



Biddle Instruments

510 Township Line Road, Blue Bell, PA 19422 • 215-646-9200

SERVICE MANUAL

for

MODEL 431F AND 431M

Cat. No. 655431

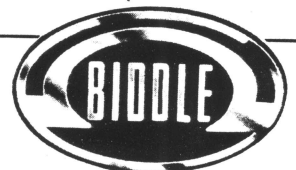
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CABLE FAULT LOCATOR

James G. Biddle INSTRUMENTS

510 Township Line Road, Blue Bell, Pennsylvania 19422

215-646-9200/Cable: BIDDLE/Telex: 83-4423 BIDDLE PMTG. Sales offices in principal cities



A member of the THORN EMI Group

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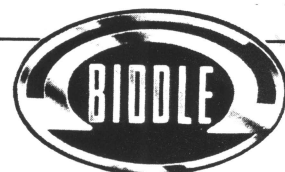
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INTRODUCTION AND TECHNICAL DATA

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SECTION 1

INTRODUCTION AND TECHNICAL DATA

INTRODUCTION

- 1 The 431 is a pulse reflection cable test set which provides a visual indication of cable faults. The principle of operation is that a pulse transmitted into a cable travels with a velocity determined by the dielectric, or insulating medium, and is reflected by discontinuities or impedance mismatches in the cable. The transmitted and reflected pulses are displayed on a cathode ray tube screen, the time interval being proportional to the distance to the point of reflection. The type of fault can be determined by analysis of the displayed waveform.
- 2 The 431 employs advanced digital circuitry enabling a high degree of accuracy greater versatility and simpler operation, with a readout of fault distance on a large, 5-digit LED display. Also incorporated is a digital memory with battery back-up which enables a displayed trace to be stored for up to 48 hours after the instrument is switched off.
- 3 The Cable Fault Locators 431F and 431M are similar except that the displayed ranges are calibrated in feet and metres respectively.

TECHNICAL DATA

Displayed Ranges	10-position rotary switch.
	431F : 10 feet to 5000 feet
	431M : 3 metres to 1500 metres
Horizontal Magnification	Approximately 3 times, thus reducing the minimum displayed range to 1 metre or 3 feet as appropriate.

Horizontal Shift	Continuously variable control sufficient to view any part of the magnified display.
Velocity Factor (cable dielectric)	Set by two digital switches to set propagation velocity factor from 0.01 to 0.99.
Fault Location	Set by positioning a bright dot cursor.
Digital Readout	5-digit 7.5 mm (0.3 inch) LED display.
Accuracy	Better than $\pm 1\%$ of range ± 1 digit: 0°C to $+40^{\circ}\text{C}$ ($+32^{\circ}\text{F}$ to $+104^{\circ}\text{F}$). Better than $\pm 3\%$ of range ± 1 digit: -20°C to $+50^{\circ}\text{C}$ (-13°F to $+131^{\circ}\text{F}$).
Resolution	431M : 0.01 metre (1 cm) 431F : 0.05 feet (0.6 inch)
Transmitted Pulse Characteristics	
Waveform	Sine squared approx.
Repetition Frequency	20 kHz
Amplitude	3 V peak into Z_0
Pulse Widths	Half height - listed overleaf:

Range		Pulse Width (ns)	
431M (m)	431F (ft)	Normal	Narrow
3	10	2	2
6	20	2	2
12	40	10	2
27	75	10	2
50	150	40	10
100	300	40	10
200	600	160	40
375	1250	160	40
750	2500	640	160
1500	5000	640	160

Source Impedance (Z_0) 50 Ω or 75 Ω (factory fitted option)

Output Connector BNC

Protection ± 400 V (d.c. + peak a.c.)

Display Modes

DIRECT Trace of cable under test displayed.

MEMORY Trace stored in memory displayed.

ALT/BOTH DIRECT and MEMORY traces displayed.

DIFF Difference between DIRECT and MEMORY traces displayed.

HOLD Secure trace in memory for up to 48 hours after the instrument is switched off.

Vertical Deflection

Range 2 mp/div. to 1000 mp/div. in 9 positions

Accuracy Better than 3% (0 to 40 °C)

Calibration ± 2 divs. in 0.2 div. increments

Cathode Ray Tube 7 x 5 cm display area.

Power Requirements

AC 93V to 130V or 185V to 260V
45 Hz to 65 Hz via I.E.C. approved connector.

- DC
- (a) Internal rechargeable nickel-cadmium battery provides approximately 5 hours continuous operation.
 - (b) External 12V to 15V DC (either polarity to ground), connected via 25-way D-type socket, without the need to disconnect the internal supplies.

Dimensions and Weight

Height 140 mm, 5.5 inches

Width 290 mm, 11.5 inches

Depth	260 mm, 10.3 inches
Weight	7.5 kg, 16.5 lb including internal battery pack.
Environmental	I.E.C. 68 for field portable test equipment.
Ambient Temperature	Operating -25°C to +55°C, -13°F to +131°F Storage -40°C to +70°C, -40°F to +158°F

SECTION 2

USER CONTROLS

NOTE: The screw fixings at the corners of the display area are for fitting the adaptor plate when a mount-on Polaroid camera is used.

POWER

Push-pull switch for power on-off.

Push for OFF

Pull for ON

FOCUS

Preset screwdriver control which affects the definition of the CRT display. Should not normally require adjustment.

INTENSITY


Rotary control which varies the brightness of the CRT display.



Continuously variable control which adjusts the vertical position of the CRT display.



Dual control:

- (1)  : Continuously variable control which adjusts the horizontal position of the CRT display.

- (2) PULL MAG: Push-pull switch which, when pulled out, expands the horizontal trace about the point positioned at the centre of the CRT.

Therefore, a reflection that indicates a fault position can be brought to the centre of the CRT screen and the trace then expanded so that it can be examined in greater detail.

RANGE

Rotary switch which selects the displayed range.

FAULT LOCATE

Continuously variable control which adjusts the position of the bright-up cursor. For accurate measurement the cursor must be positioned at the point where the leading edge of the fault reflection just leaves the horizontal.

M_p /DIV.

Rotary switch which sets the gain of the vertical amplifier. The settings are calibrated in terms of reflection coefficient (ρ).

DISPLAY

Four-position switch which selects the CRT display. The four functions which can be selected are as follows:

- (1) DIRECT : Displays the trace of line (cable) under test.

- (2) MEMORY : The trace contained in memory is displayed.
- (3) ALT.(BOTH) : DIRECT and MEMORY traces are displayed simultaneously.
- (4) DIFF. : Algebraic difference between the DIRECT and MEMORY traces is displayed.

HOLD

Push-button switch.

- (1) IN : Secures the trace stored in memory. A battery back-up facility holds the trace in memory for up to 48 hours after the instrument is switched-off. Also suspends the screen update on longer ranges.
- (2) OUT : Permits a trace to be stored in memory when the STORE (WRITE) button is activated.

WARNING:

Unless a trace is intended to be retained the HOLD button should be out, otherwise the back-up battery will discharge after switch-off.

PULSE AMPLITUDE	Continuously variable control which adjusts the amplitude of the transmitted pulse.
PULSE WIDTH	Push-button switch which, when pushed IN, selects an alternative pulse, narrower than that preselected by the RANGE switch, except on the two shortest ranges.
SET ZERO	Pre-set screwdriver control which is set such that the start of the CRT display coincides with the start of the transmitted pulse.
RANGE ERROR	Indicates that the setting of the RANGE switch differs from that of the trace stored in memory.
STORE (WRITE)	Push-button switch which transfers the display into memory.
DIELECTRIC	Digital switch which is set in accordance with the propagation velocity factor of the cable under test.
5-DIGIT LED DISPLAY	Provides readout of fault distance Display time is two to three seconds.
READ	Push-button to activate the digital display.
INTERFACE	25-way D-type socket for connecting to external accessories and applying an external 12-15V d.c. supply.

POWER INPUT SOCKET

Input for 95V to 130V (optional
185V to 260V) 45 to 65 Hz supply.

CABLE CONNECTOR

50 ohms or 75 ohms BNC.

INDICATORS:

AC

Indicates that the a.c. supply is
present.

ON

Indicates that the instrument power
is on.

BATT. LOW

Indicates that the internal battery
requires charging.

SECTION 3

PREPARATION FOR USE AND PERFORMANCE CHECK

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SECTION 3

PREPARATION FOR USE AND PERFORMANCE CHECK

PREPARATION FOR USE

Preliminary Check

- 1 (1) Remove the front panel cover by releasing the clips located on each side of the unit. The cover provides storage space for the power lead, two 3 metre (10 ft) connecting leads and other accessories.

NOTE: The carrying handle can be used as a tilt stand.

- (2) Pull the POWER switch ON and observe that the ON indicator is illuminated. If the ON indicator fails to light, recharge the internal battery.

Operation From the A.C. Supply

- 2 (1) Ensure that the a.c. supply is within the range indicated on the front panel. Connect the power plug as shown below and connect the equipment to the a.c. supply. The connections for the power plug are:

BROWN-LIVE

BLUE-NEUTRAL

GREEN/YELLOW-GROUND

- (2) Push the POWER switch to OFF and verify that the AC indicator is illuminated.

- (3) Pull the POWER control to ON and verify that both the AC and ON indicators are illuminated.

NOTE: When the POWER control is set to the OFF position the internal battery is charged, at 120 mA. The battery takes approximately 14 hours to recharge fully.

95-130V to 185-256V Conversion

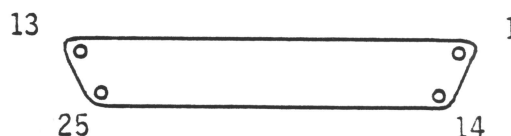
- 3 The instrument can be operated from either a nominal 110V or 230V a.c. supply, adjustment being provided by a changeover switch.

Operation From an External 12-15V d.c. Supply

- 4 A 12-15V d.c. supply is connected to the unit via a front panel 25-way D-type socket marked INTERFACE.

The connections are:

Positive - PIN 5
Negative - PIN 23



NOTE: Neither side is connected to ground. Connection to the d.c. supply does not charge the internal battery.

Operation From the Internal Battery

- 5 The instrument will automatically operate from the internal battery in the absence of the a.c. supply or external d.c. supply. If the instrument is to be used on internal battery, it is advisable to recharge before use. To recharge, connect the a.c. supply and switch the instrument off. The AC indicator should illuminate. The battery takes approximately 14 hours to charge fully.



The 431 incorporates a sensing circuit which shuts down the PSU when the battery voltage falls below a predetermined level.



Internal Battery Replacement

- 6 Withdraw the four screws from the side of the case and pull out the unit using the handle.
- 7 Disconnect the battery lead from the power supply unit and whilst holding the battery, remove the tie-wraps. Remove the battery.

PERFORMANCE CHECK

- 8 (1) Set the front panel control as follows:

PULL MAG	No expansion (i.e. pushed IN)
	Mid position
	Mid position
FAULT LOCATE	Fully counter-clockwise
PULSE WIDTH	Normal (i.e. OUT)
PULSE AMPLITUDE	Mid position
INTENSITY	Mid position
DISPLAY	Direct
mp/DIV	Fully counter-clockwise

- (2) Switch on the unit by pulling the POWER switch ON and allow at least 10 seconds for the CRT trace to appear. If necessary, adjust the FOCUS screwdriver control for good trace definition.
- (3) Adjust the  and  controls to centre the trace on the screen with the left-hand edge visible.
- (4) Depress the READ button and check that the 5-digit LED display indicates zero.
- (5) Rotate the FAULT LOCATE control clockwise and check that as the control is rotated, the bright up dot moves away from the left-hand side of the screen (slight adjustment of the INTENSITY control may be necessary).
- (6) Depress the READ button with the FAULT LOCATE fully clockwise and check that the display indicates greater than that selected by the range control. The instrument is now ready for use.

INTERNAL BATTERY CHARGING

- 9 When the internal battery is used only occasionally and is, therefore subjected to either infrequent or partial charge/discharge cycles, it appears to develop a 'memory' such that it will only power the instrument for a short period before the automatic cut-out operates. A cure can normally be effected by subjecting the battery to a number of full-charge/full-discharge cycles.

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SECTION 4

TECHNICAL DESCRIPTION

PCB2 - POWER SUPPLY, X-AMP AND BRIGHT-UP, Y-AMP

- 1 The circuitry contained on PCB2 contains a power supply which provides the various supply levels required by the 430 series Cable Fault Locators, X-amp and bright-up, and Y-amp. PCB2 in relation to the overall equipment is shown on the Interconnection Diagram, Fig.1, whilst individual circuit diagrams for all PCBs are bound in Section 6.

Power Supply

- 2 The power supply is part of the overall assembly 805273/052 and can be isolated from the rest of the board by the removal of five links within the surrounding metal screen.
- 3 The a.c. mains supply is connected to the unit via the AC INPUT socket SK201 and is fed via the mains fuse FS201 and FS202 to the primary winding of transformer T201. Bridge Rectifier network D204 to D207 and associated capacitor filter C201 provide full-wave rectification. The positive side of the supply is fed via R2123 to the AC LED to provide an indication of the presence of mains power.
- 4 Series transistor TR229, R204 and D202 provide the constant current charger for the internal battery, connected to SK202. Normally, TR229 is forward biased by the potential divider comprising the EXT CHARGE LED D201, and R204. D203 prevents the battery from discharging if the mains supply is disconnected and provides an indication of battery volts present via the front panel BAT V lamp.

- 5 IC201A is a linear operational amplifier which compares the two voltages at its inputs, pins 2 and 3. When the level on pin 3 falls, there is an output on pin 1 and this is fed to the front panel BAT LOW LED, via series resistor R209.
- 6 The series voltage regulator comprises IC201C, D208, TR202 and TR203. Operational amplifier IC201C compares the voltage set by R2114 on pin 6 with the voltage stabilized by zener diode D208 and C204. The resultant output on IC201C pin 7 is fed to TR203 base and TR202 to provide a regulated positive output.
- 7 IC201D and R210 form an overload detection circuit with D212 acting as a current limiting device across R2114 and the output of IC201D, pin 14.
- 8 A power supply shut-down circuit is provided by IC201B, D209, D210 and D211 which isolates the PSU under certain conditions. Under current overload conditions C202 will charge up and TR201 switches off thus switching off the series regulator.
- 9 IC202 acts as a free-running inverter whose frequency is approximately 19.5 kHz. The 20 kHz internal clock frequency from oscillator IC252 is fed in via C206 and R223 to TR204 which is switched on by a +6V supply. The signal is fed to IC202 via transformer T202 and D213 and is synchronized to the inverter frequency. The subsequent output on IC202 pin 6 is fed to TR205, TR207, and TR208 which all provide current gain and feed the levels to transformer T203.
- 10 T203 is tapped and these outputs in combination with capacitor and inductor networks C210-C218 and L201-L204 provide the +180V, +75V, +15V, +6V, -15V supplies on SK212. These voltage levels are then fed to the cathode ray tube. The 6.3V supply for the CRT heaters is fed out from SK209. The voltage on T203 is also fed to D219, D220, D221, C219 and C221 which form a voltage tripler circuit to provide the -1.9 kV cathode supply.

X-amp and Bright-up

- 11 The timing control circuitry on PCB4 generates a signal S2 which appears on SK205 when some information is to be displayed. The positive-going edge of the squarewave pulse S2 is fed via C229, which acts as a monostable, to IC210-11 which inverts it and produces a negative pulse at the output IC210-10. This pulse provides blanking control during flyback cycles and is fed to TR221 to produce RFB. The output at IC210-10 is also fed to IC210-9 which re-inverts it to produce a positive pulse to TR231.
- 12 When TR231 switches on, C230 begins to charge-up towards the 15V level through R288 but is held at 2.5V by D226. IC208 is a voltage follower which provides the voltage level to drive the X-amp. TR235, TR236, TR237, TR238 and TR222 provide the necessary differential amplification for the X-RAMP generator and the outputs appear on SK204 and SK206.
- 13 When an S2 pulse appears on SK205, this starts the X-RAMP cycle and the GATE signal also appears on SK205. IC209 compares the X-RAMP voltage from IC208-6 on its input, pin 2, with the voltage level set by the FAULT LOCATE potentiometer. This level appears at IC209-3 from SK206. When the X-RAMP voltage exceeds that set by the FAULT LOCATE potentiometer, an output appears on IC209-6. This output is fed to TR220 which is switched on by the +5 V line and produces a positive 'BRIGHT-UP' pulse to the CRT grid. Before the X-RAMP voltage has reached the FAULT LOCATE level, IC209 will not produce an output, but the negative pulse from IC210-10 is amplified by TR220 via TR287 to provide a negative blanking pulse during flyback cycles.

Y-amp

- 14 The outputs from the Sample and Hold gates circuitry on PCB4 appear via the coaxial connections at SK203-1 and 2 on PCB2 and are routed through the SENSITIVITY control SW201, which determines the gain via resistors R239 to R247. The output is amplified by TR225 and TR226 and associated circuitry and thence fed to analogue multiplexers IC205 and IC206 which act as a 'routing control' for the signals.
- 15 The outputs from IC205 on pins 1,4,3 and 15 are routed, via R251 and R252 to the Y-amp transistor network of TR209 to R215.
- 16 IC205 and IC206 receive digital signals from the memory. These signals appear on SK203 via the analogue-to-digital converters on PCB4. The signal routing is determined by various control signals received at the control inputs of IC205 and IC206.
- 17 YB, via IC207-5, selects blanking and discharges C226 and C227 during flyback. IC204 receives information from the memory, and also receives information direct from IC205 and calculates the difference.
- 18 'YC' is produced when the display switch SW202 is selected to the DIFFERENCE position and provides a control signal at IC206-10 via IC207A.
- 19 'YA' on SW202 provides a signal ALT FH via IC207C which produces a squarewave output and thus samples the two traces alternately when the DISPLAY switch is set to ALT.
- 20 The second internal battery 201 is normally charged by a 6V line from SK2, via D223 and R272. When the HOLD button SW203 is depressed, this prevents any memory write cycles from occurring. If the equipment is switched off, a small 3.6V supply is provided via +5V BU (+5V Back-up) to the memory. TR217 and TR218 provide regulation of two 5V lines.

PCB3 SWITCHING CONTROLS

- 21 PCB3 provides mechanical routing for the RANGE switch, X and Y shift and the fault locate potentiometer. Depending on which range the switch is set to, the Diode network D301 to D323 produces a 'binary' range of 1 to 5 on the output lines to SK301-1 to 5 (R1 to R5) SK301-1 to 4 provide the range information and SK301-5 sets whether or not the cable information has to be routed through the 'long range cable' internal memory. This line is switched by SW302 which is open for the CFL433 and CFL435 models and closed for the CFL431 model.

PCB4 COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST AND SLOW RAMP GENERATORS, PULSE GENERATOR, PULSE SELECTION, AND OUTPUT STAGE

- 22 IC452, together with C413, C414, C415 and L411, is the main oscillator which provides the internal 1.86 MHz clock frequency. The frequency appears as an output at IC452-3 and is fed to IC441-14, IC448-14, IC449-10, IC450 and IC451. These provide frequency division to produce different control frequencies.
- 23 Memory write cycles are triggered by the STORE button which causes write cycles to the memories IC417, IC418, IC437 and IC438.
- 24 The PTRIG output from IC429-5 is fed into the fast ramp generator. The fast ramp is compared by IC480 with the 'SET ZERO' potentiometer voltage level as set by R466. When the fast ramp voltage has risen to a certain level as determined by R466, COMP OUT appears on IC480-14.
- 25 COMP OUT is fed to the pulse generator and through TR445 to the protection circuitry provided by TR449, D435, and D437, to give an output on SK422. T1 to T4 select four pulse widths and the shortest pulse width is generated by TR448, R4138, C480 and associated tracking. D434, D436 and associated capacitors provide a tuned circuit matched to 50 Ω .

- 26 The address counter also drives IC435 with address lines A0 to A8 and the outputs on pins 1 and 2 are fed to operational amplifier IC433 to provide an output 'SLOW RAMP' on IC433-6. FAST RAMP and SLOW RAMP signals are then both fed into IC481.
- 27 IC481 compares the two signals and when the FAST RAMP exceeds SLOW RAMP, an output appears on IC481-14. This output is amplified by TR432 and TR433 to provide a signal MONO SWITCH and is amplified by TR434 and inverted to produce +STROBE and -STROBE.
- 28 MONO SWITCH, +STROBE and -STROBE are all fed to the sample and hold circuitry. +STROBE and -STROBE both appear at the inputs to diode network D421 to D424 which is normally biased off; where the two levels overlap, there is approximately 1.5V which is just sufficient to switch the diode bank on. D421 to D424 and C463 provide the first sample and hold gate. R4112 provides gain adjustment of the pulse output.
- 29 MONO SWITCH signal arrives slightly before the + and - STROBE signal and is fed to TR440 which switches on TR441. The time constant of C464 provides the sample duration for the second sample and hold gate.
- 30 IC482 is a voltage follower with a gain factor of 4, and amplifies and lowers the impedance to give a GATE output on SK420 pin 1. R4116 provides offset adjustment of IC482.
- 31 SW420 is the NARROW/WIDE switch. IC484 to IC486 accept range information R2 to R4 and wide or narrow selection to produce T1 to T4 and the shortest pulse width via TR456 and R4151, which provides pulse amplitude adjustment. The transmit pulse is fed out to SK422.
- 32 The outputs from the sample and hold circuitry are also fed to SK417-3 and 4 and thence to Analogue-to-digital converter IC415. The outputs appear on the D0 to D7 data bus. When the write cycle is generated, by depression of the STORE button, the data

output from the analogue-to-digital converter IC415 (controlled by MONO OUT, $\overline{W2}$ and INT from IC430) is written into memory IC417, IC418, IC437 and IC438. The outputs from the memories are fed to Digital-to-Analogue converter IC416.

- 33 IC413 is the range comparator which receives range information on lines R1 to R4. The same information is also fed to latch IC414 and when the WRITE button is depressed, a signal $\overline{W2}$ appears on IC414-5. The range information is thus latched into IC413 and compared with the existing R1 to R4. If there is any difference between the two values, an output appears on IC413 pin 3 which is fed through TR415 to light the range error LED RE2.
- 34 Velocity factor information is fed from the DIELECTRIC switch and appears on SK414-1 to 10. The information is fed into Binary-coded decimal (BCD) rate multipliers IC445 and IC446 on pins 2, 3, 14 and 15. For every 100 pulses received in on pin 9, the appropriate number of pulses are fed out on IC445 pin 6, as determined by the setting of the DIELECTRIC switch.
- 35 The output from IC445 pin 6 is then fed to SK412 which is connected to the appropriate programming board. (Individual drawings are provided for the two programming boards and these show the relevant internal connections.) A signal output appears on SK412 pin 10 and is used as a clock signal. The linking arrangement on SK412 (programming board) causes IC450 to produce the appropriate division rates.
- 36 The internal 20 kHz clock frequency generated by IC452, C413, C414 and L411 feeds through IC448 and IC449 which divide by 15 and divide by 16 respectively to IC450 pins 1 and 2. IC450 'steers' the appropriate clock rate into IC451.
- 37 IC454 drives the display board with the appropriate fault location information through resistor networks IC474, IC475 and MOS-to-LED display drivers IC447 and IC455.

38

SK412 and the programming board also defines the position of the decimal point. Outputs from pins 11, 12, 13 and 14 feed through transistors TR411 to TR414 and resistor network IC473 and thence out to SK413 to the display board PCB.

SECTION 5

MAINTENANCE

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SECTION 5

MAINTENANCEFAULT FINDING

1 The instructions given under this heading provide a systematic guide to fault-finding and identification of a fault to p.c.b. level. The fault-finding procedure is based on the five conditions listed below:

- (a) C.F.L. does not switch on.
- (b) Instrument switches on but no C.R.T. trace.
- (c) Instrument switches on; trace appears but is faulty.
- (d) Test pulse faulty.
- (e) L.E.D. Readout faulty.

2 Test equipment required:

- (a) Multimeter, e.g. AVO 8.
- (b) Oscilloscope, dual channel.

(a) C.F.L. DOES NOT SWITCH ON

'Switching on' is defined as being the presence of the correct voltages and waveforms at the output of the power supply on P.C.B. 2.

WARNING

When carrying out the following tests great care must be exercised since the 6.3 V r.m.s. supply is at a potential of -2 kV nominal.

<u>Output Voltage</u>	<u>Location</u>
+0 -6 V -0.8 V	SK212 pin 1 and SK205 pins 7 and 8.
+0.1 6.3 V -0.5 V r.m.s.	SK209 pins 1 and 2.
+0 -15 V -0.8 V	SK212 pin 4 and SK205 pins 7 and 8.
+75 V ± 5 V	SK212 pin 6 and SK205 pins 7 and 8.
+10 +180 V -5 V	SK212 pin 2 and SK205 pins 7 and 8.
-1.8 KV ± 0.1 kV	SK209 pin 4 and SK205 pins 7 and 8.

NOTE 1: All the above readings to be taken with respect to chassis.

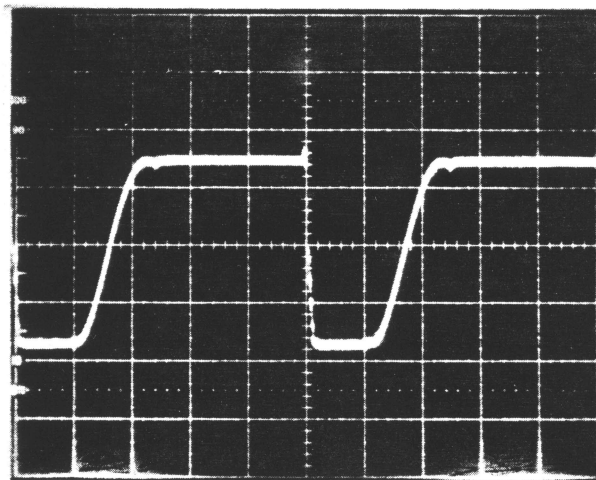
NOTE 2: The power supply contains a latched switch-off protection circuit, and once this has tripped it is necessary to switch the instrument off, and wait at least 5 seconds before the power supply is switched on again.

Frequency Output

19.2 kHz \pm 5%

Location

D222 (+VE)



Input AC coupled
with a X10 probe

Sensitivity - 0.5 V/div.

Sweep speed - 10 μ s/div.

Frequency output waveform

If the measurements of PCB 2 output voltages indicate a fault
carry out the following procedure:

NOTE: The voltages specified on the following pages were measured
using a multimeter having an impedance of 20 000 Ω /V.
Since some of the voltages are floating with respect to
the EHT voltage some differences may be noticed if a
multimeter having a different impedance is used.

TEST CONDITION	TEST	ACTION
Connect the instrument to the correct a.c. supply voltage. Check that the CHARGE LED illuminates. This indicates battery is being charged. Pull out the POWER PULL ON switch. Check that the front panel display LEDs illuminate for approximately 3 seconds. Power on is indicated by front panel LED.	Connect a multimeter, 30 V d.c. range between pin 11 (-VE) of SK201, and the +10.4 V line (+VE) on TR205 collector.	If the voltage measured is >10 V proceed to the next test. If the voltage measured is >10 V check that the output from the transformer (between D205 cathode and D204 cathode) is >12 V a.c. and that the wiring of the POWER PULL ON switch is correct. If no fault is found replace PCB 2.

(b) C.F.L. SWITCHES ON BUT NO TRACE

A trace should appear on the screen under the following conditions:

Instrument switched on, INTENSITY control fully clockwise, SENSITIVITY control counterclockwise and
 controls set to mid-position.


There are several possible causes for the non-appearance of a trace: faulty CRT, faulty power supply, a fault on PCB 2, 3 or 4 or a fault in the wiring loom and/or associated connectors.

TEST CONDITION


TEST

ACTION

Connect the instrument to the correct a.c. supply voltage and switch on.

Pull off the ribbon cable from SK204. Connect a multimeter, 30 V d.c. range, across SK204 pin 7 and 10. Adjust the  control until a zero reading is obtained.

Check the X-shift voltage at TR222 base and if it is not possible to obtain a zero reading then the X amp is faulty. Replace PCB 2.

Connect a multimeter, 30 V d.c. range, across SK204 pins 1 and 4 and adjust the  control for a zero reading

Check the Y-shift voltage at R266 and if it is not possible to obtain a zero reading then the Y-amp is faulty. Replace PCB 2.

CAUTION: The multimeter is floating at 2 kV.

Connect a multimeter, 30 V d.c. range across SK209 pins 1 and 2.

The multimeter should indicate 6.3 V approximately. If the voltage is correct, check continuity of wiring to tube base. If no wiring fault is found proceed as follows:

Connect a multimeter, 2 kV d.c. range, between SK209 pin 4 (-VE) and the chassis.

The multimeter should read approximately 1900 V. If the reading is correct, check wiring to the tube base. If no wiring fault is found proceed as follows:

TEST CONDITION	TEST	ACTION
CAUTION: The multimeter is floating at 2 kV.	Connect a multimeter, 300 V d.c. range, between SK209 pin 7 and SK209 pin 4.	The voltage reading should be variable between 20 and 60 V approximately by operation of the INTENSITY control. If the voltage reading is correct, check continuity of wiring to tube base. If the voltages are correct, proceed as follows:
	Connect a multimeter, 3 kV d.c. range, between SK211 (-VE) and the chassis (+VE).	The voltage reading should be in the region of 1.5 kV approximately. If the voltage reading is correct, check the voltage and continuity of wiring from the wiper of the FOCUS control to the tube base.
		If the voltage reading is incorrect check the -700 V line on R2102, and if this is incorrect, replace PCB 2.

TEST CONDITION

TEST

ACTION

Also check the voltage on SK209 pin 9. The voltage should be approximately -1.6 kV. If incorrect, replace PCB 2. If correct, check the continuity of wiring to the FOCUS control and between FOCUS control and SK211.

If all voltage readings are correct, proceed as follows:

Connect a multimeter, 300 V d.c. range between SK209 pin 4 (+VE) and the chassis.

The voltage reading should be variable between 0 and +180 V by adjustment of R2100.

If the voltage reading is correct, check continuity of wiring to the tube base.

If all the previous tests reveal no fault, and there is still no trace, replace the C.R.T. assembly

TEST CONDITION	TEST	ACTION
(c) <u>C.F.L. SWITCHES ON BUT TRACE FAULTY</u> <u>Summary of the possible trace faults</u>		
(i) Trace length incorrect.		
(ii) Trace out of focus.		
(iii) Trace is distorted in both the horizontal and vertical axis or cannot be positioned correctly on the tube screen.		
(iv) Trace intensity or bright-ups incorrect.		
(i) <u>Trace length incorrect</u>	Obtain a trace on the screen and ensure that the PULL MAG control is pushed in (i.e. X1)	The trace length should be approximately 7 cm. If this is incorrect, the fault could be on either PCB 2, PCB 4 or the C.R.T.
	Obtain a display on the screen, and set the RANGE control to its minimum position.	If the levels are correct, check the continuity of wiring to PCB 4, via SK205 and SK415. If no wiring fault is found, check the frequency of the signal A8 at IC423 pin 4. Should the frequency not be 36 Hz \pm 3%, a fault is likely

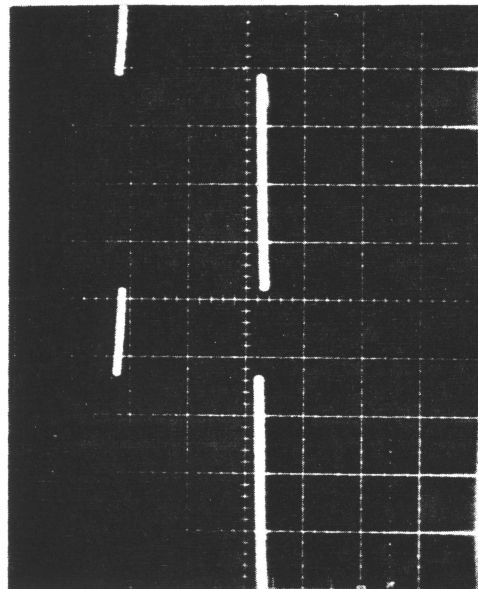
TEST CONDITION	TEST	ACTION
		in the master oscillator or divider networks. Replace PCB 4.
(ii) <u>Trace out of focus</u>	Obtain a trace on the screen. Adjust the INTENSITY, FOCUS and ASTIG controls to obtain a sharply defined trace.	If it is not possible to obtain a well defined trace, carry out the tests detailed on Page 5.4 to 5.7.
(iii) <u>Trace distorted in both the horizontal and vertical axis, or cannot be positioned correctly on the tube screen.</u>		<p data-bbox="1015 804 1144 1315">First check the input to the Y-amp at SK203 pin 2, IC205 pin 13 and TR209 base, in turn.</p> <p data-bbox="1015 229 1339 712">If the level is incorrect, then a fault is likely on the Y-amp. If the level is incorrect, check continuity of wiring to PCB 4. Should no wiring faults be found, a fault is likely on PCB 4.</p> <p data-bbox="1409 219 1588 712">If the trace remains distorted check the X-amp on PCB 2 by following the procedure described on Pages 5.4 to 5.7.</p>

TEST CONDITION	TEST	ACTION
(iv) <u>Trace brightness or bright-ups incorrect</u>		
Obtain a trace on the screen, set the RANGE control to its fifth position from minimum and set the FAULT LOCATE control to mid-position.	If the trace is present with the correct bright-ups but with the wrong overall intensity If the trace is present with the correct overall intensity but with incorrect bright-ups.	Perform the tests as described in Page 5.4 to 5.7. WARNING: Before proceeding with this test, disconnect SK209 and SK211 high voltages are present. With an oscilloscope monitor the waveform at IC209 pin 6, IC210 pin 12, TR220 collector and SK209 pin 7 in turn. The waveform should be as shown below:

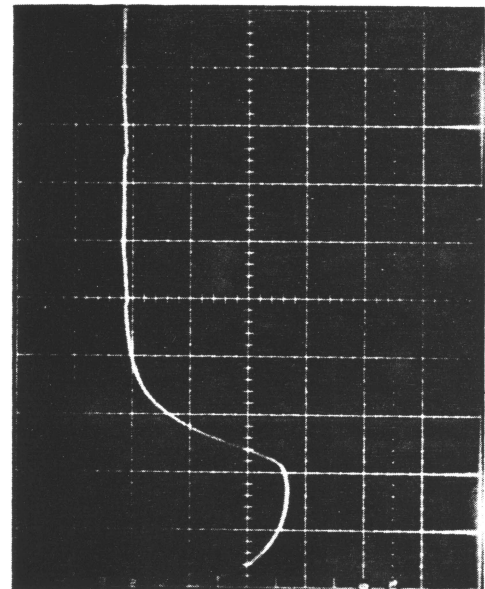
TEST CONDITION

TEST

ACTION



X10 probe
Sensitivity 0.2 V/div.
Sweep speed 5 ms/div.



X10 probe
Sensitivity 1 V/div.
Sweep speed 20 μ s/div.

TEST CONDITION

TEST

ACTION

If the correct bright-ups are now obtained, check the wiring continuity to the tube base.

Connect a multimeter, 0 to 30 V d.c. range across IC209 pin 3; SK206, SK301 pin 13 and R312, in turn.

If the waveform observed is incorrect, check the d.c. level at the FAULT LOCATE potentiometer. This level should lie between 0 and 2 V approximately at IC209 pin 3, SK206, SK301 pin 13, and R312.

(d) TEST PULSE WAVEFORM FAULTY

TEST CONDITION

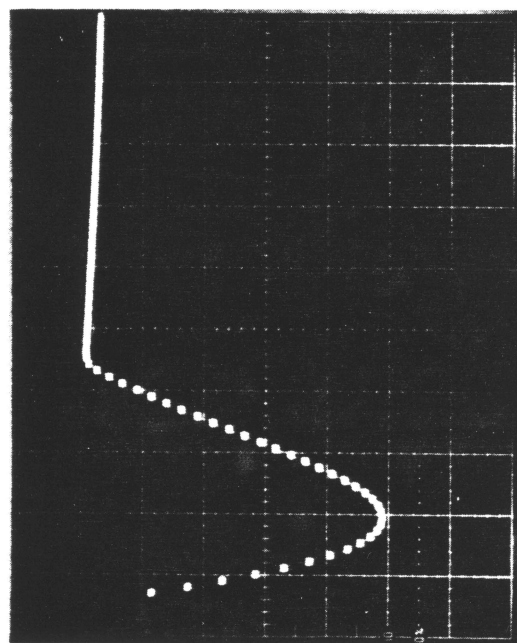
TEST

ACTION

Test pulse waveform faulty on all ranges.

Using an oscilloscope, monitor the waveform at IC482 pin 6 and IC483 pin 6.

The waveform should be as shown below:



X10 probe
Sensitivity 50 mV/div.
Sweep speed 5 ms/div.

If the waveform is correct, check wiring continuity to PCB 2 via SK420 and SK203.

If no wiring fault is found then follow the test procedure on Page 5.8.

If the waveform is incorrect, then the fault is likely on the timing from the sample and hold circuitry. Replace PCB 4

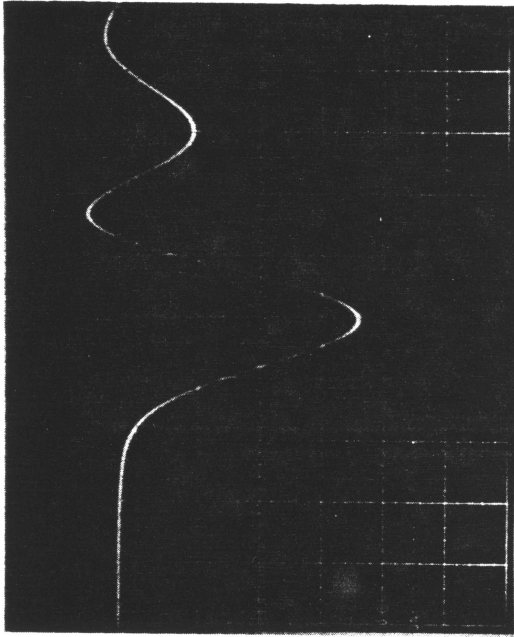
TEST CONDITION

TEST

ACTION

Using an oscilloscope, check the input gate signal to R4100 and R4103. Attach a through termination of the correct impedance ($50\ \Omega$ or $75\ \Omega$) to SK422.

The waveform should be as shown below:



X10 probe
Sensitivity 50 mV/div.
Sweep speed 1 ns/div.

If the waveform is incorrect
replace PCB4.

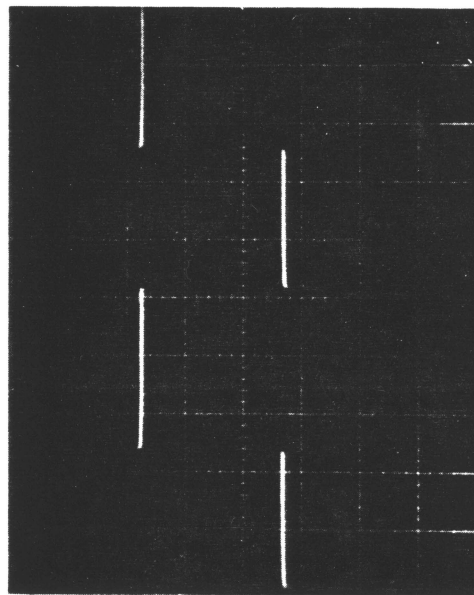
TEST CONDITION

TEST

ACTION

Using an oscilloscope, monitor the waveform on IC433-6.

The waveform should be as shown below.



X10 Probe
Sensitivity 5 mV/div.

DIFFERENCE FUNCTION FAULTY
(assuming DIRECT and MEMORY
functions are operative)

Replace PCB 2.

TEST CONDITION

TEST

ACTION

ALTERNATE FUNCTION FAULTY
(assuming DIRECT and MEMORY
functions are operative)

Check the voltage on IC207
pin 3. If incorrect, check the
continuity of wiring to PCB 4.
If no wiring fault is found,
replace PCB 4.

NOTE: If the function is
operative in memory and
longer ranges, replace
PCB 2.

(e) L.E.D. READOUT FAULTY

Obtain a trace on the C.R.T., turn
the FAULT LOCATE control fully
clockwise, and set the DIELECTRIC
switch (if fitted) to 067.

Position the bright-up at the
end of the trace. Press the
READ switch and check that the
readout for each position of
the RANGE switch indicates
greater than the RANGE switch
setting.

If there is no readout visible
replace PCB 4. If the equipment
is still faulty check the
connection to PCB 5 or replace
PCB 5.

TEST CONDITION

TEST

ACTION

Also check continuity of wiring to PCB 3. If the wiring is correct replace PCB 3. If the voltages are correct, plug in, but do not yet fit to front panel, a new dielectric switch assembly (when fitted). If this clears the fault fit the new dielectric switch. If the fault persists, replace PCB 4.

If the readout is always zero, monitor the waveform on SK415 pin 18. Set the RANGE switch to a minimum and adjust the FAULT LOCATE control until the bright-up is in the middle of the trace. The waveform should be as shown below:

TEST CONDITION

TEST

ACTION



X10 Probe
Sensitivity 0.2 V/div.
Sweep Speed 5 ms/div.

If the waveform is incorrect
check the continuity of wiring
to PCB 2. If no wiring fault
is found, replace PCB 2.

If the waveform is correct,
replace PCB 4.

DISASSEMBLY PROCEDURE

CASE REMOVAL

- 3 Stand the instrument on its end and withdraw the four screws from the side of the case. Pull out the unit using the handle.

INTERNAL BATTERY REMOVAL

- 4 Disconnect the battery lead from the power supply unit and whilst holding the battery, remove the tie-wraps. Remove the battery.

PCB 2 REMOVAL

- 5 Remove case (Para. 3), remove three screws, one nylon nut, and remove the PSU Screen lid. Disconnect SK201, 202 (internal battery), 203, 204, 205, 206, 207, 208 and 211, unscrew T201 (mains transformer) fixings from the chassis, and withdraw the retaining screws.

PCB 3 REMOVAL

- 6 Remove case (Para. 3) and disconnect SK301. Remove all knobs, nuts and washers and withdraw the front panel fixing screws. Remove front panel and nut and washer for "FAULT LOCATE" potentiometer.

PCB 4 REMOVAL

- 7 Remove case (Para. 3). Disconnect SK411, SK412 (Programming Plug), SK413, SK414 (connection to velocity factor dielectric switch), SK415, SK417, SK418, SK420, SK421, SK422 and withdraw retaining screws.

PCB 5 REMOVAL

- 8 Remove case (Para. 3) and PCB 4 (Para. 7). Disconnect SK501 (20-way direct plug-in) and remove board.

CRT REMOVAL

- 9 Remove case (Para. 3), unplug CRT base connector and RED and WHITE leads (SK207) noting polarity. Withdraw screws retaining the CRT assembly to the chassis.

CALIBRATION PROCEDURE

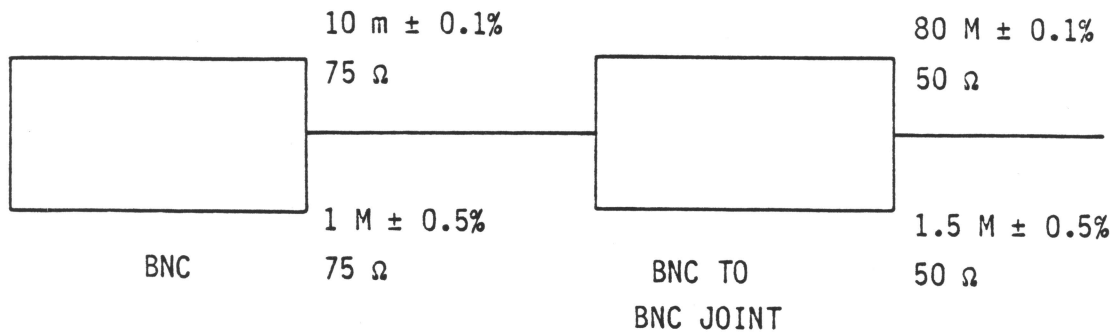
NOTE: This procedure enables the user to calibrate the equipment to an accuracy of approximately 2%. If a greater degree of accuracy is required than that attainable by using this method, details of a factory test specification and appropriate special equipment can be specified on request.

TEST EQUIPMENT AND POWER SUPPLIES

- 10 The following items of test equipment are required in order to carry out the calibration procedure.

Test Equipment

- (a) Megger, 500V d.c.
 - (b) Multimeter, AVO Model 8 or equivalent, with two X10 probes.
 - (c) Digital Voltmeter
 - (d) Oscilloscope, with X1 and X10 probes.
 - (e) Insulated trimming tool.
 - (f) Dielectric tuning wrench, Johansen 4093.
 - (g) Appropriate through termination (i.e. 50 Ω or 75 Ω).
 - (h) Calibrated coaxial cables as follows (see also diagram below):
 - (i) 1 m, 3 ft
 - (ii) 1.5 m, 5 ft
 - (iii) 10 m, 30 ft
 - (iv) 80 m, 250 ft
- All calibrated
to better than
0.1% (1 in 1000)



Power Supplies

(a) Single-phase a.c. supply of either

- (i) 185 to 260 V r.m.s., 50/60 Hz nominal
- (ii) 93 to 130 V r.m.s., 50/60 Hz nominal

INSULATION AND RESISTANCE

Preliminary

- 11 Remove the unit from the case and disconnect the internal battery. Ensure that the fuses are correctly positioned for the a.c. supply. Connect the power lead to the unit. DO NOT CONNECT TO THE MAINS POWER SUPPLY. Remove the metal screen from the power supply on PCB2.
- 12 Set front panel controls as follows:
 - (i) Power 'PULL ON' to ON.
 - (ii) INTENSITY, m_p/DIV , PULSE AMPLITUDE, set to the fully counterclockwise position.
 - (iii) \longleftrightarrow , \updownarrow , FOCUS, FAULT LOCATE, SET ZERO, to mid-position.
 - (iv) DISPLAY to direct.

- (v) MEMORY HOLD, PULSE WIDTH, switches out.
- (vi) RANGE switch to 30 metres, 10 feet as appropriate.
- (vii) PULL MAG in.
- (viii) DIELECTRIC set to 50.

13 Set internal preset controls as follows:

- (i) R260, R262, R2122, R2100, R2105, R427, R4134, R4112, R4116, C435, R466, C452, R497, C488 to their mid-positions.
- (ii) R299, R2103, R4163, R4153 to the fully counterclockwise position.

Insulation

- 14 Using the Megger, verify that the insulation resistance between the line and neutral connected together on the power lead, and the unit frame is not less than 10 M Ω . On the power lead, disconnect line from neutral and disconnect the Megger.



Resistance

- 15 Note the legend near the mains connector on the unit under test. Using the meter to measure resistance, verify that the resistance between the line and neutral leads of the power lead is:-
- (i) Not less than 60 Ω for 110 V mains.
 - (ii) Not less than 240 Ω for 230 V mains.
- 16 Using the meter to measure resistance, verify that the resistance between the earth lead of the power lead and the unit chassis is not greater than 1 ohm. Set the POWER switch to OFF (in).

FUNCTIONAL TESTS

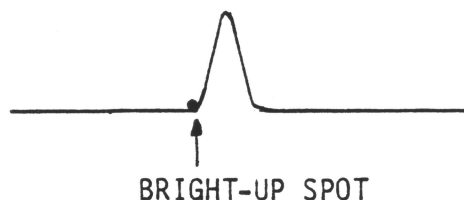
WARNING:- GREAT CARE MUST BE EXERCISED WHEN PERFORMING TESTS WITH THE POWER SUPPLY SCREEN REMOVED SINCE MAINS AND 2 KV POINTS ARE EXPOSED.

Display Testing

- 17 Connect the power lead to the supply mains appropriate to the legend near the mains connector of the unit under test. Verify that the AC lamp is illuminated and the ON lamp is extinguished.
- 18 On the unit under test set the POWER switch to ON (pull out). Verify that the AC and ON lamps are illuminated.
- 19 Using the DVM, check the potential between SK212 pin 3 (+ve) and chassis (0V). Adjust to set the +15 V line to $+15\text{ V} \pm 0.02\text{ V}$ using R2114.
- 20 Using the DVM, set the potential between TB101 pins 3 and 5 to not greater than 20 V, by means of the control.
- 21 Using the DVM, set the potential between TB101 pins 7 and 9 to not greater than 20 V, by means of the control.
- 22 Turn intensity control 1/3 of the way round from fully anticlockwise. Adjust R2103 using an insulated trimming tool until the main trace is just visible. CAUTION: THIS CONTROL IS AT A POTENTIAL OF 2 KV.
- 23 Set the RANGE control to 12 m, 40 ft as appropriate. Adjust PULSE AMPLITUDE to display 2 to 4 cm of pulse amplitude.
- 24 Set the  and  controls to centre the pulse on the screen. Adjust FOCUS and R2100 for optimum line thickness in both the X, and Y directions. If FOCUS is at one end of the control, set the POWER to OFF, open circuit R290 link, set the POWER to ON and re-check. CAUTION: R290 is at a potential of 2 kv

- 25 Set R299 for a level trace. If necessary, reverse SK207 and re-adjust R299.
- 26 Adjust R2122 and control to obtain an X deflection such that the whole of the trace is visible on the screen, i.e. with a 3 mm gap either side of the screen.
- 27 Verify that the X shift control will bring either end of the trace to the centre of the screen.
- 28 Connect the Oscilloscope to SK203 pin 6, adjust the Y SHIFT, and PULSE AMPLITUDE, to display a positive going pulse with a base level of +1 V and peak of +8 V, adjust R260 to centre the trace on the screen and R262 to display the pulse over the whole screen minus 2 mm top and bottom.
- 29 Set the RANGE control to 3 m or 10 feet as appropriate. Plug a 50 Ω or 75 Ω BNC through termination into the cable socket and proceed as follows:
- (i) Set PULSE AMPLITUDE fully clockwise.
 - (ii) Set $m_p/\text{div.}$ to 1000.
 - (iii) Adjust \updownarrow to centre the trace on the graticule.
 - (iv) Set $m_p/\text{div.}$ to 2.
 - (v) Centre the trace on the graticule by adjustment of R497.
 - (vi) Set PULSE AMPLITUDE fully anticlockwise.
 - (vii) Centre the trace on the graticule using R4116.
 - (viii) If rotation of pulse amplitude control and/or $m_p/\text{div.}$ moves the trace by more than 10 mm, then repeat the procedure from para. 29 (i).
- 30 Set the RANGE control to 100 m (300 ft) and adjust R4153 to mid-position. Connect the 90 m (280 ft) cable to the unit under test. Turn the amplitude control fully clockwise. Adjust INTENSITY, FOCUS, \longleftrightarrow and \updownarrow to produce a display with a visible bright-up spot. Set the PULSE WIDTH switch to NARROW.

- 31 Adjust the SET ZERO control (front panel) until the 5-digit display reads 90 m (280 ft) \pm 0.5 m (1.5 ft). Adjust R427 until the bright-up spot is located at the knee of the leading edge of the pulse reflected from the far end of the cable.



- 32 Adjust the FAULT LOCATE potentiometer until the bright-up spot is located at the knee of the pulse reflected from the 75 Ω /50 Ω cable junction. Verify that the display reads 10 m (30 ft) \pm 0.5 m (1.5 ft). If not satisfactory adjust SET ZERO and R427 to optimise and repeat Para. 31 and 32.
- 33 Measure the 90 m (280 ft) cable on the following ranges and verify the reading is within correct limits. Note R427 may have to be optimised.

100 m	(300 ft)	\pm	0.5 m	(1.5 ft)
200 m	(600 ft)	\pm	2 m	(6 ft)
375 m	(1200 ft)	\pm	4 m	(12 ft)
750 m	(2500 ft)	\pm	7.5 m	(25 ft)

- 34 Connect the 2.5 metre (8 ft) cable to the output socket and select the 12 metre (40 ft) range. Set PULSE WIDTH to wide pulse. Adjust C452 so that the trace starts at the knee of the transmit pulse.
- 35 Select the 3 metre (10 ft) range. Adjust R4163 so that the trace starts at the knee of the transmit pulse.

NOTES: C452 is used to correct the SET ZERO adjustment of the bottom 5 ranges.

R4163 is used to correct the SET ZERO adjustment on the 3 m and 6 m (10 ft and 20 ft) ranges and the 12 m and 25 m (40 ft and 75 ft) ranges when the narrow pulse is selected.

- 36 Select the 3 metre (10 ft) range and the narrow pulse setting (wide and narrow pulses are on 3 m and 6 m ranges). Adjust the FAULT LOCATE potentiometer until the five digit display reads 2.5 m (8 ft) \pm 0.03 m (0.1 ft). Adjust C435 until the bright up spot is at the knee of the leading edge of the pulse reflected from the far end of the cable.
- 37 Adjust the FAULT LOCATE potentiometer until located on the knee of the pulse reflected from the 75 Ω /50 Ω cable junction. Verify that the display reads 1 m (3 ft) \pm 0.03 m (0.1 ft). If not satisfactory adjust R4163 and C435 to optimise.
- 38 Measure the specified cables on the following ranges and verify the readings are within the correct limits.

Note: C435, C452 and R4163 may have to be optimised, if so recheck Para. 34 to 37.

Test Cable	Range		Tolerance
2.5 m (8 ft)	3 m (10 ft)	\pm	0.03 m (0.1 ft)
2.5 m (8 ft)	6 m (20 ft)	\pm	0.06 m (0.2 ft)
2.5 m (8 ft)	12 m (40 ft)	\pm	0.12 m (0.4 ft)
10 m (30 ft)	25 m (75 ft)	\pm	0.25 m (0.75 ft)
10 m (30 ft)	50 m (150 ft)	\pm	0.50 m (1.5 ft)

- 39 Remove the test cable. Set the bright up spot to 10 mm from the start of the trace. Pull expand and verify that the dot is between 25 and 35 mm from the start of the trace.

40 Amplifier Gain, Bandwidth, Shift, Balance

Set RANGE to 100 m, 300 ft. Set PULSE AMPLITUDE and m_p /DIV fully anticlockwise. Set PULSE WIDTH out. Plug a 50 ohms BNC T-junction into the cable socket and connect one socket to a cable of approximately 8 metres length. Connect the other socket to an Oscilloscope (input not less than 1 M Ω , not greater than 20 pF)

via a 50 Ω cable (not greater than 1 metre) and a 50 Ω through termination. Trigger the Oscilloscope on the 'P. TRIG' rising edge.

- 41 The trace on the Oscilloscope will resemble that on the unit under test (with a polarity inversion). Note that the amplitude of the last pulse is not less than 10 mV peak. Rotate the m_p/DIV control clockwise to enable identification of the pulse on the CFL. Set the m_p/DIV control and PULSE AMPLITUDE fully clockwise and measure the deflection of the pulse noted earlier. Calculate the 'Sensitivity' by using the following formula:

$$\text{Sensitivity (mV per cm)} = \frac{\text{Voltage indicated on Oscilloscope (mV)}}{\text{Deflection on unit under test (cm)}}$$

Verify that the result is not greater than 7.5 mV per cm.

- 42 Set the m_p/DIV control to 1000. Set RANGE to 6 m or 20 ft. Plug a cable of delay 10 ± 1 ns into the output socket.

Note: This cable must be of 50 Ω impedance for 50 Ω equipments, or 75 Ω impedance for 75 Ω equipments.

The transmitted pulse will be visible on the unit under test, followed by the reflected pulse approximately one-third of the way along the trace. Identify the second reflection, approximately two-thirds of the way along the trace, rotating the m_p/DIV control to ease identification. Adjust C488 using the Dielectric tuning wrench (Johansen 4093) to minimise the amplitude of the second reflection.

- 43 Connect the Oscilloscope via a X10 probe and 50 Ω termination to the output socket. Set PULSE AMPLITUDE and m_p/DIV to display 40 to 50 mm of pulse amplitude on both the Oscilloscope and the unit under test. Set RANGE to 1500 m, 5000 ft. Maintain the pulse amplitude on the Oscilloscope using R4134, whilst switching around

the ranges. Check the variation in amplitude on the unit under test, except the shorter two ranges. Verify that the variation in pulse amplitude is not greater than $\pm 20\%$.




Pulse Generator Settings

- 44 Connect a BNC through termination of 50 Ω or 75 Ω , as appropriate, to the output socket. Connect the oscilloscope, via a X10 probe to the through termination. Set to each range, in turn (except the two shorter ranges) noting the amplitude of the pulse at each range, and set the minimum pulse to 3 V by means of R4134. Verify that no pulses are distorted and that all pulses exceed 3 V.
- 45 Set the RANGE control to 12 m or 40 ft and note the pulse height. Set the RANGE control to 6 m or 20 ft and adjust the pulse to the same height by means of R4153.
- 46 Set the RANGE to each position listed below, in turn, and verify that in each case, the duration of the pulse at 50% amplitude is as stated.

<u>RANGE</u>	<u>DURATION</u>
6 m, 20 ft	1.6 to 2.4 ns
25 m, 75 ft	12 to 18 ns
100 m, 300 ft	32 to 48 ns
375 m, 1250 ft	0.18 to 0.24 μ s
1500 m, 5000 ft	0.60 to 0.90 μ s

Remove the 50 Ω termination.

System Checks

- 47 Check the range light. Set the display to MEMORY with the HOLD out and press the STORE button. Check that the RANGE ERROR light is extinguished, but that rotation of RANGE to any other setting causes the light to illuminate. Check by pressing the STORE button on each range in turn, that the Range error light is extinguished on that range exclusively, until the STORE button is operated on the next range.
- 48 Select Range 1 to 6, i.e. between 3 m, 10 ft and 100 m, 300 ft. Connect a length of cable to the output socket appropriate to the RANGE. Set DISPLAY switch to DIRECT. Set pulse AMPLITUDE, , , to produce a display occupying the full screen. Switch to MEMORY. Check that when the STORE button is pressed, the signal on the whole screen is transferred to memory. Press the HOLD button in and remove cable from the unit under test. Set the DISPLAY switch to DIRECT and check that the display has changed. Return the DISPLAY switch to MEMORY, press STORE button, and check that MEMORY is not altered. Set to the next RANGE position. Verify that the RANGE ERROR light is illuminated, and that operation of the WRITE button does not extinguish this light.
- 49 Set the DISPLAY switch to ALT, operation of the  control will position the DIRECT signal, but will leave the MEMORY in position. Reconnect the cable, switch RANGE such that the RANGE ERROR light is extinguished, and check that both traces are identical. Switch to DIFF and check that the pulses are cancelled. Remove cable and verify that the reflection returns.
- 50 To check the DIELECTRIC switch, set the RANGE switch to 100 m, or 75 ft, as appropriate. Set DIELECTRIC switch to 90, adjust FAULT LOCATE control in conjunction with the DISPLAY switch to give a reading of 90.0. Adjust DIELECTRIC switch to 91 through 99 and observe that on adjusting the DISPLAY switch at each switch position, the reading on the display is equal to the DIELECTRIC switch setting. Repeat the procedure varying the DIELECTRIC switch from 90 to 10, reading as before to be within 0.1 ft or ± 0.2 m.

Charging Circuitry and Battery

- 51 Charge the unit for 14 hours and then check that the battery will power the unit for a minimum of 5 hours.
- 52 Set the POWER switch to OFF and disconnect all test equipment and power supplies.

SECTION 6

CIRCUIT DIAGRAMS, PCB LAYOUTS AND COMPONENT LISTS

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COMPONENTS LISTS	

ILLUSTRATIONS

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CFL 431M - Front Panel	21
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CFL 431 - Plan View	23

COMPONENTS LISTS

- PCB 2 - (POWER SUPPLY, X-AMP AND BRIGHT-UP, Y-AMP)
- PCB 3 - (SWITCHING CONTROLS)
- PCB 4 - (COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST
AND SLOW RAMP GENERATORS, PULSE GENERATOR)
- PCB 5 - (DISPLAY BOARD)

SECTION 6

CIRCUIT DIAGRAMS, PCB LAYOUTS AND COMPONENT LISTS

INTRODUCTION

Circuit diagrams are drawn on a functional basis. Each diagram contains a printed circuit board (PCB) and, in certain cases, associated components that are mounted on the front panel or chassis. In addition to these individual circuit diagrams, there is a diagram that shows the inter-board connections and all front panel and chassis mounted components.

Each PCB has a reference number and the front panel and chassis combined have the reference number '1'. All components located on PCB2 have circuit references in the group 200 onwards PCB3 in the group 300 onwards etc.

COMPONENT LISTS

All electrical components are detailed in this section.

Separate component lists are provided for:

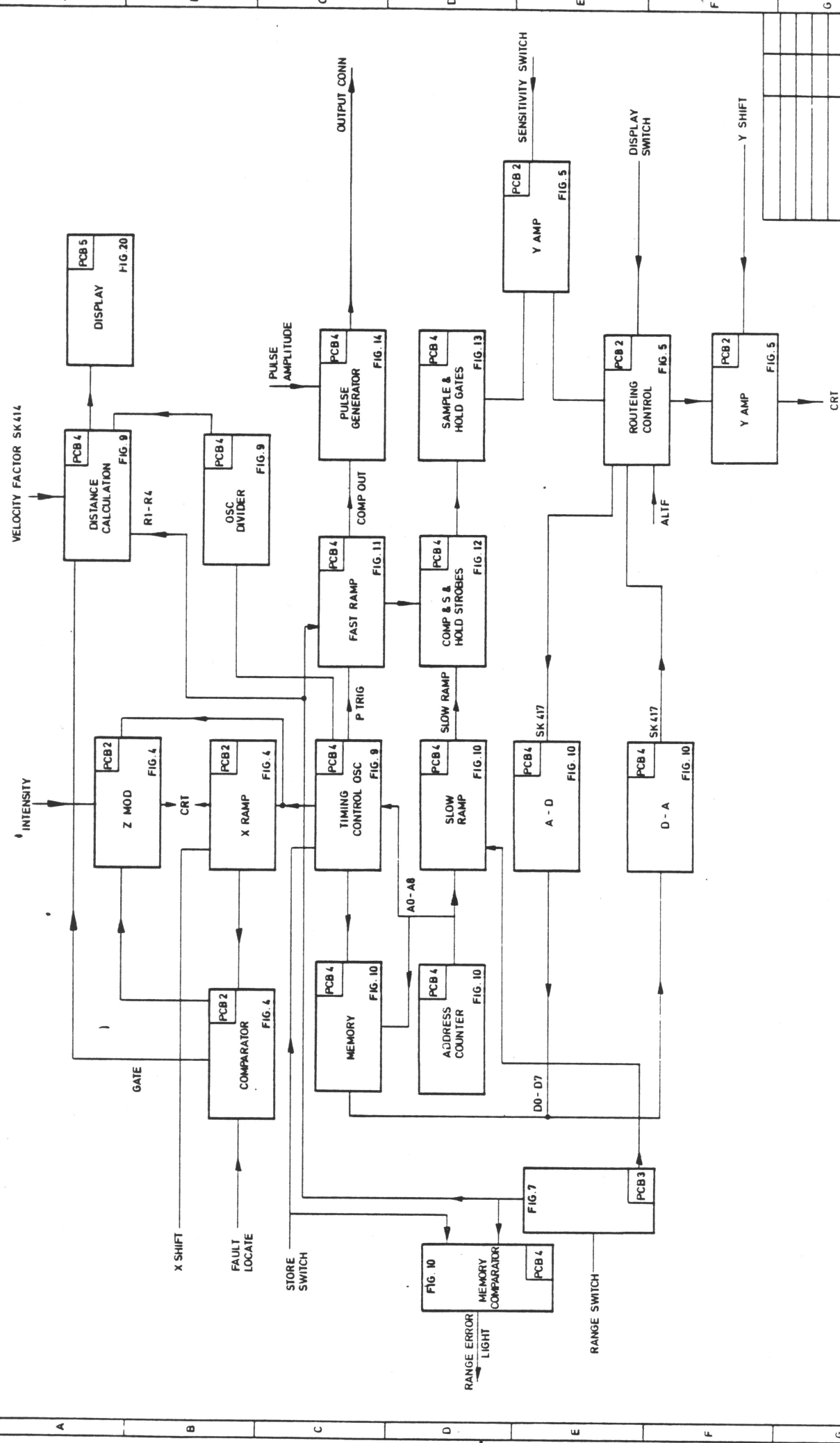
- PCB2
- PCB3
- PCB4
- PCB5

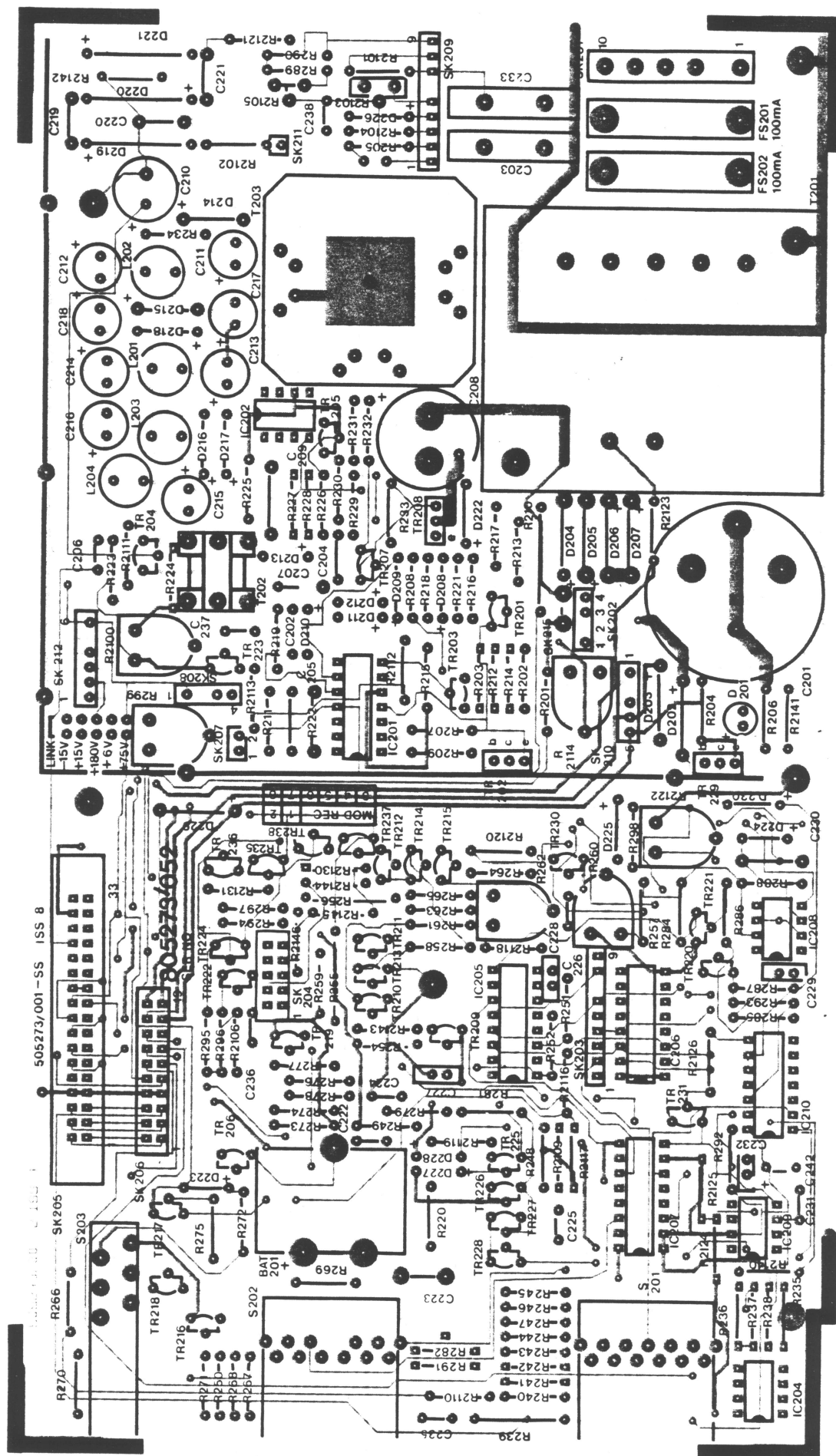
Each component list has, associated with it, a layout and circuit diagram.

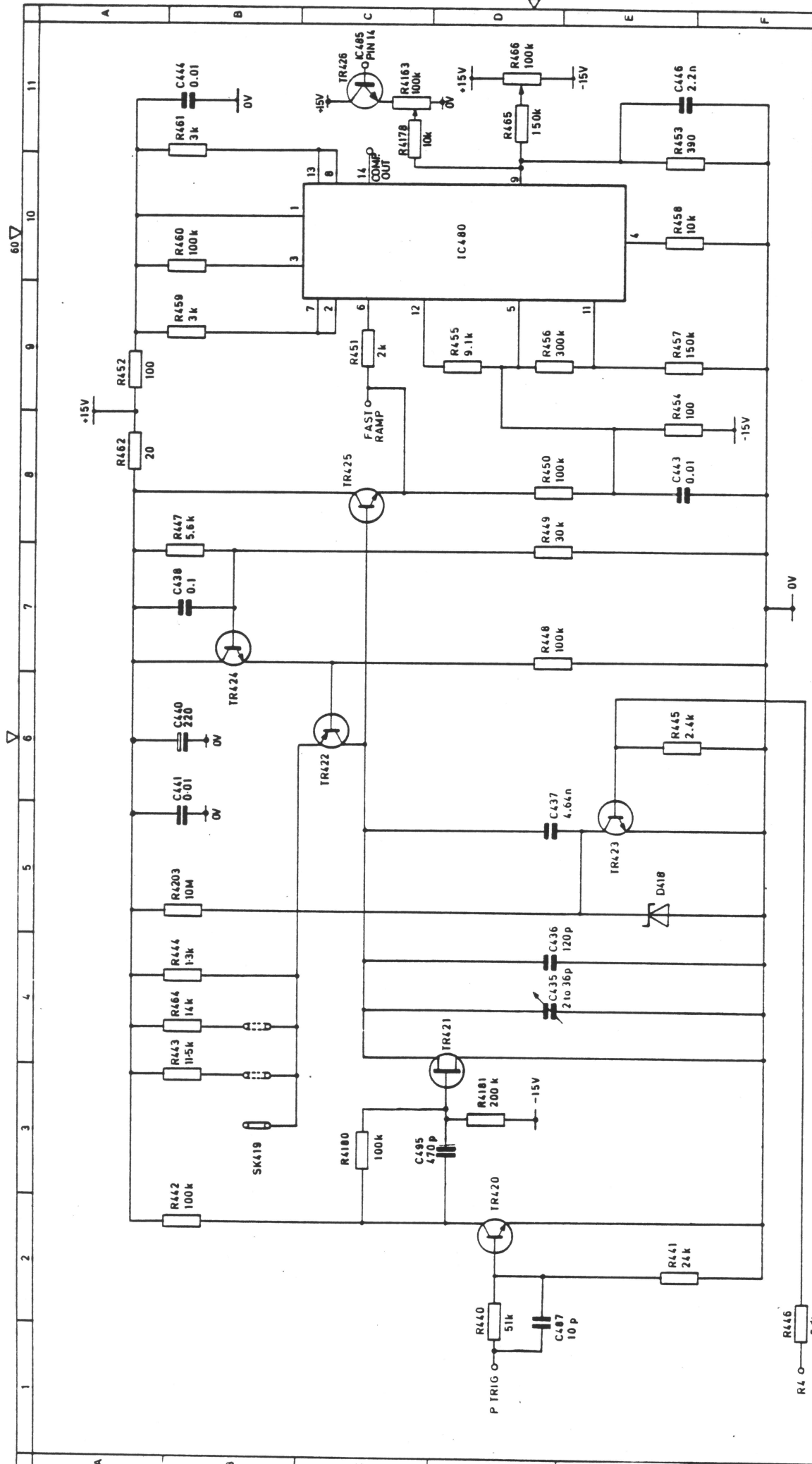
These lists show preferred Cossor Approved components, but alternative approved components may have been used during manufacture.

Replacement items supplied to the Cossor Ref. number may be dissimilar in appearance to those fitted as original equipment, but are Cossor Approved alternatives and are directly interchangeable.

When ordering spare parts always quote the MODEL and SERIAL number of the equipment.

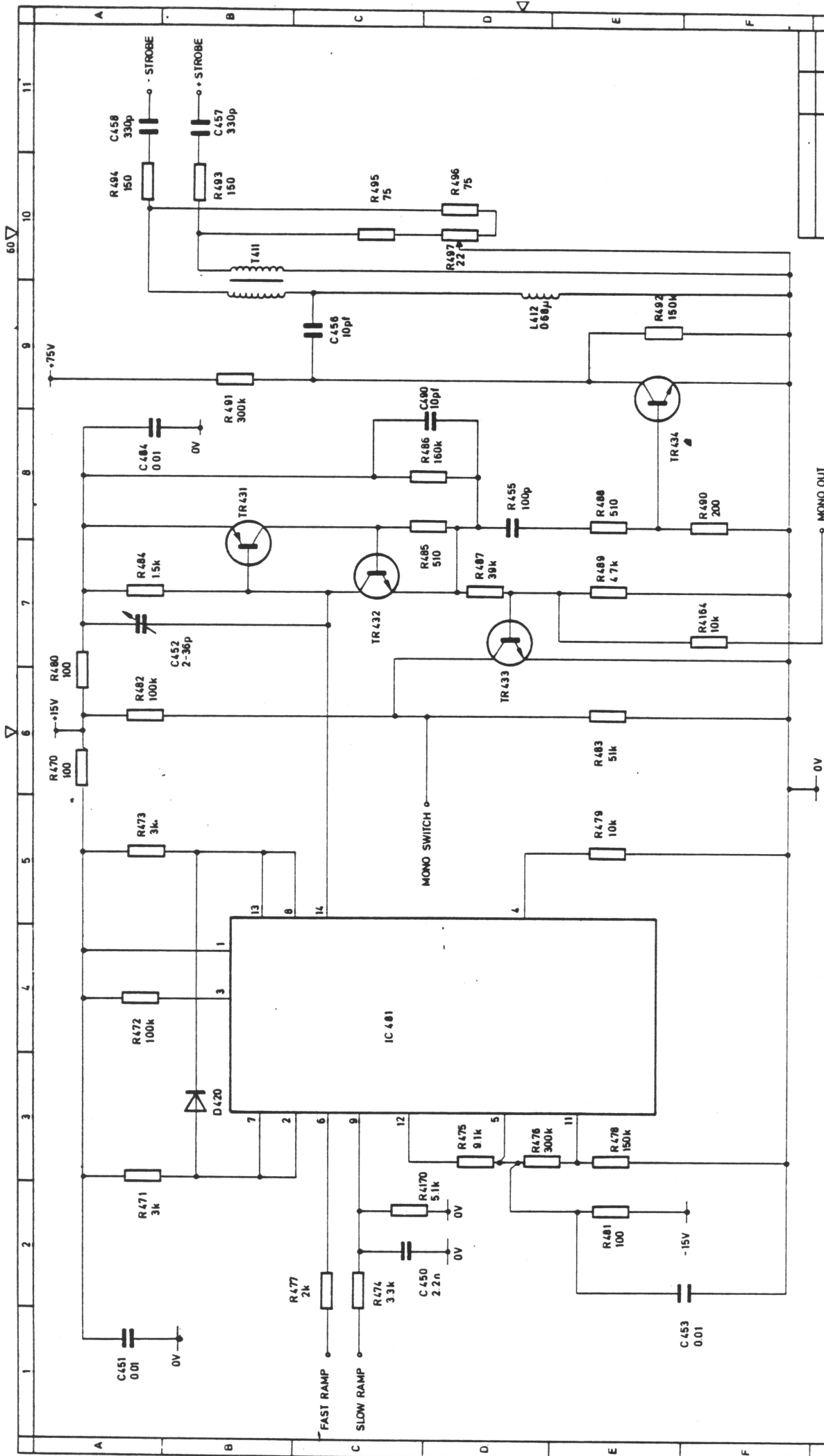






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47%				
CFL431				
PCB4 - FAST RAMP GENERATOR				
C/CD805273/054				

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CFL 431

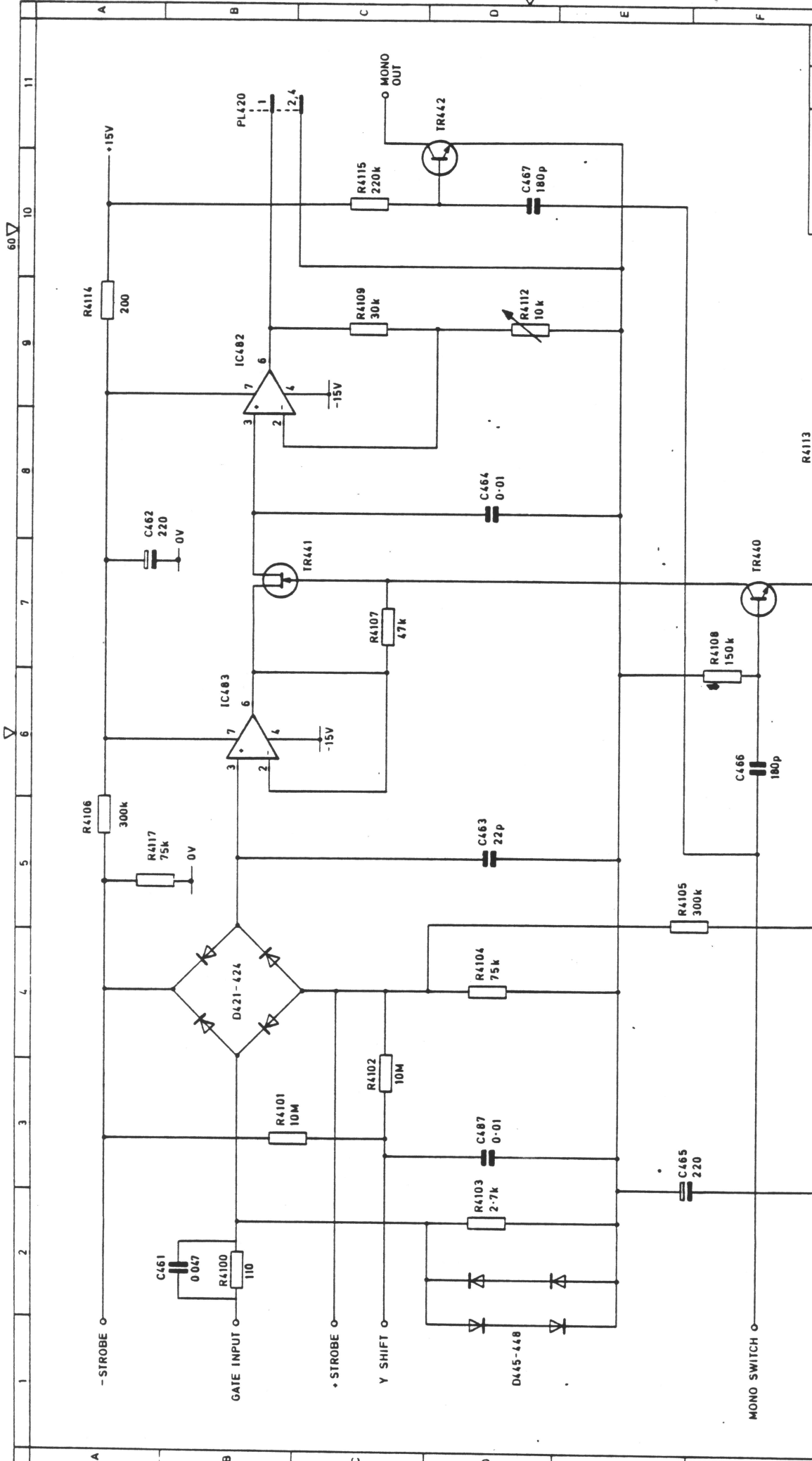
TITLE FAST & SLOW RAMP COMPARISON
PCB 4-AND SAMPLE & HOLD GATES

C/CD 805273/054

FIG 17

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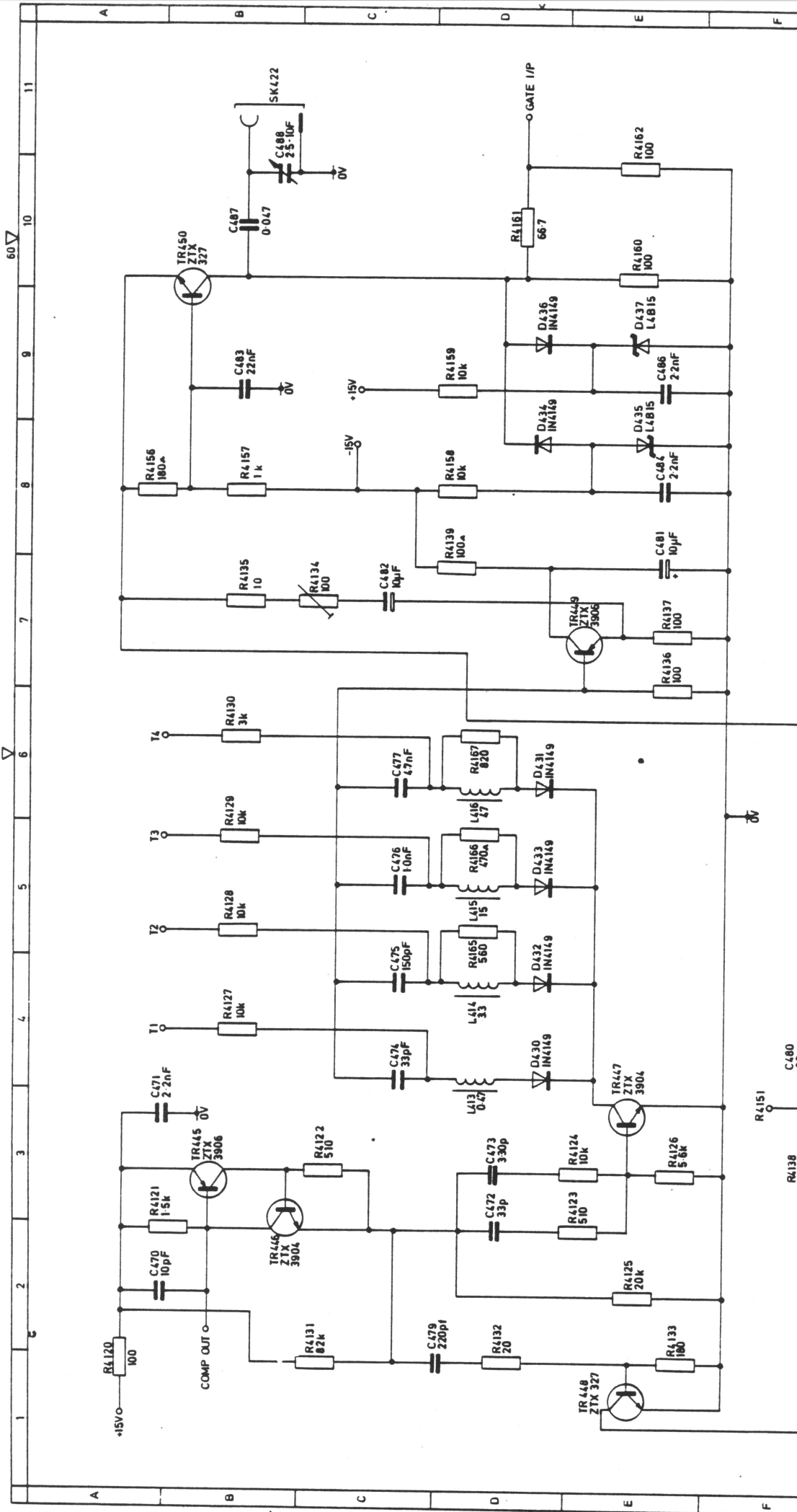
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CFL431

TITLE
PCB4 - SAMPLE AND HOLD

C/CD805273/054

FIG 12



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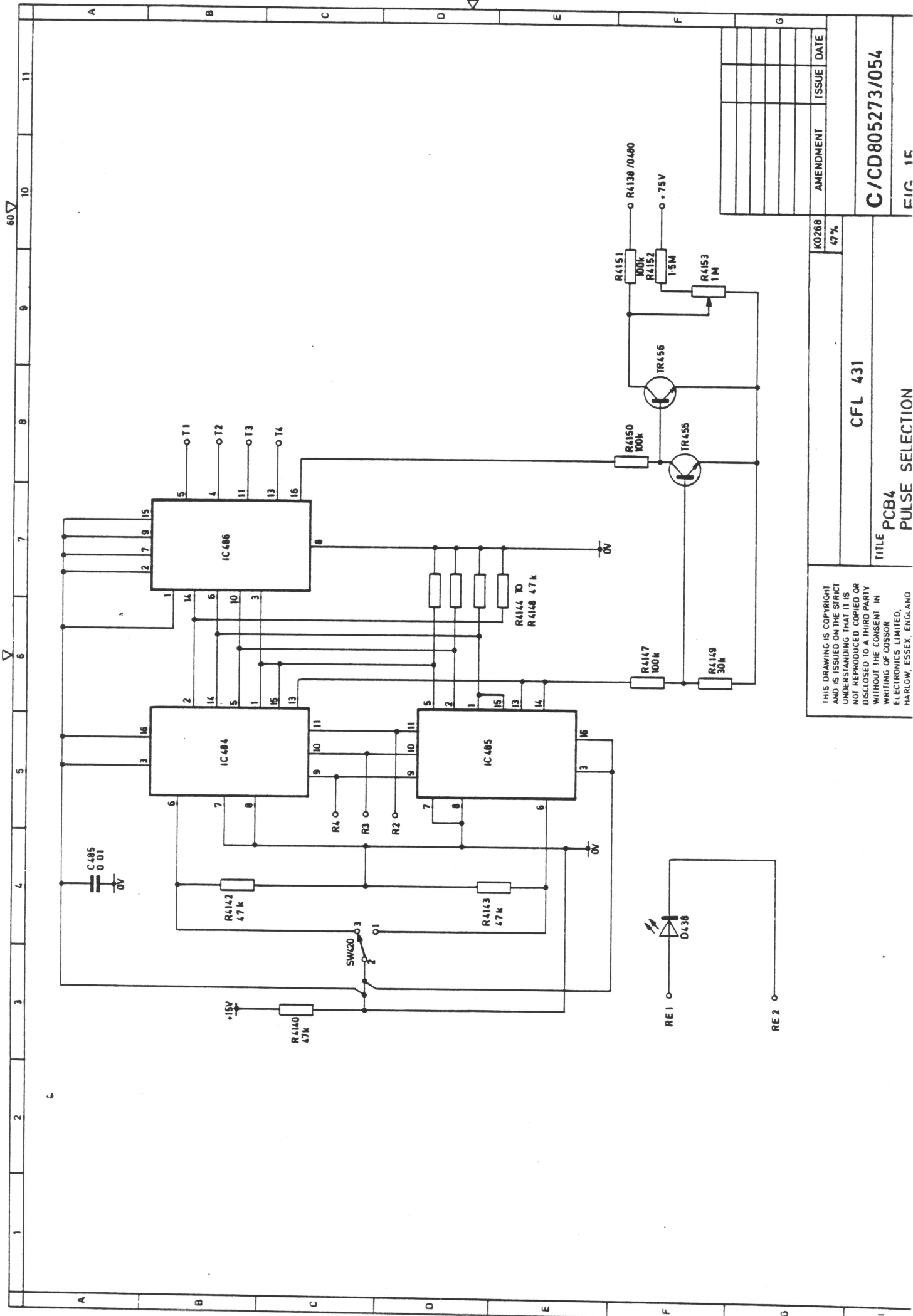
TITLE
PCB 4 - PULSE GENERATOR
CFL 431

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C/CD805273/054

FIG 14



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CFL 431

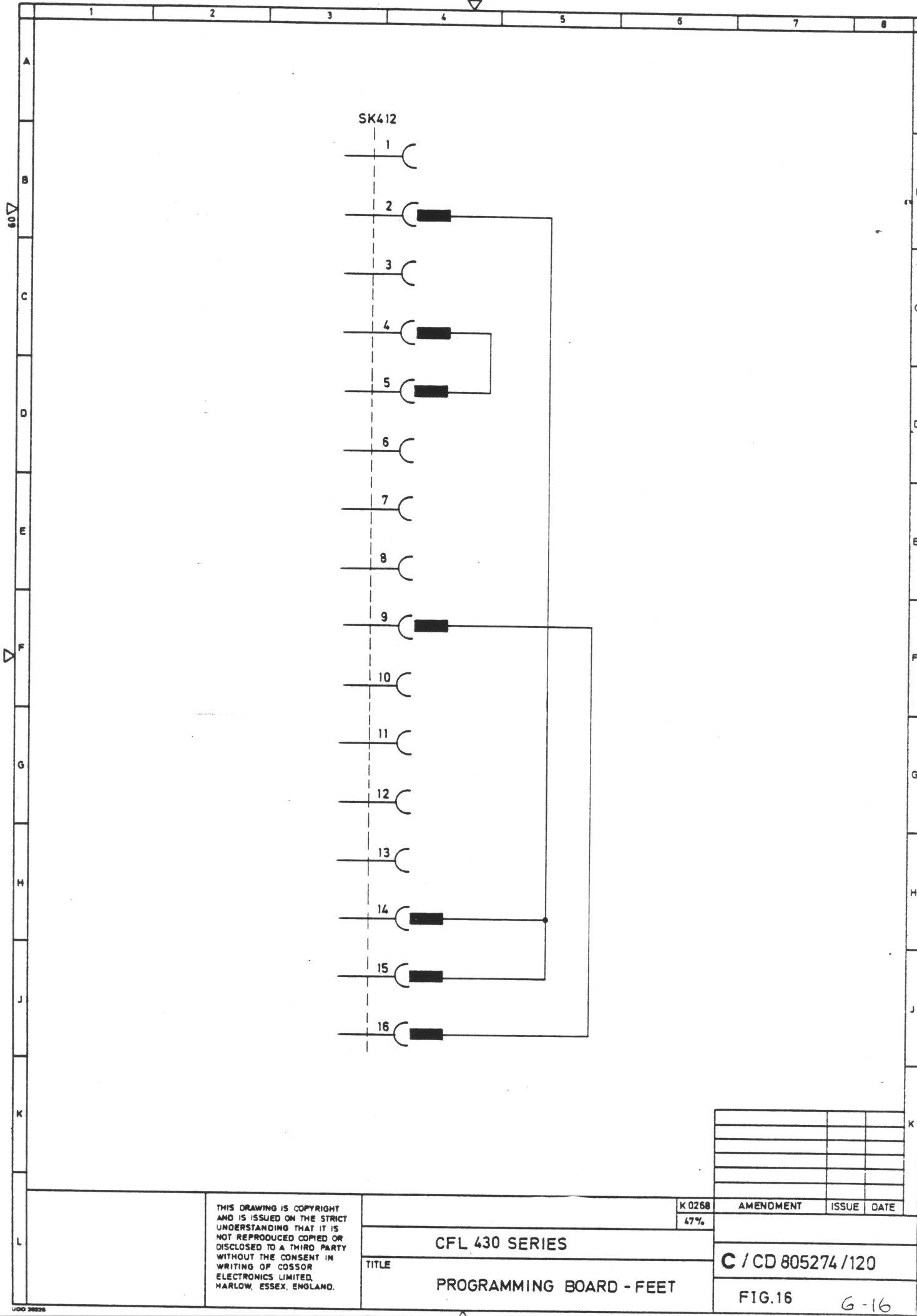
TITLE PCB4
PULSE SELECTION

C/CD805273/054

E/C 1E

AMENDMENT	ISSUE	DATE

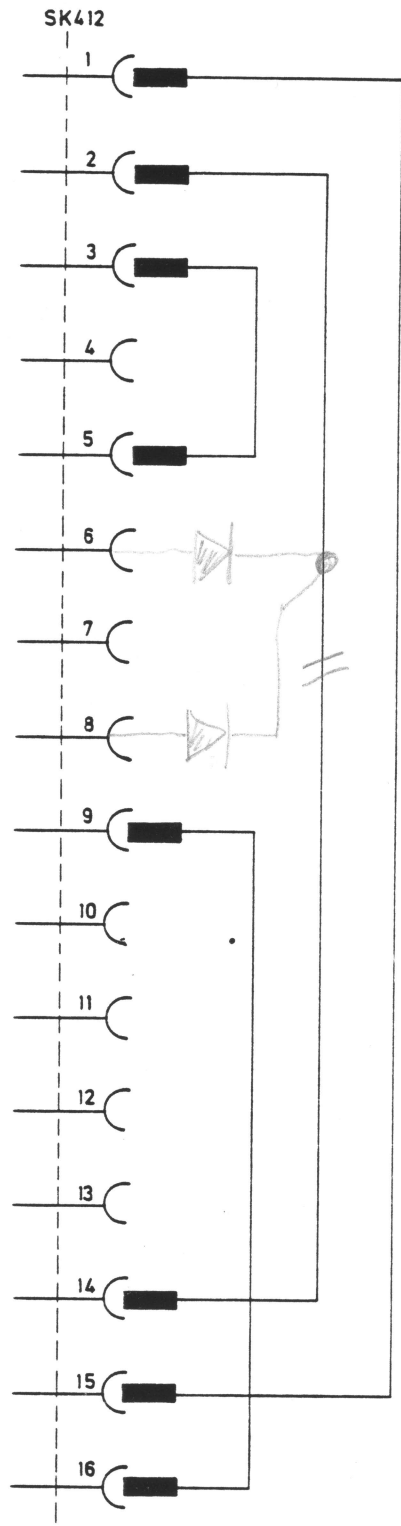
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K 0268	
47%	
CFL 430 SERIES	
TITLE	
PROGRAMMING BOARD - FEET	

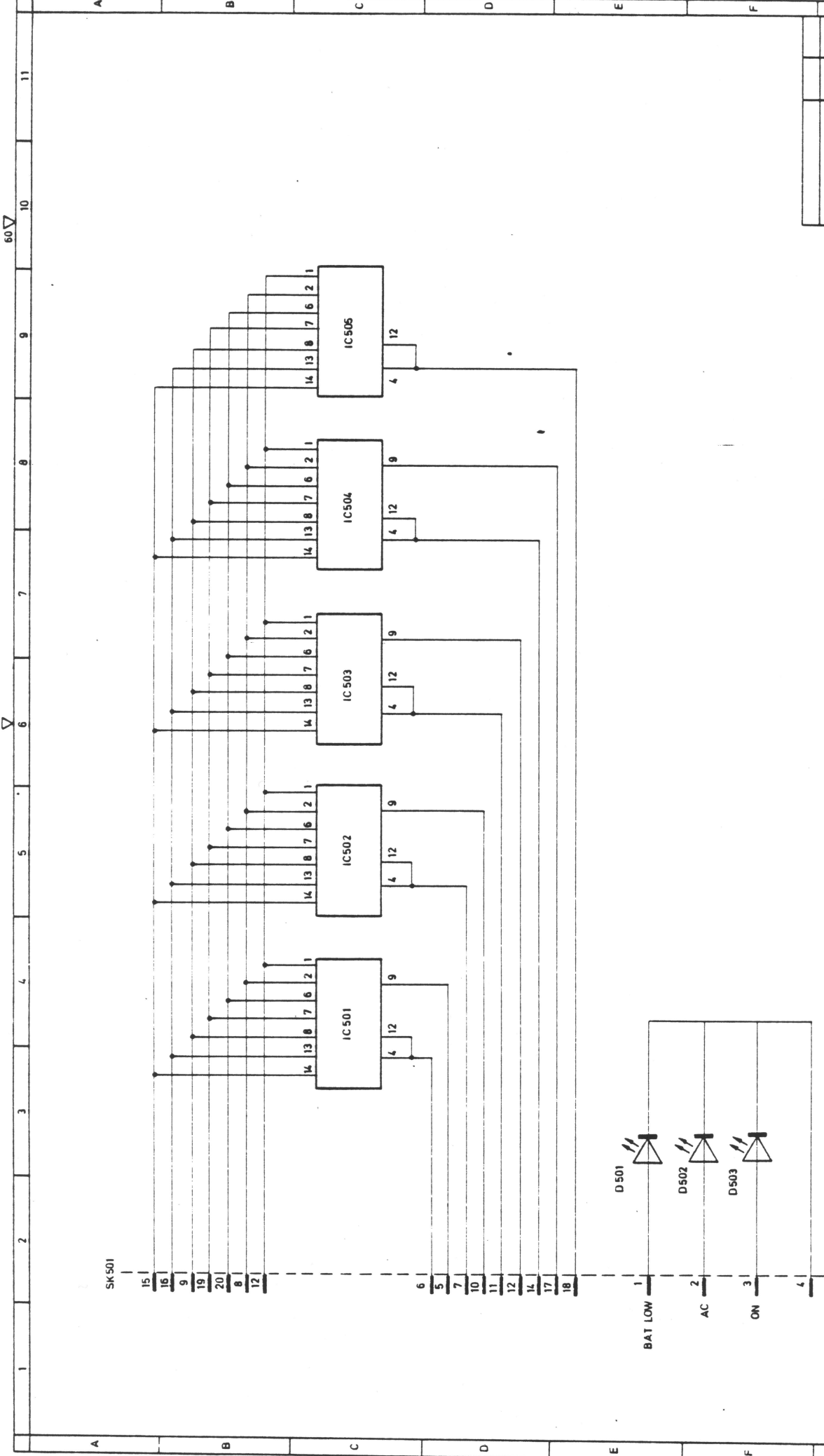
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C / CD 805274 / 120		
FIG.16		



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K 0268	47%
CFL 430 SERIES	
TITLE	
PROGRAMMING BOARD - METRES	

AMENDMENT	ISSUE	DATE
C / CD 805274/121		
FIG.17		



60V 11 10 9 8 7 6 5 4 3 2 1

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	CFL 430 SERIES							C/CD805273 / 055
	TITLE							
	PCB 5 DISPLAY BOARD							
							FIG 10	

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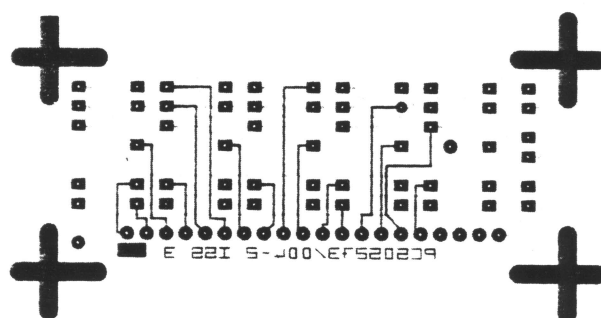


FIG. 20 PCB5 Layout

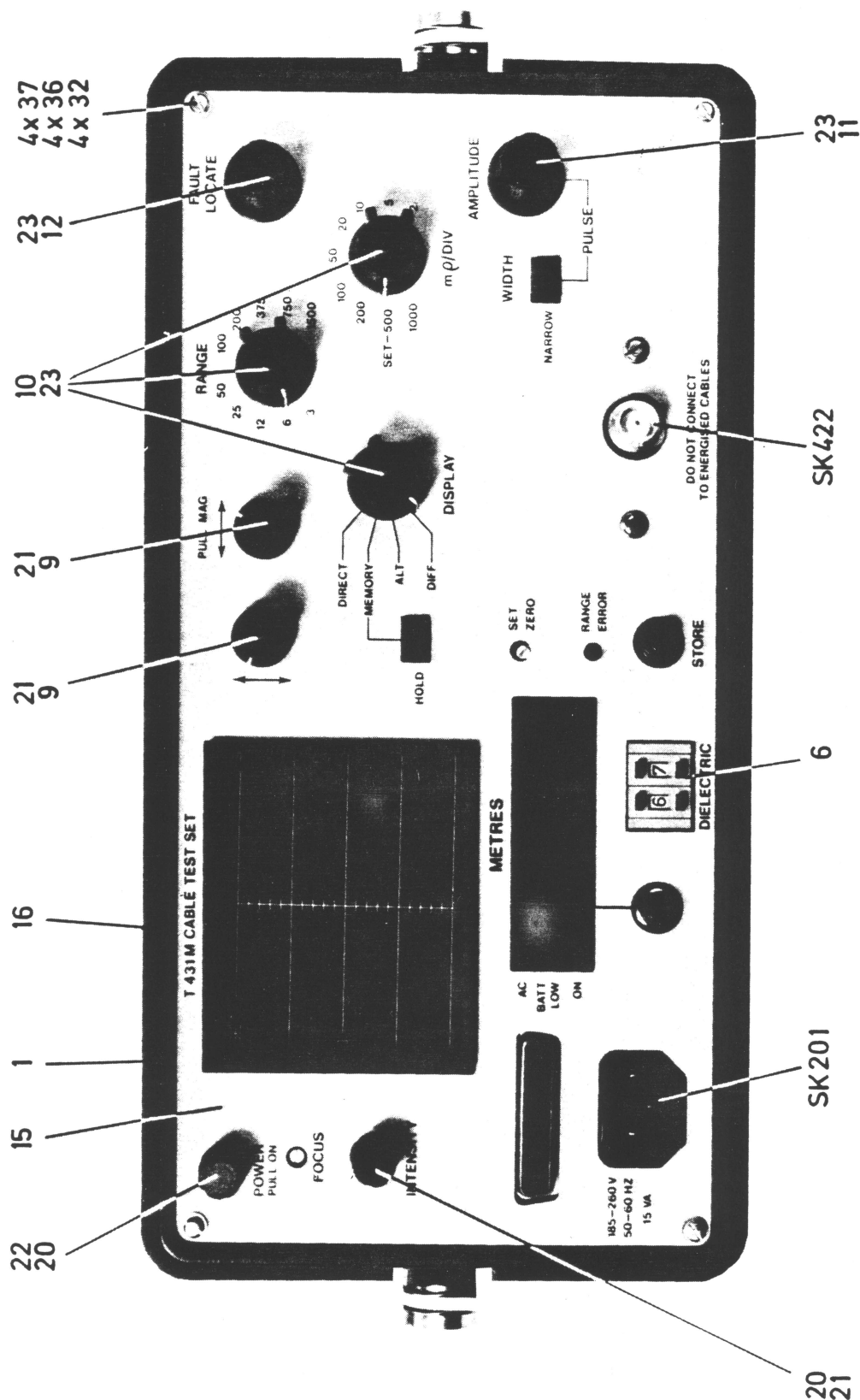


FIG. 21 C.F.L. 431 - Front Panel

FRONT PANEL (FIG. 21)

ITEM NO.	DESCRIPTION	QTY	REF.
1	Assembly, Model 431		805273/050
6	Assembly, switch (wired)	1	805273/107
9	Assembly, knob and skirt	2	804141/117
10	Assembly, knob and skirt	3	805273/081
11	Assembly, knob and skirt	1	804141/114
15	Plate, front panel overlay (marking - metres) (marking - feet)	1	505273/037 505273/035
16	Case, moulded	1	505273/022
20	Knob, black type S11004	2	916149/001
21	Knob cap, black type C110	3	916149/002
22	Knob cap, red type C110	1	916149/003
23	Cap, knob type C150	5	916053/002
32	Screw, machine BS4183	4	938320/02506
36	Washer, locking BS4463 M2.5 Crinkle	4	938191/02500
37	Washer, plain BS4320	4	938020/02510

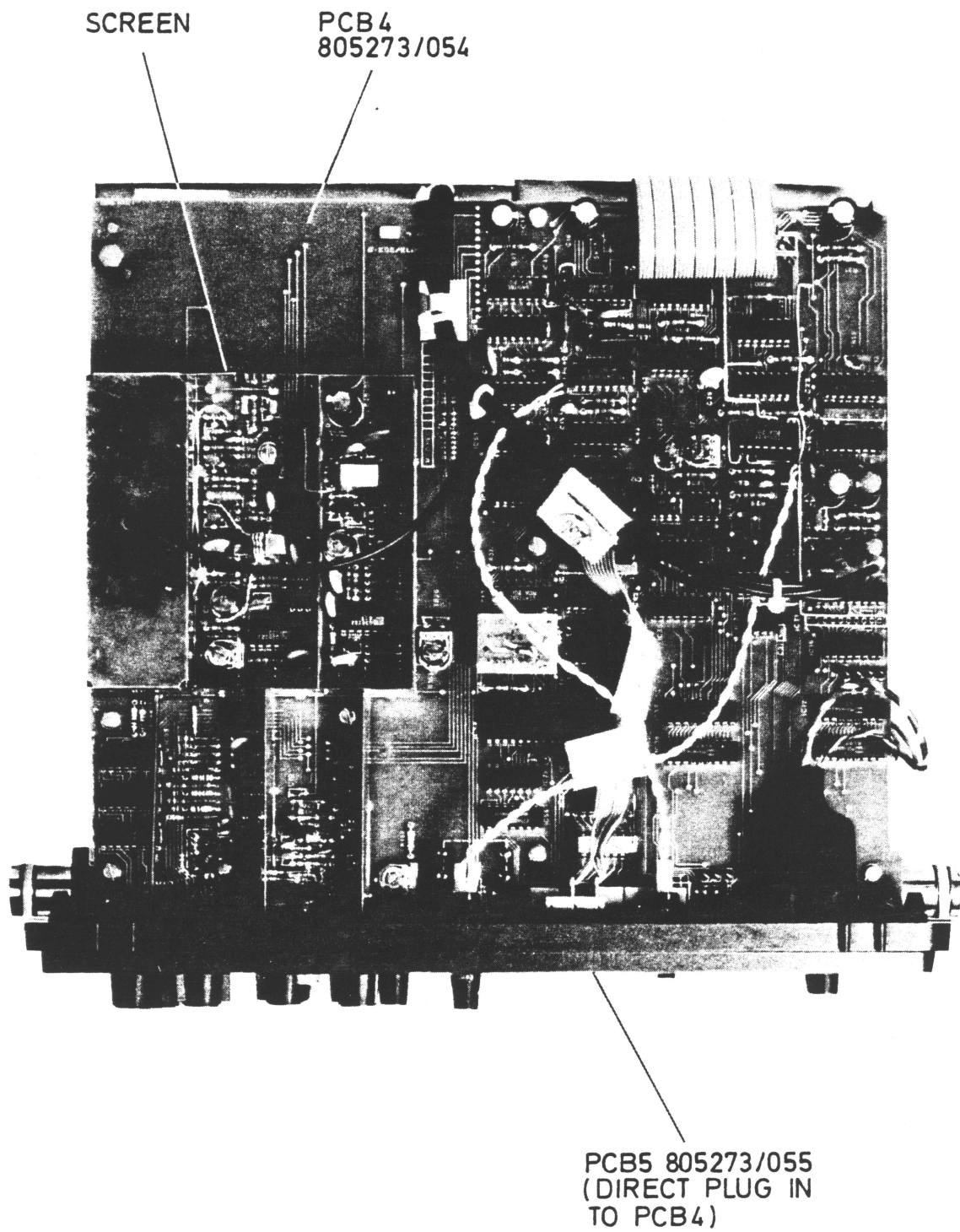


FIG. 22 C.F.L. 431 - Underside

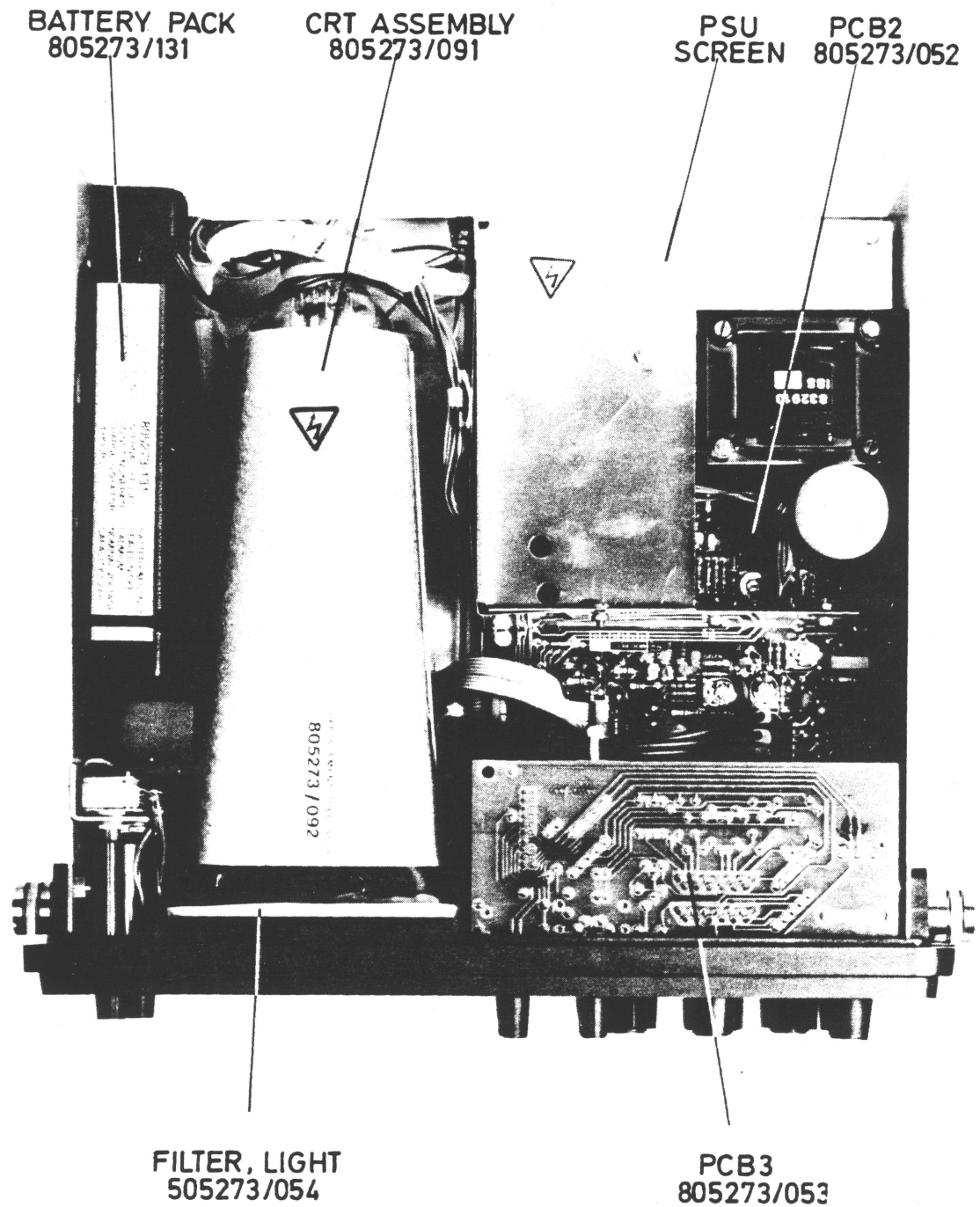


FIG. 23 C.F.L. 431 - Plan View

PCB 2
(POWER SUPPLY, X-AMP AND BRIGHT-UP, Y-AMP)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
	PCB 2 complete with components				805273/052
	<u>CAPACITORS</u>				
C201	Electrolytic	2200	-10+50	40V	AE6538/060/522A
C202					914743/001
C203	Ceramic, Disc Type	0.01	-20+50	3kV	912650/062
C204					AE6538/060/522A
C205	Polycarbonate	0.01	±10	400V	AE2003/268/610A
C206	Ceramic	100p	±20	400V	AE4602/269/410A
C207					914743/001
C208					AE6022/030/510A
C209	Mica	1000p	±20	350V	AE3603/256/510A
C210	Electrolytic	2.2	+75-10	250V	AE6022/240/222A
C211	Electrolytic	4.7	+75-10	100V	AE6022/220/247A
C212	Electrolytic	4.7	+75-10	100V	AE6022/220/247A
C213	Electrolytic	47	+50-10	25V	AE6022/040/347A
C214	Electrolytic	47	+50-10	25V	AE6022/040/347A
C215	Electrolytic	100	+50-10		AE6022/020/410A
C216	Electrolytic	100	+50-10		AE6022/020/410A
C217	Electrolytic	47	+50-10	25V	AE6022/040/347A
C218	Electrolytic	47	+50-10	25V	AE6022/040/347A
C219	Ceramic	0.01	+50-20	2kV	912650/061
C220	Ceramic	0.01	+50-20	2kV	912650/061
C221	Ceramic	0.01	+50-20	2kV	912650/061
C222	Ceramic	0.01	+80-20	250V	AE4803/240/610A
C223					914743/001
C224	Ceramic	0.01	+80-20	250V	AE4803/240/610A
C225	Ceramic	1p	±0.5pF	400V	AE4302/268/210A
C226	Ceramic	1500p	±20	50V	AE4632/149/515A
C227	Ceramic	220p	±10	50V	AE4422/148/422A
C228	Ceramic	0.01	+80-20	250V	AE4803/240/610A
C229	Ceramic	1000p	±20	50V	AE4632/149/510A
C230	Polycarbonate	0.015	±10	400V	AE2003/268/615A
C231	Ceramic	0.01	+80-20	250V	AE4803/240/610A
C232	Ceramic	470p	±20	50V	AE4632/149/447A
C233	Ceramic	0.01	+50-20	3kV	912650/062
C234	Not Used				
C235	Ceramic	10p	±0.5p	400V	AE4322/268/310A
C236	Ceramic	0.01	±0.5p	250V	AE4803/240/610A
C237	Ceramic	0.01	+80-20	250V	AE4803/240/610A
C238	Ceramic	0.01	+80-20	250V	AE4803/240/610A

PCB 2
(POWER SUPPLY, X-AMP AND BRIGHT-UP, Y-AMP) (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>DIODES</u>					
D201	Red L.E.D. RL4484				916600/001
D202	SC Device Rectifier				SR490G/410/000A
D203	SC Device 1N5817				SR601G/320/500A
D204	SC Device Rectifier 1N4002				SR490G/410/000A
D205	SC Device Rectifier 1N4002				SR490G/410/000A
D206	SC Device Rectifier 1N4002				SR490G/410/000A
D207	SC Device Rectifier 1N4002				SR490G/410/000A
D208	Diode 1N4565A		±5	6.4V	ST430A/264/330A
D209	SC Device AA143				912993/000
D210	SC Device 1N4149				SS450F/375/001A
D211	SC Device 1N4149				SS450F/375/001A
D212	SC Device 1N4149				SS450F/375/001A
D213	SC Device 1N4149				SS450F/375/001A
D214	Rectifier BA159				SR4258/510/200A
D215	Rectifier BA159				SR4258/510/200A
D216	SC Device 1S922				SR412A/415/000L
D217	SC Device 1S922				SR412A/415/000L
D218	SC Device 1S922				SR412A/415/000L
D219	SC Device High Voltage BY184				SR2203/515/000A
D220	SC Device High Voltage BY184				SR2203/515/000A
D221	SC Device High Voltage BY184				SR2203/515/000A
D222	SC Device 1N5817				SR601G/320/500A
D223	SC Device 1N4149				SS450F/375/001A
D224	SC Device 1N4149				SS450F/375/001A
D225	SC Device 1S924				SR412A/430/000L
D226	Zener Diode 1N985B		±5%	0.4W	SZ429E/410/300A
D227	SC Device 1N4149				SS450F/375/001A
D228	SC Device 1N4149				SS450F/375/001A
D229	SC Device Rectifier 1N4002				SR490G/410/000A
D230	SC Device 1N4149				SS450F/375/001A
<u>INDUCTORS</u>					
L201	R.F. Shielded	120 μ H			BC0502/448/412A
L202	R.F. Shielded	120 μ H			BC0502/448/412A
L203	R.F. Shielded	120 μ H			BC0502/448/412A
L204	R.F. Shielded	120 μ H			BC0502/448/412A

PCB 2
(POWER SUPPLY, X-AMP AND BRIGHT-UP, Y-AMP) (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>INTEGRATED CIRCUITS</u>					
IC201	LM324N				HJ300A/470/510A
IC202	CA3130E CMOS				KJ101L/120/732A
IC203	Not Used				
IC204	TL061CP				HJ350L/133/510A
IC205	4053B CMOS				JR201A/321/010A
IC206	4051B CMOS				JR201A/181/010A
IC207	CD40109BE CMOS				JY210A/400/000A
IC208	TL061CP				HJ350L/133/510A
IC209	CA3130E CMOS				KJ101L/120/732A
IC210	4069UBE CMOS				JH206/601/010A
<u>RESISTORS</u>					
R201	Metallized film	5.1k	±2	0.25W	BU3000/326/551A
R202	Metallized film	2k	±2	0.25W	BU3000/326/520A
R203	Metallized film	3k	±2	0.25W	BU3000/326/530A
R204	Metallized film	9.1k	±2	0.25W	BU3000/326/291A
R205	Carbon film	2.7	±5	0.125W	BU1000/327/227A
R206	Metallized film	2k	±2	0.25W	BU3000/326/520A
R207	Metallized film	221k	±1	0.25W	BV3100/556/221A
R208	Metallized film	274k	±1	0.25W	BV3100/556/274A
R209	Metallized film	7.5k	±2	0.25W	BU3000/326/575A
R210	Wirewound	0.10	±10	2.5W	5905/99/017/5023
R211	Metallized film	10k	±2	0.25W	BU3000/326/610A
R212	Metallized film	8.2k	±2	0.25W	BU3000/326/582A
R213	Metallized film	300k	±2	0.25W	BU3000/326/730A
R214	Metallized film	75k	±2	0.25W	BU3000/326/675A
R215	Metallized film	51k	±2	0.25W	BU3000/326/651A
R216	Metallized film	62k	±2	0.25W	BU3000/326/662A
R217	Metal glaze, High Voltage	1M	±5	0.25W	BU7020/327/210A
R218	Metallized film	120	±2	0.25W	BU3000/326/412A
R219	Metallized film	300k	±2	0.25W	BU3000/326/730A
R220	Metal glaze, High Voltage	10M	±5	0.25W	BU7020/327/310A
R221	Metallized film	130k	±2	0.25W	BU3000/326/713A
R222	Metal glaze, High Voltage	1M	±5	0.25W	BU7020/327/210A
R223	Metallized film	30k	±2	0.25W	BU3000/326/630A
R224	Metallized film	5.1k	±2	0.25W	BU3000/326/551A
R225	Metallized film	43k	±2	0.25W	BU3000/326/643A

PCB 2
(POWER SUPPLY, X-AMP AND BRIGHT-UP, Y-AMP) (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>RESISTORS</u> (contd)					
R226	Metallized film	100k	±2	0.25W	BU3000/326/710A
R227	Metallized film	68k	±2	0.25W	BU3000/326/668A
R228	Metallized film	100k	±2	0.25W	BU3000/326/710A
R229	Metallized film	750	±2	0.25W	BU3000/326/475A
R230	Metallized film	750	±2	0.25W	BU3000/326/475A
R231	Metallized film	15	±2	0.25W	BU3000/326/315A
R232	Metallized film	15	±2	0.25W	BU3000/326/315A
R233	Metallized film	20	±2	0.25W	BU3000/326/320A
R234	Metallized film	200	±2	0.25W	BU3000/326/420A
R235	Metallized film	300k	±2	0.25W	BU3000/326/730A
R236	Metallized film	300k	±2	0.25W	BU3000/326/730A
R237	Metallized film	300k	±2	0.25W	BU3000/326/730A
R238	Metallized film	300k	±2	0.25W	BU3000/326/730A
R239	Metallized film	1M	±1	0.25	BV3100/557/100A
R240	Metallized film	499k	±1	0.25	BV3100/556/499A
R241	Metallized film	200k	±1	0.25W	BV3100/556/200A
R242	Metallized film	100k	±2	0.25W	BU3000/326/710A
R243	Metallized film	49.9k	±1	0.25W	BV3100/555/499A
R244	Metallized film	20k	±1	0.25W	BV3100/555/200A
R245	Metallized film	10k	±1	0.25W	BV3100/555/100A
R246	Metallized film	4.99k	±1		BV3100/554/499A
R247	Metallized film	2k	±1	0.25W	BV3100/554/200A
R248	Metallized film	1M	±1	0.25W	BV3100/557/100A
R249	Metallized film	100	±2	0.25W	BU3000/326/410A
R250	Metallized film	51k	±2	0.25W	BU3000/326/651A
R251	Metallized film	20k	±2	0.25W	BU3000/326/620A
R252	Metallized film	100k	±2	0.25W	BU3000/326/710A
R253	Not Used				
R254	Metallized film	150k	±2	0.25W	BU3000/326/715A
R255	Metallized film	1M	±1	0.25W	BV3100/557/100A
R256	Metallized film	1M	±1	0.25W	BV3100/557/100A
R257	Metallized film	56k	±2	0.25W	BU3000/326/656A
R258	Metal glaze, High Voltage	10M	±5	0.25W	BU7020/327/310A
R259	Metal glaze, High Voltage	10M	±5	0.25W	BU7020/327/310A
R260	Variable cermet	10k	±20	0.75W	BW1011/000/610A
R261	Metallized film	33k	±2	0.25W	BU3000/326/633A
R262	Variable cermet	220k	±20	0.75W	BW1011/000/722A
R263	Metallized film	9.1k	±2	0.25W	BU3000/326/591A
R264	Metallized film	9.1k	±2	0.25W	BU3000/326/591A
R265	Metallized film	75k	±2	0.25W	BU3000/326/675A

PCB 2
(POWER SUPPLY, X-AMP AND BRIGHT-UP, Y-AMP) (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>RESISTORS</u> (contd)					
R266	Carbon film	560k	±5	0.125W	BU1000/227/756A
R267	Metallized film	51k	±2	0.25W	BU3000/326/651A
R268	Metallized film	51k	±2	0.25W	BU3000/326/651A
R269	Metallized film	100k	±2	0.25W	BU3000/326/710A
R270	Metallized film	100k	±2	0.25	BU3000/326/710A
R271	Metallized film	30k	±2	0.25W	BU3000/326/630A
R272	Metallized film	200	±2	0.25W	BU3000/326/420A
R273	Metallized film	10k	±2	0.25W	BU3000/326/610A
R274	Metallized film	20k	±2	0.25W	BU3000/326/620A
R275	Metallized film	100k	±2	0.25W	BU3000/326/710A
R276	Metallized film	100k	±2	0.25W	BU3000/326/710A
R277	Metallized film	100k	±2	0.25W	BU3000/326/710A
R278	Metallized film	30k	±2	0.25W	BU3000/326/630A
R279	Metallized film	100	±2	0.25W	BU3000/326/410A
R280	Not Used				
R281	Metallized film	10k	±2	0.25W	BU3000/326/610A
R282	Metallized film	51k	±2	0.25W	BU3000/326/651A
R283	Not Used				
R284	Metallized film	30k	±2	0.25W	BU3000/326/630A
R285	Metallized film	100k	±2	0.25W	BU3000/326/710A
R286	Metallized film	30k	±2	0.25W	BU3000/326/630A
R287	Metallized film	47k	±2	0.25W	BU3000/326/647A
R288	Metal glaze, High Voltage	10M	±5	0.25W	BU7020/327/310A
R289	Metallized film	2.2M	±5	0.25W	BU7020/327/222A
R290	Metallized film	1.5M	±5	0.25W	BU7020/327/215A
R291	Metallized film	24k	±2	0.25W	BU3000/326/624A
R292	Metallized film	100k	±2	0.25W	BU3000/326/710A
R293	Metallized film	33k	±2	0.25W	BU3000/326/633A
R294	Metallized film	1M	±1	0.25W	BV3100/557/100A
R295	Metallized film	5.6M	±2	0.25W	BU3000/326/556A
R296	Metallized film	5.6k	±2	0.25W	BU3000/326/556A
R297	Metallized film	1M	±1	0.25W	BV3100/557/100A
R298	Metallized film	300k	±2	0.25W	BU3000/326/730A
R299	Variable cermet	2.2k	±20	0.75W	BW1011/000/522A
R2100	Variable cermet	2.2M	±20	0.5W	BW1011/000/822A
R2101	Metal glaze, High Voltage	1M	±5	0.25W	BU7020/327/210A
R2102	Metal glaze, High Voltage	10M	±5	0.25W	BU7020/327/310A
R2103	Variable cermet	1M	±20	0.75W	BW1001/000/810A
R2104	General purpose	510k	±2	0.25W	5905/99/017/4533
R2105	Variable cermet	2.2M	±20	0.75W	BW1001/000/822A

PCB 2
(POWER SUPPLY, X-AMP AND BRIGHT-UP, Y-AMP) (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>RESISTORS</u> (contd)					
R2106	Metallized film	82k	±2	0.25W	BU3000/326/682A
R2107	Not Used				
R2108	Not Used				
R2109	Metallized film	120	±2	0.25W	BU3000/326/412A
R2110	Metallized film	300k	±2	0.25W	BU3000/326/730A
R2111	Metallized film	30k	±2	0.25W	BU3000/326/630A
R2112	Metallized film	182k	±1	0.25W	BV3100/556/182A
R2113	Metallized film	301k	±1	0.25W	BV3100/556/301A
R2114	Variable cermet	47k	±20	0.75W	BW1011/000/647A
R2115	Not Used				
R2116	Metallized film	20k	±2	0.25W	BU3000/326/620A
R2117	Metallized film	5.6k	±2	0.25W	BU3000/326/556A
R2118	Metallized film	300k	±2	0.25W	BU3000/326/730A
R2119	Metallized film	51k	±2	0.25W	BU3000/326/651A
R2120	Metallized film	150k	±2	0.25W	BU3000/326/715A
R2121	Metallized film	150k	±2	0.25W	BU3000/326/715A
R2122	Variable cermet	10k	±20	0.75W	BW1011/000/610A
R2123	Metallized film	9.1k	±2	0.25W	BU3000/326/591A
R2124	Metallized film	27k	±2	0.25W	BU3000/326/627A
R2125	Metallized film	27k	±2	0.25W	BU3000/326/627A
R2126	Metallized film	10k	±2	0.25W	BU3000/326/610A
R2127	Not Used				
R2128	Not Used				
R2129	Not Used				
R2130	Metal glaze, High Voltage	10M	±5	0.25W	BU7020/327/310A
R2131	Metal glaze, High Voltage	10M	±5	0.25W	BU7020/327/310A
R2132	Not Used				
R2133	Not Used				
R2134	Not Used				
R2135	Not Used				
R2136	Not Used				
R2137	Not Used				
R2138	Not Used				
R2139	Not Used				
R2140	Metallized film	10k	±2	0.25W	BU3000/326/610A
R2141	Metallized film	10k	±2	0.25W	BU3000/326/610A

PCB 2
(POWER SUPPLY, X-AMP AND BRIGHT-UP, Y-AMP) (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>SWITCHES</u>					
S201	Rotary Wafer 1 Pole 9 Posn.				CC4044/112/009A
S202	Rotary Wafer 2 Pole 4 Posn.				CC4044/212/004A
S203	Push-Button Series TJ				914012/011
<u>SOCKETS</u>					
SK201	Terminal Lead thro Type 75401-002				916430/000
SK202	Terminal Lead thro Type 75401-002				916430/000
SK203	Terminal Lead thro Type 75401-002				916430/000
SK204	Terminal Lead thro Type 75401-002				916430/000
SK205	Terminal Lead thro Type 75401-002				916430/000
SK206	Terminal Lead thro Type 75401-002				916430/000
SK207	Terminal Lead thro Type 75401-002				916430/000
SK208	Terminal Lead thro Type 75401-002				916430/000
SK209	Terminal Lead thro Type 75401-002				916430/000
SK210	Terminal Lead thro Type 75401-002				916430/000
SK211	Terminal Lead thro Type 75401-002				916430/000
SK212	Terminal Lead thro Type 75401-002				916430/000
<u>TRANSFORMERS</u>					
T201					832913/000
T202	Pulse, Thyristor Triac Power Control				CG6012/420/100A
T203	Inverter				832906/000
<u>TRANSISTORS</u>					
TR201	ZTX214K				TF301N/030/100A
TR202	BD436				TD201Y/032/000A
TR203	ZTX109K				TE305N/030/100A
TR204	ZTX214K				TF301N/030/100A
TR205	ZTX109K				TE305N/030/000A
TR206	ZTX214K				TF301N/030/100A
TR207	ZTX450K				TC301N/060/000A
TR208	DBX36				TC200Y/080/100A
TR209	ZTX109K				TE305N/030/000A
TR210	MPSA42				TA200J/300/000A
TR211	MPSA42				TA200J/300/000A
TR212	MPSA42				TA200J/300/000A
TR213	MPS-A92				TB201J/300/000A
TR214	MPS-A92				TB201J/300/000A
TR215	MPSA42				TA200J/300/000A

PCB 2
(POWER SUPPLY, X-AMP AND BRIGHT-UP, Y-AMP) (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>TRANSISTORS (contd)</u>					
TR216	ZTX214K				TF301N/030/100A
TR217	ZTX109K				TE305N/030/000A
TR218	ZTX109K				TE305N/030/000A
TR219	ZTX109K				TE305N/030/000A
TR220	MPSA42				TA200J/300/000A
TR221	ZTX3904K				TJ200N/060/000A
TR222	MPSA42				TA200J/300/000A
TR223	MPSA42				TA200J/300/000A
TR224	MPSA42				TA200J/300/000A
TR225	ZTX109K				TE305N/030/000A
TR226	ZTX109K				TE305N/030/000A
TR227	ZTX214K				TF301N/030/100A
TR228	ZTX109K				TE305N/030/000A
TR229	BD436				TD201Y/032/000A
TR230	ZTX109K				TE305N/030/000A
TR231	ZTX313K				TJ300N/015/000A
TR232	Not Used				
TR233	Not Used				
TR234	Not Used				
TR235	MPSA42				TA200J/300/000A
TR236	MPS-A92				TB201J/300/000A
TR237	MPSA42				TA200J/300/000A
TR238	MPS-A92				TB201J/300/000A
<u>MISCELLANEOUS</u>					
FS201	Fuse Cartridge Slow Blow	100mA			AY1120/310/000A
FS202	Fuse Cartridge Slow Blow	100mA			AY1120/310/000A
BAT201	Battery, Secondary NICD	3.6V			AC1115/203/600A
FH201	Fuseholder, Open				AY6031/100/000A

PCB 3
(SWITCHING CONTROLS)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
	PCB 3 complete with components 805273/053				
	<u>DIODES</u>				
D301	IN4149				SS450F/375/001A
D302	IN4149				SS450F/375/001A
D303	IN4149				SS450F/375/001A
D304	IN4149				SS450F/375/001A
D305	IN4149				SS450F/375/001A
D306	IN4149				SS450F/375/001A
D307	IN4149				SS450F/375/001A
D308	IN4149				SS450F/375/001A
D309	IN4149				SS450F/375/001A
D310	IN4149				SS450F/375/001A
D311	IN4149				SS450F/375/001A
D312	IN4149				SS450F/375/001A
D313	IN4149				SS450F/375/001A
D314	IN4149				SS450F/375/001A
D315	IN4149				SS450F/375/001A
D316	IN4149				SS450F/375/001A
D317	IN4149				SS450F/375/001A
D318	IN4149				SS450F/375/001A
D319	IN4149				SS450F/375/001A
D320	IN4149				SS450F/375/001A
D321	IN4149				SS450F/375/001A
D322	IN4149				SS450F/375/001A
D323	IN4149				SS450F/375/001A
	<u>RESISTORS</u>				
R301	Not Used				
R302	Fixed	512K	±0.1	0.1W	BV2000/326/512A
R303	Fixed	256K	±0.1	0.1W	BV2000/326/256A
R304	Fixed	128K	±0.1	0.1W	BV2000/326/128A
R305	Fixed	64K	±0.1	0.1W	BV2000/325/640A
R306	Fixed	32K	±0.1	0.1W	BV2000/325/320A
R307	Fixed	4.3K	±2	0.25W	BU3000/326/543A
R308	Not Used				
R309	Not Used				
R310	Fixed	47K	±2	0.25W	BU3000/326/647A

PCB 3
(SWITCHING CONTROLS) (Cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>RESISTORS (contd)</u>					
R311	Variable	10K		0.15W	916215/005
R312	Fixed	10K	±5	2W	BY3505/420/610A
R313	Fixed	47K	±2	0.25W	BU3000/326/647A
R314	Variable	1M		0.15W	BY0225/116/810A
R315	Fixed	100K	±2	0.25W	BU3000/326/710A
R316	Fixed	100K	±2	0.25W	BU3000/326/710A
R317	Fixed	100K	±2	0.25W	BU3000/326/710A
R318	Fixed	100K	±2	0.25W	BU3000/326/710A
R319	Fixed	100K	±2	0.25W	BU3000/326/710A
R320	Fixed	100K	±2	0.25W	BU3000/326/410A
R321	Fixed	100K	±2	0.25W	BU3000/326/410A
R322	Fixed	10	±2	0.25W	BU3000/326/410A
R323	Not Used				
R324	Not Used				
R325	Not Used				
R326	Not Used				
R327	Fixed	1K	±2	0.25W	BU3000/326/510A
R328	Fixed	120K	±2	0.25W	BU3000/326/712A
R329	Fixed	220K	±2	0.25W	BU3000/326/722A
<u>SOCKET</u>					
SK301	Type 75401-002				916430/000
<u>SWITCHES</u>					
S301	Rotary Wafer 2-pole 10-posn				CC4044/122/110A
S302	D.I.L. 1 pole c/o				CC8025/013/020A
<u>TRANSISTOR</u>					
TR301	ZTX 109K				TE305N/030/100A

PCB 4
COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST AND
SLOW RAMP GENERATORS, PULSE GENERATOR

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
	PCB complete with components				805273/054
	<u>CAPACITORS</u>				
C411	Fixed	470p	±20	400VDC	AE4602-269-447A
C412	Fixed	1.0	±10	63VDC	AE2003-218-810A
C413	Fixed	10p	±0.5p	400VDC	AE4322-268-310A
C414	Fixed	820p	±2	350VDC	AE3603-256-482A
C415	Fixed	1200p	±2	350VDC	AE3603-256-512A
C416	Fixed, Electrolytic	220	+50-10	10VDC	AE6022-020-422A
C417	Fixed	220	+50-10	10VDC	AE6022-020-422A
C418	Fixed	220	+50-10	10VDC	AE6022-020-422A
C419	Fixed	220	+50-10	10VDC	AE6022-020-422A
C420	Fixed	100p	±2	50VDC	AE4412-146-410A
C421	Fixed	220	+50-10	10VDC	AE6022-020-422A
C422	Fixed Electrolytic	10	+50-10	16VDC	AE6022-030-310A
C423	Not used				
C424	Not used	470p	±20	400VDC	AE4602-269-447A
C425	Not used	100p	±2	50VDC	AE4412-146-410A
C426	Fixed	0.01	±80-20	250VDC	AE4803-240-610A
C427	Fixed	0.01	±80-20	250VDC	AE4803-240-610A
C428	Fixed	0.01	±80-20	250VDC	AE4803-240-610A
C429	Fixed	0.01	±80-20	250VDC	AE4803-240-610A
C430	Not used				
C431	Fixed	150p	±10	50VDC	AE4412-148-415A
C432	Not used				
C433	Not used				
C434	Not used				
C435	Variable	2/36p		100VDC	AE6011-220-336A
C436	Fixed	120p	±2	50VDC	AE4412-146-412A
C437	Fixed	4640p	±1		AE1513-214-464A
C438	Fixed	0.1	±80-20	30VDC	AE4902-130-710A
C439	Not used				
C440	Fixed, Electrolytic	220	+50-10	16VDC	AE6022-030-422A
C441	Fixed	.01	+80-20	250VDC	AE4803-240-610A
C442	Not used				
C443	Not used	.01	+80-20	250VDC	AE4803-240-610A
C444	Not used	.01	+80-20	250VDC	AE4803-240-610A
C445	Not used				

PCB 4
COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST AND
SLOW RAMP GENERATORS, PULSE GENERATOR (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>CAPACITORS (Contd.)</u>					
C446	Fixed	2200p	±20	50VDC	AE4632-149-522A
C447	Not used				
C448	Not used				
C449	Not used				
C450		2200p	±20	50VDC	AE4632-149-522A
C451	Fixed	.01	+80-20	250VDC	AE4803-240-610A
C452	Variable	2-36p		100VDC	AE6011-220-336A
C453	Fixed	.01	+80-20	250VDC	AE4803-240-610A
C454	Fixed	.01	+80-20	250VDC	AE4803-240-610A
C455	Fixed	100p	±10	50VDC	AE4412-148-410A
C456	Fixed	10p	±5	50VDC	AE4402-147-310A
C457	Fixed	330p	±10	50VDC	AE4422-148-433A
C458	Fixed	330p	±10	50VDC	AE4422-148-433A
C459	Not used				
C460	Not used				
C461	Fixed	.047	±2	400VDC	AE2403-262-647A
C462	Fixed, Electrolytic	220	+50-10	16VDC	AE6022-030-422A
C463	Fixed	10p	±5	50VDC	AE4402-147-310A
C464	Fixed	.01	+80-20	250VDC	AE4803-240-610A
C465	Fixed, Electrolytic	220	+50-10	16VDC	AE6022-030-422A
C466	Fixed, Electrolytic	180p	±2	50VDC	AE4422-146-418A
C467	Fixed, Electrolytic	180p	±2	50VDC	AE4422-146-418A
C468	Not used				
C469	Not used				
C470	Fixed	10p	±5	50VDC	AE4402-147-310A
C471	Fixed	2200p	±20	50VDC	AE4632-149-522A
C472	Fixed	33p	±10	50VDC	AE4412-148-333A
C473	Fixed	330p	±10	50VDC	AE4422-148-433A
C474	Fixed	33p	±10	50VDC	AE4412-148-333A
C475	Fixed	150p	±10	50VDC	AE4412-148-415A
C476	Fixed	1000p	±10	50VDC	AE4632-148-510A
C477	Fixed	4700p	±20	50VDC	AE4632-149-547A
C478	Not used				
C479	Fixed	220p	±10	50VDC	AE4422-148-422A
C480	Fixed	18p	±5	50VDC	AE4402-147-318A
C481	Fixed, Electrolytic	10	+50-10	16VDC	AE6022-030-310A
C482	Fixed, Electrolytic	10	+50-10	16VDC	AE6022-030-310A
C483	Fixed	.022	±20	50VDC	AE0251-149-622A
C484	Fixed	2200p	±20	50VDC	AE4632-149-522A
C485	Fixed	.01μ	+80-20	250VDC	AE4803-240-610A

PCB 4

COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST AND
SLOW RAMP GENERATORS, PULSE GENERATOR (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>CAPACITORS (contd.)</u>					
C486	Fixed	2200p	±20	50VDC	AE4632-149-522A
C487	Fixed	.047	±2	400VDC	AE2403-262-647A
C488	Variable Ceramic	2.5/10p	-100±200	ppm/c	AG0029-225-310A
C489	Not used				
C490	Fixed	10p	±0.5p	400VDC	AE4322-268-310A
<u>DIODES</u>					
D413	ZC2800 HOT CARRIER				914472-000
D414	Not used				
D415	Not used				
D416	Not used				
D417	Not used				
D418	ZC2800 HOT CARRIER				914472-000
D419	ZC2800 HOT CARRIER				914472-000
D420	ZC2800 HOT CARRIER				914472-000
D421	ZC2800 HOT CARRIER				914472-000
D422	ZC2800 HOT CARRIER				914472-000
D423	ZC2800 HOT CARRIER				914472-000
D424	ZC2800 HOT CARRIER				914472-000
D425	Not used				
D426	Not used				
D427	Not used				
D428	Not used				
D429	Not used				
D430	IN4149				SS450F-375-001A
D431	IN4149				SS450F-375-001A
D432	IN4149				SS450F-375-001A
D433	IN4149				SS450F-375-001A
D434	IN4149				SS450F-375-001A
D435	LB4B15				SL210A-212-400A
D436	IN4149				SS450F-375-001A
D437	LB4B15				SL210A-212-400A
D438	Lamp Solid State LED Red				BJ5081-140-280A
D439	Not used				
D440	IN4002 Rect.				SR490G-410-000A

PCB 4
COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST AND
SLOW RAMP GENERATORS, PULSE GENERATOR (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>INDUCTORS</u>					
L401 to L410	Not used				
L411	R.F.	15 μ H	± 5		BC0010-420-315A
L412	R.F.	0.68 μ H	± 10		BC0110-511-168A
L413	R.F.	0.47 μ H	± 10		BC0020-459-147A
L414	R.F. 7.9 MHz	3.3 μ H	± 10		BC0020-438-233A
L415	R.F.	15 μ H	± 5		BC0010-420-315A
L416	R.F.	47 μ H	$\pm 10^\circ$		BC0020-416-347A
<u>INTEGRATED CIRCUITS</u>					
IC401 to IC412	Not used				
IC413	14585B				JG201A-104-000A
IC414	4042B				JL205A-401-010A
IC415	AD7574JN A/D CONVERTER 8 BIT				KP308A-120-000A
IC416	7523JN D/A CONVERTER 8 BIT				KP308A-110-100A
IC417	HM3-6561-5				MA393A-025-604A
IC418	HM3-6561-5				MA393A-025-604A
IC419	Not used				
IC420	Not used				
IC421	Not used				
IC422	4013B				JG201A-200-010A
IC423	4001				JH204A-402-019A
IC424	4081B				JH201A-402-010A
IC425	Not used				
IC426	4013B				JG201A-200-010A
IC427	LM308				HJ350L-144-650A
IC428	Not used				
IC429	4040B				JC201A-112-019A
IC430	4075B				JH203A-303-010A
IC431	Not used				
IC432	Special from HJ350L-133-510A TLOGI				76933-000
IC433	Special from HJ350L-133-510A TLOGI				76933-000
IC434	4040B				JC201A-112-019A
IC435	AD7533JN				KP310A-180-200A
IC436	Not used				
IC437	HM3-6561-5				MA393A-025-604A
IC438	HM3-6561-5				MA393A-025-604A
IC439	Not used				
IC440	Not used				
IC441	4018B				JC205A-100-100A
IC442	14536B				JP202D-100-110A

PCB 4

COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST AND
SLOW RAMP GENERATORS, PULSE GENERATOR (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>INTEGRATED CIRCUITS (Contd.)</u>					
IC443	4013B				JG201A-200-010A
IC444	4047BE				JJ202A-100-010A
IC445	14527				JA202A-100-010A
IC446	14527				JA202A-100-010A
IC447	14511				JL203A-104-000A
IC448	4017B				JC202A-105-010A
IC449	4040B				JC201A-112-019A
IC450	4053B				JR201A-321-010A
IC451	4018B				JC205A-100-100A
IC452	4001				JH204A-402-019A
IC453	4073B				JH201A-303-010A
IC454	14534BCP				JC202A-100-755A
IC455	75492				HF301A-600-000A
IC456	Not used				
IC457	Not used				
IC458	Not used				
IC459	Not used				
IC460	Not used				
IC461	Not used				
IC462	Not used				
IC463	Not used				
IC464	Not used				
IC465	Not used				
IC466	Not used				
IC467	Not used				
IC468	Not used				
IC469	Not used				
IC470	Res. Passive Network (4 x 33 K \pm 2% 8-Pin SIL PACK)				PA140N-426-633A
IC471	Res. Passive Network (9 x 100 K \pm 2% 10-Pin SIL PACK)				PA180N-426-710A
IC472	Res. Passive Network (9 x 100 K \pm 2% 10-Pin SIL PACK)				PA180N-426-710A
IC473	Res. Passive Network (4 x 100 Ω \pm 2% 8-P SIL PACK)				PA140N-426-410A
IC474	Res. Passive Network (7 x 47 Ω \pm 2% 14-P D.I.L.)				PA110B-366-347A
IC475	Res. Passive Network (7 x 4.7 K \pm 2% 14-P D.I.L.)				PA110B-366-547A
IC476	Not used				
IC477	Not used				

PCB 4

COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST AND
SLOW RAMP GENERATORS, PULSE GENERATOR (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>INTEGRATED CIRCUITS (Cont'd)</u>					
IC478	Not used				
IC479	Not used				
IC480	CA3054				HG310A-032-000A
IC481	CA3054				HG310A-032-000A
IC482	TLD61CP				HJ350L-133-510A
IC483	TLD61CP				HJ350L-133-510A
IC484	4051B				JR201A-181-010A
IC485	4051B				JR201A-181-010A
IC486	CD40109BE				JY210A-400-000A
<u>RESISTORS</u>					
R401 to R410	Not used				
R411	Metal Film	300K	±2	0.25W	BU3000/326/730A
R412	Metal Film	30K	±2	0.25W	BU3000/326/630A
R413	Metal Glaze	1M	±5	0.25W	BU7020/327/210A
R414	Metal Film	30K	±2	0.25W	BU3000/326/630A
R415	Metal Film	100K	±2	0.25W	BU3000/326/710A
R416	Not used				
R417	Metal Film	100	±2	0.25W	BU3000/326/410A
R418	Metal Glaze	1M	±5	0.25W	BU7020/327/210A
R419	Metal Film	4.7K	±2	0.25W	BU3000/326/547A
R420	Metal Film	30K	±2	0.25W	BU3000/326/630A
R421	Metal Film	200K	±2	0.25W	BU3000/326/720A
R422	Metal Film	43K	±2	0.25W	BU3000/326/643A
R423	Metal Film	100K	±2	0.25W	BU3000/326/710A
R424	Metal Film	100	±2	0.25W	BU3000/326/410A
R425	Metal Film	100	±2	0.25W	BU3000/326/410A
R426	Metal Film	22K	±2	0.25W	BU3000/326/622A
R427	Variable Cermet	2.2K	±20	0.75W	BW1011/000/522A
R428	Not used				
R429	Metal Film	30K	±2	0.25W	BU3000/326/630A
R430	Metal Film	300K	±2	0.25W	BU3000/326/730A
R431	Metal Film	4.3K	±2	0.25W	BU3000/326/543A
R432	Not used				
R433	Metal Film	30K	±2	0.25W	BU3000/326/630A
R434	Metal Film	100K	±2	0.25W	BU3000/326/710A

PCB 4
COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST AND
SLOW RAMP GENERATORS, PULSE GENERATOR (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>RESISTORS</u> (Cont'd)					
R435	Metal Film	100K	±2	0.25W	BU3000/326/710A
R436	Metal Film	30K	±2	0.25W	BU3000/326/630A
R437	Metal Film	100K	±2	0.25W	BU3000/326/710A
R438	Not used				
R439	Not used				
R440	Metal Film	51K	±2	0.25W	BU3000/326/651A
R441	Metal Film	24K	±2	0.25W	BU3000/326/624A
R442	Metal Film	100K	±2	0.25W	BU3000/326/710A
R443	Metal Film	11.5K	±1	0.25W	BV3100/555/115A
R444	Metal Film	1.3K	±1	0.25W	BV3100/554/130A
R445	Carbon Film	2.4K	±5	0.125W	BU1000/227/524A
R446	Carbon Film	5.6K	±5	0.125W	BU1000/227/556A
R447	Metal Film	7.5K	±2	0.25W	BU3000/326/575A
R448	Metal Film	100K	±2	0.25W	BU3000/326/710A
R449	Metal Film	30K	±2	0.25W	BU3000/326/630A
R450	Metal Film	100K	±2	0.25W	BU3000/326/710A
R451	Metal Film	2K	±2	0.25W	BU3000/326/520A
R452	Metal Film	100	±2	0.25W	BU3000/326/410A
R453	Metal Film	2K	±2	0.25W	BU3000/326/520A
R454	Metal Film	100	±2	0.25W	BU3000/326/410A
R455	Metal Film	9.1K	±2	0.25W	BU3000/326/591A
R456	Metal Film	300K	±2	0.25W	BU3000/326/730A
R457	Metal Film	150K	±2	0.25W	BU3000/326/715A
R458	Metal Film	10K	±2	0.25W	BU3000/326/610A
R459	Metal Film	3K	±2	0.25W	BU3000/326/530A
R460	Metal Film	100K	±2	0.25W	BU3000/326/710A
R461	Metal Film	3K	±2	0.25W	BU3000/326/530A
R462	Metal Film	20	±2	0.25W	BU3000/326/320A
R463	Not used				
R464	Metal Film	14K	±1	0.25W	BV3100/555/140A
R465	Metal Film	150K	±2	0.25W	BU3000/326/715A
R466	Variable Carbon Lin.	100K		0.15W	BY0225/214/710A
R467	Metal Film	5.1K	±2	0.25W	BU3000/326/551A
R468	Not used				
R469	Not used				
R470	Metal Film	100K	±2	0.25W	BU3000/326/410A
R471	Metal Film	3K	±2	0.25W	BU3000/326/530A
R472	Metal Film	100K	±2	0.25W	BU3000/326/710A
R473	Metal Film	3K	±2	0.25W	BU3000/326/530A
R474	Metal Film	3.3K	±2	0.25W	BU3000/326/533A

PCB 4

COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST AND
SLOW RAMP GENERATORS, PULSE GENERATOR (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>RESISTORS</u> (Cont'd)					
R475	Metal Film	9.1K	±2	0.25W	BU3000/326/591A
R476	Metal Film	300K	±2	0.25W	BU3000/326/730A
R477	Metal Film	2K	±2	0.25W	BU3000/326/520A
R478	Metal Film	150K	±2	0.25W	BU3000/326/715A
R479	Metal Film	10K	±2	0.25W	BU3000/326/610A
R480	Metal Film	100	±2	0.25W	BU3000/326/410A
R481	Metal Film	100	±2	0.25W	BU3000/326/410A
R482	Metal Film	100K	±2	0.25W	BU3000/326/710A
R483	Metal Film	51K	±2	0.25W	BU3000/326/651A
R484	Metal Film	1.5K	±2	0.25W	BU3000/326/515A
R485	Metal Film	510	±2	0.25W	BU3000/326/451A
R486	Metal Film	160	±2	0.25W	BU3000/326/716A
R487	Metal Film	39K	±2	0.25W	BU3000/326/639A
R488	Metal Film	10	±2	0.25W	BU3000/326/310A
R489	Metal Film	4.7K	±2	0.25W	BU3000/326/547A
R490	Metal Film	200	±2	0.25W	BU3000/326/420A
R491	Metal Film	300K	±2	0.25W	BU3000/326/730A
R492	Metal Film	150K	±2	0.25W	BU3000/326/715A
R493	Metal Film	150	±2	0.25W	BU3000/326/415A
R494	Metal Film	150	±2	0.25W	BU3000/326/415A
R495	Metal Film	75	±2	0.25W	BU3000/326/375A
R496	Metal Film	75	±2	0.25W	BU3000/326/375A
R497	Variable Cermet	22	±20	0.5W	BW1011/000/322A
R498	Not used				
R499	Not used				
R4100	Metal Film	110	±2	0.25W	BU3000/326/411A
R4101	Metal Glaze	10M	±5	0.25W	BU7020/327/310A
R4102	Metal Glaze	10M	±5	0.25W	BU7020/327/310A
R4103	Metal Film	51	±2	0.25W	BU3000/326/351A
R4104	Metal Film	75K	±2	0.25W	BU3000/326/675A
R4105	Metal Film	300K	±2	0.25W	BU3000/326/730A
R4106	Metal Film	300K	±2	0.25W	BU3000/326/730A
R4107	Metal Film	47K	±2	0.25W	BU3000/326/647A
R4108	Metal Film	150K	±2	0.25W	BU3000/326/715A
R4109	Metal Film	30K	±2	0.25W	BU3000/326/630A
R4110	Metal Glaze	3.3M	±5	0.25W	BU7020/327/233A
R4111	Metal Film	5.1K	±2	0.25W	BU3000/326/551A
R4112	Variable Carbon	10K		0.15W	BY0225/100/610A
R4113	Metal Film	200	±2	0.25W	BU3000/326/420A
R4114	Metal Film	200	±2	0.25W	BU3000/326/420A

PCB 4
COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST AND
SLOW RAMP GENERATORS, PULSE GENERATOR (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>RESISTORS (Cont'd)</u>					
R4115	Metal Film	220K	±2	0.25W	BU3000/326/722A
R4116	Variable Cermet	2.2M	±20	0.5W	BW1011/000/822A
R4117	Metal Film	75K	±2	0.25W	BU3000/326/675A
R4118	Not used				
R4119	Not used				
R4120	Metal Film	100	±2	0.25W	BU3000/326/410A
R4121	Carbon Film	1.5K	±5	0.125W	BU1000/227/515A
R4122	Carbon Film	510	±5	0.125W	BU1000/227/451A
R4123	Carbon Film	510	±5	0.125W	BU1000/227/451A
R4124	Carbon Film	10K	±5	0.125W	BU1000/227/610A
R4125	Carbon Film	20K	±5	0.125W	BU1000/227/620A
R4126	Carbon Film	5.6K	±5	0.125W	BU1000/227/556A
R4127	Metal Film	10K	±2	0.25W	BU3000/326/610A
R4128	Metal Film	10K	±2	0.25W	BU3000/326/610A
R4129	Metal Film	10K	±2	0.25W	BU3000/326/610A
R4130	Metal Film	3K	±2	0.25W	BU3000/326/530A
R4131	Carbon Film	82K	±5	0.125W	BU1000/227/682A
R4132	Carbon Film	20	±5	0.125W	BU3000/227/320A
R4133	Carbon Film	180	±5	0.125W	BU1000/227/418A
R4134	Variable Cermet	100	±10	0.5W	BW0507/000/410A
R4135	Carbon Film	10	±5	0.125W	BU1000/227/310A
R4136	Metal Film	100	±2	0.25W	BU3000/326/410A
R4137	Carbon Film	100	±5	0.125W	BU1000/227/410A
R4138	Carbon Film	47	±5	0.125W	BU1000/227/347A
R4139	Metal Film	100	±2	0.25W	BU3000/326/410A
R4140	Metal Film	47K	±2	0.25W	BU3000/326/647A
R4141	Metal Film	24K	±2	0.25W	BU3000/326/624A
R4142	Metal Glaze	10M	±5	0.25W	BU7020/327/310A
R4143	Metal Glaze	10M	±5	0.25W	BU7020/327/310A
R4144	Metal Glaze	10M	±5	0.25W	BU7020/327/310A
R4145	Metal Glaze	10M	±5	0.25W	BU7020/327/310A
R4146	Metal Glaze	10M	±5	0.25W	BU7020/327/310A
R4147	Metal Film	100K	±2	0.25W	BU3000/326/710A
R4148	Metal Glaze	10M	±5	0.25W	BU7020/327/310A
R4149	Metal Film	30K	±2	0.25W	BU3000/326/630A
R4150	Metal Film	100K	±2	0.25W	BU3000/326/710A
R4151	Metal Film	100K	±2	0.25W	BU3000/326/710A
R4152	Metal Film	1.5M	±5	0.25W	BU7020/327/215A
R4153	Variable Cermet	1M	±20	0.75W	BW1011/000/810A
R4154	Not used				

PCB 4
COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST AND
SLOW RAMP GENERATORS, PULSE GENERATOR (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>TRANSFORMER</u>					
T411	Ballin Assy				832944/000
<u>TRANSISTORS</u>					
TR401 to TR410	Not used				
TR411	ZTX 109K				TE305N/030/100A
TR412	ZTX 109K				TE305N/030/100A
TR413	ZTX 109K				TE305N/030/100A
TR414	ZTX 109K				TE305N/030/100A
TR415	ZTX 214K				TF301N/030/100A
TR416	Not used				
TR417	ZTX 214K				TF301N/030/100A
TR418	Not used				
TR419	Not used				
TR420	ZTX 313K				TJ300N/015/000A
TR421	ZTX 313K				TJ300N/015/000A
TR422	29N3906				TK100K/040/000A
TR423	ZTX 313K				TJ300N/015/000A
TR424	ZTX 109K				TE305N/030/100A
TR425	ZTX 109K				TE305N/030/100A
TR426	ZTX 109K				TE305N/030/100A
TR427	Not used				
TR428	Not used				
TR429	Not used				
TR430	Not used				
TR431	ZTX 510K				TK300N/012/000A
TR432	ZTX 313K				TJ300N/015/000A
TR433	ZTX 3904K				TJ200N/060/000A
TR434	ZTX 327K				TE304N/030/500A
TR435 to TR439	Not used				
TR440	ZTX 3904K				TJ200N/060/000A
TR441	2N5486				TN200J/025/010A
TR442	ZTX 3904K				TJ200N/060/000A
TR443	Not used				
TR444	Not used				
TR445	2N3906				TK100K/040/000A
TR446	ZTX 3904K				TJ200N/060/000A
TR447	ZTX 3904K				TJ200N/060/000A
TR448	ZTX 327K				TE304N/030/500A
TR449	2N3906				TK100K/040/000A

PCB 4

COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST AND
SLOW RAMP GENERATORS, PULSE GENERATOR (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>TRANSISTORS</u> (Cont'd)					
TR450	ZTX 327K				TE304N/030/500A
TR451	Not used				
TR452	Not used				
TR453	Not used				
TR454	Not used				
TR455	ZTX 109K				TE305N/030/100A
TR456	ZTX 109K				TE305N/030/100A
<u>MISCELLANEOUS</u>					
	Testpoint Type 20-2136J (11 off)				BE8505/100/000A

PROGRAMMING BOARD - FEET

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
	PCB complete with components				805274/120
	including:				
	PCB				505274/120
	Plug, Electrical Free mounting				CB9002/016/300A
	16p D.I.L				

PROGRAMMING BOARD - METRES

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
	PCB complete with components				805274/121
	including:				
	PCB				505274/121
	Plug, Electrical Free mounting				CB9002/016/300A
	16p D.I.L				

PCB 4
COUNTER LOGIC AND STORE LOGIC, SAMPLE AND HOLD, FAST AND
SLOW RAMP GENERATORS, PULSE GENERATOR (cont'd)

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
<u>RESISTORS (Cont'd)</u>					
R4155	Not used				
R4156	Carbon Film	180	±5	0.125W	BU1000/227/418A
R4157	Carbon Film	1K	±5	0.125W	BU1000/227/510A
R4158	Metal Film	10K	±2	0.25W	BU3000/326/610A
R4159	Metal Film	10K	±2	0.25W	BU3000/326/610A
R4160	Chip	100	±1		BV9211/353/100A
R4161	Chip	66.7	±1		BV9211/352/667A
R4162	Chip	100	±1		BV9211/353/100A
R4163	Variable Cermet	100K	±20	0.75W	BW1011/000/710A
R4164	Metal Film	10K	±2	0.25W	BU3000/326/610A
R4165	Metal Film	560	±2	0.25W	BU3000/326/456A
R4166	Metal Film	470	±2	0.25W	BU3000/326/447A
R4167	Metal Film	820	±2	0.25W	BU3000/326/482A
R4168 to R4177	Not used				
R4178	Metal Film	10K	±2	0.25W	BU3000/326/610A
R4179 to R4200	Not used				
R4201	Metal Film	10K	±2	0.25W	BU3000/326/610A
R4202	Metal Film	10K	±2	0.25W	BU3000/326/610A
R4203	Metal Glaze	10M	±5	0.25W	BU7020/327/310A
<u>SOCKETS</u>					
SK401 to SK410	Not used				
SK411	Terminal Leadthrough Pin. Type 75401-002				916430/000
SK412	Fixed, PCB Mtg. DIL 16-P				CB2001/016/300A
SK413	Fixed, PCB Mtg. Right Angle 4-P				AJ6507/004/000A
SK414	Terminal Leadthrough Pin. Type 75401-002				916430/000
SK415	Terminal Leadthrough Pin. Type 75401-002				916430/000
SK416	Fixed, PCB Mtg. Right Angle 25-P				AJ1023/030/250A
SK417	Terminal Leadthrough Pin. Type 75401-002				916430/000
SK418	Terminal Leadthrough Pin. Type 75401-002				916430/000
SK419	Terminal Leadthrough Pin. Type 75401-002				916430/000
SK420	Terminal Leadthrough Pin. Type 75401-002				916430/000
SK421	Not used				
SK422	Fixed, RF Type GE35026 BNC				AK0010/043/301A
<u>SWITCHES</u>					
S420	Push Button Series TJ				914012/011

PCB5
DISPLAY BOARD

CCT. REF.	DESCRIPTION	VALUE	TOL %	RTG	REF.
	PCB complete with components				805273/055
	<u>DIODES</u>				
D501	LED ESR3431 Red				BJ5091/140/240A
D502	LED ESR3431 Red				BJ5091/140/240A
D503	LED ESR3431 Red				BJ5091/140/240A
	<u>INTEGRATED CIRCUITS</u>				
IC501	LED DL704 DISPLAY NUMERIC				916216/000
IC502	LED DL704 DISPLAY NUMERIC				916216/000
IC503	LED DL704 DISPLAY NUMERIC				916216/000
IC504	LED DL704 DISPLAY NUMERIC				916216/000
IC505	LED DL704 DISPLAY NUMERIC				916216/000
	<u>SOCKET</u>				
SK501	Terminal Leadthro, Type 75401-006				916430/001

APPENDIX 1

SERVICE BULLETINS AND TECHNICAL

SERVICE ADVICE NOTES

"SERVICE BULLETIN"

PO 134

CABLE FAULT LOCATORS

SERIAL 430

These modifications have been introduced into current manufacture to
(a, improve reliability and (b, to present entire pulse on screen.

1. Planning Information

Equipment Affected

805274/011	Model 433	Mod '1' & Mod '2'
↓	↓	↓
012		
021		
022		
023		

Unit Affected

805273/052 Component Bd PCB 2 Mod 2
805274/054 Component Bd PCB 4

Issuing Authority

Alan Wiltshire

A. Wiltshire
Design Authority.

D.O. Reference

Change Notes 596/179 & 596/192

2. Accomplishment Instructions

- 2.1 Remove Component Bd PCB 2 805273/052 from unit for modification
- 2.2 Locate R229, remove and replace by new resistor R229 item 1.
- 2.3 As shown in fig 1, add resistor R2146 item 2 in parallel with C207 passing leads down same holes as Transformer T202.
Add circuit reference marking.
- 2.4 As shown in fig 2 add new capacitor C243, item 3 across TR201.
Add circuit reference marking.
- 2.5 Strike thro '2' from Mod Record label.
- 2.6 Locate R261 remove and replace by new resistor, item 4.
- 2.7 Locate R263 & R264 remove and replace by new resistors R263 & R264, item 5.
- 2.8 Locate R265 remove and replace by new resistor R265 item 6.
- 2.9 Replace board in unit
- 2.10 Remove PCB 4 805274/054 from unit for modification
- 2.11 Locate resistor network IC475 remove and replace by new item 7.

"SERVICE BULLETIN"

PD 334

- 2.12 Locate R4109 remove and replace by new resistor R4109 item 8.
- 2.13 Locate R453 remove and replace by new resistor R453 item 9.
- 2.14 Replace PCB 4 in equipment.
- 2.15 Strike through '1' & 2 on equipment mod record label
- 2.16 Test equipment for satisfactory operation as follows
 - (a) measure voltage on SK212-3 adjust R2114 until input voltage is $15V \pm 0.1$. C452 may have to be adjusted if shortest range 'SET ZERO' is out of calibration.
 - (b) Connect the Oscilloscope to SK203 Pin 4. Set to MEMORY. Using \downarrow , SENSITIVITY and STORE, store a trace which saturates the memory in both positive and negative directions. Using R260 & R262 adjust the trace so that the saturated levels are at the top and bottom of the screen (within 2mm). Rotate R262 clockwise to increase the signal on the CRT Y plates by 30-50%. Adjust R260 to ensure that the saturated portions of the trace lie above R below the tube face.

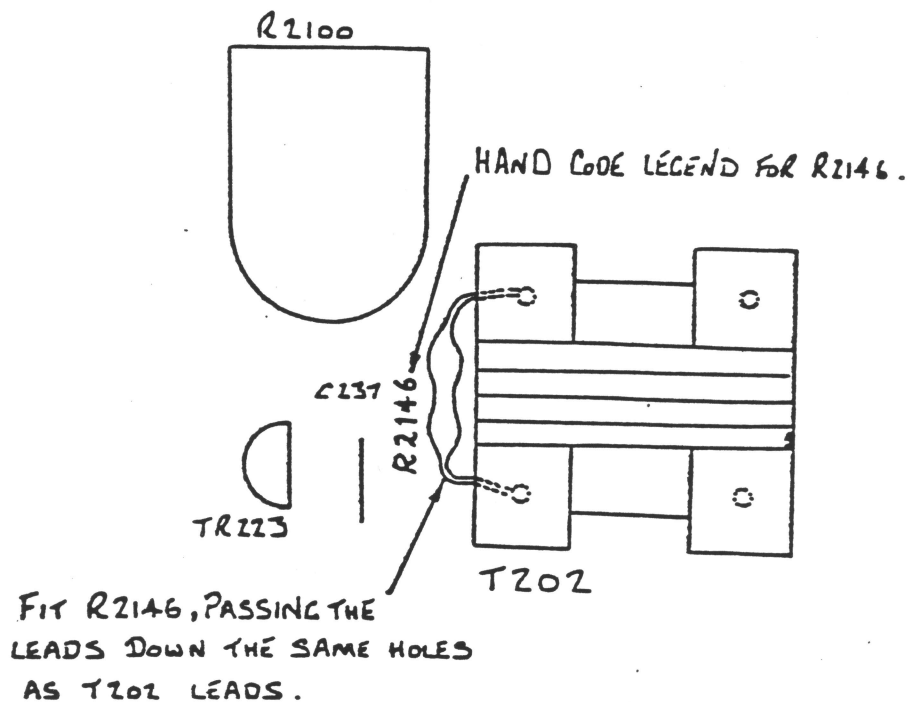
2. Material Information.

<u>Item</u>	<u>Part No.</u>	<u>Description</u>	<u>Qty</u>
1	BU3000/326 433A	Resistor, film metal 330 Ω $\pm 2\%$ 0.25 w R229	1
2	BU1000/227/ 756A	Resistor, film carbon 560K $\pm 5\%$ 0.25W R2146	1
3	AE7305/039/ 247A	Capacitor electrolytic 4.7UF $\pm 20\%$ 16v C243	1
4	BU3000/326/ 613A	Resistor film metal 13K $\pm 2\%$ 0.25W R261	1
5	BU3000/326/ 636A	Resistor film metal 36K $\pm 2\%$ 0.25W R263 & R264	2
6	BU3000/326/ 662A	Resistor film metal 62K $\pm 2\%$ 0.25W R265	1
7	PA110B/366/ 510A	Resistor, passive network 7X1K IC475	1
8	BU3000/326/ 615A	Resistor film metal 15K $\pm 2\%$ 0.25W R4109	1

"SERVICE BULLETIN"

PD 334

Item	Part No.	Description	Qty
9	BU3000/326/ 439 A	Resistor film metal 390 Ω \pm 2% 0.25W R453	1



HAND-CODE LEGEND "C243" ON BOARD AS SHOWN:-

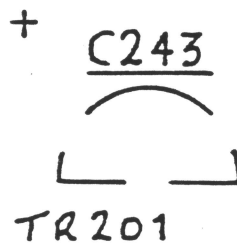


FIG 1

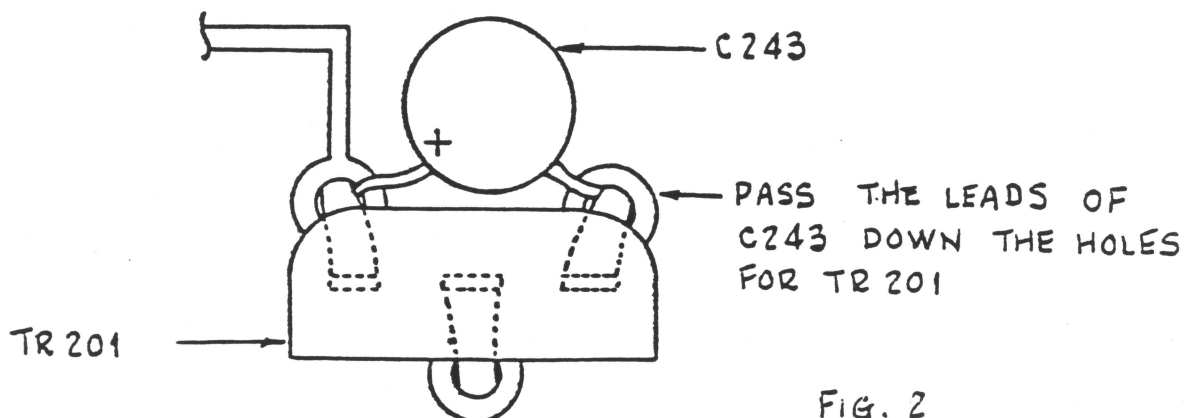


FIG. 2

"SERVICE BULLETIN"

PD 334

CABLE FAULT LOCATORS

SERIES 430

The following modifications have been incorporated into current manufacture to (a) improve reliability and (b) to present entire pulse on screen.

1. Planning Information

Equipment affected

805275/011	Model 435	Mod '1'	and	Mod '2'
↓	↓	↓	↓	↓
/012				
/021				
/022				
/023				
/024				
/033				
/035				

Units affected

805273/052 Component Bd Assy PCB 2, Mods 1 & 2

805275/054 Component Bd Assy PCB 4.

Issuing Authority



A. WILTSHIRE
Design Authority

DO Reference

Change Notes 596/155, 596/179, 596/192.

2. Accomplishment Instruction

- 2.1 Remove Component Board PCB2 (805273/052) from equipment for modification.
- 2.2 Drill 2 holes 1mm dia in approx position shown in Fig 1.
- 2.3 Using drilled holes to feed leads through, connect new resistor R4142 item 1 in parallel with C220. Add circuit reference marking.

"SERVICE BULLETIN"

PO 134

- 2.4 Add new capacitor C242, item 2, connecting +ve leg through to TR 220-Base and -ve leg to TR221-Emitter via transistor holes. Add circuit reference marking.
- 2.5 Strike through 1 on mod record label on PCB2 805273/052.
- 2.6 Locate resistor R229. Remove and replace by new resistor R229 item 3.
- 2.7 As shown in Fig 2 add resistor R2146, item 4 in parallel with C207 passing leads down same holes as transformer (T202) connections. Add circuit reference marking.
- 2.8 As shown in Fig 3 add new capacitor C243, item 2 across TR 201. Add circuit reference marking.
- 2.9 Strike through '2' on mod record label on PCB2 805273/052.
- 2.10 Locate resistor R261, remove and replace by new resistor R261 item 6.
- 2.11 Locate resistor R263 and R264, remove and replace by new resistor R263 and R264 item 7.
- 2.12 Locate resistor R265, remove and replace by new resistor R265 item 8.
- 2.13 Refit PCB2 into equipment.
- 2.14 Remove Component Board PCB 4, 805275/054 from equipment for modification.
- 2.15 Locate resistor network IC 475, remove and replace by new IC 475, item 5.
- 2.16 Refit PCB4 into equipment.
- 2.17 Strike through '1' and '2' on equipment mod record located on chassis.
- 2.18 Test equipment for satisfactory operation as follows:
 - (a) measure voltage on SK 212-3, adjust R2114 until input voltage is $15V \pm 0.1$.
 - (b) connect the Oscilloscope to SK 203 pin 4. Set to MEMORY. Using \uparrow , SENSITIVITY and STORE, store a trace which saturates the memory in both positive and negative directions. Using R260 and R262, adjust the trace so that the saturated levels are at the top and bottom of the screen (within 2mm). Rotate R262 clockwise to increase the signal on the CRT Y plates

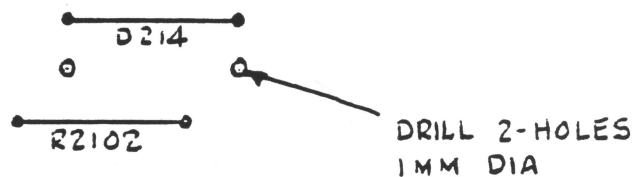
"SERVICE BULLETIN"

PD 334

by 30 - 50%. Adjust R260 to ensure that the saturated portions of the trace lie above and below the tube face.

3. Material Information

<u>Item</u>	<u>Part N°</u>	<u>Description</u>	<u>Qty</u>
1	BU7020/327/ 310A	Resistor, Metal Glaze 10M \pm 5% 0.25W R2142	1
2	AE7305/039/ 247A	Capacitor, electrolytic 4.7 μ F \pm 20% 16V C242, C243	2
3	BU3000/326/ 433A	Resistor, film metal 330 Ω \pm 2% 0.25W R229	1
4	BU1000/227/ 756A	Resistor film carbon 560K \pm 5% 0.125W R2146	1
5	PA 110B/366 510A	Resistor, passive network 7 x 1K IC475	1
6	BU3000/326/ 613A	Resistor film metal 13K \pm 2% 0.25W R261	1
7	BU3000/326/ 636A	Resistor film metal 36K \pm 2% 0.25W R263, R264	2
8	BU3000/326/ 662A	Resistor film metal 62K \pm 2% 0.25W R265	1

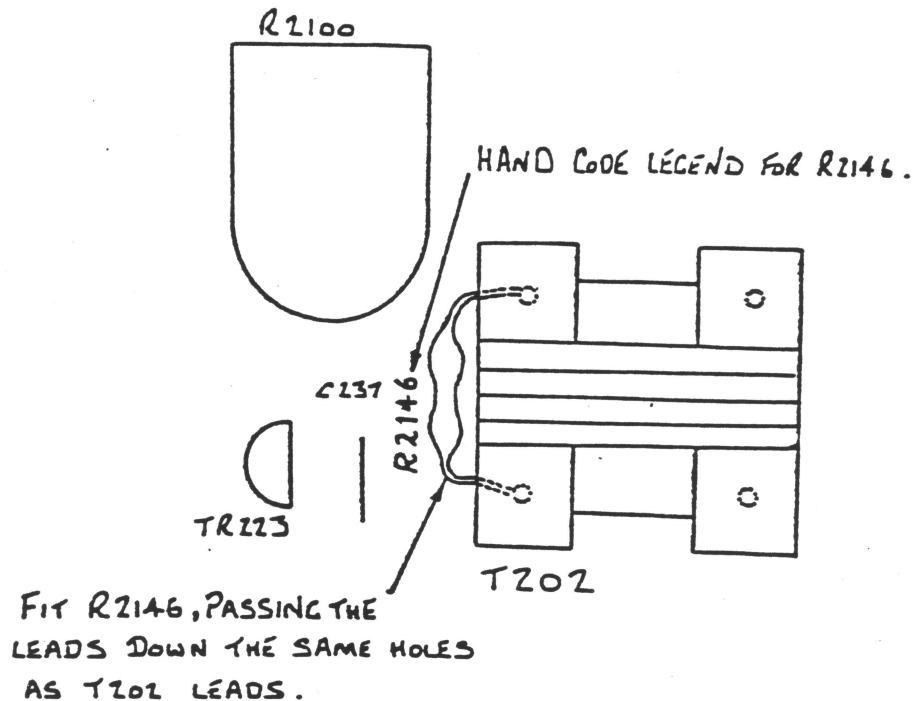


FEED LEGS OF R2142 THROUGH
HOLES & CONNECT ACROSS C220

FIG. 1.

"SERVICE BULLETIN"

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HAND-CODE LEGEND "C243" ON BOARD AS SHOWN:-

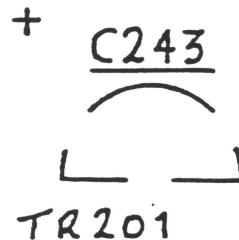


FIG 2

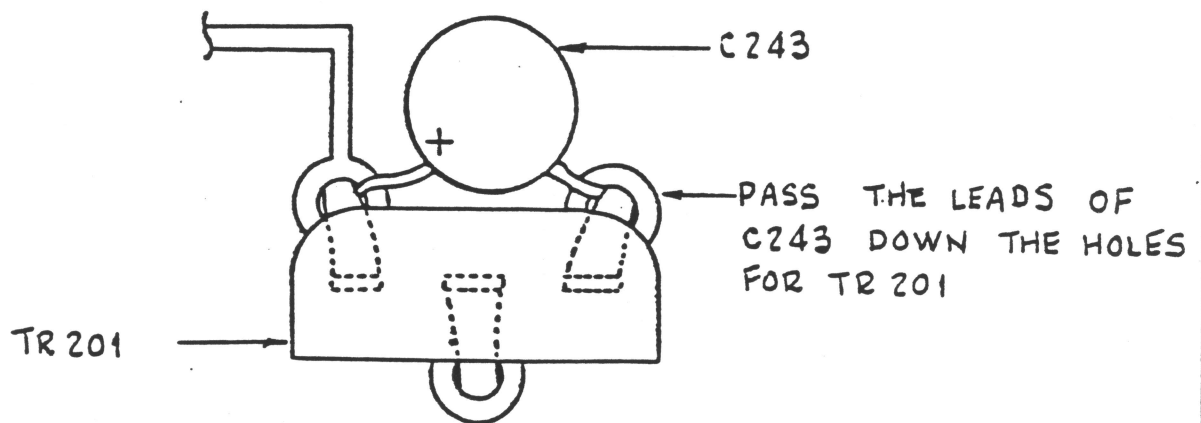


FIG. 3

"SERVICE BULLETIN"

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CABLE FAULT LOCATORSERIES 430

This modification has been introduced into current manufacture in order to improve uniformity of pulse height.

1. Planning information
Equipment Affected.

805273/011

Model 431

Mod '2'

012

021

022

023

411

412

421

423

Unit Affected

805273/054 Component Bd PCB 4A.

D.O Reference

Change Note 596/197

Issuing Authority

.....
A. Wiltshire
Design Authority.

2. Accomplishment Instructions

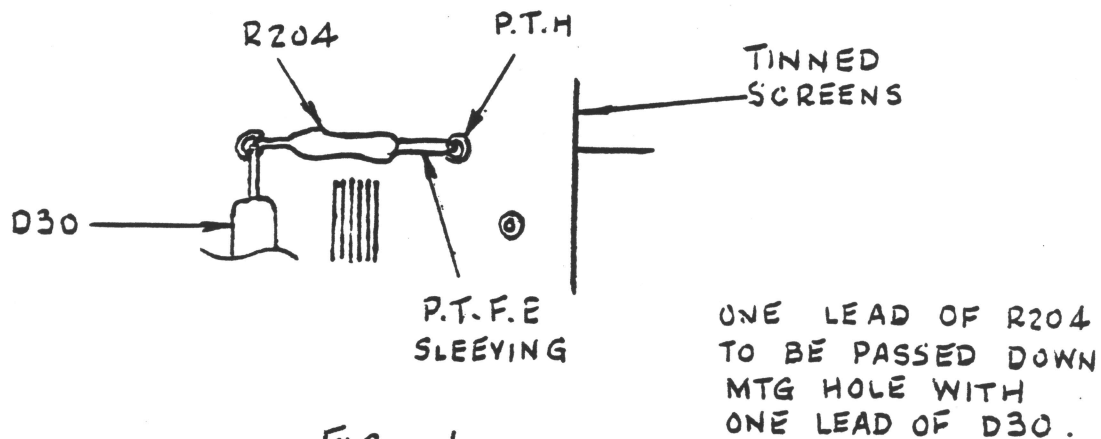
- 2.1 Remove PCB 4 (805273/054) from equipment for modification
- 2.2 Referring to fig. 1 add new resistor R4204, item 1, where shown
- 2.3 Replace PCB in equipment.
- 2.4 Switch to 12 metre range and wide pulse. Connect 75 ohm BNC feed-through termination on the output and connect it to oscilloscope. Turn pulse amplitude to maximum. Adjust R134 so that pulse displayed on oscilloscope is 3V peak, and then note the height of the pulse displayed on the CFL. Switch to the 3 metre range and adjust R153 so that the pulse displayed on the CFL is the same height as that previously noted.
- 2.5 Strike through '2' on final assembly mod record label.

"SERVICE BULLETIN"

PG 334

3. Material Information.

<u>Item</u>	<u>Part No.</u>	<u>Description</u>	<u>Qty</u>
1	BU1000/227 639A	Resistor film 39K± 5% 0.125W	1
2	936902/012	Sleeving PTFE 1 MM ID N	25mm



SERVICING ADVICE

PD 333

CABLE FAULT LOCATORS

SERIES 430

Reason for Issue

The series 430 range of Fault Locators is fitted with alternative versions of CRT Assembly. One version 805273/091 is fitted with a CRT supplied by 'Thorn', the other 805273/092 is fitted with CRT supplied by 'Mullard'. This advice is issued to inform that when the only available replacement is from the alternative source to the one fitted, additional modification is necessary.

Action Necessary

When replacing the 'Thorn' CRT assembly with the alternative from 'Mullard', the following wiring changes are necessary.

<u>Lead N°</u>	<u>Remove Lead End at</u>	<u>Connect Same Lead End to</u>
10	TB101-1	TB101-4
11	TB101-4	TB101-6
12	TB101-6	TB101-12
14	TB101-13	TB101-1
15	TB101-12	TB101-3
16	TB101-11	TB101-2
26	TB101-3	TB101-13
29	TB101-5	TB101-11

When replacing 'Mullard' CRT assembly with alternative from 'Thorn', the following wiring changes are necessary.

<u>Lead N°</u>	<u>Remove Lead End at</u>	<u>Connect Same Lead End to</u>
10	TB101-4	TB101-1
11	TB101-6	TB101-4
12	TB101-12	TB101-6
14	TB101-1	TB101-13
15	TB101-3	TB101-12
16	TB101-2	TB101-11
26	TB101-13	TB101-3
29	TB101-11	TB101-5

Test for satisfactory operation.

Referring only to Fault Locators with Serial N°s below 1800 and when there is a requirement to replace an existing 'Thorn' CRT Assembly by a 'Mullard' alternative, an additional modification is necessary. The modification affects Component Board PCB2 805273/052; on it locate R2130 and R2131 $10M \Omega \pm 5\%$, remove and replace by 2 - new resistors

AW/FJ.W. 15-10-82.

TSA N° 1 for CFL 430
Sheet 1 of 2

COSSOR

TECHNICAL SERVICING ADVICE

FD 333

1M \pm 5% 0.25W Resistor Metal Glaze, High Voltage BU7020/327/210A.

After implementation of this modification measure the voltage at SK209 pin 4 using 60 M meter (AVO), if the voltage is greater than 1.85KV a new Inverter Transformer 832906 is also required.

Connect the Oscilloscope to SK203 Pin 4.

Set to MEMORY. Using \downarrow , SENSITIVITY and STORE, store a trace which saturates the memory in both POSITIVE and NEGATIVE directions. Using R260 and R262 adjust the trace so that the saturated levels are at the top and bottom of the screen (within 2mm). Rotate R262 clockwise to increase the signal on the CRT Y plates by 30-50%. Adjust R260 to ensure that the saturated positions of the trace lie above and below the tube face.

Issuing Authority

A. Wiltshire

A. WILTSHIRE
DESIGN AUTHORITY

