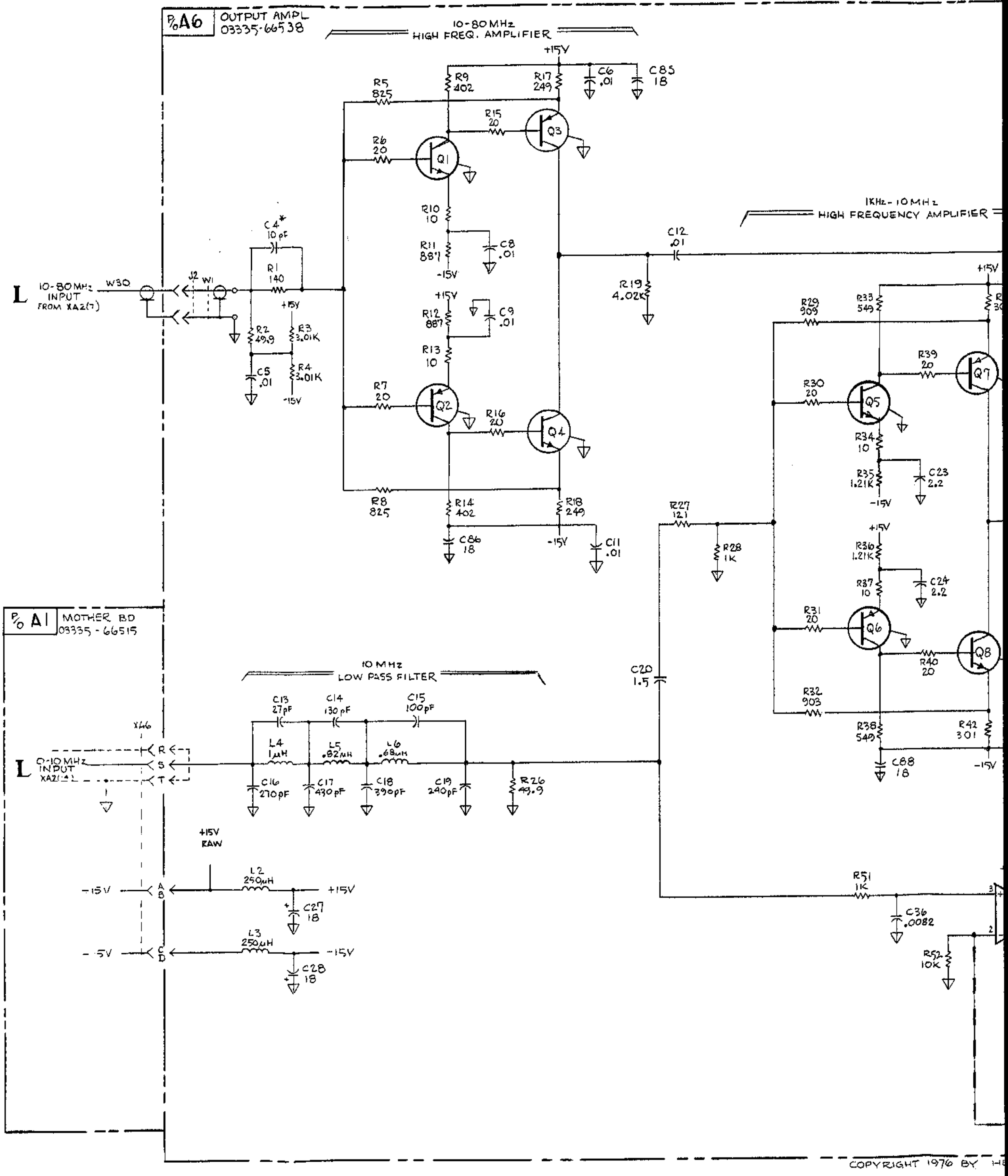


Fig 8-M-1 Sht 3 of 4

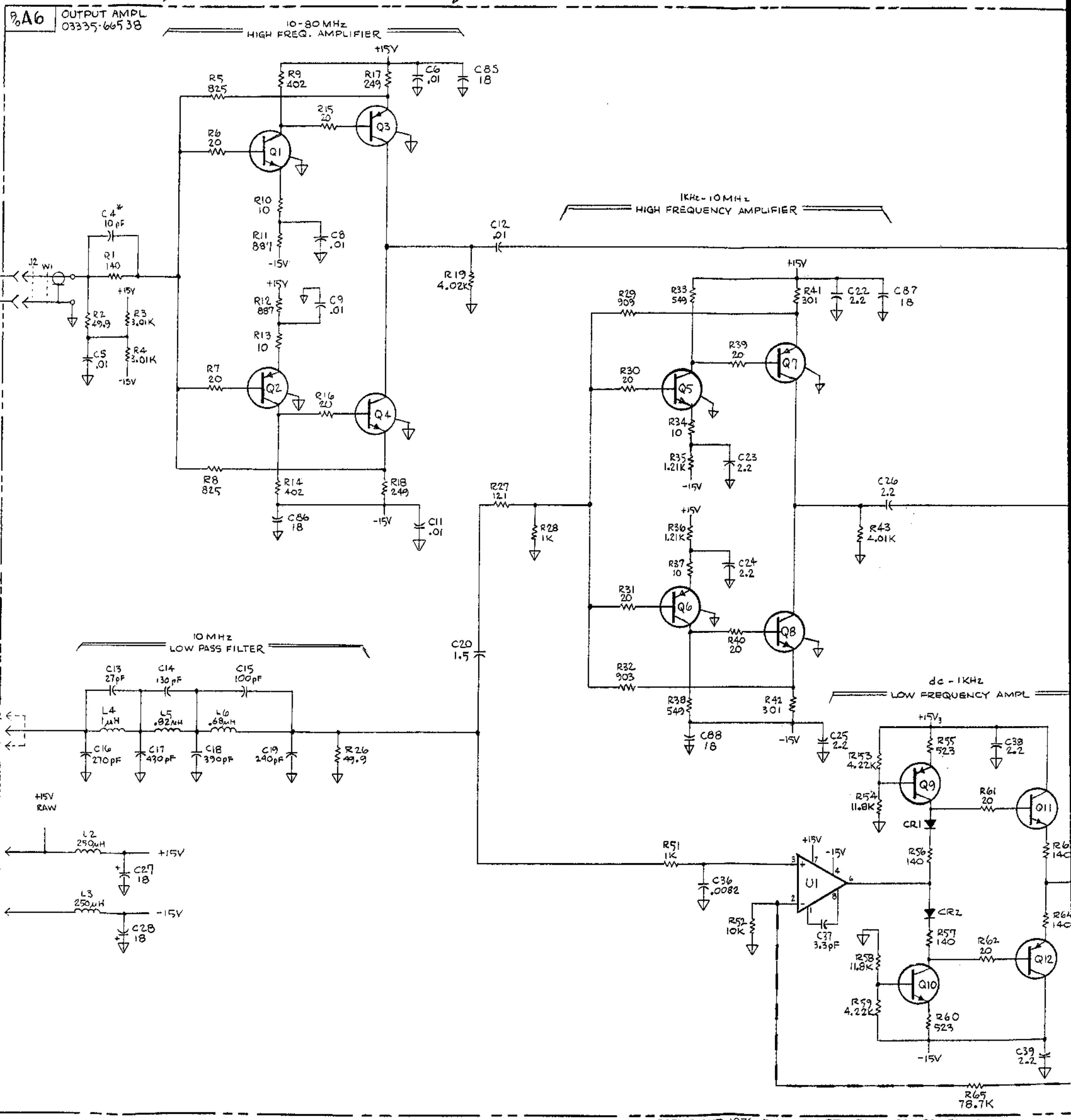
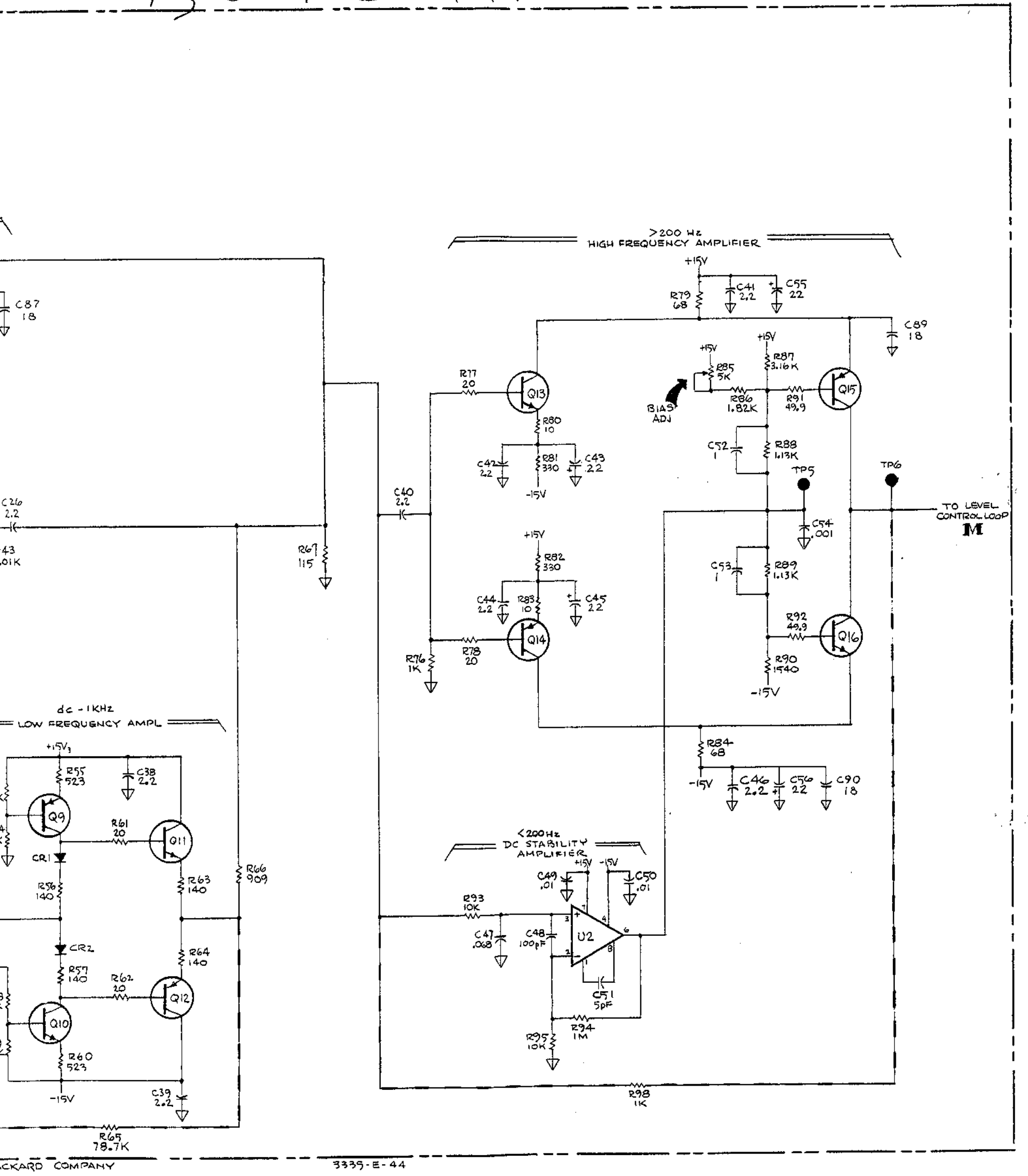


Fig 8-M-1 Sht 4 of 4



M

Figure 8-M-1. Schematic Diagram, Output Amplifier (03335-66538) A6.

Fig 8-M-2
Sht 1 of 3

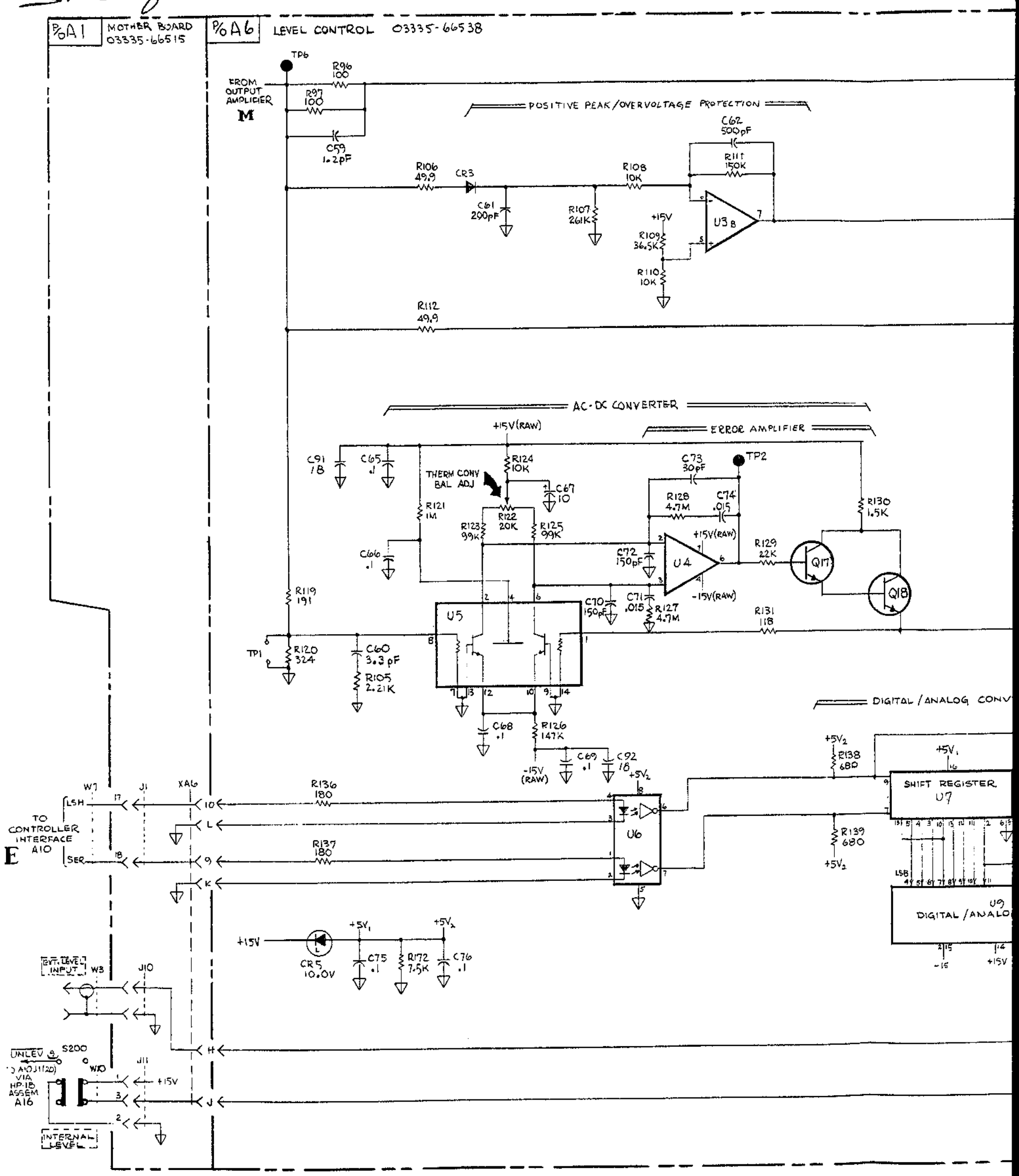
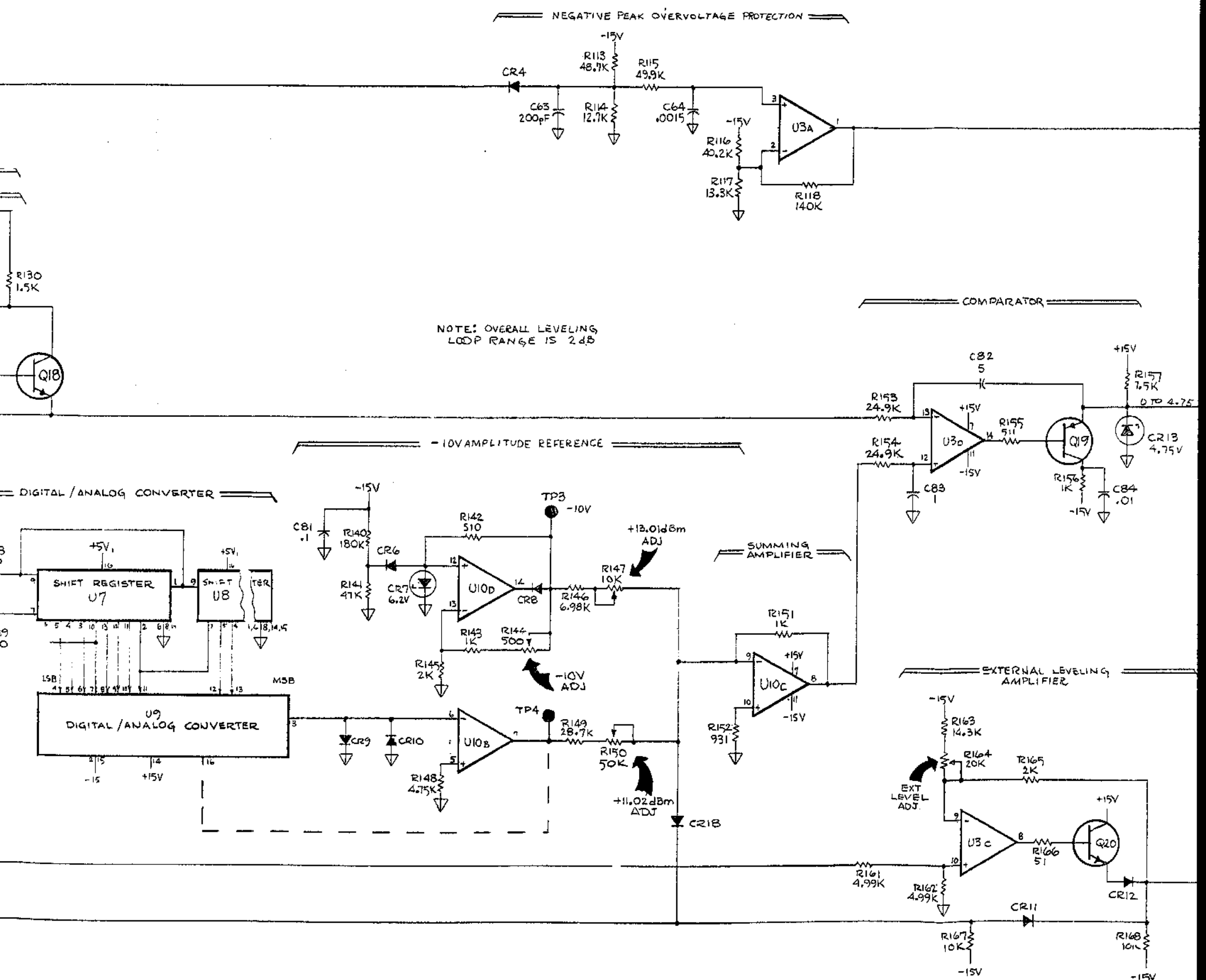
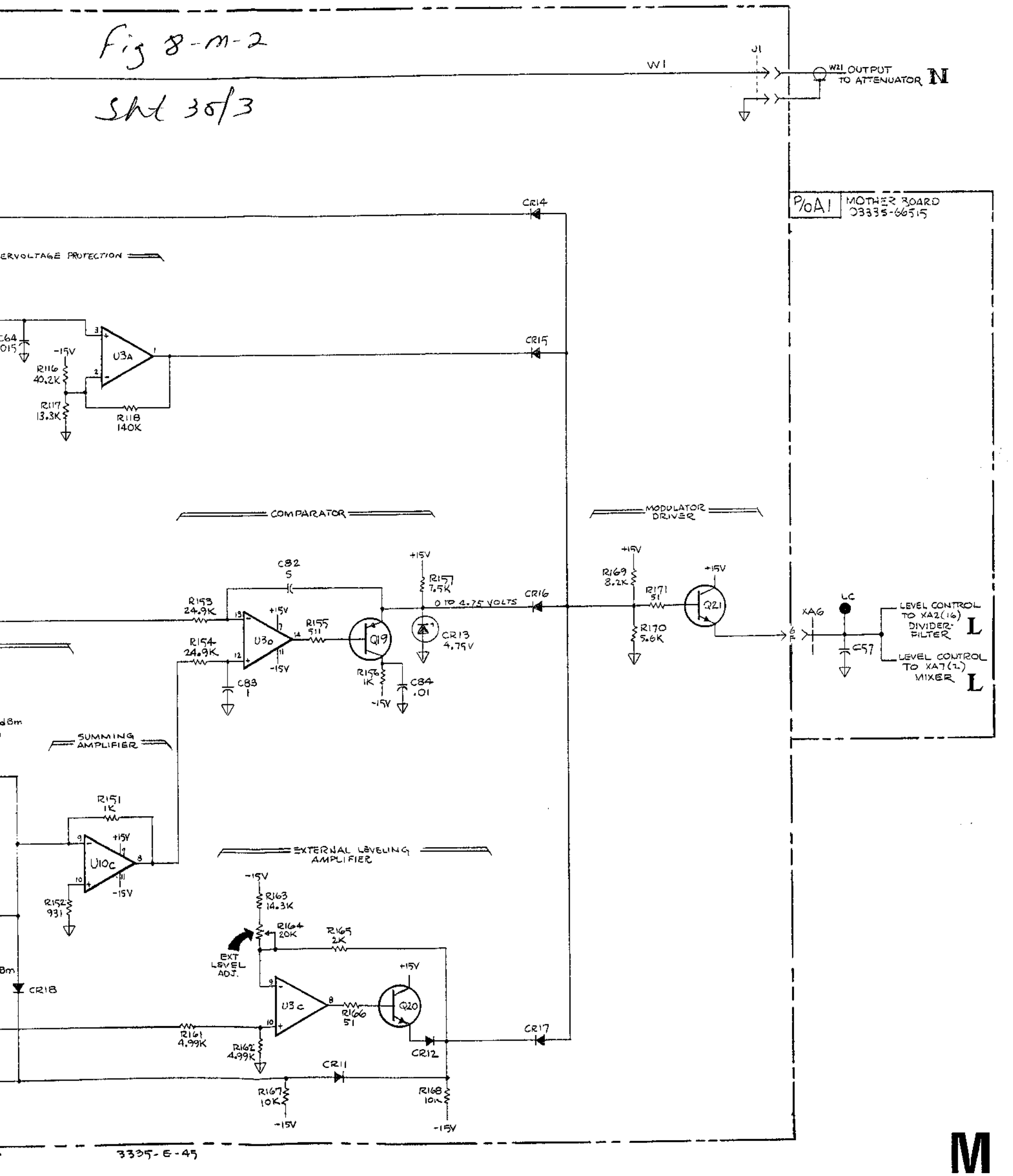


Fig 8-m-2
Sht 2 of 3



 3335-E-45



M

Figure 8-M-2. Schematic Diagram, Level Control (03335-66538) A6.

Fig 8-m-3
Sht 1 of 3

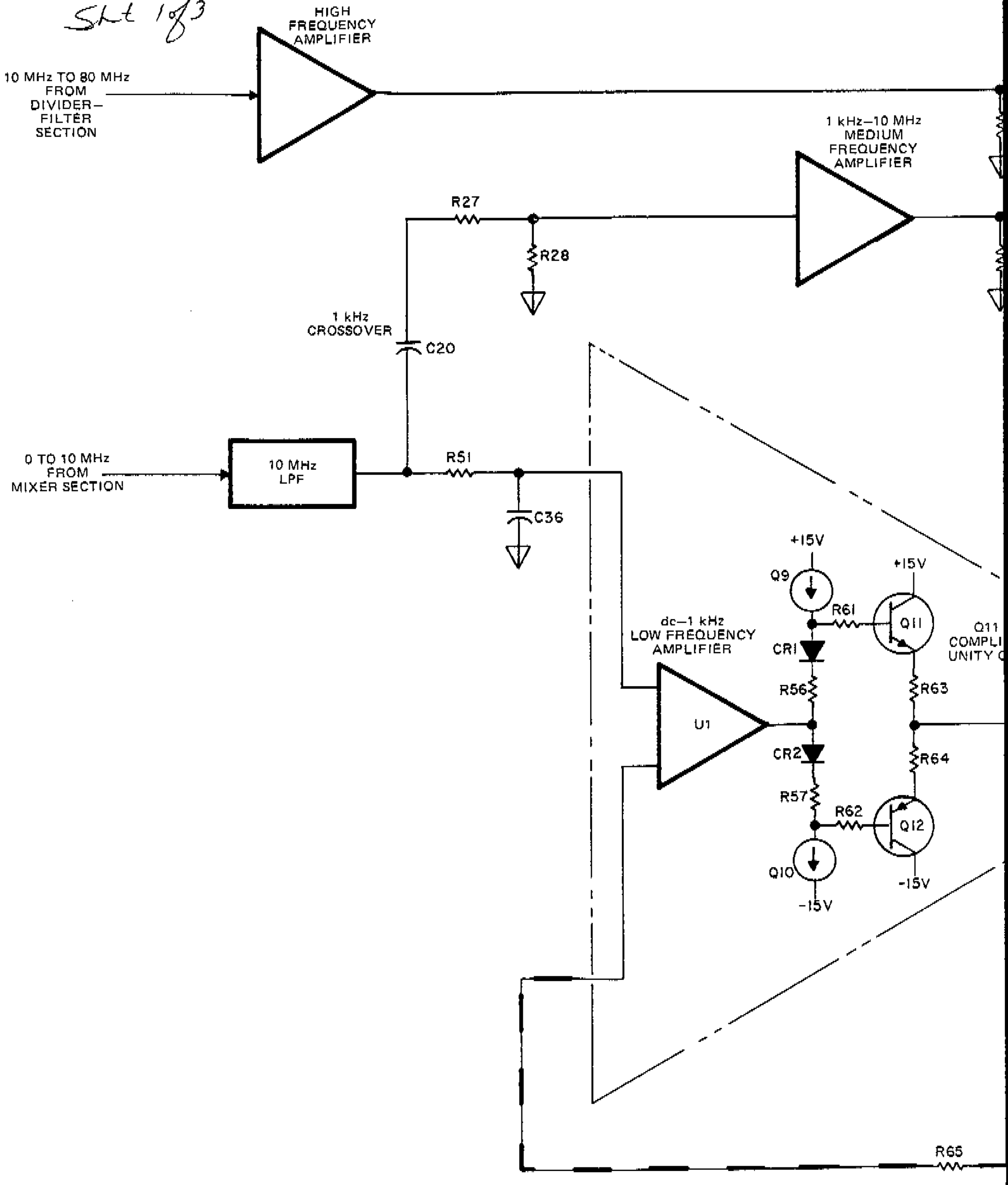


Fig 8-m-3
Sht 2 of 3

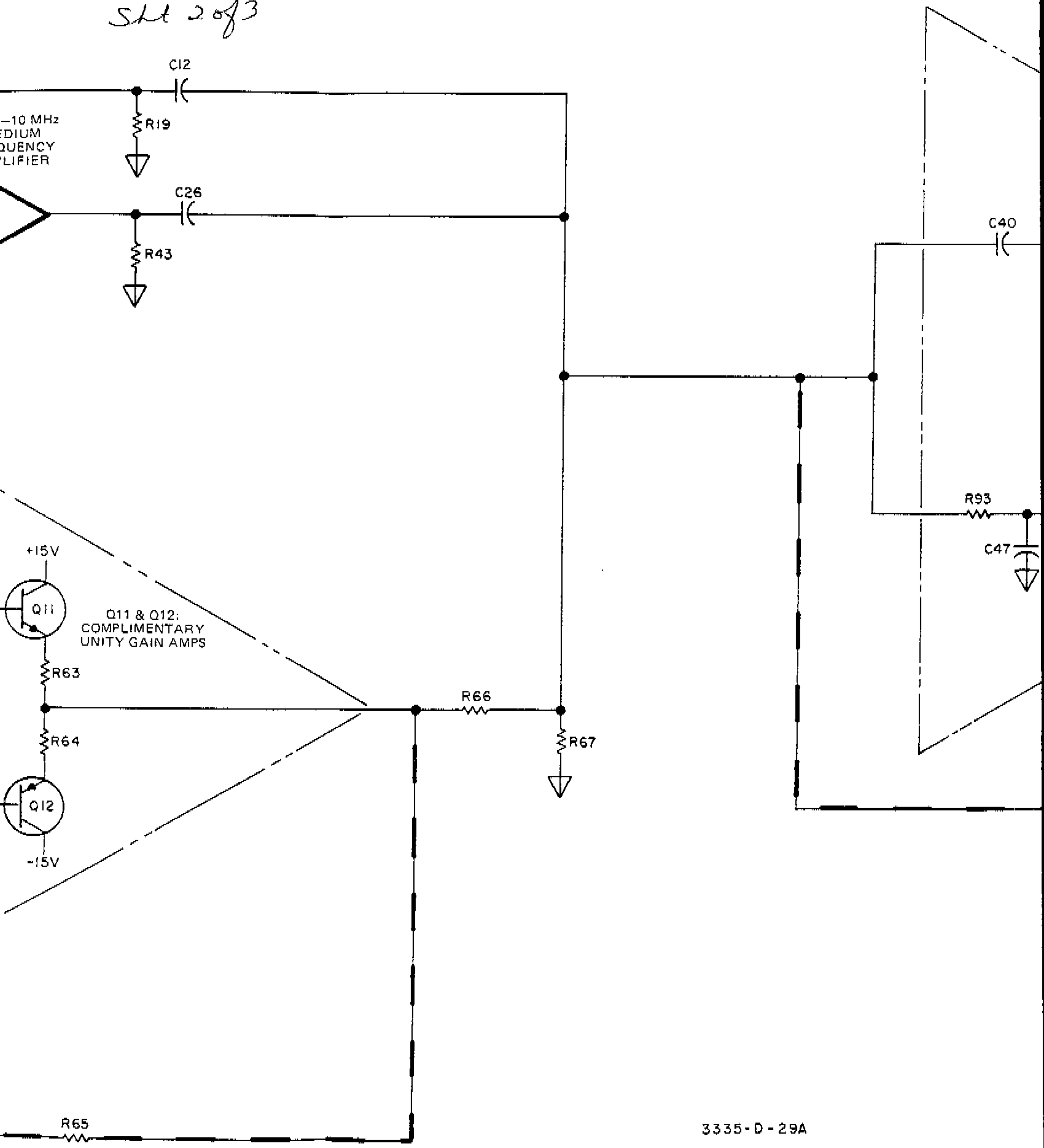


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Fig 8-M-3
Sht 3 of 3

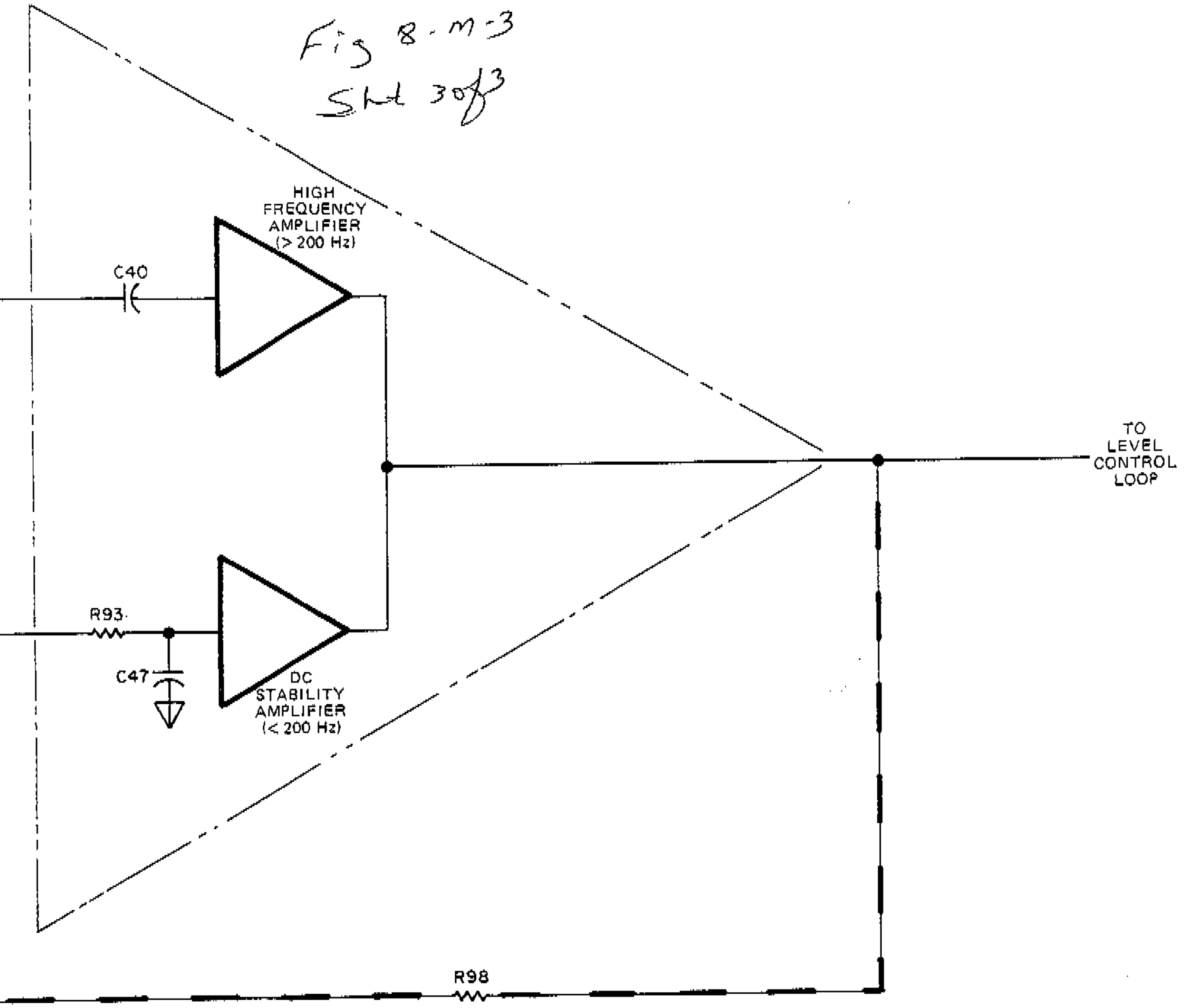


Figure 8-M-3. Block Diagram, Output Amplifier (03335-66538) A6.

Fig 8-m-4
Sht 1 of 3

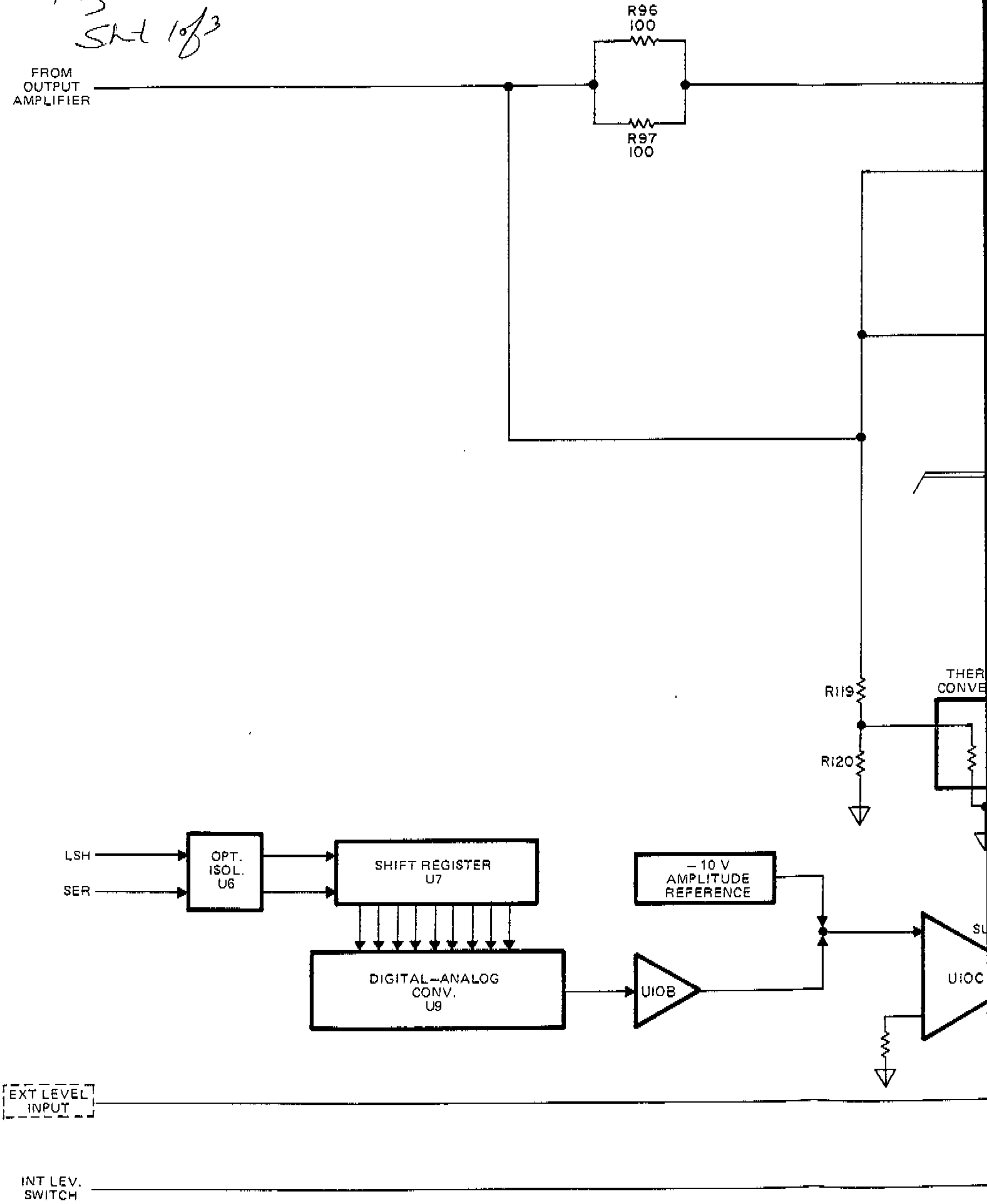


Fig 8-M-4
Sht 2 of 3

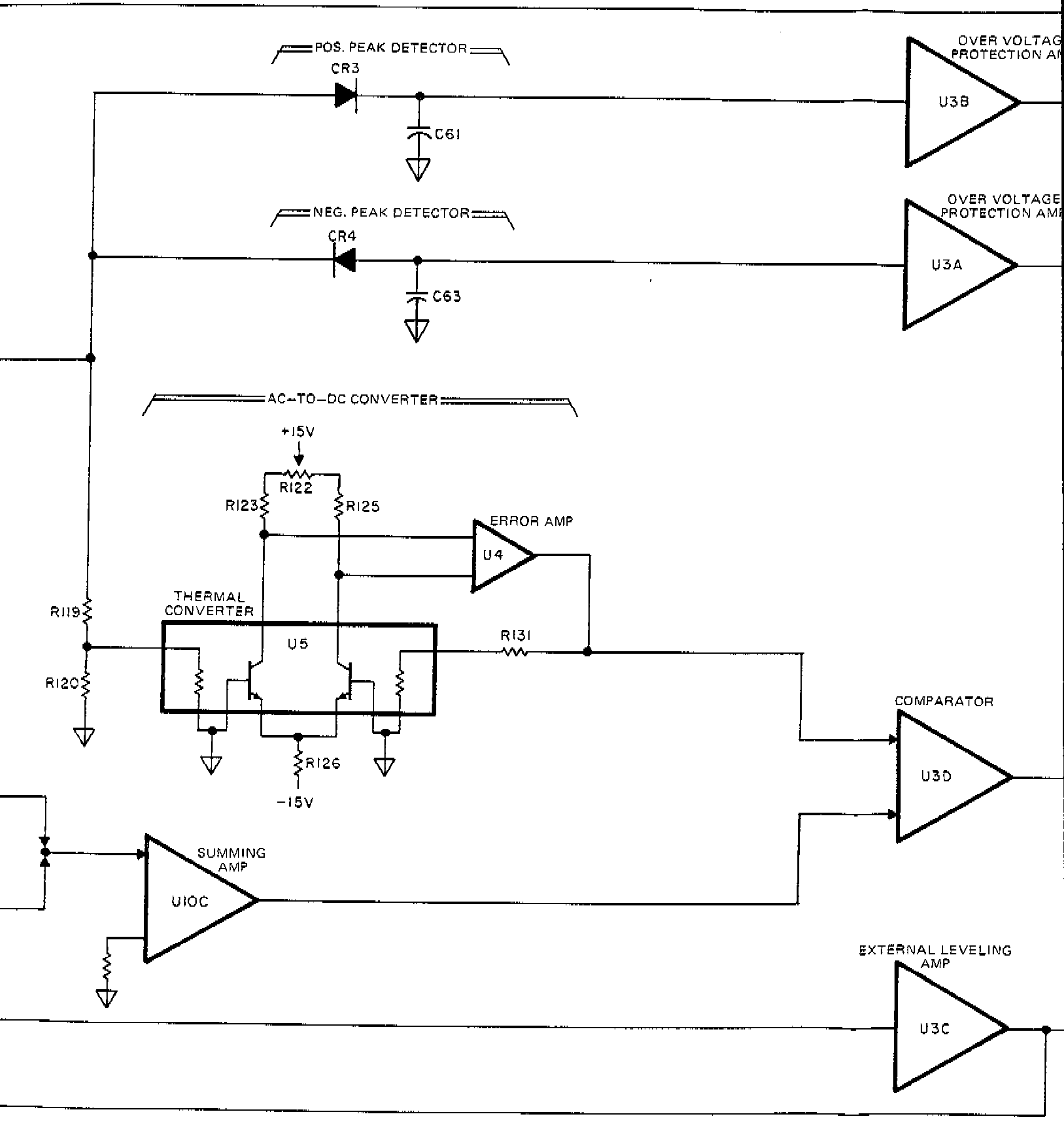


Fig 8-M-4 - Sht 3 of 3

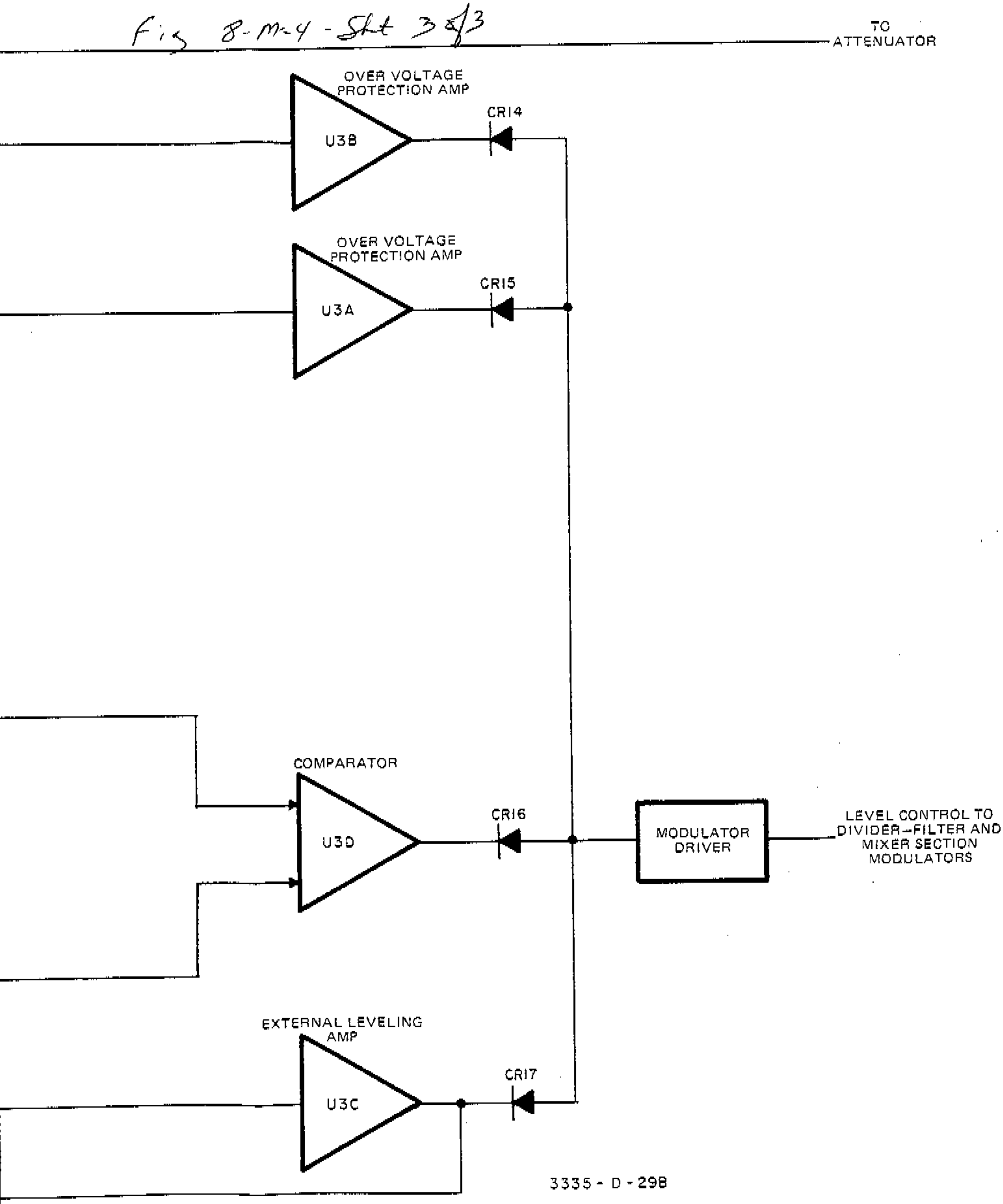


Figure 8-M-4. Block Diagram, Level Control (03335-66538) A6.

SERVICE GROUP N

ATTENUATOR
OPTION 002/004 INTERFACE
OPTION 003 INTERFACE

ADJUSTMENTS

NONE

ATTENUATOR EXCHANGE PROGRAM

The repair of the attenuator used in the -hp- 3335A is not easy and is best done at the factory by experienced personnel. Furthermore, the equipment needed to verify the attenuator accuracy after it is repaired is expensive and not always immediately available (see Figure 4-5, 4-6 and 4-7). For these reasons an exchange program has been established that allows the customer to trade his bad attenuator for a fully certified rebuilt attenuator at a reasonable cost. For more information, contact your nearest -hp- Sales and Service Office and ask about the Blue Stripe Exchange program. A list of Sales and Service Offices can be found at the back of this manual.

TOOLS

The following special tools or materials will be needed for servicing the circuitry in the attenuator cavity.

Non-Magnetic Tweezers, -hp- Part No. 8710-0929
Clean gloves or finger cots
Approximately 1 liter (1 qt.) of reagent grade 2 propanol

Some people find the tweezers more useful if the ends are bent as shown in Figure 8-N-1.

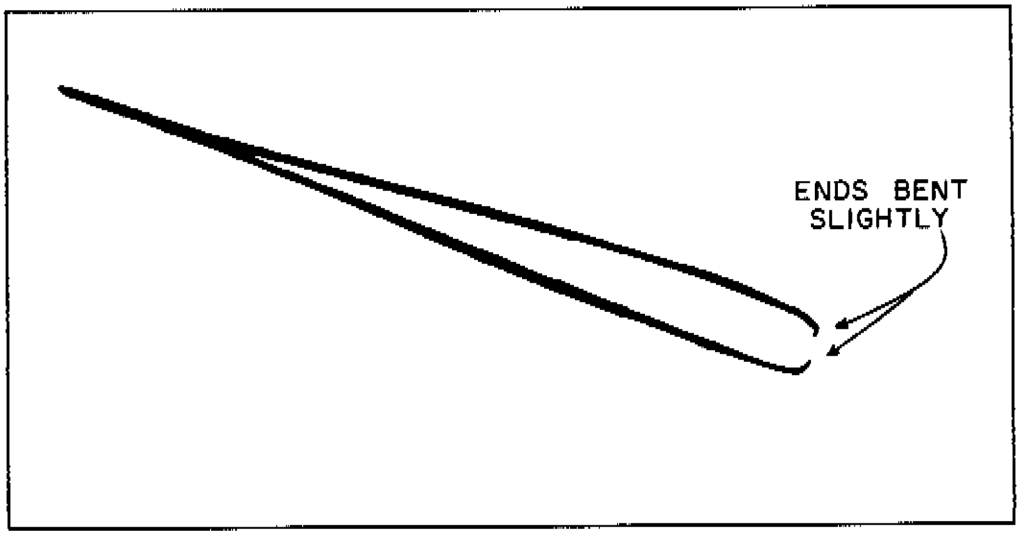
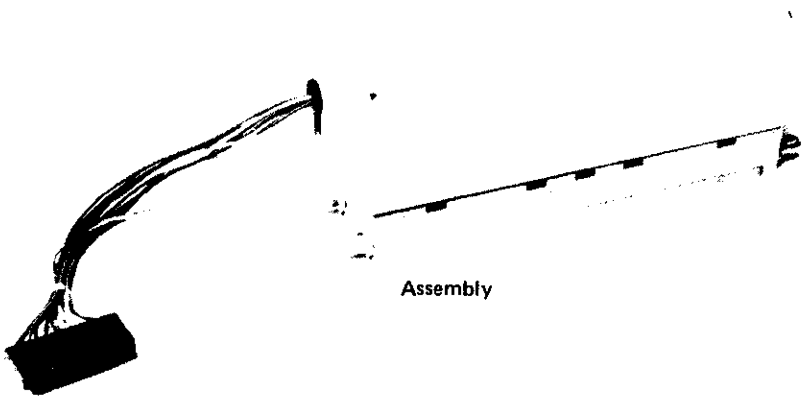


Figure 8-N-1. Tweezer Modification.

TROUBLESHOOTING AND REPAIR

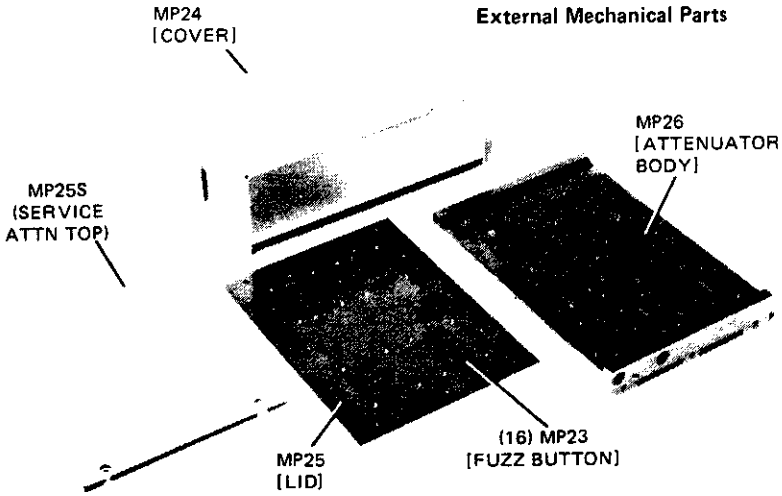
A comprehensive troubleshooting procedure is given in this section for those who do not wish to take advantage of the Blue Stripe Exchange program. Because of the sophistication and delicacy of the attenuator, it is *especially* important that you FOLLOW DIRECTIONS CAREFULLY. Read and follow the precautions given in Procedure 1. As a general rule, you should follow the troubleshooting procedure exactly. If you do find it necessary to deviate from the procedure, do it cautiously. Use the same gentle and clean handling techniques prescribed throughout this procedure. Do not force anything. Record each step as you go; it will be easier to retrace your steps if necessary.

Unfold the Attenuator Troubleshooting Tree (Figure 8-N-14). With the exception of the Flatness and Attenuator Verification tests, all of the procedures referenced on this troubleshooting tree can be found in this section. The Attenuator Flatness and Verification tests (referenced in blocks 8 and 9) require expensive test equipment that very likely is not immediately available. These tests may have to be skipped as a practical matter. Yet, if possible, do perform these tests. While these tests are somewhat diagnostic, the real purpose for placing them at this point in the troubleshooting tree is to keep you from attempting to repair a good attenuator. The attenuator is a delicate device, and it is best not opened unless really necessary.

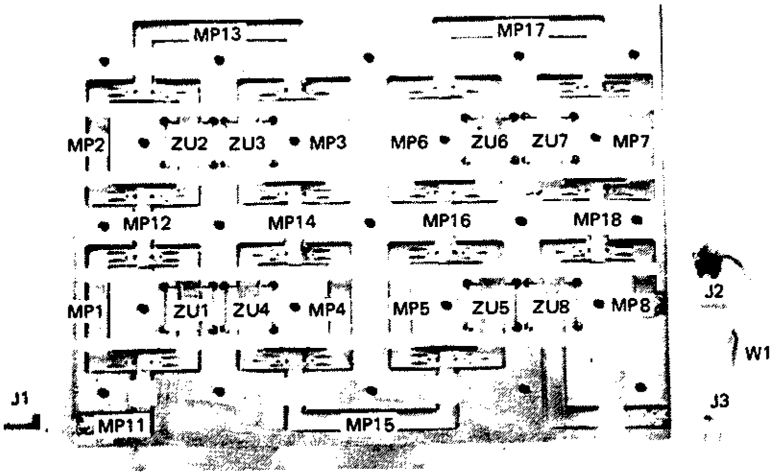


Assembly

External Mechanical Parts



Internal Mechanical Parts



ZU1–ZU7	Attenuator Pads	MP11	Input Contact
ZU8	25 ohm Pad	MP12, 14, 16, 18	Bypass Contacts
MP1–MP7	Pass-Through Contacts	MP13, 15, 17	Crossover Contacts
MP8	50 Ohm Out Contact	J1, J2, J3	SMA Connectors

Figure 8-N-2. A25 Attenuator

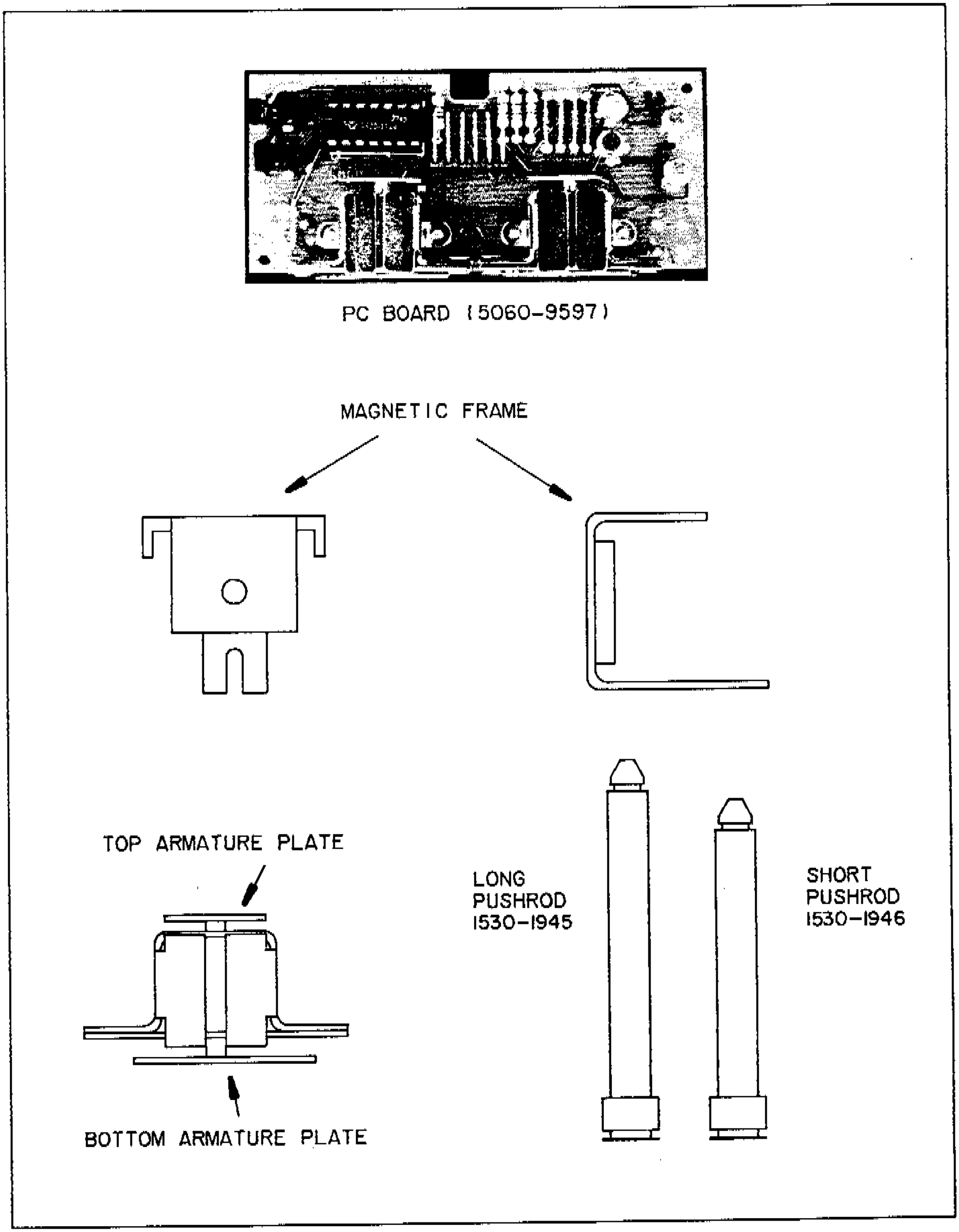


Figure 8-N-3. Printed Circuit Board Components.

PROCEDURE 1: EQUIPMENT SAFETY PROCEDURES.

CAUTION

a. Work on a clean, soft, lint-free surface.

b. Wear finger cots or clean gloves whenever the attenuator lid is off.

c. Do not force parts.

d. Use tweezers to hold the parts found in the attenuator cavity. Hold these parts by the molded plastic insulators. Never touch the metal portion of these parts with either the tweezers or your fingers.

e. Do not allow any parts to drop from the attenuator cavity. Keep the attenuator cavity facing up when the lid is removed. Proper installation of bypass and cross-over contacts can be guaranteed only at the factory. Improper replacement will shorten contact life.

f. Do not lubricate any parts on the attenuator.

PROCEDURE 2: CURSORY ATTENUATOR TEST PROCEDURE.

Experience has shown that attenuator failures are seldom marginal. As a consequence, the majority of failures can be narrowed to a particular latch using the following simple test.

a. Remove the top cover. A captive screw, located at the center of the rear edge, holds the top cover in place.

b. Connect an ac voltmeter, such as the -hp- 400FL to the selected output. Any ac voltmeter can be used that has a 50 dB measurement range and a frequency response that includes 1 kHz.

c. Set the -hp- 3335A amplitude to +13.01 dB (50 ohm out) or +11.25 dB (75 ohm out).

d. Set the -hp- 3335A frequency to 1 kHz.

e. Momentarily ground pin C on the A13 Controller Board (see Figure 8-D-1). With pin C having been grounded, the digits buttons on the front panel will actuate individual latches. Figure 8-N-4 identifies the latch actuated by each digit key.

f. Insert each pad individually and measure its nominal attenuation. Press the 0 digit key (straight through) to remove all pads from the signal path.

g. The 50 ohm or 75 ohm output latch can be tested by measuring the maximum level of each output when it is selected (+13.01 dB for 50 ohm out and +11.25 dB for 75 ohms out).

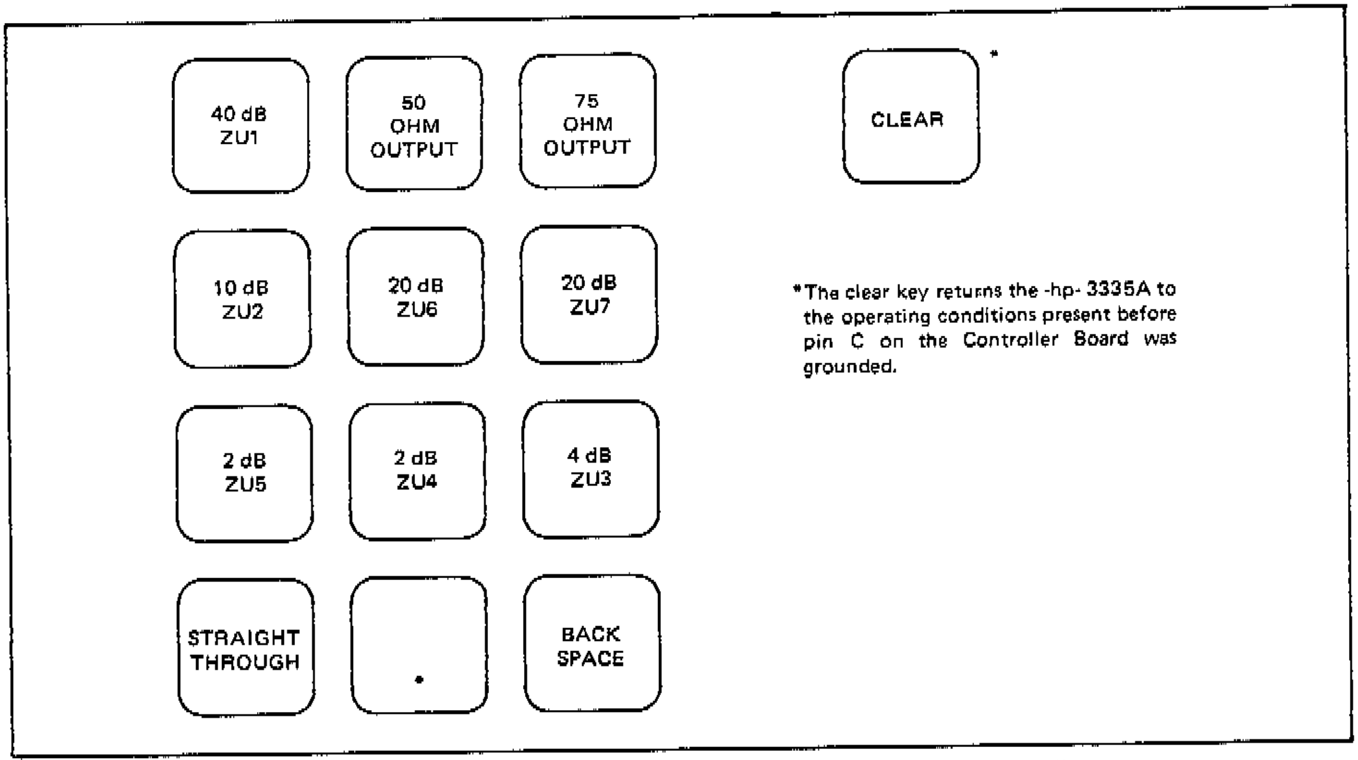


Figure 8-N-4. Attenuator Pads Activated by Digit Keys (Pin C on Controller Board Having Been Momentarily Grounded).

PROCECURE 3: ATTENUATOR REMOVAL/INSTALLATION PROCEDURE.

REMOVAL:

a. Unplug the instrument.

b. Remove the top cover. A captive screw located at the center of the rear edge holds the top cover in place.

c. Remove the bracket between the attenuator body and the fan.

d. Remove the bottom cover. A captive screw located at the center of the rear edge holds the bottom cover in place.

e. Set the -hp- 3335A on its side. Remove the three screws on the bottom of the -hp- 3335A that hold the attenuator in place.

f. Set the -hp- 3335A in its normal position.

g. Disconnect the single SMA connector connecting the rigid coax to the rear of the attenuator.

h. Slide the attenuator toward the rear of the instrument. Disconnect the remaining SMA connectors and unplug the latch control and power cable A25W1.

i. The attenuator is now free of the main chassis. Remove cover if desired.

j. If the latches are to be operated with the attenuator out of the chassis, set the -hp- 3335A on its right side and connect the latch control and power cable A25W1.

CAUTION

DO NOT REVERSE CABLE! Color codes are printed on the circuit board next to the first and last pins as an aid to proper cable connection. The red wire in the cable should go to the side marked 2 and the black wire should go to the side marked 0.

k. Once the latch control and power cable has been properly connected, power can be applied to the instrument.

INSTALLATION:

Reverse the removal procedure. See caution in Step J.

PROCEDURE 4: ATTENUATOR DRIVE CIRCUITRY INSPECTION PROCEDURE.

The solenoids that actuate the attenuator contacts are really bistable latches. A permanent magnetic field holds the armature in whichever position it is placed by the solenoid coil. There is a gap between the solenoid body and the armature plate when a latch is in the pass-through position (see Figure 8-N-5). Likewise, there is a gap between the armature plate and magnetic frame when a latch is in the attenuation position. Similar gaps are found on the bottom armature plates, but these cannot be seen as well (see Figure 8-N-6). These gaps interrupt the magnetic path and reduce the force holding the latch in position. Any change in these gaps effects the force holding the latch and therefore may make it inoperative.

All four of the printed circuit boards mounted on the attenuator body are identical (and interchangeable). Oftentimes failures can be detected by simply comparing these components. This is especially true when evaluating the armature plate spacing on the solenoids. Some problems to look for are listed below.

a. BROKEN ARMATURE COIL CONNECTIONS

b. LOOSE SCREWS

c. MATERIAL IN ARMATURE PLATE GAPS – See Figures 8-N-5 and 8-N-6 for the locations of these gaps. (The diagrams do not necessarily show the spacing of the gaps.) The bottom gaps are difficult to view. To be more confident that there is nothing in the lower gaps, remove the magnetic frame. This is done by loosening the three Allen screws and sliding the frame backwards. Since this eliminates the magnetic field, any magnetic material (by far the most likely contaminant) will fall out or stick to the frame. Replace the magnetic frame by reversing the procedure used to remove it.

d. LOOSE ARMATURE PLATES. Loose armature plates will close the gap in the magnetic path.

e. GAP SPACING. Compare the gaps on the various latches.

f. BURNT OR MISSING PARTS.

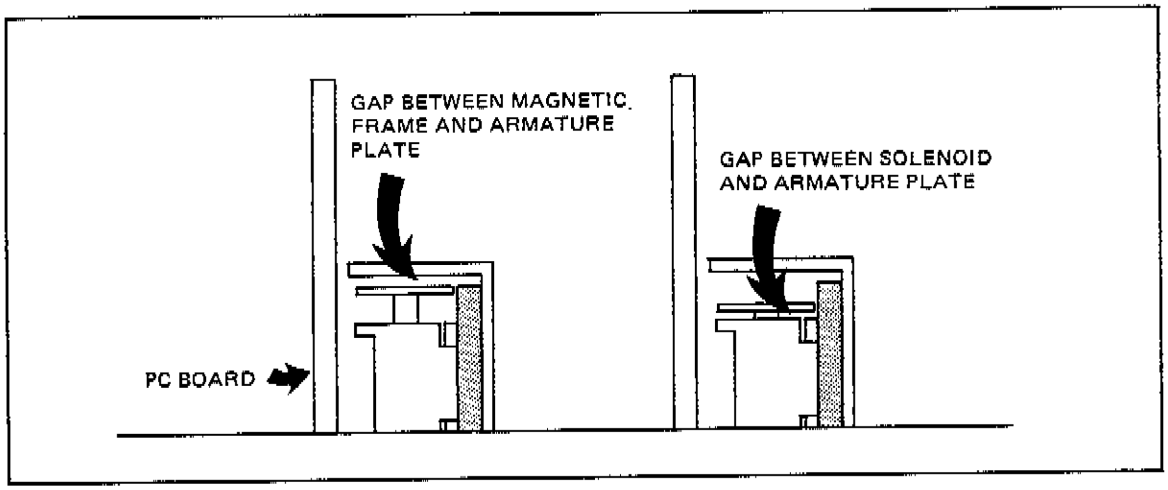


Figure 8-N-5. Armature Plate Gaps.

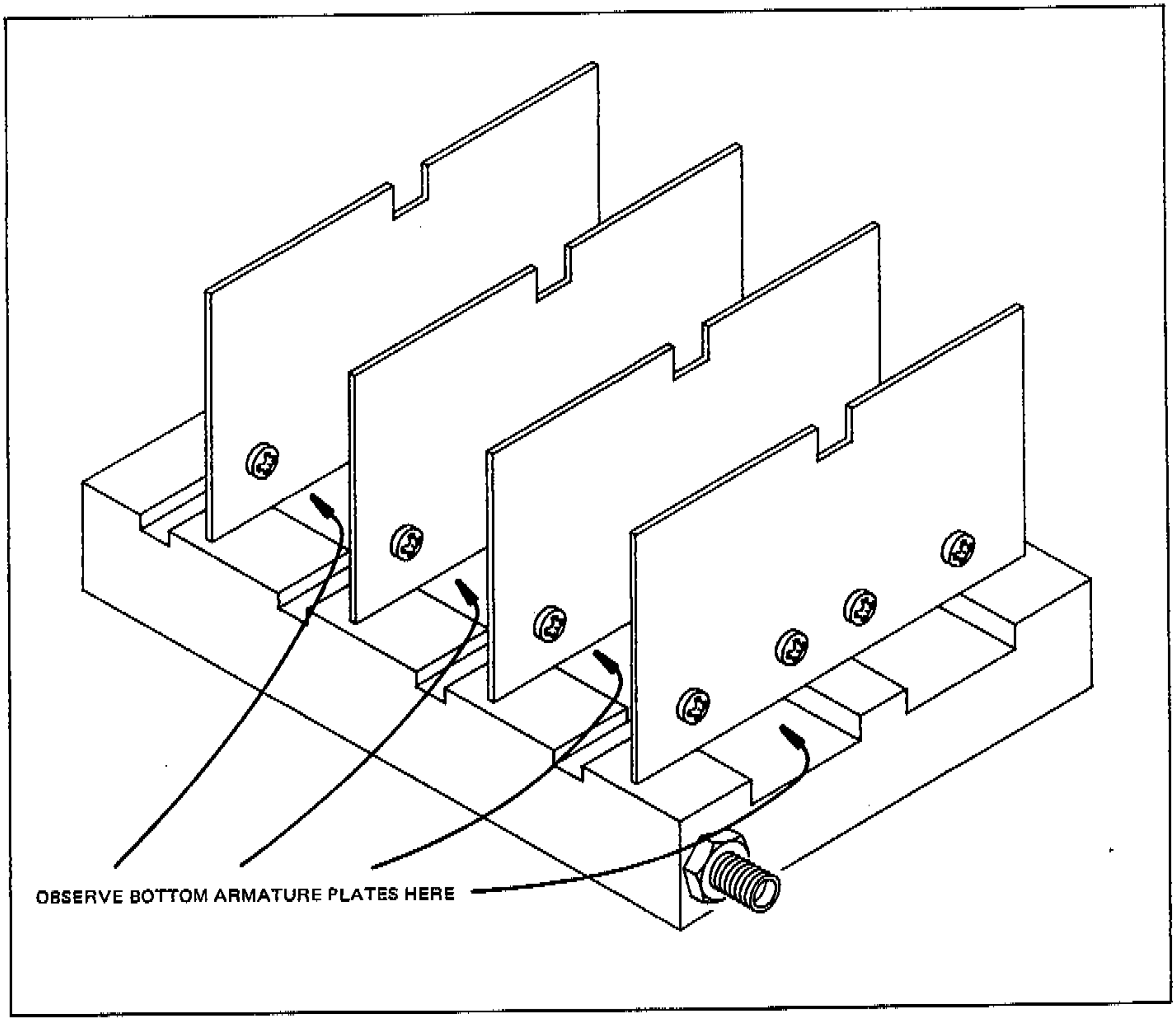


Figure 8-N-6. Bottom Armature Plates.

PROCEDURE 5: ATTENUATOR CAVITY INSPECTION PROCEDURE.

Several of the components within the attenuator cavity are quite similar to each other. Oftentimes, failures can be detected by simply comparing these components. Some other things to look for are listed below.

a. DUST – Particles of dust get between the contacts and prevent complete closure. This problem is eliminated by simply washing the attenuator (see troubleshooting tree, block 47). An accumulation of dust around a contact is a sign of excessive push rod wear. Be sure to inspect the pushrods as described below whenever dust buildup is noticed.

b. WORN OR DAMAGED PUSHRODS – Some *typical* pushrod failures are illustrated in Figure 8-N-7.

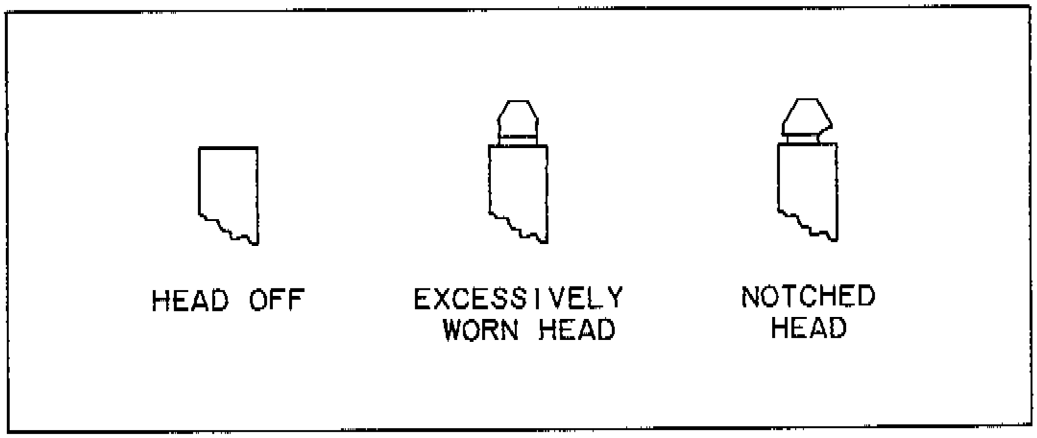


Figure 8-N-7. Pushrod Wear Patterns.

Be sure to compare the pushrods with each other.

CAUTION

All of the pushrods on a board must be replaced whenever the board is removed from the attenuator body. This is necessary because the wear pattern on the pushrods is effected by their position relative to the contacts. For much the same reason, it is good practice (but not absolutely necessary) to replace the pushrods on a board whenever an individual contact is replaced.

c. BROKEN CONTACTS

d. CRACKED CONTACTS – Although cracked contacts will not cause failed operation, they should be replaced to prevent future failures due to broken contacts.

e. DAMAGED SMA CONNECTORS – Usually the problem with an SMA connector is a damaged center pin.

PROCEDURE 6: ATTENUATOR PAD (ZU1 – ZU7) AND PASS THROUGH CONTACT (MP1 – MP7) REMOVAL/INSTALLATION PROCEDURE.

CAUTION

All parts within the attenuator body must be clean handled.

REMOVAL:

a. If several Attenuator Pads are removed, place them in separate CLEAN containers with identification. Attenuator Pads of different value cannot be interchanged in the attenuator cavity.

b. Pass-through contacts should be closed and attenuator pads open before either is removed. Actuate latch manually using armature plate located on the solenoid to place the contacts in this position.

c. Grasp one of the molded plastic spacers with the tweezers (see Figure 8-N-8). More control over the removal can be gained by pivoting the tweezers on the attenuator body.

d. Using the tweezers as a lever arm, pull up on the plastic insulators alternately until both insulators are free of the attenuator body.

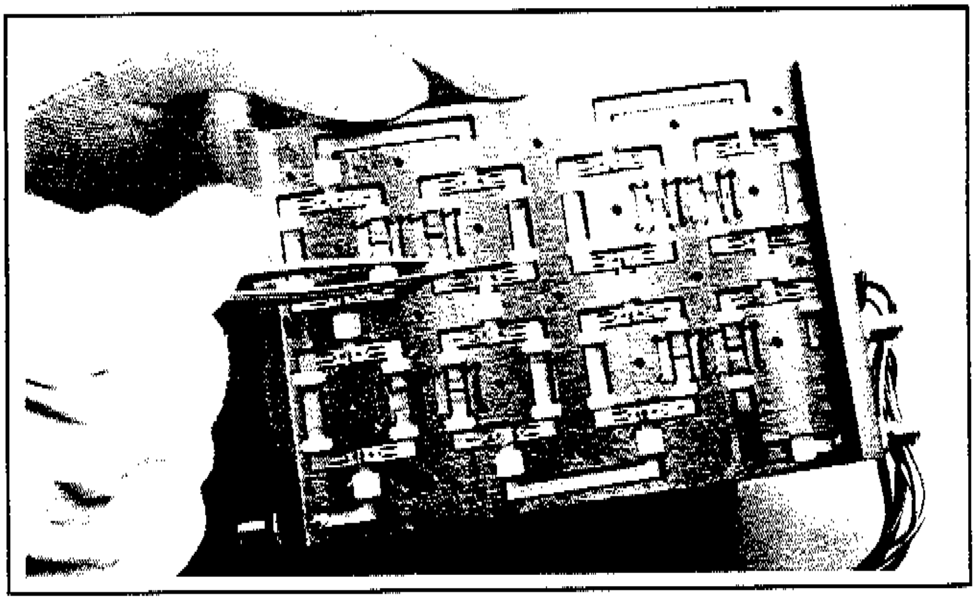


Figure 8-N-8. Attenuator Pad Removal (1).

CAUTION

When removing an attenuator pad from the body, be extremely careful of the pad wafer. It will break if wedged within the chamber. To prevent breaking, handle with care when removed from the chamber.

e. Once the molded spaces are free of the Attenuator Body, carefully slide the contacts off the pushrod heads.

CAUTION

When removing or installing a contact on a pushrod, DO NOT push the contact hard against the pushrod. The edges of the slot in the contact are sharp and will cut off the head of the pushrod.

f. CLEAN HANDLE the removed pad or contact if it is to be reinstalled.

INSTALLATION:

Reverse the removal procedure.

PROCEDURE 7: 25 OHM PAD (ZU8) AND 50 OHM OUT CONTACT REMOVAL/ INSTALLATION PROCEDURE.

CAUTION

All parts within the attenuator body must be clean handled.

REMOVAL:

a. Unsolder the SMA Connector pin by pushing down on the flat strip while heating the connection.

b. Pass-through contacts should be closed and attenuator pads open before either is removed. Actuate latch manually using armature plate located on the solenoid if necessary.

c. Grasp one of the molded plastic spacers with the tweezers (see Figure 8-N-8). More control over the removal can be gained by pivoting the tweezers on the attenuator body.

d. Using the tweezers as a lever arm, pull up on the plastic insulators alternately until all are free of the attenuator body. Of course, the 50 ohm Out contact only has one molded insulator.

e. Once the molded spacers are free of the Attenuator Body. Carefully slide the contacts off the pushrod heads.

CAUTION

When removing or installing a contact on a pushrod, DO NOT push the contact hard against the pushrod. The edges of the slot in the contact are sharp and will cut off the head of the pushrod.

f. CLEAN HANDLE the removed pad or contact if it is to be reinstalled.

INSTALLATION:

a. Reverse the removal procedure up to the point where the SMA pin is soldered.

b. When installing the 25 ohm pad, move the end of the connecting strip as necessary until the corner of the strip has the same height that the strip has at the molded insulators. Solder the connection with the connecting strip in this position.

c. Use resin core solder for all connections.

d. When soldering, position the soldering iron so that the heat flows from the iron to the center pin on the SMA connector and from the center pin to the connecting strip.

PROCEDURE 8: SMA CONNECTOR REMOVAL/INSTALLATION PROCEDURE.

CAUTION

All parts within the attenuator body must be clean handled.

REMOVAL:

a. Unsolder the SMA Connector pin by pushing down on the flat connecting strip while heating the connection.

b. Loosen the nut locking the SMA connector in place and unscrew the connector from the attenuator body.

INSTALLATION:

a. Screw the replacement connector into the attenuator body such that the white teflon insulator of the connector is flush with the inside of the body (see Figure 8-N-9).

b. Tighten the locking nut.

c. If installing the 25 ohm pad, move the end of the connecting strip as necessary until the corner of the strip has the same height that the strip has at the molded insulators. Solder the connection with the connecting strip in this position.

d. Use resin core solder for all connections.

e. When soldering, position the soldering iron so that the heat flows from the iron to the center pin on the SMA connector and from the center pin to the connecting strip.

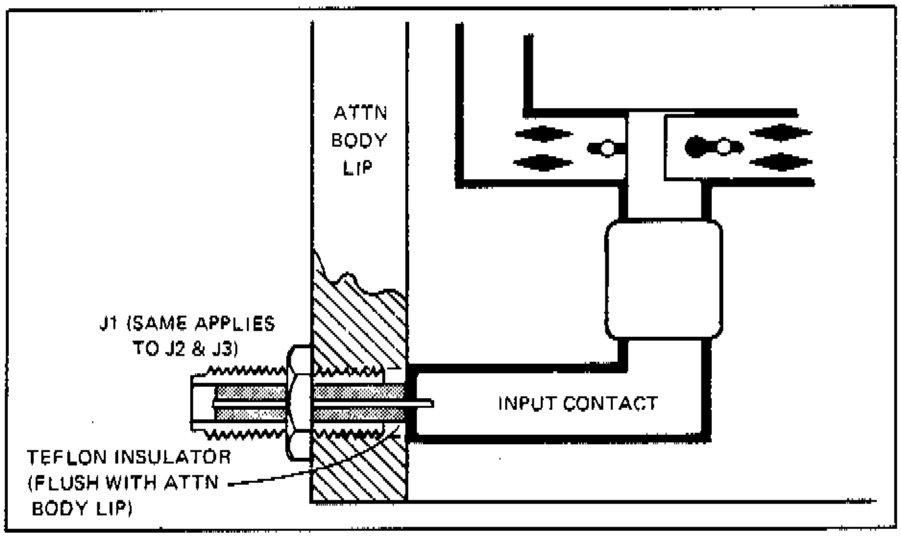


Figure 8-N-9. Connector Installation.

PROCEDURE 9: ATTENUATOR BOARD REPAIR PROCEDURE.

a. Whenever the printed circuit board is repaired without being removed from the attenuator body, the attenuator should be placed on its side as illustrated in Figure 8-N-10. This practice reduces the possibility of contaminating the attenuator cavity.

b. When trimming leads on newly installed components, be sure you can account for each scrap lead. Oftentimes these leads contain magnetic materials and are attracted to the gaps above and below the armature plates by the intense magnetic field. There they close the gap in the magnetic path and make the latch inoperative.

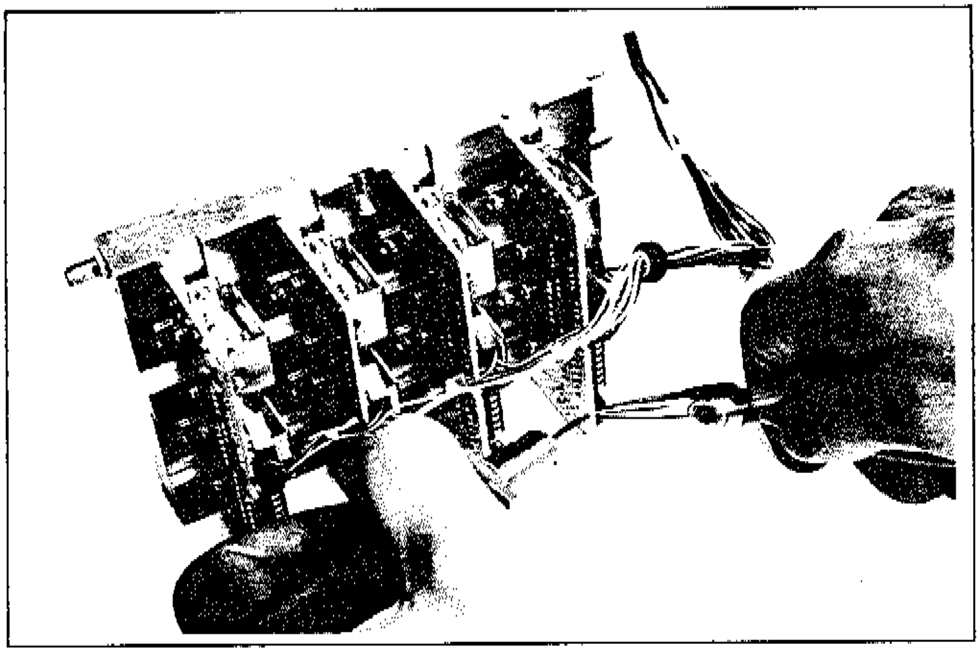


Figure 8-N-10. Attenuator Driver Repair.

PROCEDURE 10: BOARD REMOVAL/INSTALLATION PROCEDURE.

CAUTION

The solenoid wire connections are close to the screw heads (see Figure 8-N-11). Use care not to knock wires loose with the screwdriver.

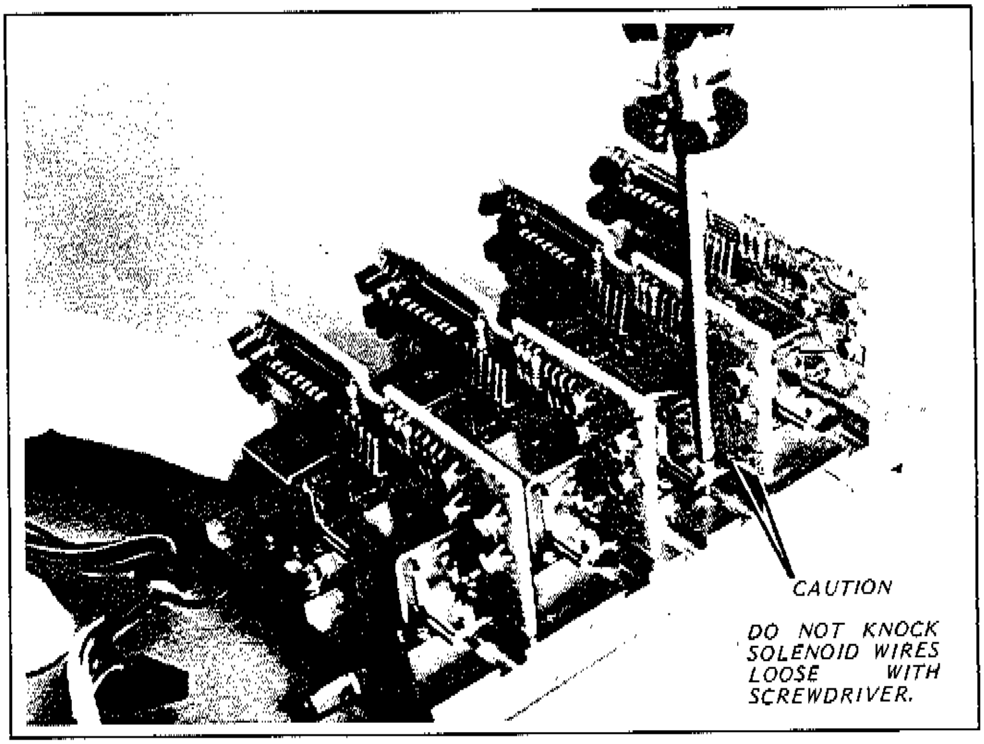


Figure 8-N-11. Attenuator Driver Assembly Removal.

REMOVAL:

a. Remove screws located on either side of the solenoid.

b. Lift board straight up.

INSTALLATION:

a. Replace *all* pushrods on the board. See Figure 8-N-12 for the locations of the short and long pushrods.

b. Reverse the removal procedure.

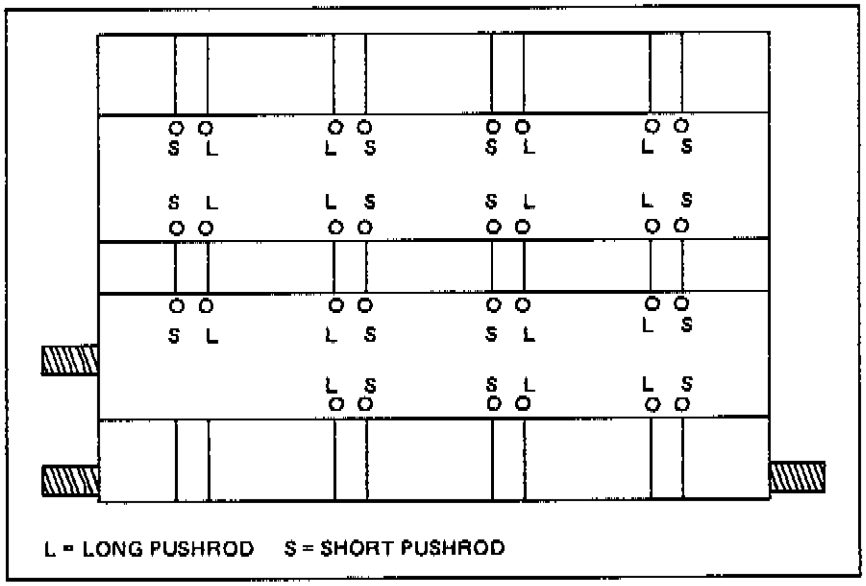


Figure 8-N-12. Pushrod Placement.

PROCEDURE 11: ATTENUATOR WASH PROCEDURE.

WARNING

This procedure requires the use of 2-propanol which is a FLAMMABLE and POISONOUS liquid. Observe the following precautions while using it.

If taken internally 2-propanol will produce serious toxic effects.

Keep out of the reach of children.

Keep away from heat and open flame or other sources of ignition.

Keep container closed when not pouring liquid.

Use with adequate ventilation and avoid prolonged breathing of the vapor.

Dispose of used 2-propanol immediately after use and in keeping with its flammable and poisonous nature.

In case of accidental ingestion seek professional assistance or contact a poison control center.

a. Obtain approximately one liter (one quart) of reagent grade 2-propanol. Of course, any grade of 2-propanol better than reagent grade can also be used. 2-propanol is also called Isopropol alcohol and Isopropanol.

b. Manually actuate the latches so that all of the attenuator pads are in the signal path.

c. Set the attenuator in a clean basin. Tilt the attenuator approximately 60 degrees (see Figure 8-N-13).

CAUTION

Do not tilt the attenuator so much that the bypass and crossover contacts fall out!

d. Starting at the top, pour 2-propanol on the attenuator cavity. Concentrate the 2-propanol wash on the contacts and on an area included in a 1-1/2" radius around any soldering that was done. Use only about 1/2 liter (1 pint) for this wash.

e. Manually actuate the latches so that all of the bypass contacts are in the signal path.

f. Position the attenuator in the basin as before and repeat the wash procedure.

g. Remove the attenuator from the basin and set it down with the attenuator cavity facing up.

h. Place the lid in the 2-propanol with the fuzz buttons up. Gently rock the basin for three minutes.

i. Remove the lid from the 2-propanol and set it down with the fuzz buttons facing up. Allow the lid to dry before installing it on the attenuator body.

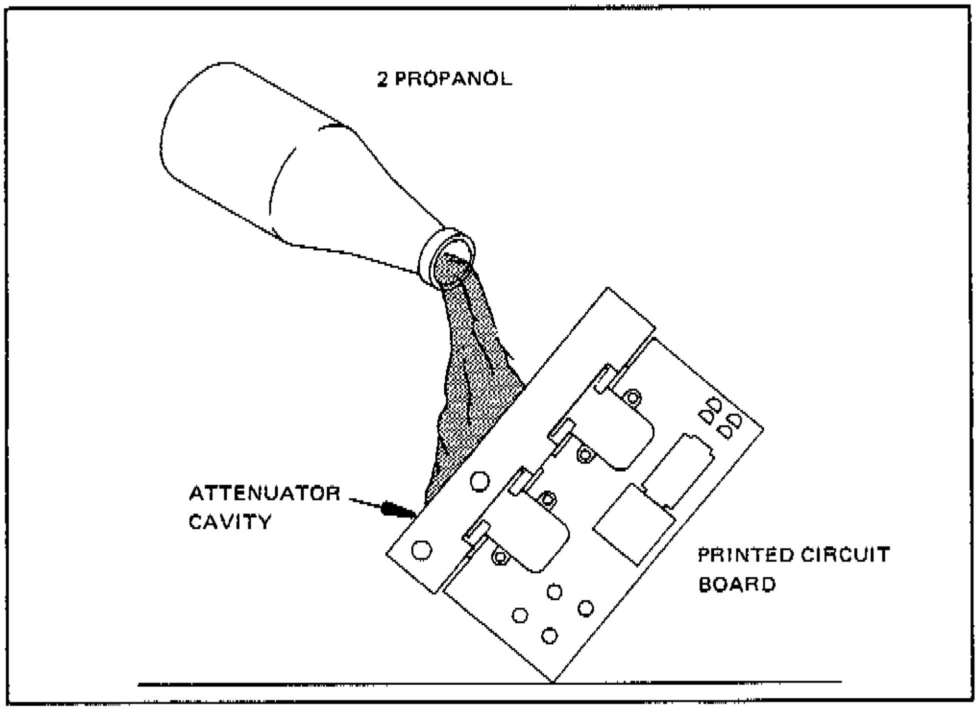


Figure 8-N-13. Attenuator Wash.

Fig 8-N-14
Sht 1 of 3

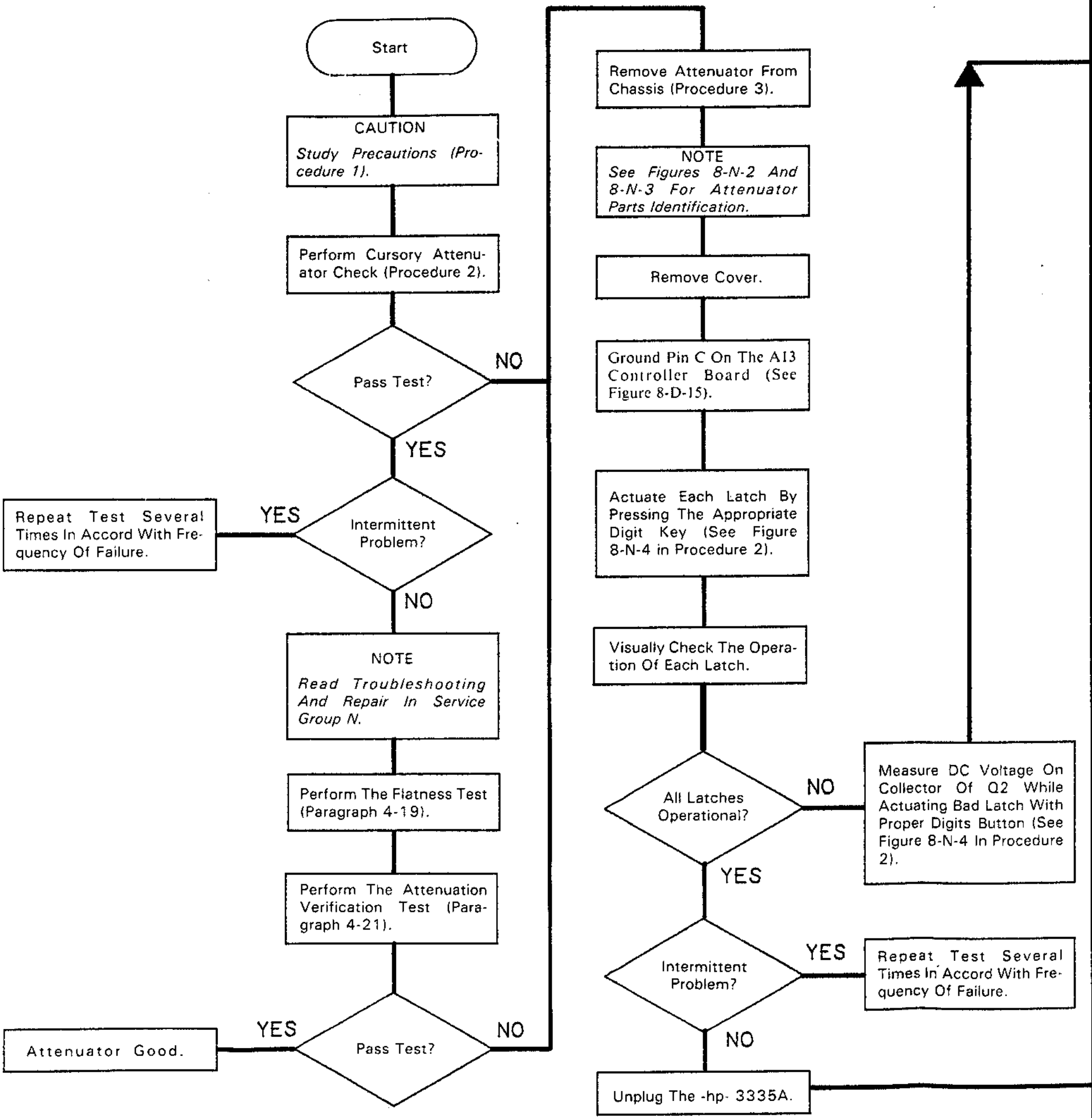


Fig 8-N-14
Sht 2 of 3

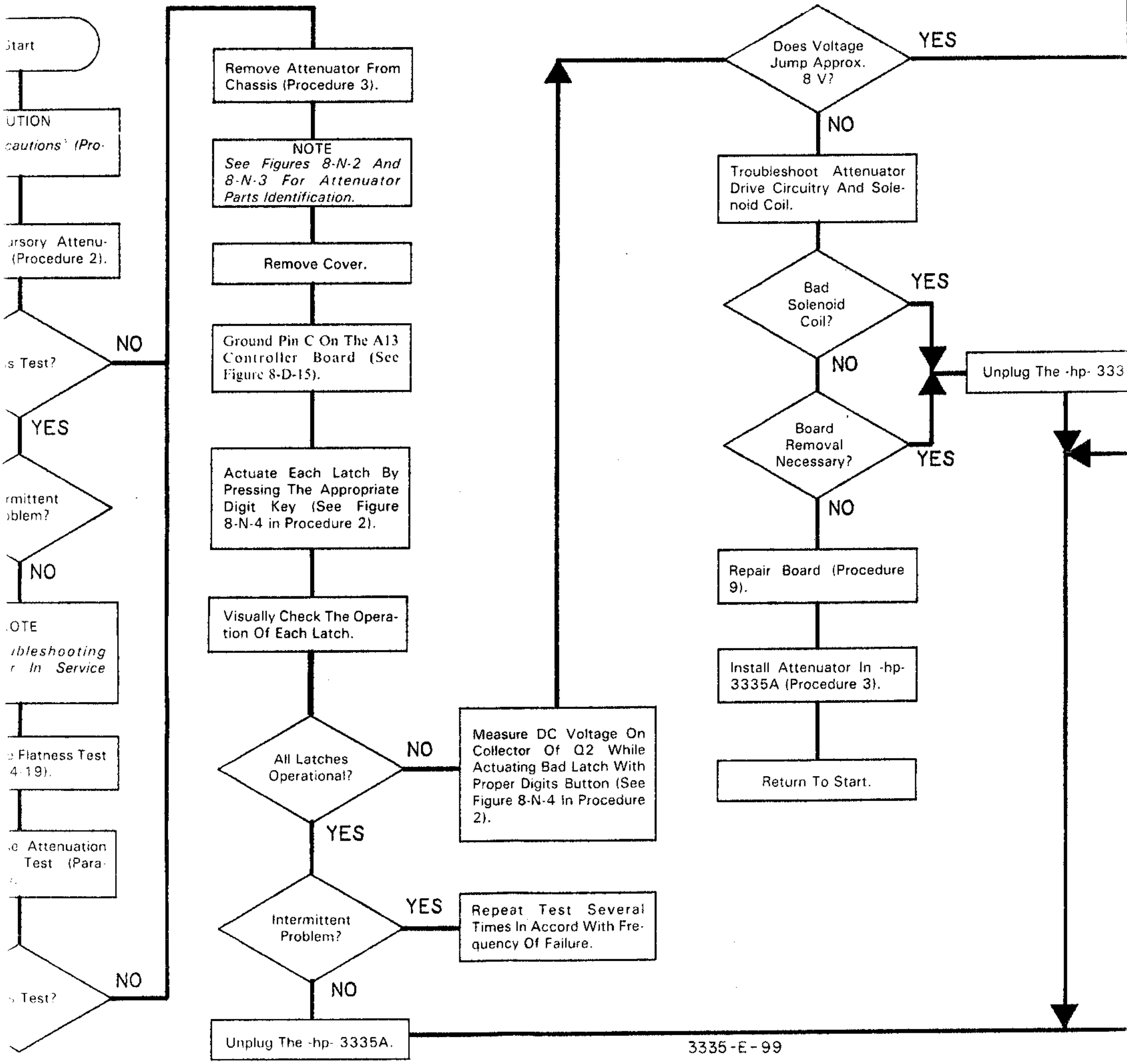


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Fig 8-N-14
Sht 3 of 3

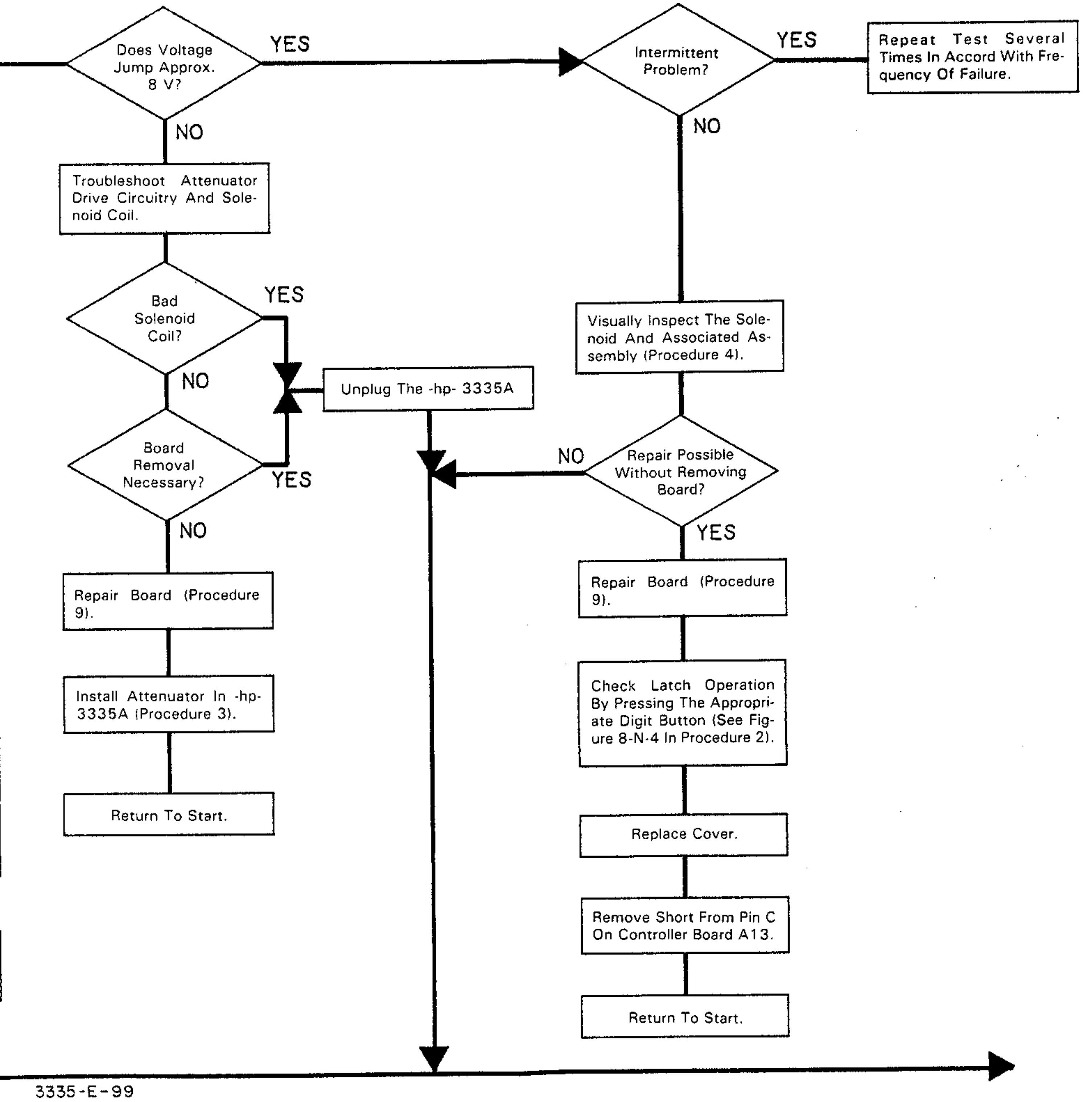


Figure 8-N-14. Attenuator Troubleshooting Tree.

Fig 8-N-14a
Sht 1of4

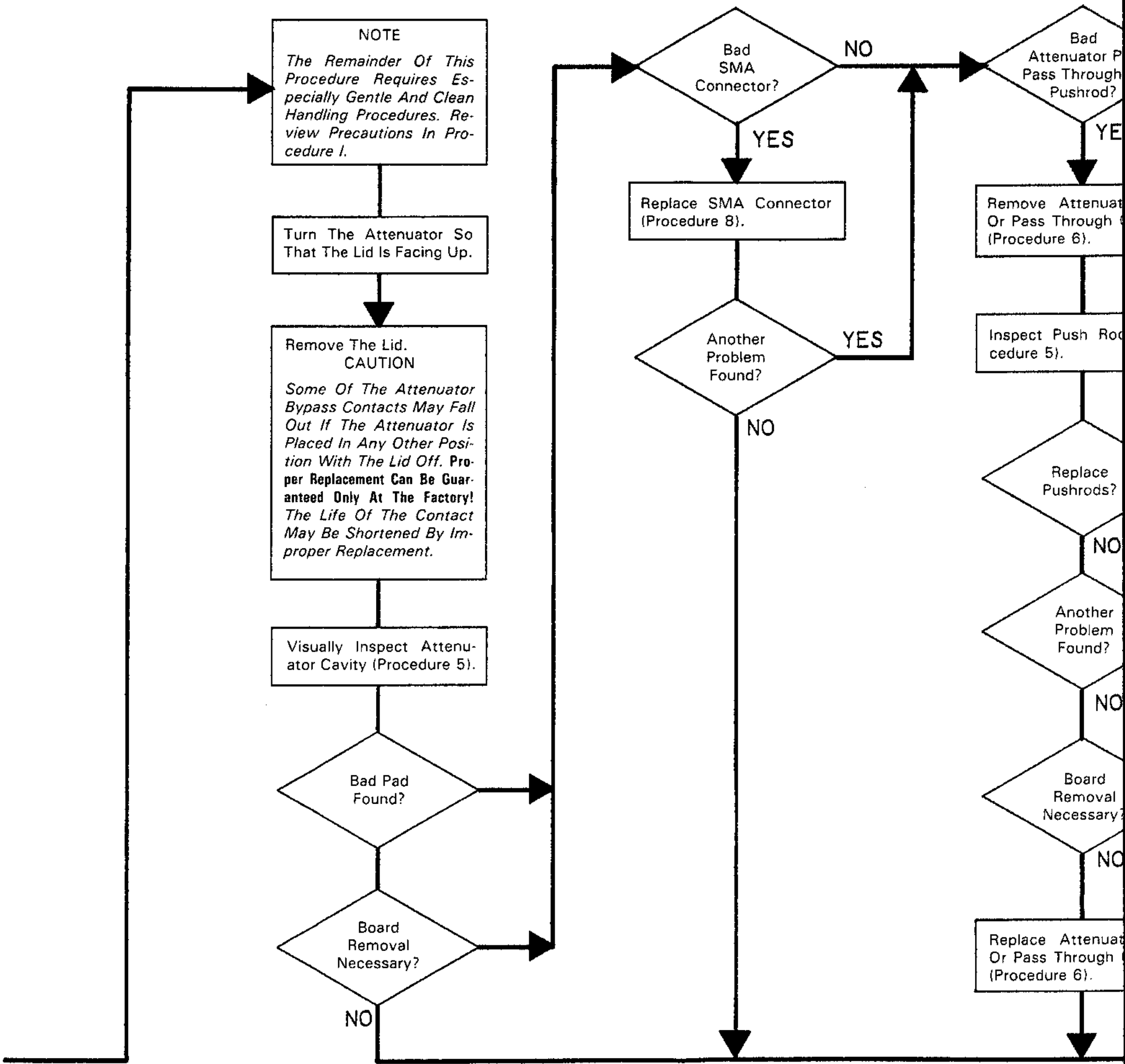


Fig 8-N-14a
Sht 2 of 4

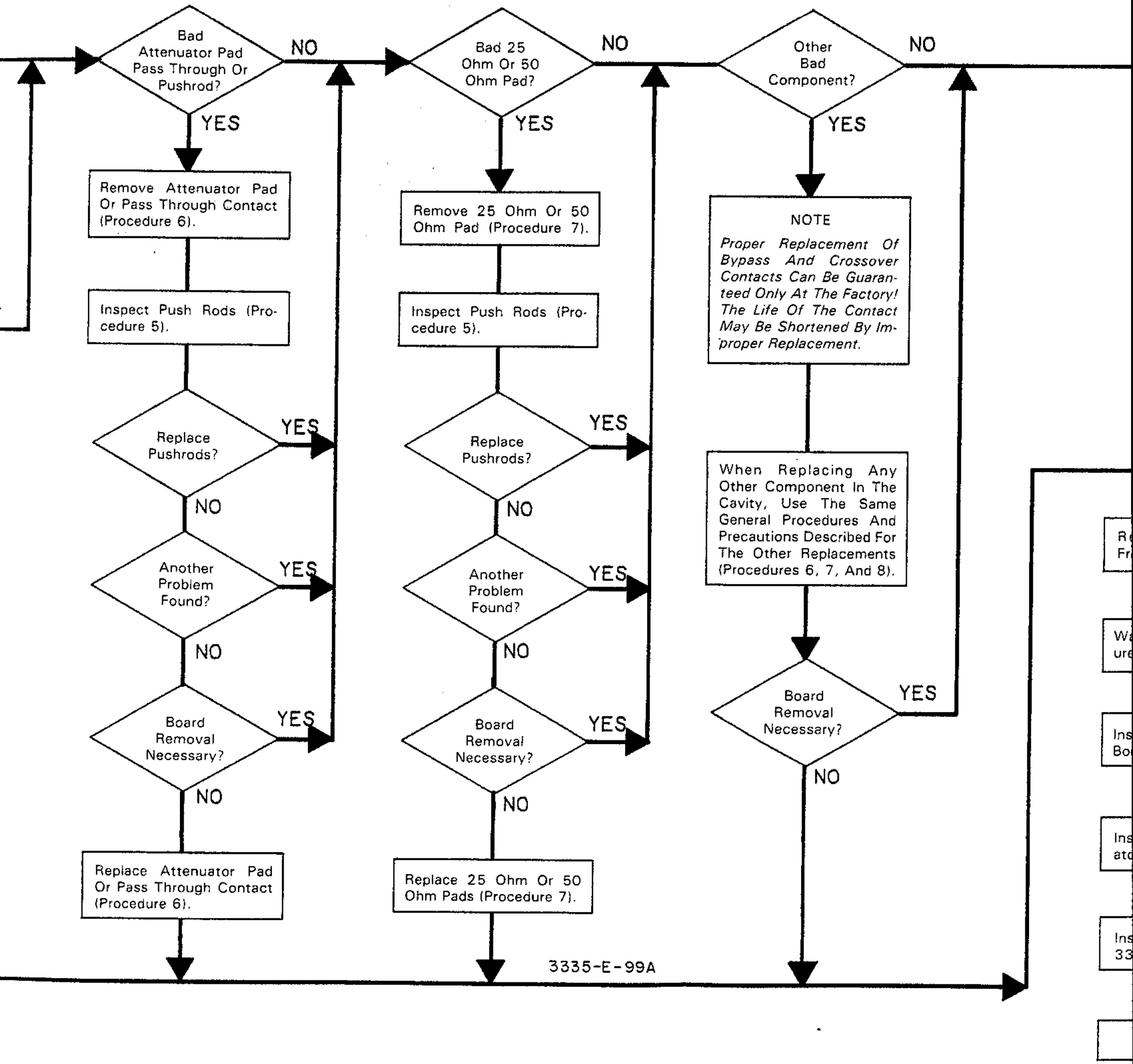


Fig 8-N-14a
Sht 3 of 4

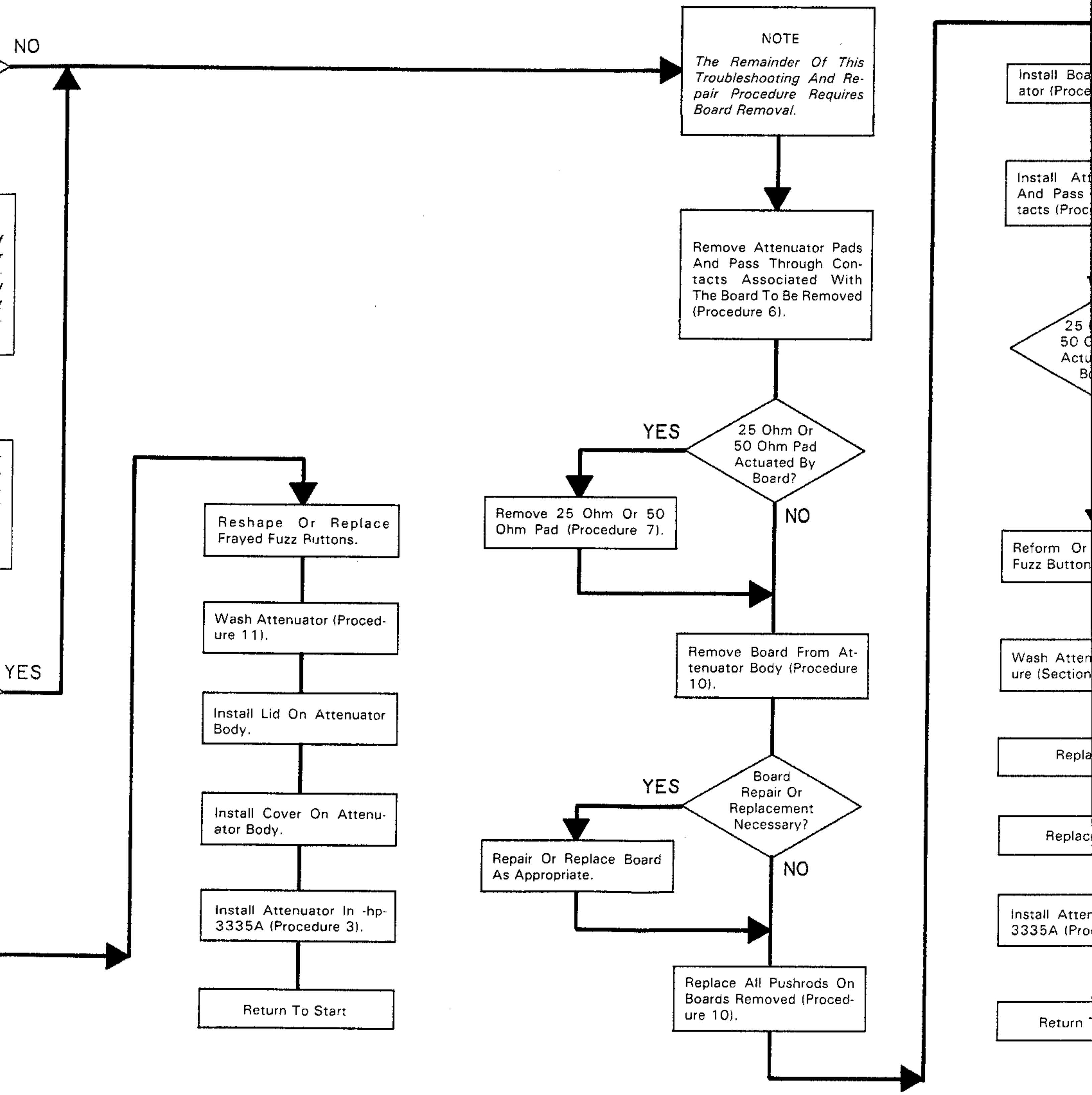


Fig 8-N-14a
Sht 1 of 4

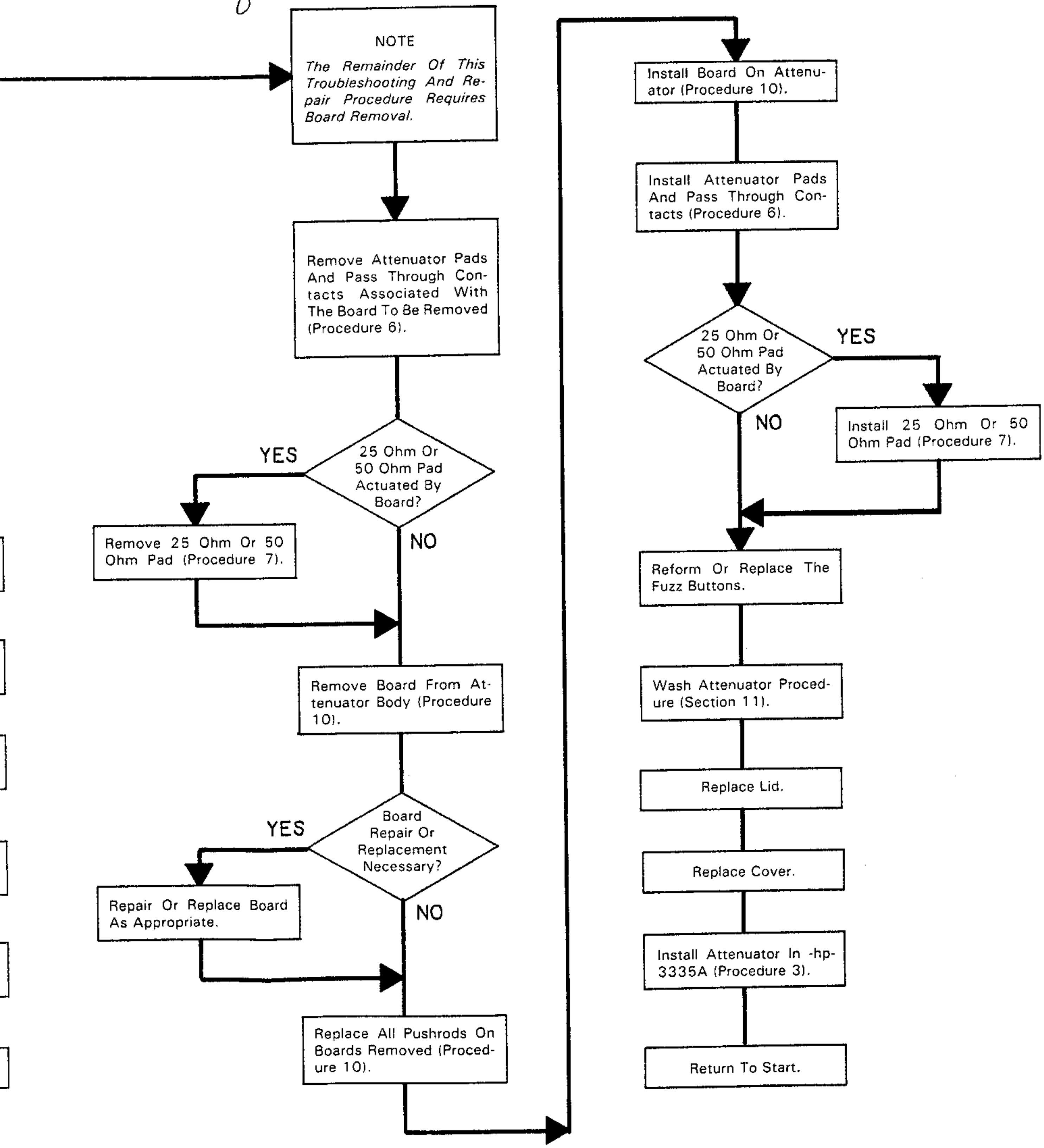


Figure 8-N-14. Attenuator Troubleshooting Tree (Cont'd).

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A19(Includes A19A1)	03335-60104	1	Option 002/004 Interface Assembly	28480	03335-60104
A19A1	03335-66519	1	PC Assembly, 75, 124, 135 ohms (Options 002 and 004) Order A19 (See Note 1)	28480	03335-66519
A19C1	0180-0197	1	Capacitor:Fxd 2.2μF	56289	150D225X9020A2
A19C2	0180-1735	1	Capacitor:Fxd .22μF	56289	150D224X9035A2
A19C3–C7	0160-3456	5	Capacitor:Fxd .001μF	28480	0160-3456
A19C8, C9	0160-2611	2	Capacitor-Fxd 1μF	28480	0160-2611
A19K1	0490-1013	1	Relay	28480	0490-1013
A19L1, L2	9100-1641	2	Coil:Fxd 240μH	24226	15/243
A19R1*			Factory Selected-Value Used in Instrument Encoded on Interface Assembly Cover XXXX XXX See Note 1 (Page 8-N-21) ↑ R1		
A	0757-0417		Resistor 562 1% .125W F TC=0+-100	03292	C4–1/8–T0–562R-F
B	0698-4457		Resistor 576 1% .125W F TC=0+–100	03292	C4-1/8-T0-576R-F
C	0698-4458		Resistor 590 1% .125W	03292	C4-1/8-T0-590R-F
D	0757-0161		Resistor 604 1% .125W F TC=0+-100	03292	C4-1/8-T0-604R-F
E	0757-0418		Resistor 619 1% .125W F TC=0+-100	03292	C4-1/8-T0-619R-F
F	0698-4459		Resistor 634 1% .125W F TC=0+-100	03292	C4-1/8-T0-634R-F
G	0698-4460		Resistor 649 1% .125W F TC=0+-100	03292	C4-1/8-T0-649R-F
H	0698-3511		Resistor 665 1% .125W F TC =0+-100	03292	C4-1/8-T0-665R-F
J	0757-0419		Resistor 681 1% .125W F TC=0+-100	03292	C4-1/8-T0-681R-F
A19R2*, R3*			Factory Selected-Value Used in Instrument Encoded on Interface Assembly Cover XXXX XXX See Note 1 (Page 8-N-21) ↑ R2 or R3		
K	0757-0346		Resistor 10 1% .125W F TC=0+-100	03292	C4-1/8-T0-10R0-F
L	0698-4350		Resistor 10.2 1% .125W F TC=0+-100	01992	PME55-1/8-T0-10R2-F
M	0698-4351		Resistor 10.5 1% .125W F TC=0+-100	01992	PME55-108-T0-10R5-F
N	0698-4352		Resistor 10.7 1% .125W F TC=0+-100	01992	PME55-1/8-T0-10R7-F
P	0757-0378		Resistor 11 1% .125W F TC=0+-100	02995	MF4C 1/8-T0-11R0-F
R	0698-4353		Resistor 11.3 1% .125W F TC=0+-100	01992	PME 55-1/8-T0-11R3-F
S	0757-0295		Resistor 11.5 1% .125W F TC=0+-100	02995	MF4C1/8-T0-11R5-F
T	0698-4354		Resistor 11.8 1% .125W F TC=0+-100	01992	PME55-1/8-T0-11R8-F
U	0757-0379		Resistor 12.1 1% .125W F TC=0+-100	02995	MF4C 1/8-T0-12R1-F
W	0698-4355		Resistor 12.4 1% .125W F TC=0+-100	01992	PME55-1/8-T0-12R4-F
X	0698-4356		Resistor 12.7 1% .125W F TC=0+-100	01992	PME55-1/8-T0-12R7-F
Y	0757-0380		Resistor 13 1% .125W F TC=0+-100	02995	MF4C 1/8-T0-13R0-F
Z	0698-3427		Resistor 13.3 1% .125W F TC=0+-100	01992	PME55-1/8-T0-13R3-F
A19R4	0683-1025	1	Resistor: 1 K	01121	CB1025
A19R5	0683-1215	1	Resistor: 120 Ohm	01121	CB1215
A19R6	0698-4529	1	Resistor: 226K	24546	C4-1/8-T0-2263-F

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A19R8*			Factory Selected-Value Used in Instrument Encoded on Interface Assembly Cover XXXX XXX ↑R8		
A	0757-0417		Resistor 562 1% .125WF TC=0+-100	03292	C4-1/8-T0-562R-F
B	0698-4457		Resistor 576 1% .125W F TC=0+-100	03292	C4-1/8-T0-576R-F
C	0698-4458		Resistor 590 1% .125W	03292	C4-1/8-T0-590R-F
D	0757-0161		Resistor 604 1% .125W F TC=0+-100	03292	C4-1/8-T0-604R-F
E	0757-0418		Resistor 619 1% .125W F TC=0+-100	03292	C4-1/8-T0-619R-F
F	0698-4459		Resistor 634 1% .125W F TC=0+-100	03292	C4-1/8-T0-634R-F
G	0698-4460		Resistor 649 1% .125W F TC=0+-100	03292	C4-1/8-T0-649R-F
H	0698-3511		Resistor 665 1% .125W F TC=0+-100	03292	C4-1/8-T0-665R-F
J	0757-0419		Resistor 681 1% .125W F TC=0+-100	03292	C4-1/8-T0-681R-F
A19R9*-R10*			Factory Selected-Value Used in Instrument Encoded on Interface Assembly Cover XXXX XXX See Note 1 (Page 8-N-21) ↑ R9 or R10		
K	0757-0346		Resistor 10 1% .125W F TC=0+-100	03292	C4-1/8-T0-10R0-F
L	0698-4350		Resistor 10.2 1% .125W F TC=0+-100	01992	PME55-1/8-T0-10R2-F
M	0698-4351		Resistor 10.5 1% .125W F TC=0+-100	01992	PME55-108-T0-10R5-F
N	0698-4352		Resistor 10.7 1% .125W F TC=0+-100	01992	PME55-1/8-T0-10R7-F
P	0757-0378		Resistor 11 1% .125W F TC=0+-100	02995	MF4C1/8-T0-11R0-F
R	0698-4353		Resistor 11.3 1% .125W F TC=0+-100	01992	PME55-1/8-T0-11R3-F
S	0757-0295		Resistor 11.5 1% .125W F TC=0+-100	02995	MF4C1/8-T0-11R5-F
T	0698-4354		Resistor 11.8 1% .125W F TC=0+-100	01992	PME55-1/8-T0-11R8-F
U	0757-0379		Resistor 12.1 1% .125W F TC=0+-100	02995	MF4C 1/8-T0-12R1-F
W	0698-4355		Resistor 12.4 1% .125W F TC=0+-100	01992	PME55-1/8-T0-12R4-F
X	0698-4356		Resistor 12.7 1% .125W F TC=0+-100	01992	PME55-1/8-T0-12R7-
Y	0757-0380		Resistor 13 1% .125W F TC=0+-100	02995	MF4C1/8-T0-13R0-F
Z	0698-3427		Resistor 13.3 1% .125W F TC=0+-100	01992	PME55-1/8-T0-13R3-F
A19T1	03335-60104	1	Transformer: 124 ohm See Note 1 (Page 8-N-21)		
A19T2	03335-60104	1	Transformer: 135 ohm See Note 1 (Page 8-N-21)		
A19U1	1820-1423	1	IC: 74LS123	01295	SN74LS123N
A19U2	1820-1211	1	IC: 74LS86	01295	SN74LS86N
A20 (Includes A20A1)	03335-60103	1	Option 003 Interface Assembly		
A20A1	03335-66521	1	PC Assembly, 75, 150 ohms (Option 003) Order A19 (See Note 1)	28480	03335-66521
A20C1	0160-2611	1	Capacitor-Fxd 1 μF	28480	0160-2611
A20R1*			Factory Selected—Value used in Instrument Encoded on Interface Assembly Cover XX XXX See Note 1 ↑ R1		

Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A	0757-0417		Resistor 562 1% .125W F TC=0+-100	03292	C4-1/8-T0-562R-F
B	0698-4457		Resistor 576 1% .125W F TC=0+-100	03292	C4-1/8-T0-576R-F
C	0698-4458		Resistor 590 1% .125W TC=0+-100	03292	C4-1/8-T0-590R-F
D	0757-0161		Resistor 604 1% .125W F TC=0+-100	03292	C4-1/8-T0-604R-F
E	0757-0418		Resistor 619 1% .125W F TC=0+-100	03292	C4-1/8-T0-619R-F
F	0698-4459		Resistor 634 1% .125W F TC=0+-100	03292	C4-1/8-T0-634R-F
G	0698-4460		Resistor 649 1% .125W F TC=0+-100	03292	C4-1/8-T0-649R-F
H	0698-3511		Resistor 665 1% .125W F TC=0+-100	03292	C4-1/8-T0-665R-F
J	0757-0419		Resistor 681 1% .125W F TC=0+-100	03292	C4-1/8-T0-681R-F
A20R2*-R3*			Factory Selected—Value Used in Instrument Encoded on Interface Assembly Cover XX XXX See Note 1 (Page 8-N-21) ↑ R2 or R3		
K	0757-0346		Resistor 10 1% .125W F TC=0+-100	03292	C4-1/8-T0-10R0-F
L	0698-4350		Resistor 10.2 1% .125W F TC=0+-100	01992	PME55-1/8-T0-10R2-F
M	0698-4351		Resistor 10.5 1% .125W F TC=0+-100	01992	PME55-108-T0-10R5-F
N	0698-4352		Resistor 10.7 1% .125W F TC=0+-100	01992	PME55-1/8-T0-10R7-F
P	0757-0378		Resistor 11 1% .125W F TC=0+-100	02995	MF4C 1/8-T0-11R0-F
R	0698-4353		Resistor 11.3 1% .125W F TC=0+-100	01992	PME55-1/8-T0-11R3-F
S	0757-0295		Resistor 11.5 1% .125W F TC=0+-100	02995	MF4C1/8-T0-11R5-F
T	0698-4354		Resistor 11.8 1% .125W F TC=0+-100	01992	PME55-1/8-T0-11R8-F
U	0757-0379		Resistor 12.1 1% .125W F TC=0+-100	02995	MF4C1/8-T0-12R1-F
W	0698-4355		Resistor 12.4 1% .125W F TC=0+-100	01992	PME55-1/8-T0-12R4-F
X	0698-4356		Resistor 12.7 1% .125W F TC=0+-100	01992	PME55-1/8-T0-12R7-F
Y	0757-0380		Resistor 13 1% .125W F TC=0+-100	02995	MF4C 1/8-T0-13R0-F
Z	0698-3427		Resistor 13.3 1% .125W F TC=0+-100	01992	PME55-1/8-T0-13R3-F
A20T1	03335-60103	1	Transformer: 150 ohm See Note 1 (Page 8-N-21)	28480	03335-60103

NOTE 1

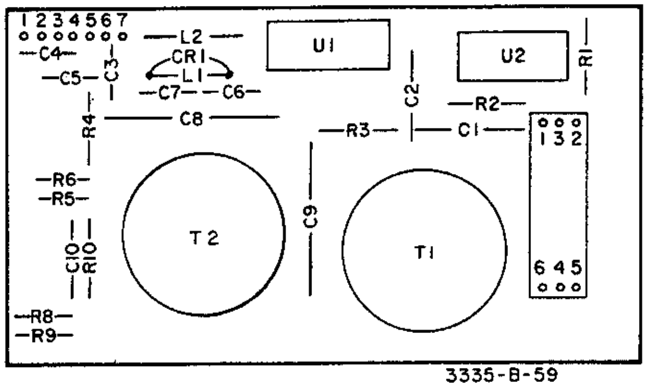
The high accuracy of the -hp- 3335A output amplitude requires that certain resistors be selected to compensate for even minor variations in the output transformer parameters. It is important that these resistors be replaced with precisely the same value selected at the factory.

Resistor values used in each instrument and the last three digits of the instrument serial number are encoded on the inside of the lid covering the Interface Assembly. In the event of output transformer failure or A19 board failure, the entire Interface Assembly must be replaced to insure the -hp- 3335A output amplitude accuracy.

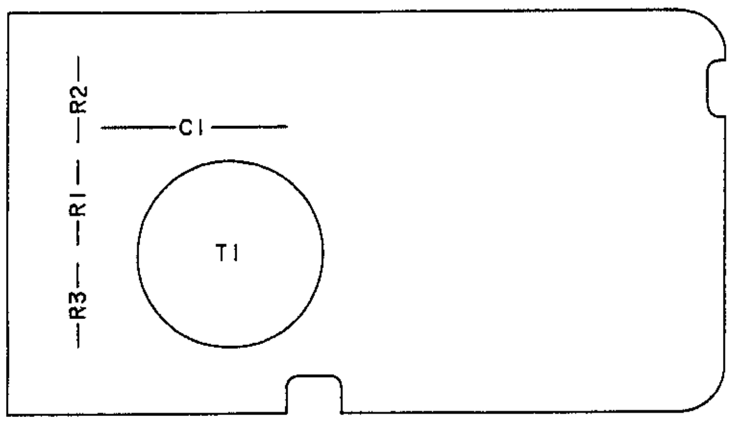
Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A25	5060–9596	1	ATTENUATOR ASSEMBLY	28480	5060–9596
	5061–0783		ATTENUATOR ASSEMBLY (REBUILT)	28480	5061–0783
A25J1–J3	1250–1486	3	SMA CONNECTOR	28480	1250–1486
A25MP1–7	03335–89515	7	CONTACT–PASSTHROUGH	28480	03335–89515
A25MP8	03335–89511	1	CONTACT–50 OHM OUT	28480	03335–89511
A25MP9, 10			UNASSIGNED		
A25MP11	03335–89512	1	CONTACT–INPUT	28480	03335–89512
A25MP12	03335–89513	4	CONTACT–BYPASS	28480	03335–89513
A25MP13	03335–89514	3	CONTACT–CROSSOVER	28480	03335–89514
A25MP14	03335–89513		CONTACT–BYPASS	28480	03335–89513
A25MP15	03335–89514		CONTACT–CROSSOVER	28480	03335–89514
A25MP16	03335–89513		CONTACT–BYPASS	28480	03335–89513
A25MP17	03335–89514		CONTACT–CROSSOVER	28480	03335–89514
A25MP18	03335–89513		CONTACT–BYPASS	28480	03335–89513
A25MP19	03335–89521	8	FRAME/MAGNET–SOLENOID	28480	03335–89521
A25MP20			UNASSIGNED		
A25MP21	1530–1945	16	PUSH ROD–LONG (WHITE TIP)	28480	1530–1945
A25MP22	1530–1946	16	PUSH ROD–SHORT (RED TIP)	28480	1530–1946
A25MP23	8160–0256	16	FUZZ BUTTON	28480	8160–0256
A25MP24	5021–0247	1	COVER–ATTN DRIVER	28480	5021–0247
A25MP25	5021–0248	1	TOP–ATTN BODY	28480	5021–0248
A25MP26	5021–0249	1	BODY–ATTN	28480	5021–0249
A25W1	8120–2379	1	CABLE ASSY	28480	8120–2379
A25ZU1	03335–89501	1	40 DB PAD	28480	03335–89501
A25ZU2	03335–89503	1	10 DB PAD	28480	03335–89503
A25ZU3	03335–89504	1	4 DB PAD	28480	03335–89504
A25ZU4, 5	03335–89505	2	2 DB PAD	28480	03335–89505
A25ZU6, 7	03335–89502	2	20 DB PAD	28480	03335–89502
A25ZU8	03335–89506	1	25 OHM PAD	28480	03335–89506
	3030–0220	23	CAP SCREW 1/4" (ATTN TOP)	28480	3030–0220
	3030–0663	24	CAP SCREW 1/8" (SOLENOID FRAME)	28480	3030–0663
	0520–0129	17	SCREW PANHD 5/16" 2–56 (MOUNT SOLENOIDS TO PC ASSY)	28480	0520–0129
	0520–0128	4	SCR MACH 2–56 1/4" PANHD POZ1	28480	0520–0128
	0520–0155	4	SCR MACH 2–56 1/8" PANHD POZ1	28480	0520–0155
	3050–0098	1	WASHER Z–56	28480	3050–0098
MP25S			SERVICE TOP–ATTN BODY (CLEAR PLASTIC) (MUST BE ORDERED IF ATTN SERVICING IS TO BE PERFORMED)		
A25A1–A4	5060–9597	4	PC ASSEMBLY, ATTN DRIVER	28480	5060–9597
A25A1–CR1–4	1901–0025	4	DIODE, SI	28480	1901–0025
A25A1Q1	1854–0071	4	TRANSISTOR, NPN SPS5103	28480	1854–0071
A25A1Q2	1854–0394	4	TRANSISTOR, SI NPN	28480	1854–0394
A25A1Q3	1854–0071		TRANSISTOR, NPN SPS5103	28480	1854–0071
A25A1Q4	1854–0394		TRANSISTOR, SI NPN	28480	1854–0394
A25A1Q5	1854–0071		TRANSISTOR, NPN SPS5103	28480	1854–0071
A25A1Q6	1854–0394		TRANSISTOR, SI NPN	28480	1854–0394
A25A1Q7	1854–0071		TRANSISTOR, NPN SPS5103	28480	1854–0071
A25A1Q8	1854–0394		TRANSISTOR, SI NPN	28480	1854–0394
A25A1R1–4	0683–1215	4	RESISTOR–FXD 120 OHM .05	01121	CB1215
A25A1SL1, 2	5060–9598	2	LATCH ASSEMBLY	28480	5060–9598
	1251–4510	1	CONN–RIGHT ANGLE	28480	1251–4510
	0380–0665	1	SPACER–RIVET ON	28480	0380–0665
A25A1U1	1820–1144	1	IC, SN74LS02N	01295	SN74LS02N
	1200–0474	1	SOCKET, 14 PIN IC	28480	1200–0474

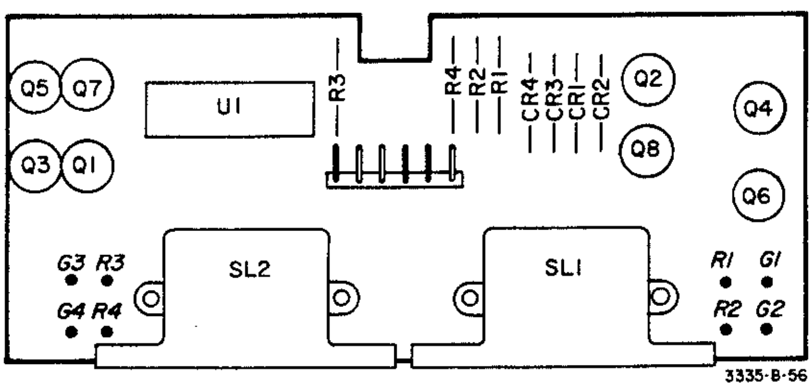
Fig 8-N-15
Sht 1 of 5



A19
-hp- Part No. 03335-66519



A20
-hp- Part No. 03335-66521



A25
-hp- Part No. 5060-9597

Fig 8-N-15

Sht 2 of 5

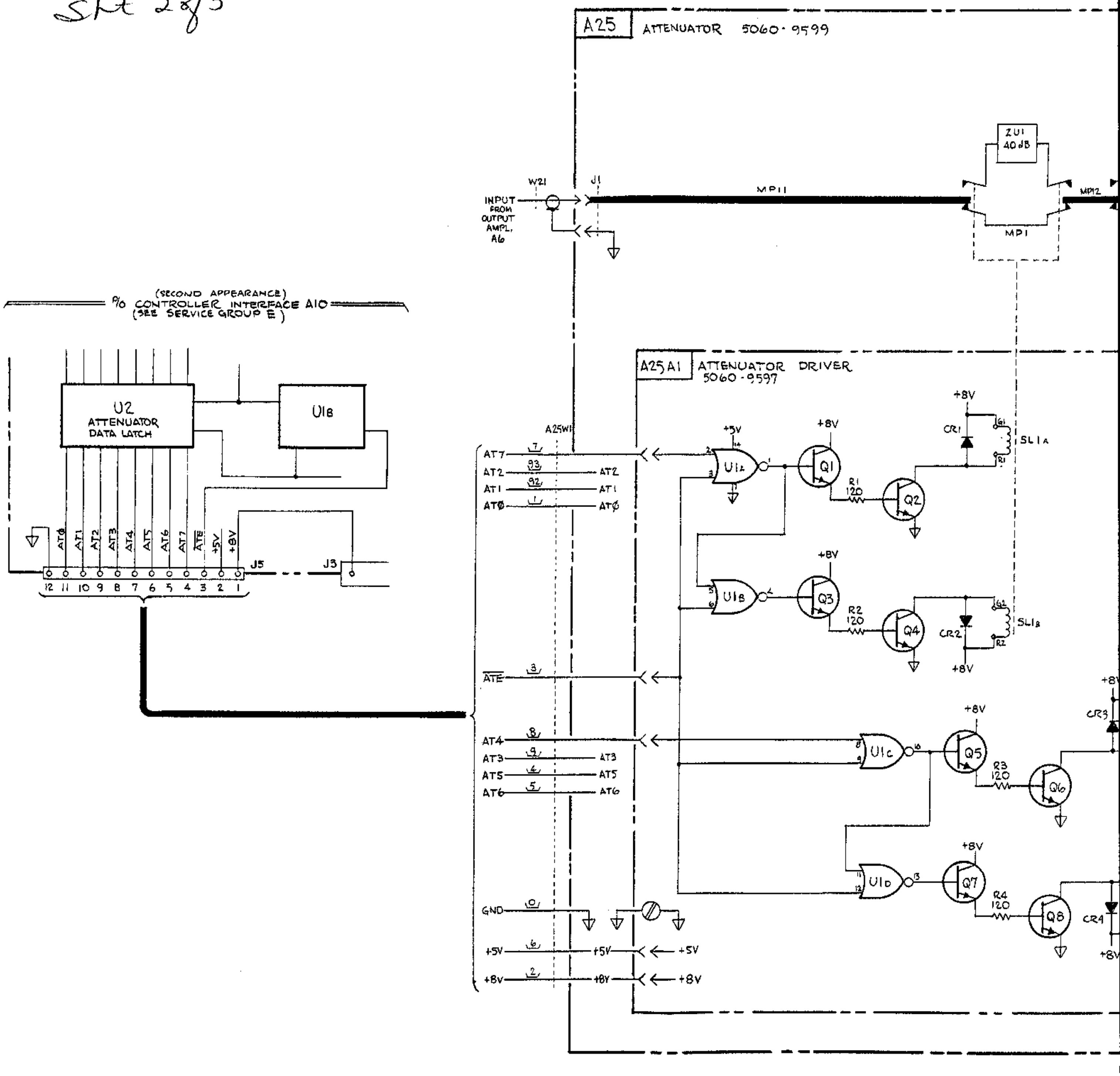
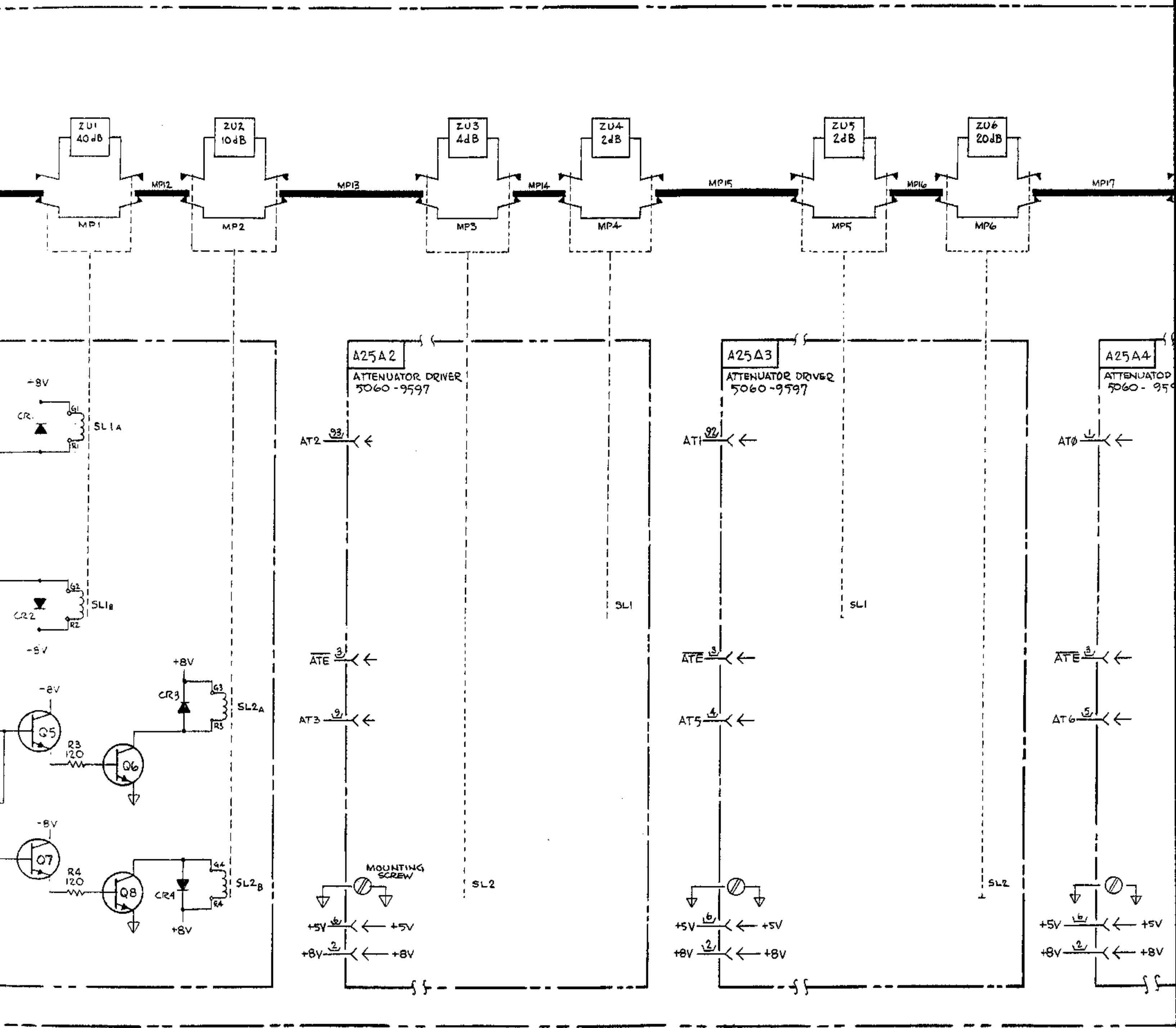


Fig 8-N-15
Sht 3 of 5



 3335-E-95

Fig 8-N-15
Sht 4 of 5

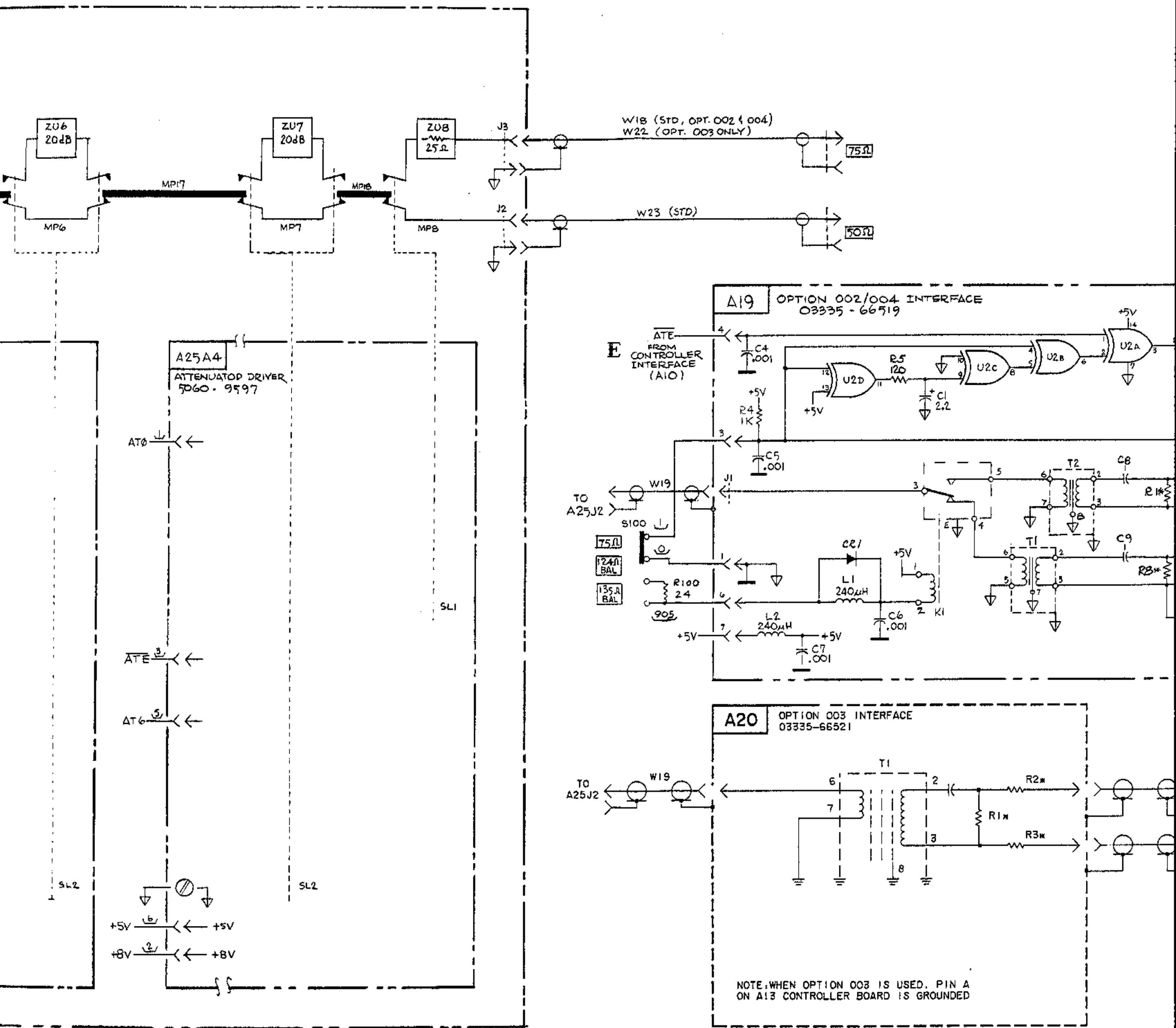


Figure 8-N-15. Schematic Diagram, 002 (03335-66519) (03335-66519).

Fig 8-N-15
Sht 5 of 5

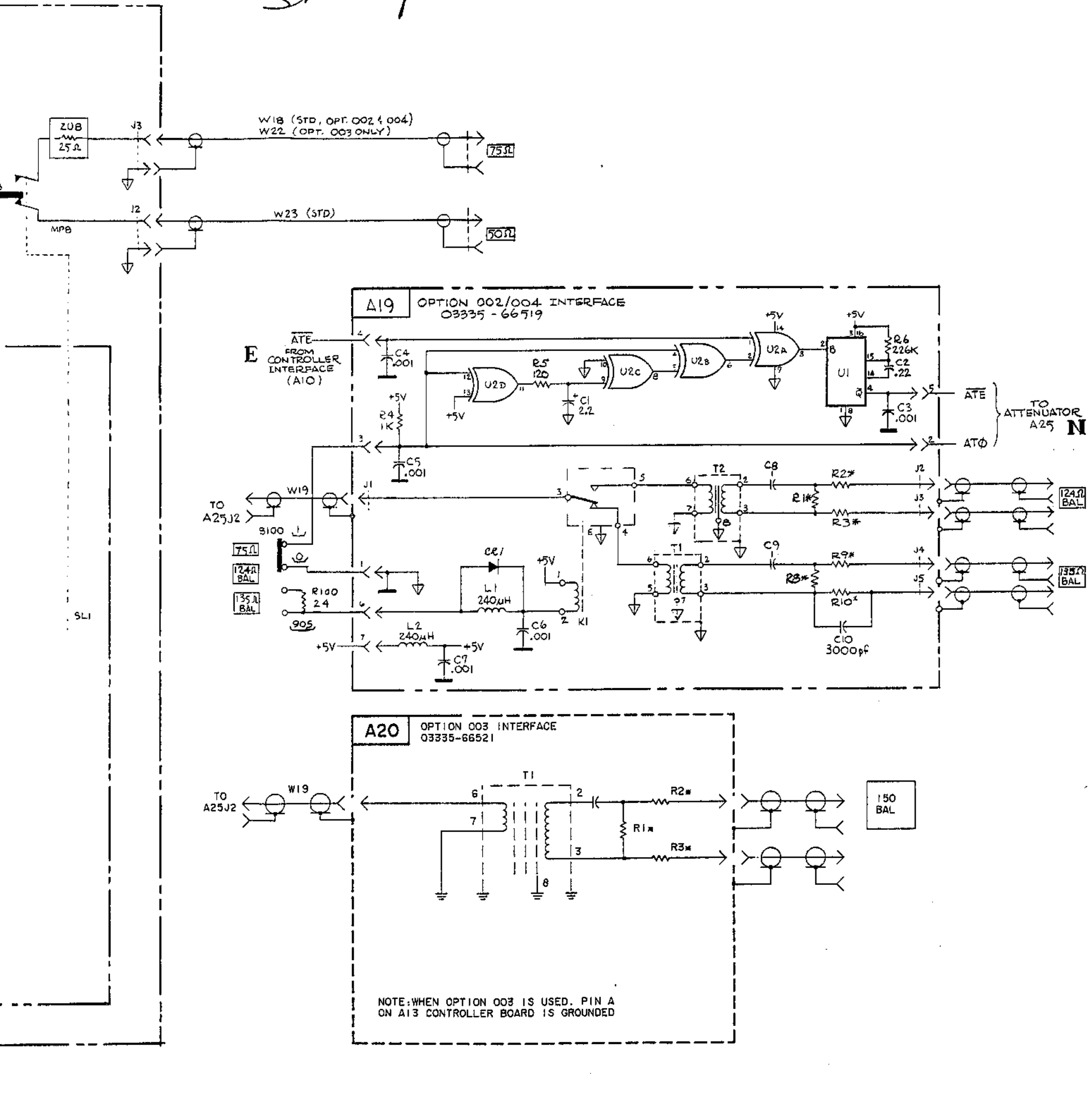


Figure 8-N-15. Schematic Diagram, Attenuator (5060-), and Options 002 (03335-66519), 003 (03335-66521) and 004 (03335-66519).

SERVICE GROUP O

FUNCTIONAL BLOCK DIAGRAM; SECTION LEVEL TROUBLESHOOTING; MODULE TROUBLESHOOTING/ADJUSTMENT SET–UP PROCEDURE

INTRODUCTION

The main purpose of Service Group O is to provide section level troubleshooting information. This includes a procedure to set up the module to obtain access to the rf connector test points on the module's mother board. The set-up procedure is also required to obtain access to the eight assemblies of the module for component level troubleshooting and adjustments.

Section level troubleshooting is in the form of a flowchart to aid in rapidly identifying the faulty section. Once the faulty section is identified, the flowchart indicates the service group containing the component level troubleshooting. Section level troubleshooting contained in the flowchart is performed using the instrument's functional block diagram.

TROUBLESHOOTING DATA

Section level troubleshooting is performed by the following procedure:

1. Perform the module troubleshooting/adjustment set-up procedure.

2. Perform the procedure outlined in the flowchart (Figure 8-O-1) with the aid of the functional block diagram (Figure 8-O-2).

MODULE TROUBLESHOOTING/ADJUSTMENT SET–UP PROCEDURE

The purpose of this procedure is to position the module and chassis in an arrangement that allows efficient access to Mother Board test points and ease of access to the assemblies of the module. The component locators in each service group are oriented to agree with this set up.

1. Unplug the power cord from the instrument.

NOTE

Steps 2 through 4 are to be performed with the instrument sitting on the four feet of the bottom cover.

2. Disconnect the 40/N MHz cable and the 10 MHz cable from the Mother Board (see Figures 8-O-3 and 8-O-4).

3. Loosen the semi-rigid coax cable connection at the attenuator and disconnect the semi-rigid coax cable connection at the module end (see Figure 8-O-3).

4. Remove the three module hold-down screws from the top of the module (see Figure 8-O-3).

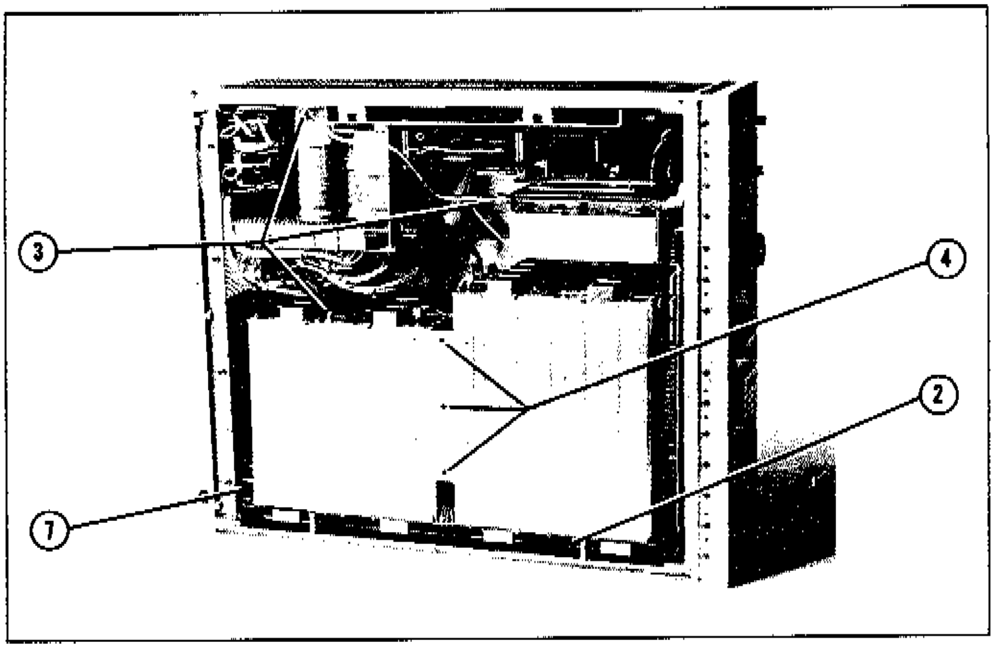


Figure 8-O-3. Module Set-Up Procedure.

5. Set the instrument on its side as shown in Figure 8-O-3 taking care that the module does not fall out.
6. Slide the module out of the chassis just enough for the four module legs to clear the chassis.
7. Disconnect the EXT LEV cable and the three-conductor EXT LEV switch connector from the Mother Board (see Figures 8-O-3 and 8-O-4).
8. Position the module as shown in Figure 8-O-5.
9. Connect a jumper between the outer pins of the EXT LEV switch connector of the Mother Board (see Figure 8-O-5). This serves the function of the LEVELING switch and places the module in the internal level mode.
10. Any communications features that have been implemented must be removed if the instrument is being prepared for adjustments. The communications features are described in Figure 8-D-1. Remove communications jumper J1 and set the amplitude blanking switch to normal as required.
11. Reconnect the power plug and turn the instrument on.

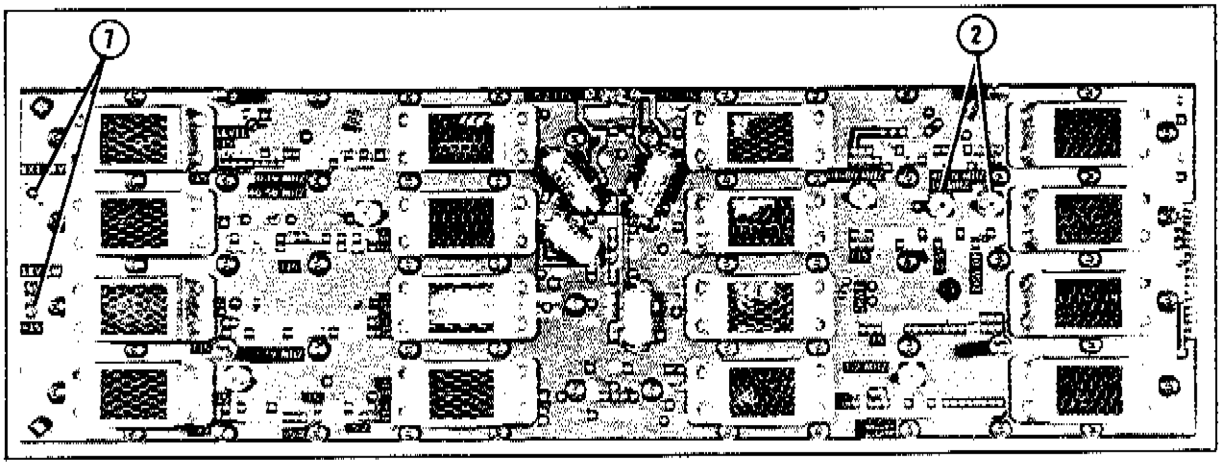


Figure 8-O-4. Mother Board Locations for Set-Up Procedure.

NOTE

Since the 40/N MHz cable was disconnected, the reference oven signal is removed from the module. This causes the front panel "UNLOCKED" annunciator to illuminate. The 40 MHz master oscillator of the Reference Section now operates open-loop.

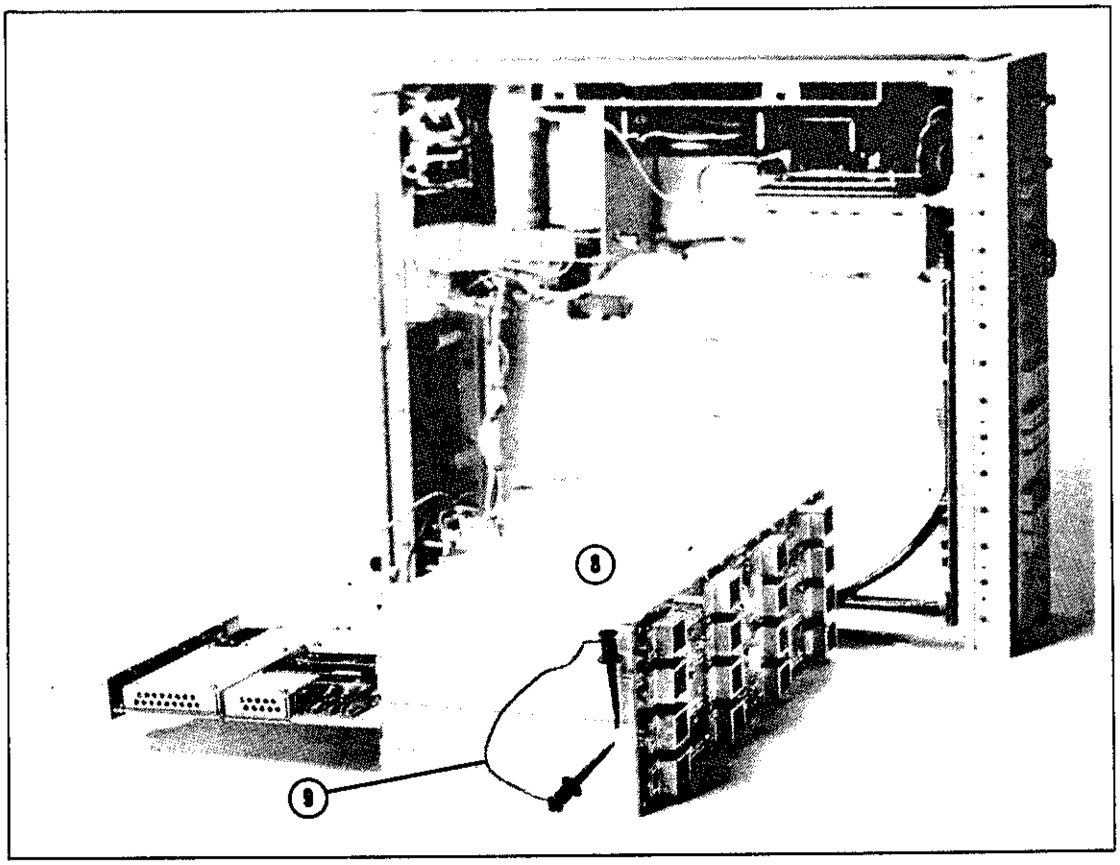


Figure 8-O-5. Module Position.

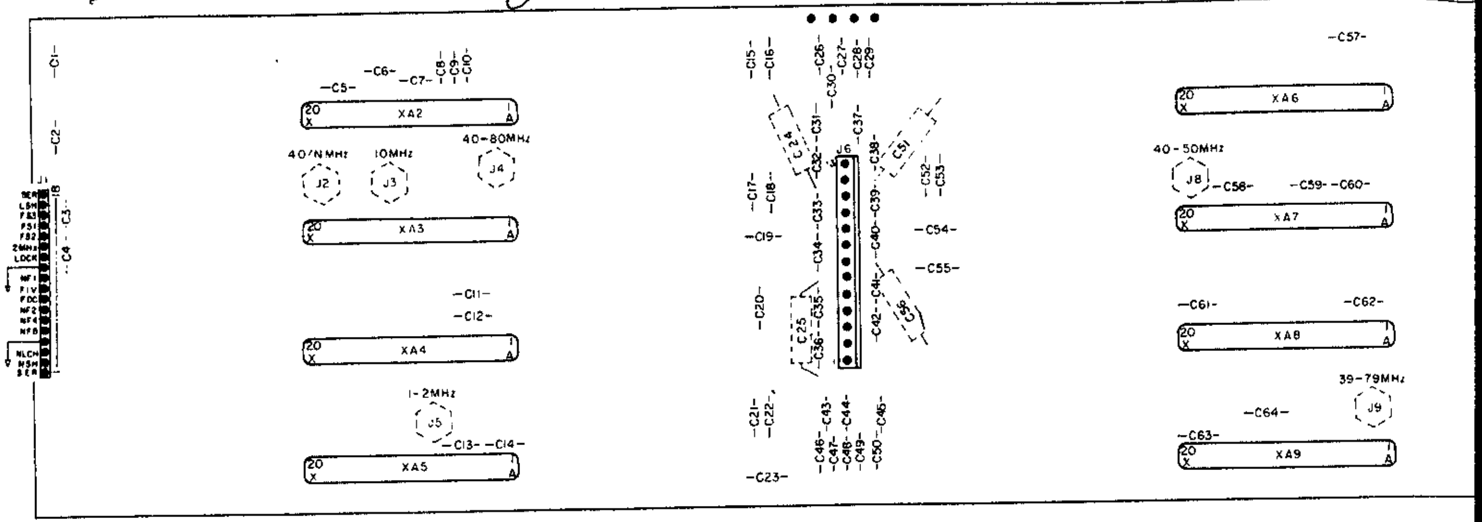
Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	03335-66515	1	P.C. ASSEMBLY, MOTHER BOARD	28480	03335-66515
A1C1	0150-0093	59	CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C2	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C3	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C4	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C5	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C6	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C7	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C8	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C9	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C10	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C11	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C12	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C13	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C14	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093
A1C15	0150-0093		CAPACITOR-FXD .01UF +80-20% 100WVDC CER	28480	0150-0093

Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1C16	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C17	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C18	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C19	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C20	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C21	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C22	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C23	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C24	0180-0058	2	CAPACITOR-FXD 50UF +75−10% 25VDC AL	56289	30D506G025CC2
A1C25	0180-0339	2	CAPACITOR-FXD 50UF +75−10% 16VDC AL	56289	30D506G016CB2
A1C26	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C27	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C28	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C29	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C30	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C31	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C32	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C33	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C34	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C35	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C36	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C37	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C38	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C39	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C40	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C41	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C42	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C43	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C44	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C45	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C46	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C47	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C48	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C49	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C50	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C51	0180-0058		CAPACITOR-FXD 50UF +75−10% 25VDC AL	56289	30D506G025CC2
A1C52	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C53	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C54	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C55	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C56	0180-0339		CAPACITOR-FXD 50UF +75-10% 16 VDC AL	56289	30D506G016CB2
A1C57	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C58	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C59	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C60	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C61	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C62	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C63	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1C64	0150-0093		CAPACITOR-FXD .01UF +80−20% 100WVDC CER	28480	0150-0093
A1J1	1251-4620	2	MOLEX, 22-10-2181	27264	OBD
A1J2	1250-0835	6	CONNECTOR-RF SMC M PC 50-OHM	98291	50-051-0000
A1J3	1250-0835		CONNECTOR-RF SMC M PC 50-OHM	98291	50-051-0000
A1J4	1250-1339	4	CONNECTOR-RF SM-SLD M PC 50-OHM	98291	52-051-0000
A1J5	1250-1339		CONNECTOR-RF SM-SLD M PC 50-OHM	98291	52-051-0000
A1J6	1251-4486	1	CONNECTOR 13-PIN M POST TYPE	27264	09-60-1131
A1J8	1250-1339		CONNECTOR-RF SM-SLD M PC 50-OHM	98291	52-051-0000
A1J9	1250-1339		CONNECTOR-RF SM-SLD M PC 50-OHM	98291	52-051-0000
A1J10	1250-0835		CONNECTOR-RF SMC M PC 50-OHM	98291	50-051-0000
A1J11	1251-4246	2	CONNECTOR 3-PIN M POST TYPE	27264	09-65-1031
A1MP1	03335-61210	1	HONEYCOMB ASSEMBLY	28480	03335-61210
	0050-0649	16	*RFI HONEYCOMB FRAME	28480	0050-0649
	8160-0255	16	HONEYCOMB	28480	8160-0255
A1XA2	1251-4531	8	CONNECTOR, PC EDGE 20-CONT/ROW 2-ROWS	28480	1251-4531
A1XA3	1251-4531		CONNECTOR, PC EDGE 20-CONT/ROW 2-ROWS	28480	1251-4531
A1XA4	1251-4531		CONNECTOR, PC EDGE 20-CONT/ROW 2-ROWS	28480	1251-4531
A1XA5	1251-4531		CONNECTOR, PC EDGE 20-CONT/ROW 2-ROWS	28480	1251-4531
A1XA6	1251-4531		CONNECTOR, PC EDGE 20-CONT/ROW 2-ROWS	28480	1251-4531
A1XA7	1251-4531		CONNECTOR, PC EDGE 20-CONT/ROW 2-ROWS	28480	1251-4531
A1XA8	1251-4531		CONNECTOR, PC EDGE 20-CONT/ROW 2-ROWS	28480	1251-4531
A1XA9	1251-4531		CONNECTOR, PC EDGE 20-CONT/ROW 2-ROWS	28480	1251-4531

Fig 8-0-1 Sht 1 of 5



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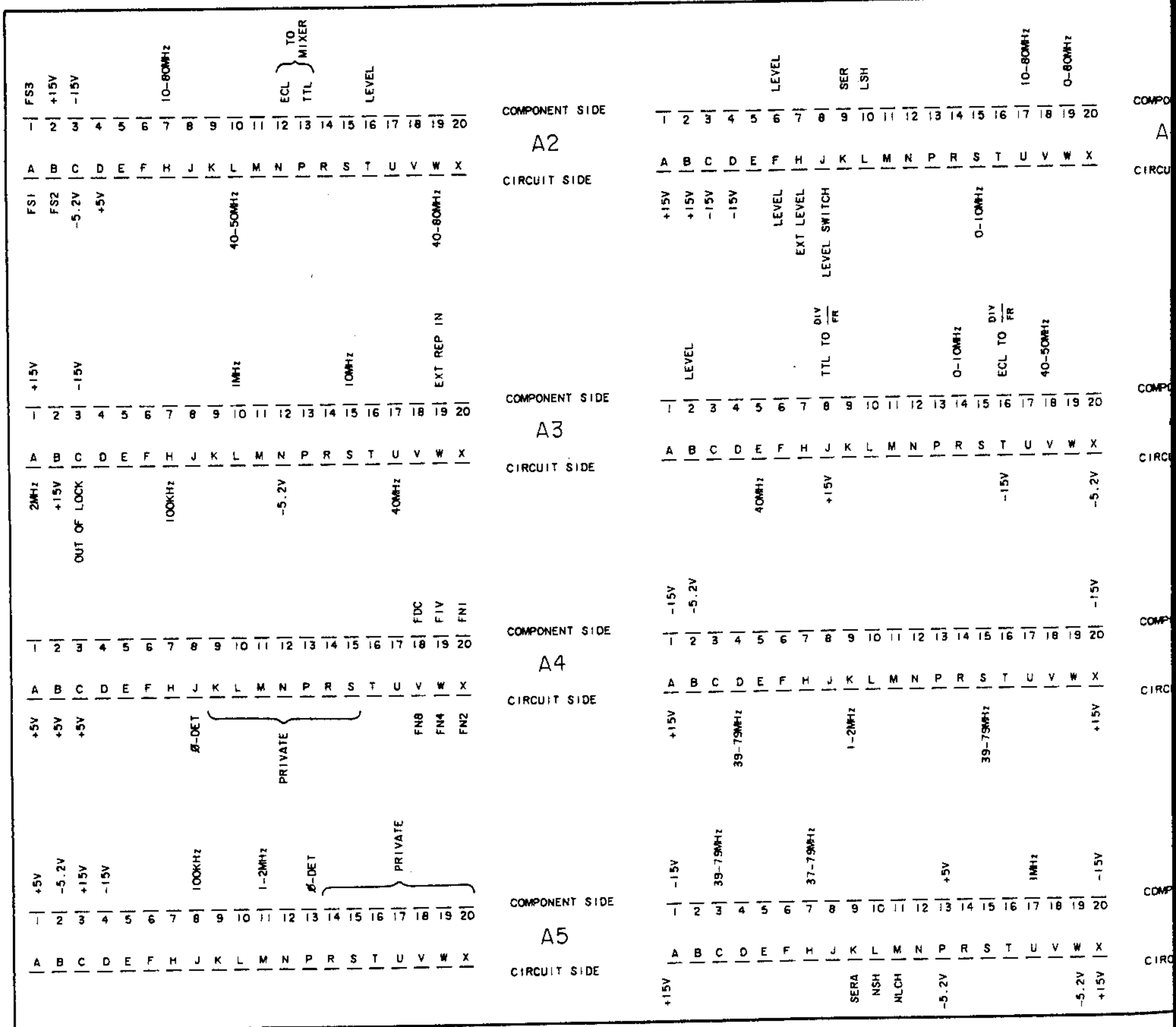
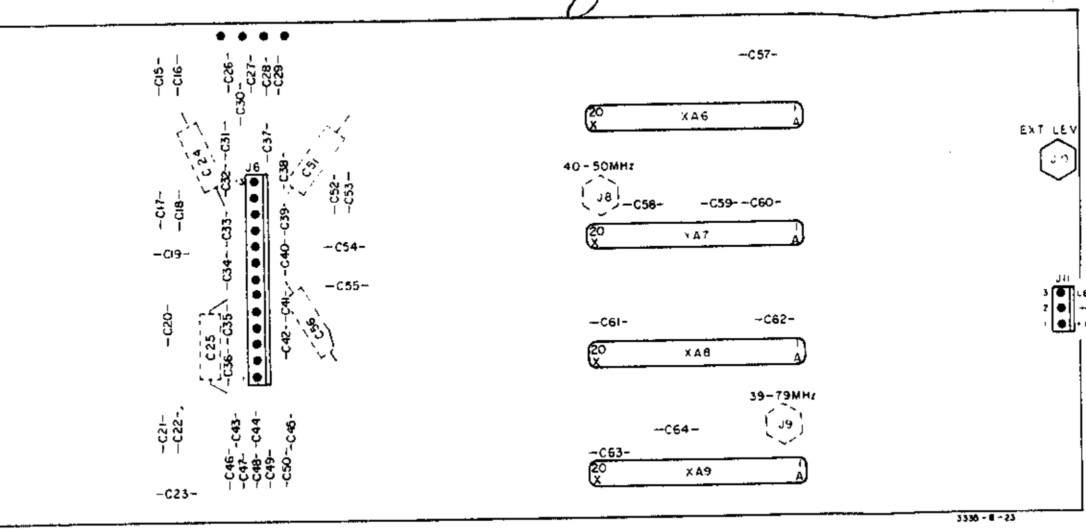


Fig 8-0-1 Sht 2 of 5



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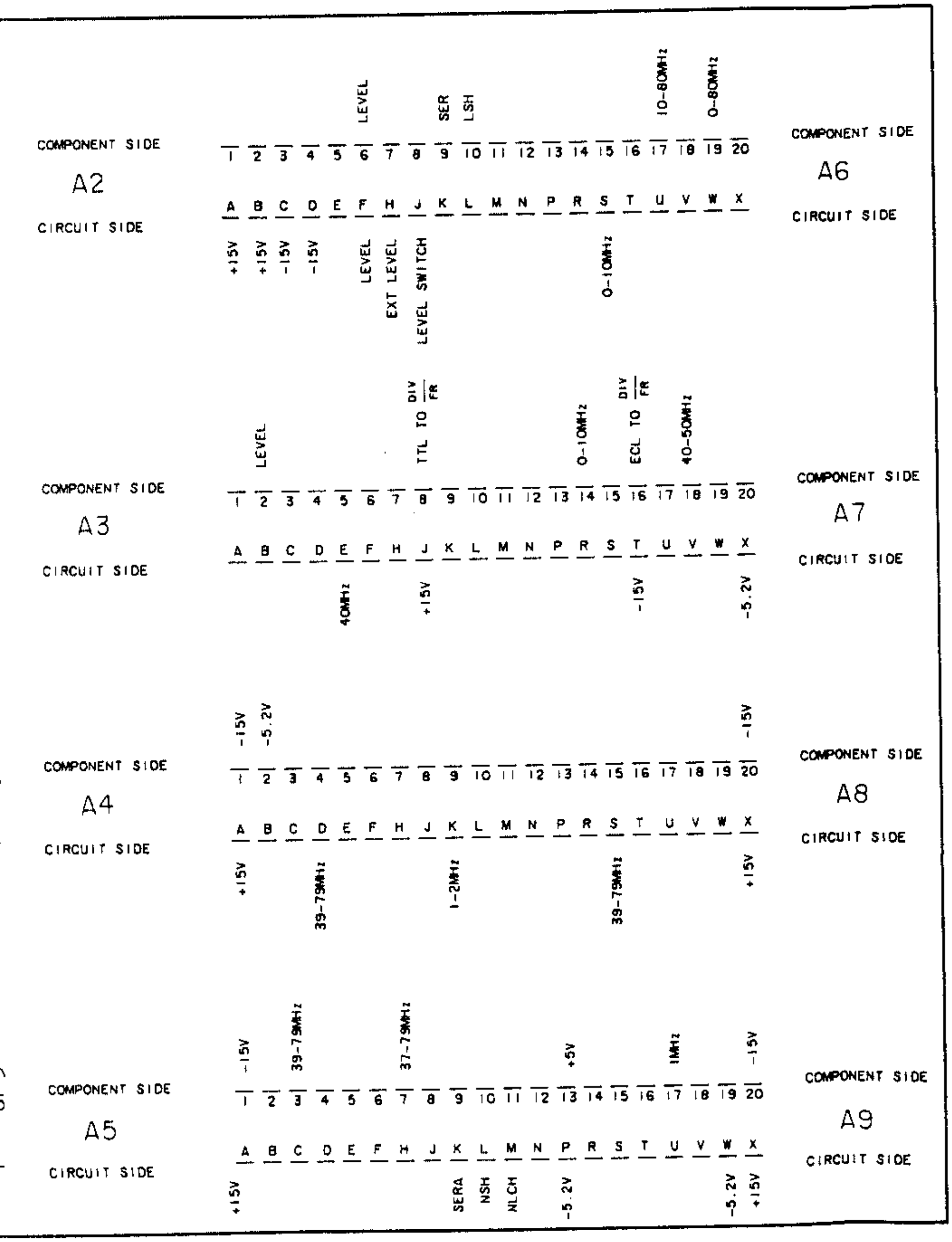
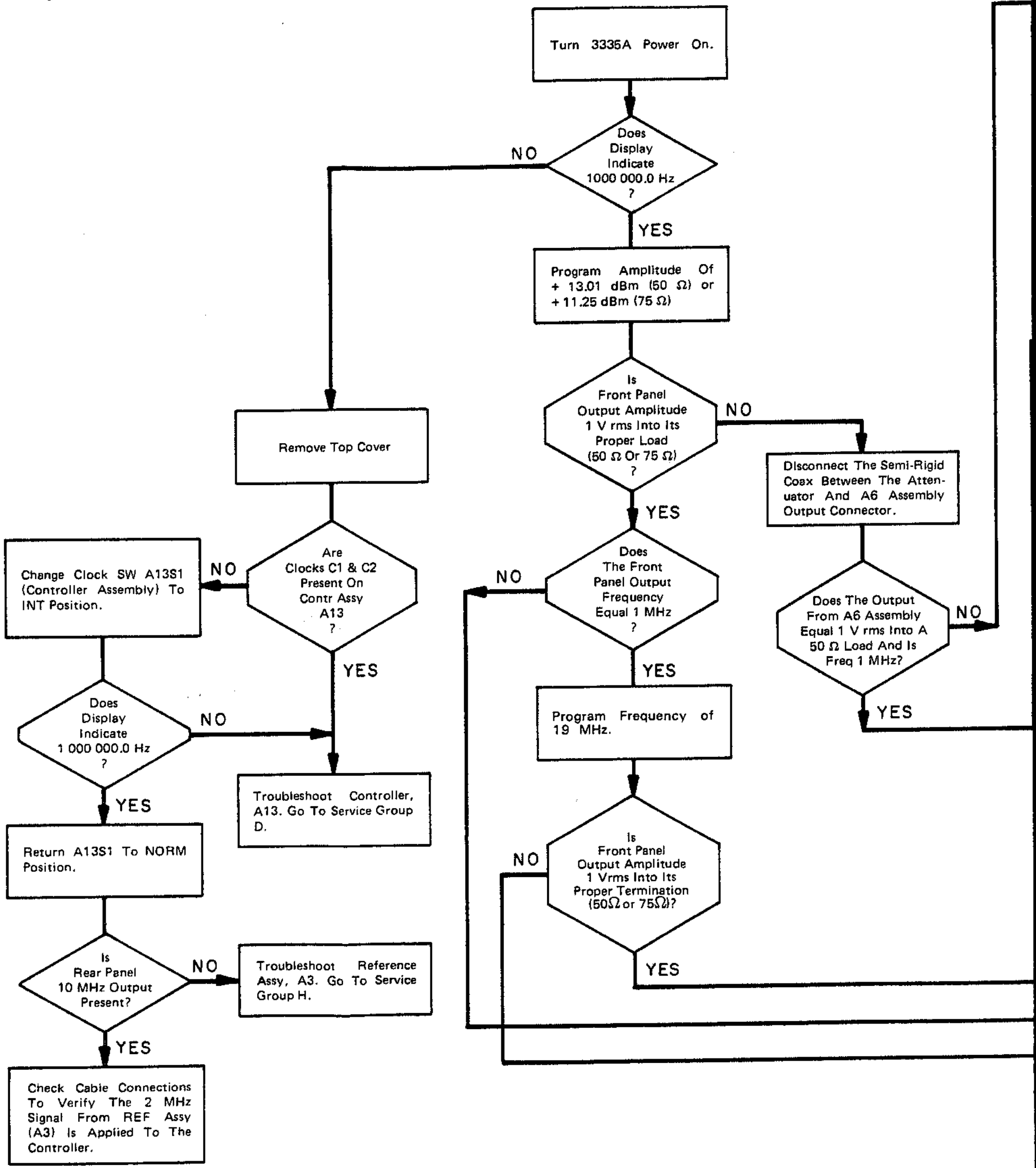


Mother Board Edge Connector Receptacles
(Viewed from the bottom of the Mother Board)

Fig 8-0-1 sht 3 of 5



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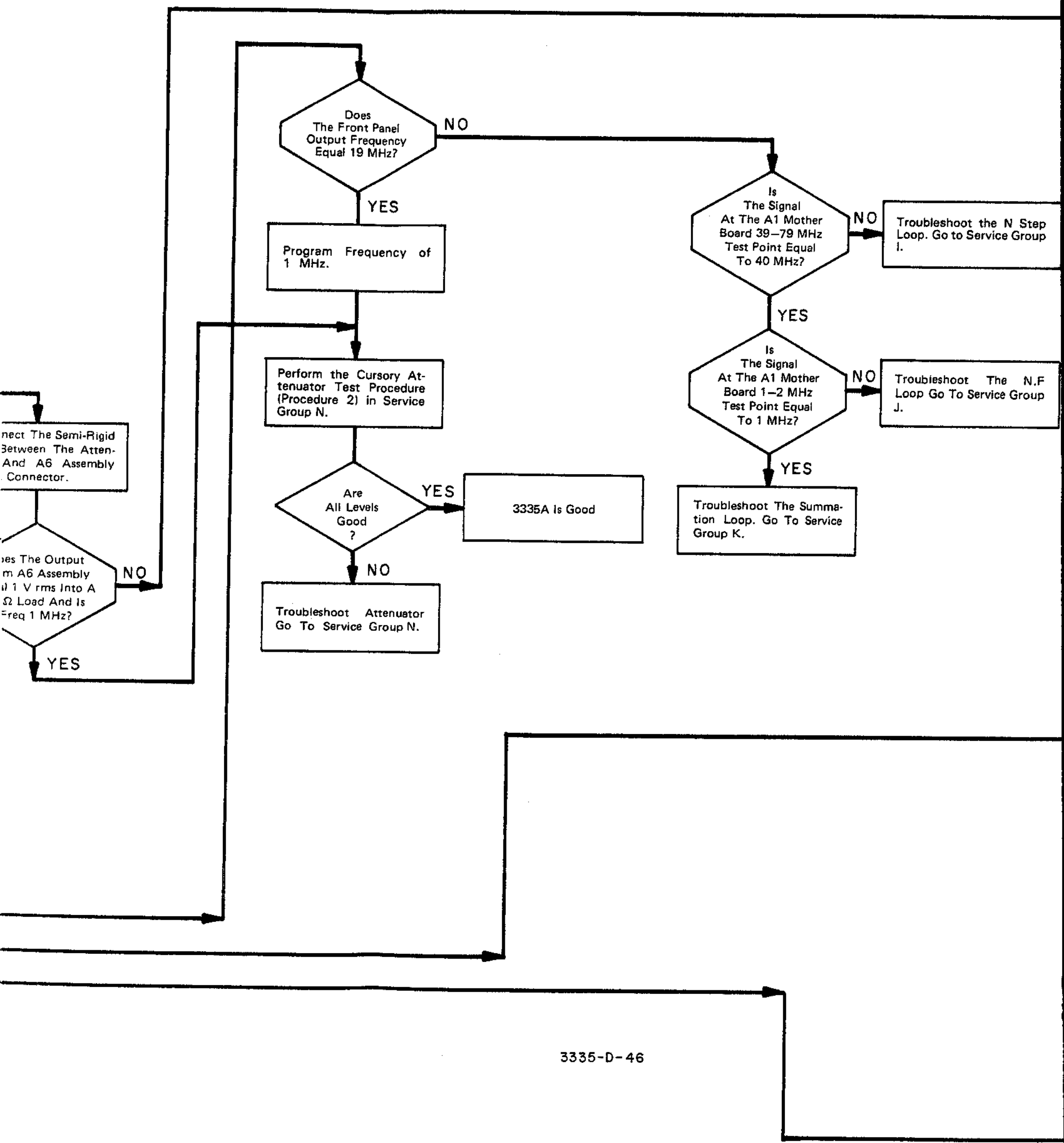


3335-D-46

Fig 8-0-1 Sht 5 of 5

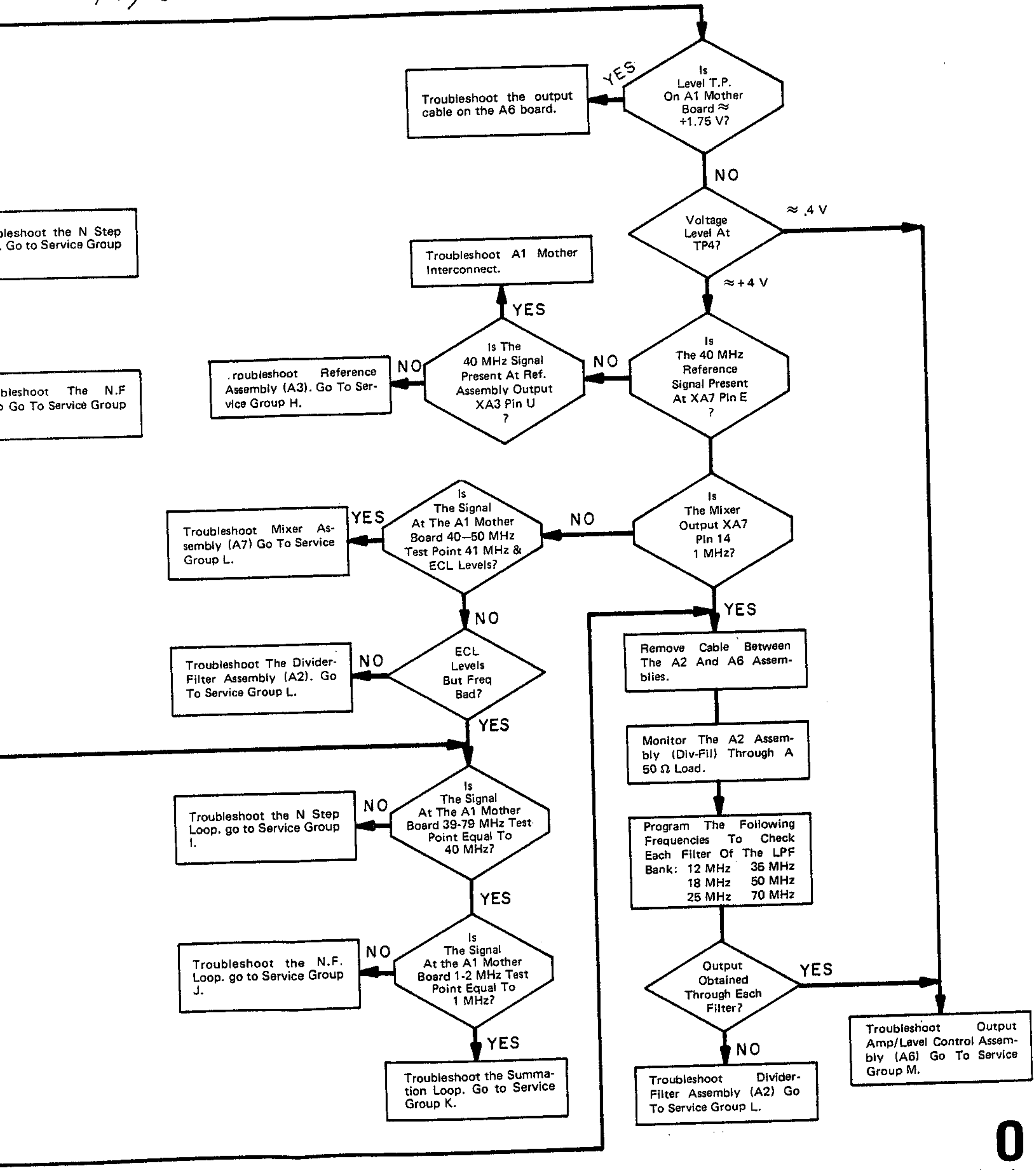


Figure 8-O-1. TS Flowchart, Section Level Troubleshooting.

Fig 8-0-2
Sht 1of5

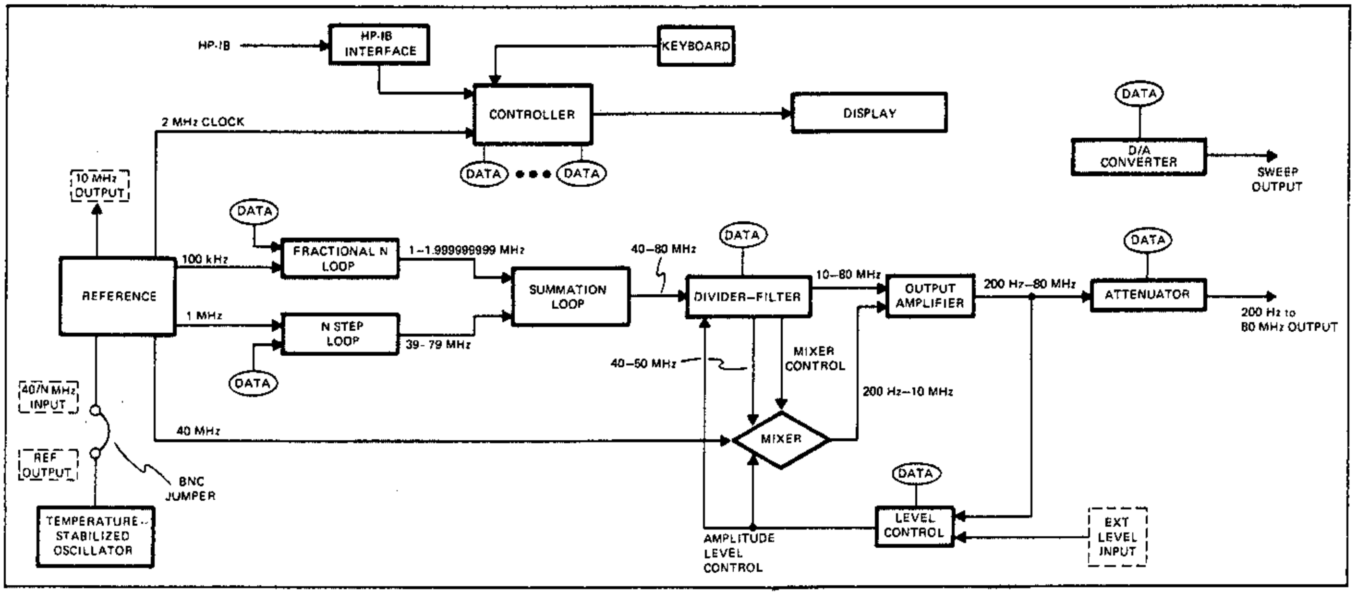
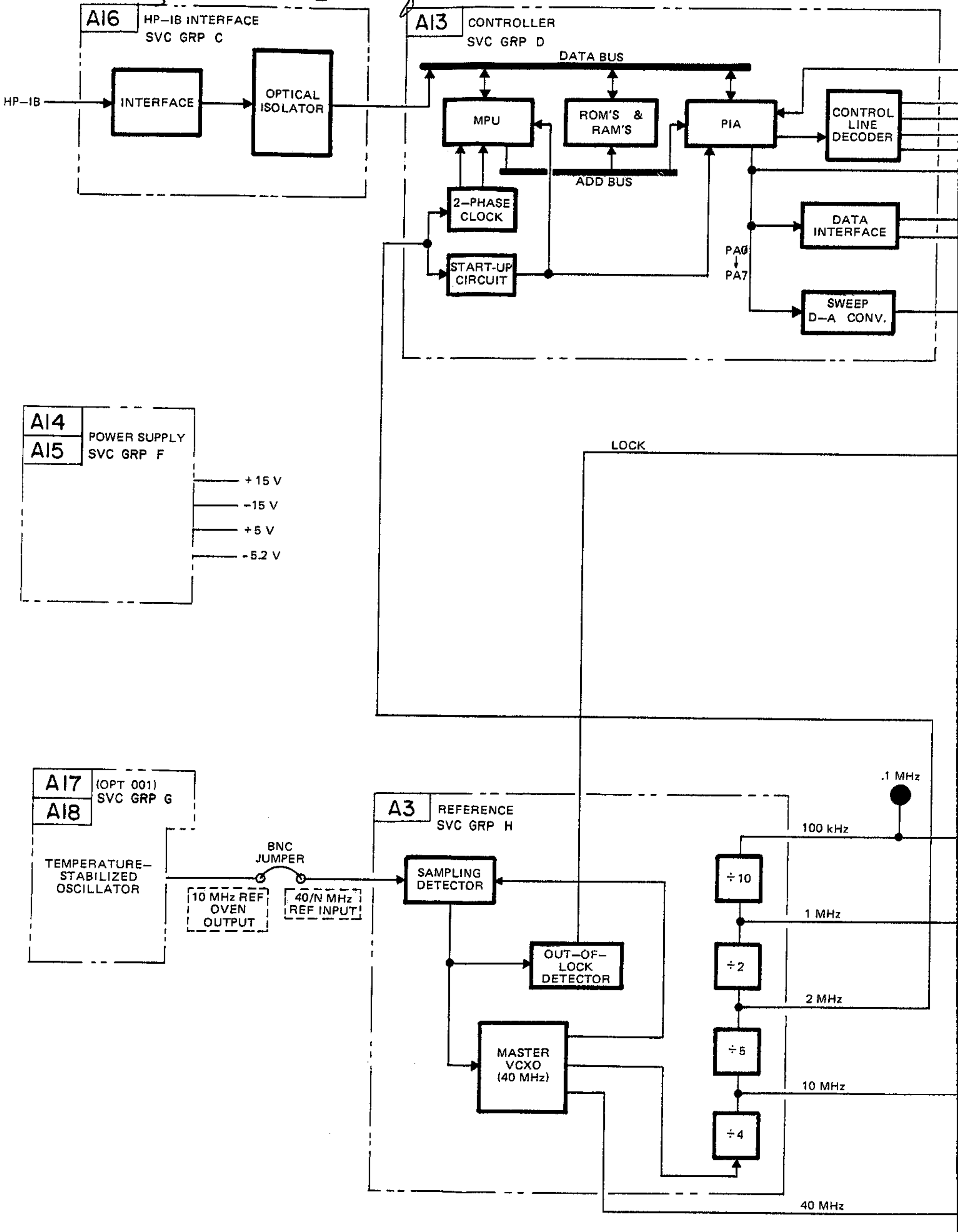


Fig 8-0-2 SH 2 of 5



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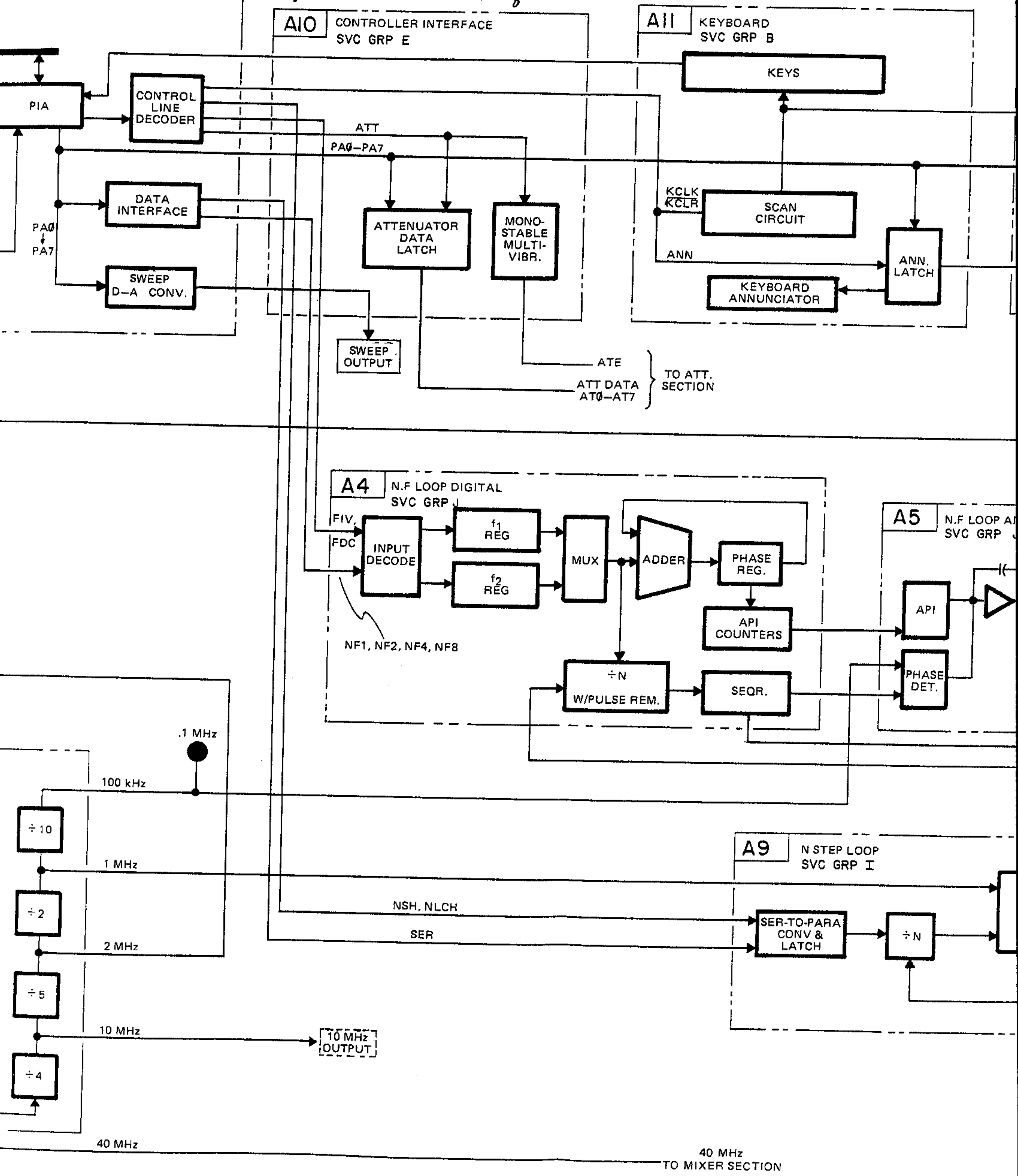

Fig 8-0-2 Sht 4 of 5

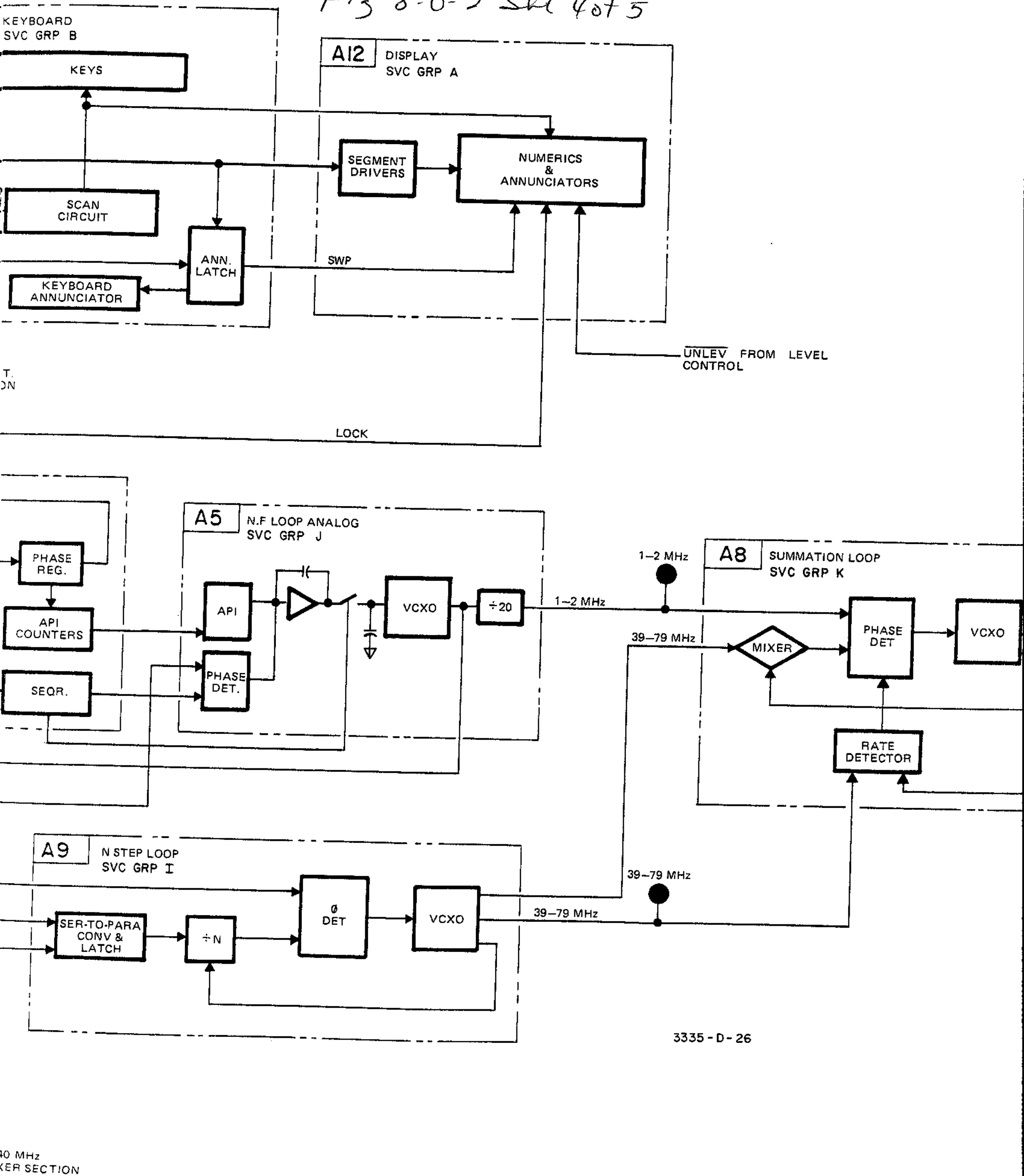

Figure 8-0-2. Block D

Fig 8-0-2 Sht 5 of 5

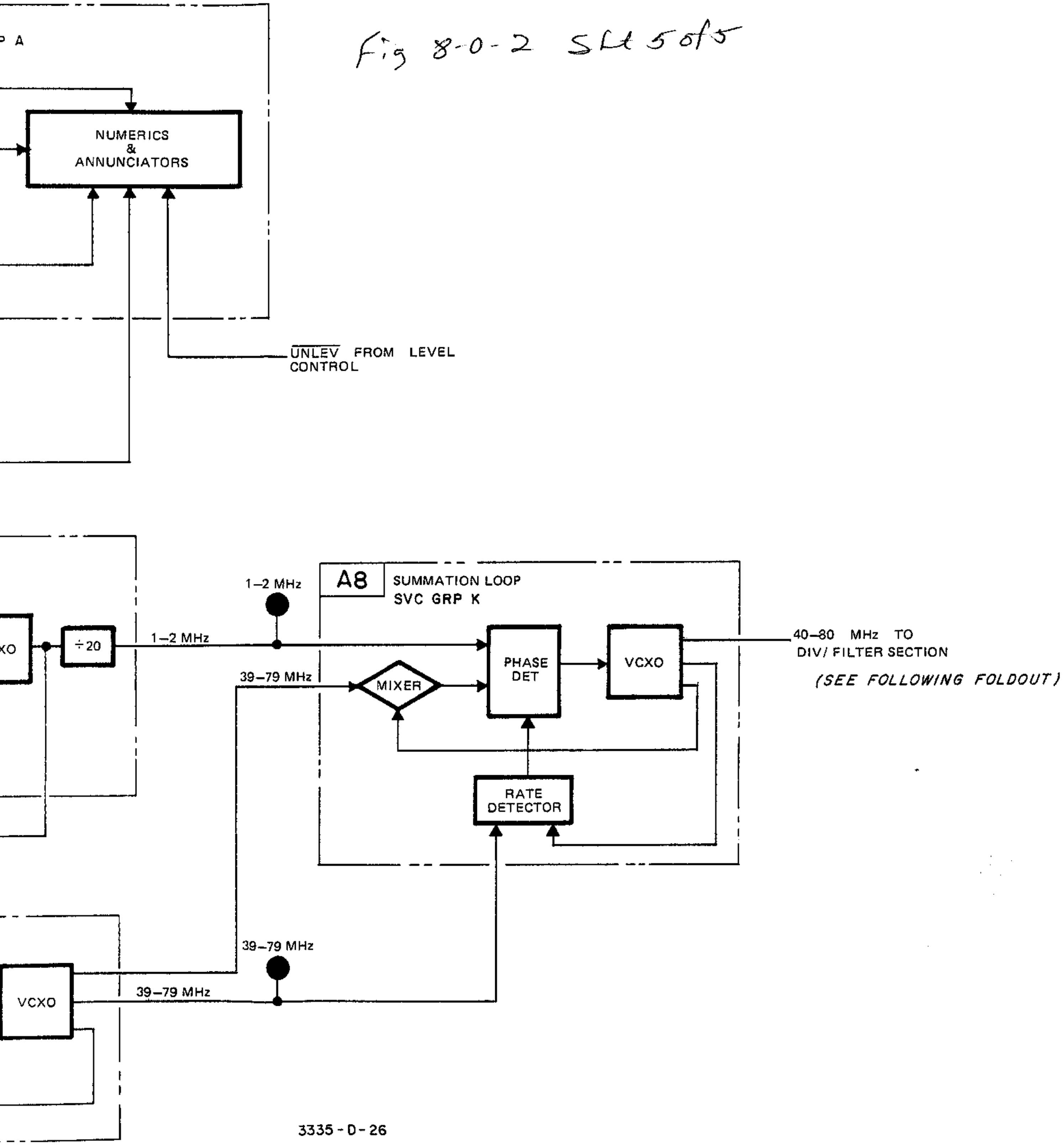

Figure 8-O-2. Block Diagram, Instrument Functional Block Diagram.

Fig 8-0-2a

Sht 1 of 5

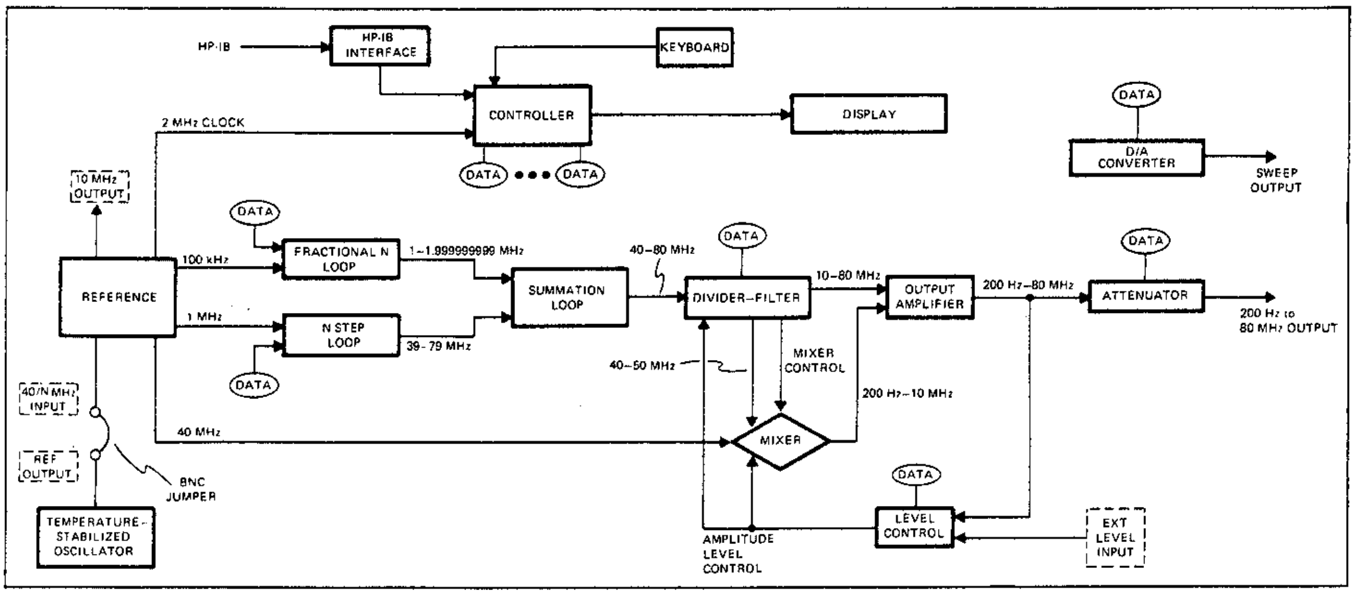

Fig 8-0-2a
Sht 2 of 5

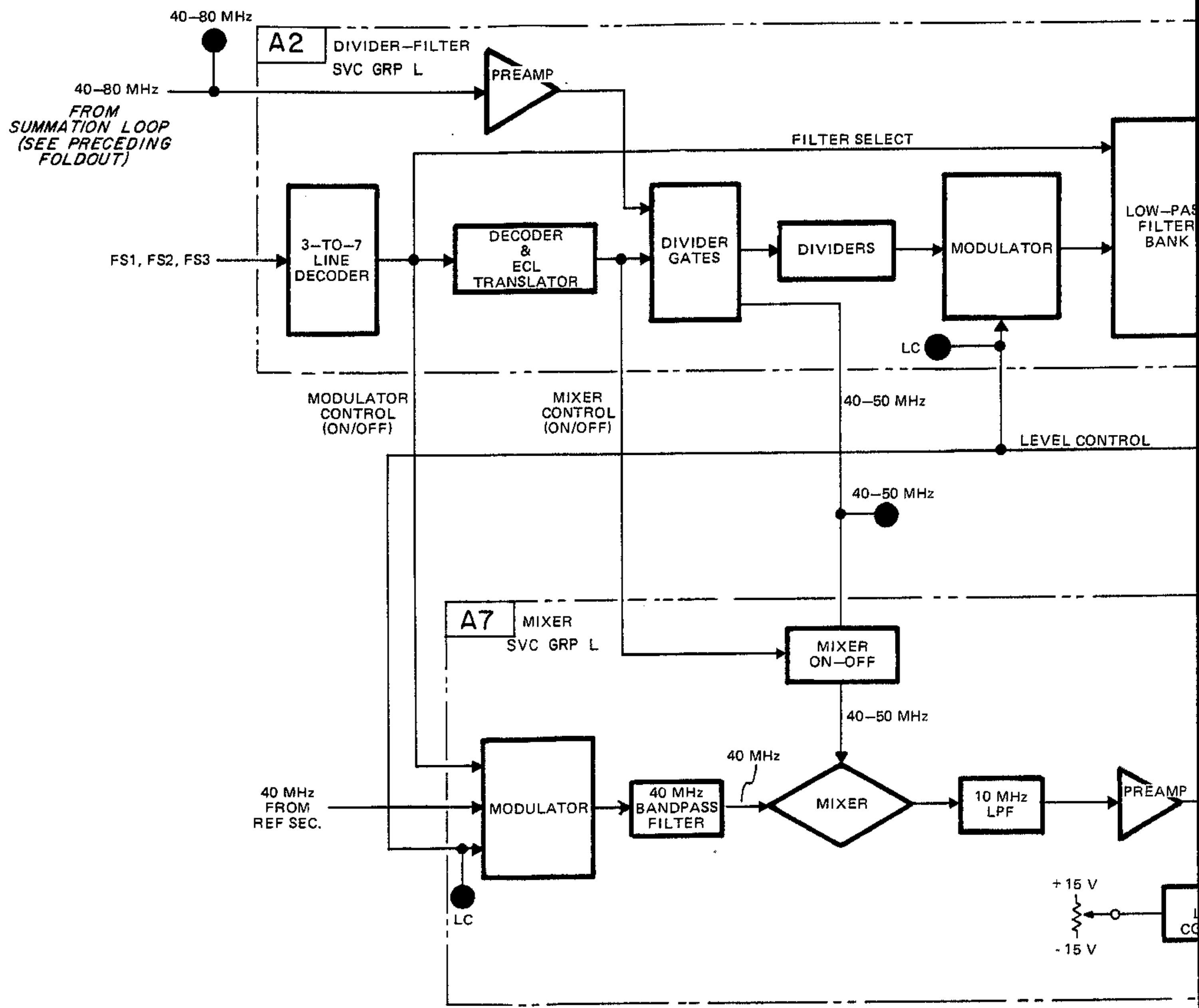

Fig 8-0-2a
Sht 3 of 5

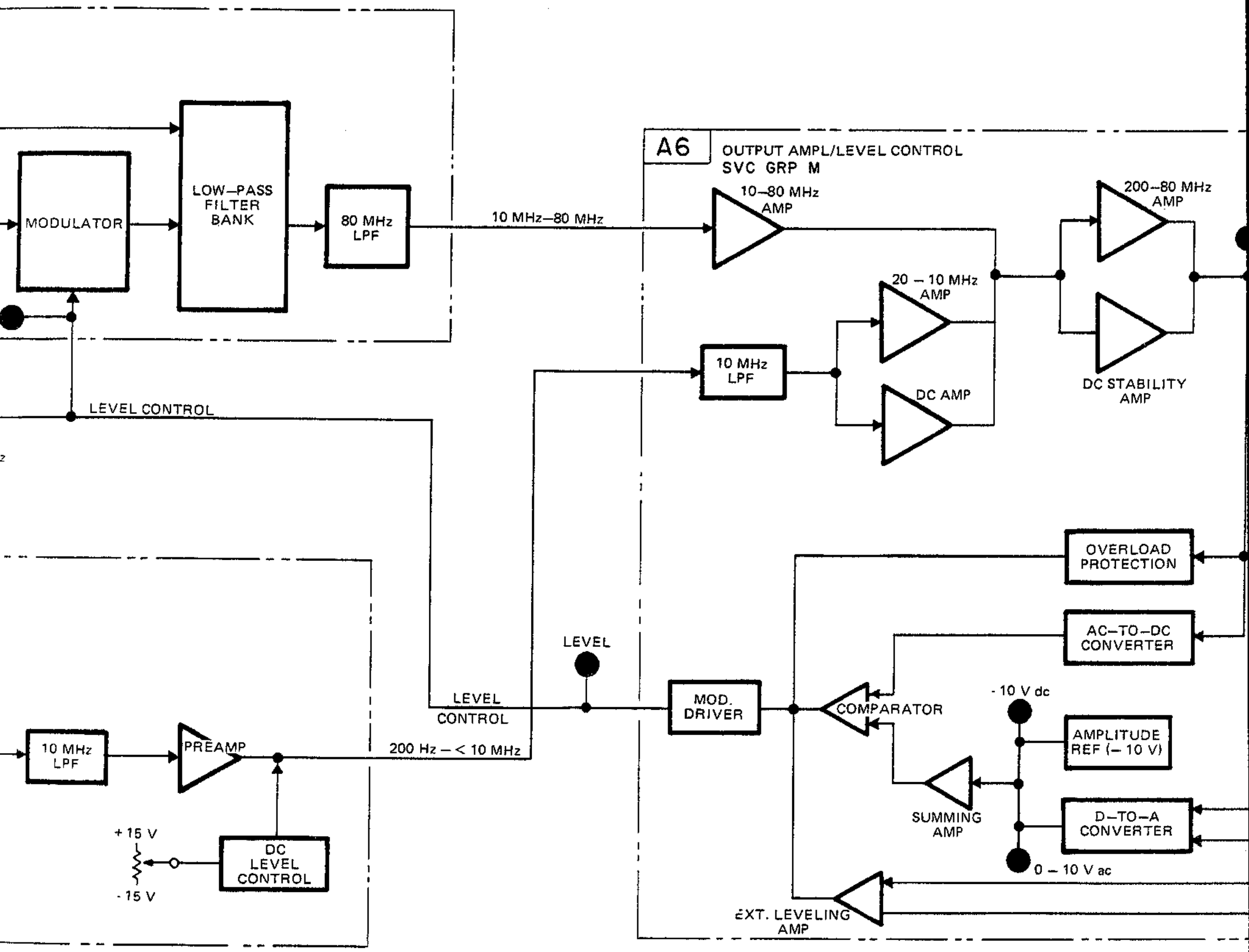

Fig 8-0-2a
Sht 4 of 5

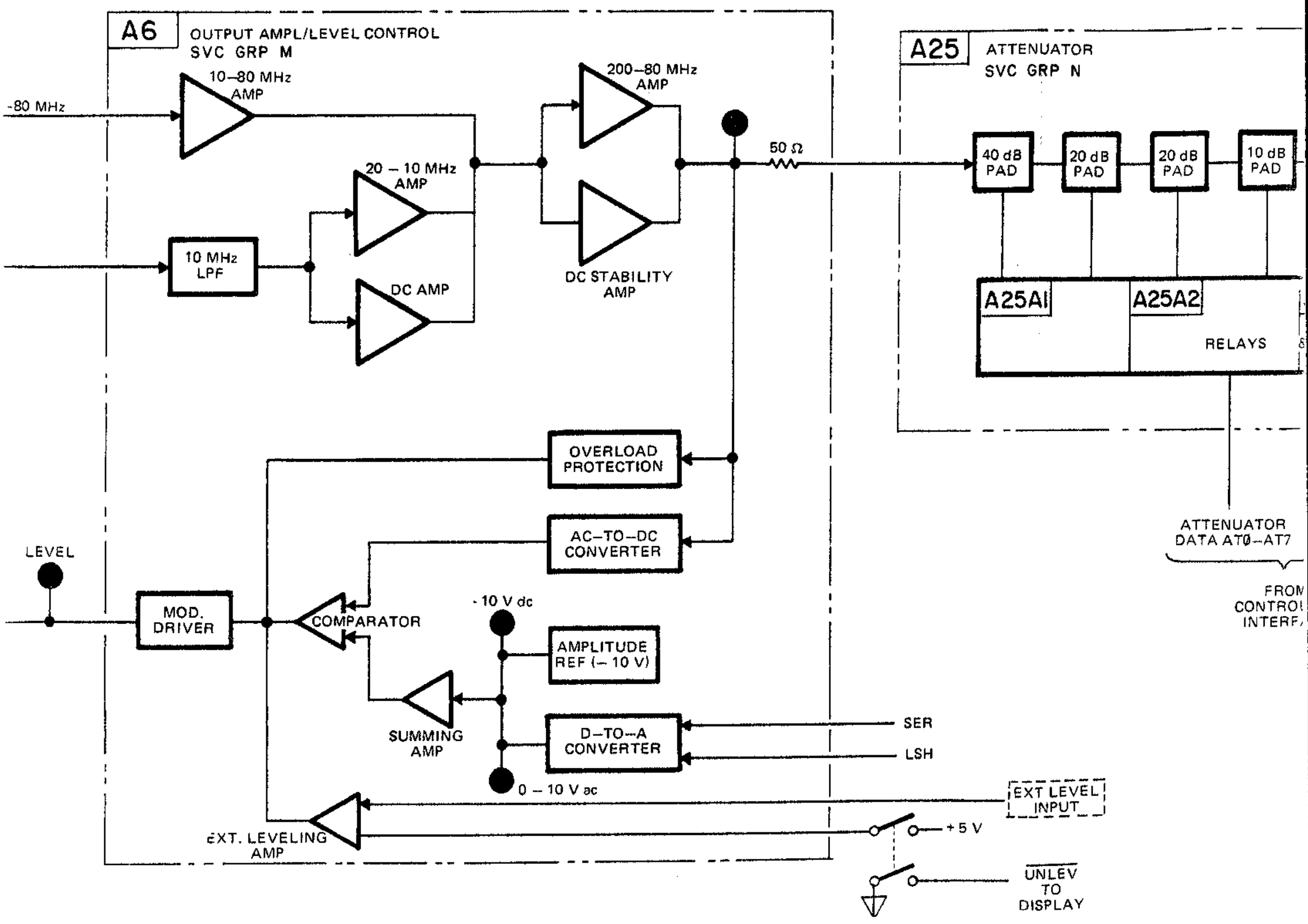

Fig 8-0-2a
Sht 5 of 5

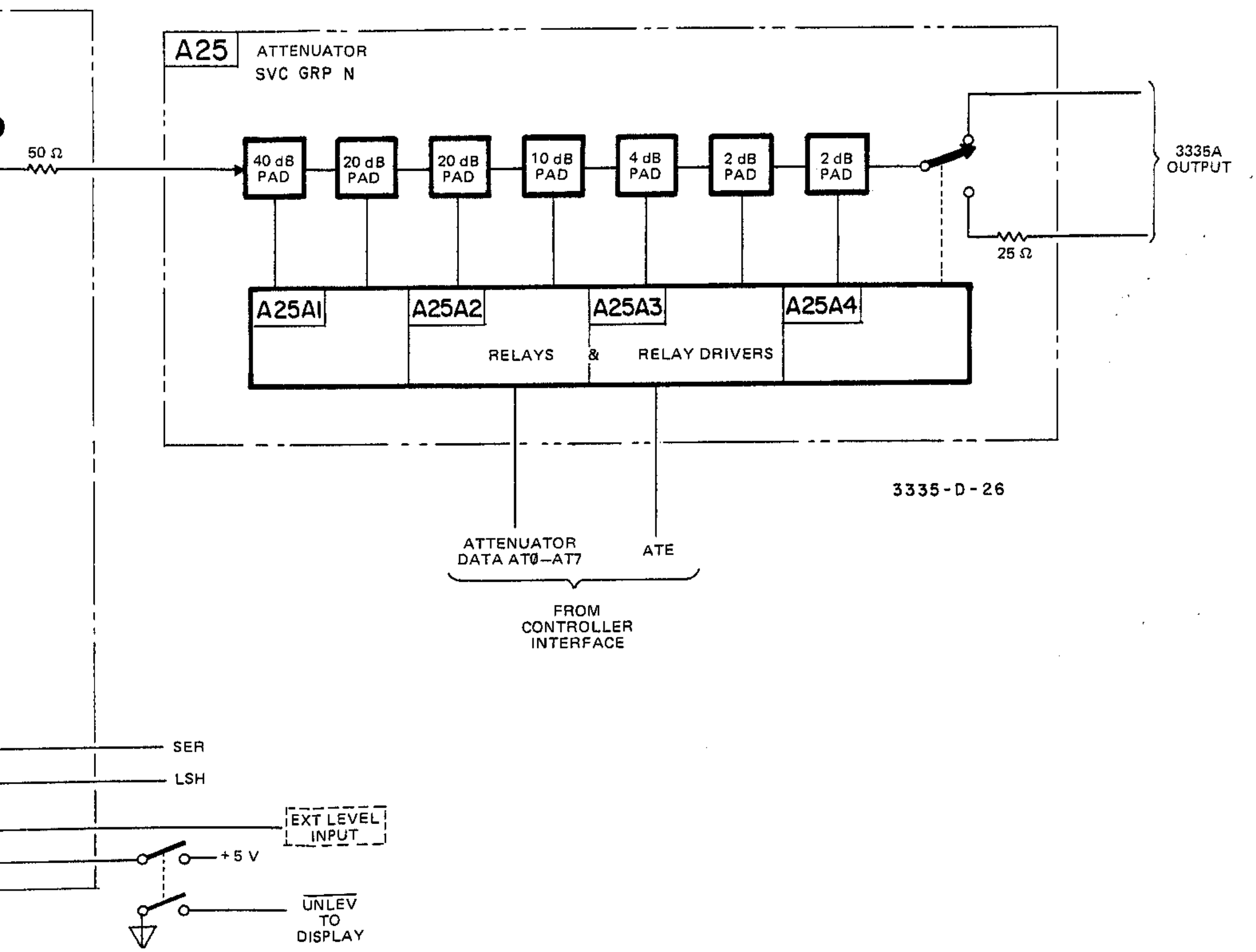

Figure 8-O-2. Block Diagram, Instrument Functional Block Diagram (Cont'd).