User Manual

8500

50 MHz Programmable
Pulse Generator

Serial Prefix: 20

Tabor Electronics Ltd.

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REVISION: C

Warranty

Tabor Electronics' products are warranted against defects in material and workmanship, when used under normal operating conditions, for a period of one year after delivery. Tabor Electronics will repair or replace without charge any product which proves defective during this period. Repair necessitated by misuse of the product is not covered by this warranty. No other warranties are expressed or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Tabor Electronics is not liable for consequential damage.

REPAIR AND CALIBRATION

Prior authorization is required from Tabor Electronics before products are returned for service. All service must be performed by Tabor Electronics' factory or an authorized service center. Please contact the factory directly for repair and re-calibration:

Tabor Electronics, Ltd.
9 Hatasia Street
Tel Hanan, Israel 20302
Tel: 972-4-821-3393
Fax: 972-4-821-3388

Tabor Electronics Ltd.

REPAIR AND CALIBRATION REQUEST FORM

To allow us to better understand your repair requests, we suggest you use the following outline when calling and include a copy with your instrument to be sent to the Tabor Repair Facility.

Model_________________Serial No.____________________Date__________________

Company Name__________________________Purchase Order #___________________

Billing Address____

City

____

State/Province Zip/Postal Code Country

Shipping Address____

City

____

State/Province Zip/Postal Code Country

Technical Contact___________________Phone Number (   )_______________________

Purchasing Contact _________________Phone Number (   )_______________________

1. Describe, in detail, the problem and symptoms you are having. Please include all set up details, such as input/output levels, frequencies, waveform details, etc.

____

____

____

____

2. If problem is occurring when unit is in remote, please list the program strings used and the controller type.

____

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____

3. Please give any additional information you feel would be beneficial in facilitating a faster repair time (i.e., modifications, etc.)

____

____

____

4. Is calibration data required? Yes No (please circle one)

Call before shipping

Note: We do not accept "collect" shipments.

Ship instruments to nearest support office listed on back.

Safety Precautions

The following safety precautions should be observed before using this product and associated computer. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present. This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product. Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cables, connector jacks, or test fixtures.

The American National Standard Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60 VDC are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before touching or disconnecting the line cord. Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables and test leads for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the product, test cables, or any other of the instrument parts while power is applied to the circuit under test. ALWAYS remove power from the entire test system before connecting cables or jumpers, installing or removing cards from the computer, or making internal changes, such as changing card address. Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always keep dry hands while handling the instrument. If you are using test fixtures, keep the lid closed while power is applied to the device under test. Safe operation requires that the computer lid be closed at all times during operation.

Carefully read the Safety Precautions instructions that are supplied with your computer. Instruments, cables, leads or cords should not be connected to humans. Before performing any maintenance, disconnect the line cord and all test cables. Finally, maintenance should be performed by qualified service personnel only. If you have no past experience in instrument servicing, we strongly recommend that installation and initial tests on the instrument be done by your dealer or by the factory itself.

Declaration of Conformity

We:

Tabor Electronics, Ltd.

P.O. Box 404

Tel Hanan, Israel 20302

declare, that the Arbitrary Waveform/Function Generator

Model 8500

meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility and complies with the requirements of the Low Voltage Directive 73/23/EEC. Compliance was demonstrated to the following specifications as listed in the official Journal of the European Communities:

Safety:

EN 61010-1

IEC 1010-1 (1990) + Amendment 1 (1992)

EMC:

EN 50081-1 Emissions:

EN 55022 - Radiated, Class B

EN 55022 - Conducted, Class B

EN 50082-1 Immunity:

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SECTION 1

GENERAL INFORMATION

1-1. INTRODUCTION

This manual provides operating and maintenance information for the Model 8500 Pulse Generator. Section 1 is a general description of the instrument. Sections 2 and 3 contain installation and operation instructions. IEEE programming is explained in Section 4. Maintenance and performance checks are give in section 5. The theory of operation is described in section 6. Section 7 outlines troubleshooting and adjustment procedure. Section 8 lists all replaceable parts. Section 9 contain schematic and component location diagrams.

1-2. DESCRIPTION

Model 8500 is a modern, multipurpose fully GPIB programmable dual channel 50 MHz pulse generator. Its superior performance makes it equally at home in electronic laboratories as well as design centers and automatic test systems. The instrument is capable of generating high power pulses with rise times of less than 5 nS. It also provides a complete digital control over pulse parameters such as pulse width, pulse delay, duty cycle high level low level rise and fall times. Model 8500 is specified to operate within a period range of 20 nS to 2 S however, under some amplitude restrictions, this range is extended to 14 nS (above 70 MHz).

Parameters are displayable with 7 bright digits. The selected function is indicated by an LED. Modification of pulse parameters are digitally set over exceptionally wide ranges:

- Period - set from 14 nS to 1.999 S
- Amplitude - set from .1 V to 16 Vp-p within a window of ±16 V
- Pulse Width - set from 7 nS to 3.999 S
- Delay - set from 0 nS to 3.999 S
- Rise/Fall Times - set from 5 nS to 20 mS
- Fixed Duty Cycle - set from 1% to 95%

When used as a bench instrument, any of 30 pre-programmed complete set-up states, stored in a non-volatile memory, can be recalled by a simple key stroke, ensuring exact duplication of previous set-ups, no matter how complex thus, saving the time which is otherwise required to set up the instrument for different tests.

Output can be selected to be continuous, gated or triggered either by an external signal or by means of front panel manual switch. An internal timer is provided to repeatedly generate an internal trigger stimulus. A burst generator provides an integer number of bursts from a minimum of 2 pulses to 65,500.

As standard, the Model 8500 is furnished with one main output channel and one auxiliary channel. The auxiliary channel, in parallel to the main output, generates a fixed voltage level of either TTL or ECL with a rise time of better than 2 nS.

An optional second channel, with its supplementary auxiliary output, is available for the Model 8500. This channel only shares a common period with the main output channel. All other parameters are independently set.

Model 8500 features a unique built-in reciprocal counter/timer which, when selected, is capable of measuring three external parmeters:

Frequency - from 10 Hz to more than 100 MHz
Period - from 10 nS to .1 S
Pulse width - from 50 nS to 1 S

The built-in counter is also used in an internal self calibration routine which corrects the basic accuracy of the VCO to better than 1 %. The self calibration routine is front panel selectable and is usable at anytime. When the Model 8500 is set to operate at its continuous mode, the internal repetition rate is periodically monitored and automatically corrected to an enhanced accuracy of 0.025% of the full scale value.

1-3. INSTRUMENT AND MANUAL IDENTIFICATION

The serial number of the instrument is located on the rear panel of the instrument. The two most significant digits identify instrument modifications. If this prefix differs from that listed on the title page of this manual, there are differences between this manual and your instrument.

Technical corrections to this manual (if any) are listed in the back of this manual on an enclosed MANUAL CHANGES sheet.

1-4. OPTIONS

There are two options which are available for the Model 8500:

Option 1 - Channel B output amplifier option
Option 2 - Universal counter option

Options are field installable or may be ordered installed. Installation procedures are given in Section 6 of this manual. There are no software modifications necessary when installing an option. Model 8500 will automatically sense the presence of the installed option and will then permit an to access parameters which are associated with the newly installed option.

1-5. SPECIFICATIONS

Instrument specifications are listed in Tables 1-1. These specifications are the limits against which the instrument is tested.

NOTE

All specifications in the following table apply with the output terminated with 50Ω feedthrough termination and with an amplitude of 10 Vp-p. Warm-up period is 30 min at an ambient temperature of 25°C ±5°C.

Table 1-1. Model 8500 Specifications

WAVEFORMS	: Pulse, Pulse complement, Linear transitions
OUTPUT MODES	: Single, Delayed, Double, Fixed duty cycle, Disabled

PULSE PARAMETERS

PERIOD

Range	: 20.0 nS to 1.999 S
Extended Range	: 14.0 nS to 20 nS (with 10 V amplitude max)
Resolution	: 3« digits with exponent
Accuracy	: ±2 % of programmed value ± 1 nS
Extended Range Accuracy	: ±5 % of programmed value ± 1 nS
Accuracy Following Self Calibration	: ±2 % of programmed value - whole range (with option 2 installed and within 1 hour following a self calibration sequence)
Accuracy with Period Control	: ± 0.5% worst case; typically ± 0.05% of full scale value (with option 2 installed and in continuous mode only)
Duty Cycle	: 1 % to 99 % (limited by 10 nS off time)
Jitter (Peak-Peak)	: .1 % ±50 pS

WIDTH, DOUBLE PULSE (Measured at 50 % of amplitude and with minimum transition time)

Range	: 7 nS to 79999 nS (with 1 nS increments) 80.0 TS to 4.000 S
Resolution	: 5 digits maximum to 79999 nS 4 digits maximum from 80.0 µS to 3.999 S
Accuracy	: ±1% of programmed value ±2 nS
Maximum Jitter (peak-Peak)	
Below 1 TS	: .1 % +50 pS
1 TS to 10 TS	: .05 %
Above 10 TS	: .005%

Table 1-1. Model 8500 Specifications (continued)

DELAY (Measured from SYNC OUT to main and auxiliary outputs at 50 % of amplitude and with minimum transition time)

Delay Range	: 0 nS to 79999 nS (with 1 nS increments) 80.0 μS to 3.999 S
Resolution	: 5 digits maximum to 79999 nS 4 digits maximum from 80.0 μS to 3.999 S
Accuracy	: ±1% of programmed value ±2 nS
Maximum Jitter (Peak-Peak)	
Below 1 TS	: .1 % +50 pS
1 TS to 10 TS	: .05 %
Above 10 TS	: .005%

OUTPUT LEVELS

CHANNEL A

High Level Range	: -11.90 V to +12.0 V into 50Ω; -23.8 V to +24.0 V into open circuit
Low Level Range	: -12.0 V to +11.9 V into 50Ω; -24.0 V to +23.8 V into open circuit
Amplitude	: .1 V to 16 V into 50Ω; .2 V to 32 V into open circuit
Resolution	: 3 digits
Accuracy (1KHz)	: ±2% of programmed value ±3% of amplitude ±40 mV
Output Protection	: protected against continuous short to case ground
Transition Times	: Fast or Linear, selectable

CHANNEL B (option 1)

Independent Parameter Settings	: High/Low Levels, Pulse Width, Pulse Delay, Single/Double Pulse, Normal/Complement
High Level Range	: -7.90 V to +8.00 V into 50Ω; -15.8 V to +16.0 V into open circuit
Low Level Range	: -8.00 V to +7.90 V into 50Ω; -16.0 V to +15.8 V into open circuit
Amplitude	: 100 mV to 16 V into 50Ω; 200 mV to 32 V into open circuit
Resolution	: 3 digits
Accuracy (1KHz)	: ±2% of programmed value ±3% of amplitude ±40mV
Output Protection	: protected against continuous short to case ground
Transition Times	: Fast only. 6 nS
Amplifier Input	
Input	: Via rear panel BNC connector
Impedance	: 50Ω
Gain	: -1 ±2% inverting
Max Amplitude	: ±5 Vp-p maximum

Table 1-1. Model 8500 Specifications (continued)

LINEAR TRANSITION TIMES (10% to 90% of amplitude)
(channel A only)

Fixed Transition	: 6 nS
Linear Transition	: 8.0 nS to 20.0 mS in 6 overlapping ranges
In-range Span	: 20:1
Resolution	: 3 1/2 digits maximum
Linearity	: ± 3 % for transitions >50 nS
Accuracy	: ± 5 % ± 2 nS

PULSE PERFORMANCE

Aberration	: <5 %
Reflections	: <10 %
Source Impedance	: 50 Ω ± 2 %

AUXILIARY OUTPUTS

SYNC OUTPUT

Output Impedance	: 50 Ω
Output Level	: 1 V minimum into 50 Ω; 2 V minimum into open circuit
Transition Time	: 2 nS
Duty Cycle	
14 nS to 1999 nS	: 50 %
Above 2000 nS	: Pulse width varies from 100 nS to 1 μS

ECL/TTL OUTPUTS (Channels A & B)

Period	: 14 nS to 1.999 S
Operating Mode	: ECL or TTL output, front panel selectable
Output Impedance	: 50 Ω ± 3 %
Pulse Parameters	: Shares parameters with the main output. Amplitude and transition times are fixed
Output Modes	: Shares mode with the main output
Output Level	
TTL	: 0/2.5 V into 50 Ω; 0/5 V into open circuit
ECL	: -.9 V to -1.7 V into 50 Ω
Transition Times	
TTL	: 4 nS
ECL	: 3 nS

Table 1-1. Model 8500 Specifications (continued)

TRIGGERING CHARACTERISTICS

Modes	
External Trigger	: Each input cycle generates a single output pulse.
External Burst	: As in external trigger for a programmable number of pulses.
Internal Trigger	: An internal timer repeatedly generates a single output pulse. Trigger period is adjustable
Internal Burst	: As in internal trigger for a programmable number of pulses
Gated	: External signal enables generator. First output pulse synchronous with the active slope of the gating signal. Last pulse always complete.
Manual	: Simulates an external triggering or gating signal
Manual Burst	: Simulates an external triggering signal
Burst Count Range	: Programmable from 2 to 65,500
Ext. Repetition Rate	
Triggered	: 50 MHz maximum
Gated	: 25 MHz maximum
Burst	: 25 MHz maximum
Int. Trigger Period	
Triggered	: Continuously adjustable from 0.05 mS to 1000 S
Burst	: Continuously adjustable from 0.05 mS to 1000 S
Input	: Via EXT FREQ / TRIG IN BNC
Input Impedance	: 10 KΩ ±5 %
Trigger Point	: Adjustable from -10.0 V to +10.0 V
Trigger Sensitivity	: ±500 mVp-p
Slope	: Selectable positive or negative going edge

TRIGGER MODES DELAYES (measured from trigger input to SYNC out)

Modes	
Triggered	: 60 nS ±10 nS
Gated	: 75 nS ±10 nS
Burst	: 75 nS ±10 nS

FIXED DUTY CYCLE MODE

Mode	: Output pulse is automatically adjusted to the programmed duty cycle parameter. The programmed pulse width parameter is ignored
Range	: 1 % to 95 %
Accuracy	: ±3 % of the programmed value ±2 nS

Table 1-1. Model 8500 Specifications (continued)

COUNTER CHARACTERISTICS (option 2)

FREQUENCY

Range	: 10 Hz to more than 100 MHz
Resolution	: 7 digits independent of frequency
Accuracy	: ±0.002 % ±1 LSD
Min detectable Pulse Width	: 5 nS

PERIOD AVERAGED

Range	: 10 nS to .1 S
Resolution	: 7 digits independent of period
Accuracy	: ±0.002 % ±1 LSD

PULSE WIDTH

Range	: 50 nS to 1 S
Max Repetition Rate	: 10 MHz
Resolution	: $\frac{100\ nS}{\sqrt{F}}$ where F = frequency in Hz
Accuracy	: ±0.002 % ±3 nS ±1 LSD (for square shaped signals)
Dead time between measured pulses	: 50 nS

GENERAL

Input	: Via EXT FREQ / TRIG IN BNC
Measurement Technique	: Reciprocal counting
Gate Time	: 1 S nominal
Sensitivity	: 500 mV p-p
Dimension	: one digit exponent

IEEE - 488 INTERFACE

Programmable controls	: All front panel controls except POWER switch. Output may be disabled through a bus command
Subsets Implemented	: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP2, DC1, DT1, C0
Data Output Format	: Fixed output format consisting of 10 or 14 ASCII characters plus terminators
Data Input Format	: ASCII characters lower or upper case. ASCII characters smaller than 20 HEX (32) are ignored except CR (0D HEX)
Service Request	: Selectable for illegal commands, errors, pulse error
String Termination	: Selectable CR, LF, EOI or combination of all.

Table 1-1. Model 8500 Specifications (continued)

Typical Programming Time (measured with Kontron GP 488 controller)

Display/Program	: 2.2 mS
Display Parameter	: 2.7 mS
Trigger Mode	: 1.7 mS
Output Mode	: 1.7 mS
Edge Mode	: 1.7 mS
Auxiliary Level	: 1.9 mS
Recall/Store Set-ups	: 3.1 mS
Parameter Programming	: 5.4 mS
Interrogate Parameter	: 4.7 mS
Interrogate Counter	: 6.4 mS
Interrogate Status	: 9.1 mS
Reading Format	: 1.7 mS
Terminator	: 1.7 mS
SRQ Mask	: 2.8 mS

GENERAL

Display	: 7 digits 7 segment LED 14.2mm high with automatic decimal point, exponent and polarity indication
Power	: 115/230 VAC $\pm$10 %, 48-62 Hz, 150 VA max
Stored Settings	: A non-volatile memory stores up to 30 front panel complete set-ups
Operating temperature	: 0 °C to 40 °C ambient
Specified accuracy	: 20 °C to 30 °C ambient
Storage temperature	: -40 °C to +70 °C
Humidity range	: 80% R.H
Dimensions	: 140 x 300 x 345 mm (H X W X L)
Weight	: approx 6 Kg

1-6. SAFETY CONSIDERATIONS

Model 8500 is a Safety Class 1 instrument with an exposed metal chassis that is directly connected to earth via the power supply cable and has been manufactured according to international safety standards. Before the instrument is switched on, make sure that protective earth terminal is connected to a protective earth via the power cord. Do not remove instrument covers when operating or when power cord is connected to mains.

Any adjustment, maintenance and repair of the opened instrument under voltage should be avoided as much as possible, but when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.

1-7. ACCESSORIES SUPPLIED

The 8500 is supplied with ac power cord and with an instruction manual.

SECTION 2

INSTALLATION

2-1. INTRODUCTION

This section contains information and instructions necessary for the installation and shipping of the pulse generator - Model 8500. Details are provided for initial inspection, power connection, grounding safety requirements, installation information, and repacking instructions for storage or shipment.

2-2. UNPACKING AND INITIAL INSPECTION

Unpacking and handling of the counter requires only the normal precautions and procedures applicable to the handling of sensitive electronic equipment. The contents of all shipping containers should be checked for included accessories and certified against the packing slip to ascertain that the shipment is complete.

2-3. PERFORMANCE CHECKS

The instrument was carefully inspected for mechanical and electrical performance before shipment from the factory. It should be free of physical defects and in perfect electrical order upon receipt. Check the instrument for damage in transit and perform the electrical procedures outlined in Section 5. If there is indication of damage or deficiency, see the warranty in this manual and notify your local Tabor field engineering representative or the factory.

CAUTION

> It is recommended that the operator be fully familiar with the specifications and all sections of this manual. Failure to do so may compromise the warranty and the accuracy which Tabor has engineered into your instrument.

2-4. POWER REQUIREMENTS

The pulse generator may be operated from any one of the following sources: a. 103.5 to 126.5 Volts (115 Volts nominal) b. 207 to 253 Volts (230 Volts nominal).

The instrument operates over the power mains frequency range of 48 to 63 Hz. Always verify that the operating power mains voltage is the same as that specified on the rear panel voltage selector switch.

CAUTION

> Failure to switch the instrument to match the operating line voltage will damage the instrument and may void the warranty.

The Model 8500 should be operated from a power source with its neutral at or near ground (earth potential). The instrument is not intended for operation from two phases of a multiphase ac system or across the legs of a single-phase, three-wire ac power system. Crest factor (ratio of peak voltage to rms) should be typically within the range of 1.3 to 1.6 at 10% of the nominal rms mains voltage.

2-5. GROUNDING REQUIREMENTS

To insure the safety of operating personnel, the U.S. O.S.H.A. (Occupational Safety and Health) requirement and good engineering practice mandate that the instrument panel and enclosure be "earth" grounded. All Tabor instruments are provided with an Underwriters Laboratories (U.L. and V.D.E) listed three-conductor power cable, which when plugged into an appropriate power receptacle, grounds the instrument. The long offset pin on the male end of the power cable carries the ground wire to the long pin of the Euro connector (DIN standard) receptacle on the rear panel of the instrument.

To preserve the safety protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green lead on the adapter to an "earth" ground.

CAUTION

> To avoid operator shock hazard do not exceed the power mains voltage frequency rating which limits the leakage current between case and power mains. Never expose the instrument to rain, excessive moisture, or condensation.

2-6. INSTALLATION AND MOUNTING

The instrument is fully solid state and dissipates only a small amount of power. No special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 50 °C, when the relative humidity exceeds 80% or condensation appears anywhere on the instrument. Avoid operating the instrument close to strong magnetic fields which may be found near high power equipment such as motors, pumps, solenoids, or high power cables. Use care when rack mounting to locate the instrument away from sources of excessive heat or magnetic fields. Always leave 4 cm (1.5zinches) of ventilation space on all sides of the instrument.

2-7. BENCH MOUNTING

The Model 8500 is shipped with plastic feet, tilt stand in place and ready for use as a bench or portable instrument. See outline drawing Figure 2-1 for dimensions.

2-8. RACK MOUNTING

The instrument may be rack mounted in a standard 19 inch EIA rack. The instrument may be rack mounted in Rack Mount Kit option 8500-rack.

2-9. PORTABLE USE

The instrument may be used in applications requiring portability. A tilt stand consisting of two retractible legs is provided with each unit.

2-10. SHORT TERM STORAGE

If the instrument is to be stored for a short period of time (less than three months), place cardboard over the panel and cover the instrument with suitable protective covering such as a plastic bag or strong kraft paper. Place power cable and other accessories with the instruemnt. Store the covered voltmeter in a clean dry area that is not subject to extreme temperature variations or conditions which may cause moisture to condense on the instrument.

2-11. LONG TERM STORAGE OR REPACKAGING FOR SHIPMENT

If the instrument is to be stored for a long period or shipped, proceed as directed below. If you have any questions contact your local Tabor field engineering representative or the Tabor Service Department at the factory.

If the original Tabor supplied packaging is to be used proceed as follows:

1.If the original wrappings, packing material, and container have been saved, repack the instrument and accessories originally shipped to you. If the original container is not available, one may be purchased through the Tabor Service Department at the factory.

2.Be sure the carton is well sealed with strong tape or metal straps.

3.Mark the carton with the model number and serial number with indelible marking. If it is to be shipped, show sending address and return address on two sides of the box; cover all previous shipping labels.

If the original container is not available, proceed as follows:

1.Before packing the unit, place all accessories into a plastic bag and seal the bag.

2.For extended storage or long distance shipping only, use U.S. government packing method II C and tape a two-unit bag of dessicant (per MIL-D-3464) on the rear cover.

3.Place a 13 cm (5 inch) by 30 cm (12 inch) piece of sturdy cardboard over the front panel for protection.

4.Place the counter into a plastic bag and seal the bag.

5.Wrap the bagged instrument and accessories in one inch thick flexible cellular plastic film cushioning material (per PPP-C-795) and place in a barrier bag (per MIL-B-131). Extract the air from bag and heat seal.

6.Place bagged instrument and accessories into a 250 mm (10 inch) x 360 mm (14 inch) x 508 mm (20 inch) fiber board box (per PPP-B-636 type CF, class WR, variety SW, grade V3C). Fill additional spaces with rubberized hair or cellular plastic cushioning material. Close box in accordance with container specifications. Seal with sturdy water resistant tape or metal straps.

7.Mark container "DELICATE INSTRUMENT", "FRAGILE", etc. Mark instrument model and serial number and date of packaging. Affix shipping labels as required or mark according to MIL-STD-129.

NOTE

> If the instrument is to be shipped to Tabor for calibration or repair, attach a tag to the instrument identifying the owner. Note the problem, the symptoms, and service or repair desired. Record the model and serial number of the instrument. Show the work authorization order as well as the date and method of shipment. ALWAYS OBTAIN A RETURN AUTHORIZATION NUMBER FROM THE FACTORY BEFORE SHIPPING THE INSTRUMENT TO TABOR.

2-12. SAFETY

Be fully acquainted and knowledgeable with all aspects of this instruction manual before using the instrument to assure operator safety and protection against personnel shock hazard.

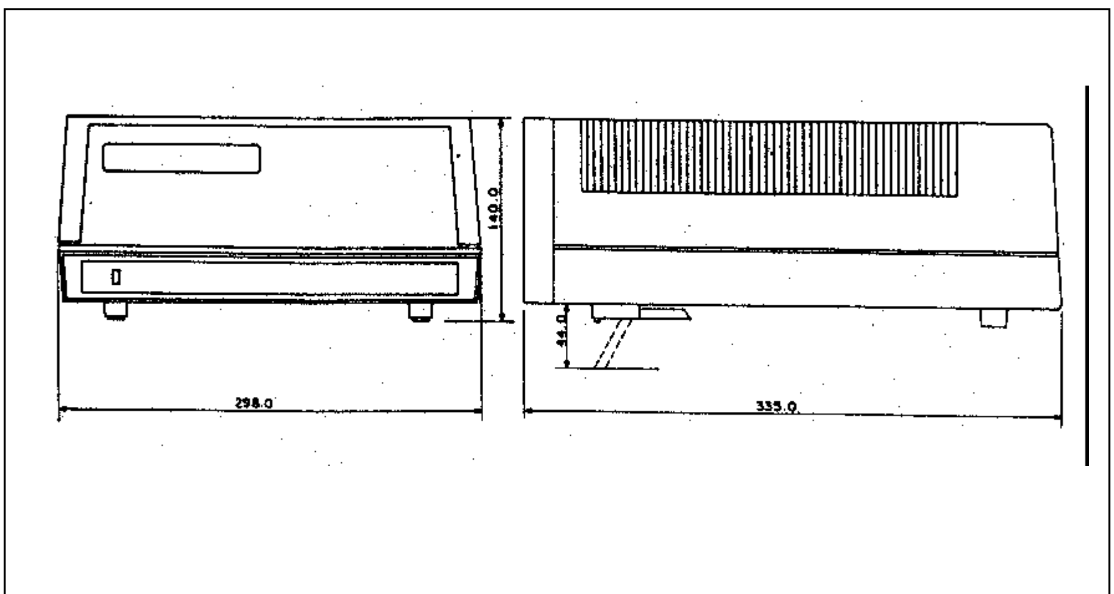

Figure 2-1. Model 8500 outline dimensions.

SECTION 3

BASIC PULSE GENERATOR OPERATION

3-1. INTRODUCTION

Model 8500 operation is divided into two general categories: basic bench operation, and IEEE-488 operation. Basic bench operation, which is covered in this section, consists of using the Model 8500 to perform basic frequency and time measurements. IEEE programming can also be used to greatly enhance the capability of the instrument in applications such as automatic test equipment. These aspects are covered in details in Sections 3 and 4.

3-2. FRONT PANEL FAMILIARIZATION

The front panel layout of the Model 8500 is shown in Figure 3-1. The front panel is generally divided into three sections: controls, connectors, display and indicators. The following paragraphs describe the purpose of each of these items in details.

3-2-1. CONTROLS

All the front panel controls except POWER are momentary contact switches. Many controls include an annunciator light to indicate the selected mode. Controls which do not have an annunciator light, when pressed, will cause an immediate reaction on the display.

Front panel controls may be divided into functional groups: Power, Display/Modify, Trigger Mode, Ouptut and Data Entry.

1.POWER - The POWER switch controls the AC power to the instrument. Pressing and releasing the switch once turns the power on. Pressing and releasing the switch a second time turns the power off.

2.DISPLAY/MODIFY - There are four DISPLAY/MODIFY push-buttons which modify the display reading. Each time a button is depressed a different parameter will be displayed. The selected parameter is indicated by an LED. The dimensions which are associated with each parameter are located below the main display.

The following parameters may be displayed and modified:

PERIOD - Time interval between the leading edges of continuous output pulses which will be available at all of the output connectors. The period is common to channel A and B.

HIGH LEVEL - The top peak voltage of the pulse at the main output connectors. High level may independently be adjusted for channel A and B.

LOW LEVEL - The bottom peak voltage of the pulse at the main output connectors. High level may independently be selected for channel A and B.

DUTY CYCLE - Percentage ratio of positive pulse width to period. When output is in complement mode, ratio is between negative pulse width to period. Duty cycle value may only be modified when the fixed duty cycle mode was selected otherwise Model 8500 will not permit an access to this parameter. Duty cycle may independently be selected for channel A and B.

PULSE WIDTH - In normal output mode the pulse width specifies the positive pulse width. In complement output mode this value relates to the negative pulse width. The specified and displayed value is that obtained with fastest edges. In linear transition mode when transition times are varied, the displayed and specified pulse width is that obtained by the turn point of the edges. This is more convenient for programming and the pulse width display is easy to interpret. Pulse width may independently be selected for channel A and B.

DELAY - In single output mode, the delay specifies the time interval between the SYNC output and the main output. In double pulse output mode, delay specifies the time interval between the two consecutive pulses. First pulse is synchronous with the SYNC OUT pulse. The specified and displayed value is that obtained with the fastest leading edge. For a slower egde, this value relates to the start point of the output pulse. Delay may independently be selected for channel A and B.

LEADING EDGE - Time interval between the 10 % and 90 % amplitude points on the leading edge. Transition time may independently be selected for channel A and B.

TRAILING EDGE - Time interval between the 90 % and 10 % amplitude points on the trailing edge. Transition time may independently be selected for channel A and B.

BURST - Integer number of output pulses which will follow a triggering stimulus. The displayed burst value is common to both channels.

TRIGGER PERIOD - A built-in generator provides an internal triggering stimulus when an external signal is not available. The displayed value specifies the interval between consecutive triggering stimuli.

TRIGGER LEVEL - Specifies a dc level thresh-hold at the trigger input connector. Crossing this level with an external signal, and with the Model 8500 set to one of the triggering modes, will stimulate the generator to output pulses. This value also specifies the thresh-hold for the counter input. The displayed burst value is common to both channels.

Table 3-2 lists the limits for each of the above parameters.

Depressing the push-button which is marked COUNTER will turn the Model 8500 into a universal counter. <u>FREQUENCY, PERIOD and PULSE WIDTH</u> could then be measured by selecting the appropriate function.

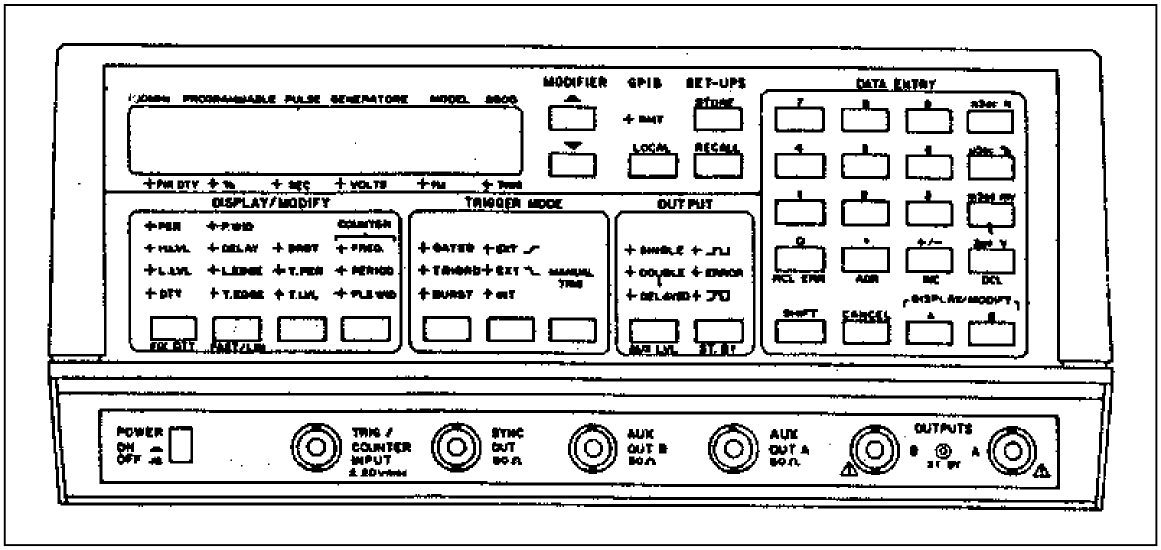

Figure 3-1. Front Panel Controls, Indicators and Connectors

3.TRIGGER MODE - There are three push-buttons in the TRIGGER MODE section. Selection of one of the trigger modes is done by depressing one of the three buttons. The selected mode is indicated by an LED. The Model 8500 may be triggered from either one of the following:

1. External signal which may be applied to the TRIG IN connector
2. An internal - independent period generator
3. GPIB commands (like GET) or
4. Manual trigger

The MANUAL trigger may be operated when the instrument is in one of the external trigger modes. This push-button when depressed will serve as a replacement to an external trigger source.

4.OUTPUT - There are two push-buttons in the OUTPUT group. One button selects between NORMAL and COMPLEMENT outputs and the other button selects between one of three operating modes: SINGLE, DOUBLE or DELAYED. The selected function is indicated by an LED.

5.DATA ENTRY - The DATA ENTRY group contains 16 entry push-buttons and 4 separate special function buttons. The process of entering data will be described later in this chapter.

SHIFT - The SHIFT button is associated with front panel 2nd functions. The 2nd functions are marked in yellow.

CANCEL - The CANCEL push-button, when depressed, terminates an incomplete data entry procedure. This button is inactive following a successful data entry procedure.

DISPLAY/MODIFY - The DISPLAY/MODIFY buttons in the DATA ENTRY group are designated as [A] and [B]. These push-buttons are inactive if Channel B (option 1) is not installed. Parameters may independently be programmed for channel A or B. Depress [A] before programming parameters for channel A. Depress [B] before programming parameters for channel B.

6.MODIFIER - The two push-buttons in the MODIFIER section are used as a digital potentiometer. The MODIFIER operates in conjunction with the DISPLAY/MODIFY group.

7.SET-UPS - There are two push-buttons in the SET-UPS section. One is use to store a complete front panel set-up. The other button is used to recall a stored set-up.

8.LOCAL - The LOCAL push-button when pressed, and the instrument was in remote operation (but not in remote lockout condition LLO), restores local operation. When the instrument is in local operation, pressing this push-button has no effect on the instrument.

3-2-2 CONNECTORS

The connectors are used to connect the Model 8500 to the unit under test.

1.<u>TRIG/COUNTER INPUT</u> - The TRIG/COUNTER INPUT connector is used for applying an external signal to the Model 8500. When the instrument is used as a counter, the signal to be measured is applied to this input.

2.<u>SYNC OUT</u> - The SYNC OUT connector outputs pulses from a 50Ω source. This output is synchronous with the main output. When the pulse generator is placed in delayed mode, the delay is measured from this output to the main output.

3.<u>OUTPUTS A AND B</u> - The two connectors are used as the main outputs for the pulse generator (Note that output B is optional). Outputs are driven from a 50Ω source. Special care should be taken when these outputs are connected to the device under test because these outputs are capable of driving up to 30 Vp-p.

4.<u>AUX OUT A AND B</u> - The two connectors designated are used to output an auxiliary signal. The auxiliary outputs may be set to generate TTL or ECL levels. (Note that output B is optional). Outputs are from a 50Ω source. Repetition rate, pulse width, delay and duty cycle are digitally programmed as for the main output channels. AUX A and AUX B are synchronous with Output A and Output B respectively.

3-2-3. DISPLAY AND INDICATORS

1.DISPLAY - The function of the display is to show the parameters and when the instrument is in counter mode - result of the processed measurement. The display consists of a 7 digit mantissa and a single digit exponent. The exponent uses a leading minus to indicate negative values. The sign on the exponent changes to + for zero or positive values. The display is also used to indicate information other than the measurement such as messages.

2.DIMENSIONS - The front panel dimensions are located below the display. there are 4 indicators which, together with the exponent, are used to determine the correct value of the displayed parameter.

3.INDICATORS - There are 28 indicators located on the front panel. The indicators are used to point at a selected function or signal to the user that the instrument is set to a special function like gated, triggered, burst, fixed duty cycle etc. There is also a trigger indicator which lights whenever the pulse generator receives a proper external trigger.

3-3. REAR PANEL FAMILIARIZATION

3-3-1. CONNECTORS AND TERMINALS

1.AC RECEPTACLE - Power is applied through the supplied power cord to the 3-terminal AC receptacle. Note that the selected power supply voltage is marked on the rear panel above the line voltage selector switch.

2.LINE SWITCH - The LINE VOLTAGE SELECTOR switch selects one of the primary voltage which are marked on both sides of the switch.

3.LINE FUSE - The line fuse provides protection for the AC power line input. For information on replacing this fuse, refer to Section 5.

4.IEEE-488 CONNECTOR - This connector is used to connect the instrument to the IEEE-488 bus.

5.CHAN B IN - This connector is a summing amplifier input. It is used to connect the output from Channel A to the input of Channel B.

3-4. POWER-UP PROCEDURE

The basic procedure of powering up the Model 8500 is described below.

1.Connect the female end of the power cord to the AC mains receptacle on the rear panel. Connect the other end of the power cord to a grounded AC outlet.

CAUTION

Be sure the power line voltage agrees with the indicated value on the rear panel of the instrument. Failure to heed this warning may result in instrument damage.

****
** WARNING **
****

The instrument is equipped with a 3-wire power cord designed to be used with grounded outlets. When the proper connections are made, the instrument chassis is connected to the power line ground. Failure to use a properly grounded outlet may result in personal shock hazard.

2.Turn on the power by pressing and releasing the POWER switch on the front panel.
3.The instrument will then begin operation by performing a display and indicator test which takes approximately one second. All mode and IEEE indicators will turn on and the display will appear as follows:

8.8.8.8.8.8.8. ±8.

4.To verify that all display segments are operating, compare the instrument's display with the above during the test.
5.Following the display test, the instrument proceeds by displaying the options installed. When no option is installed, the instrument will skip this message. If option 1 (Channel B) is installed, the instrument will display the following message:

OPT-1

If option 2 (Universal Counter) is installed, the instrument will display the following message:

OPT-2

If more than 1 option is installed, the instrument will add on the right the number of the installed option. For example, if options 1 and 2 are installed, the instrument will display the following message:

OPT-1.2

6.Once the installed options are displayed, the instrument will perform ROM and RAM tests. If all these tests are passed, the display will show the software revision level for about 1 second similar to the example below:

SoFt 1.1

7.following the software revision level, the instrument will display the previously selected IEEE primary address which is set through front panel programming and stored in the non-volatile memory. For example, with the generator programmed to address 26, the display will show:

IE Adr 26

8. Following these display messages, the instrument will go into the normal operating mode and begin generating pulses. Note that the instrument is equipped with a non-volatile memory. This RAM memory automatically monitors front panel traffic and retains the last programmed set-up for events such as accidental power loss. The instrument will then be set to the previously programmed front panel set-up.

3-5. SOFTWARE RESET

One, who is not yet fully familiar with the front panel operation of the Model 8500, may find himself locked in a "dead-end" situation where nothing operates the way it should. The fastest way to restore the pulse generator to a known condition is by resetting the instrument's software. This can be done by pressing the [SHIFT] push-button and then pressing the DCL push-button (second function to the Sec/V push-button). The instrument will be then be set to it's factory selected default. Table 3-1 summarizes these defaults.

Table 3-1. Default States After Software Reset

FUNCTION	DESCRIPTION	DEFAULT STATE
PER	Period	1.000 mS
H.LVL A,B	High Level	1.00 V
L.LVL A,B	Low Level	-1.00 V
DTY A,B	Duty Cycle	50 %
P.WID A,B	Pulse Width	200 µS
DELAY A,B	Delay	300 µS
L.EDGE	Leading Edge	Fast (5 nS)
T.EDGE	Trailing Edge	Fast (5 nS)
BRST	Burst	2
T.PER	Trigger Period	1 S
T.LVL	Trigger Level	1.6 V
FIX DTY	Fixed Duty Cycle	Off
FAST/LIN	Fast/Linear Edge	Fast
TRIGGER MODE		Continuous
OUTPUT		Single Non-inverting
ST.BY	Stand By	On
AUX LVL	Auxiliary Level	TTL
DISPLAY/MODIFY A/B	Channel selection	A
IEEE Status		Local

NOTE

> Software reset has no effect on any of the front panel set-ups which were previously stored in the memory locations 00 through 30. The software reset also has no effect on the programmed GPIB address.

3-6. DISPLAY MESSAGES

The Model 8500 has several display messages associated with basic front panel operation. The instrument has also a few front panel indications that an operating error associated with front panel programming was detected. These messages are discussed in the following. Note that the instrument has a number of additional display messages associated with IEEE-488 programming.

3-7. ERROR INDICATION

There are several error indications that may occur due to an incorrect front panel programming procedure. These indications are either visible (error message) or audible (beeper) and are described in the following. Keyboard programming errors are indicated on the front panel by an error message and by an audible alarm. For errors made via the GPIB, a service request is made, providing the appropriate service request mask was selected. Under these circumstances, the controller will address the 8500 using the serial poll command.

3-7-1. AUDIBLE ALARM

The audible alarm will sound when attempting an incorrect sequence of front panel programming. Error situation may occur under different conditions. For example, an attempt to simultaneously depress two front panel push-buttons is an illegal operation. This action will cause an audible alarm which will continue as long as the error condition exists. There are other error conditions which may cause an audible alarm. These are mentioned in different parts of the following operating instructions.

3-7-2. ERROR MESSAGES

In general, whenever a front panel or GPIB programming attempts to put the 8500 into an error condition, the 8500 responds both by front panel message and by making a Service request.

Errors are categorized in four main groups:

1. General errors
2. IEEE errors
3. Limit errors
4. Pulse setup errors

3-7-2-1. General Errors

Errors in this group are caused by improper usage of the instrument. Such errors may occur when attempting to place the instrument in an illegal mode. For example, the Model 8500 may not be placed channel B display/modify mode if option 1 is not installed. In this case when the operator attempts to put the generator in [B] position, the instrument will sound an audible alarm.

<u>Fixed Duty Cycle Error Message</u> The Fixed Duty Cycle Mode is a special case of the relation between the period and the pulse width. When the generator is placed in the fixed duty cycle mode it is automatically restricted to a certain set of conditions that can not be modified by the operator. For example, the Model 8500 when placed in the fixed duty cycle mode will not accept a change in the OUTPUT

section from SINGLE to DOUBLE pulse mode. The errors which are associated with this mode are discussed in more details in paragraph 3-17

No Battery Error Message The non-volatile memory stores complete 30 front panel set-ups. The same non-volatile memory, in case of power failure or upon regular power-up procedure, is responsible for reconstructing the last front panel set-up. The non-volatile memory is backed-up by a built-in battery which should last approximately 3 years. Losing the back-up power will cause a loss of the preselected set-ups. When back-up power is lost the instrument will display the following message:

no bAtt.

This message will be displayed for about 2 seconds in conjunction with an alarm signal, indicating that the back-up power test on the non-volatile memory has failed and that the previously selected set-ups are lost.

3-7-2-2. Limit Errors

Errors in this group are caused by programming values outside the legal limits of the parameter being programmed. For example, The instrument is capable of receiving a period value of up to 1999 counts. An attempt to program a period value of 19999 counts will cause a parameter error. At this time the instrument will sound an audible alarm and the extra digit will be disregarded. Table 3-2 summarizes all front panel parameter entry limits. It is also possible to exceed the instrument's limit when parameters are being modified using the modifier push-buttons. In this case the instrument will cease modification of the display and will sound an audible alarm.

Tabel 3-2. Front Panel Parameter Entry Limits

PARAMETER	LOW LIMIT	HIGH LIMIT
PER	14.0 nS	1.999 S
H.LVL	-11.9 V	+12.0 V
L.LVL	-12.0 V	+11.9 V
DTY	1 %	95 %
P.WID	7 nS	3.999 S
DELAY	0 nS	3.999 S
L.EDGE	8.0 nS	20.00 mS
T.EDGE	8.0 nS	20.00 mS
BRST	2 #	65,500 #
T.PER	0.05 mS	1000 S
T.LVL	-10.0 V	+10.0 V
INC	1 #	100 #
STORE	00 #	30 #
RECALL	00 #	30 #
IEEE ADR	0 #	30 #

3-7-2-3. IEEE-488 Error Messages

The generator incorporates a number of display messages which are associated with errors through the GPIB interface programming. These messages are discussed in detail in Section 4 of this manual. However, there is one message which should be explained at this point because it may interfere with front panel operation. A remote enable or a device dependent command sent to the instrument through the bus will turn on the REMOTE light and enable remote operation. In this case, all front panel push-buttons except LOCAL are disabled. An attempt to press one of these push-buttons will cause the following message to be displayed:

PrESS LcL

This message indicates that the instrument will ignore any front panel programming sequence unless the LOCAL push-button is pressed and the REMOTE light turns off.

3-7-2-4 Pulse Setup Errors

The pulse setup errors are inter-parameter inconsistencies errors, such as leading edge rise time greater than the pulse width. The pulse generator tests the programmed parameter every time a delimiter or modifier buttons are depressed. The instrument, if programmed so, will also respond with a service request. Programming the Model 8500 with a pulse error is possible and executable however, when pulse error is detected, the <u>ERROR</u> light in the <u>OUTPUT</u> block illuminates and an audible alarm sounds. This indicates that the signal at the output connector may appear with other parameters then those programmed. For evaluation purpose, it is then possible to recall the error status to the front panel display. The procedure of recalling the status of the pulse set-up error is given in paragraph 3-17.

3-8. USING THE DATA ENTRY

There are various parameters which can be modified, through front panel programming, using the data entry keys. The DATA ENTRY section comprises numeric push-buttons, delimiters buttons and special function keys.

3-8-1. Special Function Keys

There are four special function keys: DISPLAY/MODIFY A or B, CANCEL and SHIFT. The function of these keys is described below.

<u>DISPLAY/MODIFY</u>: Most of the parameters in the DISPLAY/MODIFY group may independently be programmed for channel A and channel B. The channel selection is done with the DISPLAY/MODIFY buttons [A] or [B]. If channel B is installed, the instrument will permit the selection of channel B. If channel B is not installed and [B] was depressed, the instrument will sound the alarm.

CANCEL: The [CANCEL] push-button is use for termination of a data entry process before a delimiter was depressed. Depressing this button during normal operation of the Model 8500 will have no effect on the instrument.

SHIFT: The [SHIFT] push-button is used for selecting a secondary function. All functions which are associated to the secondary functions are printed on the front panel in yellow. There are 8 functions which are accessible through the SHIFT button:

DCL	FIX DTY
INC	FAST/LIN
ADR	AUX LVL
RCL ERR	ST. BY

The operation of the secondary functions is described later in this chapter. Pressing the [SHIFT] push-button will cause the instrument to display the following reading:

SHIFT ?

The question mark (?) appears blinking; indicating that the instrument is ready for a consequent press of another push-button which was assigned a second function. Depressing [SHIFT] once more cancels this function. Depressing [CANCEL] has the same effect.

3-8-2. Numerals And Delimiters

There are 12 push-buttons in the DATA ENTRY group which are marked with numerals from 0 to 9, decimal point and a change sign key. There are also 4 buttons which are marked with various dimensions. Operator may select one of the following delimiters:

nSec	N
µSec	%
mSec	mV
Sec	V

These dimensions are the delimiters which terminate a successful data entry sequence. To start a data entry sequence proceed as follows:

1. Select the channel to be modified by pressing [A] or [B].
If parameters in channel B are to be modified observe that the letter b appears on the left side of the display.

2. Select the required parameter to be modified in the DISPLAY/MODIFY group.

3. Start the data entry procedure by depressing the numeric buttons. Observe that the exponent is replaced by a blinking question mark; indicating the a data entry sequence is in process.

4. In case of an error in the data entry sequence, depress the [CANCEL] button to cancel the entry sequence and to resume operation with the last set-up.

5. Terminate the data entry sequence by depressing one of the delimiters. Observe the parameter entry limits which are given in Table 3-2. The instrument will not accept a programmed parameter outside these limits. An attempt to program more than the allowed number of digits will cause an audible alarm.

If the operator tries to program a parameter below or above the specified limits the Model 8500, the generator will automatically force to the display the lowest or the highest limits respectively. For example, an attempt to program a pulse width value of 1 nSec will force the instrument to the low limit of 7 nSec.

3-9. USING FRONT PANEL SET-UPS

Setting up all parameters in a versatile instrument such as the Model 8500 takes some time. The set-up time is longer when a couple of tests are involve and more than one set-up is required. The Model 8500 incorporates a battery backed-up non-volatile memory that preserves stored information indefinitely. It is possible to store complete front panel set-ups in 30 different memory locations which are built into the instrument especially for this purpose. The Model 8500 also employs a special recall mode which permits to scroll through the stored set-ups.

3-9-1. STORE SET-UPS

First modify the front panel parameters as necessary to perform your tasks. When all parameters are set and checked, proceed to store this set-up as follows:

1.Depress the [STORE] pushbutton and observe that the display is modified to indicate the following:

STO ?   (? appears flashing)

This reading indicates that the instrument is ready to receive a consequent information from the DATA ENTRY buttons which will identify the memory location where front panel set-up is to be stored. Set-ups may be stored in locations 00 through 30. Depressing CANCEL cancels this function and the instrument resumes normal operation.
2.Decide upon which of the memory locations are going to be used and and depress the buttons in the DATA ENTRY section which are marked with the selected number. The instrument will display the following for one second:

STO DD   (Where DD is the selected memory location)

This display indicates that the function generator acknowledged the entered memory location. The instrument will then resume normal operation.

3-9-2. RECALL SET-UPS

The model 8500 employs a non-volatile memory (RAM). The computer circuit continuously monitors front panel traffic and saves it in a special location within the RAM. This location is separate to the front panel set-ups. After turning AC MAINS off or in case of an accidental power failure, the generator will update front panel indicators with the last set-up before the power down.

To recall a front panel set-up proceed as follows:

1.Depress the [RECALL] push-button and observe that the display is modified to indicate the following:

RCL ? (? appears flashing)

This reading indicates that the instrument is ready to recall the memory location where front panel set-up was stored. Depressing the RECALL button cancels this function and the instrument resumes normal operation.

2.Select the memory location from which to recall the desired set-up. You may recall set-ups from memory locations 00 through 30 by pressing the appropriate push-buttons in the DATA ENTRY section.

The instrument will display the following for one second:

RCL DD (Where DD is the selected memory location)

The instrument will then recall the parameters that were previously stored in the selected memory location and will update front panel indicators with the recalled parameters.

3-9-2-1. USING THE RECALL MODE

The Model 8500 employs a special recall mode which permits to scroll through a number of set-ups by pressing either the VERNIER UP or VERNIER DOWN push-buttons. This mode is especially useful for repetitive procedures as calibration and performance tests. It is also used extensively throughout the calibration and performance verification of the Model 8500.

To set the Model 8500 to operate in the recall mode proceed as follows:

1.Depress the [SHIFT] push-button and observe that the display is modified to indicate the following:

SHIFT ? (? appears flashing)

2.Depress the [RECALL] push-button and observe that the display is modified to indicate the following:

RCL 00

The instrument is now set to its recall and the display is updated with the parameters which were stored in memory 00.
3.Use the VERNIER UP or DOWN or the Data Entry buttons to scroll through the memory bank.
4.Depress [CANCEL] to exit this function and to return to normal display operation.

3-10. USING THE MODIFIER CONTROL

The modifier control consists of two push-buttons; one of which is marked with an arrow pointing up and the other is marked with an arrow pointing down. The arrow pointing up indicates that when this button is depressed, the display reading will increment one step. The arrow pointing down indicates that when this push-button is depressed, the display reading will decrement one step.

The modifier control, when modifying a parameter, is used similarly to a conventional potentiometer. For example; consider a period reading of 100.0 mS. Depressing the up push-button will increment the reading to 100.1 mS. This example is given for an incremental step setting of 1. The incremental step may be selected for sizes other than 1. Information on how to select an incremental step is given in paragraph 3-10-1. The output will then follow the new setting and the output waveform will have a period of 100.1 mS. Similarly, decrement one step using the down push-button. Depressing the modifier push-buttons for more then 1 second will cause the instrument to increment or decrement continuously.

NOTE

> To prevent operator's error, the instrument has an internal audible alarm which beeps whenever a limit is reached. Table 3-2 lists these limits.

3-10-1. Changing the Magnitude of the Incremental Step

The incremental step defines the magnitude of the step which the instrument will increment or decrement when the modifier control is depressed. The incremental step size is adjustable from 1 to 100 and is individually selectable for each parameter. For example; it is possible to select an incremental step size of 100 for period setting and an incremental step of 5 for high level setting. To modify an incremental step size depress in a sequence the [SHIFT] and the [INC] (second function to +/-) push-buttons. Observe that the following reading is displayed:

Inc NNX

Where NNX may be any number from 1 to 100.

Use the DATA ENTRY push-buttons to select a new incremental step. Depressing the [CANCEL] button will terminate this process without storing the new value. Depressing the push-button marked [N] will store the newly selected step size. Selecting a step size of more than 100 will not be accepted. Depress [CANCEL] and restart the above procedure.

3-11. SELECTING THE AUXILIARY AMPLITUDE LEVEL

The Model 8500 may be set to output, in parallel to the main output channel, an auxiliary output. The auxiliary output shares most of the parameters which are set for the main output except amplitude and rise/fall times. There are two fixed levels which were assigned to the auxiliary output connector; TTL level and ECL level. Selecting one or the other is done through front panel programming.
To select a level for the auxiliary output depress in sequence the [SHIFT] and the [AUX LVL] push-buttons. The display will be modified to one of the following reading:

TTL or
ECL

Use the MODIFIER push-buttons to select the desired auxiliary level. The level at the AUX OUT connector will follow the displayed level. To terminate the selection process, depress any button on the front panel and observe that the display resumes normal readings.

3-12. PROGRAMMING LINEAR TRANSITION TIMES

Model 8500 can generate output pulses with either fixed transition times, when set to the FAST mode or with variable transition times, when set to the linear mode. Fixed transition times are internally set to better than 5 nS. The instrument is capable of delivering linear transition times within the range of 10 nS to 20 mS in 6 overlapping ranges. In-range span is 20:1. Leading and Trailing edges may independently be selected within a common range only. Table 3-3 lists these ranges.

Table 3-3. Transition Time Ranges

RANGE	LEAD/TRAIL EDGE SPAN
1	8.0 nS - 200.0 nS
2	100 nS - 2000 nS
3	1.00 µS - 20.00 µS
4	10.0 µS - 200.0 µS
5	100 µS - 2000 µS
6	1.00 mS - 20.00 mS

While programming transition times, pulse interparameter inconsistencies may generate. For example, programming a leading edge of 10 mS with a period of 5 mS. When such an error occurs an ERROR light in the OUTPUT block will illuminate and an audible alarm will sound. This indicates that the output signal at the output connector may appear distorted. Use Table 3-4 to aid in correcting such errors.

Before programming transition times, the Model 8500 must be set to linear mode. To modify the instrument to linear mode depress in sequence [SHIFT] and then [FAST/LIN] pushbuttons. The display will be modified to the following reading:

LINEAR

This reading will be displayed for about two seconds; indicating that the Model 8500 is now set to accept variable transition times. The instrument will now allow to access and to modify the parameters which are associated with the leading edge (L.EDGE) and the trailing edge (T.EDGE). To set the generator to fixed transition times, depress in sequence the [SHIFT] and the [FAST/LIN] push-button. The instrument will display the following reading for about two seconds:

FAST

This reading indicates that the Model 8500 is now set to have an output pulses with fixed transition times of better than 5 nS. The pulse generator will not allow an access to parameters which are associated with the leading or trailing edges.

To program the transition times set the instrument to linear mode and proceed as follows:

1. Change DISPLAY/MODIFY setting to L.EDGE. Use the DATA ENTRY push-buttons, as described in paragraph 3-8, to program the required rise time. Use Table 3-3 to select the appropriate range. Note that ranges are overlapping. This means that a value within the overlapping range may end up being entered in the undesired range. To avoid such a mistake, program the required value exactly with the same decimal point and exponents as it appears in Table 3-3. For example, if the required leading edge value is 15 μS and the required transition range is the 4th range (10.0 μS - 200.0 μS), enter the value 15.0 μS. The same value if entered 15 μS, will force the undesired 5th range.

NOTE

> Changing transition ranges is only possible using the DATA ENTRY method as described in paragraph 3-8. The modifier push-buttons may be used to modify the lead/trail times within the selected range only. When using the modifier buttons and the range limit is reached, the instrument will sound an audible alarm.

2. Change the DISPLAY/MODIFY setting to T.EDGE. Program the required trailing edge using the MODIFIER push-buttons. Note that when exceeding the maximum inter-range limit setting, the instrument will sound an audible alarm. It is also possible to program the fall leading edge value using the DATA ENTRY push-buttons. While using the latest method observe the location of the decimal point so that the range, which was previously selected for the leading edge, will not change accidentally.

3-13. SELECTING THE FIXED DUTY CYCLE MODE

The model 8500 may be programmed to different pulse width values - independent to the period setting. For example, a pulse width of 20 nS may be selected with a period of 1 S. However, some applications require that the duty cycle will be set to a fixed duty cycle at all times. The Model 8500 may be programmed to a such a mode of operation. In this case, the operator has only to program the required duty cycle and forget the pulse width. The duty cycle may be selected from a range of 1 % to 95 %. Range may almost reach 99 % if the output pulse is inverted.

To select the fixed duty cycle mode, depress in a sequence the [SHIFT] and the [FIX DTY] push-buttons. The FIX DTY light will illuminate; indicating that the instrument is set to operate with a fixed duty cycle. At this time, the instrument will permit to access the DTY parameter which is associated with this mode. The Model 8500 when set to this mode will not allow to access the pulse width parameter. To remove the instrument from the fixed duty cycle mode, depress in sequence the [SHIFT] and the [FIX DTY] push-buttons. The FIX DTY light will turn off and the instrument will now permit modification of the pulse width parameter.

3-14. SELECTING AN OUTPUT MODE

The Model 8500 has three output modes. Selecting one of these modes is simply a matter of depressing the push-buttons in the OUTPUT section until the light next to the desired mode has been lit. Each channel may be programmed for a different output mode. The available output modes are described in the following:

SINGLE - Normal pulse output. The leading edge is synchronous with the SYNC output signal. The delay value has no effect on this mode.

DOUBLE - A train of double pulses output. The leading edge of the first pulse is synchronous with the SYNC output signal. The delay value specifies the time interval between the consecutive leading edges of the first two pulses.

DELAYED - Same as the SINGLE pulse mode except the leading edge is delayed from the SYNC output signal by an interval which is specified by the programmed delay value.

Each of these modes can be operated in complement operating mode.

3-14-1. DISABLING THE OUTPUT

The Model 8500 features a stand-by mode which disconnects the main output channels from the output connectors. The disable function is especially useful in times when the output is constantly connected to the device under test and when modifying pulse parameters may endanger this device.

To place the instrument in a stand-by mode depress in sequence the [SHIFT] and the [ST BY] push-buttons. The ST BY light next to the output connectors will light; indicating that the output signal is disconnected from the connectors. Note that if channel B is installed, the light indicates that this channel is disabled as well.

To resume normal operation repeat the same procedure as above. The ST BY light will turn off; indicating that the output signal in now connected to the output connectors.

3-15. TRIGGERING THE PULSE GENERATOR

Selecting one of triggering modes is simply a matter of depressing the push-buttons in the TRIGGER MODE section until the light next to the desired mode has been lit. Channels A and B share the same trigger mode. When no light in the TRIGGER MODE section is lit, the pulse generator operates in normal continuous mode. The TRIG light will illuminate every time that the generator receives a legal triggering signal an external source.

Model 8500 may operate in one of the following triggered modes:

GATED - An external signal enables the generator. First output pulse is synchronous with the active slope. Last pulse is always completed.

TRIGGERED - Each input cycle, at the TRIG INPUT connector, generates a single output pulse. Output pulse is synchronous with the active slope.

BURST - Each input cycle, at the TRIG INPUT connector, generates a train of pulses. The number of pulses are pre-programmed. First output pulse is synchronous with the active slope.

The Model 8500, when set to a trigger mode, accepts various stimulants. When operating from an external source, the generator may be programmed to be triggered on a leading edge or on a trailing edge. Selection of one or the other is done by pressing the push-button in the TRIGGER MODE section until the light next to EXT / or EXT \ is lit.

NOTE

> The TRIG INPUT connector is sensitive to dc levels. If this input is left open and the trigger level was set to a negative voltage, the pulse generator may self gate.

When external source is not available, the operator has a choice of using the MANUAL push-button or using the internal trigger generator. The MANUAL button simulates an external signal. If the Model 8500 is set to GATED mode, an output signal will be available as long as the MANUAL push-button is depressed. When the generator is set to TRIGGERED or BURST mode, each time the MANUAL button is depressed an output pulse or a burst will generate. The MANUAL push-button has no effect in normal mode of operation or when the instrument is set to internal trigger mode.

To use the internal trigger generator first set the required trigger period. Place the generator in TRIGRD OR BURST mode and depress the push-button in the TRIGGER MODE group until the light next to INT turns on.

3-16. USING THE COUNTER/TIMER

The Model 8500 may be set to operate as a stand alone universal counter/timer. When the instrument is set to the counter mode, it will still output pulses through the output channels as programmed before the counter function was selected. Note that during counter operation, period control is disabled. This means that accuracy is not controlled anymore and may change within a new accuracy limit of 2 %. To set the Model 8500 to operate in counter mode proceed as follows:

1. Select and display the trigger level (T.LVL) parameter as described in paragraph 3-8 and modify this parameter to the required value.

2. Depress the [COUNTER] push-button in the DISPLAY/MODIFY group until the light next to the desired function is lit. The instrument may be set to measure one of the following functions:

    1. Frequency from 10 Hz to 100 MHz
    2. Period from 10 nS to 1 S
    3. Pulse Width from 50 nS to 1 S

3. Apply the signal to be measured to the TRIG/COUNTER INPUT connector. Observe that the signal is within the specified dynamic levels.

3-17. PULSE ERRORS EVALUATION

Table 3-4 lists the errors and indicates the parameters which are effected by each error. In general, errors in parameter programming, may occur at both channel A and B. Errors at channel A are reference designated from 1 through 8. Errors which may occur at channel B are reference designated from 11 through 18.

To evaluate the pulse setup errors proceed as follows:

1.Depress in sequence the [SHIFT] and the [RCL ERR] push-buttons. observe that the display is modified to show the following message:

ERR DD

DD may range from 1 to 8 if an error was detected in programming channel A parameters or from 11 to 18 at channel B. If no error was detected the display will read:

ERR 0

2. The generator is capable of displaying one error at a time. To verify that all errors were recorded, depress the Modifier push-buttons UP or Down to scan through the errors. Each error is indicated by a number. The interpretation of these numbers are given in the following. These errors are described only once. Errors are the same for both channels A and B.

3. Depress [CANCEL] to resume normal operation and proceed to correct the programmed errors.

NOTE

The following abbreviations were used throughout the following error descriptions:

- PER - Period of the output signal parameter
- HIL - Programmed high level parameter
- LOL - Programmed low level parameter
- WID - Programmed pulse width parameter
- DEL - Programmed delay parameter
- LEE - Programmed leading edge rise time parameter
- TRE - Programmed trailing edge fall time parameter
- BUR - Number of programmed burst count parameter
- RPT - Period of the internal trigger generator parameter

3-17-1. PULSE ERRORS INTERPRETATION

Error 1 (Error 11)

Error 1 (11) occurs when the operator attempts to program an amplitude which is larger or smaller than the specified value. The instrument is capable of operating with an amplitude of 16 Vp-p if the period is programmed from 1.999 S to 20 nS (Within the period range of 20 nS to 14 nS the output amplitude is limited to 10 Vp-p) according to the following formulas:

$$HIL - LOL > 16.0\ V$$
$$HIL - LOL < 100\ mV$$

When such an error occurs the ERROR LED will illuminate and the instrument will not modify its previously set amplitude parameter.

Error 2 (Error 12)

Error 2 (12) occurs when the instrument is set to operate at a period range of 20 nS to 14 nS and the operator attempts to program an amplitude which is larger than the specified value of 10 Vp-p, according to the following formula:

$$HIL - LOL > 10.0\ V$$

When such an error occurs the ERROR LED will illuminate and the instrument will not modify its previously set amplitude parameter.

Error 3 (Error 13)

Error 3 (13) occurs when the instrument is set to operate at linear transition times and the operator attempts to program a leading edge rise time value larger than the programmed pusle width value, according to the following formula:

1.25LEE + 5 nS > WID

When such an error occurs the ERROR LED will illuminate. The output will follow the programmed values although the generator operates with an error. The pulse output at the output connector may look distorted as illustrated in Figure 3-2.

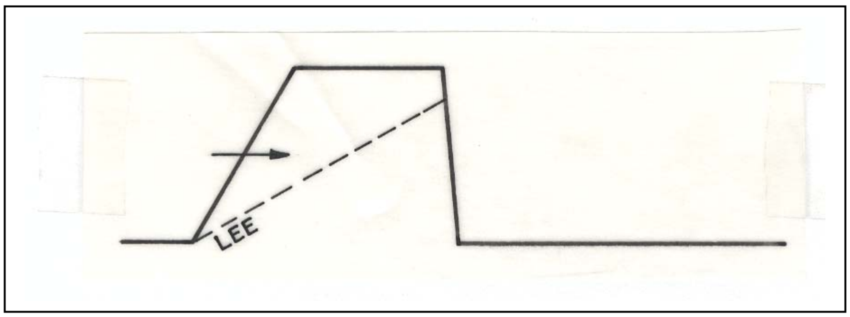

Figure 3-2. Output Wave Form With Error 3 (13)

Error 4 (Error 14)

Error 4 (14) relates to the programmed period parameter. Error 4 can not occur when the instrument is set to operate in external triggered mode. When the pulse generator is set to operate with a Double or Delayed output pulse and in linear transitions, this error will take place under the following conditions:

DLY + PW + 1.25TRE + 5 nS > PER

When the generator is set to operate with in its fast transition mode, the error will occur when the following conditions are programmed:

DLY + PW + 7 nS > PER

When the generator is set to operate having a single pulse output (non-delayed) the value of DLY in the above formulas is set to 0.

When such an error occurs the ERROR LED will illuminate. The output will follow the programmed values although the generator operates with an error. The pulse output at the output connector may look distorted as illustrated in Figure 3-3.

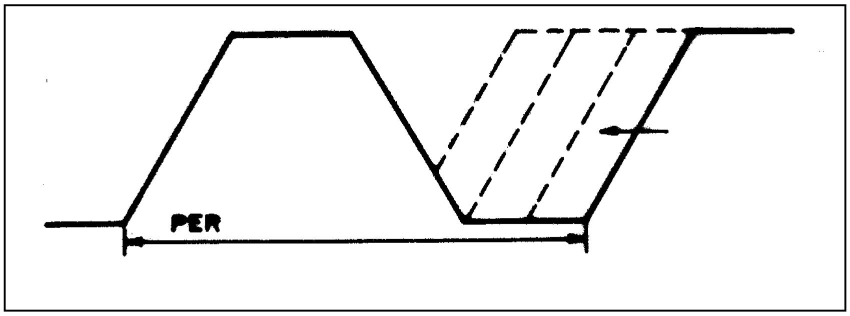

Figure 3-3. Output Wave Form With Error 4 (14)

Error 5 (Error 15)

Error 5 (15) relates to the programmed delay parameter. Error 5 can only happen in double output pulse mode. It can not occur when the instrument is set to operate in either single (non-delayed) or delayed output pulse modes. When the pulse generator is set to operate with linear transitions, this error will take place under the following conditions:

$$PW + 1.25TRE + 5\ nS > DLY$$

When the generator is set to operate with in its fast transition mode, the error will occur when the following conditions are programmed:

$$PW + 7\ nS > DLY$$

When such an error occurs the ERROR LED will illuminate. The output will follow the programmed values although the generator operates with an error. The pulse output at the output connector may look distorted as illustrated in Figure 3-4.

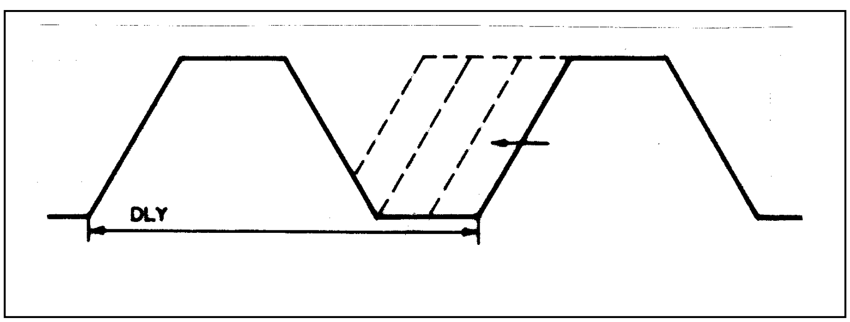

Figure 3-4. Output Wave Form With Error 5 (15)

Error 6 (Error 16)

Error 6 (16) relates to the programmed internal trigger parameter. Error 6 can only happen if the pulse generator is set to operate having an internal triggered stimulus. It can not occur under any other condition. This error will be generated under the following conditions:

$$(BUR + 1)PER > RPT$$

When such an error occurs the ERROR LED will illuminate. The output will follow the programmed values although the generator operates with an error. The pulse output at the output connector may look distorted.

Error 7 (Error 17)

Error 7 (17) relates to the fixed duty cycle operating mode and will occur only when the Model 8500 is set to operate in this mode. It can not occur under any other condition. This error will be generated when the programmed duty cycle value generates an internal pulse width outside the following limits:

PW < 7 nS

When such an error occurs the ERROR LED will illuminate. The output will follow the programmed values although the generator operates with an error. The pulse output at the output connector may look distorted.

Error 8 (Error 18)

Error 8 (18), relates to the double pulse operating mode and will occur only when the Model 8500 is set to operate in this mode. It can not occur under any other condition. This error will be generated under the following conditions:

PER < 40 nS For amplitude <10.0 V
PER < 28 nS For amplitude >10.0 V

When such an error occurs the ERROR LED will illuminate. The output will follow the programmed values although the generator operates with an error. The pulse output at the output connector may look distorted.

Table 3-4. Interparameter Error Summary.

ERROR	PROGRAMMED PARAMETER										OPERATING MODE			
	PER	HIL	LOL	DTY	WID	DLY	LEE	TRE	BUR	RPT	SINGLE	DELAYED	EXT	TRIG
1		±	±											
2	-	+	-											
3	-						+							
4	-				+	+		+						*
5					+	-		+			*	*		
6	+								+	-				
7				-										
8	-													

Notes: (+) - Programmed parameter may be too large
(-) - Programmed parameter may be too small
(*) - Error will not occur in this operating mode

3-18. SPECIAL SHIFT FUNCTIONS

Model 8500 has a number of special shift functions which permit an access to special software routines which are usually not required for normal operation of the instrument. To modify the Model 8500 for a special shift function depress the [SHIFT] push-button and then a numeric button in the data entry block. There are no special front panel markings which identify these functions. The function will be executed immediately without further front panel indication. The special shift functions are described in the following:

<u>SHIFT 1</u> - Shortens the power-up procedure, as described in paragraph 3-4 by removing the messages which are associated with the options and GPIB address. Upon power-up, the instrument will skip the power-up procedure and will immediately start displaying the panel set-up. Depressing [SHIFT 1] again will restore the power-up procedure.

<u>SHIFT 2</u> - Starts a self calibration routine. This routine is avilable only when option 2 (counter) is installed. The pulse generator then measures its output period with its internal counter and updates a calibration table for the VCO (voltage controlled oscillator).
Following a self calibration routine, the period accuracy of is improved to better than 1 %. The updated table is stored in the non-volatile memory and will not be changed unless a new calibration routine was initiated or when the RAM was replaced. The same function can be accessed pressing [SHIFT] and then [COUNTER].

<u>SHIFT 3</u> - Removes the correction factors from the above calibration table. This procedure is necessary when adjusting the Model 8500. This procedure will be discussed further is Section 7 of this manual.

<u>SHIFT 4</u> - Places the instrument in a special recall mode. This mode was described in paragraph 3-9-2-1. The same function can be accessed pressing [SHIFT] and then [RECALL].

<u>SHIFT 5</u> - Loads the non-volatile RAM with factory pre-selected set-ups which may be used in conjunction with the recall mode during performance verification. More details are given in Section 7.

<u>SHIFT 6</u> - Loads the non-volatile RAM with factory pre-selected set-ups which may be used in conjunction with the recall mode during adjustment procedure. More details are given in Section 5.

3-19. CHANGING THE GPIB ADDRESS

The GPIB address is modified using front panel programming. The non-volatile memory stores the GPIB address. a conventional address switche is not provided. Detailed instructions how to change the GPIB address are given in Section 4 of this manual.

SECTION 4

IEEE-488 OPERATION

4-1. INTRODUCTION

The IEEE-488 bus is an instrumentation data bus with standards adopted by the IEEE (Institute of Electrical and Electronic Engineerings) in 1975 and given the IEEE-488 designation. The most recent revision of bus standards was made in 1978; hence the complete description for current bus standards is the IEEE-488-1978 designation. The Model 8500 conforms to 1978 standards.

This section contains general bus information as well as detailed programming information and is divided as follows:

1. General introductory information pertaining to the IEEE-488 bus may be found primarily in paragraphs 4-2 through 4-5.

2. Information necessary to connect the Model 8500 to the bus and to change the bus address is contained in paragraphs 4-6 and 4-7.

3. Programming of the instrument with general bus command is covered in paragraph 4-8.

4. Device-dependent command programming is described in detail in paragraph 4-9. The commands outlined in this section can be considered to be the most important since they control virtually all instrument functions.

5. Additional information pertaining to front panel error messages and controller programs can be found in paragraphs 4-11-1 and 4-11-2.

4-2. BUS DESCRIPTION

The IEEE-488 bus was designed as a parallel data transfer medium to optimize data transfer without using as excessive number of bus lines. In keeping with this goal, the bus has only eight data lines which are used for both data and most commands. Five bus management lines and three handshake lines round out the complement of signal lines. Since the bus is of parallel design, all devices connected to the bus have the same information available simultaneously. Exactly what is done with the information by each device depends on many factors, including device capabilities.

A typical bus configuration for remote controlled operation is shown in Figure 4-1. The typical system will have one controller and one or more instruments to which commands are given and from which data is received. There are three categories that describe device operation. These include: controller; talker; listener.

The controller controls other devices on the bus. A talker sends data, while a listener receives data. an instrument, may be a talker only, a listener only, or both a talker and listener.

Any given system can have only one controller (control may be passed to an appropriate device through a special command). Any number of talkers or listeners may be present up to the hardware constraints of the bus. The bus is limited to 15 devices, but this number may be reduced if higher than normal data transfer rates are required or if long interconnect cables are used.

Several devices may be commanded to listen at once, but only one device may be a talker at any given time. Otherwise, communications would be scrambled much like an individual is trying to select a single conversation out of a large crowd.

Before a device can talk or listen, it must be appropriately addressed. Devices are selected on the basis of their primary address. The addressed device is sent a talk or listen command derived from its primary address. Normally, each device on the bus has a unique primary address so that each may be addressed individually. The bus also has another addressing mode called secondary addressing, but not all devices use this addressing mode.

Once the device is addressed to talk or listen, appropriate bus transactions may be initiated. For example, if an instrument is addressed to talk, it will usually place its data on the bus one byte at a time. The listening device will then read this information, and the appropriate software is then be used to channel the information to the desired location.

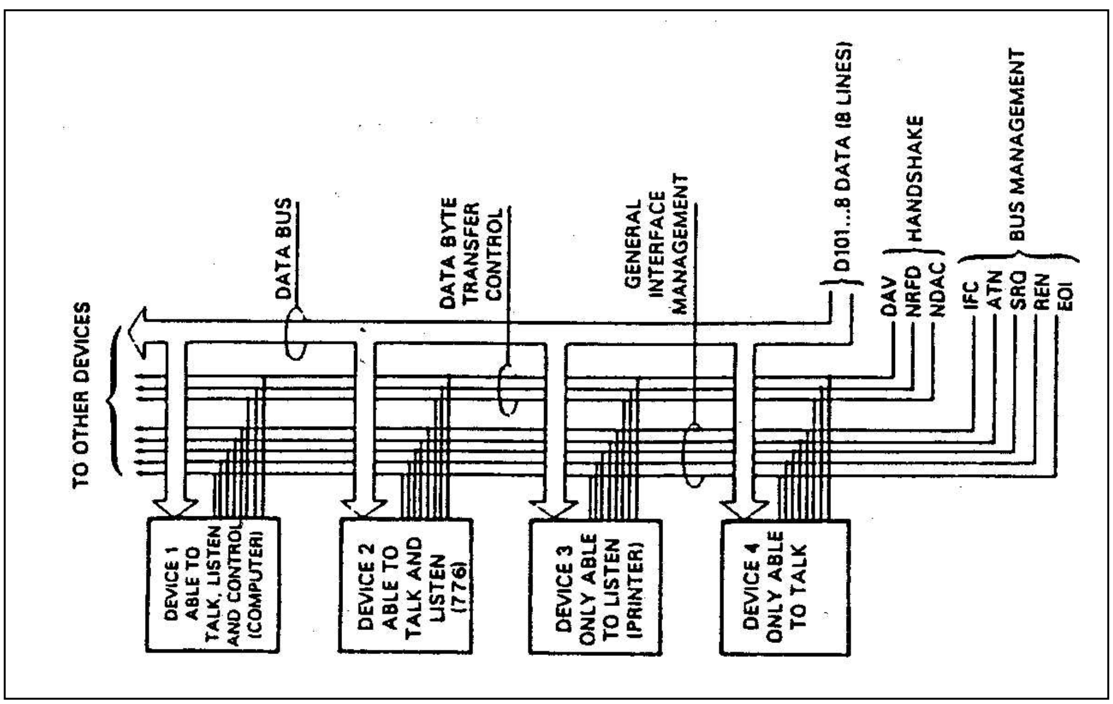

Figure 4-1. IEEE Bus Configuration

4-3. IEEE-488 BUS LINES

The signal lines on the IEEE-488 bus are grouped into three general categories. The data lines handle bus information, while the handshake and bus management lines assure that proper data transfer and bus operation takes place. Each of the bus lines is "active low" so that approximately zero volts is a logic "one". The following paragraphs describe the purpose of these lines, which are shown in Figure 4-1.

4-3-1. BUS MANAGEMENT LINES

The bus management group is made up of five signal lines that provide orderly transfer of data. These lines are used to send the uniline commands described in paragraph 4-8-1.

1.ATN (Attention) - the ATN line is one of the more important management lines. The state of the ATN line determines whether controller information on the data bus is to be considered data or a multiline command as described in paragraph 4-8-2.
2.IFC (Interface Clear) - Setting the IFC line true (low) causes the bus to go to a known state.
3.REN (Remote Enable) - Setting the REM line low sends the REM command. This sets up instruments on the bus for remote operation.
4.EOI (End Or Identify) - The EOI line is used to send the EOI command that usually terminates a multi-byte transfer sequence.
5.SRQ (Service Request) - the SRQ line is set low by a device when it requires service from the controller.

4-3-2. Handshake Lines

The bus uses three handshake lines that operate in an interlocked sequence. This method assures reliable data transfer regardless of the transfer rate. Generally, data transfer will occur at a rate determined by the slowest active device on the bus.

One of the handshake lines is controlled by the data source, while the remaining two lines are controlled by accepting devices. The three bus handshake lines are:

1.DAV (Data Valid) - The source controls the state of the DAV line.
2.NRFD (Not Ready For Data) - the acceptor controls the state of the NRFD line.
3.NDAC (Not Data Accepted) - the acceptor also controls the NDAC line.

The complete handshake sequence for one data byte is shown in Figure 4-2. Once data is on the bus, the source checks to see that NRFD is high, indicating that all devices on the bus are ready for data. At the same time NDAC should be low from the previous byte transfer. If these conditions are not met, the source must then wait until the NRFD and NDAC lines have the correct status. If the source is controller, NRFD and NDAC must remain stable for at least 100ns after ATN is set low. Because of the possibility of bus hang up, some controllers have time-out routines to display error messages if the handshake sequence stops for any reason.

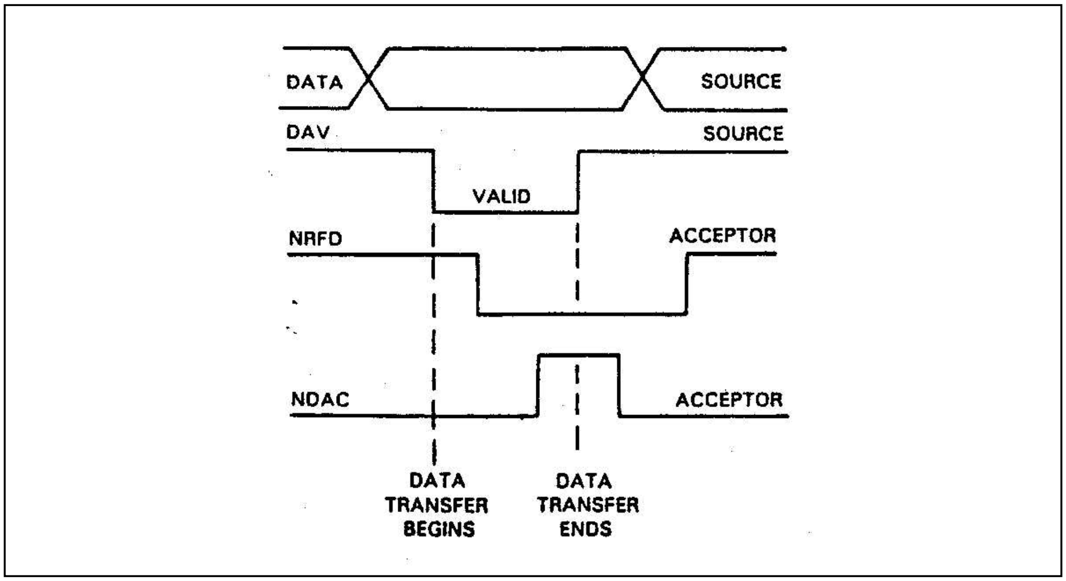

Figure 4-2. IEEE Handshake Sequence

Once the NRFD and NDAC lines are properly set, the source sets the DAV line low, indicating that data on the bus is now valid. the NRFD line then goes low; the NDAC line goes high once all devices on the bus have accepted the data. Each device will release the NDAC line at its own rate, but the NDAC line will not go high until the slowest device has accepted the data byte.

After the NDAC line goes high, the source then sets the DAV line high to indicate that the data on the bus is no longer valid. At this point, the NDAC line returns to its low state. Finally, the NRFD line is released by each of the devices at their own rates, until the NRFD line finally goes high when the slowest device is ready, and the bus is set to repeat the sequence with the next data byte.

The sequence just described is used to transfer both data and multiline command. The state of the ATN line determines whether the data bus contains data or commands.

4-3-3. Data Lines

The IEEE-488 bus uses the eight data lines that allow data to be transmitted and received in a bit-parallel, byte-serial manner. These eight lines use the convention DI01 through DI08 instead of the more common D0 through D7 binary terminology. The data lines are bidirectional and, as with the remaining bus signal lines, low is true.

4-4. INTERFACE FUNCTION CODES

The interface function codes are part of the IEEE-488-1978 standards. These codes define an instrument's ability to support various interface functions and should not be confused with programming commands found elsewhere in this manual.

Table 4-1 lists the codes for the Model 8500. The numeric value following each one or two letter code define Model 8500 capability as follows:

SH(Source Handshake Function) - The ability for the Model 8500 to initiate the transfer of message/data on the data bus provided by the SH function.

AH(Acceptor Handshake Function) - The ability for the Model 8500 to guarantee proper reception of message/data on the data bus provided by the AH function.

T(Talker Function) - The ability of the Model 8500 to send device-dependent data over the bus (to another device) is provided by the T function. Model 8500 talker capabilities exist only after the instrument has been addressed to talk.

L(Listen Function) - The ability of the Model 8500 to receive device-dependent data over the bus (from anther device) is provided by the L function. Listener function capability of the Model 8500 exist only after it has been addressed to listen.

RS(Service Request Function) - The ability of the Model 8500 to request service from the controller is provided by the RS function.

RL(Remote-Local Function) - The ability of the Model 8500 to be placed in remote or local modes is provided by the RL function.

PP(parallel Poll Function) - The ability of the Model 8500 to respond to a parallel poll request from the controller is provided by the PP function.

DC(Device Clear Function) - The ability for the Model 8500 to be cleared (initialized) is provided by the DC function.

DT(Device Trigger Function) - The ability of the Model 8500 to have its output triggered is provided by the DT function.

C(controller Function) - The Model 8500 does not have a controller function.

TE(Extended Talker Capabilities) - The Model 8500 does not have extended talker capabilities.

LE(Extended Listener Function) - The Model 8500 does not have extended listener function.

Table 4-1. Model 8500 Interface Function Codes

CODE	INTERFACE FUNCTION
SH1	Source Handshake Function
AH1	Acceptor Handshake Capabilities
T6	Talker (basic talker, serial poll, unaddressed to talk on LAG)
L4	Listener (basic listener, unaddressed to listen on TAG)
SR1	Service request capability
RL1	Remote/Local capability
PP2	Parallel Poll capability
DC1	Device Clear capability
DT1	Device Trigger capability
C0	No controller capability
E1	Open collector bus drivers
TE0	No Extended Talker capabilities
LE0	No Extended Listener capabilities

4-5. SOFTWARE CONSIDERATIONS

The most sophisticated computer in the world would be useless without the necesary software. This basic requirement is also true of the IEEE-488 bus, which requires the use of handler routines as described in this paragraph.

Before a controller can be used with the IEEE-488 interface, the user must make certain that appropiate handler software is present within the controller. With the IBM PC computer, for example, the GPIB interface card must be used with an additional software which contains the necessary handler software.

Other small computers that can be used as controllers have limited IEEE command capability. The PET/CBM computers, for example, are incapable of sending multiline commands from BASIC, although these commands can be sent through machine language routines. The capabilities of other small computers depends on the particular interface being used. Often, little software "tricks" are required to achieve the desired results.

From the preceding discussion, the message is clear: make sure the proper software is being used with the instrument. Often, the user may incorrectly suspect that a hardware problem is causing fault, when it was the software that was causing the problem all along.

4-6. HARDWARE CONSIDERATIONS

Before the instrument can be used with the IEEE-488 bus, it must be connected to the bus with a suitable connector. Also, the primary address must be properly programmed as described in this section.

4-6-1. Typical Controlled Systems

The IEEE-488 bus is a parallel interface system. As a result, adding more device is simply a matter of using more cables to make the desired connections. Because of this flexibility, system complexity can range from simple to extremely complex.

The simplest possible controlled system comprises a controller and one Model 8500. The controller is used to send commands to the instrument, which sends data back to the controller.

The system becomes more complex when additional instrumentation is added. Depending on programming, all data may be routed through the controller, or it may be transmitted directly from one instrument to another.

For very complex applications, a much larger computer can be used. Tape drives or disks may then be used to store data.

4-6-2. Connections

The instrument is connected to the bus through an IEEE-488 connector. This connector is designed to be stacked to allow a number of parallel connections on one instrument.

NOTE

> To avoid possible mechanical damage, it is recommended that no more than three connectors be stacked on any one instrument. Otherwise, the resulting strain may cause internal damage to the connectors.

NOTE

> The IEEE-488 bus is limited to a maximum of 15 devices, including the controller. Also, the maximum cable length is 20 meters. Failure to observe these limits will probably result in erratic bus operation.

Custom cables may be constructed using the information in Table 4-2. Table 4-2 also lists the contact assignments for the various bus lines. Contacts 18 through 24 are return lines for the indicated signal lines, and the cable shield is connected to contact 12. Each ground line is connected to digital common in the Model 8500.

****
** CAUTION **
****

> The voltage between IEEE common and ground must not exceed 0V or damage may result to your instrument.

Table 4-2. IEEE Contact Designations

Contact Number	IEEE-488 Designation	Type
1	DIO1	Data
2	DIO2	Data
3	DIO3	Data
4	DIO4	Data
5	EOI	Management
6	DAV	Handshake
7	NRFD	Handshake
8	NDAC	Handshake
9	IFC	Management
10	SRQ	Management
11	ATN	Management
12	SHIELD	Ground
13	DIO5	Data
14	DIO6	Data
15	DIO7	Data
16	DIO8	Data
17	REN	Management
18	Gnd	Ground
19	Gnd	Ground
20	Gnd	Ground
21	Gnd	Ground
22	Gnd	Ground
23	Gnd	Ground
24	Gnd LOGIC	Ground

4-7. CHANGING GPIB ADDRESS

The primary address of your instrument may be programmed to any value between 0 and 30 as long as the selected address is different from other devices addresses in the system. This may be accomplished using a front panel programming sequence. Note that the primary address of the instrument must agree with the address specified in the controller's program.

NOTE

The programmed primary address is briefly displayed during the power-up cycle of the Model 8500. It is stored in the non-volatile memory of the instrument and is retained even when power is turned off.

To check the present address, or to enter a new one, proceed as follows:

1.Press the [SHIFT] push-button once then press the [ADR] push-button. The display will be modified to display the following:

IE Adr x Where x may be any number from 0 to 30.

2.Use the DATA ENTRY push-buttons to select a new GPIB primary address.
3.To store the newly selected primary address depress [N]. The instrument will then resume normal operation.

4-8. BUS COMMANDS

While the hardware aspect of the bus is essential, the interface would be essentially worthless without appropriate commands to control the communications between the various instruments on the bus. This paragraph briefly describes the purpose of the bus commands, which are grouped into the following three categories:

1.Uniline commands: Sent by setting the associated bus line low.

2.Multiline commands: General bus commands which are sent over the data lines with the ATN line low (true).

3.Device-dependent commands: Special commands that depend on device configuration; sent over the data lines with ATN high (false).

Table 4-3. IEEE-488 Bus Command Summary

COMMAND TYPE	COMMAND	STATE OF ATN LINE	COMMENTS
Uniline	REN	X	Set up for remote operation
	EOI	X	Sent by setting EOI low
	IFC	X	Clears Interface
	ATN	Low	Defines data bus contents
	SRQ	X	Controlled by external device
Multiline			
Universal	LLO	Low	Locks out front panel controls
	DCL	Low	Returns device to default conditions
	SPE	Low	Enable serial polling
	SPD	Low	Disables serial polling
Addressed	SDC	Low	Returns unit to default condition
	GTL	Low	Returns to local control
	GET	Low	Triggers device for reading
Unaddress	UNL	Low	Removes all listeners from bus
	UNT	Low	Removes all talkers from bus
Device-dependent(**)		High	Programs Model 8500 for various modes.

(*) X = Don't Care, (**) See paragraph 4-9 for complete description

4-8-1 Uniline Commands

Uniline commands are sent by setting the associated bus line to low. The ATN, IFC, and REN commands are asserted only by the system controller. The SRQ command is sent by an external device. The EOI command may be sent by either the controller or an external device depending on the direction of data transfer. The following is description of each command.

REN(Remote Enable) - The remote enable command is sent to the Model 8500 by the controller to set the instrument up for remote operation. Generally, this should be done before attempting to program the instrument over the bus. The Model 8500 will indicate that it is in the remote mode by illuminating its front panel REM indicator.

To place the Model 8500 in the remote mode, the controller must perform the following steps:

1. Set the REN line true.
2. Address the Model 8500 to listen.

NOTE

Setting REN true without addressing will not cause the REM indicator to turn on; however, once REN is true, the REM light will turn on the next time an address command is received.

EOI(End Or Identify) - The EOI command is used to positively identify the last byte in a multi-byte transfer sequence. This allows variable length data words to be transmitted easily.

IFC(Interface Clear) - The IFC command is sent to clear the bus and set the Model 8500 to a known state. Table 4-4 summarizes the instrument's state after IFC or DCL. Although device configurations differ, the IFC command usually places instruments in the talk and listen idle states.

ATN(Attention) - The controller sends ATN while transmitting addresses or multiline commands. Device-dependent commands are sent with the ATN line high (false).

SRQ(Service Request) - The SRQ command is asserted by an external device when it requires service from the controller. If more than one device is present, a serial polling sequence, as described in paragraph 4-8-2, must be used to determine which has requested service.

4-8-2. Universal multiline Commands

Universal commands are multiline commands that require no addressing. All instrumentation equipped to implement the command will do so simultaneously when the command is transmitted over the bus. As with all multiline commands, the universal commands are sent over the data lines with ATN set low:

LLO(Local Lockout) - The LLO command is sent by the controller to remove the Model 8500 from the local operating mode. Once the unit receives the LLO command, all its front panel controls (except Power) will be inoperative.

NOTE

The REN bus line must be true before the instrument will respond to an LLO command.

To lock out the front panel controls of the Model 8500, the controller must perform the following steps:

1. Set ATN true.
2. Send the LLO command to the instrument.

DCL(Device Clear) - The DCL command may be used to clear the Model 8500, setting it to a known state. Note that all devices on the bus equiped to respond to a DCL will do so simultanously. When the Model 8500 receives a DCL command, it will return to the default conditions listed in Table 4-4. Factory pre-selected parameters are listed in Table 3-1.

To send a DCL command the controller must perform the following steps:

1. Set ATN true.
2. Place the DCL command on the bus.

SPE(Serial Poll Enable) - The serial polling sequence is used to obtain the Model 8500 status byte. Usually, the serial polling sequence is used to determine which of several devices has requested service over the SRQ line. However, the serial polling sequence may be used at any time to obtain the status byte from the Model 8500. For more information on status byte format, refer to paragraph 4-9-20. The serial polling sequence is conducted as follows:

1. The controller sets the ATN line true.
2. The SPE (Serial Poll Enable) command is placed on the bus by the controller.
3. The Model 8500 is addressed to talk.
4. The controller sets ATN false.
5. The Model 8500 then places its status byte on the bus to be read by the controller.
6. The controller then sets the ATN line low and places SPD (Serial Poll Disable) on the bus to end the serial polling sequence.

Steps 3 trough 5 may be repeated for other instruments on the bus by using the correct talk address for each instrument. ATN must be true when the talk address is transmitted and false when the status byte is read.

SPD(Serial Poll Disable) - The SPD command is sent by the controller to remove all instrumentation on the bus from the serial poll mode.

Table 4-4. Default Conditions. (Status After SDC or DCL)

MODE	VALUE	STATUS
Display/Program	CHA	Display/Program Channel A parameters
Display Parameter	VPER	Display period parameter
Trigger Mode	M1	Normal - continuous mode
Triggering Edge	T1	Positive edge
Output	O1	Single pulse delay off
Output Mode	C0	Complement off
	D0	Output disable off
Duty Cycle Mode	SM0	Fixed duty cycle off
Edge Mode	W1	Fast fixed edge
Auxiliary Level	TTL	TTL at auxiliary out
Interrogate Parameter	IPER	Read-back period
Reading Format	X1	Prefix on
Terminator	Z0	CR,LF with EOI
SRQ Mask	SR0	SRQ off. no mask

4-8-3. Addressed Commands

Addressed commands are multiline commands that must be preceeded by a listen command derived from the device's primary address before the instrument will respond. Only the addressed device will respond to each of these commands:

SDC(Selective Device Clear) - The SDC command performs essentially the same function as the DCL command except that only the addressed device will respond. This command is usefull for clearing only a selected instrument instead of all devices simultaneously. The Model 8500 will return to the default conditions listed in Table 4-4 when responding to an SDC command.

To transmite the SDC command, the controller must perform the following steps:

1. Set ATN true.
2. Address the Model 8500 to listen.
3. Place the SDC command on the data bus.

GTL(Go To Local) - The GTL command is used to remove the instrument from the remote mode of operation. Also, front panel control operation will usually be restored if the LLO command was previously sent. To send the GTL command, the controller must perform the following sequence:

1. Set ATN true.
2. Address the Model 8500 to listen.
3. Place the GTL command on the bus.

NOTE

> The GTL command does not remove the local lockout state. With the local lockout condition previously set, the GTL command will enable front panel control operation until the next time a listener address command is received. This places the Model 8500 in the local lockout state again.

GET(Group Execute Trigger) - The GET command is used to trigger or arm devices to perform a specific measurement that depends on device configuration. Although GET is considered to be an addressed command, many devices respond to GET without being addressed. Using the GET command is only one of several methods that can be used to initiate a measurement cycle. More detailed information on triggering can be found in Section 3 of this manual.

To send GET command over the bus, the controller must perform the following sequence:

1. Set ATN true.
2. Address the Model 8500 to listen.
3. Place the GET command on the data bus.

GET can also be sent without addressing by omitting step 2.

4-8-4. Unaddress Command

The two unaddress commands are used by the controller to simultaneously remove all talkers and listeners from the bus. ATN is low when these multiline commands are asserted.

UNL(Unlisten) - All listeners are removed from the bus at once when the UNL commands is placed on the bus.
UNT(Untalk) - The controller sends the UNT command to clear the bus of any talkers.

4-8-5. Device-Dependent Commands

The meaning of the device-dependent commands is determined by instrument configuration. Generally, these commands are sent as one or more ASCII characters that tell the device to perform a specific function. For example, F0 is sent to the Model 8500 to place the instrument in the FREQ A mode. The IEEE-488 bus treats device-dependent commands as data in that ATN is high (false) when the commands are transmitted.

4-9. DEVICE-DEPENDENT COMMAND PROGRAMMING

IEEE-488 device-dependent commands are sent to the Model 8500 to control various operating conditions such as display modify, trigger mode, output and parameter insertion. Each command is made up of an ASCII alpha character followed by one or more numbers designating specific parameters. For example the output waveform is programmed by sending an ASCII "O" followed by a number representing the output. The IEEE bus treats device-dependent commands as data in that ATN is high when the commands are transmitted.

A number of commands may be grouped together in one string. Each command must be separated from the preceding command by a comma "," character (2C HEX). The Model 8500 will ignore all non-printable ASCII characters (00 HEX through 20 HEX) except the "CR" (carriage return). A command string is terminated by an ASCII "CR" (carriage return) character (0D HEX) or a uniline command "EOI" (end or identify) which tells the instrument to execute the command string. recognized as end of command string.

Programming Example: CHA,PER10US,WID50NS,HIL2V,LOL0V

A CR or an EOI at the end of the string will set Model 8500 channel A parameters to have an output pulse with a period of 10 μS, pulse width of 50 nS and an amplitude level from 0 to 2 V into 50Ω. All other parameters remain unchanged from their previously programmed value. Note that this example does not relate to a particular controller. Other software routine commands are required for the Model 8500 to recognize this string as a device dependent command. These

routines vary with each controller and should be studied separately. Other general aspects of programming the Model 8500 were discussed in paragraph 4-8.

If an illegal command or command parameter is present within a command string, the instrument will:

1. Ignore the entire string.
2. Display appropriate front panel error message.
3. Set certain bits in its status byte.
4. Generate an SRQ if programmed to do so.

These programming aspects are covered in the following.

NOTE

> Before performing a programming example, it is recommended that the instrument be set to its default values by sending IFC and SDC over the bus.

In order to send a device-dependent command, the controller must perform the following sequence:

1. Set ATN true.
2. Address the Model 8500 to listen.
3. Set ATN false.
4. Send the command string over the data bus one byte at a time.

NOTE

REN must be true when attempting to program the Model 8500.

Commands that effect the Model 8500 are listed in Table 4-5.

Table 4-5. Device-Dependent Command Summary

MODE	COMMAND	DESCRIPTION	
Display/Program	CHA	Channel A parameters	(A)
	CHB	Channel B parameters	(B)
Display Parameter	VPER	Display period	(PER)
	VHIL	Display high level	(H.LVL)
	VLOL	Display low level	(L.LVL)
	VDTY	Display duty cycle	(DTY)
	VWID	Display pulse width	(P.WID)
	VDEL	Display delay time	(DELAY)
	VLEE	Display leading edge	(L.EDGE)
	VTRE	Display trailing edge	(T.EDGE)
	VBUR	Display burst number	(BRST)
	VRPT	Display trig period	(T.PER)
	VTLV	Display trigger level	(T.LVL)
	VFRQ	Display ext frequency	(FREQ)
	VPRD	Display ext period	(PERIOD)
	VPLS	Display ext pulse wid	(PLS WID)
Trigger Mode	M1	Normal	
	M2	Triggered Mode	(TRIGRD)
	M3	Gated Mode	(GATED)
	M4	Burst Mode	(BURST)
	T1	EXT trig positive edge	(EXT /)
	T2	EXT trig negative edge	(EXT \ )
	T3	Internal trig stimuli	(INT)
Output	O1	Single pulse delay off	(SINGLE)
	O2	Double pulse delay on	(DOUBLE)
	O3	Single pulse delay on	(DELAYED)
Output Mode	C0	Complement off	( )
	C1	Complement on	( )
	D0	Output disable off	(ST BY off)
	D1	Output disable on	(ST BY on)

Table 4-5. Device-Dependent Command Summary (continued)

MODE	COMMAND	DESCRIPTION	
Duty Cycle Mode	SM0	Fixed duty cycle off	(FIX DTY off)
	SM1	Fixed duty cycle on	(FIX DTY on)
Edge Mode	W1	Fast fixed edge	(FAST)
	W2	Linear edge on	(LIN)
Auxiliary Level	TTL	TTL at auxiliary out	(TTL)
	ECL	ECL at auxiliary out	(ECL)
Set-ups	STOnn	Store front panel set-up at nn location.	
	RCLnn	Recall set-up from nn location. nn = 00 to 30	
Parameter Programming	PER	Set period.	Delimiter=NS,US,MS,S
	HIL	Set high level.	Delimiter=MV,V
	LOL	Set low level.	Delimiter=MV,V
	DTY	Set duty cycle.	Delimiter=%
	WID	Set pulse width.	Delimiter=NS,US,MS,S
	DEL	Set delay.	Delimiter=NS,US,MS,S
	LEE	Set rise time.	Delimiter=NS,US,MS,S
	TRE	Set fall time.	Delimiter=NS,US,MS,S
	BUR	Set burst number.	Delimiter=#
	RPT	Set int trig period	Delimiter=US,MS,S
	TLV	Set trigger level	Delimiter=MV,V
Interrogate Parameter	IPER	Read-back period	Prefix: PER
	IHIL	Read-back high level	Prefix: HIL
	ILOL	Read-back low level	Prefix: LOL
	IDTY	Read-back duty cycle	Prefix: DTY
	IWID	Read-back pulse width	Prefix: WID
	IDEL	Read-back delay time	Prefix: DEL
	ILEE	Read-back leading edge	Prefix: LEE
	ITRE	Read-back trailing edge	Prefix: TRE
	IBUR	Read-back burst number	Prefix: BUR
	IRPT	Read-back trig period	Prefix: RPT
	ITLV	Read-back trigger level	Prefix: TLV
	IFRQ	Read-back ext frequency	Prefix: FRQ
	IPRD	Read-back ext period	Prefix: PRD
	IPLS	Read-back ext pulse wid	Prefix: PLS
	IERR	Read-back error status	Prefix: ERR
	ISTA	Read-back machine status A	Prefix: STA
	ISTB	Read-back machine status B	Prefix: STB
Reading Format	X0	Prefix off	
	X1	Prefix on	

Table 4-5. Device-Dependent Command Summary (continued)

MODE	COMMAND	DESCRIPTION		
Terminator	Z0	CR,LF	with	EOI
	Z1	CR,LF	without	EOI
	Z2	LF,CR	with	EOI
	Z3	LF,CR	without	EOI
	Z4	CR	with	EOI
	Z5	CR	without	EOI
	Z6	LF	with	EOI
	Z7	LF	without	EOI
	Z8	No terminator	with	EOI
	Z9	No terminator	without	EOI
SRQ Mask	SR0	SRQ off. no mask		
	SR1	SRQ on reading done		
	SR2	SRQ on pulse error		
	SR4	SRQ on error		

4-9-1. Display/Program (CHA, CHB)

The display/program command selects the channel to be programmed. One of these commands should be sent once at the beginning of the string. If channel B is not installed and CHB was sent through the bus the instrument will respond with an error message. The function may be programmed by sending one of the following commands:

1. CHA = Program parameters which are associated with channel A
2. CHB = Program parameters which are associated with channel B

4-9-2. Display Parameter (Vxxx)

The display parameter command controls what the Model 8500 places on the display. There are 11 parameters which are associated with the display parameter command and 3 commands which select the type of measurement made by the built-in counter. The machine status string (ISTT) contains a display parameter status; designated by the letter V. This status include a code of two ASCII characters which define the displayed parameter. This code may range from 01 to 14. (e.g code 05 corresponds to VWID in the following list). The display may be programmed using the following commands:

1. VPER = Display the period
2. VHIL = Display the high level
3. VLOL = Display the low level
4. VDTY = Display the duty cycle
5. VWID = Display the pulse width
6. VDEL = Display the delay time
7. VLEE = Display the leading edge
8. VTRE = Display the trailing edge
9. VBUR = Display the burst number
10. VRPT = Display the trig period
11. VTLV = Display the trigger level

The display may be programmed to show counter readings using the following commands:

12. VFRQ = Display the external frequency
13. VPRD = Display the external period
14. VPLS = Display the external pulse width

4-9-3. Trigger Mode (M, T, TRG)

The trigger mode command gives the user control over the operating mode of the Model 8500. There are a number of acceptable external sources to stimulate the pulse generator. The instrument may also be set to operate in continuous mode or with an internal stimulant. Program the Model 8500 to one of the trigger modes by sending one of the following commands:

1. M1 = Normal continuous mode
2. M2 = Triggered mode
3. M3 = Gated mode
4. M4 = Burst mode

The Model 8500 may be programmed to accept either an external stimulant or an internal stimulant by sending one of the following commands:

5. T1 = External trigger stimulant, trigger on positive edge
6. T2 = External trigger stimulant, trigger on positive edge
7. T3 = Internal trigger stimulant, T.PER controls rate
8. TRG = Trigger on GPIB command

4-9-4. Output (O)

The output command gives the user control over the delay at the output and the auxiliary connectors. The output delay may be programmed by sending one of the following commands:

1. O1 = Single pulse - delay off
2. O2 = Double pulse - delay on
3. O3 = Single pulse - delay on

4-9-4-1. Output Mode (C, D)

The output mode command gives the user control over the condition of the pulse wave form at the output connectors. Main outputs may be enabled or disabled and set to normal or complement mode by sending one of the following commands:

1. C0 = Complement off
2. C1 = Complement on

3. D0 = Output disable off
4. D1 = Output disable on

4-9-5. Duty Cycle Mode (SM)

Duty cycle mode command gives the user control over the pulse width of the Model 8500. Pulse width may be selected by the operator or left to be automatically set, using the fixed duty cycle mode, by the instrument. The pulse generator may be programmed to turn this mode on or off using the following commands:

1. SM0 = Fixed duty cycle mode off
2. SM1 = Fixed duty cycle mode on

4-9-6. Edge Mode (W)

The Edge mode selection command gives the user control over the rise time of output pulse. Modes may be set to either fast - fixed rise time or linear - variable rise time. Model 8500 may be programmed to one of the edge modes by sending one of the following commands:

1. W1 = Fast fixed edge mode, linear edge mode off
2. W2 = linear edge mode on

4-9-7. Auxiliary Level (TTL, ECL)

The auxiliary level command gives the user control over the logic level which will be present at the auxiliary outputs. The auxiliary level may be programmed by sending one of the following commands:

1. TTL = TTL level at the auxiliary outputs
2. ECL = ECL level at the auxiliary outputs

4-9-8. Set-Ups (STO, RCL)

The set-ups command gives the user control over the storage facilities of the Model 8500. The generator may store complete front panel set-ups in 31 different memory locations. These set-ups may then be recalled to the front panel using a simple bus command.

1. STOnn = Store front panel set-up at nn location
2. RCLnn = Recall front panel set-up from nn location

nn may range from 00 to 30. DCL or SDC has no effect on the stored set-ups.

4-9-9. Parameter Programming

The parameter programming command sets the Model 8500 to the various levels which are required for the unit under test. There are 11 different parameters which may be modified using this command:

1. PER = Set the period rate
2. HIL = Set the high level voltage
3. LOL = Set the low level voltage
4. DTY = Set the fixed duty cycle
5. WID = Set the pulse width
6. DEL = Set the delay time
7. LEE = Set the leading edge rise time
8. TRE = Set the trailing edge fall time
9. BUR = Set the burst count
10. RPT = Set the period of the internal trigger generator
11. TLV = Set the trigger level threshold

The programming limits for each of the above parameters are listed in Table 3-2.

After DCL or SDC, the instrument will restart to its factory defaults which are listed in Tables 3-1 and 4-4.

4-9-10. SRQ Mode (SR) and Serial Poll Status Byte Format

The SRQ command controls which of a number of conditions within the Model 8500 will cause the instrument to request service from the controller. The service request is generated by the SRQ line command. Once the SRQ is generated, the Model 8500 status byte can be checked, via serial polling, to determine if it was the Model 8500 that requested service. Other bits in the status byte could also be set depending on certain data or error conditions. The Model 8500 can be programmed to generate SRQ under one of the following conditions.

1. If a counter reading cycle has been completed.
2. If a general programming error condition has occurred.
3. If a pulse error condition has occurred.

SRQ Mask: In order to facilitate SRQ programming, the Model 8500 uses an internal mask to generate the SRQ. When a particular mask bit is set, the Model 8500 will send an SRQ when those conditions occur. Bits within the mask can be controlled by sending the ASCII letter "Q" followed by a decimal number to set the appropriate bits. Table 4-6 lists the commands to set the various mask bits, while Table 4-7 lists all legal SRQ Mask commands.

Table 4-6. SRQ Mask Commands

Command	Sets Bit Number	Condition to Generate SRQ
SR1	B0 (LSB)	Reading done
SR2	B1	Pulse set-up error
SR4	B2	General programming error

Table 4-7. SRQ Mask Legal Commands

Bit Number / Command	B2 Programming Error	B1 Pulse Error	B0 (LSB) Reading Done
SR0	NO	NO	NO
SR1	NO	NO	YES
SR2	NO	YES	NO
SR3	NO	YES	YES
SR4	YES	NO	NO
SR5	YES	NO	YES
SR6	YES	YES	NO
SR7	YES	YES	YES

NOTE

There are 8 legal SRQ mask commands that are possible with the Model 8500. Table 4-7 lists all combinations. e.g selecting SR5, Model 8500 will request service when one of reading done or programming error occurs.

Status Byte Format: The status byte contains information relating to data and error conditions within the instrument. Table 4-4 lists the meaning of the various bits. The status byte is obtained by using the SPE,SPD polling sequence.

Table 4-8. Status Byte Interpretation

Bit Number	B7	B6	B5	B4	B3	B2	B1	B0 (LSB)
Interpretation	0	rqs	0	0	0	Prog. Error	Pulse Error	Reading Done

The various bits in the status byte are described below:

1. Reading done: Set after completion of a measurement cycle in VFRQ mode. The reading done bit is cleared after Model 8500 was addressed to talk in IFRQ mode or when a non-counter parameter was selected to be displayed.

2. Pulse Error: Set if an inter-parameter error has been detected. This bit is cleared when the error is removed from the front panel set-up.

3. Programming Error: Set if an illegal command or an illegal parameter has been received. This bit is cleared by reading the error status string (IERR).

4. Rqs: Model 8500 will set this bit if one or more conditions for service request occur, and the SRQ mask, for at least one of these service request conditions is enabled. This bit is cleared by reading the Status Byte using the SPE,SPD polling sequence.

NOTES

1. Once the Model 8500 has generated an SRQ, its status byte should be read to clear the SRQ line. Otherwise the instrument will continuously assert the SRQ line.

2. The Model 8500 may be programmed to generate an SRQ for more than one condition simultaneously. For example, to set SRQ mask bits for an SRQ if a programming error and pulse error occurs, the following command would be sent: SR6. All possible mask combinations are listed in Table 4-7.

3. If the instrument is programmed to generate an SRQ when reading is done, it will generate the SRQ only once when the reading is complete; the SRQ may be cleared by reading the status byte. The reading done bit in the status byte may then be cleared by requesting another reading from the instrument.

4-10. READING FROM MODEL 8500

The Reading sequence is used to obtain from Model 8500, various information strings such as parameter set-ups, measurement, machine status or error status. Each information string is made up of ASCII alpha and alphanumeric characters. For more details on the information strings format refer to paragraph 4-10-1.

The reading sequence is conducted as follows:

1. The controller sets the ATN line true.
2. The Model 8500 is addressed to talk.
3. The controller sets ATN false.
4. The instrument sends the information string over the bus one byte at a time.
5. The controller recognizes that the string is terminated.
6. The controller sets the ATN line true.
7. The UNT (untalk) command is placed on the bus by the controller.

NOTE

Most controllers use the CR (Carriage Return) or LF (Line Feed) character to terminate their input sequences, but other techniques may be used as well to recognize the end of input sequence (for example the EOI line is low on the bus during the transfer of the last byte).

4-10-1 Interrogate Parameter commands (I)

The Interrogate Parameter commands allow access to information concerning present parameters or special status of the instrument. When the interrogate parameter command is given, the Model 8500 will update a special buffer with the interrogated parameter for the displayed channel. The next time that the generator is addressed to talk, it will transmit this string to the controller. For example to interrogate the pulse width for Channel B the following string should be sent to the Model 8500 : CHB,IWID

The Model 8500 interrogate parameter commands include:

1. IPER = Interrogate period parameter
2. IHIL = Interrogate high level parameter
3. ILOL = Interrogate low level parameter
4. IDTY = Interrogate duty cycle parameter
5. IWID = Interrogate pulse width parameter
6. IDEL = Interrogate delay time parameter
7. ILEE = Interrogate rise time parameter
8. ITRE = Interrogate fall time parameter
9. IBUR = Interrogate burst number parameter
10. IRPT = Interrogate internal trigger period parameter
11. ITLV = Interrogate trigger level parameter

12. IFRQ = Interrogate external frequency
13. IPRD = Interrogate external period
14. IPLS = Interrogate external pulse width

15. IERR = Interrogate error status
16. ISTA = Interrogate machine status - channel A
17. ISTB = Interrogate machine status - channel B

Table 4-9 shows the general data string format for each of the first fifteen commands. Default values are shown. These defaults are generated after an SDC or DCL commands.

Table 4-10 shows the interpretation for the error status and the machine status strings (IERR, ISTA and ISTB)

NOTE

The error status data strings (IERR) and the machine status data strings (ISTA/ISTB) have fixed length of 17 ASCII without the prefix and terminator. Counter data has a fixed length of 11 ASCII characters without the prefix and terminator. For all other data strings the length of the data string is 7 ASCII characters without the prefix and terminator. If the data string is sent with a prefix, three additional ASCII characters are included (refer to paragraph 4-10-3). If the data string is sent with one or two terminators, the length of the data string increases by one or two characters respectively.

Table 4-9. Data String Formats

Command	Data String Format*	Description	Dimensions
IPER	PER1.000US(term)	For period string	NS,US,MS,S
IHIL	HIL 1.00 V(term)	For high level string	MV,V
ILOL	LOL-1.00 V(term)	For low level string	MV,V
IDTY	DTY 50 %(term)	For duty cycle string	%
IWID	WID 200US(term)	For pulse width string	NS,US,MS,S
IDEL	DEL 300US(term)	For delay string	NS,US,MS,S
ILEE	LEE 10.0US(term)	For rise time string	NS,US,MS,S
ITRE	TRE 10.0US(term)	For fall time string	NS,US,MS,S
IBUR	BUR 2 #(term)	For burst number string	#
IRPT	RPT 1 S(term)	For trig period string	US,MS,S
ITLV	TLV 1.6 V(term)	For trig level string	MV,V
IFRQ	FRQ1.234567MHZ(term)	For ext frequency string	MHZ,KHZ,HZ
IPRD	PRD1.234567 US(term)	For ext period string	NS,US,MS,S
IPLS	PLS1.234567 US(term)	For ext pulse width string	NS,US,MS,S
IERR	ERR00000000000000000(term)	For error status string	
ISTA	STAxx101111000110100(term)	For machine status string CH A	
ISTB	STBxx001111000110100(term)	For machine status string CH B	

(*) CR LF is normal terminator. The terminator may be changed (see paragraph 4-10-2). The prefixes are listed in Table 4-9.

(xx) depends on the installed options

Table 4-10. Status Word Interpretation

IERR Command Status Word Format (Following SDC or DCL)

	CHANNEL A								CHANNEL B									
	ER 1	ER 2	ER 3	ER 4	ER 5	ER 6	ER 7	ER 8	ER 11	ER 12	ER 13	ER 14	ER 15	ER 16	ER 17	ER 18	ILI	
<ERR>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(CR LF)

ISTA/ISTB Command Status Word Format (Following SDC or DCL)

	OPT1	OPT2	CHA	V	M	T	O	C	D	SM	W	TTL	ECL	X	Z	SR	(term)
<STA>	0	0	1	01	1	1	1	0	0	0	1	1	0	1	0	0	(CR LF)

	OPT1	OPT2	CHB	V	M	T	O	C	D	SM	W	TTL	ECL	X	Z	SR	(term)
<STB>	1	0	0	01	1	1	1	0	0	0	1	1	0	1	0	0	(CR LF)

NOTES

1. To ensure that the correct status is received, the status string should be read immediately after sending the command, to avoid having an incorrect status transmitted.

2. The status string should not be confused with the status byte. The status string contains a string of bytes pertaining to the various operating modes of the instrument. The status byte is a single byte that is read with the SPE, SPD command sequence and contains information on RSQ status.

3. Errors 1 through 8 and 11 through 18 are described in paragraph 3-17.

4. ILI error is described in paragraph 4-11-1.

4-10-2. Terminator (Z)

To allow a wide variety of controllers to be used, the terminator can be changed by sending an appropriate command over the bus. The default value is the commonly used carriage return, line feed (CR LF) sequence (mode Z0). The terminator sequence will assume this default value after receiving a DCL or SDC.

The EOI line on the bus is usually set low by the device during the last byte of its data transfer sequence. In this way, the last byte is properly identified, allowing variable length data words to be transmitted. The Model 8500 will normally send EOI during the last byte of its data string or status word. The terminator and the EOI response from the Model 8500 may be sent with one of the following commands:

1. Z0 = CR,LF with EOI
2. Z1 = CR,LF without EOI
3. Z2 = LF,CR with EOI
4. Z3 = LF,CR without EOI
5. Z4 = CR with EOI
6. Z5 = CR without EOI
7. Z6 = LF with EOI
8. Z7 = LF without EOI
9. Z8 = No terminator with EOI
10. Z9 = No terminator without EOI

NOTES

1. Most controllers use the CR or LF character to terminate their input sequence. Using the NO TERMINATOR mode (Z8 or Z9) may cause the controller to hang up unless special programming is used.

2. Some controllers may require that EOI be present at the end of the string.

4-10-3. Prefix (X)

The prefix from the data string may be suppressed using this command. When the prefix is suppressed the output data string is three byte shorter. X command parameters include:

X0 = Send data string without prefix
X1 = Send data string with prefix

4-11. FRONT PANEL ERROR MESSAGES

The process of programming the Model 8500 involves the proper use of syntax. Syntax is defined as the orderly or systematic arrangement of programming commands or languages. The Model 8500 must receive valid commands with proper syntax or it will:

1. Ignore the entire commands string in which the invalid command appears.
2. Set appropriate bits in the status byte and error word.
3. Generate an SRQ if programmed to do so.
4. Display an appropriate front panel message.

4-11-1. Illegal Instruction (ILI) Error

An Illegal Instruction error results when the Model 8500 receives an invalid command such as A0 or an invalid parameter like 20pS. These commands are invalid because no such letter or parameter exist in the instruments programming language. When the generator receives such a command it will respond with a front panel message as follows:

ILL INS

In parallel, the ILI bit in the error status string and the B2 bit in the series poll byte will be set to 1; on the condition that the appropriate SRQ was programmed. These bits will be cleared only after the error status string (IERR) has been read.

SECTION 5

MAINTENANCE AND PERFORMANCE TESTS

5-1. INTRODUCTION

This section provides maintenance, service information, and performance tests for the Model 8500, the Channel B output amplifier (option 1), and the universal counter option (option 2). Fuse replacement procedure, line voltage selection and options installation procedure are also included.

****
** WARNING **
****

The procedures described in this section are for use only by qualified service personnel. Do not perform these procedures unless qualified to do so. Many of the steps covered in this section may expose the individual to potentially lethal voltages that could result in personal injury or death if normal safety precautinos are not observed.

5-2. LINE VOLTAGE SELECTION

The Model 8500 may be operated from either 115V or 230V nominal 50-60Hz power sources. A special transformer may be installed for 100V and 200V ranges. The instrument was shipped from the factory set for an operating voltage of 230V. To change the line voltage, proceed as follows:

****
** WARNING **
****

Disconnect the Model 8500 from the power cord and all other sources before changing the line voltage setting.

1. Using a flat-blade screwdriver, place the line voltage selection switch in the desired position. The voltages are marked on the selection switch.
2. Install a power line fuse consistent with the operating voltage. See paragraph 5-3.

<u>CAUTION</u>

The correct fuse type must be used to maintain proper instrument protection.

5-3. FUSE REPLACEMENT

The Model 8500 has a line fuse to protect the instrument from excessive current. This fuse may be replaced by using the procedure described in the following :

****
** WARNING **
****

Disconnect the instrument from the power line and from other equipment before replacing the fuse.

1. Place the end of a flat-blade screwdriver into the slot in the LINE FUSE holder on the rear panel. Push in and rotate the fuse carrier one quarter turn counterclockwise. Release the pressure on the holder and its internal spring will push the fuse and the carrier out of the holder.

2. Remove the fuse and replace it with the proper type using Table 5-1 as a guide.

CAUTION

Do not use a fuse with a rating higher than specified or instrument damage may accure. If the instrument persistently blows fuses, a problem may exist within the instrument. If so, the problem must be rectified before continuing operation.

Table 5-1. Line Fuse Selection

Power Line Voltage	Fuse Type
90 -125V	0.2A, 250V, 5x20 mm Slow Blow
195-250V	0.4A, 250V, 5x20 mm Slow Blow

5-4. CHANNEL B OUTPUT AMPLIFIER OPTION FIELD INSTALLTION (option 1)

The Channel B output amplifier option adds another output channel to the Model 8500. This output is fully synchronized to the main output - Channel A. Period and triggering modes are common. All other parameters are independently set. Similar to Channel A, Channel B option also includes an auxiliary output which may be programmed to output a fixed level. Auxiliary voltage level is selectable between ECL and TTL.

If purchased with the Model 8500, the option will be factory installed; however the instrument may be easily upgraded in the field by installing the option as described in the following. Software modification is not required. The Model 8500 will automatically sense the impression of the installed option and will adjust the software routines accordingly.

Option 1 comprises 2 boards; designated as Pulse Width/Delay and Output Amplifier B and two coax cables with quick disconnect plugs. Model 8500 provides two empty slots which are left for the assembly of Channel B.

5-4-1. Option 1 Installation Procedure

1. Remove the top and bottom covers of the instrument as described in the disassembly instructions in paragraph 5-6.

****
** WARNING **
****

Disconnect the line cord and test leads from the instrument before removing the top cover.

2. Idetify the empty slot for the pulse width/delay board as shown in Figure 5-1. The information is printed on the main board. Also observe that the plug in connectors, when plugged to the correct slot, fit exactly to the plugged board.

3. Slide the pulse width/delay board along the card guide. Make sure that the connectors mate exactly. Press down the plug-in board firmly until it locks into place and the metal ears rest on the top rail of the cage. Secure the board to the rail using the provided screws.

4. Use the same procedure as described before to plug in the output amplifier board.

<u>CAUTION</u>

Make sure that the option is plugged correctly to the main connector that is, when the option board is secured into place, no pin on the main board should by left free.

5. Solder the loose end of the shielded wire, from the pulse width/delay board to the front panel connector which is marked AUX OUT B. Solder the inner wire to the center and the outside shield to the ground lug.

6. Solder the loose end of the shielded wire, from the output amplifier B to the front panel connector which is marked OUTPUT B. Solder the inner wire to the center and the outside shield to the ground lug.

7. Replace the bottom and top covers.

8. Turn power on and observe the power up procedure. If no other option is installed the instrument will display the following:

8500-1

This reading indicates that the instrument accepted the installed option and will now allow modification of parameters which are associated with Channel B.

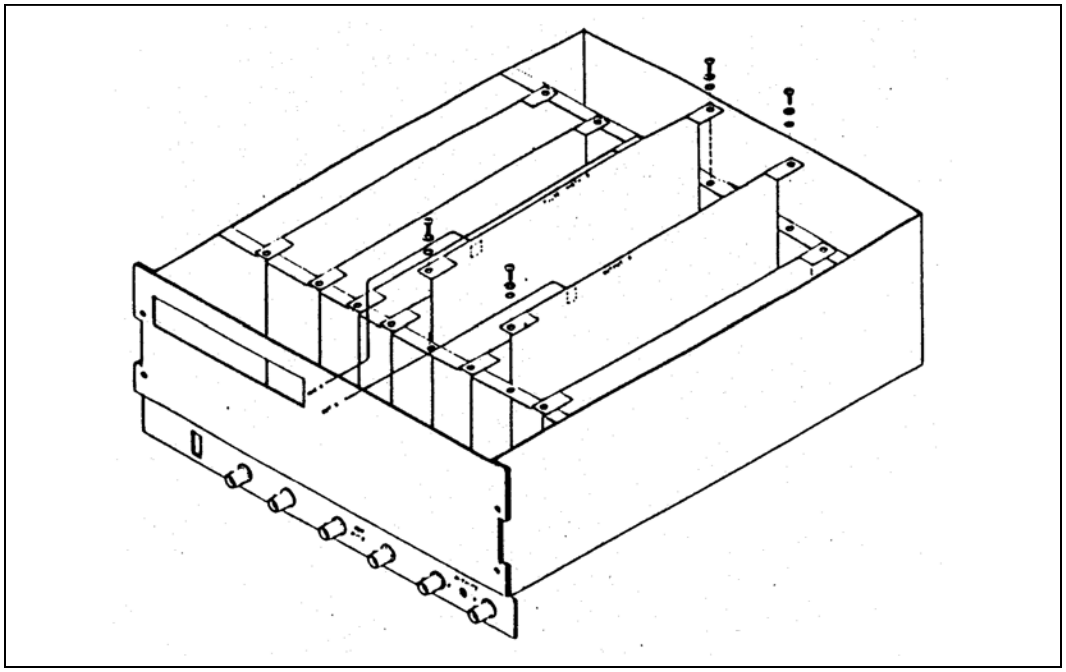

Figure 5-1. Channel B Option Field Installation.

5-5. UNIVERSAL COUNTER/TIMER OPTION FIELD INSTALLATION (option 2)

The universal counter/timer option improves the accuracy of the Model 8500 by incorporating the counter in a closed loop which automatically measures and corrects the V.C.O. Alternately, this option turns the Model 8500 into an independent counter/timer capable of measuring three independent external functions: frequency, period averaged and pulse width averaged. If purchased with the Model 8500, the option will be factory installed; however the instrument may be easily upgraded in the field by installing the option as described in the following procedure.

5-5-1. Option 2 Installation Procedure

1. Remove the top cover of the instrument as described in the disassembly instructions in paragraph 5-6.

****
** WARNING **
****

Disconnect the line cord and test leads from the instrument before removing the top cover.

2. Assembly of the counter option requires removal of the C.P.U board. Identify the C.P.U board and remove the screws which secure this board to the cage. There are two flat cable assemblies which are connected to the C.P.U board. Un-plug the two flat cables and lift the board from the cage (This is easier done if the V.C.O board is first removed).

3. Remove the three screws from the shield and remove the shield.

4. Assemble the supplied components: U9, U10, U11, U12, U13 and LK1 as shown in Figure 5-2. Note that all components can be plugged into sockets except U13 which has to be soldered to the board. Before soldering this IC observe that U13 is mounted correctly as printed on the board.

5. To assemble the C.P.U board reverse the disassembly procedure. Make sure that both flat cables are positioned correctly.

6. Secure the board to the rail using the provided screws.

7. Replace the top covers.

8. Turn power on and observe the power up procedure. If no other option is installed the instrument will display the following:

8500-2

This reading indicates that the instrument has accepted the installed option and is now ready, when selected, to operate as an independent 7 digits universal counter/timer.

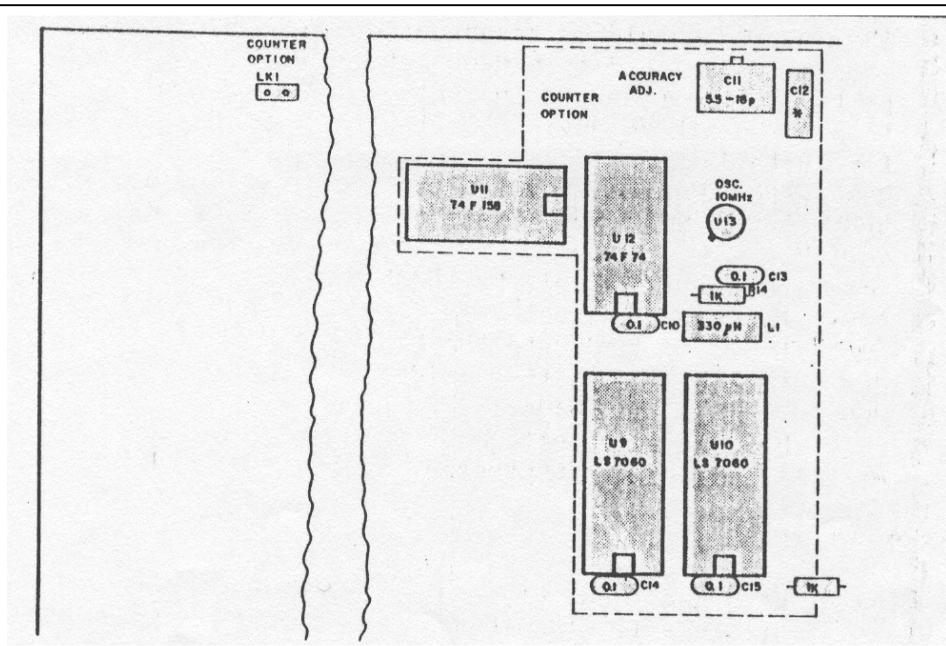

Figure 5-2. Counter Option Installation

5-6. DIASSEMBLY INSTRUCTIONS

If it is necessary to troubleshoot the instrument or replace a component, use the following disassembly procedure to remove the top and bottom covers:

1. Remove the two screws that secure the top cover to the rear panel.

2. Grasp the top cover at the rear and carefully lift it off the instrument. When the tabs at the front of the cover clear the front panel, the cover may be pulled completely clear.

3. Remove the eight screws that secure the bottom cover to the internal cage assembly.

4. Grasp the bottom cover and carefully lift it of the instrument.

5. When replacing the top and bottom covers, reverse the above procedure; be sure that the top cover tabs fit snugly into front panel recesses before completely installing the cover.

5-7. SPECIAL HANDLING OF STATIC SENSITIVE DEVICES

MOS devices are designed to operate at a very high impedance levels for low power consumption. As a result, any normnal static charge that builds up on your person or clothing may be sufficient to destroy these devices if they are not handled properly. When handling such devices, use precautions which are described in the following to avoid damaging them.

1. The MOS ICs should be transported and handled only in containers specially designed to prevent static build-up. Typically, these parts will be received in static-protected containers of plastic or foam. Keep these devices in their original containers until ready for installation.
2. Remove the devices from the protective containers only at a properly grounded work station. Also ground yourself with a suitable wrist strap.
3. Remove the devices only by the body; do not touch the pins.
4. Any printed circuit board into which the device is to be inserted must also be grounded to the bench or table.
5. Use only anti-static type solder sucker.
6. Use only grounded soldering irons.
7. Once the device is installed on the PC board, the device is normally adequately protected, and normal handling resume.

5-8. CLEANING

Model 8500 should be cleaned as often as operating condition require. Thoroughly clean the inside and the outside of the instrument. Remove dust from inaccessible areas with low pressure compressed air or vacuum cleaner. Use alcohol applied with a cleaning brush to remove accumulation of dirt or grease from connector contacts and component terminals.

Clean the exterior of the instrument and the front panel with a mild detergent mixed with water, applying the solution with a soft, lint-free cloth.

5-9. REPAIR AND REPLACEMENT

Repair and replacement of electrical and mechanical parts must be accomplished with great care and caution. Printed circuit boards can become warped, cracked or burnt from exessive heat or mechnical stress. The following repair techniques are suggested to avoid inadverant destruction or degradation of parts and assemblies.

Use ordinary 60/40 solder and 35 to 40 watt pencil type soldering iron on the circuit board. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the circuit from the base material. Keep the soldering iron in contact with the PC board for a minimum time to avoid damage to the components or printed conductors.

To desolder components use a commercial " solder sipper ", or better, solder removing SOLDER - WICK, size 3. Always replace a component with its exact duplicate as specified in the parts list.

5-10. PERFORMANCE CHECKS

The following performance checks verify proper operation of the instrument, and should normally be used :

a. As part of incoming inspection of instrument specifications;
b. As part of troubleshooting procedure;
c. After any repair or adjustment, before returning instrument to regular service.

5-10-1. Environmental Conditions

Tests should be performed under labortory conditions having an ambient temperature of 25 ±5 °C and a relative humidity of less than 80%. If the instrument has been subjected to conditions outside these ranges, allow at least one additional hour for the instrument to stabilize before beginning the adjustment procedure.

5-10-2. Warm-Up Period

Most equipment is subject to at least a small amount of drift when it is first turned on. To ensure accuracy, turn on the power to the Model 8500 and allow it to warm-up for at least 30 minutes before beginning the performance tests procedure.

5-10-3. Recommended Test Equipment

Recommended test equipment for troubleshooting, calibration and performance checking is listed in table 5-2. Test instruments other than those listed may be used only if their specifications equal or exceed the required minimal characteristics.

Table 5-2. Required Test Equipment.

Instrument	Recommended Model	Minimum Specifications	Use*
DMM	Tabor 4121	.1V- 100VDC 0.05%,Ω	P,A,T
Pulse Generator	Tabor 8201	0.5 S - 50 nS 0.1%	P,A,T
Counter/Timer	Tabor 6010	1 Hz - 125 Mhz 5PPM	P,A
Counter/Timer	Tabor 6020-1	1 Hz - 225 Mhz 1PPM	P,A,T
Synthesizer	Marconi 2219	1 MHz-1300MHz	P,A
Oscilloscope	Tektronics 2465A	350 MHz bandwidth	P,A,T
10 MHz Standard	Oscillatec	10 MHz ±10-12	P,A

* P= Performance Test, A= Adjustments, T= Troubleshooting

5-11. PERFORMANCE CHECKS PROCEDURE

Model 8500 has a special function which down-loads the required front panel set-ups for the various performance checks. To use this function depress the [SHIFT] push-button and then [5]. No readout indication will follow. The non-volatile memory is now loaded with front panel set-ups which can now be used for performance checks. The following set-ups and performance checks are identical for both channels A and B.

In the following, each procedure is associated with one memory location. Recalling a set-up will automatically update front panel parameters for the required test. No other set-up information will be given. To recall a particular set-up, use the procedure which is given in Section 3-9-2 or 3-9-2-1 of this maual.

****
** WARNING **
****

The memory down-load function will override any previous front panel set-ups. Before using this function be absolutely certain that information which is stored in the non-volatile memory is no longer required.

5-11-1. PERIOD ACCURACY CHECK

Equipment: Universal counter/timer (6020-1)

Procedure:

1. Connect the Channel A output connector to the counter input.

2. Set counter to period averaged measurements and 4 digits resolution and verify that counter reading is within the required results as follows:

MEASURED PERIOD	RECALL 8500 SET-UP	REQUIRED COUNTER READING	ALLOWED ERROR
14.0 nS	00	14.0 nS	±1.2 nS
20.0 nS	01	20.0 nS	±1.4 nS
177.7 nS	02	177.7 nS	±3.5 nS
1.777 µS	03	1.777 µS	±35 nS
17.77 µS	04	17.77 µS	±.35 µS
177.7 µS	05	177.7 µS	±3.5 µS
1.777 mS	06	1.777 mS	±35 µS
17.77 mS	07	17.77 mS	±.35 mS
177.7 mS	08	177.7 mS	±3.5 mS
0.900 S	09	1.900 S	±18 mS
1.999 S	10	1.999 S	±40 mS

5-11-2. PULSE WIDTH ACCURACY CHECK

Equipment: Universal counter/timer (6020-1)

Procedure:

1. Connect the Channel A output connector to the counter input.
2. Set counter to pulse width Averaged measurements and 4 digits resolution and verify that counter reading is within the required results as follows:

MEASURED PULSE WIDTH	RECALL 8500 SET-UP	REQUIRED COUNTER READING	ALLOWED ERROR
10 nS	02	10.0 nS	±2.0 nS
100 nS	03	100.0 nS	±3.0 nS
1000 nS	04	1.000 µS	±12 nS
10000 nS	05	10.00 µS	±100 nS
100.0 µS	06	100.0 µS	±1.0 µS
1.000 mS	07	1.000 mS	±10 µS
10.00 mS	08	10.00 mS	±100 µS
100.0 mS	09	100.0 mS	±1.0 mS
900 mS	10	900.0 mS	±9.0 mS

3. Repeat the above checks for channel B (if installed).

5-11-3. DELAY ACCURACY CHECK

Equipment: Universal counter/timer (6020-1)

Procedure:

1. Connect the SYNC out connector to the counter channel A.
2. Connect the Channel A OUTPUT connector to the counter channel B.
3. Set counter to time interval A to B averaged measurements and

verify that counter reading is within the required results as follows:

MEASURED PULSE WIDTH	RECALL 8500 SET-UP	REQUIRED COUNTER READING	ALLOWED ERROR
10 nS	02	10.0 nS	±2.0 nS
100 nS	03	100.0 nS	±3.0 nS
1000 nS	04	1.000 μS	±12 nS
10000 nS	05	10.00 μS	±100 nS
100.0 μS	06	100.0 μS	±1.0 μS
1.000 mS	07	1.000 mS	±10 μS
10.00 mS	08	10.00 mS	±100 μS
100.0 mS	09	100.0 mS	±1.0 mS
900 mS	10	900.0 mS	±9.0 mS

4. Repeat the above checks for channel B (if installed).

5-11-4. AMPLITUDE ACCURACY CHECK

Equipment: DMM (4121)

Procedure:

1. Connect the Channel A output connector to the DMM input.
2. Set the DMM to ACV measurements and verify that the DMM reading is within the required results as follows:

MEASURED PULSE WIDTH	RECALL 8500 SET-UP	REQUIRED COUNTER READING	ALLOWED ERROR
±8.00 V	11	8.000 V	±0.240 V
±4.00 V	12	4.000 V	±0.150 V
±1.50 V	13	1.500 V	±0.045 V
±400 mV	14	400.0 mV	±12.0 mV
±150 mV	15	150.0 mV	±4.5 mV

3. Repeat the above checks for Channel B (if installed).

5-11-5. TRANSITION TIMES ACCURACY CHECK

Equipment: Universal counter/timer (6010), oscilloscope

Procedure:

1. Connect the Channel A OUTPUT connector to the counter channel A.
2. Set counter to rise time averaged measurements and 4 digits resolution and verify that counter reading is within the required results as follows:

MEASURED PULSE WIDTH	RECALL 8500 SET-UP	REQUIRED COUNTER READING	ALLOWED ERROR
100.0 nS	16	100.0 nS	±7.0 nS
1000 nS	17	1.000 µS	±52 nS
10.00 µS	18	10.00 µS	±500 nS
100.0 µS	19	100.0 µS	±5.0 µS
1000 µS	20	1.000 mS	±50 µS
10.00 mS	21	10.00 mS	±500 µS

3. Set counter to fall time measurements and verify that counter reading is within the required results as follows:

MEASURED PULSE WIDTH	RECALL 8500 SET-UP	REQUIRED COUNTER READING	ALLOWED ERROR
100.0 nS	16	100.0 nS	±7.0 nS
1000 nS	17	1.000 µS	±52 nS
10.00 µS	18	10.00 µS	±500 nS
100.0 µS	19	100.0 µS	±5.0 µS
1000 µS	20	1.000 mS	±50 µS
10.00 mS	21	10.00 mS	±500 µS

4. Remove the cable from the counter and connect it to the oscilloscope input.
5. Set oscilloscope for a trace of 6 vertical divisions and verify rise/fall time reading as follows:

MEASURED RISE/FALL TIME	RECALL 8500 SET-UP	REQUIRED OSCILLOSCOPE TRACE
5 nS	22	5 nS

5-11-6 COUNTER ACCURACY AND TRIGGER SENSITIVITY CHECKS

Equipment: Synthesizer (2219)

Procedure:

1. Connect the Synthesizer output to the TRIG/COUNTER INPUT connector. Terminate the cable with a feed through 50Ω termination.

2. Connect the 10 MHz standard to the external reference input at the synthesizer.

3. Set synthesizer as follows:

Frequency: 100 MHz
Amplitude: 300 mV
Mode : External reference

4. Verify that 8500 display reading is as follows:

RECALL 8500 SET-UP	REQUIRED 8500 READING	ALLOWED ERROR
23	100.0000 MHz	±2 KHz

5-11-7. TRIGGER MODES OPERATION CHECKS

Equipment: Pulse/Function generator (8201), oscilloscope (2345), counter (6020-1)

Procedure:

1. Set 8201 controls as follows:

PARAMETER	SET-UP
FREQ	1 KHz
AMPL	1 Vp-p
OUTPUT	Square wave
MODE	Normal - continuous

2. Connect the output connector from the pulse generator to the TRIG INPUT. Terminate the cable with a feed through 50Ω termination.

3. Connect the 8500 SYNC OUT to the oscilloscopes's external trigger.

4. Set oscilloscope to external trigger and verify that Model 8500 outputs as follows:

VERIFIED MODE	RECALL 8500 SET-UP	REQUIRED OSCILLOSCOPE TRACE
GATED	24	GATED SIGNAL
TRIGGERED	25	TRIGGERED SIGNAL
BURST	26	BURSTS OF 2 PULSES

5. Remove all cables from the 8500.
6. Connect AUX OUT A connector to Channel B on the counter.
7. Set counter function to totalize B mode and trigger level B to 1.00 V. Reset counter.

8. Depress [MANUAL] push-button and verify that Model 8500 outputs as follows:

VERIFIED MODE	RECALL 8500 SET-UP	REQUIRED COUNTER READING	ALLOWED ERROR
MANUAL, BURST	27	65,500	±0

SECTION 6

THEORY OF OPERATION

6-1. INTRODUCTION

This section contains an overall functional description of the Model 8500 as well as detailed circuit analysis of the various sections of the instrument. Information pertaining to the standard IEEE-488 interface and the various options are also included.

Information is arranged to provide a description of individual functional circuit blocks. As an aid to understanding, the descriptions are keyed to accompanying block diagrams and simplified schematics. Detailed schematics and component layout drawings are located at the end of this instruction manual.

6-2. OVERALL FUNCTIONAL DESCRIPTION

The Model 8500 is a 7 digit pulse generator with a complete digital control over all pulse parameters such as period, pulse width, delay, transition times amplitude etc. The pulse generator utilizes a microprocessor circuit which permits high resolution and high accuracy programming of the various parameters. For example, pulse width may be programmed from 7 nS to 79.999 mS with steps of 1 nS.

Due to the complexity of the Model 8500 it was necessary to divide the instrument into functional sections and build each section on a different plug-in board. The use of the plug-in board system also simplifies troubleshooting and permits easy replacement of defective boards.

The system is constructed on a main board assembly. This board contain connectors and the necessary wires which connect between the various boards. The plug-in boards are supported by a cage. Card guides lead the boards to their matting connectors. Connectors on the plug-in boards are designed so that each board will only fit to one slot. This system simplifies board location identification.

Each board is marked with its function. The same markings are inscribed on the main board. Only two boards are interchangeable. They are: pulse width/delay A and pulse width/delay B. All other boards should be plugged exactly as marked on the main board.

Information is arranged to provide a description of individual plug-in board. Description includes functional circuit blocks and theory of operation. As an aid to understanding, the descriptions are keyed to accompanying block diagrams and simplified schematics. Detailed schematics and component layout drawings are located at the end of this instruction manual.

6-3. POWER SUPPLY BOARD

The power supply board generates the necessary voltage levels which are essential for operating the various circuits. The following paragraphs contain a description of the power supply board. Its

circuit and components location drawing may be found at the end of this manual.

The power supply board generates seven different voltage levels. These are: +24 V, -24 V, +15 V, -15 V, +5 V, -5 V, and -2.5 V. CR1 rectify the ac voltage for U1 and U2 which generate the +24 V and -24 V respectively. U3 and U6 generate the -15 V and +15 V respectively. U5 regulates the -2.5 V. Its input is driven by the -5 V supply.

The +5 V and the -5 V supplies are made of a switching circuit. Figure 6-1 is a simplified block diagram describing a common switching supply circuit.

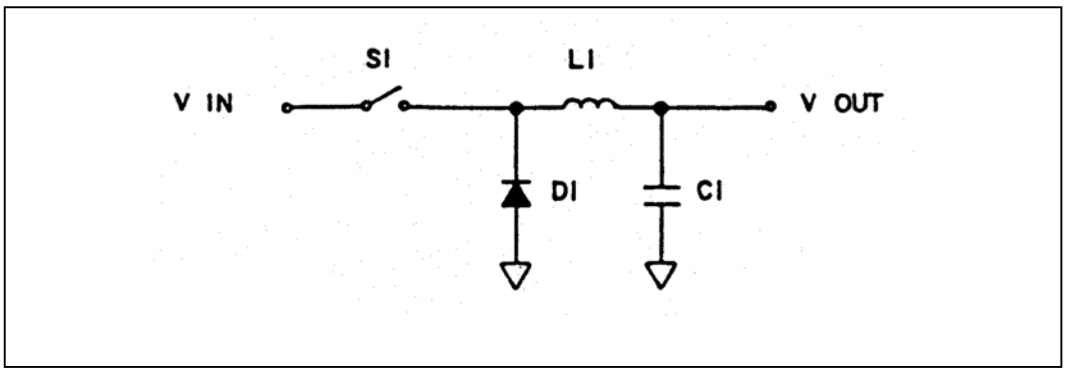

Figure 6-1. Switching Power Supply - Simplified Block Diagram

In the above block diagram, when S1 is switched on, D1 is reverse biased, allowing current from Vin to flow through L1 to the load at Vout. Switching off S1 causes the energy which is stored in L1 to drive Vout. C1 stores energy during transition times and also filters Vout. Vout is a function of the switch time off - T1 and switch time on - T2 as expressed in the following formula:

$$Vout = \frac{T1}{T1 + T2} Vin$$

The above theory is applied to the circuit which is used in the Model 8500. The +5 V supply is made of a switch - Q4, Q5 and their associated components. A switch controller - U7 and its associated components. A coil - L2 and a filtering capacitor C17.

U7 is a self oscillating circuit. Its output is switched on and off when the output voltage (Vout) exceeds a reference voltage which is generated internally by R21 and R22. The comparator generates the correct duty cycle which controls the output voltage as expressed in the above formula. CR6 prevents Vout from exceeding +5 V which may damage TTL devices.

Similarly, the - 5 V supply is made of a switch - Q1 and Q2 and their associated components. A switch controller - U4 and its associated components. A coil - L1 and decoupling capacitor C24 and C25. Voltage reference is generated by R11 and R12.

6-4. C.P.U BOARD

The C.P.U board controls front panel traffic, generates serial information which drives the various serial to parallel converters, controls the internal 8 bit bus and its handshake commands, controls its memory bank including the non-volatile memory bank and provides the required circuits for the counter functions. The C.P.U board also contains the circuits which are necessary for the GPIB interface. The following paragraphs contain a description of the C.P.U board. Its circuit and components location drawing may be found at the end of this manual.

6-4-1. CPU Block Diagram

Circuit operation centers around the CPU unit, U4. The 8031 is an 8-bit CPU capable of directly addressing up to 64K bytes of program memory (ROM) and up to another 64K bytes of data memory (RAM). The CPU works with a 10 MHz clock which is divided internally to provide a bus operation of about 1MHz.

Software for the CPU is contained in an EPROM (Erasable Programmable Read-Only Memory). U7 is a 27256 EPROM containing 32K bytes of software. Temporary non-volatile storage is provided by U8, RAM (Random Access Memory) which can store up to 2048 bytes of information.

Interfacing between the CPU and the IEEE bus is performed by dedicated IEEE-488 bus interface IC, U14. This IC performs many bus functions automatically to minimize CPU overhead. Buffering between the 8291 IC and the IEEE bus lines is done with bus drivers U14 and U15.

Interfacing between the CPU to the keyboard and the display is performed by the Keyboard/Display interface IC - U1.

U20 is an eight bit D to A converter which generates an analog voltage for the trigger level circuit. U21 is a D to A converter which generates an analog voltage for the V.C.O circuit. U21 is buffered by U22, Q8 and their associated components.

6-4-2 Memory Mapping

The 8031 CPU is capable of directly addressing two banks of 64k (65,536) bytes memory. One bank of memory is the program memory and the second memory bank is the data memory. The selection of the banks is done internally by the CPU. Although the CPU has this large addressing capability, only a portion of the possible memory space is actually needed.

The Model 8500 uses a total of 32K of program memory stored in the 27256 EPROM U7, and a total of 1K of data memory is stored in U8 and. The 8031 CPU uses a memory-mapped I/O scheme, additional memory location must be aloacted for the various I/O function. All the memory-mapped I/O functions are in the data memory space. Table 6-1 lists the memory locations for the various memory elements.

Because of a partial decoding scheme used in this instrument, for some memory elements, a larger memory slot is allocated than the actual memory needed.

Table 6-1. Model 8500 Memory Mapping

Selected Device/Operation	Allocated Memory	Actual Memory Locataion
CS for DAC 1	6800H - 6FFFH	6800H
CS ofr DAC 2	7000H - 77FFH	7000H
VCO Reset	7800H - 7FFFH	7800H
Strobe for TTL shift register	8000H - 87FFH	9000H
Strobe for ECL shift register	8800H - 8FFFH	8800H
GPIB interface	9000H - 97FFH	9000H - 9009H
RAM	9800H - 9FFFH	9800H - 9FFFH
Reset for 7060	A000H - A7FFH	A000H
CS for N1 & N2	A800H - AFFFH	A800H
Key board and display control	B000H - B7FFH	B000H, B001H
Scan reset for counters N1 & N2	B800H - BFFFH	B800H

6-4-3. Address Decoding

The CPU has a total of 16 address lines which are used to locate a specific memory slot. The LOW address line (A0 to A7) are multiplexed on the address/data bus, and the ALE (address latch enable) signal is used to separate the LOW address from the address/data bus witch is done by U6 address latch. Since no memory or interface element can fully decode address locations, additional address decoding must be used.

U2 and U19 are 1-of-8 decoder. The decoders are enabled by A14 and A15. Once the decoder is selected the decoding is done by addressing lines A11, A12, A13, A14 and A15.

6-4-4. Reciprocal Counter/ Timer

The Model 8500 features a built-in universal counter/timer. This counter employs the reciprocal measurement technique which gives an outstanding resolution, in frequency measurements, throughout the specified frequency range. Although complex, this technique requires only a few integrated circuits. Model 8500 displays its counter reading with 7 digit plus exponent.

The counter comprises a highly accurate reference oscillator - U13, two counting registers - U9 (N1) and U10 (N2), synchronizer - U12 and selector U11. A fixed gate time of about 1 second is generate by the microprocessor. U9 and U10 are connected directly to the data bus. Information from these circuits are processed and converted to frequency measurement using the following formula:

$$F = \frac{N1}{N2 \times T}$$

where; T = the period of the reference clock

6-4-5. Keyboard/Display Interface

The Keyboard/Display Interface IC U1 is used to control the front panel display and to find out which one of the buttons was pushed.

6-4-6. IEEE Interface

The Model 8500 has a built in IEEE-488 interface that allows the instrument to be controlled through the system controller. Commands may be given over the bus and data may be requested from the instrument as well.

The IEEE interface is made up of U14, a 8291 GPIA (General Purpose Interface Adapter), and U15 and U16, which are interface bus drivers. On the CPU side of the GPIA, data transmission is handled much like any other bus transaction. The CPU accesses the GPIA through the usual D0 through D7 data lines. Address decoding for the internal 14 registers (7 read and 7 write) is provided by the CS, WR, RD and A0, A1, A2 terminals.

The output of the 8291 IC is standard IEEE format; the eight data lines (DIO1 through DIO8) the three handshake lines (DAV, NDAC, NRFD), and the five management lines (ATN, REN, IFC, SRQ, EOI), are all active low with approximately zero volts representing a logic one. The two IEEE bus drivers, U15 and U16 are necessary to bring the drive capability of the interface up to the normal IEEE maximum 15 devices.

The GPIA simplifies CPU interfacing to the IEEE bus because many control sequences take place automatically. For example, when a write is done to the data output register, the handshake sequence is automatically performed at the proper time. Without the GPIA chip, complicated CPU routines would be required to accomplish control sequence that are performed automatically.

6-5. V.C.O BOARD

The VCO board comprises a few functional blocks which are closely related to the oscillator circuit. The main part is the voltage controlled oscillator which, under microprocessor control, generates the output repetition rate. This board also includes input amplifier for the trigger and the counter circuit, burst generator, and the necessary circuit for the various triggering options. The following paragraphs contain a description of the V.C.O board. Its circuit and components location drawing may be found at the end of this manual.

6-5-1. Control Circuit

The control circuit generates the correct digital words which are necessary to control the analog circuits. There are two control chains

TTL chain - U30 through U32 and ECL chain - U33 through U36. U9b, U9c, U10b, U11a and U13d are gate selectors which select the appropriate signal to drive the trigger circuit.

6-5-2. Current Generator

The current generator provides accurate current which are necessary to drive the V.C.O circuit. The current generator comprises D/A convertor U16, reference diode CR1 U2, Q10, U36, Q1 and their associated components. Voltage is generated by the D/A convertor is accurately controlled and directly proportional to the output period. U3a, Q11, U4a, Q12, Q21 and their associated components provide a mirror multiplier and base line correction for the V.C.O and the clamp circuit.

6-5-3. Current Controlled Oscillator & Clamping Circuit

The current controlled generator and the clamping circuit are described in the following simplified block diagram.

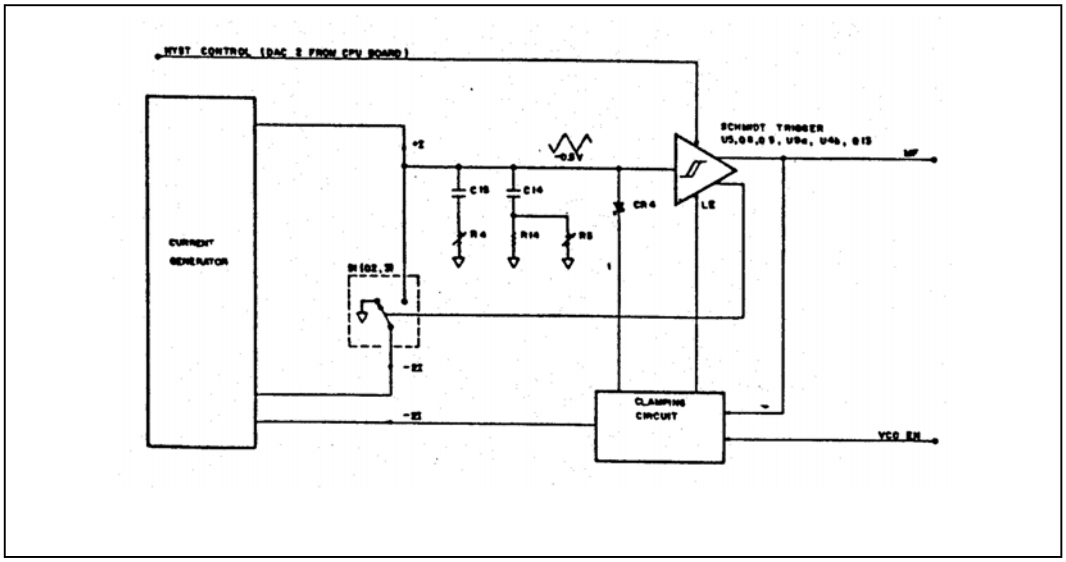

Figure 6-2. C.C.O & Clamping Circuit- Simplified Block Diagram

C14 is charged by a constant positive current from the current generator until the upper threshold of 0 V is reached. The shmidt trigger circuit then changes its state and negative current is now flowing from the current generator charging C14 with negative current until the negative threshold level of -0.5 V is reached. The shmidt trigger circuit then again changes state. This sequence generates oscillation of a square wave with 50 % duty cycle and having an ECL level. this oscillation is then translated to the actual output period at the output terminal. C14 is used at periods from 20 nS to 199.9 nS and C15 is used from 200 nS to 2 S. Q4 selects between these two capacitors.

The clamping circuit disables the oscillation of the V.C.O circuit at times when the instrument is set to operate at triggered gated or burst modes. The VCO enable is then set to low and Vclamp through CR4 forces the level on the timing capacitor to -0.5 V ensuring an

accurate first period in gated and burst modes after the VCO EN becomes true. The base line compensation ensures a -0.5 V level at pin 4 of U5 regardless of the period setting.

6-5-4. Trigger/Counter Input Circuit

The trigger circuit conditions the input signal for the proceeding circuitry. The signal is routed from the input connector to the shmidt trigger amplifier - Q19,Q20, U15 and their associated components. R101, R97, C43 and C46 attenuate the input singal by 4. U29 shifts the DC level to around -1.29 V. The DAC1 circuit generates the required trigger level offset. U8b select between positive or negative slopes. U15b disables the trigger circuit when the instrument is set to operate at normal mode.

6-5-5. Gated/Burst circuit

The heart of the gated/burst circuit is U24a. The trigger signal is received from the trigger input circuit and is applied through U11b to the D input of U24a. The clock input at U24a is fed by U10a which selects between the outputs of U9c and U10b. U10a also serves as the burst clock to the burst counter chain - U23, U25, U27, U28 and their associated components. The burst stop signal drives the D input of U24a through U26. Q15 through Q18 and their associated components convert the ECL level from U8c to TTL and shapes the output for the SYNC drive at the SYNC OUT connector. U14 and delay lines DL1 through DL4 delay the SYNC out signal so that the main output and the SYNC output signals come at the same time. U6a is connected as a time stretcher which stretches the input triggering signal for the microprocessor circuit.

6-6. PULSE WIDTH/DELAY BOARD

When both channels A and B are installed, two pulse width/delay boards are installed. Both boards are exactly identical and will be referred in the following as pulse width/delay board.

The pulse width/delay board comprises pulse width generator, delay generator, programmable dividers, auxiliary output amplifier, normal/complement selector and digital control circuitry. The following paragraphs contain a description of the pulse width/delay board. Its circuit and components location drawing may be found at the end of this manual.

6-6-1. Control Circuit

The control circuit generates the correct digital words which are necessary to control the various circuits. there are two control chains TTL chain - U33 through U34 and ECL chain - U35 through U40.

6-6-2. Pulse Width Circuit

The heart of the pulse width circuit is a gateable 50 MHz oscillator - U17c and its associated components. U16b controls the

start and stop sequence of U17c and later provides the signal for the auxiliary output circuit. The 50 MHz from U17c is routed to a 3 digit divide by N counter which consists of U15 and U26 through U28. The signal is then routed through U25a to a divide by 10n range counter which is formed by U1, U11 and U23. When all the outputs from the range counter turn logical "1", U2 and U14a enable the gate U3c which in turn permits transitions from U15 to pass through the propagation delay chain - DL1 through DL6 which then provides the stop pulse for the control flip-flop - U16b. The start signal for the control flip-flop is generated by the V.C.O board.

6-6-3. Delay Circuit

The heart of the delay circuit is a gateable 50 MHz oscillator - U22c and its associated components. U21a controls the start and stop sequence of U22c. The 50 MHz from U22c is routed to a 3 digit divide by N counter which consists of U18 and U29 through U31. The signal is then routed through U25b to a divide by 10n range counter which is formed by U12, U22 and U24. When all the outputs from the range counter turn logical "1", U13 and U14b enable the gate U7c which in turn permits transitions from U18 to pass through the propagation delay chain - DL7 through DL11 which then provides the stop pulse for the control flip-flop - U21a. The start signal for the control flip-flop is generated by the V.C.O board.

6-6-4. Auxiliary Output Buffer

The auxiliary output buffer may output either a TTL level or ECL level and is being controlled by the switch - Q3 and Q6 and their associated components. The output buffer comprises Q4, Q5 and emitter followers Q7through Q10 and their associated components.

6-7. RISE/FALL TIME BOARD

The rise/fall time board receives the ECL signal from the pulse width/delay board and is responsible for modifying its transitions to the programmed leading and trailing edge times. This board is also controls the amplitude of the pulse as it enters the final amplification stage. The rise time/fall time board is active only in conjunction with channel A. The rise/fall time board contain control circuit, current generator, fast path current switch, slow path current switch and range capacitors, FET buffer and trans-conductance amplifier. The following paragraphs contain a description of the rise/fall time board. Its circuit and components location drawing may be found at the end of this manual.

6-7-1. Control Circuit

The control circuit generates the correct digital words which are necessary to control the various circuits. The control circuit comprises a serial to parallel chain U22 through U26. Q43, U20 and their associated components control the path of the input signal. Fast transition times are routed to the "fast" current switch. When linear transition times are required, the output of this selector drives the "slow" current switch.

6-7-2. "Fast" Current Path

The fast current switch comprises Q23 through Q26. When fast transition times are required, K2 is switched to the junction of Q23 and Q25. D/A converter - U1, U2 through U6, Q1 through Q6 and their associated components control the voltage level of the fast transition times pulse.

6-7-3. "Slow" Current Path

The current switch for the "slow" path consists of the emitter coupled transistors Q15 through Q18 and their associated components. The voltage is limited at its positive rail by Q19 and Q20 and to its negative limit by Q21 and Q22. When linear transitions is selected, K2 is switched to the trans-conductance amplifier - collector of Q37.U9, U14, U8, U10, U11, U12, U15 through U17 and Q7 through Q13 with their associated components, generate the positive and negative currents which are necessary to drive the "slow" current switch and control the amplitude level. U28, Q27 through Q31 and their associated components select a range capacitor which, when charged by the "slow" current switch, generates linear transitions. Range capacitors consists on C21 through C28. The linear transitions are then buffered by the FET amplifier - Q32, level shifted by Q33 and Q34 and routed to the trans-conductance amplifier Q36 through Q40 and their associated components. The signal is then routed via K2 to the output amplifier board.

6-8. OUTPUT AMPLIFIER - CHANNEL A

The output amplifier - A generates the required power for driving high frequency pulses into a impedance of 50Ω. The output amplifier board contains a control circuit, floating power supply, offset amplifier, attenuator, low frequency amplifier and high frequency amplifier.The following paragraphs contain a description of the output amplifier board. Its circuit and components location drawing may be found at the end of this manual.

6-8-1. Control Circuit

The control circuit generates the correct digital words which are necessary to control the floating power supply and the offset circuit. The control circuit comprises a serial to parallel converter chain U1, U3 and U6.

6-8-2. Floating Power Supply

The floating power supply generates +24 V and -24 V which can be offset in reference to the gnd level. However, the overwhole amplitude span of 48 V is preserved. U2 and U4 generate the voltage levels which offset the power supplies. U14 and Q5 through Q9 generate the positive supply rail. U13 and Q1 through Q4 generate the negative supply rail.

6-8-3. Offset Generator

The offset generator comprises x1 offset generator and x10 offset generator. x1 offset is generated by the D/A U8 and operational amplifiers U11 and U12 and their associated components and applied to the power amplifier through R64 and R65. Voltage reference for the offset generator is supplied from the C.P.U board. The x10 offset is switched in only at low amplitude levels. Offset is divided by R66 and R69 and is switched on and off by Q16.

6-8-4 Attenuator and High and Low frequency Amplifiers

Pulse is routed from the rise/fall time board via a coax cable to the attenuator. K1 through K3 and R27 through R35 attenuate the signal to the programmed amplitude level. The signal is then routed to the trans-impedance amplifier which has two parallel amplifiers: low frequency path and high frequency path.

The low frequency amplifier comprises U10 and its associated components. The high frequency amplifier comprises Q10 through Q29 and their associated components. U9, Q12 and Q13 and their associated components compensate for the offset current of the amplifier while U10 and its associated components compensate for the offset voltage, amplifies the low frequency components of the signal and applies the offset current to the power amplifier. Q20 through Q27 are power transistors which are connected in parallel to have a sufficient power capability to drive high frequency and high amplitude levels into a 50Ω load.

6-9. OUTPUT AMPLIFIER - CHANNEL B

The output amplifier for channel B generates the required power for driving high frequency pulses into a impedance of 50Ω. The output amplifier board contains a control circuit, Pulse shaper, amplitude controller, offset amplifier, attenuator, low frequency amplifier and high frequency amplifier. The following paragraphs contain a description of the output amplifier board. Its circuit and components location drawing may be found at the end of this manual.

6-9-1. Control Circuit

The control circuit generates the correct digital words which are necessary to control the floating power supply and the offset circuit. The control circuit comprises a serial to parallel converter chain U4, U5, U7 and U9.

6-9-2. Pulse Shaper and Amplitude control

The pulse shaper consists of Q1 through Q4 and their associated components. The amplitude is controlled by the D/A converter - U3, U2a and Q5 and by the positive and negative current generators U6a and U6b respectively and their associated components.

6-9-2. Offset Generator

The offset generator comprises x1 offset generator and x10 offset generator. x1 offset is generated by the D/A U10 and operational amplifiers U11 and U15 and their associated components. Voltage reference for the offset generator is supplied from a zener diode CR8. The x10 offset is switched in only at low amplitude levels. Offset is generated by U14 and its associated components and is switched on and off by Q16.

6-9-3 Attenuator and High and Low frequency Amplifiers

Pulse is routed from the pulse shaper to the attenuator. K1 through K3 and R31 through R39 attenuate the signal to the programmed amplitude level. The signal is then routed to the trans-impedance amplifier which has two parallel amplifiers: low frequency path and high frequency path.

The low frequency amplifier comprises U13 and its associated components. The high frequency amplifier comprises Q10 through Q25 and their associated components. U9, Q12 and Q13 and their associated components compensate for the offset current of the amplifier while U13 and its associated components compensate for the offset voltage, amplifies the low frequency components of the signal and applies the offset current to the power amplifier. Q21 through Q25 are power transistors which are connected in parallel to have a sufficient power capability to drive high frequency and high amplitude levels into a 50Ω load.

SECTION 7

ADJUSTMENTS

7-1. INTRODUCTION

This section contains information necessary to adjust the Model 8500, the Channel B output amplifier (option 1) and the universal counter/timer (option 2).

WARNING

> The procedures described in this section are for use only by qualified service personnel. Do not perform these procedures unless qualified to do so. Many of the steps covered in this section may expose the individual to potentially lethal voltages that could result in personal injury or death if normal safety precautions are not observed.

7-2. ADJUSTMENTS

7-2-1. Environmental Conditions

Adjustments should be performed under laboratory conditions having an ambient temperature of 25 ±5 °C and a relative humidity of less than 70%. If the instrument has been subjected to conditions outside these ranges, allow at least one additional hour for the instrument to stabilize before beginning the adjustment procedure.

7-2-2. Warm-Up Period

Most equipment is subject to at least a small amount of drift when it is first turned on. To ensure long-term calibration accuracy, turn on the power to the Model 8500 and allow it to warm-up for at least 30 minutes before beginning the adjustment procedure.

7-2-3. Recommended Test Equipment

Recommended test equipment for calibration is listed in Table 5-2. Test instruments other than those listed may be used only if their specifications equal or exceed the required characteristics.

7-2-4. Adjustment Procedures

All adjustments are performed with the POWER switch ON. The top cover should be removed to allow access to test points and adjustments. Between adjustments, always leave top cover on the unit to keep internal temperature.

WARNING

Take special care to prevent contact with live circuits or power line area which could cause electrical shock resulting in serious injury or death. Use an isolated tool when making adjustments. Use plastic or nylon screw-driver when adjusting the time base trimmer as other material will cause confusion in this adjustment.

Refer to the schematic and components location drawings at the end of this manual, throughout the following adjustment procedures. Adjustment points are highlighted on the components location diagrams. Follow this procedure in the sequence indicated because some of the adjustments are interrelated and dependent on the proceeding steps.

Verify that Model 8500 is functioning according to the performance checks. Make sure that all results are within, or close to, the range of the required specifications, otherwise troubleshoot the instrument and correct the fault.

Center all trimmers and if necessary, remove selected components and clear the holes to allow a selection of new components.

Perform the following adjustment procedure. Adjustments can not be made to obtain a specific result if other problem exists within the instrument.

7-3. ADJUSTMENT PROCEDURE

Model 8500 has a special function which down-loads the required front panel set-ups for the various adjustment procedures. To use this function depress the [SHIFT] push-button and then [6]. No readout indication will follow. The non-volatile memory is now loaded with front panel set-ups which can now be used for the following adjustment procedures.

In the following, each procedure is associated with one memory location. Recalling a set-up will automatically update front panel parameters for the required procedure. No other set-up information will be given. To recall a particular set-up, use the procedure which is given in Section 3-9-2 or 3-9-2-1 of this maual.

****
** WARNING **
****

The memory down-load function will override previous front panel set-ups. Before using this function be absolutely certain that information which is stored in the non-volatile memory is no longer required.

7-3-1. TRIGGER INPUT SENSITIVITY ADJUSTMENT

Equipment: Pulse/Function generator (8201), Oscilloscope (2465A)

Procedure: Performed on V.C.O board assembly

1. Set 8201 controls as follows:

   Output - Sinewave
   Frequency - 1 KHz
   Amplitude - 500 mVp-p
   Offset - 0 V
   Symmetry - 50 %

2. Connect the test instruments as described in Figure 7-1.

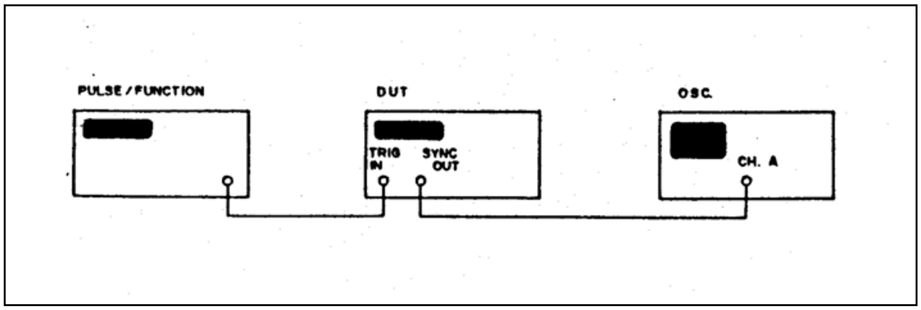

Figure 7-1. Trigger Input Sensitivity Adjustment.

3. Recall memory, set oscilloscope and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED OSCILLOSCOPE TRACE	ALLOWED ERROR
1	00	V.C.O R7	Rectangular wave with 50 % duty cycle	±5 %

7-3-2. TRIGGER INPUT H.F COMPENSATION ADJUSTMENT

Equipment: Pulse/Function generator (8201), Oscilloscope (2465A), 2 Extension cables, x10 Probe

Procedure: Performed on V.C.O board assembly

1. Remove the V.C.O board assembly from the cage and connect to the main board through the extension cables. Make sure that all plugs are connected correctly and no pins are left open.

2. Set 8201 controls as follows:

Output - Squarewave
Frequency - 100 KHz
Amplitude - 1 Vp-p
Offset - 0 V
Symmetry - 50 %

3. Connect the x10 probe to U15 pin 5. Connect the ground terminal to U15 pin 1.

4. Recall memory, set oscilloscope and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED OSCILLOSCOPE TRACE
2	00	V.C.O C46	Rectangular wave with min over/undershoots

7-3-3 REFERENCE OSCILLATOR ADJUSTMENT (with option 2 installed)

Equipment: 10 MHz standard

Procedure: Performed on C.P.U board assembly

1. Connect the 10 MHz standard to the 8500 TRIG/COUNTER INPUT.
2. Recall memory and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED DISPLAY READING	ALLOWED ERROR
3	00	C.P.U C11	10.00000 MHz	±100 Hz

7-3-4. PERIOD ADJUSTMENT

Equipment: Counter (6020)

Procedure: Performed on V.C.O and C.P.U board assemblies

1. Rotate trimmers as follows. Leave the rest untouched:

R3 - Midway
R4 - Fully clockwise
R5 - Fully counterclockwise

2. Connect Model 8500 output A to counter channel A input and set counter controls as follows:

Function - Period averaged
Gate time - 100 mS
Trigger level - 0.00 V
Impedance - 50Ω
Displayed digits - 4

3. Recall memories and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED COUNTER READING / REMARKS	ALLOWED ERROR
4	01	V.C.O R1	500.0 nS	±2 nS
5	02	V.C.O R4	210.0 nS	±1 nS
6			Repeat steps 4-5	
7	03	V.C.O R3	1.900 µS	±2 nS
8			Repeat steps 4-7	
9	04	V.C.O R2	190.0 nS	±.5 nS
10	05	V.C.O R5	32.00 nS	±.1 nS
11			Repeat steps 9-10	
12	06	C.P.U R16	18.00 nS	±.5 nS

7-3-5 FIRST PERIOD ADJUSTMENT

Equipment: Pulse/Function generator (8201), Oscilloscope (2465A)

Procedure: Performed on V.C.O board assembly

1. Set 8201 frequency output to 10 KHz.
2. Connect the test instruments as described in Figure 7-2.

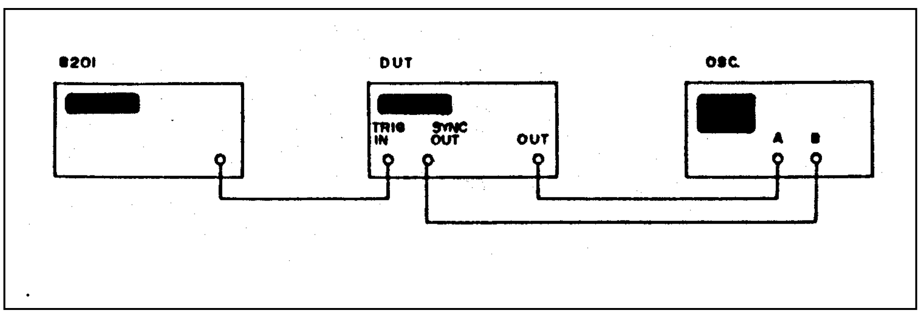

Figure 7-2. First Period Adjustment.

4. Recall memory, set oscilloscope to positive trigger, synchronize on Channel B and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED OSCILLOSCOPE TRACE	ALLOWED ERROR
13	01	V.C.O R6	First period 500 nS	±5 nS

5. Change 8201 frequency to 100 KHz

6. Recall memory, change oscilloscope setting to x10 and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED OSCILLOSCOPE TRACE	ALLOWED ERROR
14	05	V.C.O C40	First period 32 nS	±1 nS

7-3-6 PULSE WIDTH ADJUSTMENT

Equipment: Counter (6020)

Procedure: Performed on Pulse Width/Delay board assembly

1. Set counter to Pulse Width Averaged measurements and connect 8500 OUTPUT A to counter. Use 50Ω feedthrough termination at the counter input.
2. Recall memory and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED COUNTER READING	ALLOWED ERROR
15	07	P/W A C21	3.999 mS	±10 µS

3. If Channel B (option 1) is installed, perform step 15 on pulse width/delay B board assembly.

7-3-7 DELAY ADJUSTMENT

Equipment: Counter (6020)

Procedure: Performed on Pulse Width/Delay board assembly

1. Set counter to Time Interval A to B measurements.

2. Connect 8500 SYNC OUTPUT connector to Channel A on the counter. Connect 8500 OUTPUT A connector to Channel B on the counter. Use 50Ω feedthrough termination at the counter input.

3. Recall memory and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED COUNTER READING	ALLOWED ERROR
16	08	DELAY A C25	3.999 mS	±10 µS

3. If Channel B (option 1) is installed, perform step 16 on pulse width/delay B board assembly.

7-3-8. CHANNEL A - AMPLITUDE ADJUSTMENT

7-3-8-1. AMPLITUDE ADJUSTMENT - FAST TRANSITION

Equipment: DMM (4121), 50Ω feedthrough terminator

Procedure: Performed on Rise/Fall Time board assembly

1. Set DMM to DCV measurement and to 30 V range.
2. Connect 8500 Channel A output to the DMM.
3. Recall memory and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED DMM READING	ALLOWED ERROR
17	09	RISE R14	+8.000 V	±50 mV
18	10	RISE R6	-8.000 V	±50 mV

7-3-8-2. AMPLITUDE ADJUSTMENT - LINEAR TRANSITIONS

Equipment: DMM, 50Ω feedthrough terminator

Procedure: Performed on Rise/Fall Time board assembly

1. Set DMM to DCV function and 20V range. Connect ground terminal to case ground.
2. Recall memory and perform adjustments as described in the following table.
3. Connect DMM V terminal to collector of Q20 and collector of Q22 in steps 19 and 20 respectively.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED DMM READING	ALLOWED ERROR
19	11	RISE R2	Q20 +2.30 V	±10 mV
20	11	RISE R12	Q22 -2.30 V	±10 mV

4. Remove DMM probes and Connect 8500 Channel A output to the DMM.
5. Recall memory and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED DMM READING	ALLOWED ERROR
21	11	RISE R89	0 V	±20 mV
22	12	RISE R12	+8.000 V	±50 mV
23	13	RISE R2	-8.000 V	±50 mV

7-3-9. LINEAR TRANSITIONS ADJUSTMENT

Equipment: Counter (6010), 50Ω feedthrough termination

Procedure: Performed on Rise/Fall Time board assembly

1. Set counter to Rise A measurement and fast gate time. Connect 8500 OUTPUT A to counter channel A.
2. Recall memory and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED COUNTER READING	ALLOWED ERROR
24	14	RISE R43	1.000 mS	±0.1 mS
25	14	FALL R30	1.000 mS	±0.1 mS
26	15	RISE C21	100 nS	±1 nS
27	16	RISE C23	1000 nS	±5 nS
28	17	RISE C24	10.00 μS	±50 nS

7-3-10. CHANNEL A - PULSE RESPONSE ADJUSTMENT

Equipment: Oscilloscope (2465A), DMM, x10 attenuator (50Ω)

Procedure: Performed on Output Amplifier A board assembly

1. Remove shorting links LK1 and LK2.
2. Set DMM to DCV function and 100V range. Connect ground terminal to case ground.
3. Perform adjustments as described in the following table.
4. Connect DMM V terminal to LK1 and and LK2 in steps 28 and 29 respectively.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED DMM READING	ALLOWED ERROR
29	18	OUT A R37 LK1	-24.0 V	±100 mV
30	18	OUT B R36 LK2	+24.0 V	±100 mV

5. Remove DMM probes from 8500 output amplifier A.

6. Connect 8500 OUTPUT A to oscilloscope input through a x10 attenuator and set oscilloscope input impedance to 50Ω.

7. Set R74 at mid-position.

8. Recall memory, set oscilloscope and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED OSCILLOSCOPE TRACE
31	18	OUT A C25	Best pulse response
32	18	OUT A C37	Best pulse response
33			Repeat steps 31-32
34	19	OUT A R74	Best pulse response
35			Repeat steps 31-34
36	20	OUT A R73	Best pulse flatness
37	21	OUT A R73	Best pulse flatness
38			Repeat steps 36-37

NOTE

Pulse response adjustment may have an effect on the amplitude. If necessary, repeat steps 7-3-8 and 7-3-9.

7-3-11. CHANNEL A - OUTPUT OFFSET ADJUSTMENT

Equipment: DMM, 50Ω feedthrough termination

Procedure: Performed on Output Amplifier A board assembly

1. Set DMM to DCV function and 20 V range.

2. Connect 8500 OUTPUT A to DMM input. Terminate DMM input with a 50Ω termination.

3. Recall memory and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED DMM READING	ALLOWED ERROR
39	22	OUT A R52	+7.950 V	±50 mV
40	23	OUT A R69	+1.000 V	±5 mV

7-3-12. SYSTEM DELAYS ADJUSTMENT

Equipment: Oscilloscope (2465A), Two identical BNC cables

Procedure: Performed on V.C.O board assembly

1. Connect the test instruments as described in Figure 7-3.

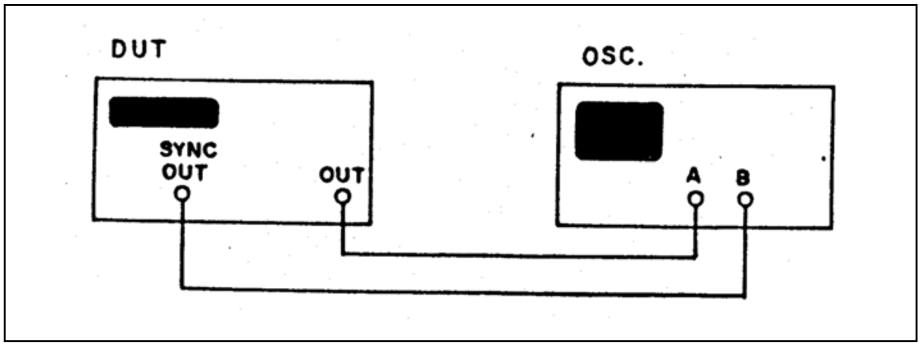

Figure 7-3. Systems Delay Adjustment.

2. Set both oscilloscope inputs to 50Ω impedance. Set oscilloscope time base to 5 nS/div. Display traces of both channels. Synchronize oscilloscope on Channel B and trigger on positive edge.

3. Recall memory, set oscilloscope and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED OSCILLOSCOPE TRACE	ALLOWED ERROR
41	24	V.C.O C72	Delay SYNC-OUT 0 nS	±0.5 nS

7-3-13. CHANNEL B - AMPLITUDE ADJUSTMENT

Equipment: DMM, 50Ω feedthrough termination

Procedure: Performed on Output Amplifier B board assembly

1. Set DMM to DCV function and 20 V range.
2. Connect 8500 OUTPUT B to DMM input. Terminate DMM input with a 50Ω termination.
3. Recall memory and perform adjustments as described in the following table. Steps 42 and 43 are made with the same adjusting trimmer. In the following, repeat steps 42 and 43 until the the best result is obtained.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED DMM READING	ALLOWED ERROR
42	09	CHB R18	+8.000 V	±50 mV
43	10	CHB R18	-8.000 V	±50 mV

7-3-14. CHANNEL B - PULSE RESPONSE ADJUSTMENT

Equipment: Oscilloscope (2465A), x10 attenuator (50 ϒ)

Procedure: Performed on Output Amplifier B board assembly

1. Connect 8500 OUTPUT A to oscilloscope input through a x10 attenuator and set oscilloscope input impedance to 50 ϒ.

2. Set R75 at mid-position.

3. Recall memory, set oscilloscope and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED OSCILLOSCOPE TRACE
44	18	OUT B C17	Best pulse response
45	18	OUT B C33	Best pulse response
46			Repeat steps 44-45
47	19	OUT B R74	Best pulse response
48			Repeat steps 44-47
49	20	OUT B R75	Best pulse flatness
50	21	OUT B R75	Best pulse flatness
51			Repeat steps 49-50

NOTE

Pulse response adjustment may have an effect on the amplitude. If necessary, repeat steps 7-3-13.

7-3-15. CHANNEL B - OUTPUT OFFSET ADJUSTMENT

Equipment: DMM, 50Ω feedthrough termination

Procedure: Performed on Output Amplifier B board assembly

1. Set DMM to DCV function and 20 V range (2 V range for step 53)
2. Connect 8500 OUTPUT B to DMM input. Terminate DMM input with a 50Ω termination.
3. Recall memory, set oscilloscope and perform adjustments as described in the following table.

STEP	RECALL 8500 SET-UP	ADJUSTMENT CONTROL	REQUIRED DMM READING	ALLOWED ERROR
52	22	OUT B R54	+7.950 V	±50 mV
53	25	OUT B R67	+0.800 V	±5 mV

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SECTION 8

PARTS LIST

8.1 GENERAL

This section contains information for ordering replacement parts. the replacement parts are available from the vendors listed or from Tabor Electronics. Mechanical parts are shown separately on Figure 8-1.

8.2 ORDERING INFORMATION

When ordering replacement parts, always include the following information:

a) Instrument Model number.
b) Instrument Serial number.
c) Tabor part number.
d) Part description.
e) Circuit designation (where applicable).

8.3 MAINTENANCE KIT

A maintenance Kit is available. This Kit contains a complement of spare parts which will maintain up to ten Model 8500 Function Generators. A list of the Kit parts is available upon request.

Tabor will do its best to improve the instrument and make changes in style of components and replacement parts. Replacement parts may differ in appearance from those found in your instrument but are always equal or superior in performance.

8.4 PARTS DESCRIPTION

In the following Parts List Tables, unless otherwise noted, resistors power rating is 1/4W, resistance is given in ohms, and capacitance is given in ΙF.

Matched or selected components may only be bought from the factory. Selection guides for such components are not given anywhere in this manual.

Table 8-1. Model 8500 PARTS LIST - MAIN BOARD ASSEMBLY

DWG REF	PART NUMBER	DESCRIPTION
	7100-18300	PC BOARD
CR1	0300-50200	DIODE BRIDGE KBL-005 5A GI
CR2	0300-50100	DIODE BRIDGE WS005
CR3	0300-21100	DIODE REF 1N825A
Q1	0400-01200	TSTR 2N3904A
C5	1535-01080	CAP ELECT 1000UF/50V
C6	1535-01080	CAP ELECT 1000UF/50V
C7	1534-02280	CAP ELEC 2200UF/35V
C8	1534-01080	CAP ELECT 1000 MF/35V
R2	0100-01030	RES COMP 10K 5% 1/4W
R3	0100-04320	RES COMP 4.3K 5% 1/4W
R5	0100-04320	RES COMP 4.3K 5% 1/4W
R4	0100-09110	RES COMP 910 5% 1/4W
J1	3000-30250	CON MALE 2 x 8

Table 8-2. Model 8500 PARTS LIST - FRONT PANEL ASSEMBLY

DWG REF	PART NUMBER	DESCRIPTION
	7100-18400	P.C. BOARD
U1	0510-02700	LOW POWER SCHOTTKY 74LS138
U2	0510-02700	LOW POWER SCHOTTKY 74LS138
U3	0510-02700	LOW POWER SCHOTTKY 74LS138
Q1	0400-01800	TSTR PNP 2N4403
Q2	0400-01800	TSTR PNP 2N4403
Q3	0400-01800	TSTR PNP 2N4403
Q4	0400-01800	TSTR PNP 2N4403
Q5	0400-01800	TSTR PNP 2N4403
Q6	0400-01800	TSTR PNP 2N4403
Q7	0400-01800	TSTR PNP 2N4403
Q8	0400-01800	TSTR PNP 2N4403
Q9	0400-01800	TSTR PNP 2N4403
Q10	0400-01800	TSTR PNP 2N4403
Q11	0400-01800	TSTR PNP 2N4403
Q12	0400-01800	TSTR PNP 2N4403
Q13	0400-01800	TSTR PNP 2N4403
C1	1533-01070	CAP ELECTR 100UF/25V
DS1-	1200-10800	7 SIGMENT DISPLAY MDSP 5501
DS7	1200-10800	7 SIGMENT DISPLAY MDSP 5501
DS8	1200-10100	LED HDSP 7507 1U
DS9	1200-10200	LED HDSP 7501 7 SEG
DS10	1000-00300	MINI 3MM LED RED 5082-4480
DS11	1000-00700	LED RED MV 57124-18 G.I
DS12	1000-00700	LED RED MV 57124-18 G.I
DS13	1000-00700	LED RED MV 57124-18 G.I

Table 8-2. Model 8500 PARTS LIST - FRONT PANEL ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
DS14	1000-00300	MINI 3MM LED RED 5082-4480
DS15	1000-00700	LED RED MV 57124-18 G.I
DS16	1000-00700	LED RED MV 57124-18 G.I
DS17	1000-00700	LED RED MV 57124-18 G.I
DS18	1000-00700	LED RED MV 57124-18 G.I
DS19	1000-00300	MINI 3MM LED RED 5082-4480
DS20	1000-00700	LED RED MV 57124-18 G.I
DS21	1000-00700	LED RED MV 57124-18 G.I
DS22	1000-00700	LED RED MV 57124-18 G.I
DS23	1000-00300	MINI 3MM LED RED 5082-4480
DS24	1000-00700	LED RED MV 57124-18 G.I
DS25	1000-00700	LED RED MV 57124-18 G.I
DS26	1000-00700	LED RED MV 57124-18 G.I
DS27	1000-00300	MINI 3MM LED RED 5082-4480
DS28	1000-00700	LED RED MV 57124-18 G.I
DS29	1000-00700	LED RED MV 57124-18 G.I
DS30	1000-00700	LED RED MV 57124-18 G.I
DS31	1000-00300	MINI 3MM LED RED 5082-4480
DS32	1000-00700	LED RED MV 57124-18 G.I
DS33	1000-00700	LED RED MV 57124-18 G.I
DS34	1000-00700	LED RED MV 57124-18 G.I
DS35	1000-00700	LED RED MV 57124-18 G.I
DS36	1000-00700	LED RED MV 57124-18 G.I
DS37	1000-00700	LED RED MV 57124-18 G.I
DS38	1000-00700	LED RED MV 57124-18 G.I
DS39	1000-00700	LED RED MV 57124-18 G.I
DS40	1000-00700	LED RED MV 57124-18 G.I
DS41	1000-00700	LED RED MV 57124-18 G.I
DS42	1000-00700	LED RED MV 57124-18 G.I
DS43	1000-00300	MINI 3MM LED RED 5082-4480
S1-	2000-61600	SW TRW PUSH BUTTON
S33	2000-61600	SW TRW PUSH BUTTON
R1-	0100-02210	RES COMP 220 5% 1/4W
R13	0100-02210	RES COMP 220 5% 1/4W
R14	0100-02700	RES COMP 27 5% 1/4W
R15	0100-03300	RES COMP 33 5% 1/4W
J1	3000-40150	CON 20 PIN MALE
J1A	3000-40700	CON 20 PIN FEMALE

Table 8-3. Model 8500 PARTS LIST - C.P.U BOARD ASSEMBLY

DWG REF	PART NUMBER	DESCRIPTION
	7100-18500	PC BOARD - C.P.U
U1	0500-20700	KEYBOARD/DISPL.INT. P8279
U2	0510-02700	74LS138
U3	0520-07300	74HC4049
U4	0500-21410	SINGLE CHIP MICROCOMP P8031
U5	0520-07100	74HCT4040
U6	0510-03650	74LS373
U7	0500-21240	27256-250nSEC
U8	0500-11160	MK48ZO2B-20 MOSTEK
U9	0550-00200	32BIT BINARY COUNTER LS 7060
U10	0550-00200	32BIT BINARY COUNTER LS 7060
U11	0500-12750	74F158
U12	0500-12600	D-FLIP-FLOP 74F74
U13	0800-70000	OSCILLATOR 10MHZ 10P.P.M TADRN
U14	0500-21300	G.P.I.B P8291A
U15	0500-21520	BUFFER FOR G.P.IB DS 75161 N
U16	0500-21510	BUFFER FOR G.P.IB DS 75160 N
U17	0500-11600	BUFFER 9668
U18	0520-07300	74HC4049
U19	0510-02700	74LS138
U20	0560-00500	DIGITAL TO ANALOG CONV AD558KD
U21	0560-00500	DIGITAL TO ANALOG CONV AD558KD
U22	0500-56500	DUAL OP AMP LM1458N
Y1	0800-30000	CRYSTAL 10MHZ C.T.S
SP1	0900-01900	BEEPER AT-02
L1	0600-03310	COIL 330 UH 2500-04 DEL.
LK1	3000-40610	CON JUMPER
LK1A	3000-30200	CON 75160-315
RN1	0109-01500	RES NET MDP-16-03-150G
Q1	0400-01810	TSTR NPN 2N4401
Q2	0400-01200	TSTR 2N3904A
Q3	0400-01200	TSTR 2N3904A
Q4	0400-01200	TSTR 2N3904A
Q5	0400-01340	TSTR 2N3906A
Q6	0400-01340	TSTR 2N3906A
Q7	0400-01340	TSTR 2N3906A
Q8	0400-01340	TSTR 2N3906A
Q9	0400-01340	TSTR 2N3906A
CR1	0300-00400	DIODE SI 1N4151
CR2	0300-21100	DIODE REF 1N825A
R1	0100-03320	RES COMP 3.3K 5% 1/4W
R2	0100-01030	RES COMP 10K 5% 1/4W
R3	0100-01520	RES COMP 1.5K 5% 1/4W
R4	0100-01010	RES COMP 100 5% 1/4W

Table 8-3. Model 8500 PARTS LIST - C.P.U BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
R6	0100-01020	RES COMP 1K 5% 1/4W
R7	0100-01020	RES COMP 1K 5% 1/4W
R8	0100-08210	RES COMP 820 5% 1/4W
R9	0100-08210	RES COMP 820 5% 1/4W
R10	0100-08210	RES COMP 820 5% 1/4W
R11	0100-01020	RES COMP 1K 5% 1/4W
R12	0100-01020	RES COMP 1K 5% 1/4W
R13	0100-01020	RES COMP 1K 5% 1/4W
R14	0100-01020	RES COMP 1K 5% 1/4W
R15	0104-15020	RES MF 15K 1% 1/4W
R16	0203-0103A	10K TRIM
R18	0104-63410	RES MF 6.34K 1% 1/4W
R19	0100-01020	RES COMP 1K 5% 1/4W
R20	0104-75010	RES MF 7.5K 1% 1/4W
R21	0104-75010	RES MF 7.5K 1% 1/4W
R22	0100-08210	RES COMP 820 5% 1/4W
R23	0100-01020	RES COMP 1K 5% 1/4W
C1	1500-01040	CAP CER .1 UF-20%+80% 50V
C2	1500-01040	CAP CER .1 UF-20%+80% 50V
C3	1540-03350	CAP TANT 3.3UF/25V
C4	1500-01040	CAP CER .1 UF-20%+80% 50V
C5	1500-01040	CAP CER .1 UF-20%+80% 50V
C6	1500-01040	CAP CER .1 UF-20%+80% 50V
C7	1500-01040	CAP CER .1 UF-20%+80% 50V
C8	1500-01040	CAP CER .1 UF-20%+80% 50V
C9	1500-01040	CAP CER .1 UF-20%+80% 50V
C10	1500-01040	CAP CER .1 UF-20%+80% 50V
C12		SELECTED
C13	1500-01040	CAP CER .1 UF-20%+80% 50V
C14	1500-01040	CAP CER .1 UF-20%+80% 50V
C15	1500-01040	CAP CER .1 UF-20%+80% 50V
C16	1500-01040	CAP CER .1 UF-20%+80% 50V
C17	1531-04770	CAP ELEC 470UF/6V
C18	1500-01040	CAP CER .1 UF-20%+80% 50V
C19	1500-01040	CAP CER .1 UF-20%+80% 50V
C21	1500-01040	CAP CER .1 UF-20%+80% 50V
C11	1550-0180A	CAP VAR 5-18PF NPO
J1	3000-30520	CON FEMALE 2X8-8200
J2	3000-30520	CON FEMALE 2X8-8200
J3	3000-30260	CON MALE 2X10
J4	3000-30270	CON MALE 2X12

Table 8-4. Model 8500 PARTS LIST - V.C.O BOARD ASSEMBLY

DWG REF	PART NUMBER	DESCRIPTION
	7100-18600	PC BOARD - V.C.O
U1	0500-90900	ANALOG SW DG211CJ
U2	0500-53400	SUPER GAIN OP AMP LN308A
U3	0500-56500	DUAL OP AMP LM1458N
U4	0500-56500	DUAL OP AMP LM1458N
U5	0500-60600	AD9685BD
U6	0500-40920	ECL TO TTL-TTL TRANS MC10125P
U7	0500-40930	ECL DIVIDER MC10138P
U8	0500-40950	ECL XOR/XNOR MC10107P
U9	0500-40900	ECL NOR 10102
U10	0500-45100	ECL OR/NOR GATE MC10H105P
U11	0500-40900	ECL NDR 10102
U12	0500-40910	ECL OR/NOR GATE MC10105P
U13	0500-40900	ECL NOR 10102
U14	0500-40900	ECL NOR 10102
U15	0500-41100	TRIPLE LINE REC 10216
U16	0560-00800	12 BIT D/A CONVERTOR AD7541AJN
U17	0510-04900	74LS490
U18	0510-04900	74LS490
U19	0510-02650	74LS133
U20	0510-04900	74LS490
U21	0510-01100	74LS74
U22	0510-00100	74LS00
U23	0500-45600	ECL 10HO16
U24	0500-41200	ECL FLIP-FLOP 10131
U25	0500-45600	ECL 10HO16
U26	0500-40850	ECL 10109
U27	0500-45600	ECL 10HO16
U28	0500-45600	ECL 10HO16
U29	0500-56500	DUAL OP AMP LM1458N
U30	0540-01100	8 BIT SHIFT REGISTOR CD 4094B
U31	0540-01100	8 BIT SHIFT REGISTOR CD 4094B
U32	0540-01100	8 BIT SHIFT REGISTOR CD 4094B
U33	0540-01100	8 BIT SHIFT REGISTOR CD 4094B
U34	0540-01100	8 BIT SHIFT REGISTOR CD 4094B
U35	0540-01100	8 BIT SHIFT REGISTOR CD 4094B
U36	0540-01100	8 BIT SHIFT REGISTOR CD 4094B
Q1	0400-40800	TSTR NPN 2N4959
Q2	0400-40600	TSTR NPN MRF 904
Q3	0400-40600	TSTR NPN MRF 904
Q4	0400-00700	TSTR NPN BFY 90
Q5	0400-00700	TSTR NPN 2N5179
Q6	0400-00700	TSTR NPN 2N5179
Q7	0400-00700	TSTR NPN 2N5179
Q8	0400-40600	TSTR NPN MRF 904
Q9	0400-40600	TSTR NPN MRF 904

Table 8-4. Model 8500 PARTS LIST - V.C.O BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
Q10	0400-01200	TSTR 2N3904A
Q11	0400-01340	TSTR 2N3906A
Q12	0400-00700	TSTR NPN 2N5179
Q13	0400-00700	TSTR NPN 2N5179
Q14	0400-01200	TSTR 2N3904A
Q15	0400-00700	TSTR NPN 2N5179
Q16	0400-00700	TSTR NPN 2N5179
Q17	0400-00750	TSTR 2N5771
Q18	0400-00750	TSTR 2N5771
Q19	0400-01200	TSTR 2N3904A
Q20	0400-01340	TSTR 2N3906A
Q21	0400-00700	TSTR NPN 2N5179
CR1	0300-21100	DIODE REF 1N825A
CR2	0300-20900	DIODE ZENER 1N749A 4.3 V
CR3	0300-20900	DIODE ZENER 1N749A 4.3 V
CR4	0300-10300	DIODE HOT CARRIER 5082-2835
L1	0600-03330	COIL 3.3 UH 1537-24
L2	0600-03330	COIL 3.3 UH 1537-24
L3	0600-0R100	0.1 mH
L7	4200-00000	BEAD
R1	0203-0502A	RES VAR 5K 3386W-1-502
R2	0203-0502A	RES VAR 5K 3386W-1-502
R3	0203-0103A	RES VAR 10K 3386F-1-103
R4	0203-0100A	RES VAR 10 3386W -1-100
R5	0203-0202A	RES VAR 2K 3386W-1-202
R6	0203-0102A	RES VAR 1K 3386W
R7	0203-0103A	RES VAR 10K 3386F-1-103
R8	0104-20040	RES MF 2M 1% 1/4W
R9	0100-01510	RES COMP 150 5% 1/4W
R10	0104-40200	RES MF 402 1% 1/4W
R11	0100-02230	RES COMP 22K 5% 1/4W
R12	0100-01020	RES COMP 1K 5% 1/4W
R13	0102-05610	RES COM 560 1/8W 5%
R14	0102-05600	RES COMP 56 5% 1/8W BB5605
R15	0104-49R90	RES MF 49.9 1% 1/4W
R16	0104-4R020	RES MF4.02 1% 1/4W
R17	0104-14010	RES MF 1.4K 1% 1/4W
R18	0104-10020	RES MF 10K 1% 1/4W
R19	0100-02710	RES COMP 270 5% 1/4W
R20	0100-03300	RES COMP 33 5% 1/4W
R21	0100-02710	RES COMP 270 5% 1/4W
R22	0100-03300	RES COMP 33 5% 1/4W
R23	0102-03900	RES COMP 39 5% 1/8W BB3905
R24	0102-02210	RES COMP 220 5% 1/8W BB2215
R25	0100-03300	RES COMP 33 5% 1/4W
R26	0100-03300	RES COMP 33 5% 1/4W
R27	0102-05600	RES COMP 56 5% 1/8W BB5605

Table 8-4. Model 8500 PARTS LIST - V.C.O BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
R28	0100-03310	RES COMP 330 5% 1/4W
R29	0100-03310	RES COMP 330 5% 1/4W
R30	0104-20010	RES MF 2K 1% 1/4W
R31	0104-11500	RES MF 115 1% 1/4W
R32	0100-07510	RES COMP 750 5% 1/4W
R33	0104-33210	RES MF 3.32K 1% 1/4W
R34	0104-18210	RES COMP 1.82K 1% 1/4W
R35	0104-18210	RES COMP 1.82K 1% 1/4W
R36	0100-01010	RES COMP 100 5% 1/4W
R37	0104-20000	RES MF 200 1% 1/4W
R38	0104-10020	RES MF 10K 1% 1/4W
R39	0104-49900	RES MF 499 1% 1/4W
R40	0104-49910	RES MF 4.99K 1% 1/4W
R41	0102-01010	RES COMP 100 5% 1/8W BB1015
R42	0100-01010	RES COMP 100 5% 1/4W
R43	0104-17410	RES MF 1.74K 1/4W 1%
R44	0104-26100	RES MF 261 1% 1/4W
R45	0104-20000	RES MF 200 1% 1/4W
R46	0100-03300	RES COMP 33 5% 1/4W
R47	0104-49900	RES MF 499 1% 1/4W
R48	0104-49900	RES MF 499 1% 1/4W
R49	0100-03300	RES COMP 33 5% 1/4W
R50	0100-05610	RES COMP 560 5% 1/4W
R51	0100-05610	RES COMP 560 5% 1/4W
R52	0100-07510	RES COMP 750 5% 1/4W
R53	0100-01020	RES COMP 1K 5% 1/4W
R54	0100-03310	RES COMP 330 5% 1/4W
R55	0100-03310	RES COMP 330 5% 1/4W
R56	0100-09100	RES COMP 91 5% 1/4W
R57	0100-01040	RES COMP 100K 5% 1/4W
R58	0100-05610	RES COMP 560 5% 1/4W
R60	0100-03310	RES COMP 330 5% 1/4W
R61	0100-01010	RES COMP 100 5% 1/4W
R62	0100-05610	RES COMP 560 5% 1/4W
R63	0100-05610	RES COMP 560 5% 1/4W
R65	0100-03310	RES COMP 330 5% 1/4W
R66	0100-03310	RES COMP 330 5% 1/4W
R67	0100-05610	RES COMP 560 5% 1/4W
R68	0100-03310	RES COMP 330 5% 1/4W
R69	0100-09100	RES COMP 91 5% 1/4W
R70	0100-03300	RES COMP 33 5% 1/4W
R71	0100-05610	RES COMP 560 5% 1/4W
R72	0100-02010	RES COMP 200 5% 1/4W
R73	0100-03300	RES COMP 33 5% 1/4W
R74	0100-09100	RES COMP 91 5% 1/4W
R75	0100-09100	RES COMP 91 5% 1/4W

Table 8-4. Model 8500 PARTS LIST - V.C.O BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
R76	0104-10000	RES MF 100 1% 1/4W
R77	0104-10000	RES MF 100 1% 1/4W
R78	0100-01010	RES COMP 100 5% 1/4W
R79	0100-08200	RES COMP 82 5% 1/4W
R80	0100-08200	RES COMP 82 5% 1/4W
R81	0100-01010	RES COMP 100 5% 1/4W
R82	0100-03310	RES COMP 330 5% 1/4W
R83	0100-09100	RES COMP 91 5% 1/4W
R84	0100-01010	RES COMP 100 5% 1/4W
R85	0100-05610	RES COMP 560 5% 1/4W
R86	0100-09100	RES COMP 91 5% 1/4W
R87	0100-09100	RES COMP 91 5% 1/4W
R88	0100-09100	RES COMP 91 5% 1/4W
R89	0100-09100	RES COMP 91 5% 1/4W
R90	0100-09100	RES COMP 91 5% 1/4W
R91	0100-09100	RES COMP 91 5% 1/4W
R92	0100-09100	RES COMP 91 5% 1/4W
R93	0100-05610	RES COMP 560 5% 1/4W
R94	0100-03310	RES COMP 330 5% 1/4W
R95	0100-01020	RES COMP 1K 5% 1/4W
R96	0100-03910	RES COMP 390 5% 1/4W
R97	0104-47010	RES MF 4.7K 1% 1/4W
R98	0100-03310	RES COMP 330 5% 1/4W
R99	0100-03310	RES COMP 330 5% 1/4W
R100	0100-03310	RES COMP 330 5% 1/4W
R101	0104-15020	RES MF 15K 1% 1/4W
R102	0104-19620	RES MF 19.6K 1% 1/4W
R103	0104-18230	RES MF 182K 1% 1/4W
R104	0104-60410	RES MF 6.04K 1% 1/4W
R105	0104-30100	RES MF 301 1% 1/4W
R106	0104-10020	RES MF 10K 1% 1/4W
R107	0104-10020	RES MF 10K 1% 1/4W
R108	0104-40200	RES MF 402 1% 1/4W
R109	0104-18210	RES COMP 1.82K 1% 1/4W
R110	0104-33220	RES MTF 33.2K 1% 1/4W
R111	0100-03310	RES COMP 330 5% 1/4W
R112	0100-03310	RES COMP 330 5% 1/4W
R113	0100-09100	RES COMP 91 5% 1/4W
R114	0100-03310	RES COMP 330 5% 1/4W
R115	0100-05610	RES COMP 560 5% 1/4W
R116	0100-05610	RES COMP 560 5% 1/4W
R117	0100-03310	RES COMP 330 5% 1/4W
R118	0100-05610	RES COMP 560 5% 1/4W
R119	0100-09100	RES COMP 91 5% 1/4W
R120	0100-09100	RES COMP 91 5% 1/4W
R121	0100-03310	RES COMP 330 5% 1/4W
R122	0100-05120	RES COMP 5.1K 5% 1/4

Table 8-4. Model 8500 PARTS LIST - V.C.O BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
R200	0104-15020	RES MF 15K 1% 1/4W
R201	0100-01010	RES COMP 100 5% 1/4W
R202	0100-08200	RES COMP 82 5% 1/4W
R203	0100-02020	RES COMP 2K 5% 1/4W
C1	1500-03300	CAP CER 33 PF 20% 50V
C2	1500-01040	CAP CER .1 UF-20%+80% 50V
C3	1500-01040	CAP CER .1 UF-20%+80% 50V
C4	1500-01040	CAP CER .1 UF-20%+80% 50V
C5	1500-01010	CAP CER 100 PF 20% 50V
C6	1500-01040	CAP CER .1 UF-20%+80% 50V
C7	1500-01040	CAP CER .1 UF-20%+80% 50V
C9	1500-01040	CAP CER .1 UF-20%+80% 50V
C11	1500-01040	CAP CER .1 UF-20%+80% 50V
C13	1500-01040	CAP CER .1 UF-20%+80% 50V
C14	1510-08200	CAP MICA 82PF 10% 500V
C15	1510-08210	CAP MICA 820 PF 10% 300V
C16	1560-01040	CAP CHIP .1 UF 50V
C17	1560-01040	CAP CHIP .1 UF 50V
C18	1500-01040	CAP CER .1 UF-20%+80% 50V
C19	1500-01040	CAP CER .1 UF-20%+80% 50V
C20	1500-01040	CAP CER .1 UF-20%+80% 50V
C21	1500-01040	CAP CER .1 UF-20%+80% 50V
C25	1500-01040	CAP CER .1 UF-20%+80% 50V
C26	1500-01030	CAP CER 10 NF 20% 50V
C27	1500-01040	CAP CER .1 UF-20%+80% 50V
C28	1500-01040	CAP CER .1 UF-20%+80% 50V
C29	1500-01040	CAP CER .1 UF-20%+80% 50V
C30	1500-01040	CAP CER .1 UF-20%+80% 50V
C31	1500-01040	CAP CER .1 UF-20%+80% 50V
C32	1500-01040	CAP CER .1 UF-20%+80% 50V
C33	1500-01040	CAP CER .1 UF-20%+80% 50V
C34	1500-01040	CAP CER .1 UF-20%+80% 50V
C35	1500-01040	CAP CER .1 UF-20%+80% 50V
C36	1500-01040	CAP CER .1 UF-20%+80% 50V
C22	1500-01040	CAP CER .1 UF-20%+80% 50V
C23	1500-01040	CAP CER .1 UF-20%+80% 50V
C37	1500-01040	CAP CER .1 UF-20%+80% 50V
C38	1500-01040	CAP CER .1 UF-20%+80% 50V
C39	1500-01040	CAP CER .1 UF-20%+80% 50V
C40		SELECTED
C41	1500-01040	CAP CER .1 UF-20%+80% 50V
C42	1500-01040	CAP CER .1 UF-20%+80% 50V
C43	1500-04R70	CAP CER 4.7 PF 20% 50V
C44	1500-01040	CAP CER .1 UF-20%+80% 50V
C45	1500-01040	CAP CER .1 UF-20%+80% 50V
C46	1550-02000	CAP VAR 5-40P

Table 8-4. Model 8500 PARTS LIST - V.C.O BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
C47	1500-01040	CAP CER .1 UF-20%+80% 50V
C48	1500-01040	CAP CER .1 UF-20%+80% 50V
C49	1500-01040	CAP CER .1 UF-20%+80% 50V
C50	1500-01040	CAP CER .1 UF-20%+80% 50V
C51	1500-01040	CAP CER .1 UF-20%+80% 50V
C52	1500-01010	CAP CER 100 PF 20% 50V
C53	1500-01040	CAP CER .1 UF-20%+80% 50V
C54	1500-01040	CAP CER .1 UF-20%+80% 50V
C55	1500-01040	CAP CER .1 UF-20%+80% 50V
C56	1500-01040	CAP CER .1 UF-20%+80% 50V
C57	1500-01040	CAP CER .1 UF-20%+80% 50V
C58	1500-01040	CAP CER .1 UF-20%+80% 50V
C59	1500-01040	CAP CER .1 UF-20%+80% 50V
C60	1500-01040	CAP CER .1 UF-20%+80% 50V
C61	1533-01070	CAP ELEC 100UF/25V
C62	1533-01070	CAP ELEC 100UF/25V
C63	1534-01070	CAP ELEC 100MF/40V
C64	1534-01070	CAP ELEC 100MF/40V
C65	1532-0107P	CAP ELEC 100uF/16V
C66	1532-0107P	CAP ELEC 100uF/16V
C67	1532-0107P	CAP ELEC 100uF/16V
C68	1500-04R70	CAP CER 4.7 PF 20% 50V
C69		SELECTED
C70	1500-05600	CAP CER 56PF 20% 50V
C71	1500-01020	CAP CER 1 NF 20% 50V
C72		SELECTED
C73		SELECTED
J1	3000-30520	CON FEMALE 2X8-8200
J2	3000-30520	CON FEMALE 2X8-8200
J3	3000-16000	CON RF MALE JACKSON
J4	3000-16000	CON RF MALE JACKSON
DL1	0600-10500	DLY LINE 10NSEC 0402-0010-93
DL2	0600-10400	DLY LINE 8nSEC 0402-0008-93
DL3	0600-10400	DLY LINE 8nSEC 0402-0008-93
DL4	0600-10500	DLY LINE 10NSEC 0402-0010-93
J3A	3000-17000	CON RF FEMALE JACKSON
J4A	3000-17000	CON RF FEMALE JACKSON
J4A	3000-17000	CON RF FEMALE JACKSON

Table 8-5. Model 8500 PARTS LIST - P.W/DELAY BOARD ASSEMBLY

DWG REF	PART NUMBER	DESCRIPTION
	7100-18700	PC BOARD - PULSE WIDTH/DELAY
U1	0510-04900	74LS490
U2	0510-02650	74LS133
U3	0500-45000	ECL NOR MC10H102P
U4	0500-45000	ECL NOR MC10H102P
U5	0500-45100	ECL OR/NOR GATE MC10H105P
U6	0500-45000	ECL NOR MC10H102P
U7	0500-45000	ECL NOR MC10H102P
U8	0500-45000	ECL NOR MC10H102P
U9	0500-45100	ECL OR/NDR GATE MC10H105P
U10	0500-45000	ECL NOR MC10H102P
U11	0510-04900	74LS490
U12	0510-04900	74LS490
U13	0510-02650	74LS133
U14	0500-40860	ECL 10124
U15	0500-45500	ECL 10H109
U16	0500-45300	ECL FLIP-FLOP MC10H131P
U17	0500-45100	ECL OR/NDR GATE MC10H105P
U18	0500-45500	ECL 10H109
U19	0500-45300	ECL FLIP-FLOP MC10H131P
U20	0500-45100	ECL OR/NOR GATE MC10H105P
U21	0500-45300	ECL FLIP-FLOP MC10H131P
U22	0510-04900	74LS490
U23	0500-20350	74S196
U24	0500-20350	74S196
U25	0500-40920	ECL TO TTL-TTL TRANS MC10125P
U26	0500-40970	10136
U27	0500-40970	10136
U28	0500-40970	10136
U29	0500-40970	10136
U30	0500-40970	10136
U31	0500-40970	10136
U32	0500-45100	ECL OR/NOR GATE MC10H105P
U33	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U34	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U35	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U36	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U37	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U38	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U39	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U40	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U41	0500-40950	ECL XOR/XNOR MC10107P
Q1	0400-01340	TSTR 2N3906A
Q2	0400-01340	TSTR 2N3906A
Q3	0400-02500	TSTR J-109

Table 8-5. Model 8500 PARTS LIST - P.W/DELAY BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
Q4	0400-20050	TSTR BFW-30
Q5	0400-20050	TSTR BFW-30
Q6	0400-01200	TSTR 2N3904A
Q7	0400-00100	TSTR PNP 2N3640
Q8	0400-00200	TSTR NPN 2N3646
Q9	0400-01610	TSTR 2N3866A
Q10	0400-00800	TSTR 2N5160A
R1	0102-05610	RES COMP 560 1/8W 5%
R2	0102-09100	RES COMP 91 1/8W 5%
R3	0102-09100	RES COMP 91 1/8W 5%
R4	0102-09100	RES COMP 91 1/8W 5%
R5	0102-09100	RES COMP 91 1/8W 5%
R6	0102-09100	RES COMP 91 1/8W 5%
R7	0102-09100	RES COMP 91 1/8W 5%
R8	0102-05610	RES COM 560 1/8W 5%
R11	0102-03310	RES MF 330 5% 1/8W
R12	0102-05610	RES COM 560 1/8W 5%
R13	0102-09100	RES COMP 91 1/8W 5%
R14	0102-09100	RES COMP 91 1/8W 5%
R15	0102-09100	RES COMP 91 1/8W 5%
R16	0102-09100	RES COMP 91 1/8W 5%
R17	0102-09100	RES COMP 91 1/8W 5%
R18	0102-05610	RES COM 560 1/8W 5%
R19	0102-03310	RES MF 330 5% 1/8W
R20	0102-09100	RES COMP 91 1/8W 5%
R21	0102-05610	RES COM 560 1/8W 5%
R22	0102-05610	RES COM 560 1/8W 5%
R23	0102-05610	RES COM 560 1/8W 5%
R24	0102-05610	RES COM 560 1/8W 5%
R25	0102-05610	RES COM 560 1/8W 5%
R26	0102-09100	RES COMP 91 1/8W 5%
R28	0102-03310	RES MF 330 5% 1/8W
R29	0102-05610	RES COM 560 1/8W 5%
R30	0100-09100	RES COMP 91 5% 1/4W
R31	0102-05610	RES COM 560 1/8W 5%
R32	0102-05610	RES COM 560 1/8W 5%
R33	0102-05610	RES COM 560 1/8W 5%
R35	0102-03310	RES MF 330 5% 1/8W
R36	0102-09100	RES COMP 91 1/8W 5%
R37	0102-05610	RES COM 560 1/8W 5%
R38	0102-09100	RES COMP 91 1/8W 5%
R39	0102-05610	RES COM 560 1/8W 5%
R40	0102-05610	RES COM 560 1/8W 5%
R41	0102-03310	RES MF 330 5% 1/8W
R42	0100-01020	RES COMP 1K 5% 1/4W

Table 8-5. Model 8500 PARTS LIST - P.W/DELAY BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
R43	0100-01020	RES COMP 1K 5% 1/4W
R44	0102-05610	RES COM 560 1/8W 5%
R45	0102-05610	RES COM 560 1/8W 5%
R46	0102-03310	RES MF 330 5% 1/8W
R47	0102-05610	RES COM 560 1/8W 5%
R48	0102-05610	RES COM 560 1/8W 5%
R49	0100-03310	RES COMP 330 5% 1/4W
R50	0102-05610	RES COM 560 1/8W 5%
R51	0102-05610	RES COM 560 1/8W 5%
R52	0102-05610	RES COM 560 1/8W 5%
R53	0102-05610	RES COM 560 1/8W 5%
R54	0102-05610	RES COM 560 1/8W 5%
R55	0102-03310	RES MF 330 5% 1/8W
R56	0102-03310	RES MF 330 5% 1/8W
R57	0102-09100	RES COMP 91 1/8W 5%
R58	0100-01810	RES COMP 180 5% 1/4W
R59	0102-09100	RES COMP 91 1/8W 5%
R60	0102-05610	RES COM 560 1/8W 5%
R61	0100-02220	RES COMP 2.2K 5% 1/4W
R62	0100-01810	RES COMP 180 5% 1/4W
R63	0100-05610	RES COMP 560 5% 1/4W
R64	0100-05610	RES COMP 560 5% 1/4W
R65	0100-01030	RES COMP 10K 5% 1/4W
R66	0100-01030	RES COMP 10K 5% 1/4W
R67	0100-01530	RES COMP 15K 5% 1/4W
R68	0100-01030	RES COMP 10K 5% 1/4W
R69	0100-02040	RES COM 200K 5% 1/4W
R70	0100-01820	RES COMP 1.8K 5% 1/4W
R71	0100-02200	RES COMP 22 5% 1/4W
R72	0100-02200	RES COMP 22 5% 1/4W
R73	0100-01010	RES COMP 100 5% 1/4W
R74	0104-71R5A	RES MTF 71.5 1/2W 1%
R75	0100-02210	RES COMP 220 5% 1/4W
R76	0104-16500	RES MF 165 % 1/4W
R77	0100-01520	RES COMP 1.5K 5% 1/4W
R78	0100-01520	RES COMP 1.5K 5% 1/4W
R79	0100-01520	RES COMP 1.5K 5% 1/4W
R80	0100-01520	RES COMP 1.5K 5% 1/4W
R81	0100-03300	RES COMP 33 5% 1/4W
R82	0100-03300	RES COMP 33 5% 1/4W
R83	0104-5R620	RES MF 5.62 % 1/4W
R84	0104-5R620	RES MF 5.62 % 1/4W
R85	0100-03910	RES COMP 390 5% 1/4W
R86	0100-05610	RES COMP 560 5% 1/4W
R87	0100-03910	RES COMP 390 5% 1/4W
R88	0100-05610	RES COMP 560 5% 1/4W

Table 8-5. Model 8500 PARTS LIST - P.W/DELAY BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
R89	0104-43R20	RES MF 43.2 1% 1/4W
R90	0100-02220	RES COMP 2.2K 5% 1/4W
R91	0100-03910	RES COMP 390 5% 1/4W
R92	0100-05610	RES COMP 560 5% 1/4W
R93	0100-09100	RES COMP 91 5% 1/4W
R94	0100-08200	RES COMP 82 5% 1/4W
C1	1500-01040	CAP CER .1 UF-20%+80% 50V
C2	1500-01040	CAP CER .1 UF-20%+80% 50V
C3	1500-01040	CAP CER .1 UF-20%+80% 50V
C4	1500-01040	CAP CER .1 UF-20%+80% 50V
C5	1500-01040	CAP CER .1 UF-20%+80% 50V
C6	1500-01040	CAP CER .1 UF-20%+80% 50V
C7	1500-01040	CAP CER .1 UF-20%+80% 50V
C8	1500-01040	CAP CER .1 UF-20%+80% 50V
C9	1500-01040	CAP CER .1 UF-20%+80% 50V
C10	1500-01040	CAP CER .1 UF-20%+80% 50V
C11	1500-01040	CAP CER .1 UF-20%+80% 50V
C12	1500-01040	CAP CER .1 UF-20%+80% 50V
C13	1500-01040	CAP CER .1 UF-20%+80% 50V
C14	1500-01040	CAP CER .1 UF-20%+80% 50V
C15	1500-01040	CAP CER .1 UF-20%+80% 50V
C16	1500-01040	CAP CER .1 UF-20%+80% 50V
C17	1500-01040	CAP CER .1 UF-20%+80% 50V
C18	1500-01040	CAP CER .1 UF-20%+80% 50V
C19	1500-01040	CAP CER .1 UF-20%+80% 50V
C20	1500-02700	CAP CER 27PF 20% 63V
C21	1550-02700	CAP VAR 3.5-20PF 5MM ST
C22	1500-01040	CAP CER .1 UF-20%+80% 50V
C23	1500-01040	CAP CER .1 UF-20%+80% 50V
C24	1500-02700	CAP CER 27PF 20% 63V
C25	1550-02700	CAP VAR 3.5-20PF 5MM ST
C26	1500-01040	CAP CER .1 UF-20%+80% 50V
C27	1500-01040	CAP CER .1 UF-20%+80% 50V
C28	1500-01040	CAP CER .1 UF-20%+80% 50V
C29	1500-01040	CAP CER .1 UF-20%+80% 50V
C30	1500-01040	CAP CER .1 UF-20%+80% 50V
C31	1500-01040	CAP CER .1 UF-20%+80% 50V
C32	1500-01040	CAP CER .1 UF-20%+80% 50V
C33	1500-01040	CAP CER .1 UF-20%+80% 50V
C34	1500-01040	CAP CER .1 UF-20%+80% 50V
C35	1500-01040	CAP CER .1 UF-20%+80% 50V
C36	1500-01040	CAP CER .1 UF-20%+80% 50V
C37	1500-01500	CAP CER 15 PF 20% 50V
C38	1533-01070	CAP ELEC 100UF/25V
C39	1533-01070	CAP ELEC 100UF/25V

Table 8-5. Model 8500 PARTS LIST - P.W/DELAY BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
C40	1533-01070	CAP ELEC 100UF/25V
C41	1533-01070	CAP ELEC 100UF/25V
C42	1500-01040	CAP CER .1 UF-20%+80% 50V
C44	1500-01040	CAP CER .1 UF-20%+80% 50V
C46	1500-01040	CAP CER .1 UF-20%+80% 50V
C47	1500-01040	CAP CER .1 UF-20%+80% 50V
C48	1510-06R20	CAP MICA 6.2PF 10% 500V
C49	1500-01040	CAP CER .1 UF-20%+80% 50V
C50	1500-01040	CAP CER .1 UF-20%+80% 50V
C51	1500-01040	CAP CER .1 UF-20%+80% 50V
C52	1500-01040	CAP CER .1 UF-20%+80% 50V
C53	1500-01800	CAP CER 18P
C56	1500-01000	CAP CER 10 PF 20% 50V
C57	1500-01000	CAP CER 10 PF 20% 50V
C58	1500-01000	CAP CER 10 PF 20% 50V
C60	1500-01000	CAP CER 10 PF 20% 50V
C61	1500-01000	CAP CER 10 PF 20% 50V
C62	1500-01000	CAP CER 10 PF 20% 50V
C65	1500-01040	CAP CER .1 UF-20%+80% 50V
DL1	0600-10100	DLY LINE 1nSEC 0402-0001-93
DL2	0600-10200	DLY LINE 2nSEC 0402-0002-93
DL3	0600-10300	DLY LINE 4nSEC 0402-0004-93
DL4	0600-10400	DLY LINE 8nSEC 0402-0008-93
DL5	0600-10400	DLY LINE 8nSEC 0402-0008-93
DL6	0600-10000	DLY LINE 7nSEC 0402-0007-93
DL7	0600-10100	DLY LINE 1nSEC 0402-0001-93
DL8	0600-10200	DLY LINE 2nSEC 0402-0002-93
DL9	0600-10300	DLY LINE 4nSEC 0402-0004-93
DL10	0600-10400	DLY LINE 8nSEC 0402-0008-93
DL11	0600-10000	DLY LINE 7nSEC 0402-0007-93
DL12	0600-10400	DLY LINE 8nSEC 0402-0008-93
DL13	0600-10300	DLY LINE 4nSEC 0402-0004-93
DL14	0600-10400	DLY LINE 8nSEC 0402-0008-93
DL15	0600-10400	DLY LINE 8nSEC 0402-0008-93
DL16	0600-10000	DLY LINE 7nSEC 0402-0007-93
DL18	0600-10500	DLY LINE 10NSEC 0402-0010-93
DL19	0600-10400	DLY LINE 8nSEC 0402-0008-93
J1	3000-30520	CON FEMALE 2 x 8
J2	3000-30520	CON FEMALE 2 x 8
J3	3000-16000	CON RF MALE
J3A	3000-17000	CON RF FEMALE
	7100-18800	PC BOARD - RISE TIME
R2	0203-0202A	RES VAR 2K
R3	0104-75010	RES MF 7.5K 1% 1/4W

Table 8-6. Model 8500 PARTS LIST - RISE TIME BOARD ASSEMBLY

DWG REF	PART NUMBER	DESCRIPTION
R4	0104-20020	RES MF 20K 1% 1/4W
R5	0104-20010	RES MF 2K 1% 1/4W
R6	0203-0202A	RES VAR 2K
R7	0104-30100	RES MF 301 1% 1/4W
R8	0100-04700	RES COMP 47 5% 1/4W
R9	0100-01030	RES COMP 10K 5% 1/4W
R10	0101-02010	RES COMP 200 V 5% 1/2W
R11	0104-20020	RES MF 20K 1% 1/4W
R12	0203-0102A	RES VAR 1K
R13	0104-30110	RES MF 3.01K 1% 1/4W
R14	0203-0102A	RES VAR 1K
R15	0104-20010	RES MF 2K 1% 1/4W
R16	0104-30100	RES MF 301 1% 1/4W
R17	0100-04700	RES COMP 47 5% 1/4W
R18	0100-01030	RES COMP 10K 5% 1/4W
R19	0101-02010	RES COMP 200 V 5% 1/2W
R20	0104-75010	RES MF 7.5K 1% 1/4W
R21	0104-30100	RES MF 301 1% 1/4W
R22	0104-46410	RES MF 4.64K 1% 1/4W
R23	0104-20010	RES MF 2K 1% 1/4W
R24	0104-30100	RES MF 301 1% 1/4W
R25	0104-30100	RES MF 301 1% 1/4W
R26	0104-10030	RES MF 100K 1% 1/4W
R27	0104-36510	RES MF 3.65K 1/4W 1%
R28	0104-14010	RES MF 1.4K 1% 1/4W
R29	0104-90900	RES MF 909 % 1/4W
R30	0203-0201A	RES VAR 200
R31	0104-30100	RES MF 301 1% 1/4W
R32	0100-04700	RES COMP 47 5% 1/4W
R33	0104-10010	RES MF 1K 1% 1/4W
R34	0104-10010	RES MF 1K 1% 1/4W
R35	0104-15100	RES MTF 150 1% 1/4W
R36	0100-04700	RES COMP 47 5% 1/4W
R37	0100-01000	RES COMP 10 5% 1/4W
R41	0104-14010	RES MF 1.4K 1% 1/4W
R42	0104-90900	RES MF 909 % 1/4W
R43	0203-0201A	RES VAR 200
R44	0104-30100	RES MF 301 1% 1/4W
R45	0100-04700	RES COMP 47 5% 1/4W
R46	0104-10010	RES MF 1K 1% 1/4W
R47	0104-10010	RES MF 1K 1% 1/4W
R48	0104-15100	RES MTF 150 1% 1/4W
R49	0100-04700	RES COMP 47 5% 1/4W
R50	0100-03310	RES COMP 330 5% 1/4W
R51	0100-06800	RES COMP 68 5% 1/4W
R52	0100-03310	RES COMP 330 5% 1/4W

Table 8-6. Model 8500 PARTS LIST - RISE TIME BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
R56	0100-02020	RES COMP 2K 5% 1/4W
R57	0100-06810	RES COMP 680 5% 1/4W
R58	0100-02020	RES COMP 2K 5% 1/4W
R59	0100-06810	RES COMP 680 5% 1/4W
R60	0100-03300	RES COMP 33 5% 1/4W
R61	0100-01010	RES COMP 100 5% 1/4W
R62	0100-05100	RES COMP 51 5% 1/4W
R63	0100-05100	RES COMP 51 5% 1/4W
R64	0100-02020	RES COMP 2K 5% 1/4W
R65	0100-06810	RES COMP 680 5% 1/4W
R66	0100-02020	RES COMP 2K 5% 1/4W
R67	0100-06810	RES COMP 680 5% 1/4W
R69	0100-03300	RES COMP 33 5% 1/4W
R70	0104-49R90	RES MF 49.9 1% 1/4W
R53	0100-01010	RES COMP 100 5% 1/4W
R54	0100-03310	RES COMP 330 5% 1/4W
R71	0100-02210	RES COMP 220 5% 1/4W
R72	0100-05110	RES COMP 510 5% 1/4W
R73	0100-05610	RES COMP 560 5% 1/4W
R77	0100-05100	RES COMP 51 5% 1/4W
R78	0100-01010	RES COMP 100 5% 1/4W
R80	0104-10000	RES MF 100 1% 1/4W
R81	0100-01810	RES COMP 180 5% 1/4W
R82		* SELECTED
R83	0100-08210	RES COMP 820 5% 1/4W
R84		* SELECTED
R85	0100-08210	RES COMP 820 5% 1/4W
R86	0104-10000	RES MF 100 1% 1/4W
R87	0104-10000	RES MF 100 1% 1/4W
R88	0104-3650A	RES MTF 365 OHM 1% 1/2W
R89	0203-0101A	RES VAR 100
R90	0100-03300	RES COMP 33 5% 1/4W
R91	0100-04700	RES COMP 47 5% 1/4W
R92	0104-22600	RES MF 226 1% 1/4W
R93	0104-10020	RES MF 10K 1% 1/4W
R94	0104-49910	RES MF 4.99K 1% 1/4W
R95	0104-2490A	RES MTF 249 1% 1/2W
R96	0104-90R90	RES MF 90.9 % 1/4W
R97	0104-90R90	RES MF 90.9 % 1/4W
R98	0104-49R90	RES MF 49.9 1% 1/4W
R99	0104-49R90	RES MF 49.9 1% 1/4W
R100	0100-01820	RES COMP 1.8K 5% 1/4W
R101	0100-01820	RES COMP 1.8K 5% 1/4W
R104	0100-03920	RES COMP 3.9K 5% 1/4W
R105	0100-03920	RES COMP 3.9K 5% 1/4W
R106	0100-03900	RES COMP 39 5% 1/4W

Table 8-6. Model 8500 PARTS LIST - RISE TIME BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
U1	0560-00700	10 BIT D/A CONVERTOR AD7533JN
U2	0500-56310	OP AMP LM741C
U3	0500-56310	OP AMP LM741C
U4	0500-56310	OP AMP LM741C
U5	0500-56310	OP AMP LM741C
U6	0500-56310	OP AMP LM741C
U7	0500-56310	OP AMP LM741C
U8	0500-56310	OP AMP LM741C
U9	0560-00700	10 BIT A/D CONVERTOR AD7533JN
U10	0500-53400	OP AMP LN308A
U11	0500-53400	OP AMP LN308A
U12	0500-56000	OP AMP LF13741
U13	0500-56310	OP AMP LM741C
U14	0560-00700	10 BIT D/A CONVERTOR AD7533JN
U15	0500-53400	SUPER GAIN OP AMP LN308A
U16	0500-53400	SUPER GAIN OP AMP LN308A
U17	0500-56310	OP AMP LM741C
U18	0500-56310	OP AMP LM741C
U20	0500-40900	ECL NDR 10102
U21	0500-56310	OP AMP LM741C
U22	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U23	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U24	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U25	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U26	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U27	0500-56500	DUAL OP AMP LM1458N
U28	0500-53210	QUAD OP AMP LM324
Q1	0400-01200	TSTR 2N3904A
Q2	0400-01340	TSTR 2N3906A
Q3	0400-01200	TSTR 2N3904A
Q4	0400-01340	TSTR 2N3906A
Q5	0400-01200	TSTR 2N3904A
Q6	0400-01340	TSTR 2N3906A
Q7	0400-01910	TSTR 2N5210
Q8	0400-01340	TSTR 2N3906A
Q9	0400-01340	TSTR 2N3906A
Q10	0400-01200	TSTR 2N3904A
Q11	0400-01900	TSTR 2N5087
Q12	0400-01200	TSTR 2N3904A
Q13	0400-01200	TSTR 2N3904A
Q14	0400-01340	TSTR 2N3906A
Q15	0400-00750	TSTR 2N5771
Q16	0400-00750	TSTR 2N5771
Q17	0400-00700	TSTR NPN 2N5179
Q18	0400-00700	TSTR NPN 2N5179

Table 8-6. Model 8500 PARTS LIST - RISE TIME BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
Q19	0400-00200	TSTR NPN 2N3646
Q20	0400-00200	TSTR NPN 2N3646
Q21	0400-00750	TSTR 2N5771
Q22	0400-00750	TSTR 2N5771
Q23	0400-00750	TSTR 2N5771
Q24	0400-00750	TSTR 2N5771
Q25	0400-20050	TSTR BFW30
Q26	0400-20050	TSTR BFW30
Q27	0400-01200	TSTR 2N3904A
Q28	0400-01200	TSTR 2N3904A
Q29	0400-01200	TSTR 2N3904A
Q30	0400-01200	TSTR 2N3904A
Q31	0400-01200	TSTR 2N3904A
Q32	0400-40500	TSTR DN5566
Q33	0400-00200	TSTR NPN 2N3646
Q34	0400-00200	TSTR NPN 2N3646
Q35	0400-01200	TSTR 2N3904A
Q36	0400-00750	TSTR 2N5771
Q37	0400-00750	TSTR 2N5771
Q38	0400-00200	TSTR NPN 2N3646
Q39	0400-00200	TSTR NPN 2N3646
Q40	0400-00200	TSTR NPN 2N3646
Q41	0400-01200	TSTR 2N3904A
Q42	0400-01200	TSTR 2N3904A
Q43	0400-01200	TSTR 2N3904A
CR2	0300-20200	DIODE ZENER 1N753A 6.2 V
CR3	0300-20000	DIODE ZENER 1N746A 3.3 V
CR4	0300-20200	DIODE ZENER 1N753A 6.2 V
CR5	0300-20000	DIODE ZENER 1N746A 3.3 V
CR6	0300-20010	DIODE ZENER 1N751A 5.1 V
CR7	0300-20000	DIODE ZENER 1N746A 3.3 V
CR8	0300-20010	DIODE ZENER 1N751A 5.1 V
CR9	0300-20000	DIODE ZENER 1N746A 3.3 V
CR10	0300-20000	DIODE ZENER 1N746A 3.3 V
CR11	0300-90250	DIODE 1N4740A
CR12	0300-20010	DIODE ZENER 1N751A 5.1 V
CR13	0300-00400	DIODE 1N4151
CR14	0300-00400	DIODE 1N4151
CR15	0300-00400	DIODE 1N4151
CR16	0300-00400	DIODE 1N4151
CR21	0300-20400	DIODE ZENER 1N758A 10 V
CR22	0300-00400	DIODE 1N4151
CR23	0300-00400	DIODE 1N4151

Table 8-6. Model 8500 PARTS LIST - RISE TIME BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
C1	1533-01070	CAP ELEC 100UF/25V
C2	1533-01070	CAP ELEC 100UF/25V
C3	1500-01040	CAP CER .1 UF-20%+80% 50V
C4	1500-01040	CAP CER .1 UF-20%+80% 50V
C5	1533-01070	CAP ELEC 100UF/25V
C6	1533-01070	CAP ELEC 100UF/25V
C7	1533-01070	CAP ELEC 100UF/25V
C8	1500-01040	CAP CER .1 UF-20%+80% 50V
C9	1500-01040	CAP CER .1 UF-20%+80% 50V
C10	1500-04700	CAP CER 47PF 20% 50V
C11	1500-01040	CAP CER .1 UF-20%+80% 50V
C12	1500-01040	CAP CER .1 UF-20%+80% 50V
C13	1500-04700	CAP CER 47PF 20% 50V
C14	1500-04700	CAP CER 47PF 20% 50V
C15	1500-01040	CAP CER .1 UF-20%+80% 50V
C16	1500-01040	CAP CER .1 UF-20%+80% 50V
C17	1500-04700	CAP CER 47PF 20% 50V
C18	1500-01040	CAP CER .1 UF-20%+80% 50V
C19	1500-01040	CAP CER .1 UF-20%+80% 50V
C20	1500-01040	CAP CER .1 UF-20%+80% 50V
C21		* SELECTED
C22	1500-02710	CAP CER 270P
C23		* SELECTED
C24		* SELECTED
C25	1522-03020	CAP POLY 3N/400V 2%
C26	1522-33220	CAP POLY 33.2N/63V 2%
C27	1522-33230	CAP POLY 0.33263V 2%
C28	1522-33240	CAP POLY 3.32uf/63v 1% KED-213
C29	1500-01040	CAP CER .1 UF-20%+80% 50V
C30	1500-01040	CAP CER .1 UF-20%+80% 50V
C31	1500-01040	CAP CER .1 UF-20%+80% 50V
C32	1500-01040	CAP CER .1 UF-20%+80% 50V
C33	1500-02200	CAP CER 22 PF 20% 50V
C34	1500-01040	CAP CER .1 UF-20%+80% 50V
C35	1500-01040	CAP CER .1 UF-20%+80% 50V
C38	1521-01020	CAP POLY .001UF 20% 63V
C39	1500-01040	CAP CER .1 UF-20%+80% 50V
C40	1500-01040	CAP CER .1 UF-20%+80% 50V
C41	1540-0106A	CAP TANT 10 MF 35 V
C42	1540-0106A	CAP TANT 10 MF 35 V
C43	1500-01020	CAP CER 1 NF 20% 50V
C44	1500-01020	CAP CER 1 NF 20% 50V
C46	1500-01040	CAP CER .1 UF-20%+80% 50V
C47	1500-02200	CAP CER 22 PF 20% 50V
C48	1500-01040	CAP CER .1 UF-20%+80% 50V

Table 8-6. Model 8500 PARTS LIST - RISE TIME BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
RN1	0108-01020	RES NET MDP14-03-102G 1K/14
RL1	0900-01100	RELAY DUAL INLINE 1A 5V-6007
RL2	0900-01000	RELAY DUAL INLINE 1C 5V-6007
J1	3000-30520	CON FEMALE 2X8-8200
J2	3000-30520	CON FEMALE 2X8-8200
L1	4200-00000	FERRITE BEAD CERAMAG24 57-1355
L2	4200-00000	FERRITE BEAD CERAMAG24 57-1355

Table 8-7. Model 8500 PARTS LIST - OUTPUT A BOARD ASSEMBLY

DWG REF	PART NUMBER	DESCRIPTION
	7100-18900	P.C. BOARD CHANNEL A OUTPUT
U1	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U2	0560-00700	10 BIT D/A CONVERTOR AD7533JN
U3	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U4	0500-56500	DUAL OP AMP LM1458N
U5	0500-56310	OP MAPL. LM 741-C
U6	0540-01100	8 BIT SHIFT REGISTOR CD 4094B
U7	0500-11600	BUFFER 9668 (L204)
U8	0560-00800	D-A 12 BIT CONVERTOR AD7541AJN
U9	0500-53400	OP AMP LN308A
U10	0500-53400	OP AMP LN308A
U11	0500-53400	OP AMP LN308A
U12	0500-53400	OP AMP LN308A
U13	0500-56310	OP AMP LM741C
U14	0500-56310	OP AMP LM741C
K1	0900-00700	RELAY RZ-1
K2	0900-00700	RELAY RZ-1
K3	0900-00700	RELAY RZ-1
K4	0900-00700	RELAY RZ-1
Q1	0400-01340	TSTR 2N3906A
Q2	0400-01340	TSTR 2N3906A
Q3	0400-01500	TSTR PNP 2N2905A
Q4	0400-10200	TSTR TIP32
Q5	0400-02600	TSTR MPSA42
Q6	0400-01200	TSTR 2N3904A
Q7	0400-40100	TSTR NPN 2N2219A
Q8	0400-01200	TSTR 2N3904A
Q9	0400-10150	TSTR TIP32
Q10	0400-00200	TSTR NPN 2N3646
Q11	0400-00750	TSTR 2N5771
Q12	0400-01200	TSTR 2N3904A
Q13	0400-01340	TSTR 2N3906A
Q14	0400-00200	TSTR NPN 2N3646

Table 8-7. Model 8500 PARTS LIST - OUTPUT A BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
Q15	0400-00100	TSTR PNP 2N3640
Q16	0400-40000	TSTR 2N4392A
Q17	0400-00800	TSTR 2N5160A
Q18	0400-01610	TSTR 2N3866A
Q19	0400-01200	TSTR 2N3904A
Q20	0400-01610	TSTR 2N3866A
Q21	0400-40900	LT1839 TRW
Q22	0400-01610	TSTR 2N3866A
Q23	0400-01610	TSTR 2N3866A
Q24	0400-00800	TSTR 2N5160A
Q25	0400-00800	TSTR 2N5160A
Q26	0400-00800	TSTR 2N5160A
Q27	0400-00800	TSTR 2N5160A
Q28	0400-01340	TSTR 2N3906A
Q29	0400-01200	TSTR 2N3904A
R2	0104-10020	RES MF 10K 1% 1/4W
R3	0104-10020	RES MF 10K 1% 1/4W
R4	0100-03920	RES COMP 3.9K 5% 1/4W
R5	0100-03920	RES COMP 3.9K 5% 1/4W
R6	0100-01010	RES COMP 100 5% 1/4W
R7	0100-07520	RES COMP 7.5K 5% 1/4W
R8	0104-15020	RES MF 15K 1% 1/4W
R9	0100-02710	RES COMP 270 5% 1/4W
R10	0100-01820	RES COMP 1.8K 5% 1/4W
R11	0101-01R0A	RES COMP 1 5% 1w
R12	0100-01020	RES COMP 1K 5% 1/4W
R13	0100-02720	RES COMP 2.7K 5% 1/4W
R14	0104-20020	RES MF 20K 1% 1/4W
R15	0104-11520	RES MF 11.5K 1% 1/4W
R16	0100-02720	RES COMP 2.7K 5% 1/4W
R17	0100-01020	RES COMP 1K 5% 1/4W
R18	0100-05630	RES COMP 56K 5% 1/4W
R19	0104-15020	RES MF 15K 1% 1/4W
R20	0100-02710	RES COMP 270 5% 1/4W
R21	0100-01820	RES COMP 1.8K 5% 1/4W
R22	0101-01R0A	RES COMP 1 5% 1w
R23	0100-02720	RES COMP 2.7K 5% 1/4W
R24	0104-20020	RES MF 20K 1% 1/4W
R25	0104-11520	RES MF 11.5K 1% 1/4W
R26	0100-02720	RES COMP 2.7K 5% 1/4W
R27	0104-21500	RES MF 215 1% 1/4W
R28	0104-24R30	RES MF 24.3 1% 1/4W
R29	0104-21500	RES MF 215 1% 1/4W
R30	0104-95R30	RES MF 95.3 1/4W 1%
R31	0104-71R50	RES MF 71.5 % 1/4W

Table 8-7. Model 8500 PARTS LIST - OUTPUT A BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
R32	0104-95R30	RES MF 95.3 1/4W 1%
R33	0104-61R9A	RES MF 61.9 1% 1/2W
R34	0104-24900	RES MF 249 1% 1/4W
R35	0104-61R9A	RES MF 61.9 1% 1/2W
R36	0203-0202A	RES VAR 2K
R37	0203-0202A	RES VAR 2K
R40	0104-1001A	RES MTF 1% 1/2W 1K
R41	0100-01030	RES COMP 10K 5% 1/4W
R42	0104-10010	RES MF 1K 1% 1/4W
R43	0104-10010	RES MF 1K 1% 1/4W
R44	0104-10000	RES MF 100 1% 1/4W
R45	0104-10020	RES MF 10K 1% 1/4W
R46	0104-10010	RES MF 1K 1% 1/4W
R47	0104-10010	RES MF 1K 1% 1/4W
R48	0104-10000	RES MF 100 1% 1/4W
R49	0104-1001A	RES MTF 1% 1/2W 1K
R50	0100-01030	RES COMP 10K 5% 1/4W
R51	0100-02710	RES COMP 270 5% 1/4W
R52	0203-0202A	RES VAR 2K
R54	0104-10010	RES MF 1K 1% 1/4W
R55	0100-01020	RES COMP 1K 5% 1/4W
R56	0100-01040	RES COMP 100K 5% 1/4W
R57	0100-01210	RES COMP 120 5% 1/4W
R58	0100-02700	RES COMP 27 5% 1/4W
R59	0104-1001A	RES MTF 1% 1/2W 1K
R60	0104-1001A	RES MTF 1% 1/2W 1K
R61	0101-0332A	RES COMP 3.3K 1W 5%
R62	0101-0332A	RES COMP 3.3K 1W 5%
R63	0100-01210	RES COMP 120 5% 1/4W
R64	0104-24920	RES MF 24.9K 1% 1/4W
R65	0104-24920	RES MF 24.9K 1% 1/4W
R66	0104-12110	RES MF 1.21K 1% 1/4W
R67	0104-10020	RES MF 10K 1% 1/4W
R68	0104-10020	RES MF 10K 1% 1/4W
R69	0203-0201A	RES VAR 200
R70	0100-03900	RES COMP 39 5% 1/4W
R71	0100-03900	RES COMP 39 5% 1/4W
R72	0100-03900	RES COMP 39 5% 1/4W
R73	0203-0201A	RES VAR 200
R74	0203-0102A	RES VAR 1K
R75	0100-04R70	RES COMP 4.7 5% 1/4W
R76	0104-11510	RES MF 1.15K 1% 1/4W
R77	0100-02710	RES COMP 270 5% 1/4W
R78	0104-10020	RES MF 10K 1% 1/4W
R79	0104-10020	RES MF 10K 1% 1/4W
R80	0100-01000	RES COMP 10 5% 1/4W

Table 8-7. Model 8500 PARTS LIST - OUTPUT A BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
R81	0100-03900	RES COMP 39 5% 1/4W
R82	0100-03900	RES COMP 39 5% 1/4W
R83	0100-03900	RES COMP 39 5% 1/4W
R84	0101-0100A	RES COMP 10 5% 1W
R85	0101-01000	RES COMP 10 5% 1/2W
R86	0101-01000	RES COMP 10 5% 1/2W
R87	0101-01000	RES COMP 10 5% 1/2W
R88	0104-1001A	RES MTF 1% 1/2W 1K
R89	0104-1001A	RES MTF 1% 1/2W 1K
R90	0101-01000	RES COMP 10 5% 1/2W
R91	0101-01000	RES COMP 10 5% 1/2W
R92	0101-01000	RES COMP 10 5% 1/2W
R94	0100-03300	RES COMP 33 5% 1/4W
R95	0101-0100A	RES COMP 10 5% 1W
R96	0100-01030	RES COMP 10K 5% 1/4W
R97	0100-01030	RES COMP 10K 5% 1/4W
R98	0100-01030	RES COMP 10K 5% 1/4W
R100	0100-03900	RES COMP 39 5% 1/4W
R101	0100-03900	RES COMP 39 5% 1/4W
R102	0104-49R9A	RES MF 49.9 1% 2W
R103	0104-49R9A	RES MF 49.9 1% 2W
R104	0104-49R9A	RES MF 49.9 1% 2W
R105	0104-49R9A	RES MF 49.9 1% 2W
CR2	0300-20200	DIODE 1N753A 6.2 V
CR4	0300-00400	DIODE 1N4151
CR5	0300-00400	DIODE 1N4151
CR8	0300-00400	DIODE 1N4151
CR9	0300-00400	DIODE 1N4151
CR10	0300-00400	DIODE 1N4151
C1	1533-01070	CAP ELEC 100UF/25V
C2	1533-01070	CAP ELEC 100UF/25V
C3	1533-01070	CAP ELEC 100UF/25V
C4	1535-02270	CAP ELEC 220UF/50V
C5	1535-02270	CAP ELEC 220UF/50V
C6	1500-01040	CAP CER .1 UF-20%+80% 50V
C7	1510-04710	CAP CER 470P
C8	1500-01040	CAP CER .1 UF-20%+80% 50V
C9	1500-01020	CAP CER 1 NF 20% 50V
C10	1500-01040	CAP CER .1 UF-20%+80% 50V
C11	1510-08200	CAP CER 82 PF
C12	1500-01020	CAP CER 1 NF 20% 50V
C13	1500-06820	CAP CER 6.8 NF 20% 50V
C14	1540-01060	CAP TANT 10 UF 25V
C15	1510-04700	CAO CER 47P

Table 8-7. Model 8500 PARTS LIST - OUTPUT A BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
C16	1500-03300	CAP CER 33P
C17	1500-01040	CAP CER .1 UF-20%+80% 50V
C18	1500-03310	CAP CER 330PF 20% 50V
C19	1500-04700	CAP CER 47PF 20% 50V
C20	1500-01040	CAP CER .1 UF-20%+80% 50V
C21	1500-04700	CAP CER 47PF 20% 50V
C22	1500-04700	CAP CER 47PF 20% 50V
C23	1521-01040	CAP POLY.1UF 20% 100V MKT-1818
C24	1535-02270	CAP ELEC 220UF/50V
C25	1550-0260A	CAP VAR 3-10 PF
C26	1521-01040	CAP POLY .1UF 20% 100V MKT-1818
C27	1521-01040	CAP POLY .1UF 20% 100V MKT-1818
C28	1521-01040	CAP POLY .1 100V
C29	1500-01040	CAP CER .1 UF-20%+80% 50V
C30	1500-03R30	CAP CER 3.3 PF 20% 50V
C31	1521-01040	CAP POLY .1UF 20% 100V MKT-1818
C32	1521-01040	CAP POLY .1UF 20% 100V MKT-1818
C33	1521-01040	CAP POLY 0.1 100V
C34	1521-01040	CAP POLY.1UF 20% 100V MKT-1818
C35	1521-01040	CAP POLY.1UF 20% 100V MKT-1818
C36	1535-02270	CAP ELEC 220/50V
C37	1550-0180A	CAP VAR 5.5-18P
C38	1540-01060	CAP TANT 10 UF 35V
C39	1540-01060	CAP TANT 10 UF 35V
C40	1500-01020	CAP CER 1 NF 20% 50V
C41	1500-01020	CAP CER 1 NF 20% 50V
C42	1540-0106A	CAP TANT 10 35V
C43	1500-03300	CAP CER 33P
C44	1500-01040	CAP CER 0.1
C45	1500-02200	CAP CER 22P
J1	3000-30520	CON FEMALE 2 x 8
J2	3000-16000	CON RF MALE
J2A	3000-17000	CON RF FEMALE
J3	3000-16000	CON RF MALE
J3A	3000-17000	CON RF FEMALE
HS	3800-01500	8 x HEAT SINK FE398
HS	3800-01800	2 x HEAT SINK J-25-1304
L1-	4200-00000	FERRITE BEAD CERAMAG24 57-1355
L16	4200-00000	FERRITE BEAD CERAMAG24 57-1355

Table 8-1. Model 8500 PARTS LIST - OUTPUT B BOARD ASSEMBLY

DWG REF	PART NUMBER	DESCRIPTION
	7100-19000	P.C. BOARD CHANNEL B OUTPUT
U1	0500-40900	ECL NOR 10102
U2	0500-56500	DUAL OP AMP LM1458N
U3	0560-00700	10 BIT D/A CONVERTOR AD7533JN
U4	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U5	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U6	0500-56500	DUAL OP AMP LM1458N
U7	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U8	0500-11600	BUFFER 9668 (L204)
U9	0540-01100	8 BIT SHIFT REGISTOR CD4094B
U10	0560-00700	10 BIT D/A CONVERTOR AD7533JN
U11	0500-53400	OP AMP LN308A
U12	0500-53400	OP AMP LN308A
U13	0500-53400	OP AMP LN308A
U14	0500-56500	DUAL OP AMP LM1458N
U15	0500-53400	OP AMP LN308A
Q1	0400-00750	TSTR 2N5771
Q2	0400-00750	TSTR 2N5771
Q3	0400-00700	TSTR NPN 2N5179
Q4	0400-00700	TSTR NPN 2N5179
Q5	0400-01200	TSTR 2N3904A
Q6	0400-01340	TSTR 2N3906A
Q7	0400-01200	TSTR 2N3904A
Q8	0400-01340	TSTR 2N3906A
Q10	0400-00200	TSTR NPN 2N3646
Q11	0400-00750	TSTR 2N5771
Q12	0400-01200	TSTR 2N3904A
Q13	0400-01340	TSTR 2N3906A
Q14	0400-00200	TSTR NPN 2N3646
Q15	0400-00100	TSTR PNP 2N3640
Q16	0400-40000	TSTR 2N4392A
Q17	0400-00800	TSTR 2N5160A
Q18	0400-01610	TSTR 2N3866A
Q19	0400-01200	TSTR 2N3904A
Q20	0400-02500	TSTR J-109
Q21	0400-40900	TSTR 2N2219A
Q22	0400-01610	TSTR 2N3866A
Q23	0400-01610	TSTR 2N3866A
Q24	0400-00800	TSTR 2N5160A
Q25	0400-00800	TSTR 2N5160A
Q26	0400-00800	TSTR 2N5160A
CR1	0300-20100	DIODE 1N752A 5.6 V
CR2	0300-20000	DIODE 1N746A 3.3 V
CR3	0300-20100	DIODE 1N752A 5.6 V
CR4	0300-20000	DIODE 1N746A 3.3 V

Table 8-8. Model 8500 PARTS LIST - OUTPUT B BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
CR5	0300-21100	DIODE REF 1N825A
CR6	0300-20000	DIODE 1N746A 3.3 V
CR7	0300-20000	DIODE 1N746A 3.3 V
CR8	0300-21100	DIODE REF 1N825A
CR9	0300-90250	DIODE 1N4740A
CR10	0300-00400	DIODE 1N4151
CR11	0300-00400	DIODE 1N4151
CR12	0300-90250	DIODE 1N4740A
CR13	0300-00400	DIODE 1N4151
CR14	0300-00400	DIODE 1N4151
CR15	0300-00400	DIODE 1N4151
CR16	0300-00400	DIODE 1N4151
R1	0100-01310	RES COMP 130 5% 1/4W
R2	0100-05110	RES COMP 510 5% 1/4W
R3	0100-08200	RES COMP 82 5% 1/4W
R7	0100-03300	RES COMP 33 5% 1/4W
R8	0100-06810	RES COMP 680 5% 1/4W
R10	0100-02220	RES COMP 2.2K 5% 1/4W
R11	0100-02220	RES COMP 2.2K 5% 1/4W
R12	0100-01010	RES COMP 100 5% 1/4W
R13	0100-01010	RES COMP 100 5% 1/4W
R14	0100-06810	RES COMP 680 5% 1/4W
R15	0100-01010	RES COMP 100 5% 1/4W
R16	0100-03310	RES COMP 330 5% 1/4W
R17	0100-03310	RES COMP 330 5% 1/4W
R18	0203-0501A	RES VAR 500 3386W
R19	0104-40210	RES MF 4.02K 1% 1/4W
R20	0100-01520	RES COMP 1.5K 5% 1/4W
R21	0104-75100	RES MF 750 1% 1/4W
R22	0104-20010	RES MF 2K 1% 1/4W
R23	0104-20010	RES MF 2K 1% 1/4W
R24	0104-12100	RES MTF 121 1/4W
R25	0104-12100	RES MTF 121 1% 1/4W
R27	0104-1000B	RES MTF 100 1% 1W
R28	0104-1000B	RES MTF 100 1% 1W
R29	0104-10010	RES MF 1K 1% 1/4W
R30	0104-10010	RES MF 1K 1% 1/4W
R31	0104-21500	RES MF 215 1% 1/4W
R32	0104-24R30	RES MF 24.3 1% 1/4W
R33	0104-21500	RES MF 215 1% 1/4W
R34	0104-95R30	RES MF 95.3 1% 1/4W
R35	0104-71R50	RES MF 71.5 % 1/4W
R36	0104-95R30	RES MF 95.3 1% 1/4W
R37	0104-61R9A	RES MF 61.9 1% 1/2W
R38	0104-24900	RES MF 249 1% 1/4W

Table 8-8. Model 8500 PARTS LIST - OUTPUT B BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
R39	0104-61R9A	RES MF 61.9 1% 1/2W
R40	0101-0152A	RES COMP 1.5K 5% 1W
R41	0100-01030	RES COMP 10K 5% 1/4W
R42	0104-10000	RES MF 100 1% 1/4W
R43	0104-10010	RES MF 1K 1% 1/4W
R44	0104-10010	RES MF 1K 1% 1/4W
R45	0104-10020	RES MF 10K 1% 1/4W
R46	0104-10000	RES MF 100 1% 1/4W
R47	0104-10010	RES MF 1K 1% 1/4W
R48	0104-10010	RES MF 1K 1% 1/4W
R49	0101-0152A	RES COMP 1.5K 5% 1W
R50	0100-01030	RES COMP 10K 5% 1/4W
R51	0100-02710	RES COMP 270 5% 1/4W
R52	0100-01520	RES COMP 1.5K 5% 1/4W
R53	0100-01020	RES COMP 1K 5% 1/4W
R54	0203-0202A	RES VAR 2K 3386W
R55	0104-10010	RES MF 1K 1% 1/4W
R56	0100-01040	RES COMP 100K 5% 1/4W
R57	0100-03320	RES COMP 3.3K 5% 1/4W
R58	0100-01210	RES COMP 120 5% 1/4W
R59	0100-02700	RES COMP 27 5% 1/4W
R60	0104-1001A	RES MTF 1% 1/2W 1K
R61	0104-1001A	RES MTF 1% 1/2W 1K
R62	0100-01210	RES COMP 120 5% 1/4W
R63	0100-01040	RES COMP 100K 5% 1/4W
R64	0104-10020	RES MF 10K 1% 1/4W
R65	0100-03320	RES COMP 3.3K 5% 1/4W
R66	0104-24920	RES MF 24.9K 1% 1/4W
R67	0203-0501A	RES VAR 500 3386W
R68	0104-10020	RES MF 10K 1% 1/4W
R69	0104-49920	RES MF 49.9K 1% 1/4W
R70	0104-15010	RES MF 1.5K 1% 1/4W
R71	0100-01030	RES COMP 10K 5% 1/4W
R72	0100-03900	RES COMP 39 5% 1/4W
R73	0100-03900	RES COMP 39 5% 1/4W
R74	0100-03300	RES COMP 33 5% 1/4W
R75	0201-01020	RES VAR 1K 3329H
R76	0102-0332A	RES COMP 3.3K 5% 2W
R77	0104-11510	RES MF 1.15K 1% 1/4W
R78	0104-10020	RES MF 10K 1% 1/4W
R79	0100-03300	RES COMP 33 5% 1/4W
R80	0100-03900	RES COMP 39 5% 1/4W
R81	0100-03300	RES COMP 33 5% 1/4W
R82	0201-02010	RES VAR 200 3329H
R83	0101-0100A	RES COMP 10 5% 1W
R84	0100-04R70	RES COMP 4.7 5% 1/4W

Table 8-8. Model 8500 PARTS LIST - OUTPUT B BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
R85	0100-02410	RES COMP 240 5% 1/4W
R86	0104-10020	RES MF 10K 1% 1/4W
R87	0100-04R70	RES COMP 4.7 5% 1/4W
R88	0101-0100A	RES COMP 10 5% 1W
R89	0101-01000	RES COMP 10 5% 1/2W
R90	0104-1001A	RES MTF 1% 1/2W
R91	0104-1001A	RES MTF 1K 1% 1/2W
R92	0101-01000	RES COMP 10 5% 1/2W
R93	0101-01000	RES COMP 10 5% 1/2W
R94	0100-03300	RES COMP 33 5% 1/4W
R95	0101-01000	RES COMP 10 5% 1/2W
R96	0104-49R9A	RES MF 49.9 1% 1W
R97	0104-49R9A	RES MF 49.9 1% 1W
R98	0104-49R9A	RES MF 49.9 1% 1W
R99	0104-49R9A	RES MF 49.9 1% 1W
C1	1533-01070	CAP ELEC 100UF/25V
C2	1533-01070	CAP ELEC 100UF/25V
C3	1533-01070	CAP ELEC 100UF/25V
C4	1533-01070	CAP ELEC 100UF/25V
C5	1500-01040	CAP CER .1 UF-20%+80% 50V
C6	1500-01040	CAP CER .1 UF-20%+80% 50V
C7	1500-01040	CAP CER .1 UF-20%+80% 50V
C8	1500-01040	CAP CER .1 UF-20%+80% 50V
C9	1500-01040	CAP CER .1 UF-20%+80% 50V
C10	1500-01040	CAP CER .1 UF-20%+80% 50V
C11	1500-01020	CAP CER 1 NF 20% 50V
C12	1500-06820	CAP CER 6.8 NF 20% 50V
C13	1500-01040	CAP CER .1 UF-20%+80% 50V
C14	1500-08200	CAP CER 82P
C15	1500-01020	CAP CER 1 NF 20% 50V
C16	1500-04700	CAP CER 47PF 20% 50V
C17	1550-01000	CAP VAR 3-10PF VERTICAL
C18	1500-01040	CAP CER .1 UF-20%+80% 50V
C19	1500-01040	CAP CER .1 UF-20%+80% 50V
C20	1500-03310	CAP CER 330P
C21	1500-04700	CAP CER 47PF 20% 50V
C22	1500-01040	CAP CER .1 UF-20%+80% 50V
C23	1500-04700	CAP CER 47PF 20% 50V
C24	1521-01040	CAP POLY .1UF 20% 100V MKT-1818
C25	1500-03R90	CAP CER 3.9P
C26	1500-01040	CAP CER .1 UF-20%+80% 50V
C27	1521-01040	CAP POLY .1UF 20% 100V MKT-1818
C28	1521-01040	CAP POLY .1UF 20% 100V MKT-1818
C29	1521-01040	CAP POLY .1UF 20% 100V MKT-1818
C30	1521-01040	CAP POLY .1UF 20% 100V MKT-1818

Table 8-8. Model 8500 PARTS LIST - OUTPUT B BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
C31	1521-01040	CAP POLY .1UF 20% 100V MKT-1818
C32	1521-01040	CAP POLY .1UF 20% 100V MKT-1818
C33	1550-02500	CAP VAR 7-25 PF
C34	1521-01040	CAP POLY .1UF 20% 100V MKT-1818
C35	1521-01040	CAP POLY .1UF 20% 100V MKT-1818
C36	1535-02270	CAP ELEC 220UF 50V
C37	1535-02270	CAP ELEC 220UF 50V
C38	1500-01040	CAP CER .1 UF-20%+80% 50V
C39	1500-01040	CAP CER .1 UF-20%+80% 50V
C40	1500-01040	CAP CER .1 UF-20%+80% 50V
C41	1500-01040	CAP CER .1 UF-20%+80% 50V
C42	1500-04700	CAP CER 47PF 20% 50V
C43	1540-01060	CAP TANT 10UF 35V
C44	1540-01060	CAP TANT 10UF 35V
C45	1540-01060	CAP TANT 10UF 35V
K1	0900-00700	RELAY RZ-1
K2	0900-00700	RELAY RZ-1
K3	0900-00700	RELAY RZ-1
K4	0900-00700	RELAY RZ-1
J1	3000-30520	CON FEMALE 2 x 8
J2	3000-16000	CON RF MALE
J2A	3000-17000	CON RF FEMALE
J3	3000-16000	CON RF MALE
J3A	3000-17000	CON RF FEMALE
HS	3800-01500	6 x HEAT SINK FE398
HS	3800-01800	2 x HEAT SINK J-25-1304

Table 8-9. Model 8500 PARTS LIST - POWER SUPPLY BOARD ASSEMBLY

DWG REF	PART NUMBER	DESCRIPTION
	7100-19000	PC BOARD - POWER SUPPLY
R1	0101-00R5A	RES COMP .5 5% 1w
R2	0100-01210	RES COMP 120 5% 1/4W
R3	0100-01210	RES COMP 120 5% 1/4W
R4	0100-01010	RES COMP 100 5% 1/4W
R5	0101-01020	RES COMP 1K 5% 1/2W
R6	0100-01030	RES COMP 10K 5% 1/4W
R7	0100-01020	RES COMP 1K 5% 1/4W
R8	0100-05630	RES COMP 56K 5% 1/4W
R9	0100-03020	RES COMP 3K 5% 1/4W
R10	0104-49910	RES MF 4.99K 1% 1/4W
R11	0104-49910	RES MF 4.99K 1% 1/4W
R12	0104-49910	RES MF 4.99K 1% 1/4W
R13	0104-15420	RES COMP 15.4K 1% 1/4W
R14	0100-01020	RES COMP 1K 5% 1/4W

Table 8-9. Model 8500 PARTS LIST - POWER SUPPLY BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
R15	0100-02210	RES COMP 220 5% 1/4W
R16	0100-01010	RES COMP 100 5% 1/4W
R17	0100-02220	RES COMP 2.2K 5% 1/4W
R18	0100-05630	RES COMP 56K 5% 1/4W
R19	0100-03020	RES COMP 3K 5% 1/4W
R20	0104-49910	RES MF 4.99K 1% 1/4W
R21	0104-49910	RES MF 4.99K 1% 1/4W
R22	0104-49910	RES MF 4.99K 1% 1/4W
R23	0104-49910	RES MF 4.99K 1% 1/4W
R24	0100-02210	RES COMP 220 5% 1/4W
R25	0101-01R0A	RES COMP 1 5% 1w
U1	0500-52600	VOLTAGE REGULATOR MC7824CP
U2	0500-52700	VOLTAGE REGULATOR MC7924CP
U3	0500-52500	VOLTAGE REGULATOR MC7915CP
U4	0500-52800	VOLTAGE REGULATOR SG3525A
U5	0500-53500	VOLTAGE REGULATOR LM337T
U6	0500-52100	VOLTAGE REGULATOR MC7815CP
U7	0500-52800	VOLTAGE REGULATOR SG3525A
CR1	0300-50100	DIODE BRIDGE WS005
CR2	0300-90500	DIODE MBR 1035
CR3	0300-20400	DIODE 1N758A 10 V
CR4	0300-90400	DIODE ICTE-5
CR5	0300-90600	DIODE 1N5821
CR6	0300-90300	DIODE SA-5A
C1	1534-02280	CAP ELEC 2200UF/35V
C2	1535-02270	CAP ELEC 220UF 50V
C3	1534-02280	CAP ELEC 2200UF/35V
C4	1535-02270	CAP ELEC 220UF 50V
C5	1534-03380	CAP ELEC 3300UF/35V
C6	1534-03380	CAP ELEC 3300UF/35V
C7	1535-02270	CAP ELEC 220UF 50V
C8	1535-01081	CAP ELEC 1000UF/40V
C9	1532-0228B	CAP ELEC 2200UF/16V
C10	1540-01060	CAP TANT 10 UF 25V
C11	1500-02030	CAP CER 20 NF 20% 50V
C12	1500-01040	CAP CER .1 UF-20%+80% 50V
C13	1534-03380	CAP ELEC 3300UF/35V
C14	1534-03380	CAP ELEC 3300UF/35V
C15	1535-02270	CAP ELEC 220UF 50V
C16	1535-01081	CAP ELEC 1000 UF/40V
C17	1532-0228B	CAP ELEC 2200 UF/16V
C19	1500-02030	CAP CER 20 NF 20% 50V
C20	1500-01040	CAP CER .1 UF-20%+80% 50V
C21	1533-01070	CAP ELEC 100UF/25V

Table 8-9. Model 8500 PARTS LIST - POWER SUPPLY BOARD ASSEMBLY (continued)

DWG REF	PART NUMBER	DESCRIPTION
Q1	0500-53800	TSTR D44H5
Q4	0500-53900	TSTR D45H5
Q2	0400-40100	TSTR NPN 2N2219A
Q3	0400-01340	TSTR 2N3906A
Q5	0400-01340	TSTR 2N3906A
F1	1100-12900	1.6A FAST BLOW
F2	1100-11300	0.5A FAST BLOW
L1	2500-02800	200MH
L2	2500-02850	1mH
J1	3000-30520	CON FEMALE 2 x 8
J2	3000-30520	CON FEMALE 2 x 8

SECTION 9

SCHEMATIC DIAGRAMS

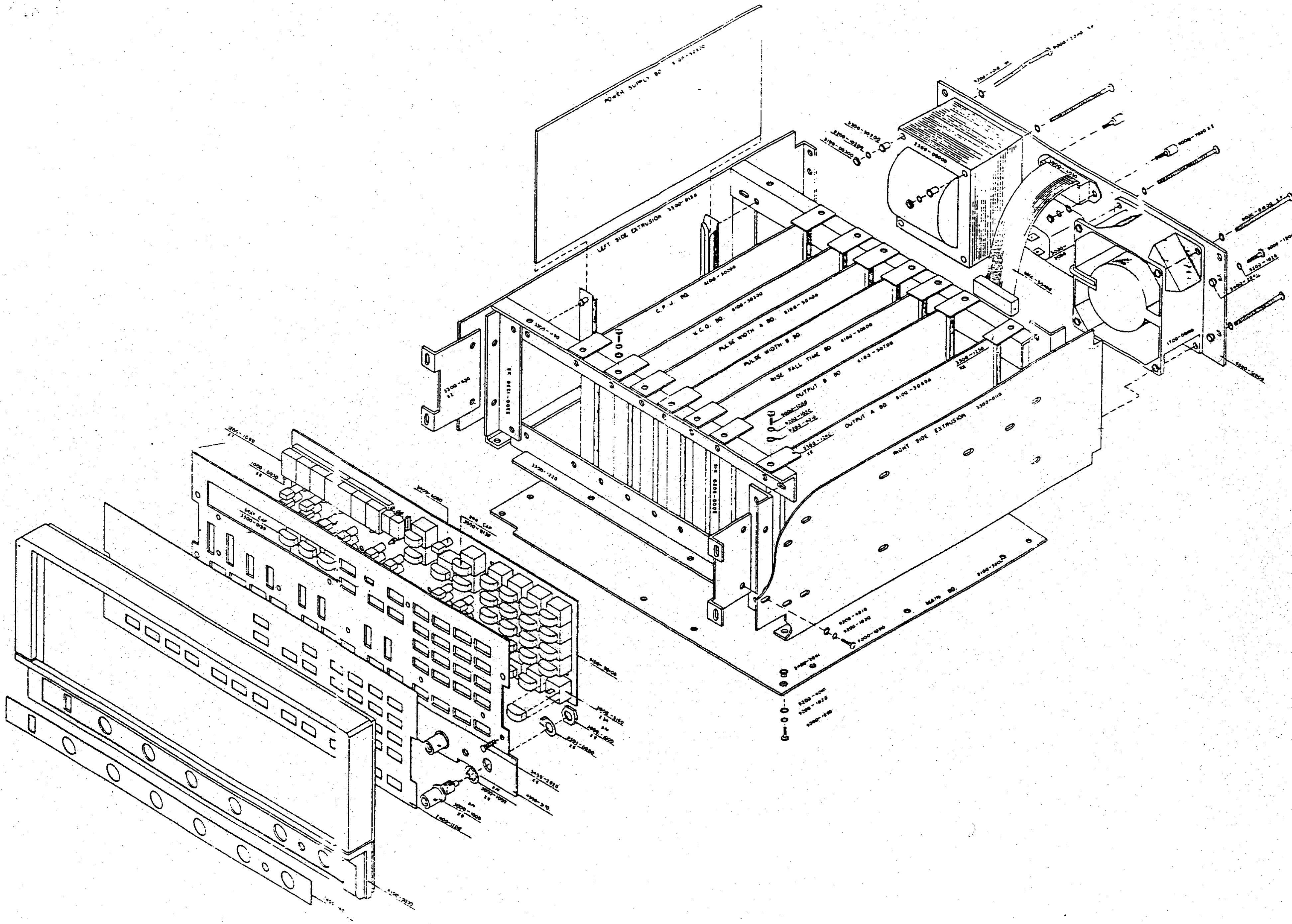
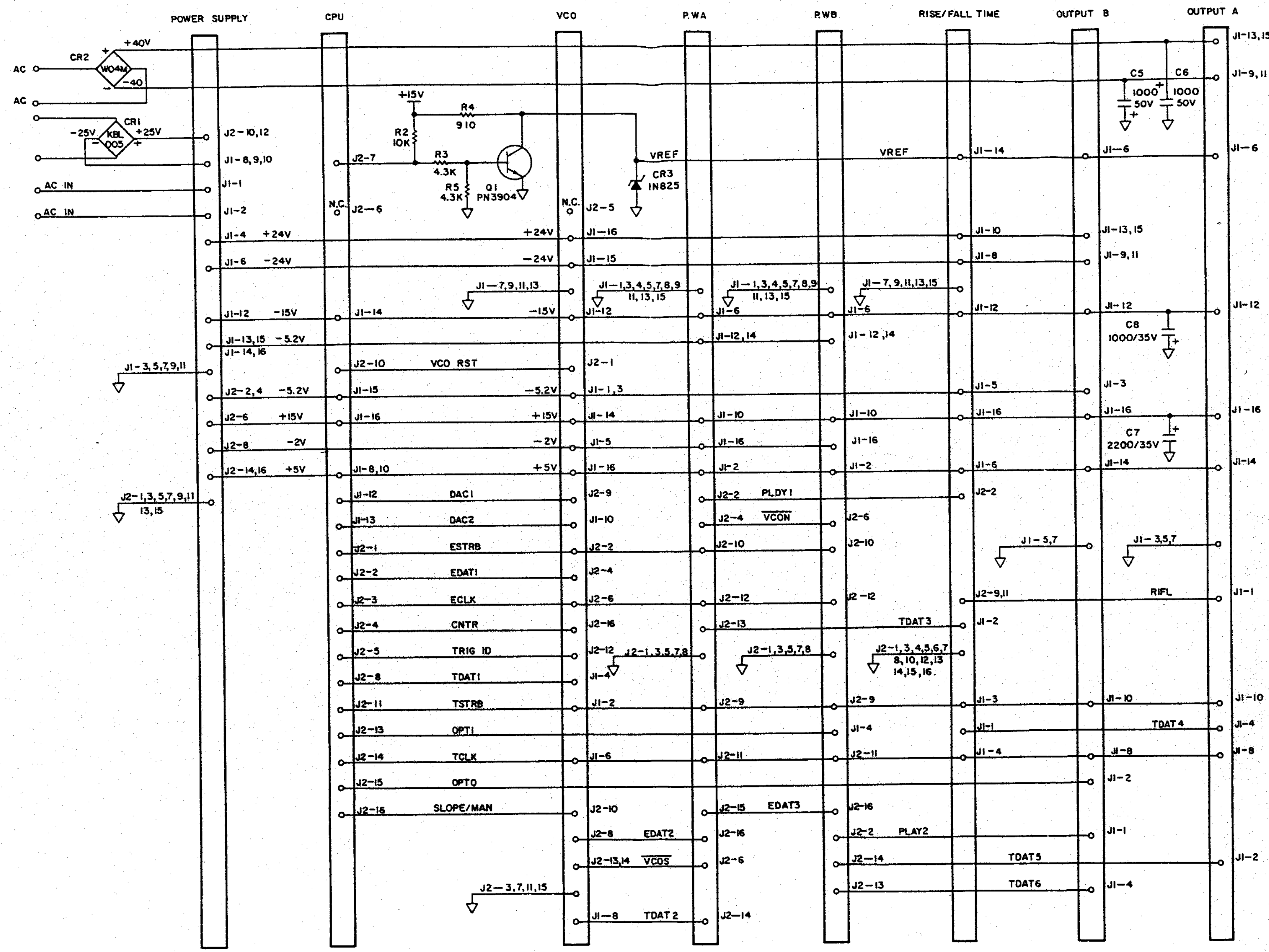
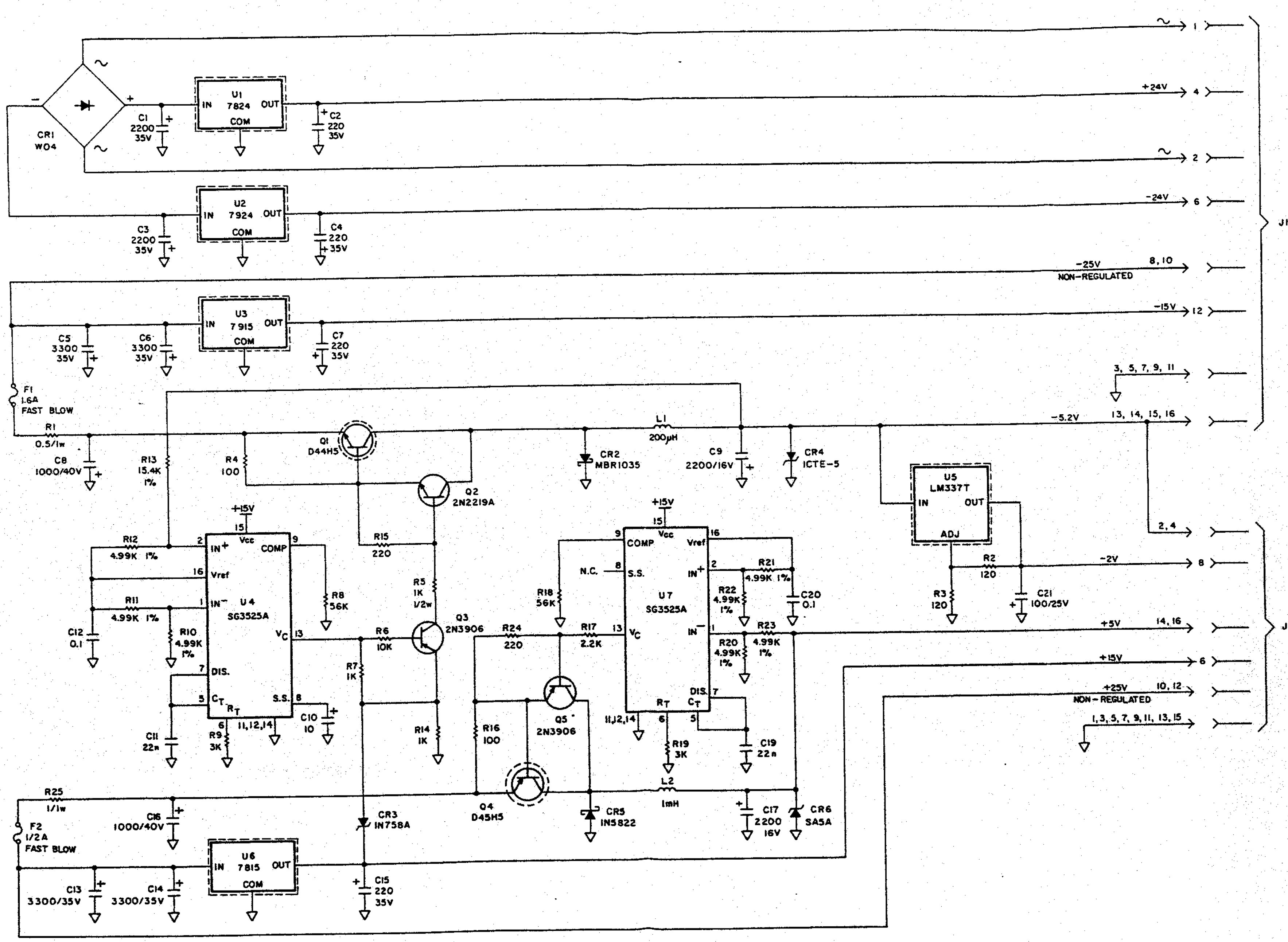


Figure 8-1. Model 8500 - Exploded View

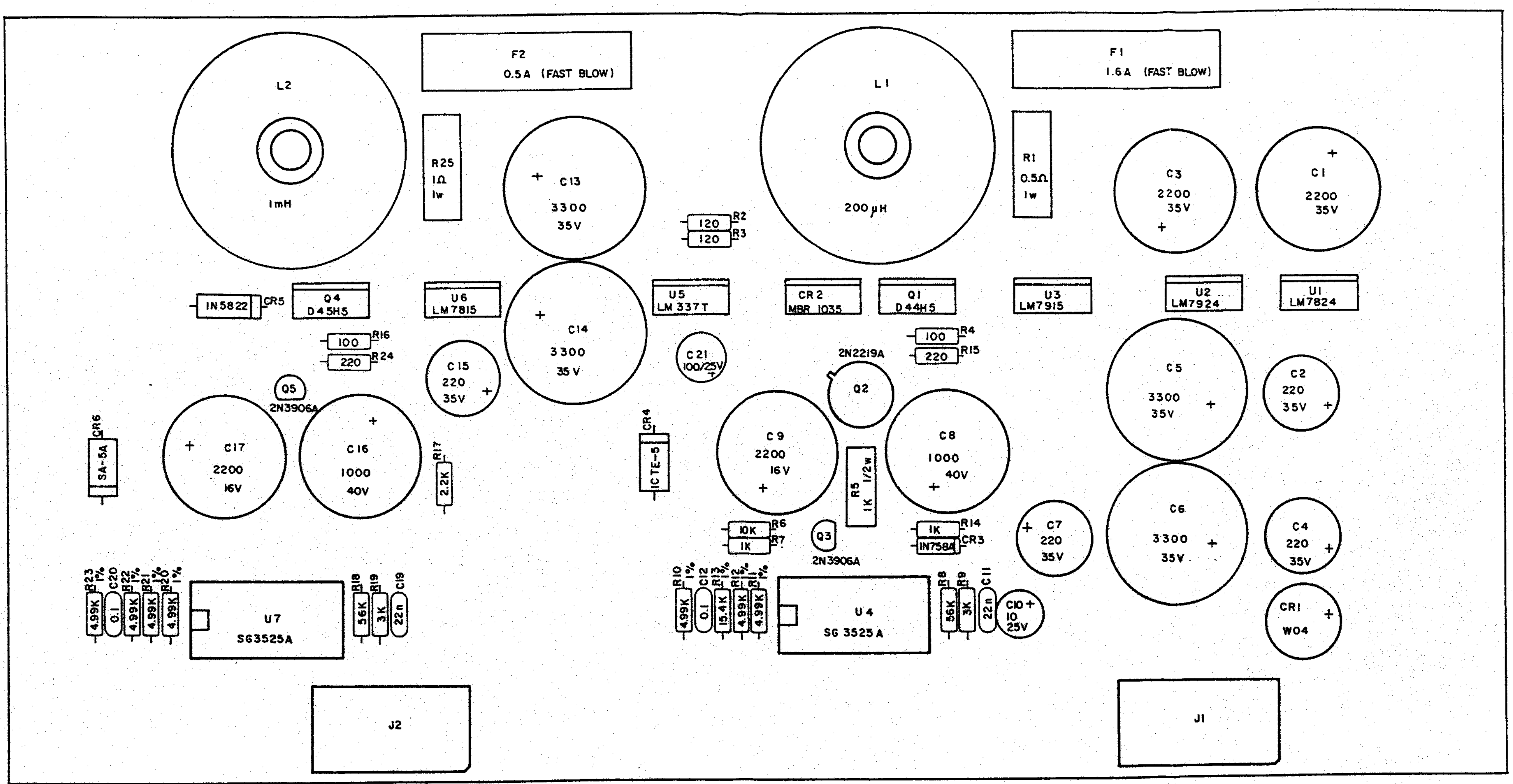


9-1 Main Board - Inter-connection Diagram

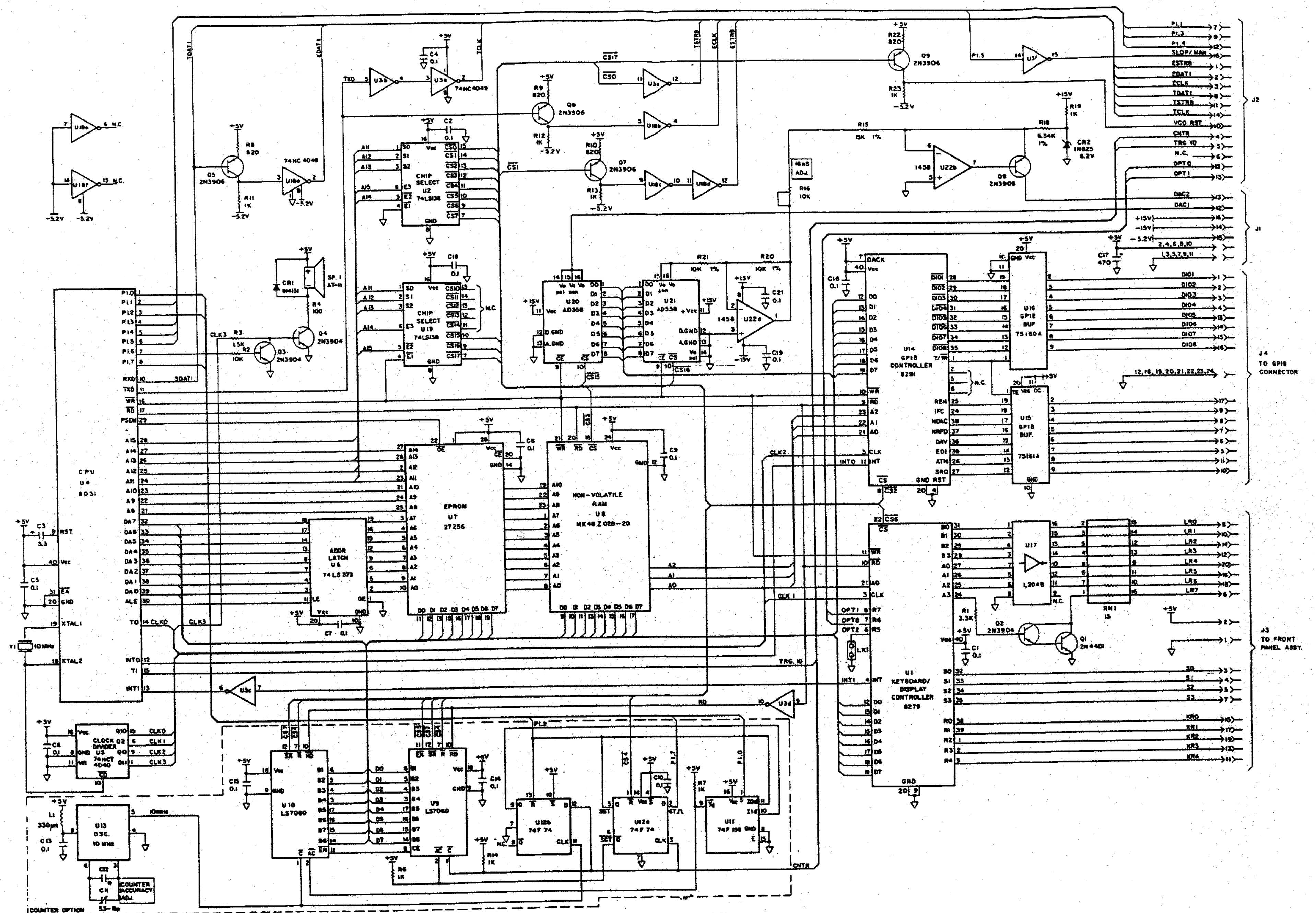


NOTES
1. ALL CAP VALUES ARE GIVEN IN μF UNLESS OTHERWISE NOTED.
2. ALL RES VALUES ARE GIVEN IN Ω UNLESS OTHERWISE NOTED.
3. * DENOTES SELECTED VALUE MOST FREQUENT VALUE SHOWN.

9-2 Power Supply Board - Schematic Drawing

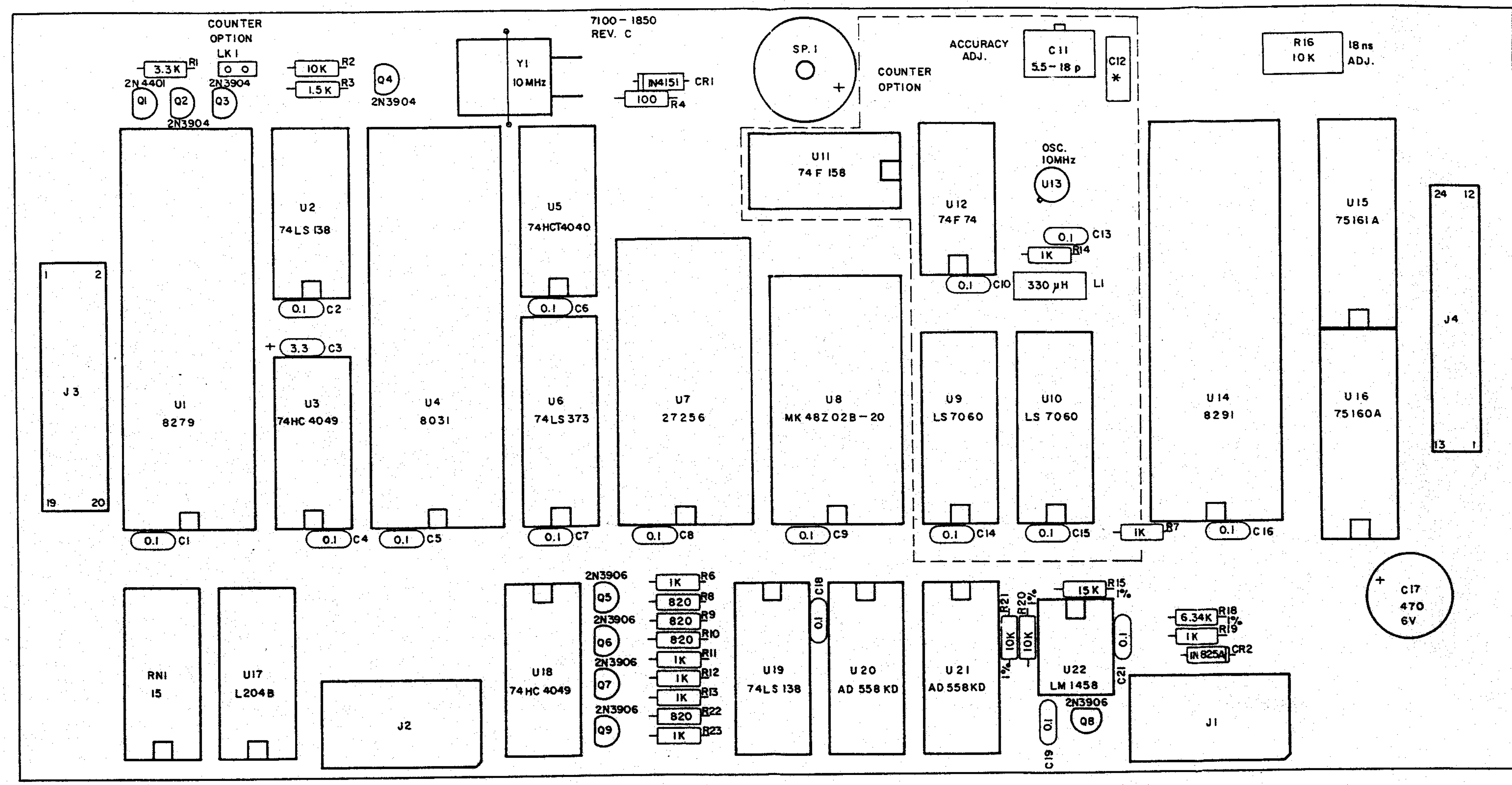


9-3 Power Supply Board - Assembly Drawing

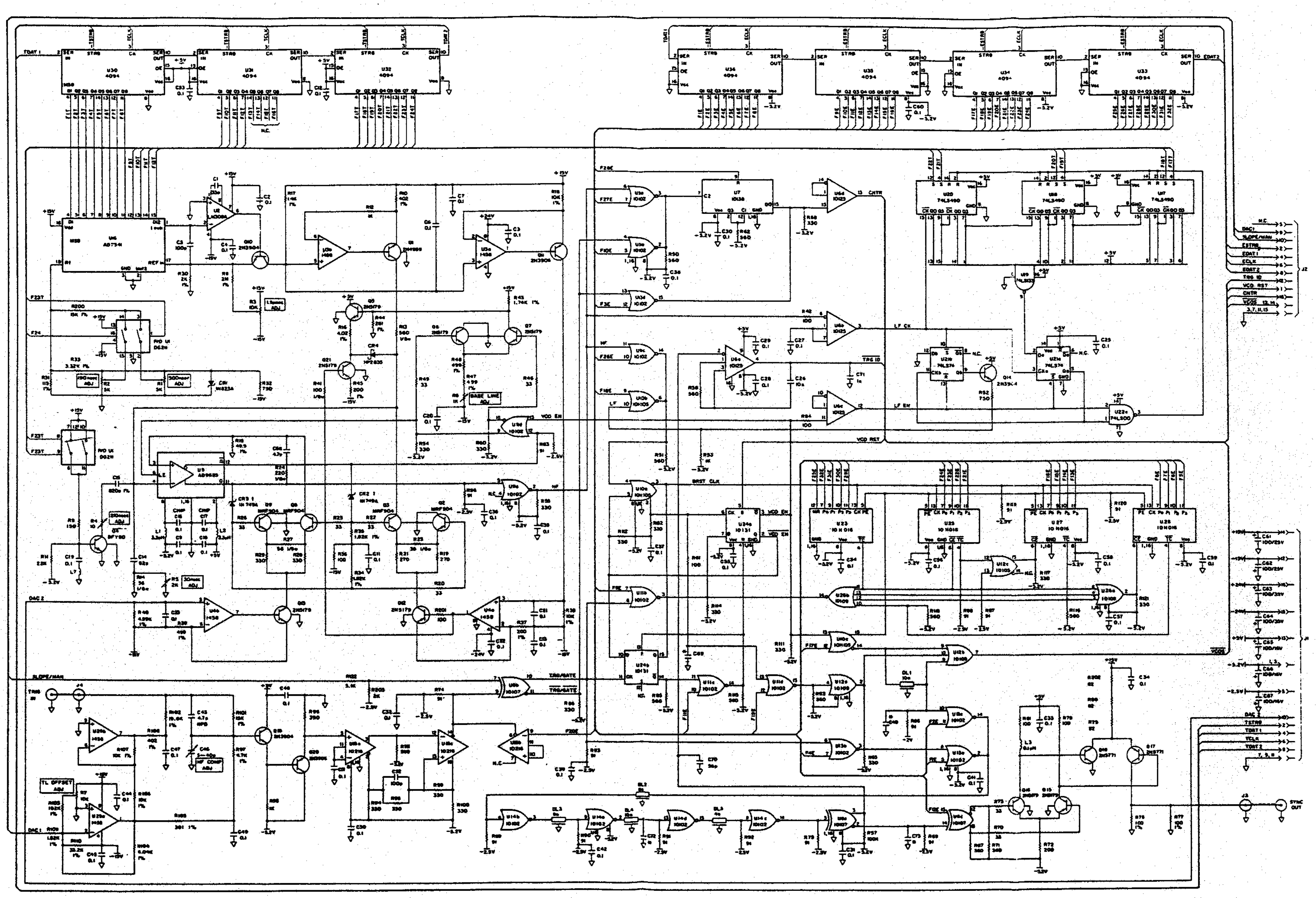


NOTES
1 ALL CAP VALUES ARE GIVEN IN µF UNLESS OTHERWISE NOTED
2 ALL RES VALUES ARE GIVEN IN Ω UNLESS OTHERWISE NOTED
3 * DENOTES SELECTED VALUE MOST FREQUENT VALUE SHOWN.

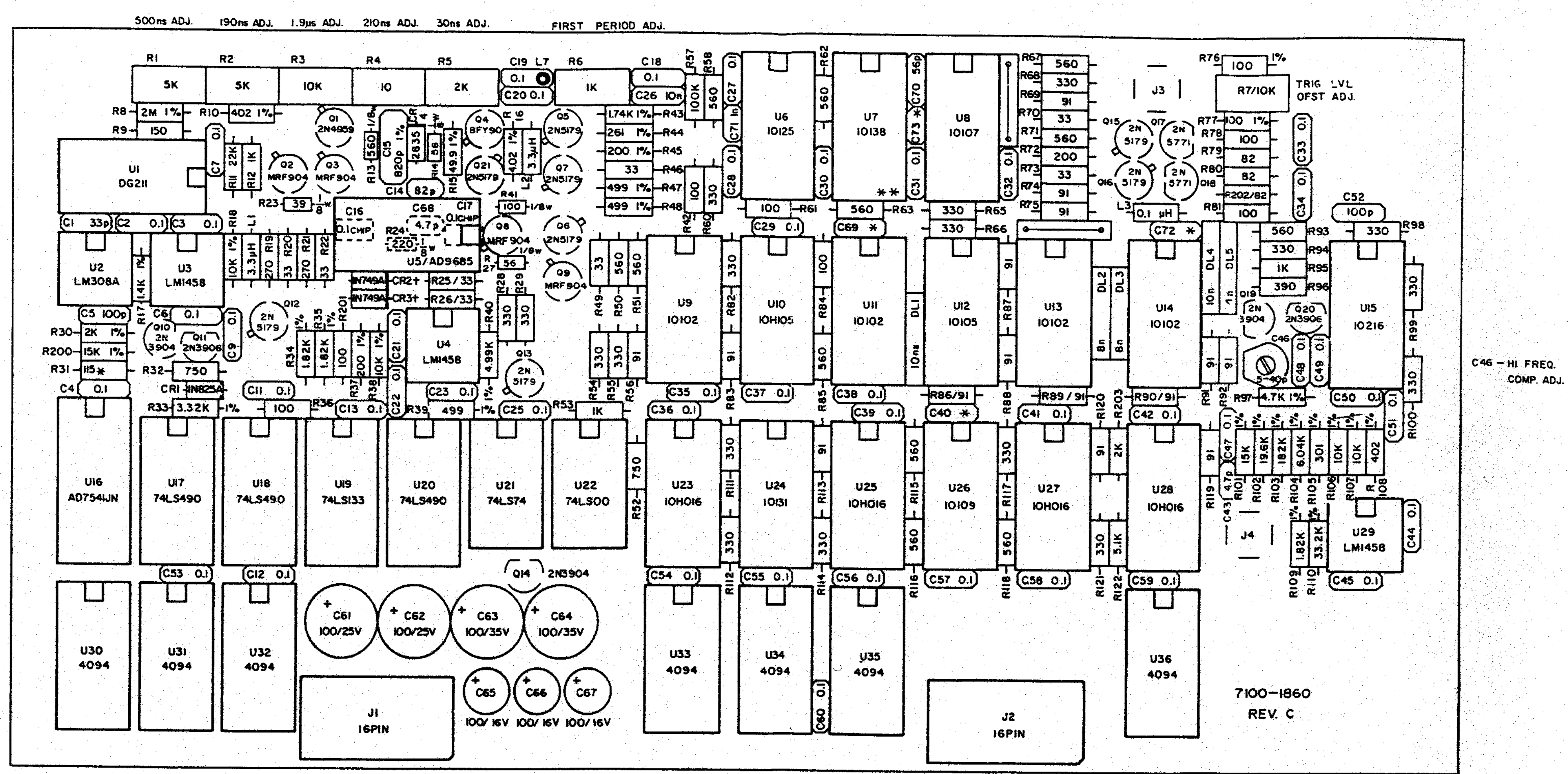
9-4 C.P.U Board - Schematic Drawing



9-5 C.P.U Board - Assembly Drawing

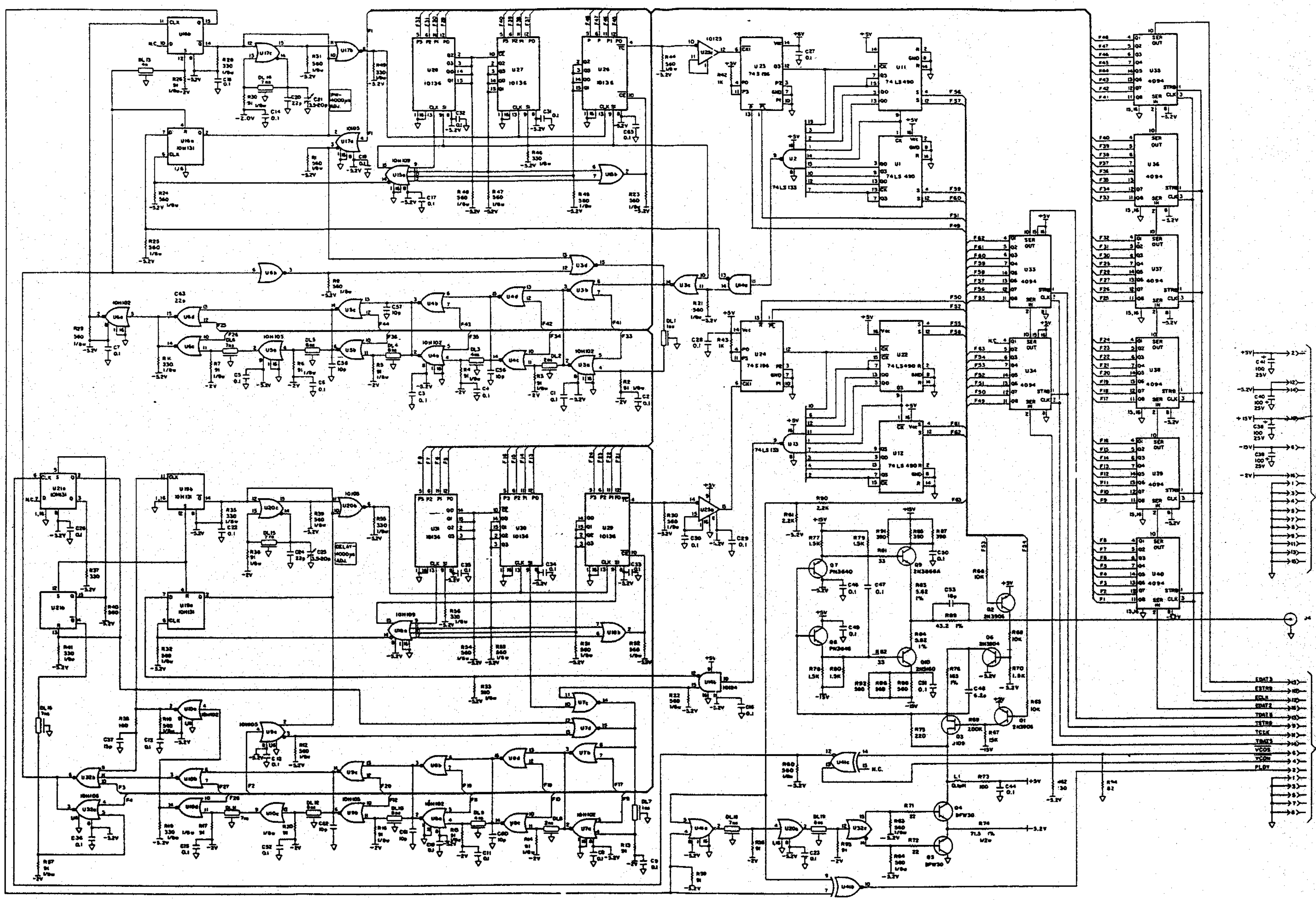


9-6 V.C.O Board - Schematic Drawing



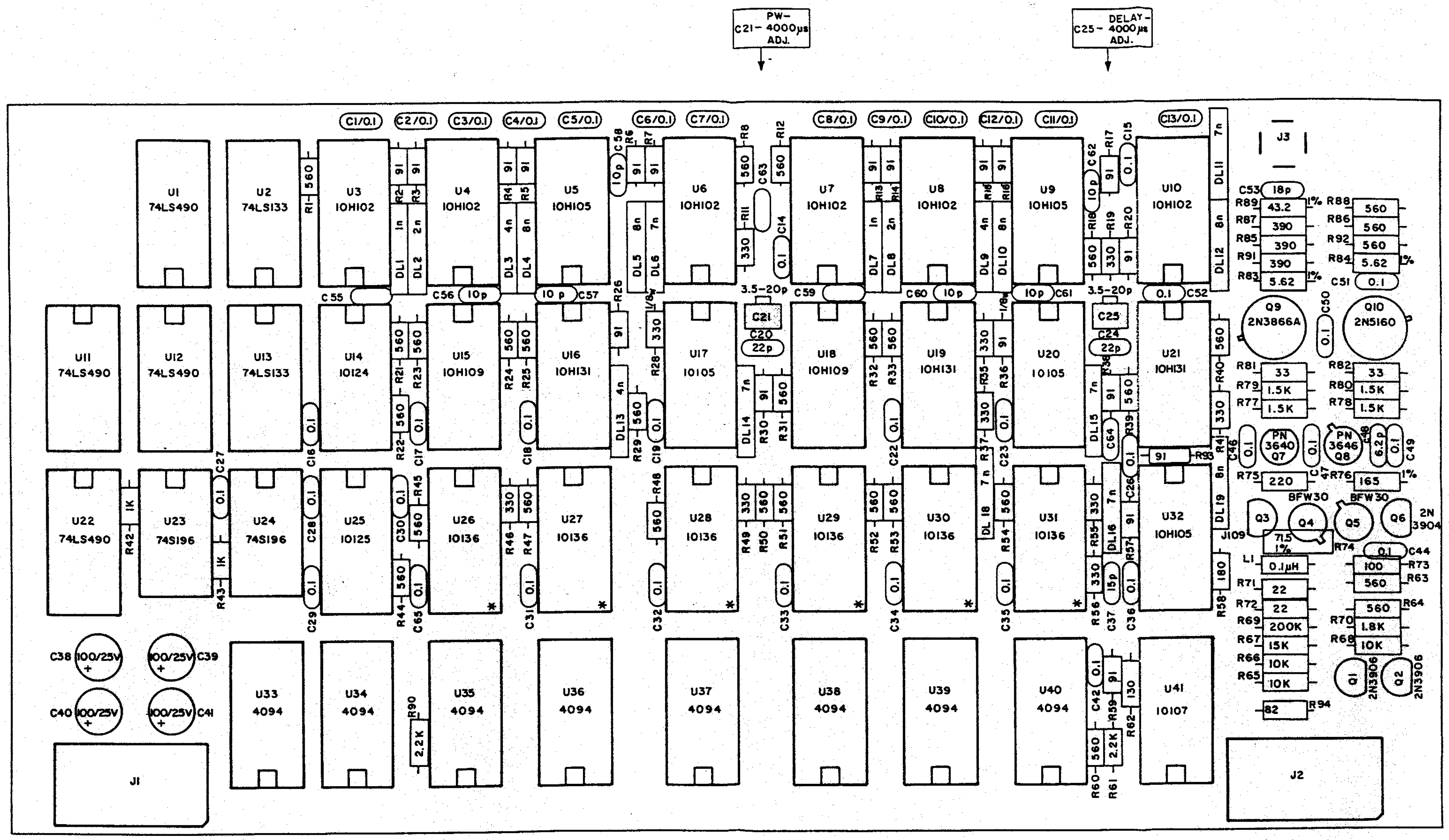
NOTES:
1. ALL CAP. VALUES ARE GIVEN IN μF UNLESS OTHERWISE NOTED.
2. ALL RES. VALUES ARE GIVEN IN Ω UNLESS OTHERWISE NOTED.
3. * DENOTES SELECTED VALUE MOST FREQUENT VALUE SHOWN.

4. † DENOTES MATCHED PAIR.
5. ** HEAT SINK.



NOTES
1. ALL CAP VALUES ARE GIVEN IN µF UNLESS OTHERWISE NOTED
2. ALL RES VALUES ARE GIVEN IN Ω UNLESS OTHERWISE NOTED
3. * DENOTES SELECTED VALUE MOST FREQUENT VALUE SHOWN

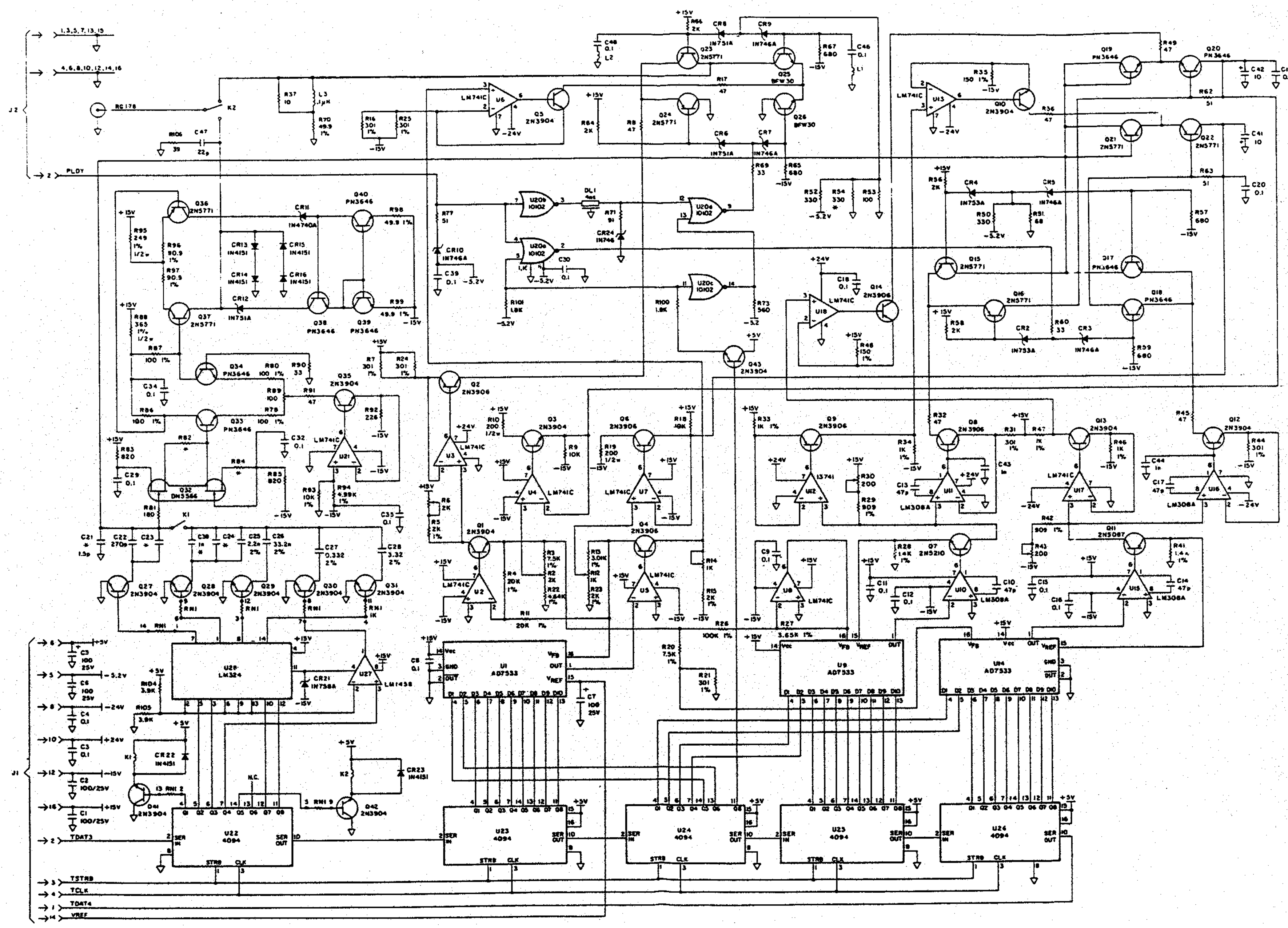
9-8 Pulse Width/Delay Board - Schematic Drawing



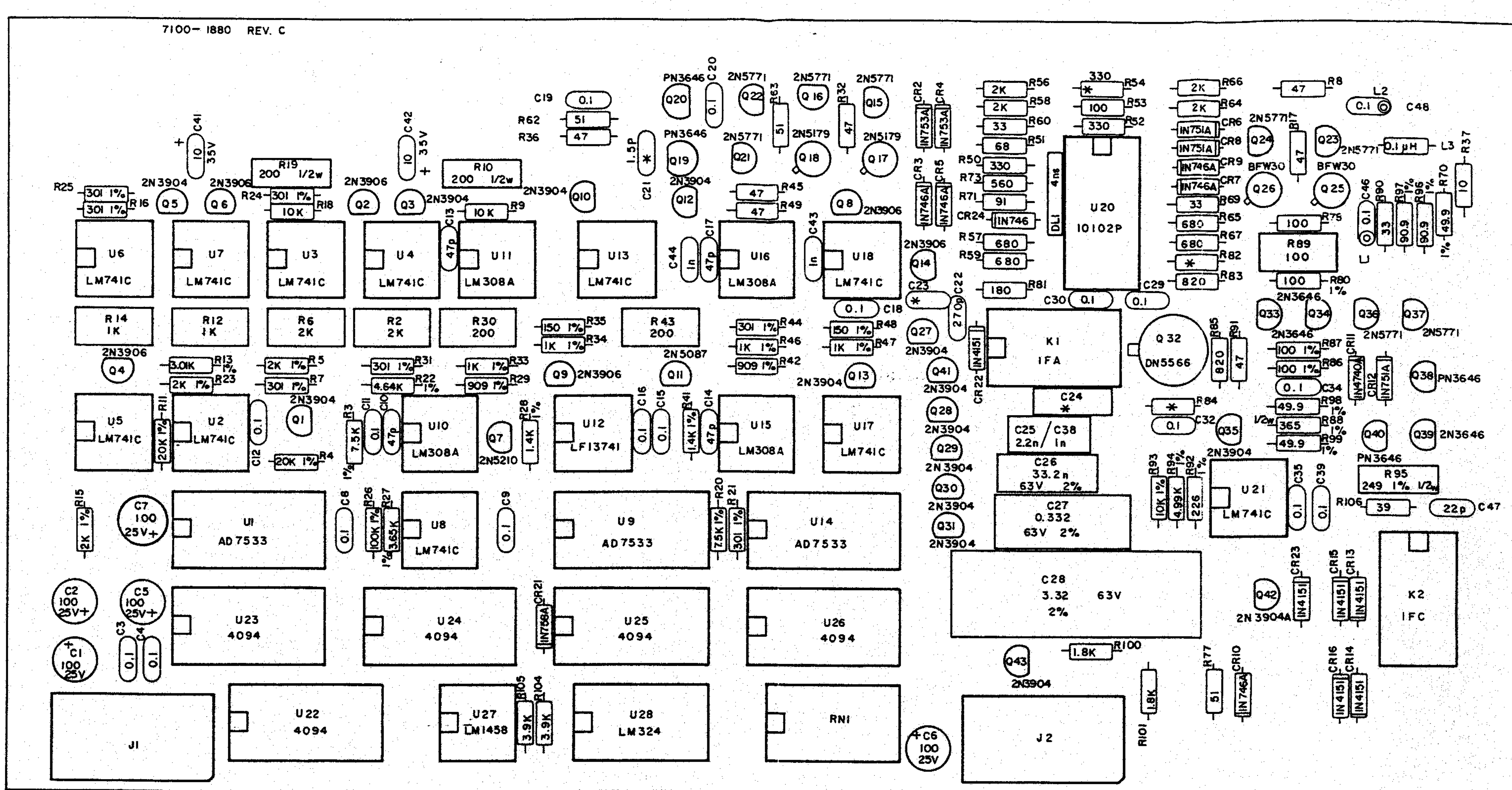
NOTES:

1. ALL CAP. VALUES ARE GIVEN IN μF UNLESS OTHERWISE NOTED.
2. ALL RES. VALUES ARE GIVEN IN Ω UNLESS OTHERWISE NOTED.
3. * DENOTES HEAT SINK.

9-9 Pulse Width/Delay Board - Assembly Drawing

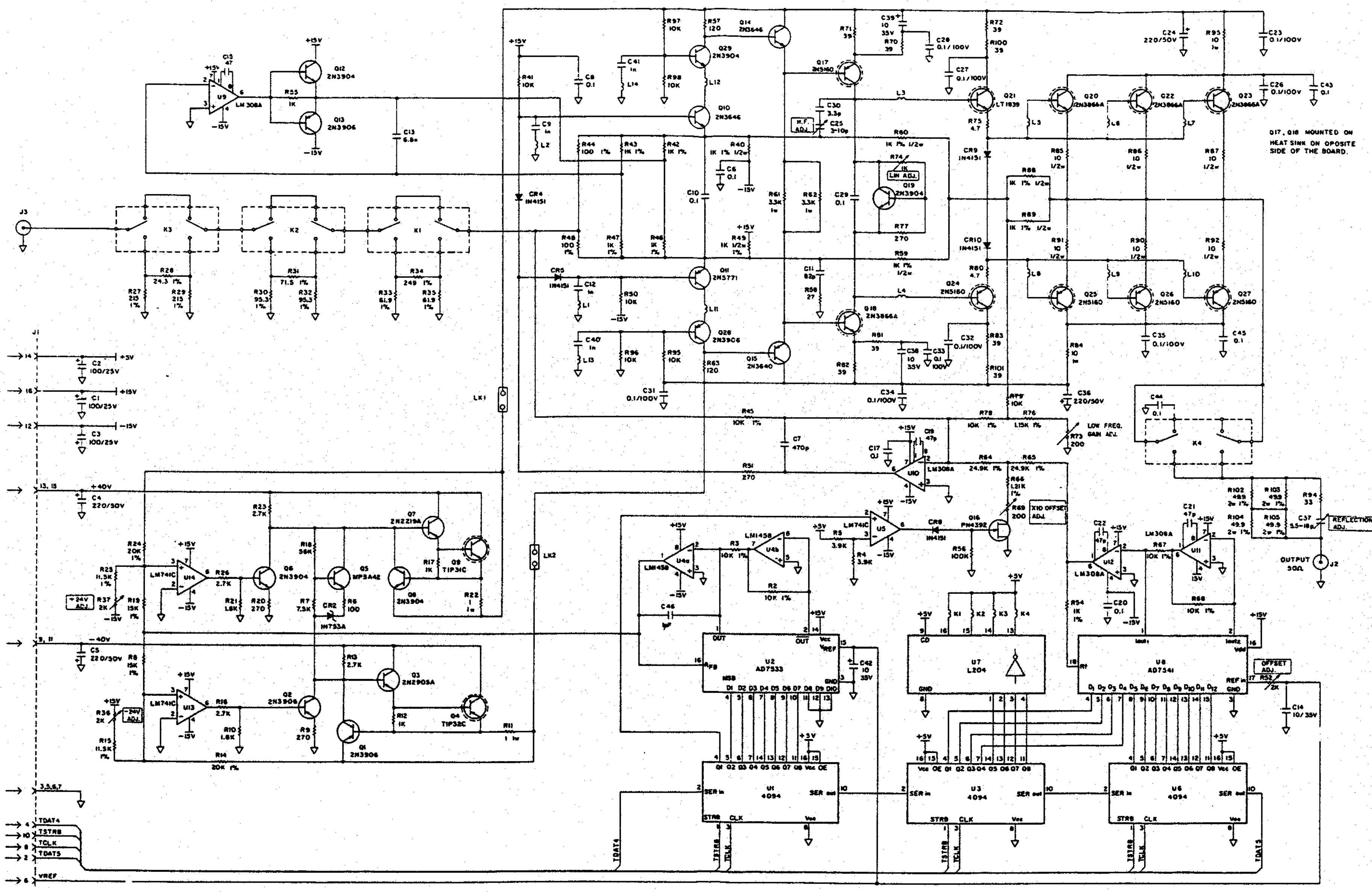


9-10 Rise/Fall Time Board - Schematic Drawing



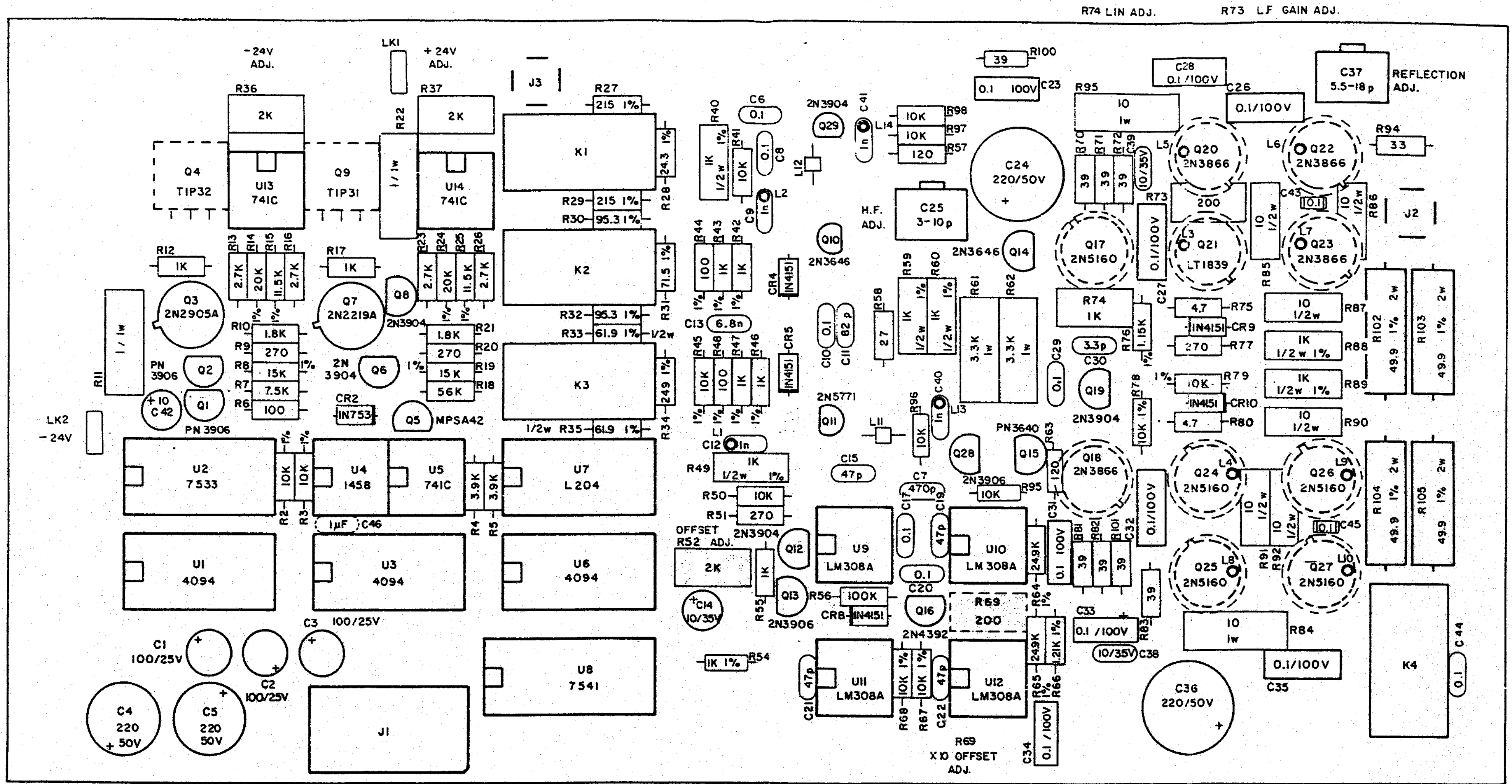
R14—L.LVL / FAST ADJ.
R12—L.LVL / LIN ADJ.
R6—H.LVL / FAST ADJ.
R2—H.LVL / LIN ADJ.
R30—RISE TIME ADJ.
R43—FALL TIME ADJ.
R89—OFFSET ADJ.

9-11 Rise/Fall Time Board - Assembly Drawing



9-12 Channel A Output Amplifier Board - Schematic Drawing 9-12

NOTES
1 ALL CAP VALUES ARE GIVEN IN μF UNLESS OTHERWISE NOTED
2 ALL RES VALUES ARE GIVEN IN Ω UNLESS OTHERWISE NOTED
3 [illegible]

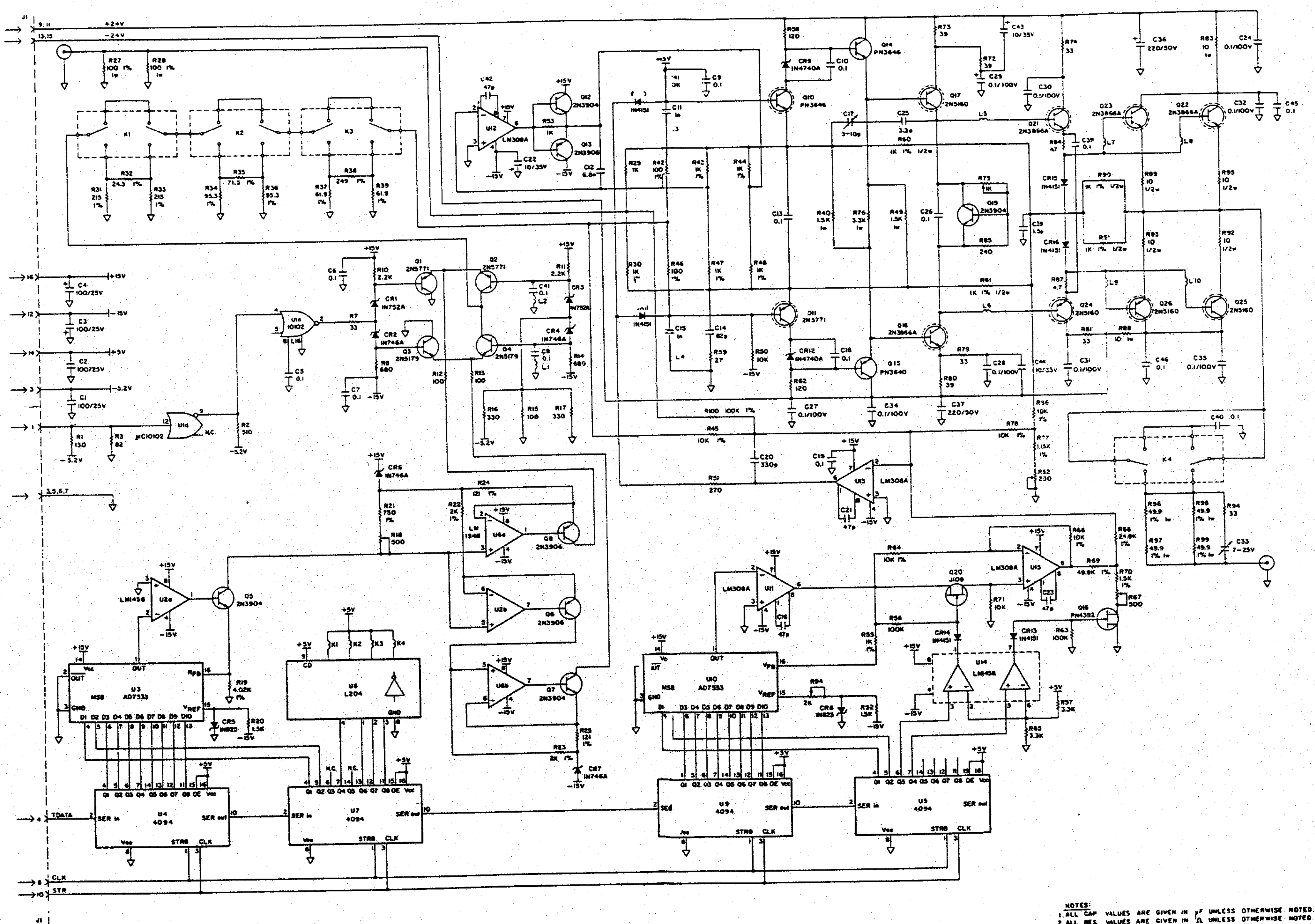


Q17, Q18, Q20-Q27 MOUNTED ON HEATSINK ON OPOSITE SIDE OF THE BOARD.

NOTES:

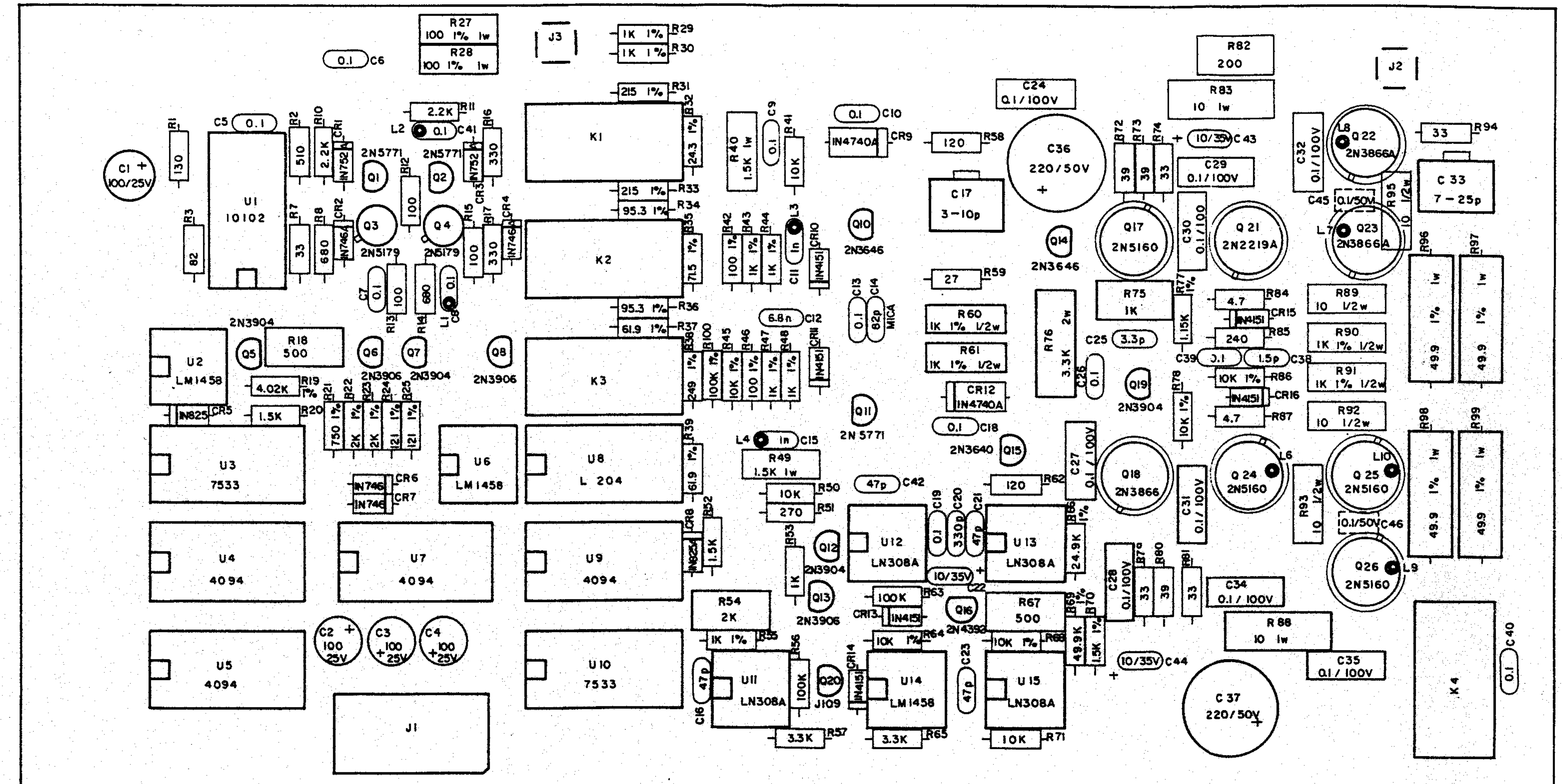
1. ALL CAP. VALUES ARE GIVEN IN µF UNLESS OTHERWISE NOTED.
2. ALL RES. VALUES ARE GIVEN IN Ω UNLESS OTHERWISE NOTED.
3. * DENOTES SELECTED VALUE MOST FREQUENT VALUE SHOWN.

9-13 Channel A Output Amplifier Board - Assembly Drawing 9-13

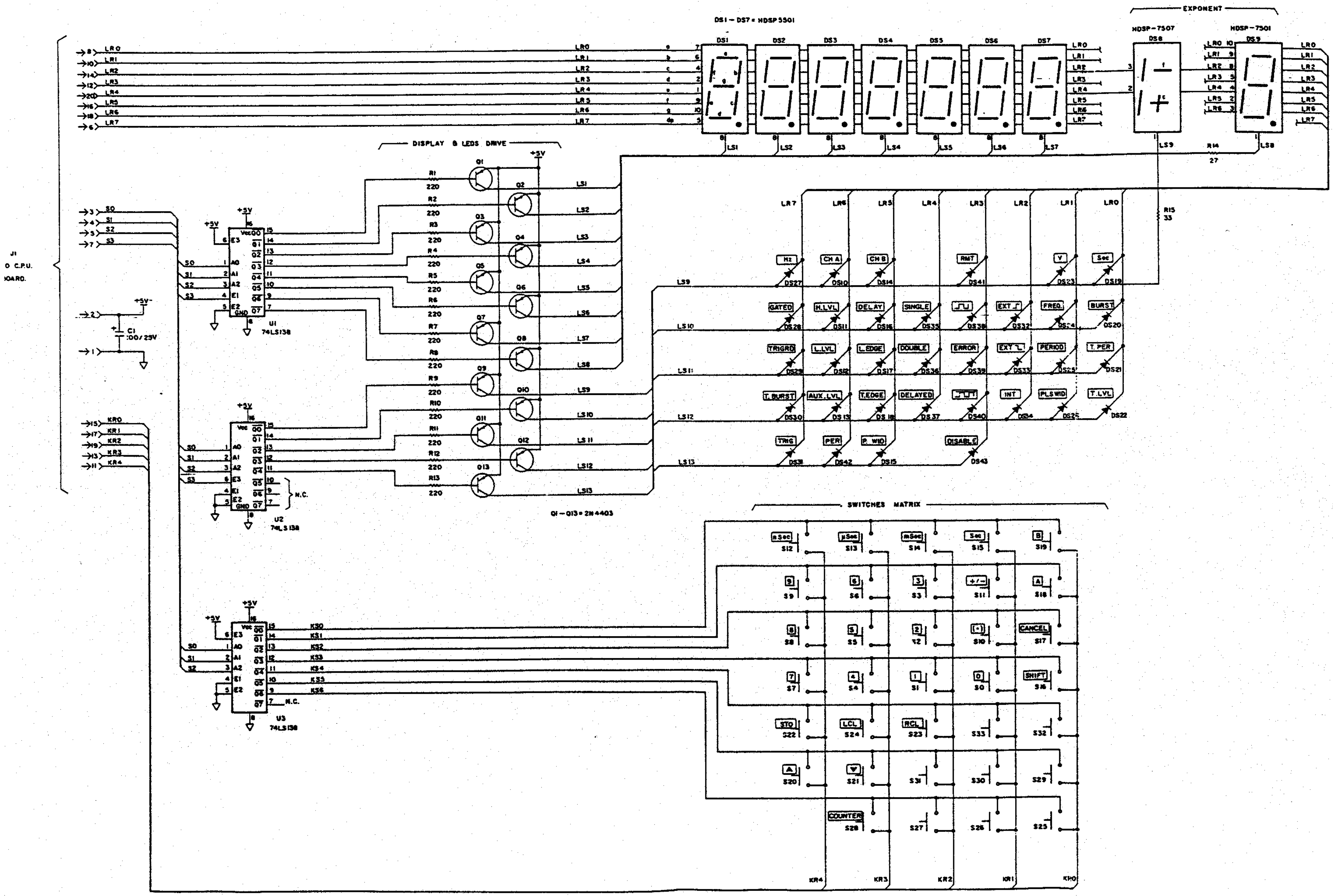


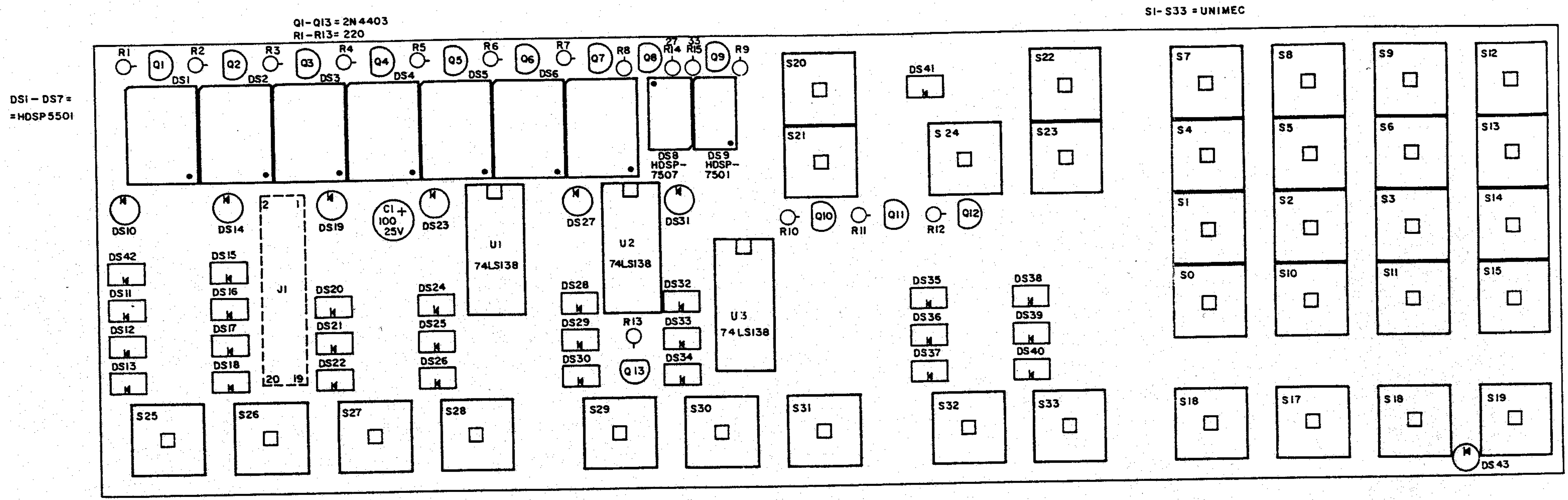
NOTES:
1. ALL CAP VALUES ARE GIVEN IN µF UNLESS OTHERWISE NOTED.
2. ALL RES. VALUES ARE GIVEN IN Ω UNLESS OTHERWISE NOTED.
3. * DENOTES SELECTED VALUE MOST FREQUENT VALUE SHOWN.

9-14 Channel B Output Amplifier Board - Schematic Drawing 9-14



9-15 Channel B Output Amplifier Board - Assembly Drawing 9-15


DS1 — DS7 = HDSP 5501
EXPONENT
HDSP-7507
HDSP-7501
DISPLAY & LEDS DRIVE
Q1 — Q13 = 2N4403
SWITCHES MATRIX
74LS138
N.C.
J1
TO C.P.U. BOARD
C1
.00/25V
R14
27
R15
33
Hz
CH A
CH B
RMT
V
Sec
GATED
H.LVL
DELAY
SINGLE
FREQ.
BURST
TRIGRD
L.LVL
L.EDGE
DOUBLE
ERROR
PERIOD
T. PER
T. BURST
AUX.LVL
T.EDGE
DELAYED
INT
PLS.WID
T.LVL
TRIG
PER
P. WID
DISABLE
CANCEL
SHIFT
STO
LCL
RCL
COUNTER



9-17 Display Board - Assembly Drawing