

## Errata

**Title & Document Type:** 8082A Pulse Generator Operating and Service Manual

**Manual Part Number:** 08082-90003

**Revision Date:** September 1983

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### HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

### About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

### Support for Your Product

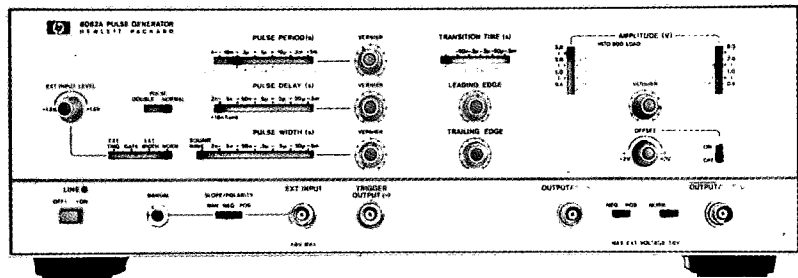
Agilent no longer sells or supports this product. You will find any other available product information on the Agilent Test & Measurement website:

[www.tm.agilent.com](http://www.tm.agilent.com)

Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

# PULSE GENERATOR 8082A

4

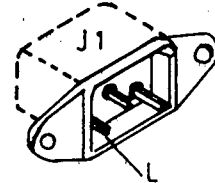


**HP MODEL 8062A PULSE GENERATOR**

Serial Numbers: from 1822G2936 to 1822G3145

**FL 1 LINE FILTER WIRING**

It is possible that the Line Filter (FL 1) in instruments with S.N. as shown above may be wired incorrectly, causing F 1 to be in the neutral (return) side. To ensure that the Line Fuse F 1 is in the phase (Line) side of the line supply, perform the following whenever an instrument is received for service or repair.



Remove the Power Cord and Fuse Cover. Using an Ohmmeter, check that there is a low resistance path (0 Ohm) between the line terminal (L) of the line connector and the tip of the fuse (Ensure that the fuse is not blown). If this is correct, the Line Filter (FL 1) is correctly installed and no further action is required.

If not, check the Line Filter wiring against Figure 1 and correct the wiring as necessary.

Figure 1 shows the correct Line Filter wiring.

Figure 2 shows a part of Power Supply Schematic

Figure 1

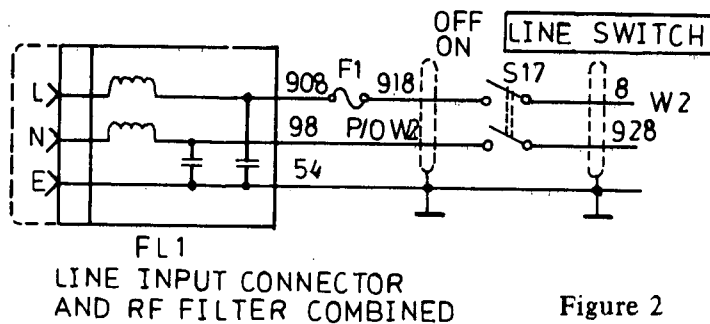
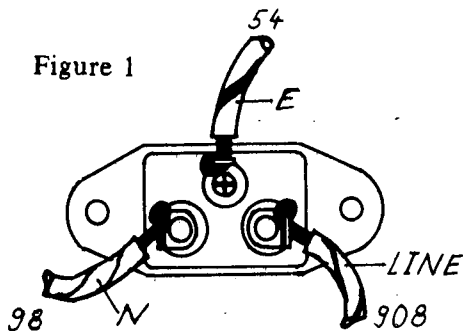


Figure 2

MI/cz/WA

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SUPERSEDES:

None

**MODEL 8082A PULSE GENERATOR**

Serial Numbers: 1822G3805 and below

**RECOMMENDED REPLACEMENT OF A5 R218 / R221**

On BD AY OFFSET 08082-66505, resistors R218 and R221 may be damaged by excessive power in worst case.

To improve the reliability of the current sources:

Replace R218 and R221 365 Ohm .25 Watt  
with 365 Ohm .5 Watt HP PART NUMBER 0757-0810.

Whenever an instrument with the SN mentioned above is received for service or repair, perform the following procedure:

Remove	A5R218/R221	365 Ohm
Replace with	A5R218/R221	365 Ohm (P/N 0757-0810)

After replacement, the performance checks and if necessary the adjustments must be done.

Please update your O/S Manual to reflect this change.



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SUPERSEDES:

None

**MODEL 8160A PROGRAMMABLE PULSE GENERATOR**

Serial Numbers: 2047G0605 and below

**RECOMMENDED REPLACEMENT OF THE FUSEHOLDER**

For the obsolete fuseholder, body (P/N 2110-0470) and fuseholder, cap (P/N 2110-0465) the below shown parts are the recommended replacement.

New parts:

XF1 Fuseholder, body	P/N 2110-0564
XF1 Fuseholder, cap	P/N 2110-0565
XF1 Nut Hex	P/N 2110-0569
XF1 Sleeve	P/N 08160-21701
XF1 Washer	P/N 1400-0090

Whenever an instrument with the SN mentioned above is received for repair because of a defective fuseholder, replace the complete fuseholder.

Refer to Figure 1 for the assembly of the new fuseholder parts.

**NOTE:**

The contacts of the fuseholder, body must be bended slightly to fit into the holes of board A13.

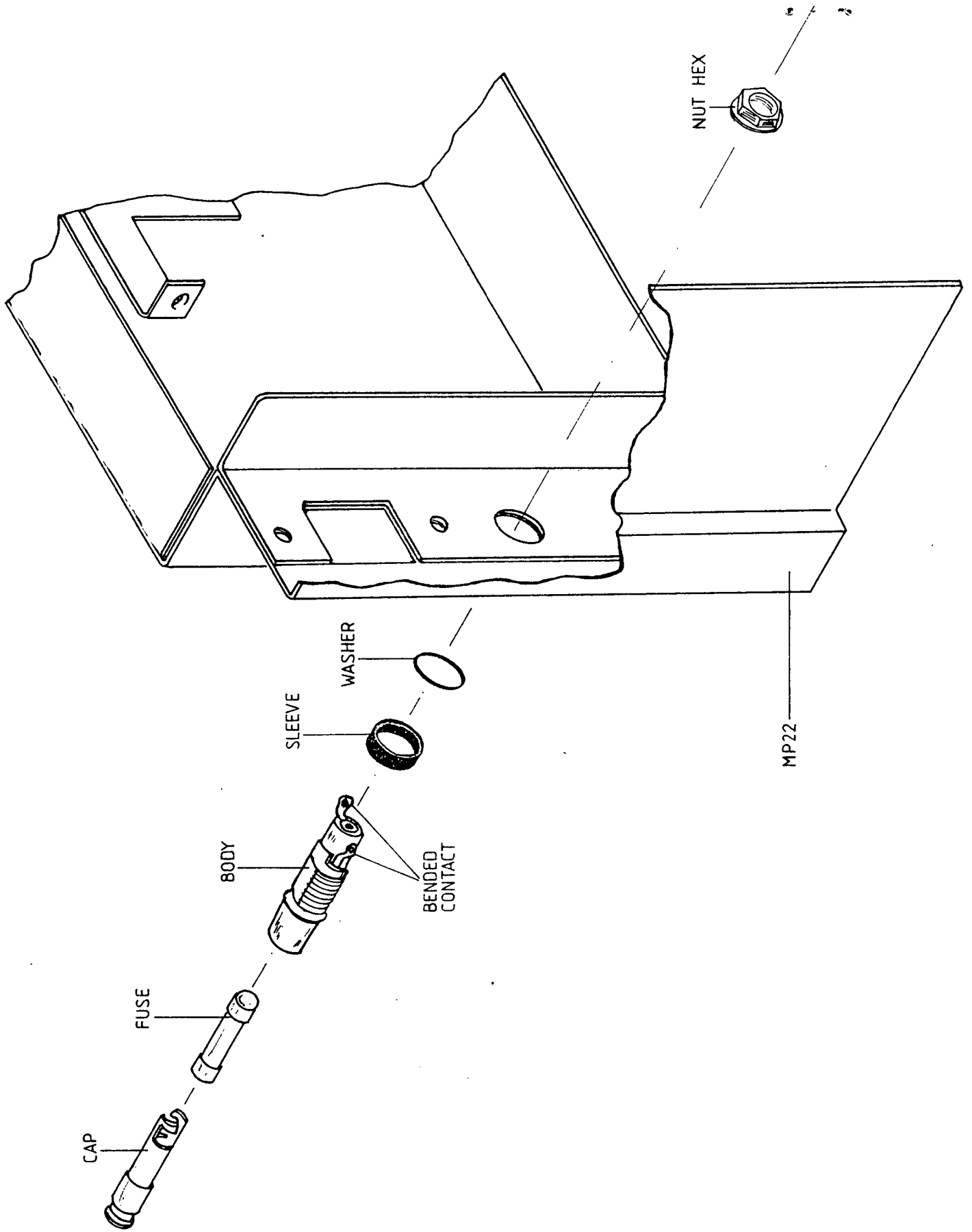
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SUPERSEDES:

None

**MODEL 8161A PROGRAMMABLE PULSE GENERATOR**

Serial Numbers: 2419G0535 and below

**RECOMMENDED REPLACEMENT OF THE FUSEHOLDER**

For the obsolete fuseholder, body (P/N 2110-0470) and fuseholder, cap (P/N 2110-0465) the below shown parts are the recommended replacement.

New parts:

XF1 Fuseholder, body	P/N 2110-0564
XF1 Fuseholder, cap	P/N 2110-0565
XF1 Nut Hex	P/N 2110-0569
XF1 Sleeve	P/N 08160-21701
XF1 Washer	P/N 1400-0090

Whenever an instrument with the SN mentioned above is received for repair because of a defective fuseholder, replace the complete fuseholder. Refer to Figure 1 for the assembly of the new fuseholder parts.

**NOTE:**

The contacts of the fuseholder, body must be bended slightly to fit into the holes of board A13.

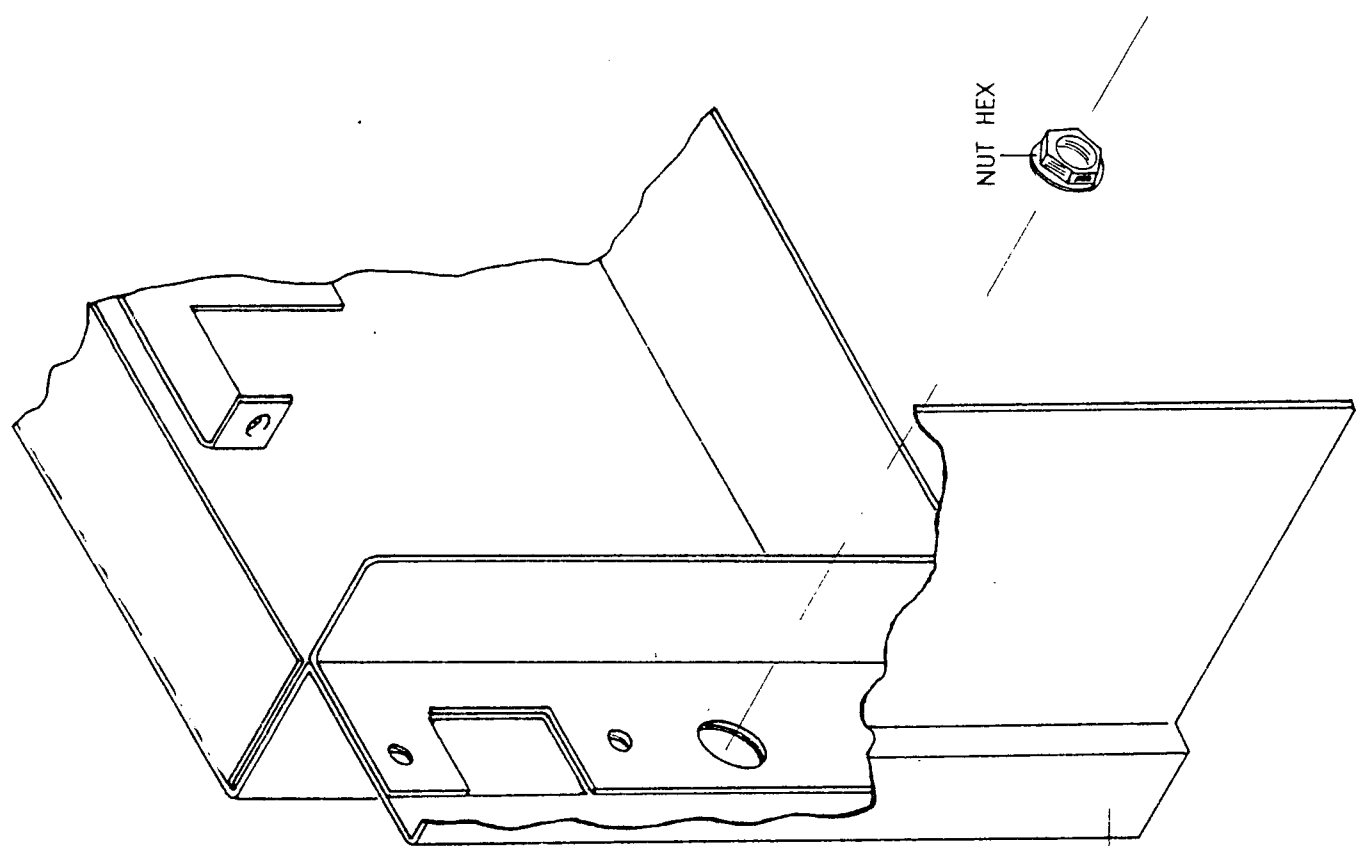
Please update your O/S Manual to reflect this change.

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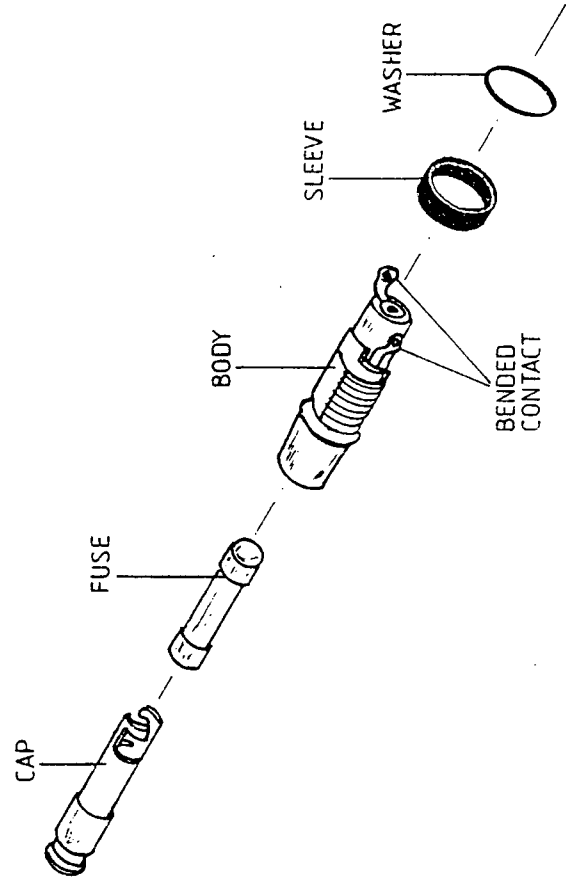


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NUT HEX

MP22



CAP

FUSE

BODY

SLEEVE

WASHER

BANDED CONTACT





**HEWLETT  
PACKARD**

# MANUAL CHANGES

Manual for Model Number	8082A
Manual printed on	September 1983
Manual Part Number	08082-90003

Make all ERRATA corrections.

Check the following table for your instrument serial prefix/serial number and make the listed changes to your manual.

► New Item

Serial Prefix or Serial Number	Manual Changes	Serial Prefix or Serial Number	Manual Changes
ERRATA 1822G03146	and above 1		

INDEX OF MANUAL CHANGES

MANUAL CHANGE	A1	A2	A3	A4	A5	A6	A7	A8	A9	FRAME	MISCELL.
ERRATA				U2,U3 X2, (X1,X2)	X4,(X4)					XF3, XF4	Page 6-18
1										MP34, 35 MP36	

ERRATA

On Table 6-3, Replaceable Frame Parts List :

Add:	XF3	2110-0569	NUT HEX
	XF4	1400-0090	WASHER NEOPRENE

On Page 6-9/10, Replaceable Parts List :

	A4U2	should read 1826-0111	A4U3 ← IC-DUAL OP AMPL
	A4U3	should read 5081-3009	A4U2 ← IC SEALED PKG
	A4X2	should read 1200-0548	A4X1 ← SOCKET-IC 16 CONT
Add:	A4 (X1)	5040-9314	LOCK CLIP 14 POL
	A4 (X2)	5040-9316	LOCK CLIP 16 POL

On Page 6-12, Replaceable Parts List :

To	A5X4	1200-0588	SOCKET-IC 16 CONT
Add:	A5 (X4)	5040-9316	LOCK CLIP 16 POL

On Page 6-18, change Grid Location	G-2 from CR33 to CR39
	L-3 from R38 to R4
and	
Add:	D-2 R245

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MANUAL CHANGE 1

On Page 6-5, Replaceable Parts List :

				Qty
Add:	MP34	2360-0201	SCREW	4
	MP35	2190-0918	WASHER	4
	MP36	3050-0016	WASHER	4

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# Specification

## PULSE CHARACTERISTICS

(Source and load impedance 50  $\Omega$ )

**Transition Times:**  $\leq 1$  ns to 0.5 ms in 6 ranges. First range from  $\leq 1$  ns to 5 ns controls leading and trailing edges simultaneously; risetime and falltime may differ up to 25 % of the faster edge. For all other ranges, edges are independently variable up to 1:10.

**Overshoot and Ringing:**  $\leq \pm 6$  % of pulse amplitude, may increase to  $\pm 10$  % with amplitude vernier CCW.

**Preshoot:**  $\leq \pm 5$  % of pulse amplitude.

**Linearity:** Linearity aberration for both slopes  $\leq 5$  % for transition times  $> 5$  ns.

**Output:** Maximum amplitude is 5 V from 50  $\Omega$  into 50  $\Omega$ . Maximum output voltage is  $\pm 5$  V (amplitude + offset).

**Offset:**  $\pm 2$  V, into 50  $\Omega$ .

**Baseline:** 0 V  $\pm 150$  mV (max. amplitude range, offset switched off).

**DC-Source Impedance:** 50  $\Omega$  + 5 %, -10 %.

**Reflection Coefficient (typical):**

Attenuator setting	
ECL	5 %
0.5 - 1.0 V	5 %
1.0 - 2.0 V	8 %
2.0 - 5.0 V	15 %

**Output Protection:** Cannot be damaged by open or short circuits or application of external signals  $\leq \pm 6$  volts or  $\pm 200$  mA.

**Attenuator:** Two separate three step-attenuators reduce the outputs to 1 V. Vernier is common for both outputs and reduces the output to 0.4 V minimum. A further position provides ECL-compatible outputs (-0.9 V to -1.7 V typ. open circuit).

## TIMING

**Repetition Rate:**  $> 250$  MHz to  $< 1$  kHz in 6 ranges.

**Period Jitter:**  $< 0.1$  % + 50 ps.

**Delay:**  $< 2$  ns to  $> 0.5$  ms in 6 ranges plus typ 17 ns with respect to trigger output.

**Delay Jitter:**  $< 0.1$  % + 50 ps.

**Double Pulse:** Up to 125 MHz max (simulates 250 MHz).

**Variable Delay Time (max):**  $> 50$  % of period - 2 ns.

**Pulse Width:**  $< 2.3$  ns min to  $> 0.5$  ms max (6 ranges).

**Width Jitter:**  $< 0.1$  % + 50 ps.

**Width Duty Cycle (max):**  $> 50$  %.

**Square Wave:** A further position of the Pulse Width switch provides Square Wave output. (Delay and double pulse are disabled, max. Rep. Rate 250 MHz). Duty cycle is 50 %  $\pm 10$  % up to 100 MHz, 50 %  $\pm 15$  % for  $> 100$  MHz.

**Trigger Output:** Negative-going square wave (50 % duty cycle typ.)  $> 500$  mV from 50  $\Omega$  into 50  $\Omega$ . Internal 50  $\Omega$  load can be switched off by slide-switch on PC-board. Amplitude increases to  $\geq 1$  V into 50  $\Omega$  up to 200 MHz.

**Trigger Output Protection:** Cannot be damaged by short circuit or application of external  $\pm 200$  mA.

## EXTERNALLY CONTROLLED OPERATION

### External Input

**Input Impedance:** 50  $\Omega$   $\pm 10$  %. DC coupled.

**Maximum Input:**  $\pm 6$  V.

**Trigger Level:** Adjustable -1.5 V to +1.5 V.

**Slope Control:** Positive, negative or manual selectable.

In the MAN-position all ext functions can be controlled by push button. Button pushed in simulates an "on-signal".

**Sensitivity:** Sine-wave  $> 200$  mVpp, pulses  $> 200$  mV.

**Repetition Rate:** 0 to  $> 250$  MHz.

### Ext - Controlled Modes

**Ext Trigger:** Rep rate is determined by external trigger signal. Trigger output delay 7 ns typical. Square wave mode is disabled.

**Synchronous Gating:** Rate generator starts with a half-period delay. Last pulse is of normal width even if gate ends during the pulse.

**External Width:** Output pulse width determined by width of drive input. Rep rate and delay are disabled.

## GENERAL

**Power Requirements:** 100 V, 120 V, 220 V, 240 V rms (+5 %, -10 %) 48-440 Hz. Power consumption 85 VA max.

### Environmental:

**Operating Temperature:** 0 to 55°C.

**Storage Temperature:** -40 to +70°C.

**Humidity Range:** 95 % R.H., 0 to 40°C.

**Weight:** Net 7.9 kg (17.44 lbs), shipping 8.9 kg (19.63 lbs).

**Dimensions:** 133 mm high, 426 mm wide, 345 mm deep (5.2 x 16.75 x 13.6 in).

## OPTIONS

Option 907 Front Handle Kit

Option 908 Rack Flange Kit

Option 909 Rack Flange plus Front Handle Kit

Option 910 Additional Instrument Manual

Specifications describe the instrument's warranted performance. Supplement characteristics - identified by the word "typical" - are intended to provide information useful in applying the instrument by giving typical, but non-warranted, performance parameters.

*Data subject to change.*

OPERATING AND SERVICE MANUAL

**8082A**

# **PULSE GENERATOR**

## **SERIAL NUMBERS**

This manual applies directly to instrument with serial number 1822G02846 and higher. Any change made in instruments having serial numbers higher than the above number will be found in a "Manual Changes" supplement supplied with this manual. Be sure to examine the supplement for changes which apply to your instrument and record these changes in the manual. Backdating information for instruments with lower serial numbers can be found in Section 7 (yellow pages).

c HEWLETT-PACKARD GMBH 1983  
HERRENBERGER STR. 110, D-7030 BOBLINGEN  
FEDERAL REPUBLIC OF GERMANY

MANUAL PART No. 08082-90003  
MICROFICHE PART No. 08082-90503

PRINTED: SEP 1983

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## SAFETY SUMMARY

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

**GENERAL** — This is a Safety Class I instrument (provided with terminal for protective earthing) and has been manufactured and tested according to international safety standards.

**OPERATION — BEFORE APPLYING POWER** — comply with the installation section. Additionally, the following shall be observed:

Do not remove instrument covers when operating.

Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers and devices connected to it should be connected to a protective earth via a ground socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in serious personal injury.

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible, and when inevitable, should be carried out only by a skilled person who is aware of the hazard involved. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation is present. Do not replace components with power cable connected.

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

Do not install substitute parts or perform any unauthorized modification to the instrument.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

## SAFETY SYMBOLS



The apparatus will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the apparatus against damage.



Indicates dangerous voltages.



Earth terminal

## WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure, practice or the like, which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

## CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the equipment. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.



WARNING



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

## 1-1 INTRODUCTION

1-2 The 8082A is a 250 MHz dual channel pulse source with variable leading and trailing edge transition times as fast as 1ns. It also has variable pulse frequency, delay, width, offset and amplitude. The normal/complement relationship and the polarity of either output can be reversed. Single pulse, double pulse and square wave operation are available. There are also four trigger modes:

1-3 **Normal Mode.** In this mode the 8082A operates as a self-contained pulse source with full control of the pulse parameters from the front panel controls.

1-4 **Ext Trig Mode.** In this mode the pulse and trigger output frequencies are determined by the frequency of an externally applied signal. The other pulse parameters are varied from the front panel controls.

1-5 **Gate Mode.** In this mode a gating signal enables the pulse and trigger outputs.

1-6 **External Width Mode.** In this mode the pulse frequency and width are determined by the frequency and width of an externally applied signal. The delay between input and output is fixed. The trigger output is the shaped trigger input signal.

## 1-7 ECL OUTPUT

1-8 The 8082A has an ECL position on each of its amplitude range switches. When either or both of the switches are set to this position, both 8082A outputs automatically deliver a fixed voltage swing of  $-0.9V$  to  $-1.7V$  typical (into an open circuit) for driving ECL logic.

Table 1-1 Specifications

These specifications apply when:

1) both outputs are terminated by a 50- $\Omega$  load,

2) the internal 50- $\Omega$  source impedance is selected.

## PULSE CHARACTERISTICS

(Source and load impedance 50 $\Omega$ )

**Transition Times:**  $\leq$  1ns to 0.5ms in 6 ranges. First range from  $\leq$  1ns to 5ns controls leading and trailing edges simultaneously. For all other ranges transition times variable independently up to 1:10.

Difference between risetime and fall-time is less than 25% of the faster transition time of the two.

**Overshoot and Ringing:**  $\leq \pm 5\%$  of pulse amplitude may increase to  $\pm 10\%$  with amplitude vernier CCW.

**Preshoot:**  $\leq \pm 5\%$  of pulse amplitude.

**Linearity:** Linearity aberration for both slopes  $\leq 5\%$  for transition times  $> 5$ ns.

**Output:** Maximum amplitude is 5V from 50 $\Omega$  into 50 $\Omega$ . Maximum output voltage is  $\pm 5$ V (amplitude + offset).

**Offset:**  $> \pm 2$ V, into 50 $\Omega$

**Baseline:** 0V  $\pm 150$ mV with offset switched off and amplitude range set to maximum. Other amplitude ranges reduce baseline proportionately.

**DC-Source Impedance:** 50 $\Omega \pm 5\%$

**Reflection Coefficient:** Reflection is 2% typical for steps with 1ns rise time applied to output connector on all amplitude ranges except 5V range. On the 5V range, the reflection may be 15%.

**Output protection:** Cannot be damaged by open or short circuits or application of ext  $\leq \pm 6$  volts or  $\pm 200$ mA independent of control settings.

**Attenuator:** Two separate three step-attenuators reduce the outputs to 1V. Vernier is common for both outputs and reduces the output to 0.4V minimum. A further position provides ECL-compatible outputs ( $-0.9$ V to  $-1.7$ V typ. open circuit).

## TIMING

**Repetition Rate:**  $> 250$  MHz to  $< 1$  kHz in 6 ranges.

**Period Jitter:**  $< 0.1\% + 50$ ps

**Delay:**  $< 2$ ns to  $> 0.5$ ms in 6 ranges plus typ. 18ns fxd. with respect to trigger output.

**Delay Jitter:**  $< 0.1\% + 50$ ps

**Double Pulse:** Up to 125 MHz max. (simulates 250MHz). Min pulse spacing  $\geq 4$ ns.

**Delay Duty Cycle:**  $> 50\%$

**Pulse Width:**  $< 2$ ns to  $> 0.5$ ms in 6 ranges.

**Width Jitter:**  $< 0.1\% + 50$ ps

**Width Duty Cycle:**  $> 50\%$

**Square Wave:** A further position of the Pulse Width switch provides Square Wave output. (Delay and double pulse are disabled, max. Rep. Rate 250 MHz). Duty cycle is 50%  $\pm 10\%$  up to 100 MHz, 50%  $\pm 15\%$  for  $> 100$  MHz.

**Trigger Output:** Negative going Square Wave (50% duty cycle typ.)  $> 500$ mV from 50 $\Omega$  into 50 $\Omega$ . Internal 50 $\Omega$  load can be switched off by slide-switch on PC-board. Amplitude increases to  $\geq 1$ V into 50 $\Omega$  up to 200 MHz.

**Trigger Output Protection:** Cannot be damaged by short circuit or application of external  $\pm 200$ mA.

## EXTERNALLY CONTROLLED OPERATION

### External Input

**Input Impedance:** 50 $\Omega \pm 10\%$ . DC coupled.

**Maximum Input:**  $\pm 6$ V

**Trigger Level:** Adjustable  $-1.5$ V to  $+1.5$ V.

**Slope Control:** Positive, negative or manual selectable. In the MAN-position all ext. functions can be controlled by push button. Button pushed in simulates an "on-signal".

**Sensitivity:** Sine-wave  $> 200$ mVpp, pulses  $> 200$ mV.

**Repetition Rate:** 0 to  $> 250$  MHz.

### Ext.-Controlled Modes

**Ext. Trigger:** There are approximately 7ns delay between the external input and the trigger output. Rep.-Rate is ext. controlled (is triggered by external signal). Trigger output provides the pulse-shaped input signal. Square wave mode is disabled.

**Synchronous Gating:** Gating signal turns rep. rate generator on. Last pulse is of normal width even if gate ends during the pulse.

**External Width:** Output pulse width determined by width of drive input. Rep. Rate and Delay are disabled. Trigger output provides shaped input signal.

## OPTIONS

Option 907	Front Handle Kit
Option 908	Rack Flange Kit
Option 909	Rack Flange plus Front Handle Kit
Option 910	Additional Instrument Manual

## GENERAL

**Power Requirements:** 100V, 120V, 220V, 240V (+5%, -10%) 48 - 440 Hz. Power consumption 85VA max.

**Weight:** Net 7.9 kg (17.44 lbs), shipping 8.9 kg (19.63 lbs).

**Dimensions:** 426mm wide, 145mm high, 380mm deep (16 3/4 ins. x 5 11/16 ins. x 15 ins.).

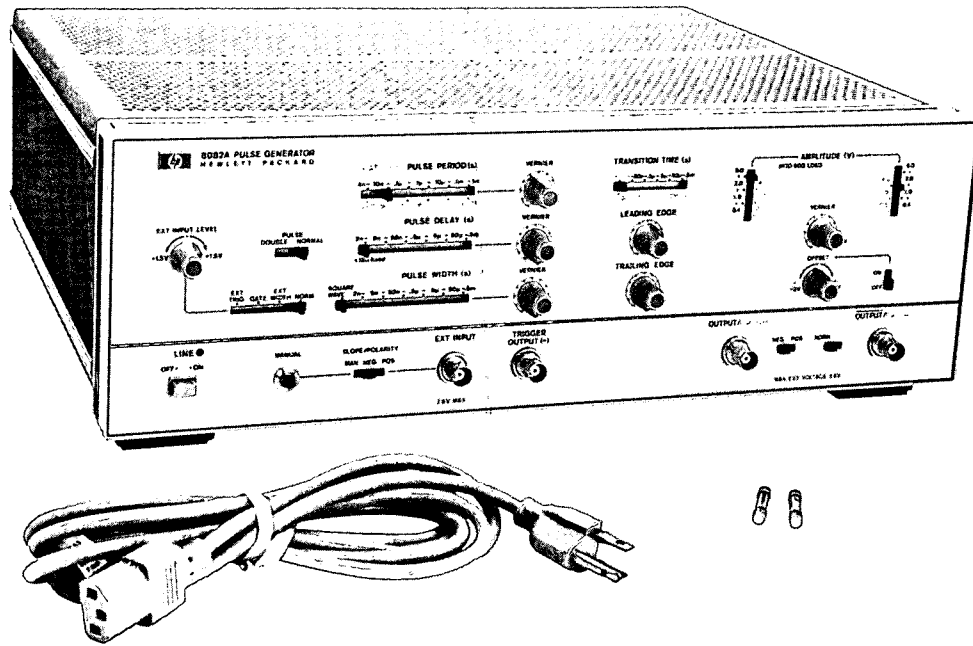
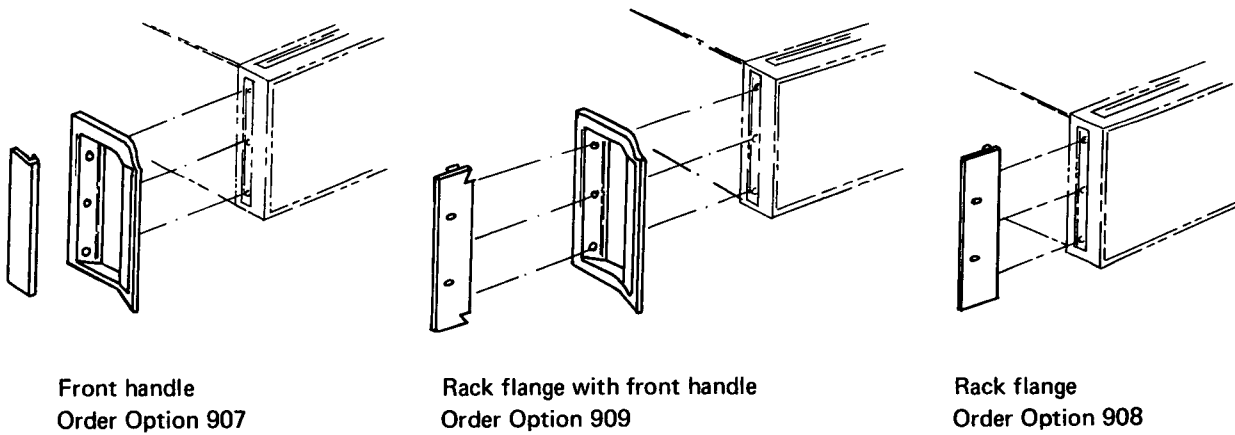


Figure 2-1. 8082A and Supplied Accessories



Front handle  
Order Option 907

Rack flange with front handle  
Order Option 909

Rack flange  
Order Option 908

Figure 2-2. Available Accessories

**2-1 GENERAL****2-2 Initial Inspection**

2-3 Inspect the instrument and accessories for physical damage, and if damage is evident, refer to paragraph 2-19 for the recommended claim procedure and repacking information.

**2-4 Accessories**

2-5 The following accessories are supplied with the standard instrument (Figure 2-1):

	HP Part Number
1A fuse (for 220/240V operation)	2110-0007
2A fuse (for 110/120V operation)	2110-0202
Power cord	see Figure 2-3
Operating and Service Manual	

For an additional manual, order option 910.

Handles or rack mounting flanges are delivered with the instrument only if the appropriate option (Figure 2-2) is ordered.

**2-6 Power Cords**

2-7 The instrument is supplied with one of the power cords shown in Figure 2-3.

**2-8 INSTALLATION****2-9 Power Cord**

2-10 The 3-wire power cable supplied with the 8016A, when connected to the appropriate power outlet, grounds the instrument cabinet and panels. To preserve this safety feature when operating the instrument from an outlet without a ground connection, use an appropriate adapter and connect the ground lead (green/yellow) to an external ground.

2-11 If the plug on the cable does not fit your power outlet, then cut the cable at the plug end and connect a suitable plug. The plug should meet local safety requirement and include the following features:

- Minimum current rating of 2A
- Ground connection
- Cable clamp

The colour coding used in the cable will depend on the cable supplied (see Figure 2-3).

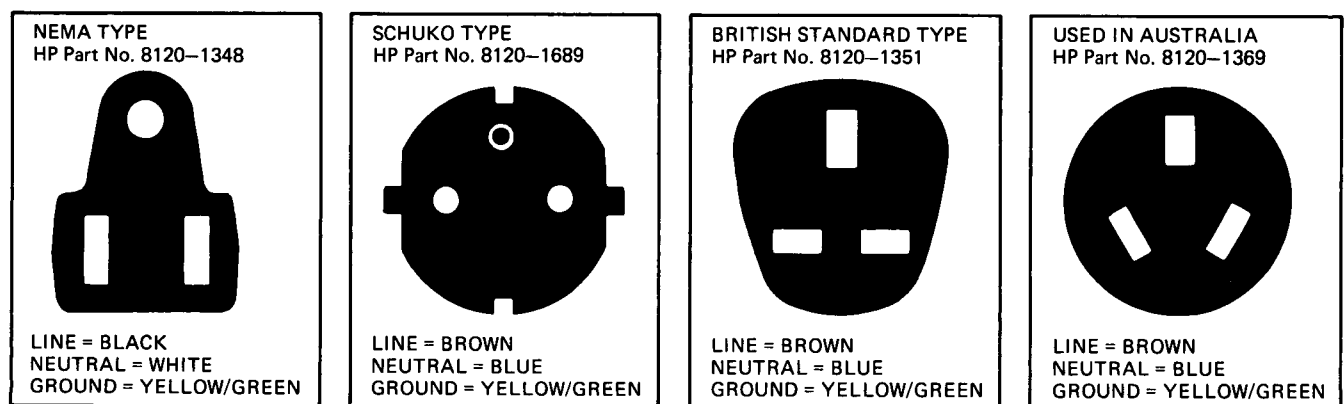


Figure 2-3. Power Cords

**WARNING**

To avoid the possibility of injury or death, the following precautions must be followed before the instrument is switched on:

- a. If this instrument is to be energized via an auto-transformer for voltage reduction, make sure that the ground connection is not interrupted.
- b. The power cable plug shall only be inserted into a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord without a protective conductor (grounding).
- c. The safety check (Table 5-27) shall be executed before connecting the instrument to the supply.

**2-12 Power Source requirements**

2-13 The instrument will operate from nominal ac line supplies of 100V, 120V, 220V or 240V (-10%, +5%) at 48 Hz to 66 Hz. Two switches on the rear panel allow one of the four voltages to be selected.

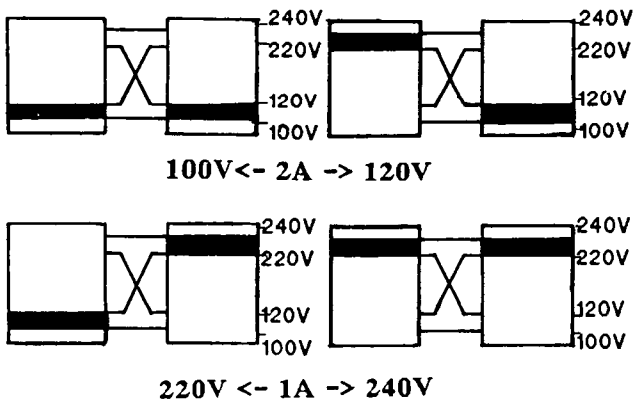


Figure 2-4. Switch Settings for the various Normal Powerline Voltages

**CAUTION**

Before applying power to the instrument, check on the rear panel that the switch is set in accordance with local supply conditions.

2-14 To check the power requirements proceed as follows:

- a. Remove the fuse and check its value:  
for 220V/240V operation 1A  
for 100V/120V option 2A
- b. Check that the line selector switch positions corresponds to the local supply voltage. If they do not correspond use a screwdriver to change the switch positions.
- c. Insert the correct fuse into the fuseholder.
- d. Connect the power cable to the rear connector.

**2-15 Temperature Requirements**

2-16 The instrument operates within specifications when the ambient temperature is between 0°C (32°F) and 50°C (122°F). The word generator may be stored between -40°C (-40°F) and 75°C (167°F).

**2-17 RACK MOUNTING**

2-18 Figure 2-2 shows the possible handle/rack-mounting configurations. If handles are fitted and subsequently need to be removed, the plastic trim must first be taken off as shown in Figure 2-5.

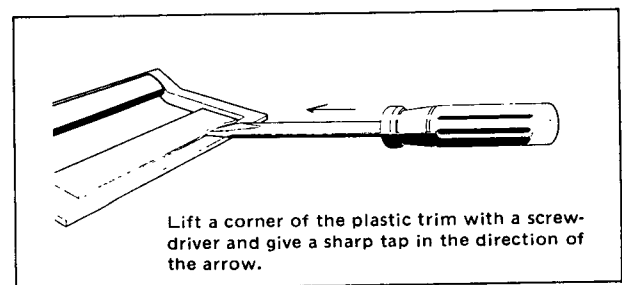


Figure 2-5. Removing Plastic Trim



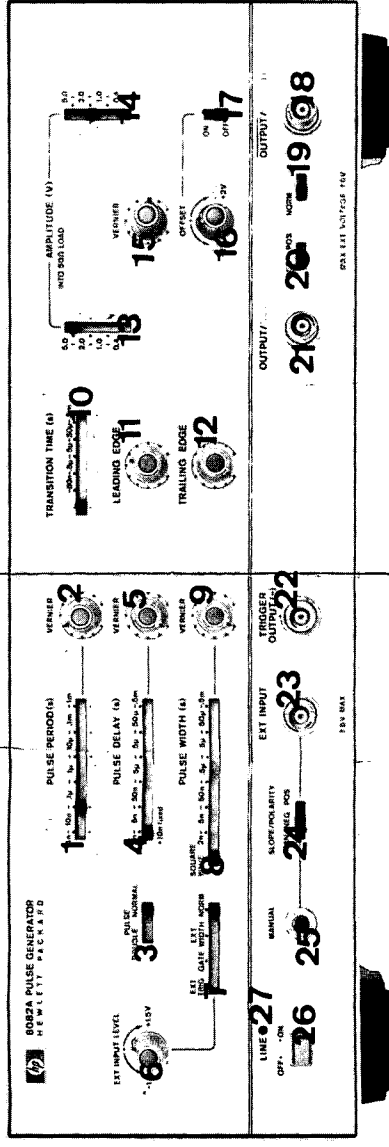
**2-19 CLAIMS AND REPACKAGING**

**2-20 Claims for Damage**

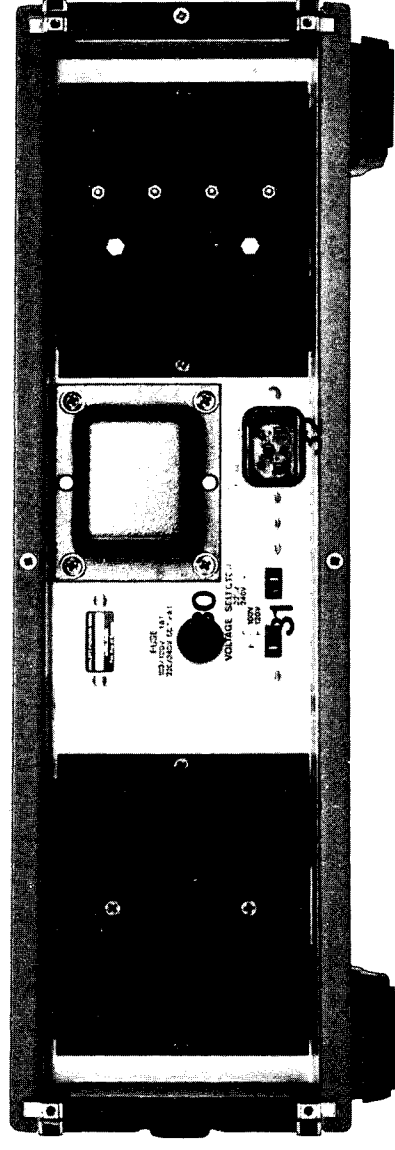
2-21 If physical damage is evident or if the instrument does not meet specification when received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office. The Sales/Service Office will arrange for repair or replacement of the unit without waiting for settlement of the claim against the carrier.

**2-22 Repackaging for Shipment and Storage**

2-23 If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office, attach a tag showing owner, address, model and serial number, and the repair required. The original shipping carton and packaging material may be re-usable but the Hewlett-Packard Sales/Service Office will also provide information and recommendations on materials to be used if the original packing is not available or re-usable.



- 1 RATE switch: for selecting the range of the pulse rate.
- 2 Rate VERNIER: for continuous adjustment of the repetition rate within the range selected on the RATE switch. Clockwise rotation increases the pulse period (reduces the rate).
- 3 PULSE DOUBLE/NORMAL switch: in the DOUBLE PULSE position the 8082A delivers two pulses for every trigger pulse — one pulse in phase with the trigger output and one delayed by the amount set on the PULSE DELAY controls. DOUBLE PULSE is not available in the EXT WIDTH mode and is automatically inhibited if selected. In the NORMAL position, for each trigger pulse, the 8082A delivers one pulse which is delayed on the trigger pulse by the amount set on the PULSE DELAY controls.
- 4 PULSE DELAY switch: for selecting the range of the pulse delay with respect to the trigger output in NORM, GATE and EXT TRIG modes. Has no effect in the EXT WIDTH and SQUARE WAVE modes.
- 5 Pulse delay VERNIER: for continuous adjustment of the pulse delay within the range selected on the PULSE DELAY switch. Clockwise rotation increases the delay.
- 6 EXT INPUT LEVEL control: defines the threshold level of the EXTERNAL INPUT over a range  $-1.5V$  to  $+1.5V$ .
- 7 Mode switch: selects either the internal (NORM) mode or one of three external modes (EXT WIDTH, GATE or EXT TRIG).
- 8 PULSE WIDTH switch: selects the range of the pulse width required in all modes except EXT WIDTH. When SQUARE WAVE is selected a square wave output of 50% duty cycle is produced. The frequency of the square wave depends on the PULSE PERIOD setting.
- 9 Pulse width VERNIER: for continuous adjustment of the pulse width within the range set on the PULSE WIDTH switch.
- 10 TRANSITION TIME switch: for selecting the range of leading and trailing edge transition times.
- 11 LEADING EDGE vernier: for continuous adjustment of the leading edge transition time within the range selected on the TRANSITION TIME switch. On the fastest range this vernier controls both leading and trailing edges.
- 12 TRAILING EDGE vernier: for continuous adjustment of the trailing edge transition time within the range selected on the TRANSITION TIME switch.
- 13 AMPLITUDE switch: for selecting the range of the output pulse amplitude available at the OUTPUT / OUTPUT connector. In the ECL position the OUTPUT / OUTPUT connector delivers pulses of fixed amplitude  $(-0.9V$  to  $-1.7V$  into an open circuit) and the amplitude vernier and the offset control are disabled.
- 14 AMPLITUDE switch: for selecting range of the output pulse amplitude available at the OUTPUT / OUTPUT connector. In the ECL position the OUTPUT / OUTPUT connector delivers pulses of fixed amplitude  $(-0.9V$  to  $-1.7V$  into an open circuit) and the amplitude vernier and the offset control are disabled.
- 15 Amplitude VERNIER: for continuous adjustment of pulse amplitude from both pulse outputs simultaneously within the ranges set on the AMPLITUDE switches.
- 16 OFFSET vernier: for adjustment of the baseline of both output pulses simultaneously over the range  $-2V$  to  $+2V$ .
- 17 OFFSET switch: for enabling/disabling the OFFSET vernier. In the OFF position the baseline of both outputs is zero volts.
- 18 OUTPUT / OUTPUT connector: BNC connector.
- 19 NORM / COMPL switch: reverses the duty cycle of the two outputs, what was the normal output becomes the complement and vice versa.
- 20 NEG/POS switch: determines the polarity of both output pulses.
- 21 OUTPUT / OUTPUT connector: BNC connector.
- 22 TRIGGER OUTPUT (-) connector: BNC connector, supplies negative square wave at a rate determined by the setting of the pulse period controls. Pulse delay is referred to the negative going edge of the trigger. In EXT TRIG and EXT WIDTH modes it will deliver a shaped version of the trigger input. In GATE mode it will deliver pulses at the rate set on the pulse period controls for as long as the gate is open.
- 23 EXT INPUT connector: BNC connector to which trigger pulses are applied in the EXT TRIG, GATE and EXT WIDTH modes.
- 24 SLOPE / POLARITY switch determines whether a rising (POS) or falling (NEG) signal will trigger or gate the external input on. MANUAL position means that the external signal can be simulated by pressing the MANUAL button.
- 25 MANUAL button provides a means of initiating a single pulse (EXT TRIG mode) each time the button is pressed, a train of pulses (GATE mode) while the button is pressed, or a pulse whose width is equal to the time the button is pressed (EXT WIDTH mode).
- 26 LINE ON/OFF switch: press-for-on, press-for-off switch.
- 27 LINE lamp: glows when LINE ON/OFF switch is ON.



#### REAR PANEL

- 30 Fuse
- 31 Line voltage selector See Section 2
- 32 Line connector

#### INTERNAL (See Figure 6-2)

- A3S1 Trigger output  $50\Omega$  internal load on/off.

Figure 3-1. Controls and Connectors

### 3-1 GENERAL

3-2 This section is divided into two parts. The first part gives some general notes on the operation of the 8082A together with operating instructions for each of the four operating modes:

NORM operating mode  
EXT WIDTH operating mode  
GATE operating mode  
EXT TRIG operating mode

Full setting-up instructions are given for Normal mode followed by any changes in control settings required for the other three modes. Stylized waveforms are given for each mode to show the resultant pulse shapes. For ease

of operation the instructions will refer to Figure 3-1 which shows the controls identified by a reference number in a circle. The same reference numbers are used in the text when each control is mentioned.

3-3 The second part of this section gives applications information.

### 3-4 EXTERNAL INPUT CHARACTERISTICS

3-5 The SLOPE/POLARITY switch determines whether a rising (POS) or falling (NEG) signal will trigger or gate the external input on. Figure 3-2 shows the effects of these controls in the External Width mode.

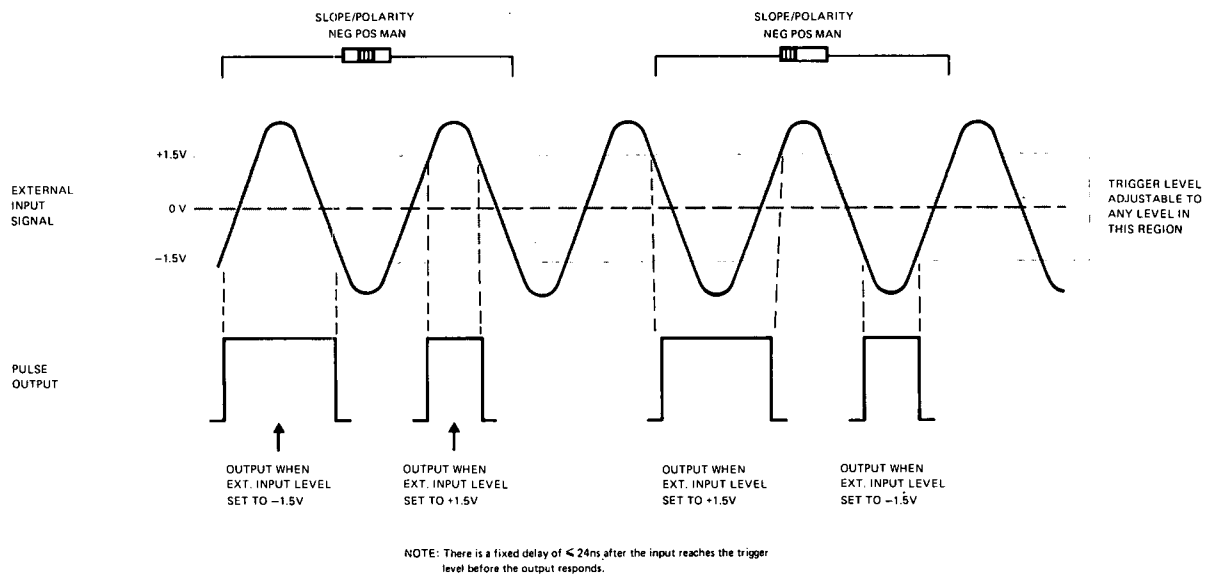


Figure 3-2. Effect of External Input Controls

3-6 Any external input pulses must have an amplitude of at least 200mV peak-to-peak and must be at least 2ns wide at the level at which triggering is to occur.

3-7 If the SLOPE/POLARITY switch is set to MAN, the external signal can be simulated by pressing the MANUAL pushbutton. This button provides a means of initiating a single pulse (EXT TRIG mode) each time the button is pressed, a train of pulses (GATE mode) while the button is pressed, or a pulse whose width is equal to the time the button is pressed (EXT WIDTH mode).

### 3-8 SQUARE WAVE OPERATION

3-9 There is a Square Wave facility on the 8082A which produces a square wave output of 50% duty cycle in NORMAL mode. If Square Wave is selected in External Trigger or External Width modes, the output is a pulse shaped version of the trigger input (the output waveforms are the same as for External Width mode, see Figure 3-4). If Square Wave is selected in Gate mode, the output is a gated square wave, the repetition rate of which is set up on the pulse period controls.

### 3-10 OUTPUT AMPLITUDE CONTROLS

#### 3-11 Vernier

3-12 Because the amplitude vernier is common to both outputs, the amplitude relationship of one output to the other is 1:1, 1:2 or 1:5.

#### 3-13 ECL Outputs

3-14 To obtain normal and complement ECL compatible pulses from the two outputs, either one or both amplitude range switches should be set to the ECL position. The ECL levels supplied are  $-0.9V$  to  $-1.7V$  into an open circuit, i.e. without an external 50 ohm load. These output levels can be altered by changing the values of resistors R 5 (ECL amplitude) and R60 (ECL-DC offset) on board A5 (Amplitude Vernier and DC Offset board).

### 3-15 INCOMPATIBLE CONTROL SETTINGS

3-16 When operating the 8082A, the layout of the Pulse Period, Delay and Width controls helps to avoid incompatible settings as shown in Figure 3-3. Generally, the Pulse Period control should be farthest right but the controls can all be in a straight vertical line if the Pulse Period vernier is more clockwise than the other two verniers.

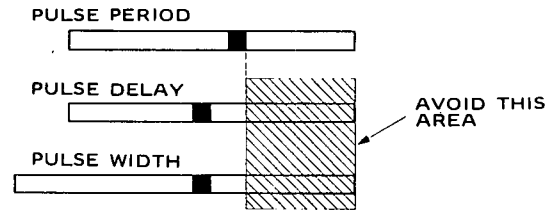


Figure 3-3. Positioning of Controls

### 3-17 NORM OPERATING MODE

3-18 In this mode the 8082A requires no external trigger signal to produce an output. Pulse rate, width, delay, transition times, amplitude and offset are all adjusted by the front panel controls.

3-19 The initial settings (listed below) are given to obtain a normal pulse waveform (Figure 3-4) for someone unfamiliar with the operation of the 8082A. Both pulse outputs and the trigger output should be connected to a high-frequency oscilloscope using a 50 ohm system. The oscilloscope (an HP 180C main-frame with 1810A plug-in or similar 1 GHz bandwidth sampling oscilloscope) should be set with the sweep time at  $0.5\mu s/cm$  and with the sensitivity at  $200mV/cm$ .

LINE (26)		ON
PULSE PERIOD (1)		$1\mu-10\mu$
VERNIER (2)		Mid-range
PULSE DELAY (4)		$2n-5n$
VERNIER (5)		CCW ( $2n$ )
PULSE WIDTH (8)		$50n-.5\mu$
VERNIER (9)		CW ( $1.5\mu$ )
NORMAL/DOUBLE PULSE switch (3)		NORMAL
Mode Switch (7)		NORM
TRANSITION TIME (10)		$50n-.5\mu$
LEADING EDGE (11)		Mid-range
TRAILING EDGE (12)		Mid-range
AMPLITUDE (13)		$1.0-2.0$
AMPLITUDE (14)		$1.0-2.0$
VERNIER (15)		CCW ( $1.0$ )
OFFSET ON/OFF switch (17)		OFF
NORM/COMPL switch (19)		NORM
NEG/POS switch (20)		POS

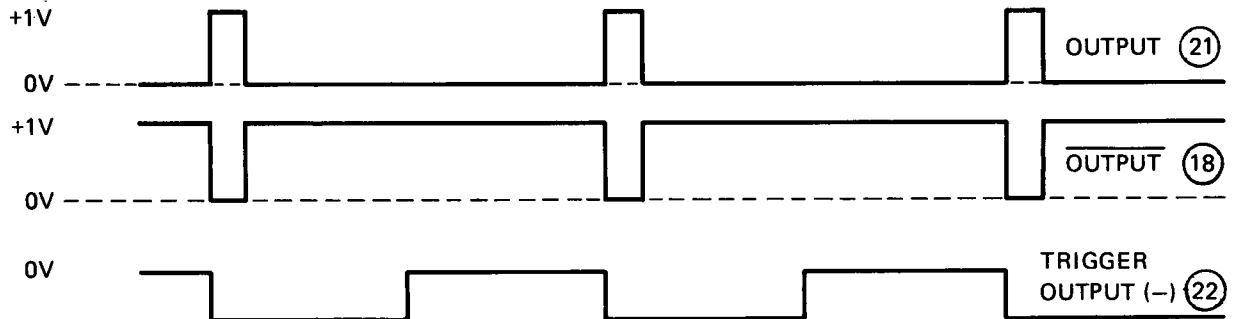


Figure 3-4. Pulse Output in NORM Mode

### 3-20 EXT WIDTH OPERATING MODE

3-21 In External Width mode, the pulse repetition rate and width are determined by the repetition rate and width (at the threshold set by the EXT INPUT LEVEL control) of an externally applied signal. In EXT WIDTH mode the PULSE PERIOD controls, the PULSE DELAY controls, the PULSE WIDTH controls and the DOUBLE/NORMAL PULSE switch have no effect on the pulse output. To obtain an output similar to that in Figure 3-5, adjust the controls as shown below. It is assumed that the controls are already set-up as described above for a Normal pulse; therefore only the alterations to these control settings will be given.

- Set the Mode switch (7) to EXT WIDTH.
- Apply an external trigger to the EXT INPUT (23). The input should have the following characteristics:  
Pulse shape — sine or square wave  
Amplitude — between 200mV and 6V  
Frequency — 14kHz
- Set the EXT INPUT LEVEL (6) control as required to vary the switching threshold.
- Set the SLOPE/POLARITY switch as required to trigger off the rising (POS) or falling (NEG) edge of the trigger.

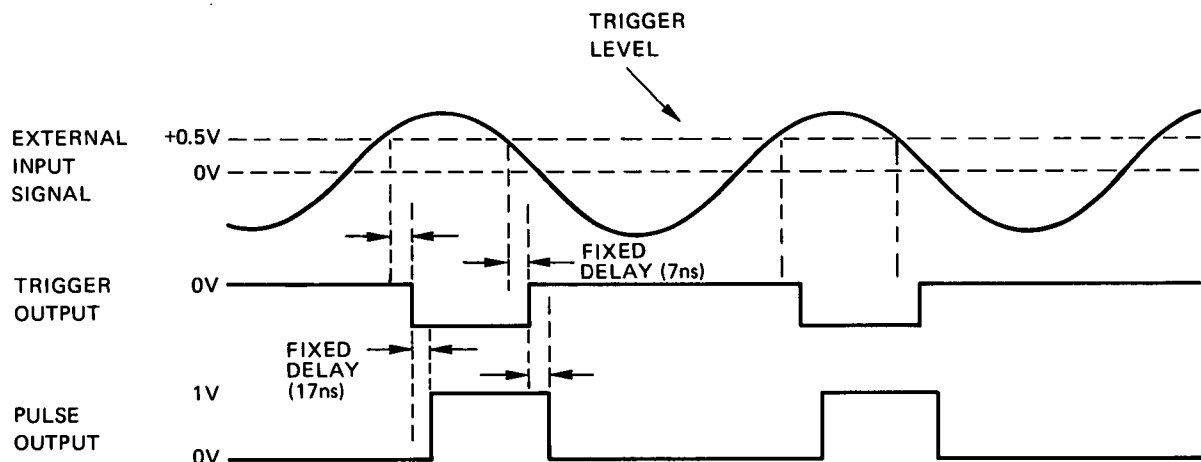


Figure 3-5. Pulse Output in External Width Mode

### 3-22 GATE OPERATING MODE

3-23 In Gate mode the repetition rate is defined by the rate controls but no output occurs until the voltage of an externally applied signal rises above (SLOPE/POLARITY switch set to POS) or falls below (SLOPE/POLARITY switch set to NEG) the level set on the EXT INPUT LEVEL control. The last pulse of a 'burst' is always of correct width even if the gate closes during

the pulse. To obtain an output similar to that in Figure 3-6, adjust the controls as shown below. It is assumed that the controls are already set-up as described above for a pulse in External Width mode; therefore only the alterations to these control settings will be given. Switching to External Width mode when in Gate mode can be used to check for correct functioning of the gate signal.

- a. Set the Mode switch (7) to GATE.

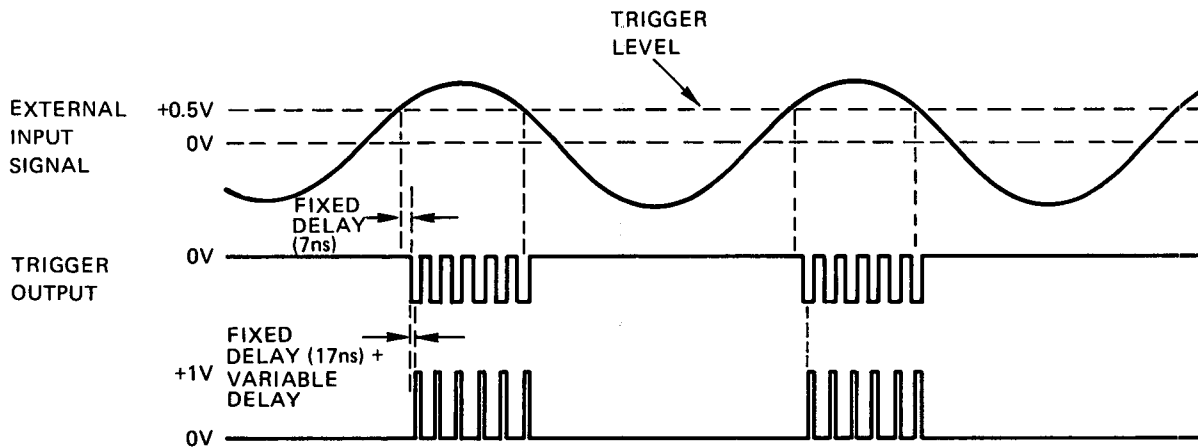


Figure 3-6. Pulse Output in Gate Mode

### 3-24 EXT TRIG OPERATING MODE

3-25 In External Trigger mode the pulse and trigger repetition rates are determined by the repetition rate of an externally applied signal. To obtain an output similar to that in Figure 3-7, adjust the controls as shown

below. It is assumed that the controls are already set-up as described above for a pulse in Gate mode; therefore only the alterations to these control settings will be given.

- a. Set the Mode switch (7) to EXT TRIG.

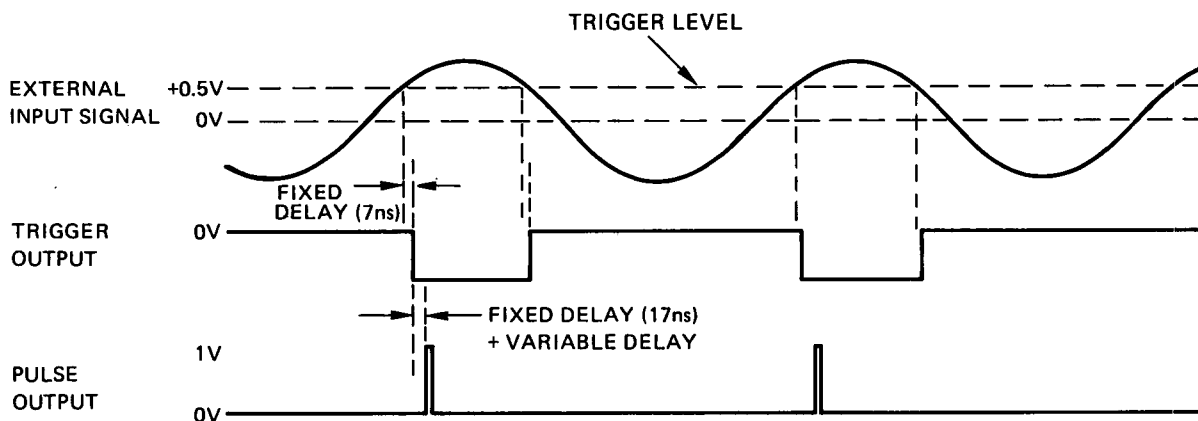


Figure 3-7. Pulse Output in External Trigger Mode

### 3-26 APPLICATIONS NOTES

3-27 The following section indicates some applications of the 8082A.

### 3-28 Digital Applications

3-29 The 8082A can be used to test the following digital integrated circuit (IC) logic families at their normal operating speeds:

	Propagation delay per gate
RTL	12ns – 27ns
DTL	30ns
TTL	12ns
Schottky TTL	3ns
ECL (including MECL III)	1ns – 4ns

For convenience of operation a special ECL output is available on the 8082A. This means that by simply setting either amplitude range switch to the ECL position, an output pulse with a voltage swing of  $-0.9\text{V}$  to  $-1.7\text{V}$  is produced into an open circuit.

When using the 8082A to test any of the above logic families, particularly the fast MECL III logic, it is important to operate with a 50 ohm transmission system. The coaxial cable does not need to be terminated at the IC and by a 50 ohm resistor; the internal 50 ohm termination of the 8082A is of sufficiently high quality to provide a clean pulse shape in almost all cases (see paragraph 3-31) without an external termination, even at the fastest transition times. This has the advantage that it enables the 50 ohm coaxial cable to be soldered directly to the pins of the IC under test without requiring a 50 ohm terminating resistor. It should be noted, however, that when no external termination is used, no connections can be made at any intermediate point along the transmission cable. For example, suppose the pulse on leaving the 8082A has 2V amplitude across an effective 25 ohms (50 ohm internal termination in parallel with 50 ohm cable); when the pulse reaches the IC its amplitude is doubled to 4V (open end reflection). This 4V is reflected back along the cable and is absorbed by the 50 ohm termination in the 8082A with only 2% typical reflection at amplitudes up to 4V. The effect of this action is to produce the stepped pulse shown in figure 3-8 at any intermediate point along the cable.

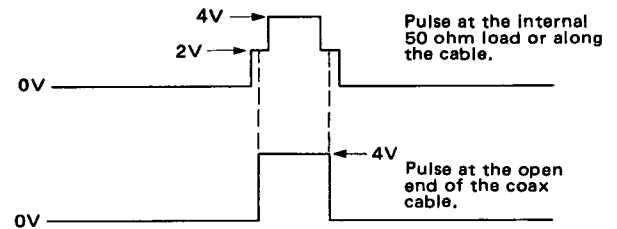


Figure 3-8. Stepped pulse with high-Z output

3-30 If a detailed analysis of IC waveshapes and timings is to be made, a 1 GHz sampling oscilloscope with a high impedance input probe should be used. The probe should be connected at the IC pin and not at any intermediate point along the 50 ohm cable.

3-31 If a number of IC's on one PC board are being driven from one point on the board and the printed circuit track is more than 10cm long, then an external 50 ohm resistor at the end of the 50 ohm system may be required to preserve the clean pulse shape at the IC input pins.

3-32 One point to remember, particularly when testing 1ns ECL, is the loss of edge speed due to the coaxial cable. However, the 8082A is fast enough to accommodate this edge speed degradation without exceeding the manufacturers specification. A 1.23 metre cable is available as HP Accessory number 10503A.

3-33 When testing flip-flops (Motorola MC1666 for example), two pulse generators are required, one to provide the clock input and one to provide the data input. One pulse generator is run in square wave mode and the other is run in external trigger and double pulse mode and is synchronized from the trigger output of the first pulse generator (Figure 3-9). Allowance must be made for the differential delay that will occur between the two outputs. This is caused by the fact that there is an extra 7ns delay in the second 8082A (24ns against 17ns) due to the delay between the trigger input and the trigger output. To preserve the correct timing relationship, therefore, between the two sets of pulse outputs, the data pulse output must be delayed by a further 7ns. This can be achieved by increasing the length of the data output transmission cable (delay is about 5ns per metre).

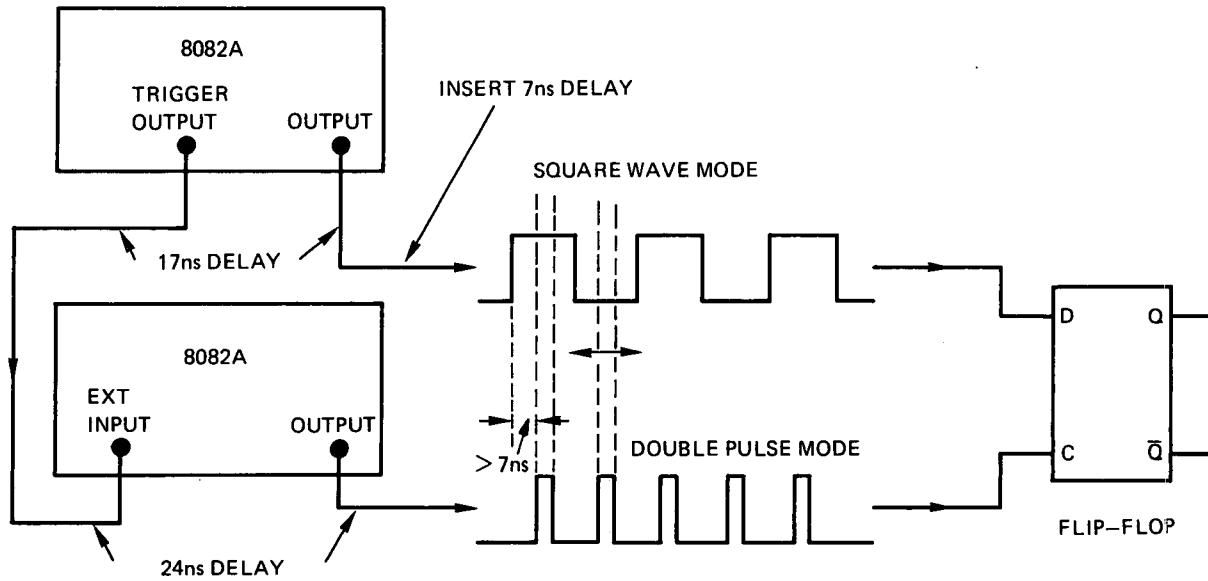


Figure 3-9. Flip-Flop Test Circuit

3-34 The minimum set-up time required for switching the flip-flop from '0' to '1' (or vice versa) can be measured as shown in Figure 3-10. The pulse delay controls of the clock output are slowly decreased and because the output is in double pulse form, only the second pulse in each case advances to-

wards the leading edge of its data input (in this case a '1'). The minimum set-up time is found when the flip-flop ceases to switch properly from '0' to '1'. The minimum set-up time for switching from '1' to '0' can then be found by switching to the complement of the data input and repeating the exercise.

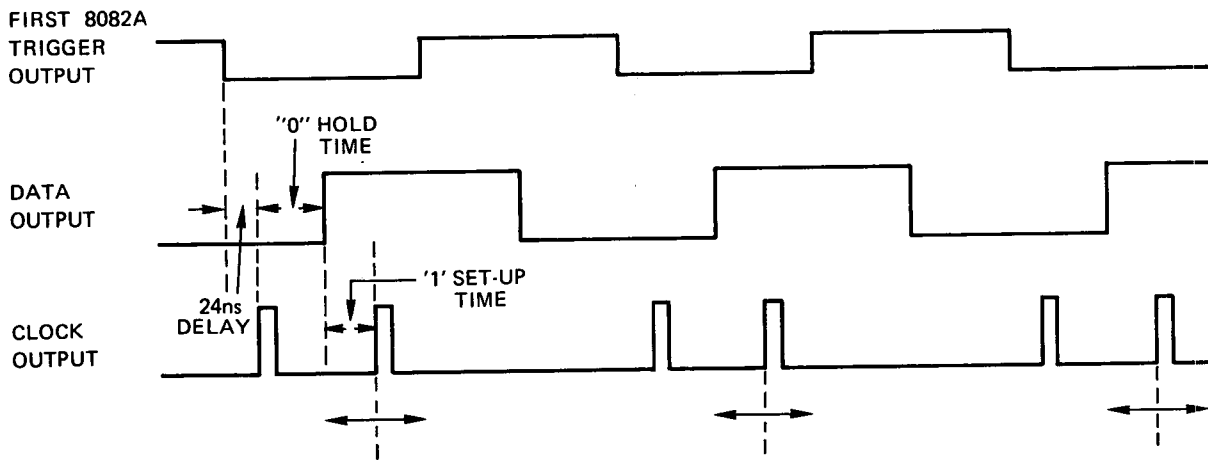


Figure 3-10. Flip-Flop Test Waveforms



3-35 The clock pulse transition times can be adjusted to observe the variation in the propagation delay of the flip-flop or to simulate edge degradation caused by a high fanout of the clock pulse line.

3-36 The 8082A can be used as a pulse shaper. When set to external width mode, an external signal (the output of a word generator for example) connected to the trigger input is available in pulse shaped form at the pulse output. Adjusting the trigger level control to the appropriate level helps to recover the shape of even badly distorted pulses.

3-37 The 8082A can also be used to generate noise pulses; the pulse width is set to minimum and the amplitude to 5V and then the transition times are increased. This has the effect of reducing the pulse amplitude and, in fact, the transition times can be increased until a spike of approximately 1ns width and 800mV amplitude (ECL amplitude) is produced (see Figure 3-11).

This can be set to the required dc level using the offset controls and connected to the logic circuit under

test to simulate noise. The amplitude and offset of the noise spike can be varied and their effect on the circuit monitored.

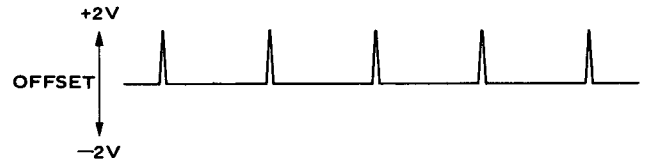


Figure 3-11. Noise Pulses

### 3-38 Analog Applications

3-39 The 8082A can also be used effectively in analog applications. Twisted pairs of transmission lines and differential amplifiers can be tested using the normal and complement outputs; the common amplitude vernier is very useful in this application for varying the amplitude of both outputs simultaneously. Trigger levels of Schmitt trigger circuits can be tested using output pulses with very slow transition times (as slow as 0.5ms).

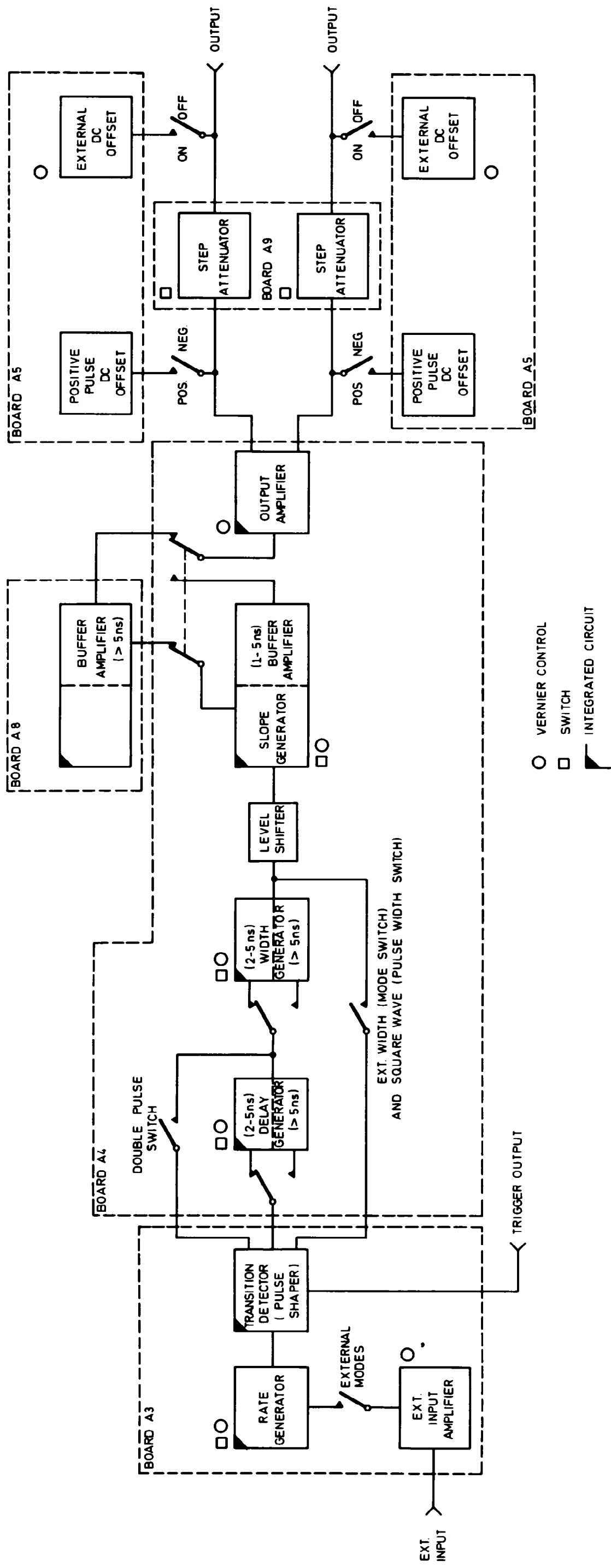


Figure 4-1. 8082A Pulse Generator - Block Diagram

#### 4-1 INTRODUCTION

4-2 A basic block diagram of the 8082A is shown in figure 4-1 and this should be referred to when reading the following description. The pulse repetition rate is generated either internally by the Rate Generator or externally by an external input signal, depending on the mode of operation. The square wave output of the Rate Generator is input to the Transition Detector where it is pulse shaped to produce a train of 2ns wide spikes. These pulse spikes are then applied to the Delay and Width Generators. Each of these generators is divided into two parts for periods of 1-5ns or > 5ns and the incoming signal is routed into the appropriate part. The Output of the Width Generator is level shifted and input to the Slope Generator where the slope of the leading and trailing pulse edges is made variable (variable transition times).

4-3 If Double Pulse mode is selected, both the delayed and undelayed waveforms are input to the Width Generator. If External Width mode is selected, both the Delay and Width Generators are by-passed and the output of the Transition Detector is input to the level shifter.

4-4 The output of the Slope Generator is input to one of two Buffer Amplifiers dependent on the transition time setting (1-5ns or > 5ns). Normal and complement outputs from the Buffer Amplifier are then input to the dual channel Output Amplifier. Here the amplitude variation within ranges is added in the form of an Amplifier Vernier, which is common to both channels.

4-5 The positive pulse DC Offset circuits are responsible for shifting the voltage level of both channels from a negative level to a positive level, using the NEG/POS switch, if positive output pulses are required (the normal/complement relationship of the two channels is also automatically reversed when this action is performed). This means that either negative normal pulses or positive normal pulses are available from one output connector.

4-6 After being set to the correct polarity, the amplitude of both signals is set to the appropriate range using an active Step Attenuator circuit.

4-7 Finally the External DC Offset circuit provides an offset voltage to shift the baseline of both output signals together over the range -2V to +2V if required. This circuit can be switched off in which case both signal baselines are at 0V.

#### 4-8 REPETITION RATE GENERATOR

4-9 The function of the repetition rate generator is to provide a train of pulses, approximately 2ns wide, for the delay generator or a 50% duty cycle waveform if square wave is selected; also to provide a train of 50% duty cycle square wave pulses for the output trigger. A block diagram of the unit is given in Figure 4-2 and a schematic diagram in Service Sheet 1.

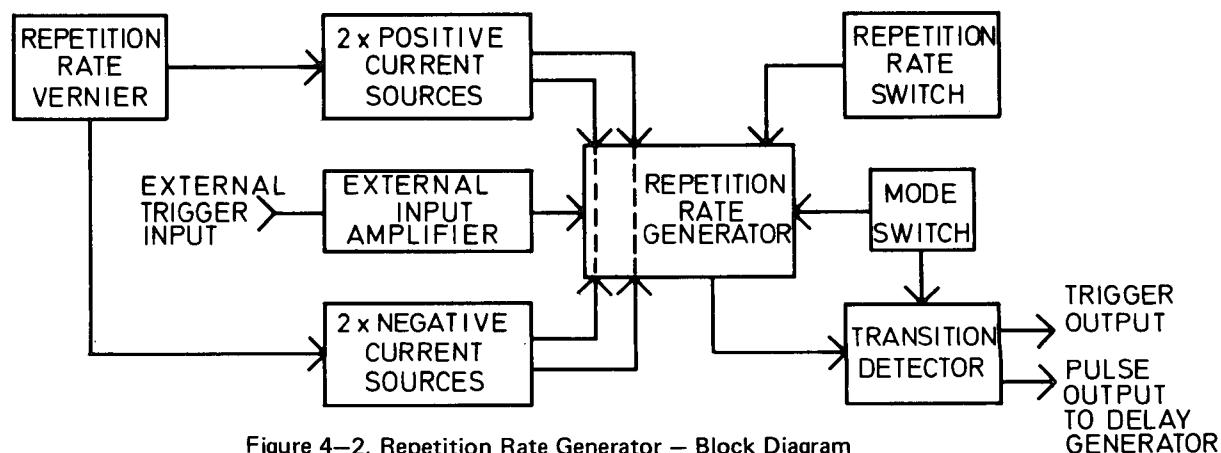


Figure 4-2. Repetition Rate Generator - Block Diagram

## 4-10 External Input Amplifier

4-11 In any mode except NORMAL mode, the output of the rate generator is controlled, either gated or triggered, by the external input amplifier. The amplitude of the external input signal is limited by a bridge circuit to approximately  $\pm 2V$ . The signal then enters one side of a differential amplifier, the reference voltage on the other side of which is determined by the setting of the EXT. TRIG LEVEL control. Thus the threshold level of the input signal, i.e. the voltage level at which gating or triggering occurs, can be varied. The SLOPE/POLARITY switch determines whether a rising (POS) or falling (NEG) switch determines whether a rising (POS) or falling

input signal will cause triggering or gating. If set to MAN, the switch disables the external input signal and enables the MANUAL button so that pressing the button simulates one pulse from the external input.

## 4-12 Rate Generator

4-13 In the NORMAL mode, the output of the pulse generator is derived from the rate generator. The rate generator consists of a ramp generator which feeds a Schmitt trigger to produce a 50% duty cycle square wave output. A simplified diagram of the circuit is shown in Figure 4-3.

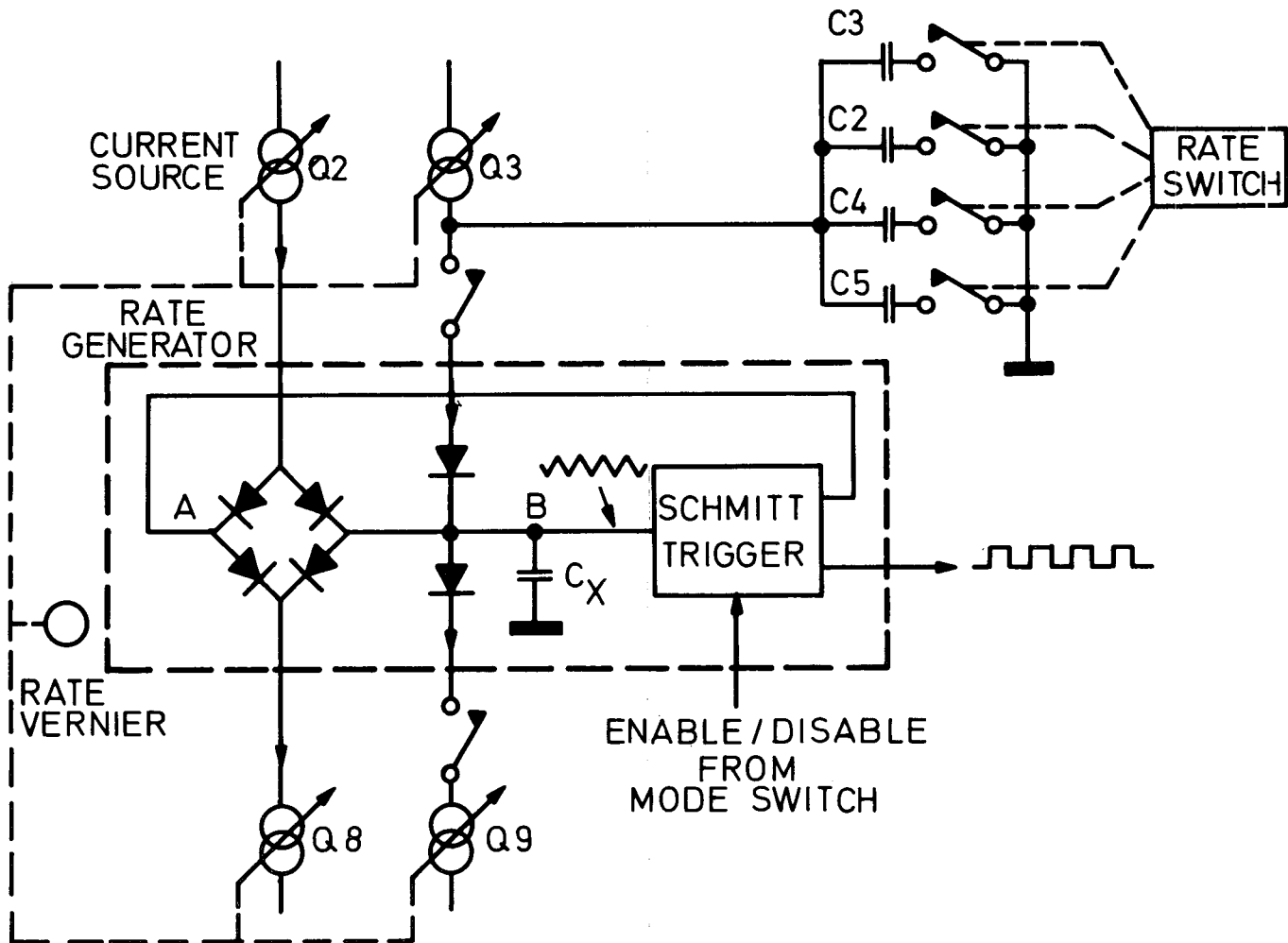


Figure 4-3. Rate Generator

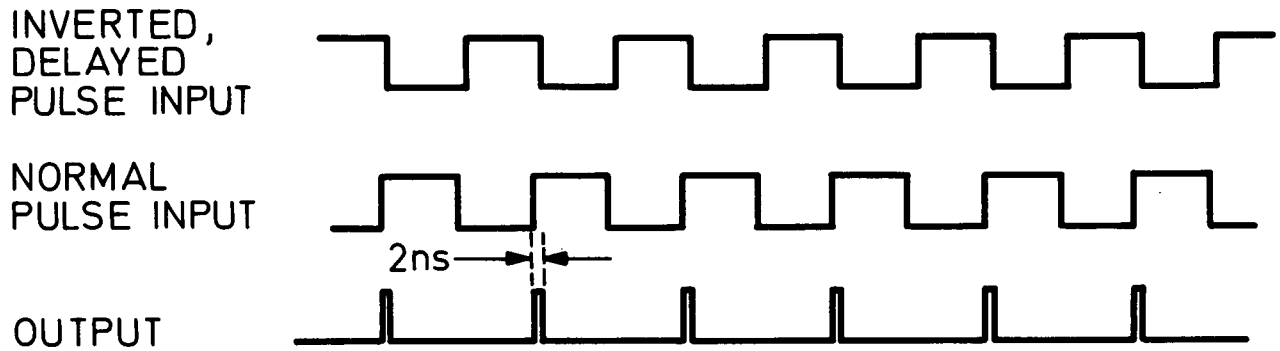


Figure 4-4. Transition Detector Pulse Output

4-14 Four current sources (Q2, Q3, Q8 and Q9) provide current for the rate generator; two of these sources (Q3 and Q9) are inhibited by logic switches (U6, Q4, Q5) when the repetition rate is set to the fastest range (100 – 250 MHz). Thus on the fastest range if capacitor  $C_X$  is discharged, point B is at a low level and the output of the Schmitt trigger is high. In this state current from source Q2 charges capacitor  $C_X$  and current from the Schmitt trigger flows into current sink Q8. When the charge on  $C_X$  has reached the threshold level of the Schmitt trigger, the output of the Schmitt trigger and hence the level at A goes to a low level. Current from Q2 now flows, via A back into the Schmitt trigger and  $C_X$  discharges into current sink Q8.

4-15 This action produces a triangular waveform at point B and a 50% duty cycle square wave at the Schmitt trigger output when both current sources Q2 + Q8 are equal. When the rate switch is set to any of the lower repetition rate ranges, current sources Q3 and Q9 and the extra capacitors (C2 – C5) are switched in. The circuit action is the same; the extra capacitors are required to provide the longer charge/discharge times. The repetition rate is adjusted within each range by the rate vernier, which adjusts the current from both current sources simultaneously.

4-16 The square wave output from the Schmitt trigger is used to drive the transition detector stage.

#### 4-17 Transition Detector

4-18 This circuit produces two outputs; a trigger output and a pulse output for the delay generator. The trigger output is merely an inversion of the input, i.e. a

negative 50% duty cycle square wave, and can be switched to either  $> 500\text{mV}$  or  $\geq 1\text{V}$  amplitude. The pulse output is produced by inverting and delaying the pulse input (delay produced by 2ns fixed delay line) and then presenting this waveform, together with the normal pulse input, to an AND gate. The resultant waveform is as shown in Figure 4-4. The pulse spikes produced are of constant width regardless of repetition rate and are input to the Delay Generator. In Square Wave mode the Transition Detector has no effect on the signal, i.e. the square wave passes straight through.

#### 4-19 Repetition Rate Vernier

4-20 The repetition rate vernier produces a variable voltage (0V to 6.4V) into a differential amplifier (U5). The output of the differential amplifier drives a transistor Q1 which acts as a phase splitter for the two positive and two negative current sources.

#### 4-21 DELAY AND WIDTH GENERATORS

4-22 The output of the Transition Detector is input to the Delay Generator integrated circuit (U2). The purpose of this circuit is to produce an output that is delayed on the input by the setting of the delay controls. The pulse width and shape remain unchanged. In double pulse mode, both the delayed and undelayed pulses are gated out to the Width Generator. The circuit is divided into two parts for delaying signals with different periods (2 to 5ns and  $> 5\text{ns}$ ) and the input signal is input to the appropriate part.

4-23 Figure 4-5 is a simplified diagram of the Delay Generator and should be referred to when reading the following description.

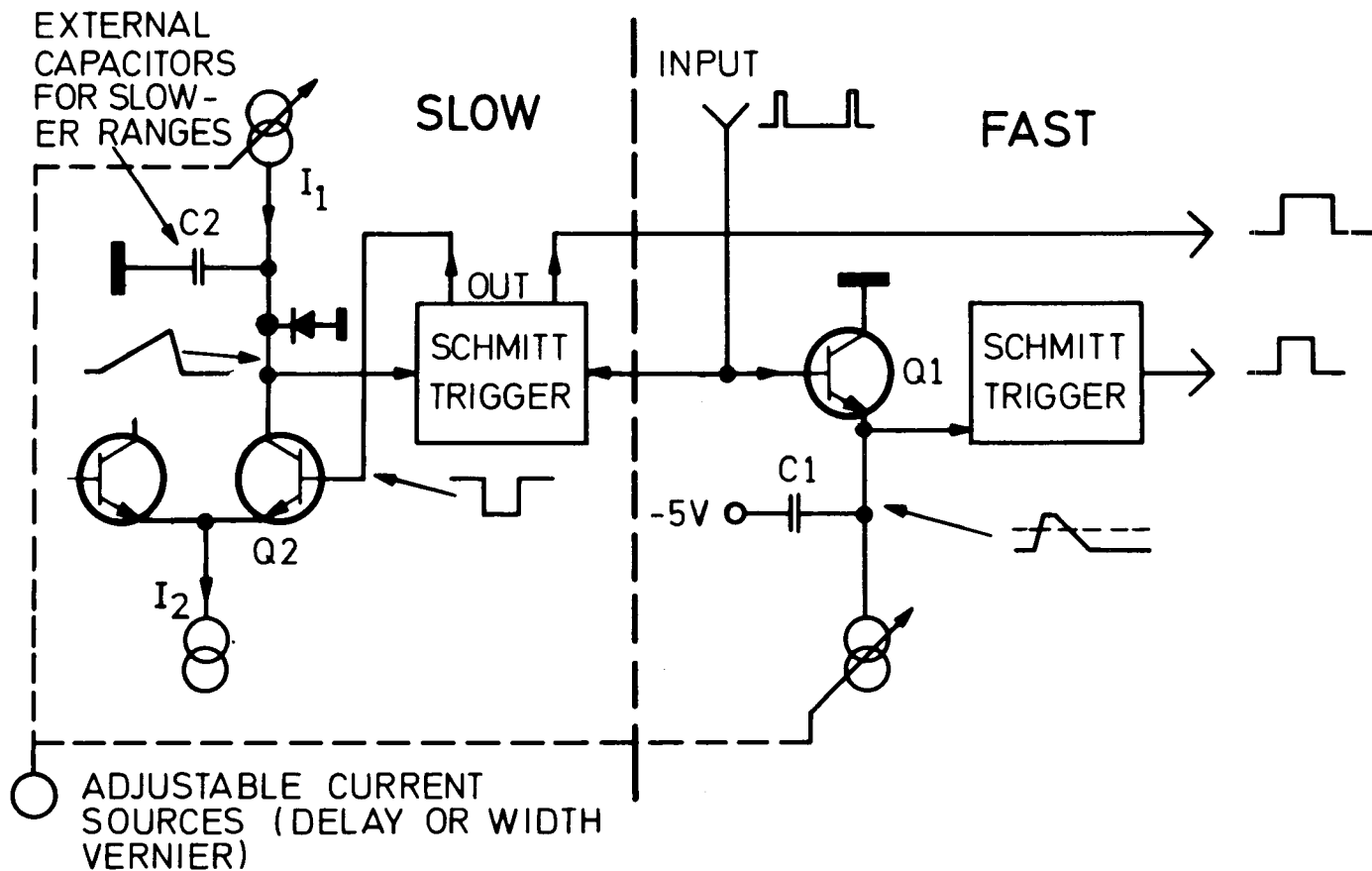


Figure 4-5. Delay Generator — Block Diagram

4-24 The input is common to both the slow and fast parts of the Delay Generator. If the delay range switch is set to 2–5ns, the fast section is used. In this case the 2ns wide pulse spike from the Transition Detector turns transistor Q1 on and rapidly charges internal capacitor C1. The Schmitt trigger turns on when its threshold level is reached. When the 2ns pulse goes low, transistor Q1 turns off and capacitor C1 discharges into the current sink. The rate of discharge is determined by the current setting (delay vernier). The Schmitt trigger turns off again when the voltage of C1 falls below the threshold level. Thus the output of the Schmitt trigger is a step wave of width dependent on the delay vernier setting.

4-25 If the delay range switch is set to any range > 5ns, the slow Delay Generator circuit is used. In this case, the 2ns wide pulse turns on the Schmitt trigger in the slow circuit and one of the outputs of this Schmitt trigger turns transistor Q2 off. Thus the current source connected to Q2 now starts to charge the external capacitor C2 (the value of this capacitor depends on the delay

range switch setting). The Schmitt trigger turns off again when the voltage on C2 has reached the threshold level. Therefore transistor Q2 turns on again and as current  $I_2$  is greater than  $I_1$ , capacitor C2 starts to discharge again. Thus the output of the Schmitt trigger is a square wave of width dependent on the delay range switch setting and the delay vernier setting.

4-26 The outputs of the two Schmitt triggers are OR'ed together and one of the two complementary outputs of the OR gate is passed through a 2ns delay line. The overall effect of the logic gating is to produce, at the Delay Generator output, a 2ns pulse that is delayed on the Delay Generator input by the delay control settings.

4-27 The output of the Delay Generator is input to the Width Generator integrated circuit (U4). The IC's used in both the Delay and Width Generator circuits are identical and the description of the Delay Generator operation in paragraphs 4-23 to 4-25 also applies to the Width Generator. The difference is in the output gating; the output of the Width Generator is a pulse of width

dependent on the width control settings. In Double Pulse mode, both the delayed and undelayed pulses are widened.

4-28 SLOPE GENERATOR

4-29 The function of the slope generator is to convert the leading and trailing edges of the input

signal - derived from the width circuit - from "fixed" to "variable" transition times with stable amplitude. The generator and its control circuits are distributed over three boards - A4, A5 and A8 - and two corresponding schematics - 3a and 2b. Since the slope generator operation is dependent on the control circuits, these will be described first.

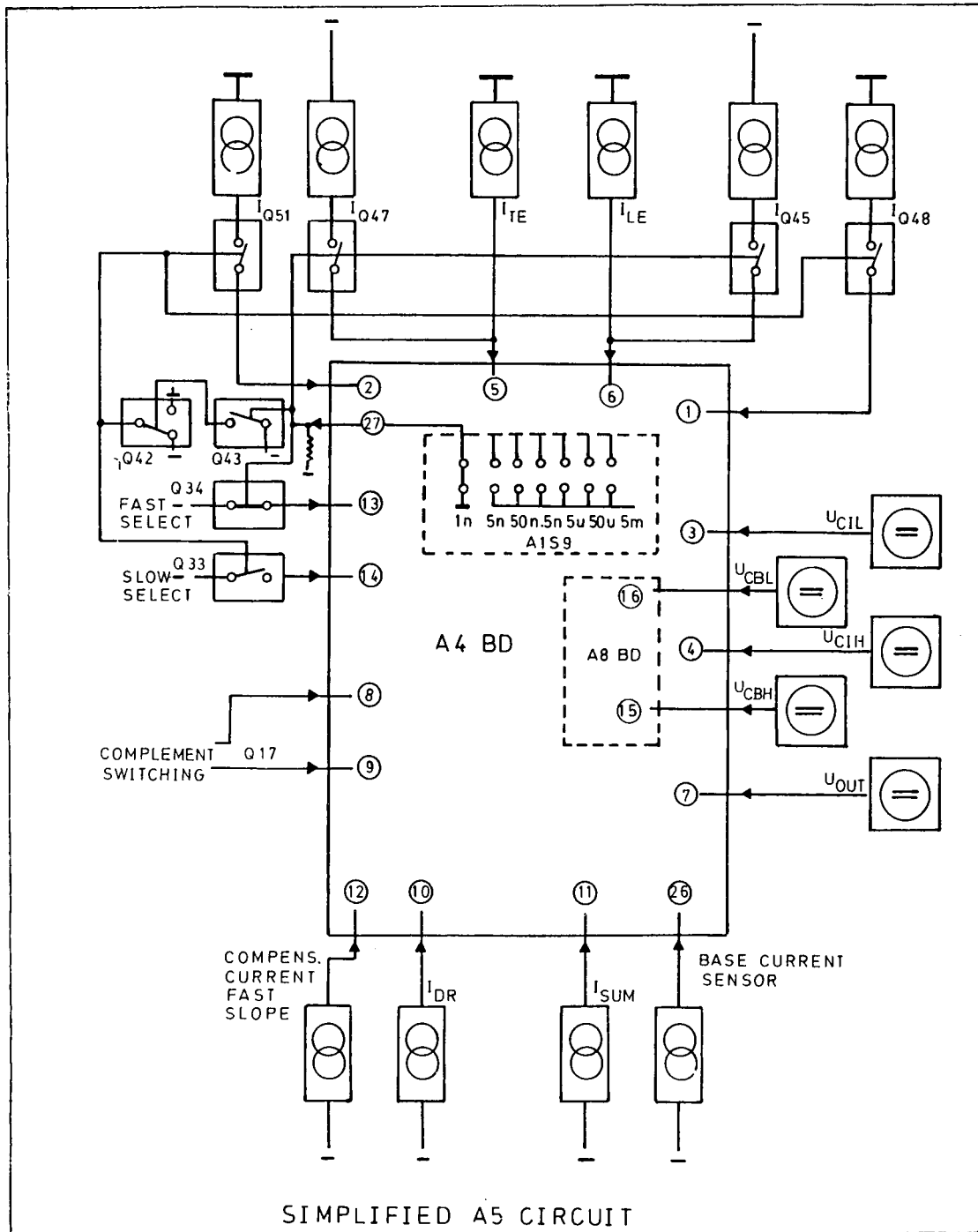


Figure 4-6a Simplified Control A5 Circuit

4-30 Reference to Schematic 3a and Figure 4-6a shows that the control circuit (A5) is comprised of several voltage controlled current sources (output dependent on LEE and TRE verniers), voltage sources and signal selector switches.

#### 4-30a Current Sources

For edges < 5 ns the two range selection current sources Q48 and Q51 are switched off (external slope capacitors A4 C15-C22 on schematic 2b not used). Only LEE vernier (A1 R5) controls the LEE and TRE constant current sources Q53 and Q56. Current sinks Q45 and Q47 are disabled (under control of Q44/Q46) and Q38 base is adjusted, under the control of U8, to sink the current-sum output by the slope generator. Variation of Base current is also controlled by U8. Compensation current for fast slope is supplied (sunk) by Q58. Emitter current output (sunk) by Q40.

4-30b For edges > 5 ns, control of the current sources is basically the same as for the fast ranges with the differences that both verniers are active, Q48 and Q51 are biased on to provide a constant current which is sunk by Q45 and Q47, these being enabled via Q44 and Q46. Q58 is switched off.

4-31a Reference to schematic 2b and Figure 4-6b shows the slope generator circuit to be comprised of a set of range capacitors and associated selection circuitry, a voltage level shifter, a slope generator buffer amplifier for slopes < 5 ns (A4 U5) and a buffer amplifier for slopes > 5ns (A8 U1).

4-31b The operation of the circuit is as follows:

The incoming signal (from width circuit) is level shifted by Q69, Q70 etc. and input to the slope generator section of U5 as a normal and a complementary signal. The operation of the slope generator part of the circuit is best explained by referring to Figure 4-6c and the following description which can then be applied to the actual circuit of schematic 2b.

4-32 For transition times from 1 ns - 4.9 ns the four constant current Sources (IS1, IS2 and IS4) are switched off.

Assume that the currents ITE and ILE, as fixed by the transition time settings are 10 mA and 20 mA respectively, then  $I_{sum} = 30 \text{ mA}$  ( $I_{sum} = ILE + ITE$ ). If the output from the previous stage, the level shifter, is input to the slope generator as shown at a and b, then at time t1 transistor Q1 turns on and Q2 turns off. Thus the only current source that can now supply constant current sink  $I_{sum}$  is ITE (10 mA). Thus the deficiency of 20 mA is made up by the intrinsic capacitance of Q1 which discharges. This provides the slope of c from t1 to t2. When the voltage has dropped to the level at t2 (slightly lower than the potential of voltage source V2), diode CR3 starts to conduct and prevents the voltage from falling any further.

4-33 At time t3, transistor Q1 turns off and Q2 turns on. The current source ITE (10 mA) cannot now drain into  $I_{sum}$  and so it starts to re-charge the intrinsic capacitance of Q1 (slope of c from t3 to t4). When the voltage level of point c reaches t4 (slightly higher potential than voltage source V1), diode CR1 starts to conduct and holds the voltage at this level.

4-34 The same action as described above controls the voltage levels at point d. Thus it can be seen that the transition times of the pulses at points c and d depend on the currents from the two sources (ITE and ILE) which in turn depend on the transition time settings.

4-35 For transition times 5 to 50ns (slow range), only the current sources IS1, IS2, IS3 and IS4 are switched on. ( $I_{Q47} = I_{Q51}$ ;  $I_{Q45} = I_{Q48}$ ) This provides a constant current path as shown in Figure 4-6c in order to keep CR5 and CR6 forward biased. For transition times greater than 50ns, 4 pairs of additional external capacitors (C15 to C22) are switched in to supplement the intrinsic capacitances of Q1 and Q2. Reference to 4-6c shows these capacitors as CX1 and CX2 which must have the same value +/- 1%.



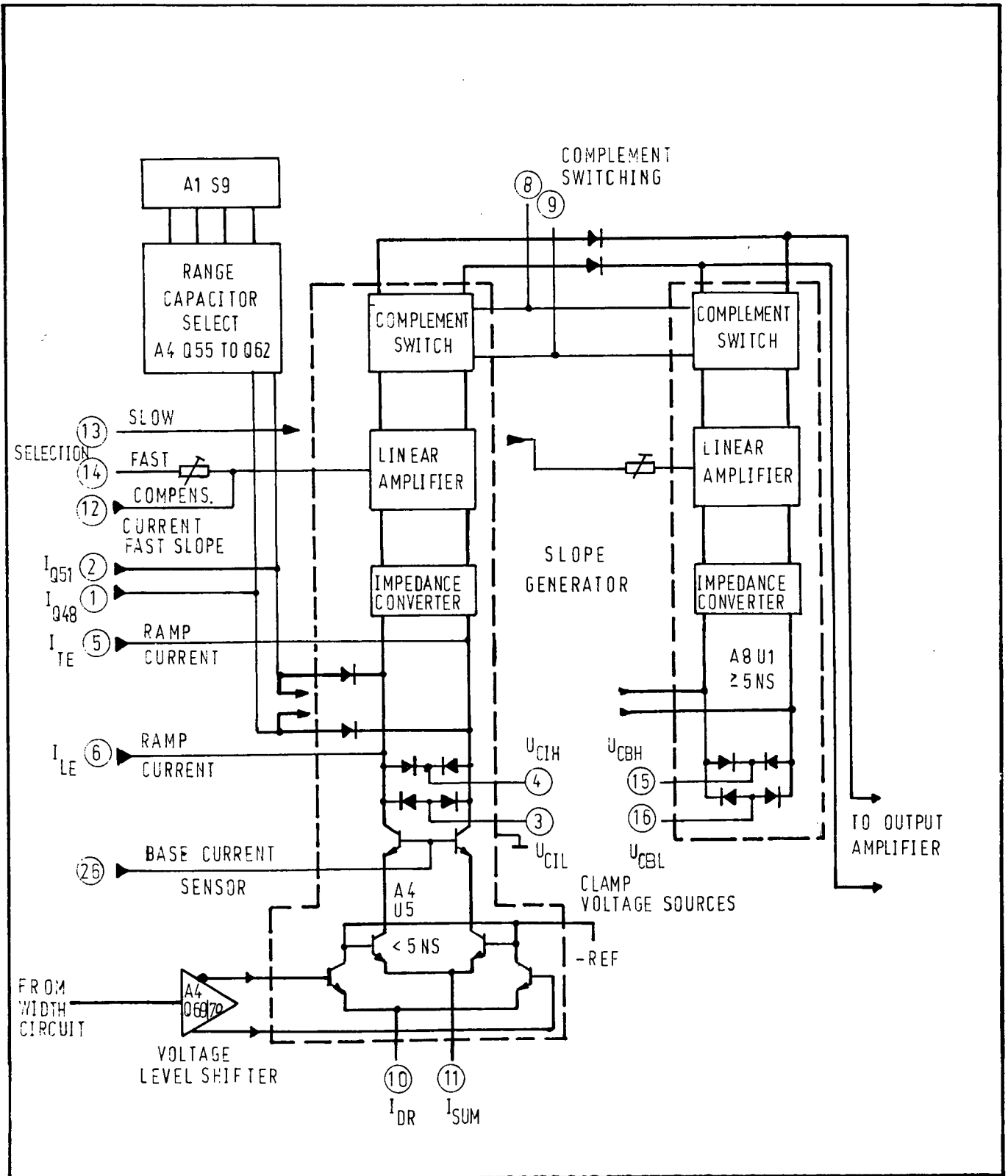


Figure 4-6b Simplified Slope Generator Circuit

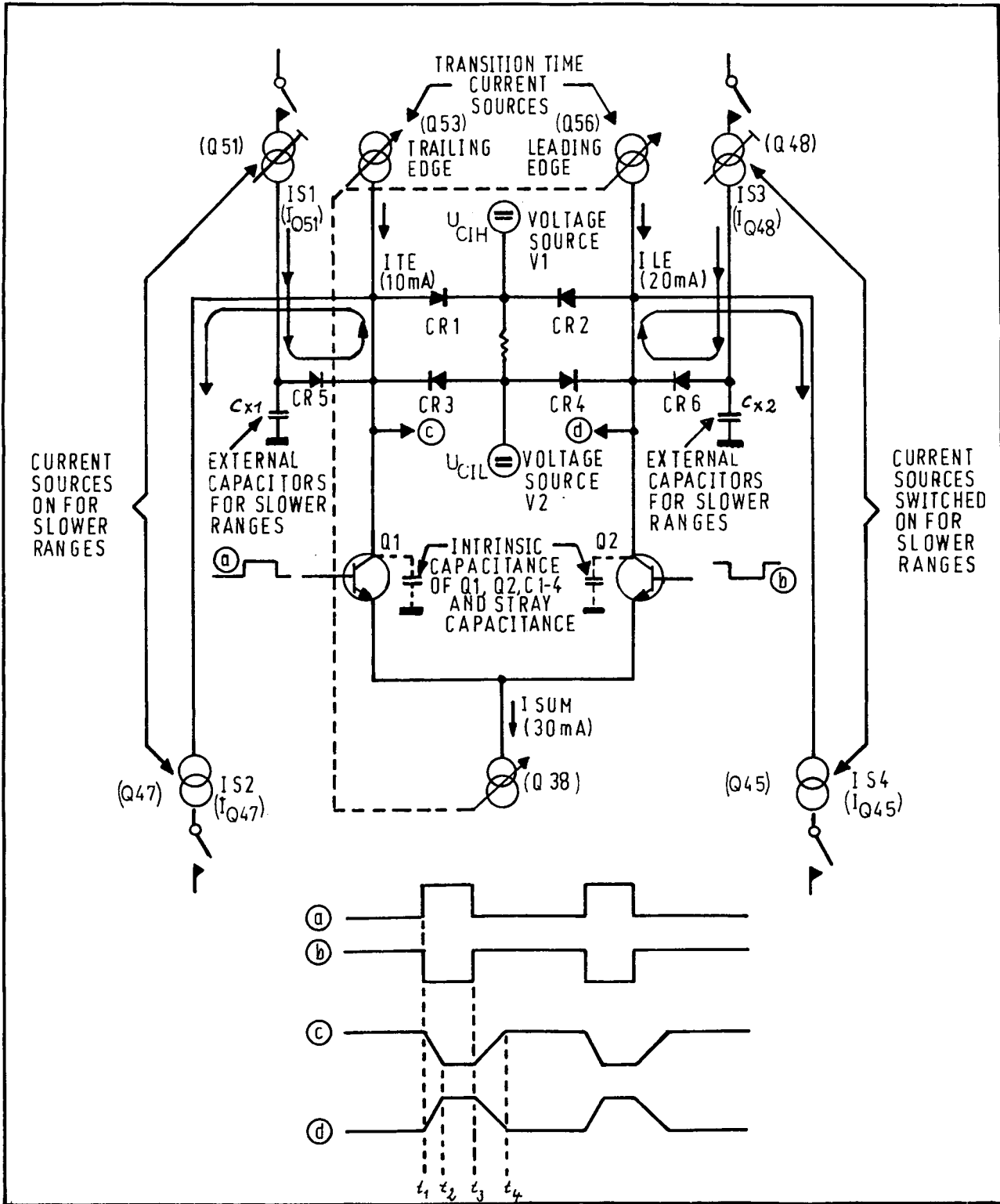


Figure 4-6c. Slope generator operation and waveforms. References in brackets are for Schematic 3a comparison.

**4-36 BUFFER AMPLIFIERS**

4-37 The outputs of the slope generator (normal and complement) are input to one of two buffer amplifiers dependent on the transition time settings (1 - 4.9 ns or > 5 ns). The buffer amplifier for the fast ranges is in the same IC as the slope generator (U5). The buffer amplifier for the slow ranges is on sub-assembly A8. The changeover is accomplished by switching the current sources and -25 V supplies and by the fact that in the fast range the diodes within U5 (pins 14 and 15) are reversed biased so preventing signal flow between U5 and A8 U1. Refer to Q33, 34, 42, 43 on Service Sheet 3a. As shown in Service Sheet 2b, the circuits in the Buffer Amplifier provide a low-to-high impedance converter, a linear amplifier and a facility for normal/complement switching.

**4-38 8082A OUTPUT AMPLIFIER AND VERNIER ATTENUATOR.**

4-39 The function of the output amplifier and offset generator is to amplify the two signals output from the slope generator to required Amplitude and offset. The associated circuit components are distributed over three boards - A5, A4 and A9 - and three corresponding schematics - 3b, 2c and 4.

**4-40 Complement switching (schematic 3b)**

These signals 8 and 9 are input to the slope generator (schematic 2b) but are part of the output modes function (schematic 3 b). They provide UNC1 and UNC2.

4-41 Reference to schematic 2c, 3b and Figure 4-7 shows that the circuit consists basically of the output amplifier (A4 U6), three active vernier current sources, four offset generators, two attenuators (each selectable for 2 steps - 8dB or 14dB attenuation) and their control devices.

**4-42 Output amplifier (also called active vernier) functions as follows:**

The outputs from the slope generator (schematic 2b) are input to the output amplifier U6. There are two attenuating elements per attenuator stage (see Figure 4-8), one for normal and one for complement output, and three attenuator stages in parallel to increase the dynamic range of attenuation. The attenuator uses the current-sharing principle of a differential amplifier. As Figure 4-8 shows, each attenuating stage is a differential amplifier connected so that the signal current flows into (or out of) the common emitters. The output current is taken from one of the collectors and fed to the external resistor, which converts output current to voltage.

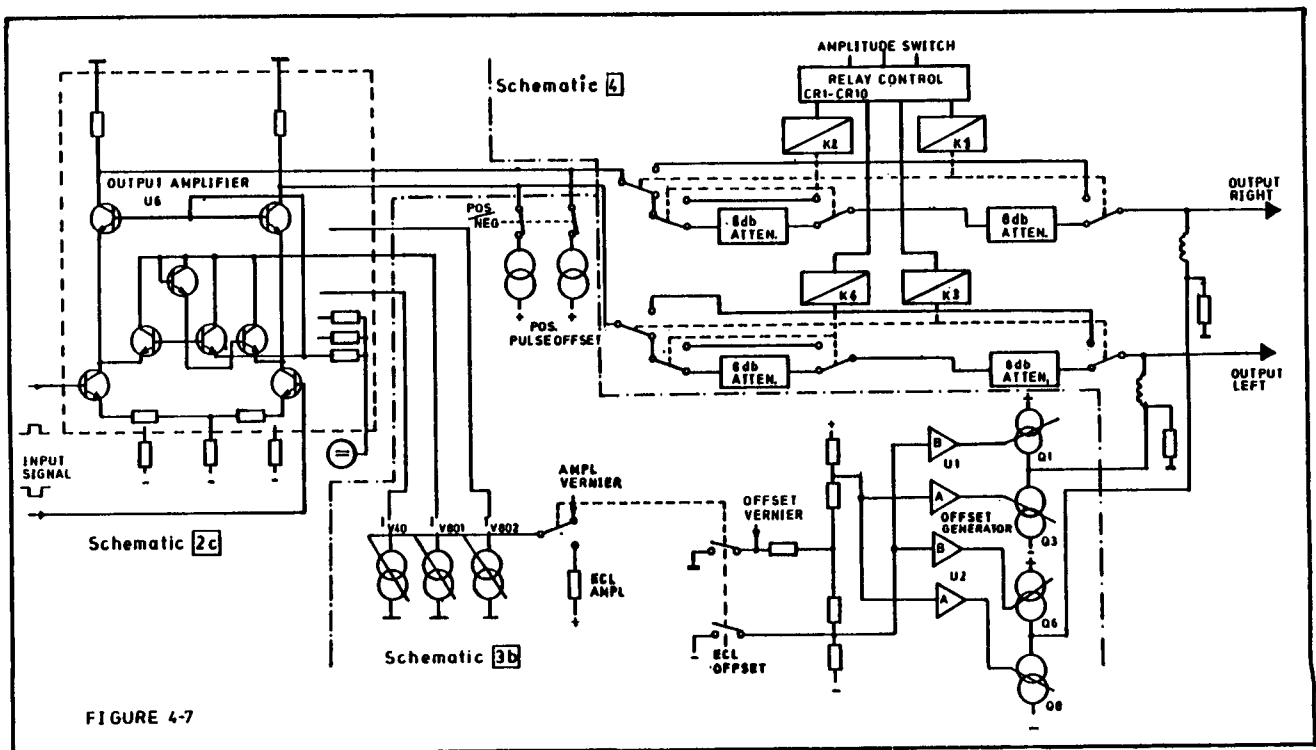


FIGURE 4-7

Figure 4-7

In a differential amplifier the current flow in each collector is proportional to the potential difference between the two bases. Thus, by varying the potential  $V_v$  (See Figure 4-8) on the base of one of the transistors, the current  $I_{out}$  can be controlled. However, because of the characteristic of the base-emitter voltage of each transistor, the attenuation has a logarithmic characteristic.

The input signal controls the share of current source  $I$  which flows through each input transistor. Similarly,  $V_v$  controls the current in both attenuator transistors Q1, Q2 or Q3, Q4 (Figure 4-8). Suppose that  $V_v$  sets an attenuation factor of 2 and, for simplicity,  $I = 1$  mA. If the input is such that  $I$  is shared equally, then  $I_1 = 0.5$  mA and  $I - I_1 = 0.5$  mA. Also  $I_x = 1/2 I_1 = 0.25$  mA and  $I_y = 1/2 (I - I_1) = 0.25$  mA. Now, suppose that the input changes the sharing of current  $I$  so that  $I_1 = 0.2$  mA, and  $I - I_1 = 0.8$  mA, then  $I_y = 0.4$  mA and  $I_x = 0.1$  mA. In either case, the sum  $I_x + I_y$  remains constant, and is in fact constant for all input signals and attenuation ratios. Therefore a constant current source (controlled by the amplitude vernier) can be used to supply the current  $I_x + I_y$ .

If  $I_v = I$ , then  $I_{out} = I_{out} = 0$

If  $I_v = 0$ , then  $I_{out} = I_{out} = 0.5 I$

4-43 An advantage of being able to use the one current source to supply both elements of each attenuator is that the relationship of input control current to output (signal) current is essentially linear but a slight non-linearity is due to emitter-bulk resistances and  $hFE$  and must be compensated for. This is done by a segmented approximation using U3A, U3B, U4B on A5 (Service Sheet 3b) and the three sets of attenuating differential amplifier in U6.

#### 4-44 DC OFFSET FOR POSITIVE PULSE OUTPUTS

4-45 The signal levels from the Output Amplifier need to be level shifted from negative to positive if positive pulse outputs are required. This is achieved by the Positive Pulse DC Offset circuits (one for each channel - see Service Sheets 2c and 3b). If the NEG/POS switch is set to POS, two actions occur, the normal/complement relationship of the signals is switched in the Buffer Amplifier and the Positive Pulse DC Offset circuit is switched on to raise the signal levels from negative to positive.

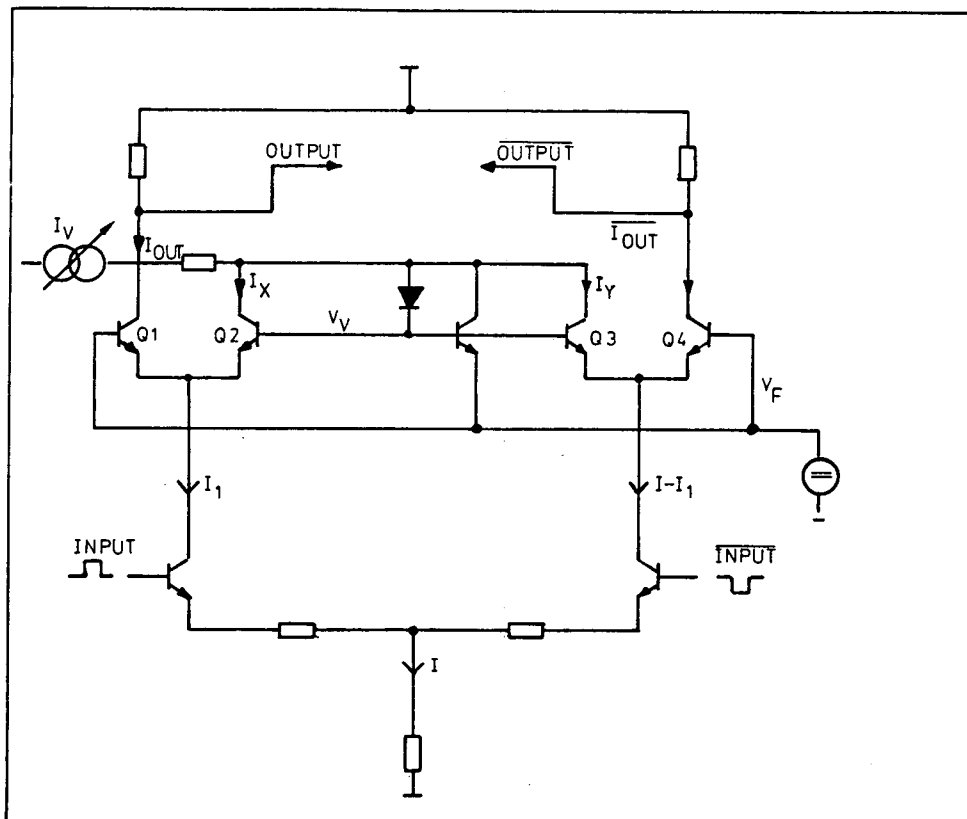


Figure 4-8 Operating principle for each stage of active vernier

#### 4-46 STEP ATTENUATOR

4-47 The amplitude of the output pulses is controlled by a Step Attenuator (one for each channel - see Service Sheet 4). The amplitude range switch selects different combinations of attenuators via a diode matrix (CR1 to CR19). Attenuators used provide 8dB (voltage -2.5) and 14 dB (voltage -5) of attenuation.

#### 4-48 EXTERNAL DC OFFSET

4-49 The output pulse baseline can be adjusted over the range -2 V to + 2V using the External DC Offset circuit (Service Sheet 3b). Both output channels are controlled by a common vernier and the circuit can also be switched off in which case the pulse baselines are at 0 V.

#### 4-50 ECL MODE

4-51 Reference to schematic 3b shows that if Amplitude switch is set to ECL the Offset vernier A1 R8 is without any influence (Q14 switched on). Also Q15 is switched on and a fixed neg Offset is applied. The ECL amplitude is done by A5 R5 (Amplitude vernier A1 R7 is not active).

## 5-1 GENERAL

5-2 This section contains information on the removal of covers and assemblies, performance verification and recalibration procedures, safety checks and troubleshooting procedures.

5-3 Before attempting to remove covers, assemblies or components, disconnect the instrument from the ac line supply. It is advisable also to leave the instrument for a few minutes after disconnecting from the line to enable capacitors to discharge.

## 5-4 REMOVAL OF COVERS

5-5 The top, bottom and side covers can be removed by releasing the captive screw at the rear of each cover and sliding the respective cover to the rear.

## 5-6 REMOVAL OF ASSEMBLIES (See Figure 6-1)

### 5-7 General

5-8 Remove the instrument top cover and remove the metal retaining strip across the top rear of the boards.

### 5-9 Power Supply Board – Assembly 2

5-10 Cut the two plastic straps securing the connector to the rear of the board. Ease the connector off the end of the board.

5-11 Ease the board out of its connector on the rear of the Mother board (A1).

### 5-12 Repetition Rate Generator Board – Assembly 3

5-13 Disconnect the four coaxial cables from the Output Amplifier board (A3).

5-14 Ease the board out of its connector on the rear of the Mother board (A1).

### 5-15 Output Amplifier Board – Assembly 4

5-16 Disconnect the two coaxial cables from the Step Attenuator board (A9).

5-17 Disconnect the four coaxial cables from the Repetition Rate board (A4).

5-18 Disconnect the two flat cables from the Offset board (A5) at board A4 end.

5-19 Remove the two screws securing board A4 heat sink to the rear of the frame.

5-20 Carefully ease the board out of its connector on the Mother board (A1) and withdraw it through the cut-out in the rear of the frame.

### 5-21 Buffer Amplifier Board – Assembly 8

5-22 First remove the Output Amplifier board (A4) from the instrument.

5-23 Remove the screw securing board A8 to board A4 and carefully separate the two boards.

### 5-24 Output Amplifier Board (A4) – Hybrid Circuit Renewal

5-25 First remove the Output Amplifier board (A4) from the instrument.

5-26 Remove the four screws securing the heat sink to the board and remove the hybrid circuit.

5-27 When fitting the new hybrid circuit, thermal compound must be used to give good thermal contact between the circuit and the heat sink (compound part number 6040-0265).

**5-28 Offset Board – Assembly 5**

5-29 Disconnect the two flat cables from the Output Amplifier board (A4) at board A4 end.

5-30 Disconnect the flat cable from the Step Attenuator board (A9) at board A5 end.

5-31 Ease the board out of its connector on the rear of the Mother board (A1).

**5-32 Mother Board – Assembly 1**

5-33 First remove boards A2, A3, A4 and A5.

5-34 Remove the eight knobs from the front panel using an Allen key.

5-35 Remove the nuts securing the four BNC connectors to the front panel.

5-36 Disconnect the two wires from the Manual pushbutton at their connectors on the Mother board.

5-37 Remove the two screws securing the power ON/OFF switch to the Mother board.

5-38 Remove the two screws securing the Mother board to the front panel and remove the board.

**5-39 PERFORMANCE CHECKS**

5-40 Performance checks (Table 5-1 to 5-13) give the procedures for verifying that the 8082A is working to the specifications. The checks should be performed in sequence from 5-1 to 5-13.

For Adjustments and Safety Check refer to paragraph 5-41 on page 5-13.

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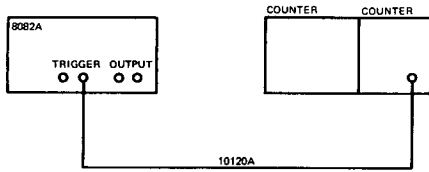
Table 5-1. Test Equipment and Accessories for Performance Checks

INSTRUMENT	BRIEF SPECIFICATION	RECOMMENDED MODEL
Pulse Generator	10 MHz square wave output with 50% duty cycle	HP 8011A
Counter	Frequency range 0-50 MHz	5245L
	Prescaler plug-in	5252A
Oscilloscope	Dual Channel, 50 MHz bandwidth, 5mV/div. sensitivity, sweep speeds 5ns/div. to 2s/div. with sweep delay.	HP 180A with plug-ins 1801A and 1820A
Sampling Oscilloscope	Dual Channel, 1 GHz bandwidth, 1mV/div. sensitivity, sweep speeds 10ns/div. to 2s/div. 50-Ω input impedance.	Tek 760 with 7T11 7S11 and S-3A
Digital Voltmeter	100V range to 4 significant figures. Accuracy $\pm 0.05\%$ $\pm 1$ digit.	HP 3440A with plug-in 3443A
Test Oscillator	Frequency range 10 Hz - 10 MHz	HP 651A
Test Oscillator	Frequency range 10 to 500 MHz	HP 3200B
<b>ACCESSORIES</b>		
50Ω co-axial cable terminated with BNC male connectors (4 required)		HP 10120A
Connector BNC male to N female (2 required)		HP 1250-0077
Connector BNC male to N male (2 required)		HP 1250-0780
50Ω Feed-through termination (2 required)		HP 11048B/C
Pulse Adder		HP 15104A
20dB Attenuator, 50Ω (2 required)		HP 8491A



### PERFORMANCE CHECKS

Table 5-2. Performance Check - Repetition Rate



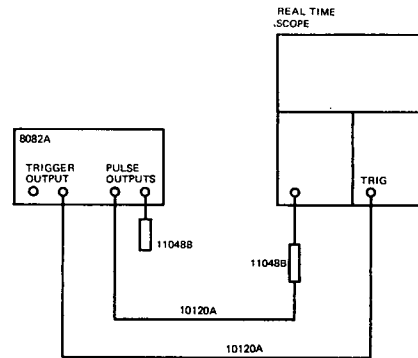
STEP

- |    |                  |                      |
|----|------------------|----------------------|
| 1  | 8082A settings:  | 5252A settings:      |
| 1  | REPETITION RATE  | 250M-100M Max. count |
| 2  | VERNIER          | CCW rate             |
| 3  | NORM/DOUBLE      | NORM                 |
| 4  | DELAY            | 2n-5n                |
| 5  | VERNIER          | CCW                  |
| 7  | MODE SWITCH      | NORM                 |
| 8  | WIDTH            | 2n-5n                |
| 9  | VERNIER          | CCW                  |
| 10 | TRANSITION TIME  | 1n-5n                |
| 11 | LEADING VERNIER  | CCW                  |
| 12 | TRAILING VERNIER | CCW                  |

2 Measure the frequency as follows:

REPETITION RATE 1	VERNIER 2	COUNTER	RESULT
250M-100M	CCW	0.1m	> 250M
250M-100M	CW	0.1m	< 100M
100M-10M	CCW	0.1m	> 100M
100M-10M	CW	0.1m	< 10M
10M-1M	CCW	0.1m	> 10M
10M-1M	CW	0.1m	< 1M
1M-100K	CCW	1m	> 1M
1M-100K	CW	1m	< 100K
100K-10K	CCW	10m	> 100K
100K-10K	CW	10m	< 10K
10K-1K	CCW	0.1s	> 10K
10K-1K	CW	0.1s	< 1K

Table 5-3. Performance Check - Delay (Slow)

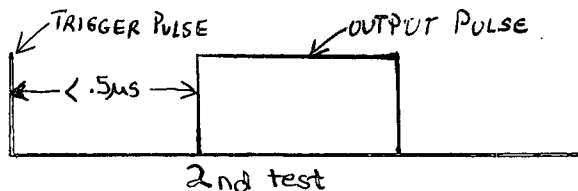


STEP

- 8082A settings:
- RATE VERNIER CW
- AMPLITUDE 2.0-5.0

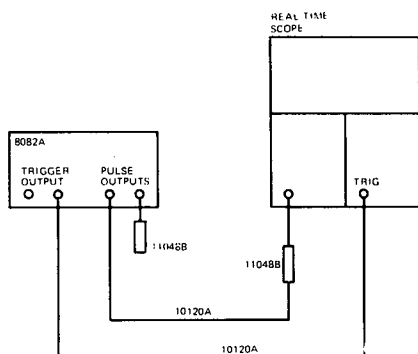
2 Set trigger pulse on first line of graticule and measure time between trig and output pulse (leading edges) *Falling edge use scope neg. slope*  
*scope - and ext trigger*

8082A					
RATE 1	DELAY 4	VERNIER 5	WIDTH 8	Sweep time	RESULT
1M-0.1M	50n-0.5μ	CW	50n-0.5μ	0.1μs	> 0.5μs
1m-0.1M	0.5μ-5μ	CCW	50n-0.5μ	0.1μs	< 0.5μs
0.1M-10K	0.5μ-5μ	CW	0.5μ-5μ	1μs	> 5μs
0.1M-10K	5μ-50μ	CCW	0.5μ-5μ	1μs	< 5μs
10K-1K	5μ-50μ	CW	0.5μ-5μ	10μs	> 50μs
10K-1K	50μ-0.5m	CCW	5μ-50μ	10μs	< 50μs
10K-1K	50μ-0.5m	CW	5μ-50μ	0.1ms	> 500μs



### PERFORMANCE CHECKS

Table 5-4. Performance Check – Width (Slow)



STEP

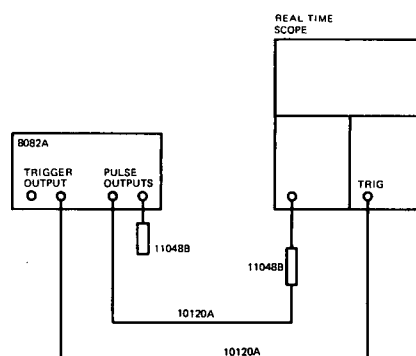
1 8082A settings:

- 13 AMPLITUDE 2.0-5.0
- 14 AMPLITUDE 0.4-1.0
- 15 AMP. VERNIER CW
- 4 delay 5n-50n CCW
- 2 rate vernier CW

2 Measure the width:

8082A			Sweep time	RESULT
RATE 1	WIDTH 8	VERNIER 9		
1M-0.1M	50n-0.5μ	CW	0.1μs	> 0.5μs
1M-0.1M	0.5μ-5μ	CCW	0.1μs	< 0.5μs
0.1M-10K	0.5μ-5μ	CW	1μs	> 5μs
0.1M-10K	5μ-50μ	CCW	1μs	< 5μs
10K-1K	5μ-50μ	CW	10μs	> 50μs
10K-1K	50μ-0.5m	CCW	10μs	< 50μs
10K-1K	50μ-0.5m	CW	0.1ms	> 0.5ms

Table 5-5. Performance Check – Jitter



*main @ 10μs/div  
DLY @ .05μs/div*

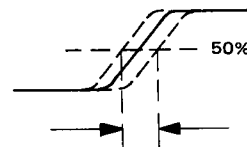
STEP

Period jitter

1 8082A settings:

- 1 REPETITION RATE 0.1M-10K
- 4 DELAY 2n-5n
- 5 VERNIER CCW
- 8 WIDTH 0.5μ-5μ
- 9 VERNIER CCW

2 Turn rep. rate vernier (2) to get a 10 division period display on screen. Set scope delay until the second leading edge is visible



3 Check period jitter: < 1 cm ≈ 0.1%

Delay jitter

4 8082A settings:

- 1 REP. RATE 10K-1K
- 2 VERNIER CW
- 4 DELAY 5μ-50μ
- 8 WIDTH 5μ-50μ

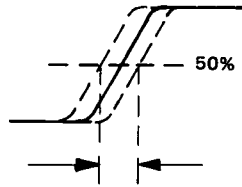
Scope:  
Turn delay to 10 cm.

5 Turn delay vernier (5) for 50μs delay.

6 Set scope delay until leading edge is visible.

**PERFORMANCE CHECKS**

Table 5-5. (cont'd)



7 Check delay jitter  $< 0.5 \text{ cm} \approx 0.1\%$

Width jitter

8 8082A settings: scope settings:  
 1 REP. RATE 10K-1K Turn delay to 10 cm.  
 2 VERNIER CW  
 8 WIDTH  $5\mu-50\mu$   
 9 VERNIER for a  $50\mu\text{s}$  display

9 Set scope delay CCW until the trailing edge is visible.

10 Check width jitter:  $< 0.5 \text{ cm} \approx 0.1\%$

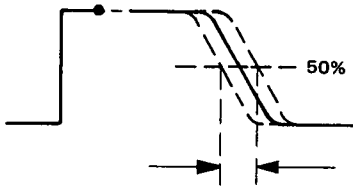
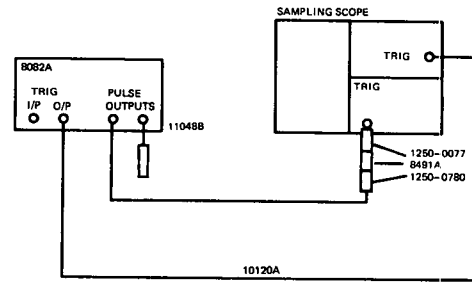


Table 5-6. Performance Check - Width (Fast)



STEP

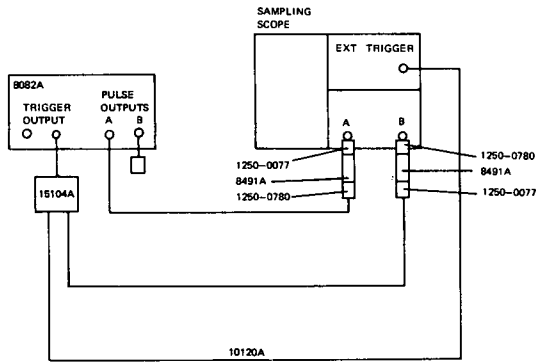
1 8082A settings:  
 1 REPETITION RATE 250M-100M  
 2 VERNIER CCW  
 4 DELAY 2n-5n  
 5 VERNIER CCW

2 Check the following:

8082A			SCOPE		RESULT
RATE 1	WIDTH 8	VERNIER 9	Main swp	exp. swp	
250M-100M	2n-5n	CCW	10n	2n	$< 2\text{ns}$
100M-10M	2n-5n	CW	10n	2n	$> 5\text{ns}$
100M-10M	5n-50n	CCW	10n	2n	$< 5\text{ns}$
10M-1M	5n-50n	CW	$0.2\mu$	20n	$> 50\text{ns}$
10M-1M	$50\text{n}-0.5\mu$	CCW	$0.2\mu$	10n	$< 50\text{ns}$

PERFORMANCE CHECKS

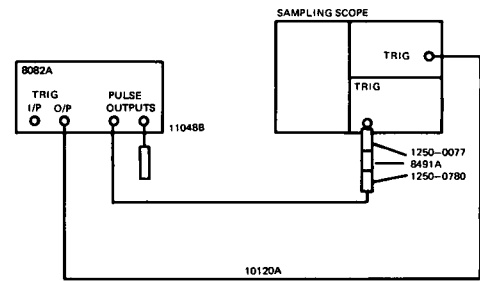
Table 5-7. Performance Check - Delay (Fast)



STEP

- 1 8082A settings:
  - 8 WIDTH 2n-5n
- 2 Set channel B on first line of graticule. Measure time between neg. trig. and pos. (leading edge) output pulse.

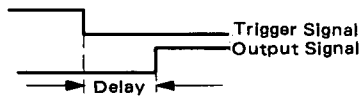
Table 5-8. Performance Check - Square Wave Duty Cycle



STEP

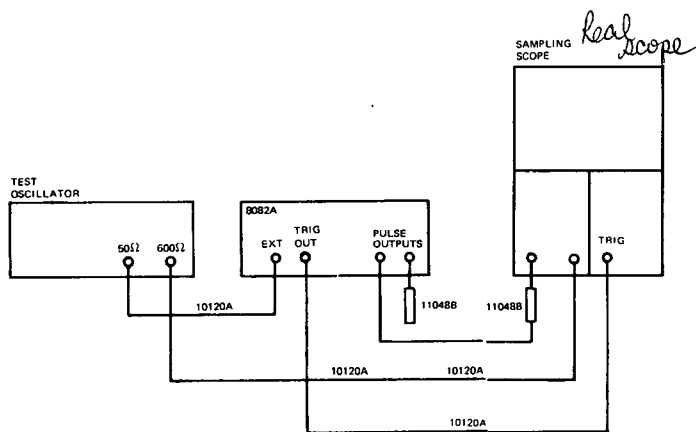
- 1 8082A settings:
  - 1 REPETITION RATE 250M-100M
  - 2 VERNIER CCW
- 2 Measure duty cycle Limit > 35% < 65%
- 3 Turn rate vernier (2) CW.
- 4 Measure duty cycle at 100 MHz Limit > 35% < 65%
- 5 Set rep. rate (1) to 100M-10M and turn rate vernier (2) CCW.
- 6 Measure duty cycle at 100 MHz Limit > 35% < 65%
- 7 Turn rate vernier (2) CW.
- 8 Measure duty cycle at 10 MHz Limit > 40% < 60%
- 9 Set rep rate (1) to 10M-1M.
- 10 Measure duty cycle at 1 MHz Limit > 40% < 60%

8082A				SCOPE		RESULT fxd del typ 18ns
RATE 1	VERNIER 2	DELAY 4	VERNIER 5	meantime	expanded	
10M-1M	CCW	2n-5n	CCW	20n	5n	> 16ns < 19ns
10M-1M	CCW	2n-5n	CW	20n	5n	fxd del + > 5ns
10M-1M	CCW	5n-50n	CCW	20n	5n	fxd del + < 5ns
10M-1M	CCW	5n-50n	CW	20n	10n	fxd del + > 50ns
10M-1M	middle	50n-500n	CCW	50n	10n	fxd del + < 50ns



PERFORMANCE CHECKS

Table 5-9. Performance Check - External Functions



STEP

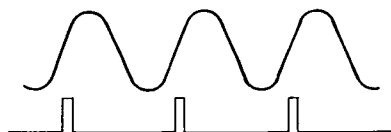
- 1 8082A settings:
  - 4 DELAY 50μ-0.5m
  - 5 VERNIER CCW
  - 6 EXT INPUT LEVEL middle
  - 7 MODE SWITCH EXT. TRIG.
  - 8 WIDTH 50μ-0.5m
  - 9 VERNIER CCW
  - 24 SLOPE POLARITY POS

Test oscillator settings: 1KHz, 1V

FREQUENCY VERNIER 1  
 FREQUENCY RANGE 1K  
 OUTPUT 1V

2 EXT TRIGGER

Pulse should appear only during positive slope of sine wave. Pulse is variable by width and delay and its trig. point is variable by EXT INPUT LEVEL (6).



- 3 Set SLOPE POLARITY (24) to MAN and press MAN button (25): Only one pulse must occur.
- 4 Set SLOPE POLARITY (24) to NEG. Pulse should appear only during negative slope of sine wave. Pulse is variable by width and delay and its trig. point is variable by EXT INPUT LEVEL (6).
- 5 EXT WIDTH

Set MODE SWITCH (7) to EXT WIDTH.  
 Set SLOPE POLARITY (24) to POS.

Table 5-9. (cont'd)

- 6 Pulse must only occur during the positive part of the sinewave. It should only be variable by EXT INPUT LEVEL (6), independent of width, delay and rep. rate.



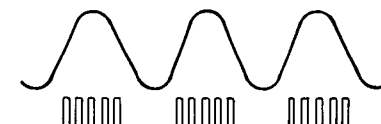
- 7 Repeat with SLOPE/POLARITY (24) set to NEG. This time a pulse must only occur during the negative part of the sinewave.

8 GATE

Set the 8082A as follows:

- |                   |          |
|-------------------|----------|
| 1 REPETITION RATE | 10K-1K   |
| 2 VERNIER         | CCW      |
| 4 DELAY           | 50μ-0.5m |
| 5 VERNIER         | CCW      |
| 7 MODE SWITCH     | GATE     |
| 8 WIDTH           | 50μ-0.5m |
| 9 VERNIER         | middle   |
| 24 SLOPE POLARITY | POS      |

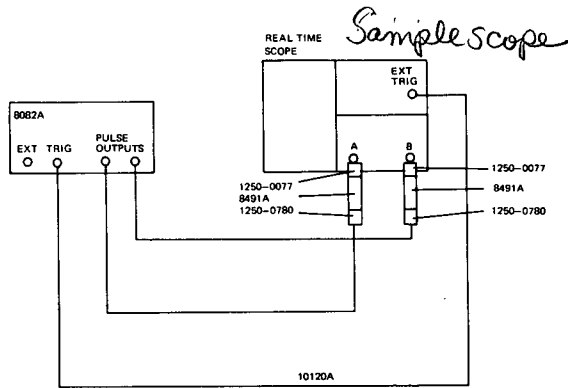
- 9 Leading edges of output pulses must only occur during positive part of sinewave. Pulses are available by all controls (rep. rate, width, delay, ext. input level).



- 10 Set the SLOPE POLARITY (24) to NEG. Pulses must only occur during negative slope of sinewave.

PERFORMANCE CHECKS

Table 5-10. Performance Check - Transition Time



STEP

- 1 8082A settings:
  - 1 REPETITION RATE 250M-100M
  - 2 VERNIER CW
  - 4 DELAY 2n-5n
  - 8 WIDTH 2n-5n
  - 13 AMPLITUDE 2.0-5.0
  - 14 AMPLITUDE 2.0-5.0
  - 10 TRANSITION 1n-5n
  - 11 VERNIER CCW
- 2 Adjust the width vernier for 50% duty cycle.
- 3 Adjust the scope for a full screen display, set to Expand and centre the leading edge of the pulse on the display.
- 4 Measure transition time between 10% and 90% points. < 1ns
- 5 Centre trailing edge on the display and measure transition time between 10% and 90% < 1ns
- 6 Repeat 1 to 4 with NEG/POS switch (20) in NEG position.
- 7 Repeat 1 to 4 with NORM/COMPL switch (19) set to COMPL.

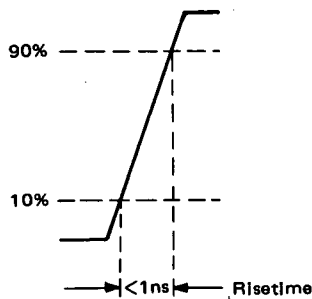
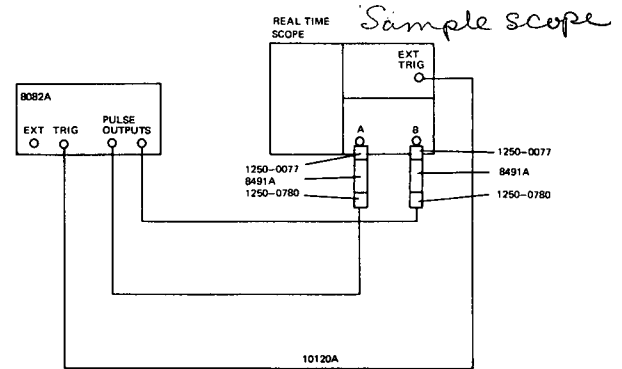
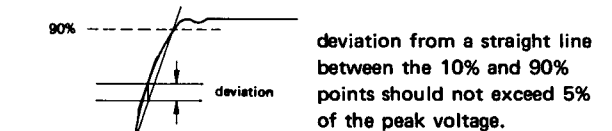
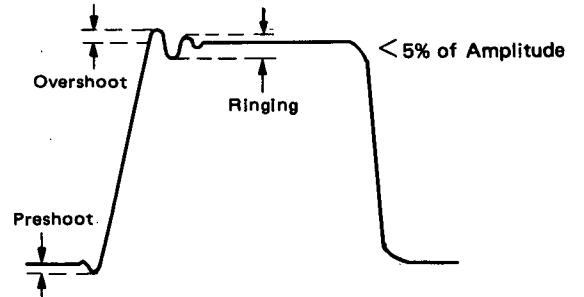


Table 5-11. Performance Check - Pre-shoot, Overshoot, Ringing and Linearity



STEP

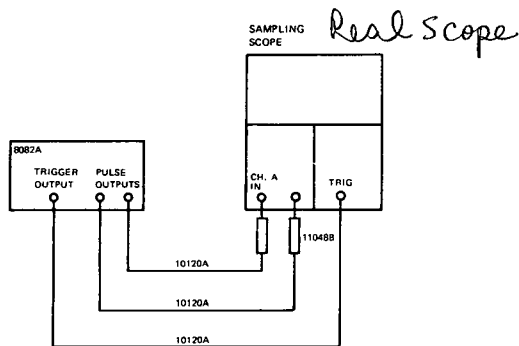
- 1 8082A settings:
  - 1 REP RATE 10m-1m
  - 8 WIDTH 50n-0.5n
  - 10 TRANSITION TIME 5n-50n
  - 19 NORM/COMPL SWITCH NORM
  - 20 NEG/POS SWITCH POS
- 2 Adjust width vernier for a 50% duty cycle and 8 div vertically.
- 3 Adjust leading vernier 11 and trailing vernier 12 for 10ns transition time.
- 4 Measure, with reference to diagrams below, preshoot, overshoot, ringing and linearity.



- 5 Repeat with the NEG/POS switch (20) set to NEG.
- 6 Repeat with the NORM/COMPL switch (19) set to COMPL.

## PERFORMANCE CHECKS

Table 5-12. Performance Check – Amplitude

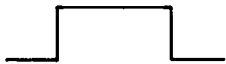


## STEP

- 1 8082A settings:
  - 1 REPETITION RATE 10K-1K
  - 2 VERNIER CCW
  - 8 WIDTH SQUARE WAVE
- 2 Set the baseline of the scope to zero.
- 3 Measure the amplitude of both outputs as follows:

8082A		
AMPLITUDE	VERNIER	RESULT
13, 14	15	
5.0-2.0	CW	> 5V
5.0-2.0	CCW	< 2V
2.0-1.0	CW	> 2V
2.0-1.0	CCW	< 0.8V
1.0-0.5	CW	> 1.0V
1.0-0.5	CCW	< 0.5V

- 4 Set NORM/COMPL switch (19) to COMPL and repeat step 3.
- 5 Switch either AMPLITUDE switch (13 or 14) to ECL and measure the level and amplitude.

-0.45V typ  Value is double if 50 ohm load is removed.  
 -0.85V typ

- 6 Set AMPLITUDE to 5.0-2.0, MODE SWITCH (7) to EXT TRIG, SLOPE POLARITY (24) to MAN and adjust the scope for a baseline reference. Set OFFSET switch (17) to ON and turn OFFSET VERNIER (16) from CW to CCW.
- 7 Baseline should shift from  $\geq -2V$  to  $\geq +2V$ .

PERFORMANCE CHECKS

Table 5-13. Performance Check Record (1 of 4)

Hewlett-Packard Company Model 8082A Pulse Generator Serial No.....		Tested by .....  Date .....		
Table No.	Check Description	Results		
		Min.	Actual	Max.
5-2	REPETITION RATE    VERNIER			
	250M-100M    CCW	250M		
	250M-100M    CW			100M
	100M-10M    CCW	100M		
	100M-10M    CW			10M
	10M-1M    CCW	10M		
	10M-1M    CW			1M
	1M-100K    CCW	1M		
	1M-100K    CW			100K
	100K-10K    CCW	100K		
	100K-10K    CW			10K
10K-1K    CCW	10K			
10K-1K    CW			1K	
5-3	Delay (slow)			
	RATE    DELAY    VERNIER    WIDTH			
	1M-0.1M    50n-0.5μ    CW    50n-0.5μ	0.5μs		
	1m-0.1M    0.5μ-5μ    CCW    50n-0.5μ			0.5μs
	0.1M-10K    0.5μ-5μ    CW    0.5μ-5μ	5μs		
	0.1M-10K    5μ-50μ    CCW    0.5μ-5μ			5μs
	10K-1K    5μ-50μ    CW    0.5μ-5μ	50μs		
	10K-1K    50μ-0.5m    CCW    5μ-50μ			50μs
10K-1K    50μ-0.5m    CW    5μ-50μ	500μs			
5-4	Width (slow)			
	RATE    WIDTH    VERNIER			
	1M-0.1M    50n-0.5μ    CW	0.5μs		
	1M-0.1M    0.5μ-5μ    CCW			0.5μs
	0.1M-10K    0.5μ-5μ    CW	5μs		
	0.1M-10K    5μ-50μ    CCW			5μs
	10K-1K    5μ-50μ    CW	50μs		
	10K-1K    50μ-0.5m    CCW			50μs
10K-1K    50μ-0.5m    CW	0.5ms			



PERFORMANCE CHECKS

Table 5-13. Performance Check Record (2 of 4)

Table No.	Check Description	Results				
		Min.	Actual	Max.		
5-5	<b>Jitter</b> Period jitter Delay jitter Width jitter			0.1 %		
				0.1 %		
				0.1 %		
5-6	<b>Width (fast)</b>  RATE      WIDTH      VERNIER 250M-100M    2n-5n      CCW 100M-10M      2n-5n      CW 100M-10M      5n-50n     CCW 10M-1M        5n-50n     CW 10M-1M        50n-0.5μ   CCW	5ns		2ns		
				5ns		
		50ns		50ns		
		5-7	<b>Delay (fast)</b>  RATE      VERNIER      DELAY      VERNIER 10M-1M    CCW          2n-5n      CCW 10M-1M    CCW          2n-5n      CW 10M-1M    CCW          5n-50n     CCW 10M-1M    CCW          5n-50n     CW 10M-1M    middle       50n-500n   CCW  * Fixed delay, typically 18ns	16ns	(D*)	19ns
						D+5ns
D+50ns				D+5ns		
				D+50ns		
5-8	<b>Square Wave Duty cycle</b>  RATE                                  VERNIER 250-100M                              CCW 250-100M                              CW  100M-10M                                CCW 100M-10M                                CW  10M-1M                                    CW			35%		65%
						65%
		35%		65%		
				60%		
		40%		60%		
				60%		



**PERFORMANCE CHECKS**

Table 5-13. Performance Check Record (4 of 4)

Table No.	Check Description			Results			
				Min.	Actual	Max.	
5-11	<b>Preshoot, Overshoot, Ringing and Linearity</b>						
		NEG/POS	NORM/COMPL				
	Preshoot	POS	NORM			5%	
		NEG	NORM			5%	
		NEG	COMPL			5%	
		POS	COMPL			5%	
	Overshoot	POS	NORM			5%	
		NEG	NORM			5%	
		NEG	COMPL			5%	
		POS	COMPL			5%	
	Ringing	POS	NORM			5%	
		NEG	NORM			5%	
		NEG	COMPL			5%	
		POS	COMPL			5%	
	Linearity	POS	NORM			5%	
		NEG	NORM			5%	
		NEG	COMPL			5%	
		POS	COMPL			5%	
	5-12	<b>Amplitude</b>					
		AMPLITUDE	VERNIER	NORM/COMPL			
5.0-2.0		CW	NORM	5V			
5.0-2.0		CCW	NORM			2V	
2.0-1.0		CW	NORM	2V			
2.0-1.0		CCW	NORM			0.8V	
1.0-0.5		CW	NORM	1.0V			
1.0-0.5		CCW	NORM			0.5V	
5.0-2.0		CW	COMPL	5V			
5.0-2.0		CCW	COMPL			2V	
2.0-1.0		CW	COMPL	2V			
2.0-1.0		CCW	COMPL			0.8V	
1.0-0.5		CW	COMPL	1.0V			
1.0-0.5		CCW	COMPL			0.5V	
ECL				HI-0.45V typ LO-0.85V typ			
5.0-2.0		OFFSET VERNIER					
		CW		-2V			
		CCW		+2V			

### ADJUSTMENTS

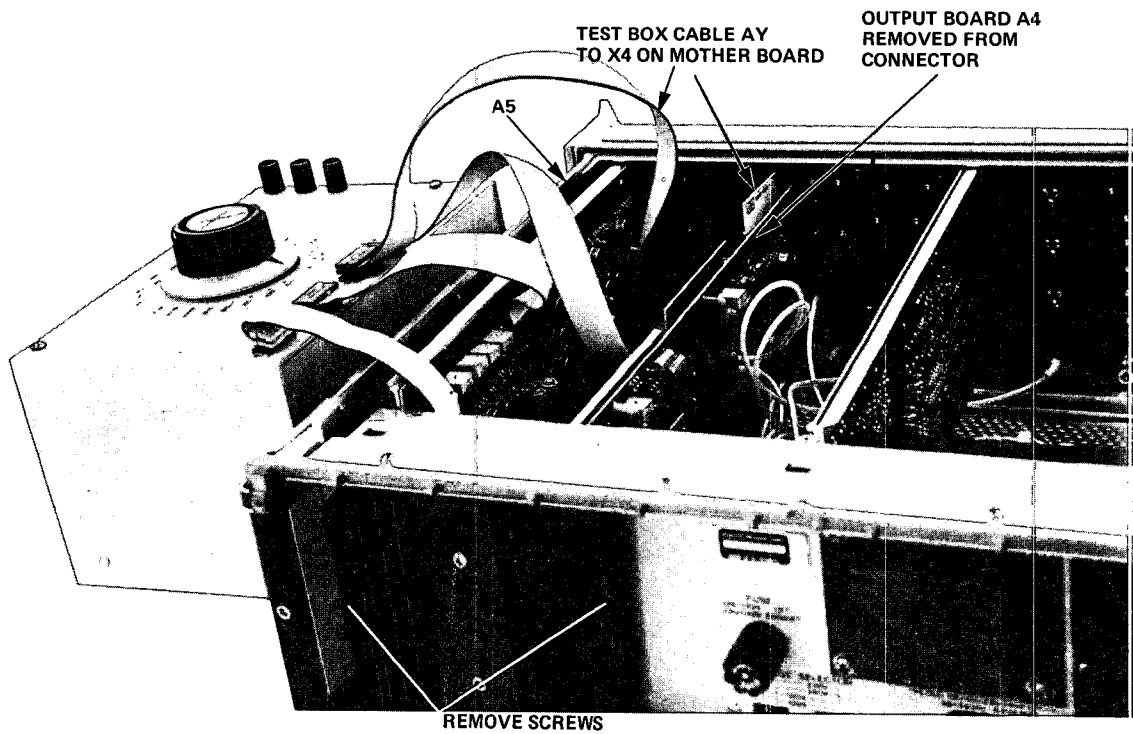
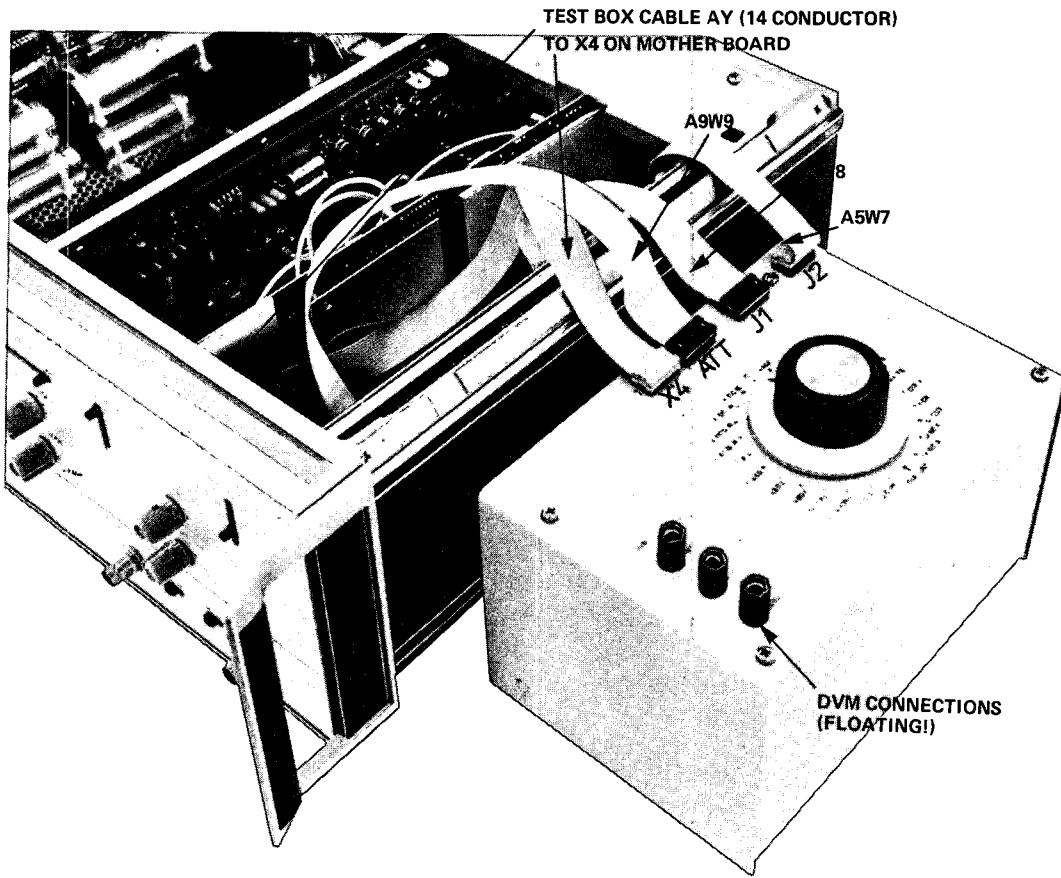


Figure 5-1. Connections between Test Box 15265A and 8082A.

## ADJUSTMENTS

### 5-41 INTERNAL CHECKS AND ADJUSTMENTS

5-42 The internal checks and adjustments section (Tables 5-14 to 5-26) gives the procedure for adjusting a serviceable instrument to bring it within specification. The checks should be performed in the order in which they appear. A summary of adjustments and selectable components is presented in Table 5-14. Figure 5-2 at the end of this section gives the locations of the adjustments.

**NOTE:** Ensure that BOTH outputs of the 8082A are terminated by a 50  $\Omega$  load whenever pulse measurements or adjustments are to be made.

### 5-43 TROUBLESHOOTING USING THE 15265A TEST BOX

5-44 The Test Box is designed to facilitate troubleshooting and adjustments of the current sources in Board A5. It is connected in place of Board A4 and simulates the load presented to Board A5. A switch on the Test Box selects the parameter for monitoring on the externally-connected DVM. The checks and adjustments which can be performed by the Test Box are summarized in Table 5-16.

5-45 To connect the Test Box, refer to Figure 5-1 and use the following procedure:

Switch 8082A off. Remove the 8082A top cover. Remove the two screws from the Output Amplifier (board A4) heat sink on the rear of the 8082A. Unplug the Output Amplifier from its connector by about 2 cm and carefully push the connector-end of the board to one side.

#### WARNING

Any interruption of the protective (grounding) conductor inside or outside the instrument or disconnection of the protective earth terminal is likely to make the apparatus dangerous. Intentional interruption is prohibited. Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, when inevitable, should be carried out only by a skilled person who is aware of the hazard involved. The opening of covers or removal of parts, except those to which access can be gained by hand, may expose live parts, and also accessible terminals may be live.

Disconnect the three ribbon cables:

A5 W8 from A4 J1  
A5 W7 from A4 J2  
A9 W9 from A5 J-ATT

Connect the extender board to the X4 socket (socket from which board A4 has been disconnected).

Connect the other extender cable to the J-ATT connector on board A5.

Connect the ends of cables J1, J2, J-ATT and X5 to the Test Box as shown in Figure 5-1.

Connect DVM (floating mode, auto range) and verify operation of Test Box by performing first check in Table 5-16.

### 5-46 SAFETY CHECK

5-47 This check (Table 5-27) should be performed following the internal checks and adjustments to verify the instrument safety.

### 5-48 TROUBLESHOOTING TIPS

5-49 The quadruple AND gate A3 U6 in the rep rate circuit can be damaged if the -5V or -10V supplies are shorted to ground.

5-50 Instruments with serial numbers 1410G00430 and below may be liable to latch-up when switching transition times from 5-50 $\mu$  to 50 $\mu$ -0.5m. If this occurs, insert diode CR 37 (partnumber 1901-0040) in series with A5 Q37 (anode to collector).

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, etc.) are used for replacement. The use of repaired fuses and the short-circuiting of fuseholders must be avoided.

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

Table 5-14. Summary of adjustable and factory-selected components

Component	Adjusts	Table in which adjustment is described
A2 R7	+10V power supply	5-17
A2 R10	-5V power supply	5-17
A2 R21	-10V power supply	5-17
A2 R29	-25V power supply	5-17
A3 R6	Max rep rate	5-18
A3 R5	Min rep rate	5-18
A3 R77*	SW duty cycle < 100 MHz rep rate	5-18
A3 R87		
A3 R92*	Duty cycle in gate mode	5-25
A4 R38*	Maximum delay	5-19
A4 R42*	Double pulse	5-26
A4 R43	Width adjust	5-24
A4 R88*	Max width	5-19
A4 R240	Min width	5-24
A4 R214		
A4 R232	Risetime (fast), rolloff, overshoot neg baseline shift	5-20
A4 L(CR32)		
A4 L(CR33)	Risetime (fast), overshoot	5-20
A4 R253	Output amplifier	5-20
A5 R142*	Slow transition time in the first integrator range (1-5 $\mu$ s)	5-20
A5 R147		
A5 R148	Integrator (working window)	5-16 (8), 5-20
A5 R161		
A5 R162	A8-adjust (working window)	5-16 (8)
A5 R213		
A5 R230	Integrator minimum current	5-22
A5 R136		
A5 R217	Dual slope, slope equivalence	5-22 (5)
A5 R171		
A5 R172	Integrator (slow ranges)	5-16 (5), 5-22
A5 R210	Internal supply voltage for integrator	5-16 (10) 5-20
A5 R80		
A5 R81		
A5 R115	Positive pulse baseline tracking	5-23
A8 R16		
A8 R17	Integrator buffer amplifier (slow ranges)	5-21
* Factory-selected		

Table 5-15. Test Equipment and Accessories for Internal Checks and Adjustments

INSTRUMENT	BRIEF SPECIFICATION	RECOMMENDED MODEL
Pulse Generator	10 MHz square wave output with 50% duty cycle	HP 8011A
Counter	Frequency range 0-50 MHz	5245L
	Prescaler plug-in	5252A
Oscilloscope		HP 180A with plug-ins 1801A and 1820A
Sampling Oscilloscope	Dual Channel, 1 GHz bandwidth, 1mV/div. sensitivity, sweep speeds 10ns/div. to 2s/div. 50- $\Omega$ input impedance.	HP 180A with plug-in 1810A
Digital Voltmeter	100V range to 4 significant figures. Accuracy $\pm 0.05\%$ $\pm 1$ digit.	HP 3440A with plug-in 3443A
Test Oscillator	Frequency range 10 Hz - 10 MHz	HP 651A
Test Oscillator	Frequency range 10 to 500 MHz	HP 3200B
Test Box		15265A

### ACCESSORIES

50 $\Omega$ co-axial cable terminated with BNC male connectors (4 required)	HP 10120A
Connector BNC male to N female (2 required)	HP 1250-0077
Connector BNC male to N male (2 required)	HP 1250-0780
50 $\Omega$ Feed-through termination (2 required)	HP 11048B/C
Pulse Adder	HP 15104A
20dB Attenuator, 50 $\Omega$ (2 required)	HP 8491A

Table 5-16. Test and Adjustments Performed by Test Box 15265A

## Classification of tests:

- Class A These tests can only be performed using the Test Box.
- Class B Conventional methods can be used instead.
- Class C The Test Box checks a sub-function of Board A5. A final adjustment using the complete 8082A (i.e. with Board A4 operational) is necessary.

NOTE: DVM must be floating.

Test No.	Class	Purpose	Selector setting	DVM reading
1	—	Self test	-14V	-14V ± 0.5V
2	B	Transition time switch function 1n-5n 5n-0.5m (approx equal to A5 R166/167 voltage to ground).	S9A	< 80mV -25V ± 100mV
3	B	Current source values: transition time switch 1n-5n  transition time switch 5n-50n ( $I_{Q51} \approx V_{A5R211}/147\Omega$ ) ( $I_{Q48} \approx V_{A5R213}/147\Omega$ )  (For this measurement, connect collector A5 Q58 via approx. 510Ω to ground.)  ( $I_{DR} \approx V_{A4R180}/38.3\Omega$ )	I <sub>Q51</sub> I <sub>Q48</sub> I <sub>Q51</sub> I <sub>Q48</sub> I <sub>DR</sub>	< 10mV < 10mV 285 ± 25mV 285 ± 25mV 85 ± 10mV  (10mV = 1mA).
Test No.	Class	Purpose	Selector setting	DVM reading
4	B	Trans time switch 1n-5n.	I <sub>SUM</sub> I <sub>SUM</sub>	510mV ± 40mV 90mV ± 30mV 10mV ≈ 1mA
4a		Leading edge vernier CCW leading edge vernier CW ( $I_{SUM} \approx$ voltage across A4 R174 divided by 13,3 ohm)		
4b		Leading edge vernier CCW leading edge vernier CW ( $I_{LE} \approx$ voltage across A4 L21 divided by R <sub>L21</sub> ohm)		
4c		Leading edge vernier CCW leading edge vernier CW ( $I_{TE} \approx$ voltage across A4 L20 divided by R <sub>L20</sub> ohm)		
4d	B	Leading edge vernier CCW	I <sub>DR</sub>	285mV ± 30mV
		(For this measurement, connect collector of A5 Q58 via approx 510 Ω to ground.) leading edge vernier CW	I <sub>DR</sub>	20mV + 10mV / - 5mV
		(For this measurement, connect collector of A5 Q58 via approx 510 Ω to ground.) ( $I_{DR} \approx$ voltage across A4 R180 divided by 38,3 ohm) (Value depends on A5 R142 - factory selected.)		10mV ≈ 1mA
4e	A, C	Rotating leading edge vernier from CW to CCW preadjust A5 R136  preadjust A5 R217	DIF I  DIF I	constant ΔU ± 20mV 100mV ≈ 1mA  minimum - 25mV ± 15mV

\*If Test Box is used





Table 5-16. (Continued)

Test No.	Class	Purpose	Selector setting	DVM reading	
11	B	<p>Amplitude vernier check: amplitude vernier CW (attenuator not in ECL-mode).</p> <p>amplitude vernier CCW (attenuator not in ECL-mode).</p> <p>attenuator in ECL-mode</p> <p>Scale factors:</p> <p>I<sub>V801</sub>, I<sub>V802</sub>:           5V ≈ 80mA I<sub>V40</sub>:                    5V ≈ 40mA I<sub>V</sub>:                        5V ≈ 200mA</p> <p>I<sub>V801</sub> ≈ V<sub>A5</sub> Q20 EMITTER-GND/5 ohm. I<sub>V802</sub> ≈ V<sub>A5</sub> Q21 EMITTER-GND/5 ohm. I<sub>V40</sub> ≈ V<sub>A5</sub> Q21 EMITTER-GND/10 ohm. I<sub>V</sub> ≈ I<sub>V801</sub> + I<sub>V802</sub> + I<sub>V40</sub></p>	<p>I<sub>V801</sub> I<sub>V802</sub> I<sub>V40</sub> I<sub>V</sub> I<sub>V801</sub> I<sub>V802</sub> I<sub>V40</sub> I<sub>V</sub> I<sub>V801</sub> I<sub>V802</sub> I<sub>V40</sub> I<sub>V</sub></p>	<p>0V + 0mV/-20mV 0V + 0mV/-20mV 0V + 0mV/-60mV 0V + 0mV/-80mV 3.4V ± 0.2V 2.1V ± 0.2V 3.4V ± 0.2V 2.87V ± 0.3V 3.35V ± 0.3V 1.35V ± 0.15V 3.4V ± 0.3V 2.55V ± 0.25V</p>	
Test No.	Class	Purpose	Selector setting	DVM reading	
12	C	<p>Pos pulse: tracking offset</p> <p>This adjustment (A5 R80, R81, R115) must be made with the whole instrument (see Table 5-23).</p>	<p>I<sub>POS A</sub> I<sub>POS B</sub></p>	<p>typ. 1.9/5.3V typ. 1.9/5.3V</p>	
13	B	<p>Ext dc-offset: ext offset on, vernier CCW + CW (not ECL)</p> <p>(can be measured at each of the 2 8082A pulse output jacks, which must be terminated by 50 ohm).</p> <p>in ECL position</p>	<p>I<sub>DC A</sub> I<sub>DC B</sub>  I<sub>DC A</sub> I<sub>DC B</sub></p>	<p>± 2.25V   ± 0.15V ± 2.25V   ± 0.15V  -0.45V   ± 50mV -0.45V   ± 50mV</p>	

## ADJUSTMENTS

Table 5-17. Power Supply

## STEP

1	8082A settings:	
	1 REPETITION RATE	250M-100M
	2 VERNIER	CCW
	3 NORM/DOUBLE	NORM
	4 DELAY	2n-5n
	5 VERNIER	CCW
	6 EXT INPUT LEVEL	middle
	7 MODE SWITCH	EXT TRIG
	8 WIDTH	2n-5n
	9 VERNIER	CCW
	10 TRANSITION TIME	1n-5n
	11 LEADING VERNIER	CCW
	12 TRAILING VERNIER	CCW
	13 AMPLITUDE	0.4-1
	14 AMPLITUDE	0.4-1
	15 AMP VERNIER	CW
	16 OFFSET VERNIER	middle
	17 OFFSET SWITCH	OFF
	19 NORM/COMPL	NORM
	20 NEG/POS SWITCH	NEG
	24 SLOPE POLARITY	POS
2	Set the DVM to auto-range and connect it between GND and the voltage TP's.	
3	Measure and adjust the following points:	
	TP + 10V	Adjust A2 R7 to + 10V $\pm$ 20mV
	TP - 5V	Adjust A2 R10 to - 5V $\pm$ 10mV
	TP - 10V	Adjust A2 R21 to - 10V $\pm$ 20mV
	TP - 25V	Adjust A2 R29 to - 25V $\pm$ 30mV

Table 5-18. Rep. Rate

## STEP

1	8082 settings:	
	3 DOUBLE /NORMAL	NORMAL
	4 DELAY	2n-5n
	5 VERNIER	CCW
	7 MODE SWITCH	NORM
	8 WIDTH	2n-5n
	9 VERNIER	CCW
	10 TRANSITION TIME	1n-5n
	11 LEADING VERNIER	CCW
	12 TRAILING VERNIER	CCW
	Counter Setting:	
	Sensitivity	1V
	Max. count rate	350 MHz
2	Measure and adjust the frequency as follows:	

8082A		COUNTER TIME BASE	ADJUST	RESULT
REP. RATE 1	VERNIER 2			
250M-100M	CCW	0.1ms	A3 R6	255 $\pm$ 0.5 MHz
100M-10M	CW	0.1ms	A3 R5	9.3 $\pm$ 0.1 MHz

A3 R6 affects highest rep rate only (CCW).

A3 R5 affects all ranges below and including 100M-10M (CW).

A3 R77 affects duty cycle at 100MHz (10MHz)

## ADJUSTMENTS

Table 5-19. Delay and Width (Verniers CW)

## STEP

1 8082A settings:

1 REPETITION RATE 10M-1M	
2 VERNIER	CW
4 DELAY	as required, but not 2n-5n
5 VERNIER	CW
8 WIDTH	as required, but not 2n-5n
9 VERNIER	CW

2 A4 R38 affects the delay in all ranges (except 2n-5n) when the vernier is CW. Range of values for A4 R38 is 100 k $\Omega$  upwards, increase in resistance increases delay. This adjustment is done at the factory.

5 Max width in all ranges (except 2n-5n) can be increased when the vernier is CW) by increasing A4 R88. Range of values is 100 k $\Omega$  upwards. This adjustment is done at the factory.

## ADJUSTMENTS

Table 5-20. Amplitude, Risetime, Overshoot (1n-5n Transition Time)

1 8082A settings:

1 REPETITION RATE	10M-1M (VERNIER for 5 MHz)
3 DOUBLE/NORM	NORM
7 MODE SWITCH	EXT WIDTH
8 WIDTH	SQUARE WAVE
10 TRANSITION TIME	1n-5n, VERNIERS CW
13 AMPLITUDE	2.0-5.0
14 AMPLITUDE	2.0-5.0
18,21 Both outputs must be terminated by 50 ohms at all times	
20 NEG/POS SWITCH	NEG

2 Verify tests 8, 10 in Table 5-16.

3 Adjust A4 R214, R232 for max output voltages  $> 5.15V$  and  $< 5.35V$ , then optimize settings for acceptable pulse shape.

**NOTE:** A5 R210 may be re-adjusted if difficulty is experienced in reaching the maximum amplitude with the A4 R214/232 adjustment ( $- 7.2V$  to  $- 6.7V$  is permissible; 100mV variation means about 60mV output amplitude variation). Increasing voltage in negative direction increases the overshoot.

See Table 5-16 test 10.

4 Re-adjust A4 R214 for a baseline shift  $> 30mV$  and  $< 70mV$  (worst case: both channels, norm and compl, ampl. vernier CW, neg. pulse). Observe baseline while rotating amplitude vernier between CW and CCW. The best setting has been found to be  $- 40mV$ .

*affect perturbation on pulse (adj. for best perturbation and knee in pulse at min vernier)*

5 Set amplitude vernier CCW (i.e. 2V output). If a hook is apparent at the start of the positive going edge, adjust A4 R214, then A4 R232, for an acceptable pulse shape. Repeat steps 3 and 4 adjust for best compromise.

6 Turn amplitude vernier CW and transition time verniers CCW. Adjust A4 R253 for  $-6.3 \pm 0.1V$  at R253 wiper (TP 16).

7 Set 8082A transition time to 1n-5ns LE-vernier CW. Select A5 R142 for a transition time  $> 6.5ns$  and  $< 7.5ns$  in the worst case of both edges.

**NOTE:** A5 R142 has possible values 1.87 K ... 3.01 K.

8 Verify tests 4, 8, 10 in Table 5-16.

Measure transition times, overshoot and ringing. LE-Vernier CCW.

**NOTE:**

- fast edges have greater overshoot and ringing than slower ones.
- positive output pulses will be slightly faster than negative ones.
- A4 R214, R232 also affect transition time and overshoot (but see steps 3, 4, 5 above).
- Transition times and overshoot are affected by the inductors (wires) parallel to A4 CR32, CR33. A 1-cm variation of wire length is allowed, corresponding to 30ps in transition time, 0.7 % absolute in overshoot.
- It is permissible to re-adjust  $U_{CIH}$  (Table 5-16 Test 8) in the range  $- 14.44V$  to  $- 14.51 V \pm 5mV$ , and  $U_{CIL}$  in the range  $- 14.78V$  to  $- 14.84 V \pm 5mV$ , without re-adjusting  $U_{CBH}$  and  $U_{CBL}$ .

This decreases the transition times by about 40ps and increases overshoot by about 1 % absolute compared with the values given in Table 5-16 Test 8. If these adjustments are made, repeat steps 3 to 5.

## ADJUSTMENTS

Table 5-21. Amplitude, Risetime, Overshoot  
(Slower Transition Times)

## STEP

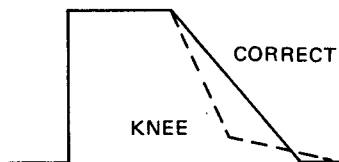
- 1 8082A settings: as previous table, except:
  - 1/2 REP RATE about 2 MHz
  - 10 TRANSITION TIME 5n-50n, VERNIERS CW
  - 13/14/15 AMPLITUDE max.
- 2 Verify tests 3b, 4e, 5, 6, 7, 8, 10 of Table 5-16.
- 3 Adjust A8 R16, R17 for max output voltage  $> 5.1V$  then optimize settings for acceptable pulse shape.
- 4 If possible, re-adjust A8 R16 for a baseline shift  $\approx -40mV$ , ampl. vernier CW (worst case: both channels, norm and compl).
- 5 Set amplitude vernier CCW (i.e. 2V output). If a hook is apparent at the start of the positive going edge, adjust A4 R16, then A4 R17, for an acceptable pulse shape. Repeat steps 3 and 4 and adjust for best compromise.
- 6 With max output voltage, and with transition time verniers CW, compare the output amplitudes (in both channels and for norm and compl. pulses) in the fastest transition time range with those in any of the slower ranges. If the pulse amplitudes are not within 100mV of each other, increase the smaller amplitude (step 3 of this, or previous, table).

Table 5-22. Pulse Shape and Transition Times

## STEP

- 1 8082A settings:
 

10 TRANSITION TIME	5n-50n
11 LEADING VERNIER	CCW
12 TRAILING VERNIER	CW
- 2 If trailing edge has a knee, adjust A5 R136, R217 for a constant slope.



- 3 Set leading edge vernier CW. Rotate trailing edge vernier, observing leading edge.  
Re-adjust A5 R136 for a constant leading edge slope.
- 4 Set trailing edge vernier CW. Rotate leading edge vernier observing trailing edge.  
Re-adjust A5 R136 for a constant trailing edge slope.  
(A 5% variance in slope is usual).
- 5 Increase rep. rate until waveform is triangular (may possibly be distorted). Verify that the amplitude decreases.
- 6 Re-adjust A5 R171, R172 for a clean triangular waveform.
- 7 Repeat steps 2 to 4.
- 8 Set both transition time verniers CW and adjust A5 R213 (230) for leading (trailing) edge times of 65ns. (This adjustment affects only the CW transition time of range 5n-50n and slower).
- 9 Repeat steps 2 to 8 if adjustment was made in step 8.

## ADJUSTMENTS

Table 5-23. Positive Pulse Baseline

## STEP

- 1 Set 8082A for positive output pulses.
- 2 Observe right channel baseline shift while rotating amplitude vernier. Adjust A5 R81 for minimum baseline shift (a fixed dc offset may be present).
- 3 Adjust A5 R80 for zero dc offset in right channel.
- 4 Adjust A5 R115 for zero dc offset in left channel.
- 5 Carry out septs 1 to 4 for normal and compl modes, with transition times of 1n-5n and 5n-50n, and with transition time verniers CCW and CW. Re-adjust A5 R80, R81, R115 for the best compromise. Baseline shift should not exceed  $\pm 100$ mV in the 5-2V attenuator range.

Table 5-24. Width

## STEP

- 1 8082A settings:
 

1 REP RATE	ABOUT 20 MHz
8 WIDTH	2-5ns
9 WIDTH VERNIER	CW
10 TRANSITION TIME	1-5ns
11 VERNIER	CCW
- 2 Set A4 R43 for a 7ns pulse width.
- 3 Set 8082A to max rep rate, min delay, min width. Set A4 R240 for a pulse width of about 2.00 ns or about 50 % duty cycle. Optimize adjustments for the worst case of norm/compl. right/left channel.
- 4 Set pulse width selector to SW. Observe pulse amplitude and baseline shift while varying rep rate between 250 MHz and 100 MHz. ( $\pm 3$  % variance is usual).

Table 5-25. Double Pulse

## STEP

- 1 8082A settings:
 

1, 2 REP RATE	10 MHz approx
8, 9 WIDTH	Min
3 DOUBLE PULSE/NORM	DOUBLE PULSE
4 DELAY	5n-50n
5 VERNIER	CCW
- 2 Verify pulses are equal in width. First pulse width can be adjusted by selecting A4 R42 values in the range 1.6 to 10 k $\Omega$ . This adjustment is done at the factory.
- 3 If A4 R42 is changed, repeat tables 5-24 and 5-25.

Table 5-26. Gate

## STEP

- 1 8082A settings:
 

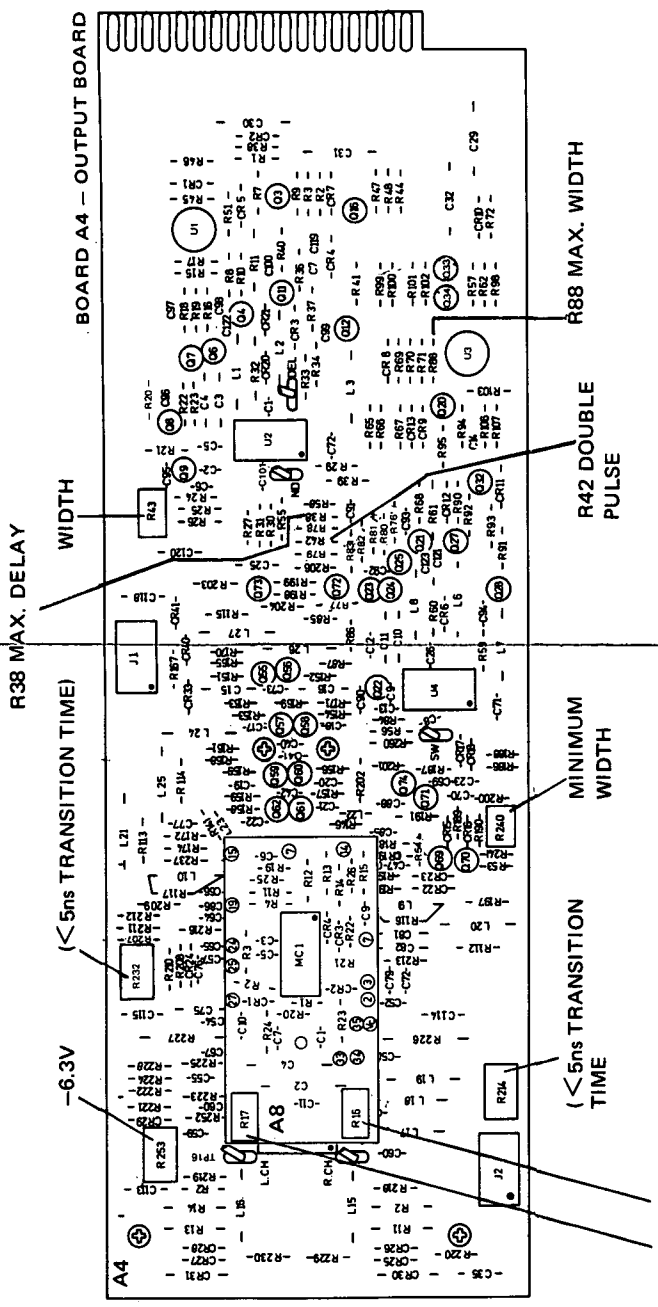
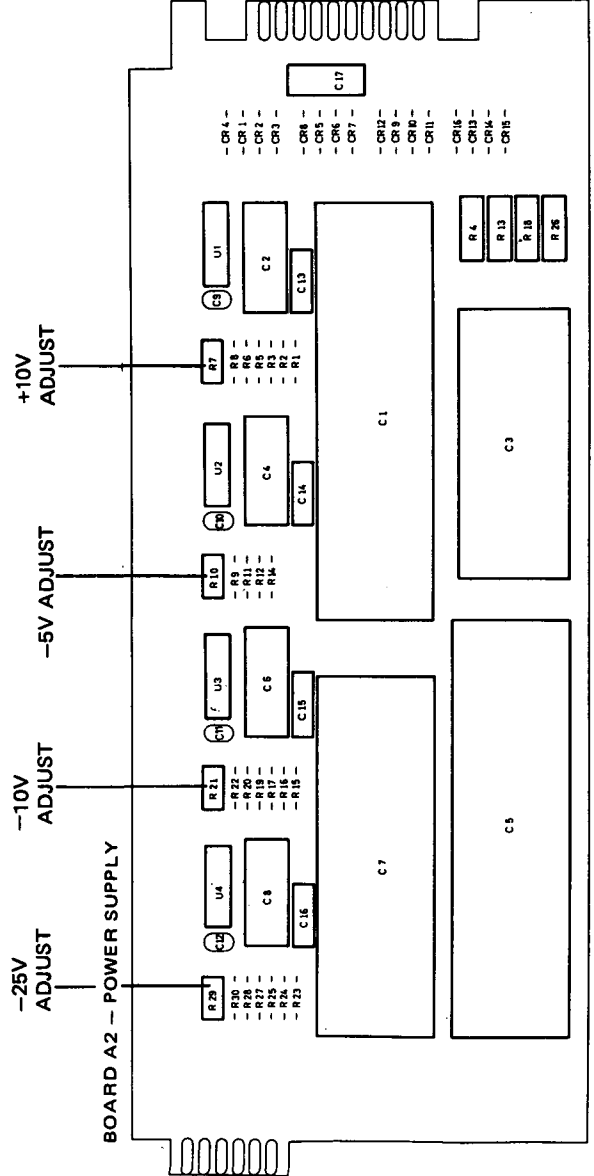
1 REP RATE	Max
8, 9 WIDTH	Min
7 MODE SWITCH	GATE
- 2 Drive 8082A from a 5 MHz, 50 % duty cycle source (approx values).
- 3 Adjust A3 R87 for a correct first pulse.
- 4 Set the 8082A to SQUARE WAVE.
- 5 Re-adjust A3 R87 and A4 R240, if necessary. (If re-adjusted, verify step 3).
- 6 If A3 R87 adjustment is not successful, connect resistor between A3 J3 (SW output, A3 U2 pin 7) and -10V (at A3 C13). Values lie in range 1.2 k $\Omega$  to 5.6 k $\Omega$ .  
**NOTE:** For instruments with serial numbers 1410G00270 and below: disconnect ground leads at A4 Q69 and Q70 of the co-ax cables which link the width circuit (A4 U4) to the level shifter (A4 Q69, Q70).
- 7 Repeat steps 2 to 5. Set ampl. vernier (15) CCW (i.e. 2V). Vary the frequency and duty cycle of the gate source and observe the output, from both channels of the 8082A, while varying the frequency (from 250 MHz -100 MHz) in the following modes: NEG, POS, NORM, COMP and SQUAREWAVE, PULSE. The pulse fluctuation should be less than 5 % while the pulse width should not exceed 2.3 ns.

## SAFETY CHECK

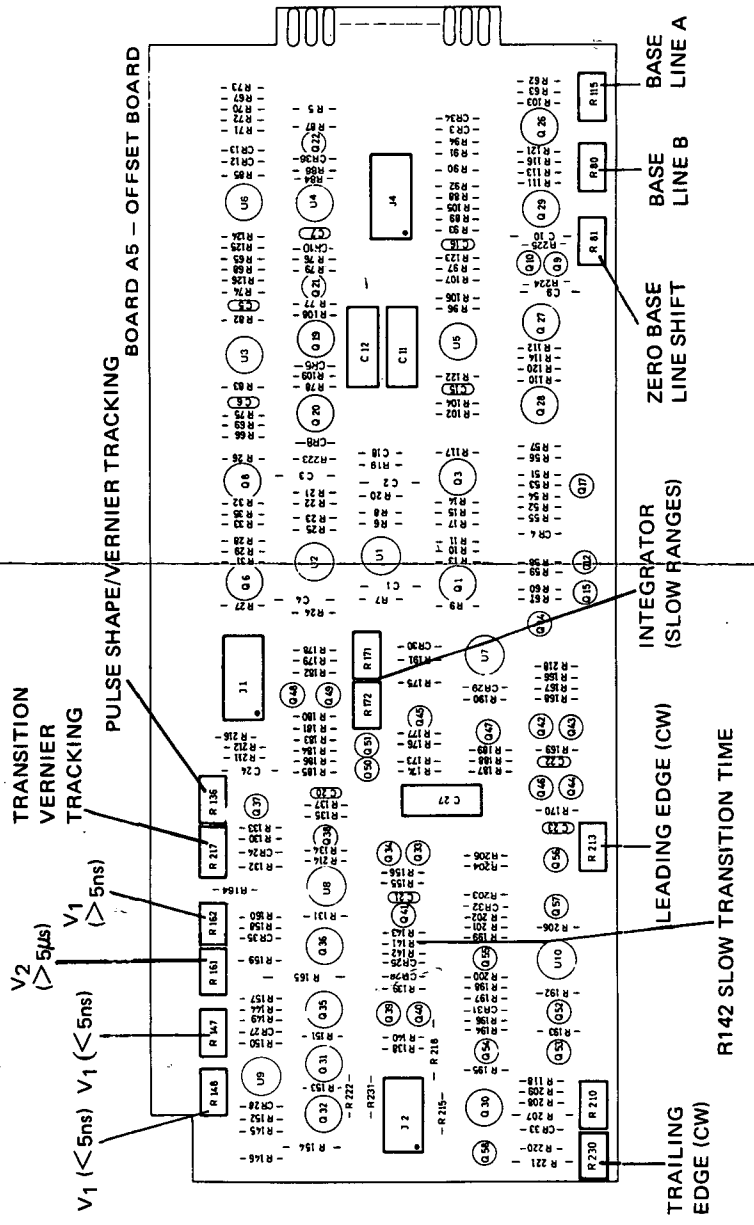
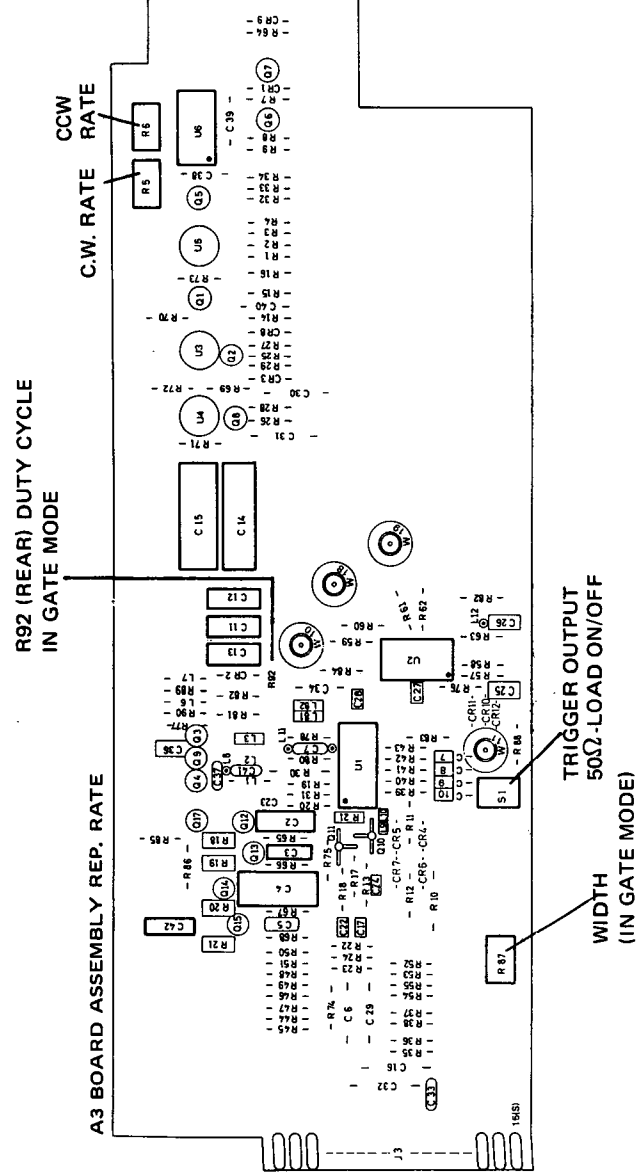
Table 5-27. Safety Check

- 1 Disconnect power cord from line, visually inspect interior for any sign of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine cause and remedy.
- 2 Check resistance from 8082A cabinet to ground pin on power plug with suitable ohmmeter. The reading must be less than one ohm. Flex the power cord while making this measurement to detect any intermittent discontinuity. Check internal ground connections on boards and frame. Also check resistance of any front or rear panel ground terminals marked  $\perp$ .
- 3 Check resistance from 8082A cabinet to line and neutral (tied together) with the power switch on and the power source disconnected. The minimum acceptable resistance is two megohms. Replace any component which results in a failure or refer to production Memo or Service Note issued by product division for alternate action.
- 4 Check line fuse to verify that the proper value is installed.
- 5 Check that the plastic safety cover is installed inside the base of the 8082A, below the line fuse.
- 6 Check that all coaxial and flat cables inside the 8082A are properly connected. Check that all boards and the heatsink on the chassis are properly connected. Make sure that board A8 is properly connected to board A4.
- 7 Inform Hewlett-Packard (internally, the responsible product division) of any repeated failures in the above tests or any other safety features.





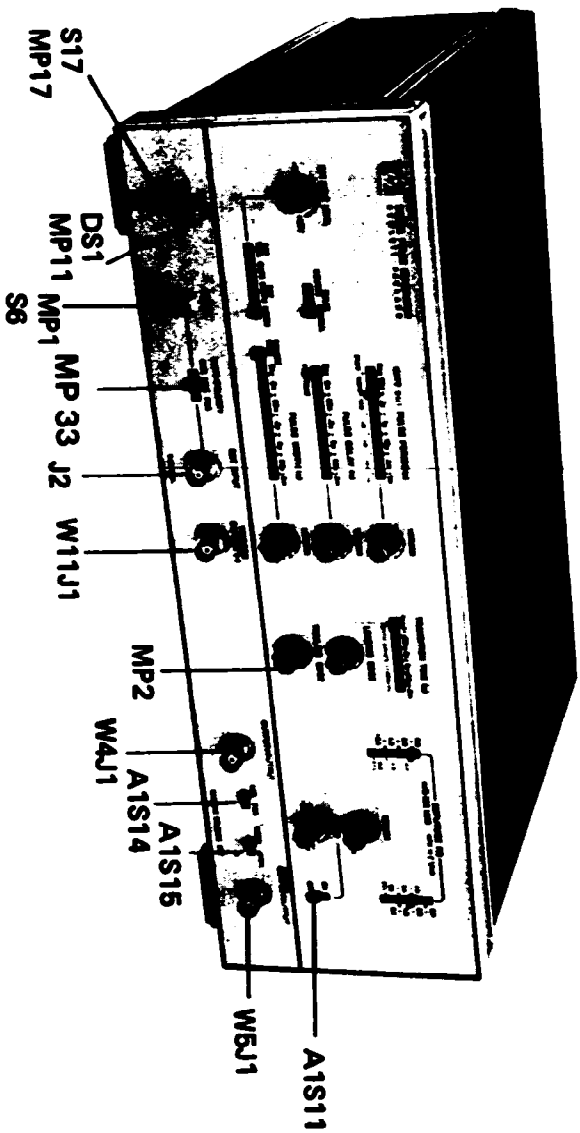
INTEGRATOR BUFFER



ANT NORD  
590  
2023  
2462

Refer to Figure 6-1 for board location

Figure 5-2. Location of adjustment controls



Board A1 - Mother Board Layout

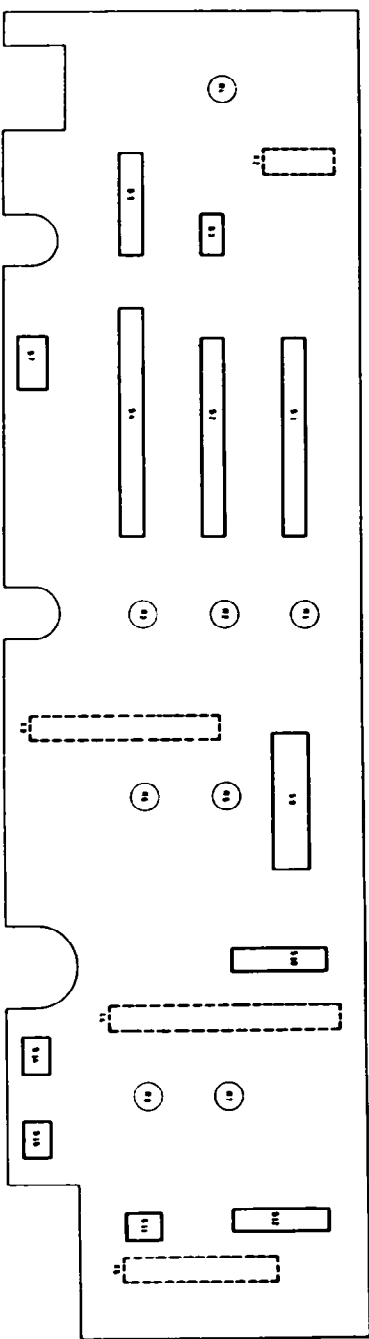


Figure 6-1. Mainframe parts identification

DIAGRAMS AND REPLACEABLE PARTS

6-1 INTRODUCTION

6-2 This section contains the circuits, component location diagrams and the lists of replaceable parts. Waveforms shown with the circuits are included for guidance only and failure to observe identical results should not be automatically taken as indication of a fault. Tables 6-1 and 6-2 provide information relating to the replaceable parts lists and the circuit diagrams.

6-3 ORDERING INFORMATION

6-4 General

6-5 The replaceable parts tables list parts in alpha-numerical order of their reference designators and indicate the description and HP stock number of each part, together with any applicable notes.

6-6 To order a replacement part, address order or enquiry either to your authorized Hewlett-Packard

sales representative or to:

CUSTOMER SERVICE  
Hewlett-Packard Company,  
333 Logue Avenue,  
Mountain View, California 94040

or, in Western Europe, to:

Hewlett-Packard (Schweiz) SA  
Rue du Bois-du-Lan 7  
1217 Meyrin 2  
Geneva

6-7 Specify the following information for each part:

- a) Model and complete serial number of instrument.
- b) Hewlett-Packard stock number.
- c) Circuit reference stock number.
- d) Description

To order a part not listed, give a complete description of the part and include its function and location.

Table 6-1. Component Designators

A	= assembly	U	= micro-circuit
B	= motor	P	= plug
BT	= battery	Q	= transistor
C	= capacitor	R	= resistor
CP	= coupler	RT	= thermistor
CR	= diode	S	= switch
DL	= delay line	T	= transformer
DS	= lamp	TB	= terminal board
F	= fuse	TP	= test point
FL	= filter	V	= vacuum tube, neon bulb, photocell, etc.
I:R	= heater	VR	= voltage regulator
J	= jack/connector	W	= cable
K	= relay	X	= socket
L	= inductor	Y	= crystal
M	= meter		

Components mounted on an assembly are identified by prefixing the component reference designator by the assembly designator. Thus, for example, A4CR9 is diode 9 on assembly 4.

Designators of components mounted on the frame receive no prefix.

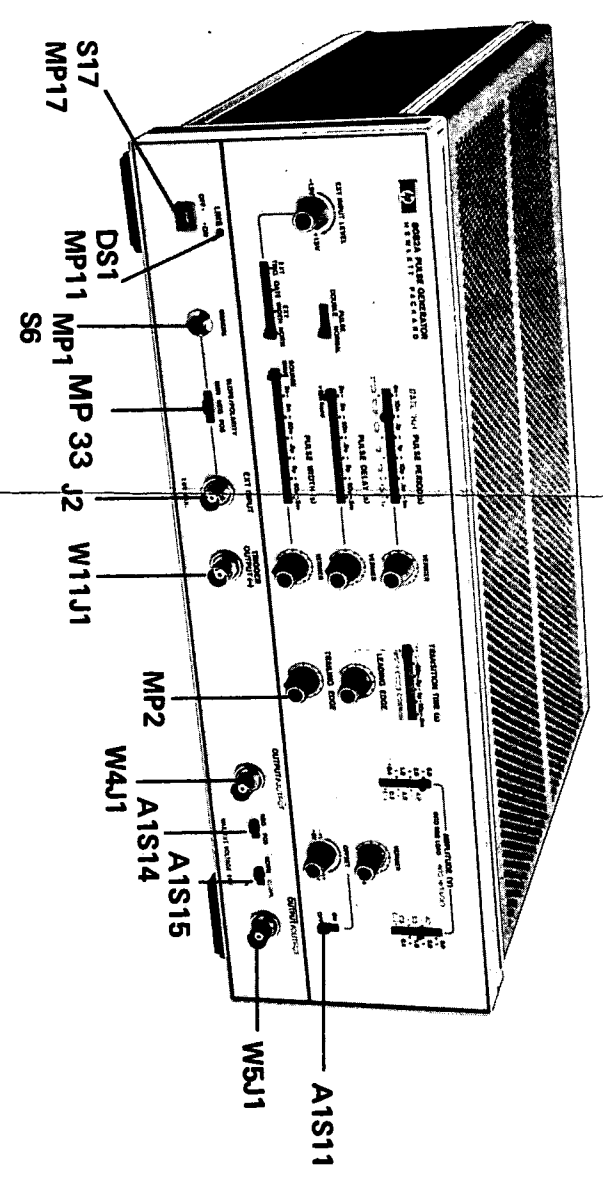
Table 6-2. Manufacturers' Code Numbers and Abbreviations for Parts List

Abbreviations

A	AMPERE(S)	H	HENRY(IES)	NPN	NEGATIVE POSITIVE	RWV	REVERSE WORKING
ASSY	ASS'Y	HP	MERCURY	NSR	NEGATIVE	S-B	VOLTAGE
BD	BOARD(S)	HZ	HEWLETT PACKARD	OBD	NOT SEPARATELY	SCR	SLOW BLOW
BH	BINDER HEAD	IF	HERTZ	OH	REPLACEABLE	SE	SILICON CONTROLLED
BP	BANDPASS	IMPG	INTERMEDIATE FREQ	OX	ORDER BY	SECT	RECTIFIER
C	CENT(10 <sup>2</sup> )	INCD	INCANDESCENT	PC	DESCRIPTION	SI	SELENIUM
CAR	CARBON	INCL	INCLUDE(S)	PHL	OVAL HEAD	SECT	SECTION(S)
CCW	COUNTERCLOCKWISE	INS	INSULATION(ED)	PIV	OXIDE	SIL	SECTION(S)
CER	CERAMIC	INT	INTERNAL	P	PEAK	SIL	SILICON
CMO	CABINET MOUNT ONLY	K	KILO (10 <sup>3</sup> )	PC	PRINTED (ETCHED)	SL	SILVER
COAX	COAXIAL	KG	KILOGRAM	PF	CIRCUIT(S)	SP	SLIDE
COEF	COEFFICIENT	LB	POUND(S)	PF	PICOFARADS	SPL	SINGLE POLE
COMP	COMPOSITION	LH	LEFT HAND	PHL	PICOFARADS	SPL	SPECIAL
CONN	CONNECTOR(S)	LOG	LINEAR TAPER	PIV	PHILLIPS	ST	SINGLE THROW
CRT	CATHODE-RAY TUBE	LPF	LOGARITHMIC TAPER	PNP	PEAK INVERSE	STD	STANDARD
CW	CLOCKWISE	LVR	LOW-PASS FILTER(S)	P/O	VOLTAGE(S)	TA	TANTALUM
D	DECI (10 <sup>-1</sup> )	M	LEVER	PORC	POSITIVE	TD	TIME DELAY
DEPC	DEPOSITED CARBON	MEG	MILLI (10 <sup>-3</sup> )	POT	POSITIVE	TFL	TEFLON
DP	DOUBLE POLE	MEG	MEGA (10 <sup>6</sup> )	POT	POSITIVE	TGL	TOGGLE
DT	DOUBLE THROW	MET FILM	METAL FILM	POS	POSITION(S)	THYR	THYRISTOR
ELECT	ELECTROLYTIC	MET OX	METAL OXIDE	P-P	POTENTIOMETER(S)	TI	TITANIUM
ENCAP	ENCAPSULATED	MFR	MANUFACTURER	P-P	PEAK TO PEAK	TNLDIO	TUNNEL DIODE(S)
EXT	EXTERNAL	MINAT	MINIATURE	PRGM	PROGRAM	TOL	TOLERANCE
F	FARAD(S)	MOM	MOMENTARY	PS	POLYSTYRENE	TRIM	TRIMMER
FET	FIELD EFFECT	MTG	MOUNTING	PWV	PEAK WORKING	U	MICRO (10 <sup>-6</sup> )
FH	FLAT HEAD	MY	MYLAR	RECT	VOLTAGE	V	VOLTS
FIL H	FILLISTER HEAD	N	NANO (10 <sup>-9</sup> )	RF	RECTIFIER(S)	VAR	VARIABLE
FXD	FIXED	N/C	NORMALLY CLOSED	RFI	RADIO FREQUENCY	VDCW	DC WORKING VOLT(S)
G	GIGA (10 <sup>9</sup> )	NE	NEON	RH	RADIO FREQUENCY	W	WATT(S)
GE	GERMANIUM	N/O	NORMALLY OPEN	RH	INTERFERENCE	W/	WITH
GL	GLASS	NOP	NEGATIVE POSITIVE	RMS	INTERFERENCE	W/	WORKING INVERSE
GRD	GROUND		ZERO (ZERO TEMPERATURE COEFFICIENT)	RMO	ROUND HEAD	WIV	VOLTAGE
				RMS	OR	W/O	WITHOUT
					RIGHT HAND	WW	WIREWOUND
					RACK MOUNT ONLY		
					ROOT MEAN SQUARE		

Manufacturer's Code Numbers

REF. NO.	MANUFACTURER NAME	ADDRESS	ZIP CODE
G0005	DEUTSCHE VITRUM GMBH L CO	GERMANY	92009
00501	ILLUMINATED PRODUCTS INC	ANAMER CA	17109
00779	APP INC	HARRISBURG PA	17109
01221	ALLEN-BRADLEY CO SERICOND CPMT DIV	MILWAUKEE WI	53212
01295	TEXAS INSTR INC	DALLAS TX	75222
02114	PERDUQUE CORP	SOMERSET NJ	08876
02115	ALA COND SOLID STATE DIV	SOMERSET NJ	08876
02116	ADONOR INC	WHIPPANY NJ	07981
02117	ADONOR ELECTRONIC PRODUCTS	WHIPPANY NJ	07981
02118	ADONOR ELECTRONIC PRODUCTS	WHIPPANY NJ	07981
02119	ADONOR ELECTRONIC PRODUCTS	WHIPPANY NJ	07981
02120	ADONOR ELECTRONIC PRODUCTS	WHIPPANY NJ	07981
02121	ADONOR ELECTRONIC PRODUCTS	WHIPPANY NJ	07981
02122	ADONOR ELECTRONIC PRODUCTS	WHIPPANY NJ	07981
02123	ADONOR ELECTRONIC PRODUCTS	WHIPPANY NJ	07981
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02198	ADONOR ELECTRONIC PRODUCTS	WHIPPANY NJ	07981
02199	ADONOR ELECTRONIC PRODUCTS	WHIPPANY NJ	07981
02200	ADONOR ELECTRONIC PRODUCTS	WHIPPANY NJ	07981



Board A1 - Mother Board Layout

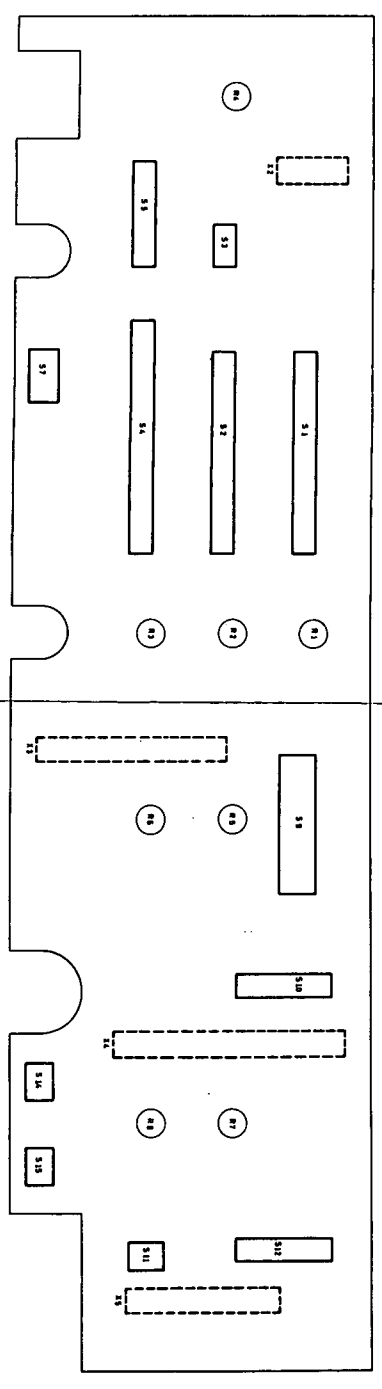


Figure 6-1. Mainframe parts identification

## DIAGRAMS AND REPLACEABLE PARTS

## 6-1 INTRODUCTION

6-2 This section contains the circuits, component location diagrams and the lists of replaceable parts. Waveforms shown with the circuits are included for guidance only and failure to observe identical results should not be automatically taken as indication of a fault. Tables 6-1 and 6-2 provide information relating to the replaceable parts lists and the circuit diagrams.

## 6-3 ORDERING INFORMATION

## 6-4 General

6-5 The replaceable parts tables list parts in alpha-numerical order of their reference designators and indicate the description and HP stock number of each part, together with any applicable notes.

6-6 To order a replacement part, address order or enquiry either to your authorized Hewlett-Packard

sales representative or to:

CUSTOMER SERVICE  
Hewlett-Packard Company,  
333 Logue Avenue,  
Mountain View, California 94040

or, in Western Europe, to:

Hewlett-Packard (Schweiz) SA  
Rue du Bois-du-Lan 7  
1217 Meyrin 2  
Geneva

6-7 Specify the following information for each part:

- Model and complete serial number of instrument.
- Hewlett-Packard stock number.
- Circuit reference stock number.
- Description

To order a part not listed, give a complete description of the part and include its function and location.

Table 6-1. Component Designators

A	= assembly	U	= micro-circuit
B	= motor	P	= plug
BT	= battery	Q	= transistor
C	= capacitor	R	= resistor
CP	= coupler	RT	= thermistor
CR	= diode	S	= switch
DL	= delay line	T	= transformer
DS	= lamp	TB	= terminal board
F	= fuse	TP	= test point
FL	= filter	V	= vacuum tube, neon bulb, photocell, etc.
I:R	= heater	VR	= voltage regulator
J	= jack/connector	W	= cable
K	= relay	X	= socket
L	= inductor	Y	= crystal
M	= meter		

Components mounted on an assembly are identified by prefixing the component reference designator by the assembly designator. Thus, for example, A4CR9 is diode 9 on assembly 4.

Designators of components mounted on the frame receive no prefix.

Table 6-2. Manufacturers' Code Numbers and Abbreviations for Parts List Abbreviations

A	AMPERE(S)	H	HENRY(IES)	NPN	NEGATIVE POSITIVE	RWV	REVERSE WORKING
ASSY	ASS' MRL Y	HP	HERTZ	NSR	NOT SEPARATELY REPLACEABLE	S-B	VOLTAGE
BD	BOARD(S)	HZ	HERTZ	NSR	NOT SEPARATELY REPLACEABLE	SCR	SLOW BLOW SILICON CONTROLLED RECTIFIER
BH	BINDER HEAD	IF	INTERMEDIATE FREQ	OBD	ORDER BY DESCRIPTION	SE	SELENIUM SECOND(S)
BP	BANDPASS	IMPG	IMPRGNATED	OH	OVAL HEAD	SECT	SECTION(S)
C	CENTI(10 <sup>-2</sup> )	INCD	INCANDESCENT	OX	OXIDE	SI	SILICON SILVER
CAR	CARBON	INCL	INTERNAL	P	PEAK	SIL	SLIDE
CCW	COUNTERCLOCKWISE	INT	INTERNAL	PC	PRINTED (ETCHED)	SP	SINGLE POLE
CER	CERAMIC	K	KILO(10 <sup>3</sup> )	PC	PRINTED (ETCHED)	SPL	SPECIAL
CMO	CABINET MOUNT ONLY	KG	KILOGRAM	PF	PICOFARADS	ST	SINGLE THROW STANDARD
COAX	COAXIAL	LB	POUND(S)	PHL	PHILLIPS	STD	STANDARD
COEF	COEFFICIENT	LH	LEFT HAND	PIV	PEAK INVERSE	TA	TANTALUM
COMP	COMPOSITION	LIN	LINEAR TAPER	PNP	VOLTAGE(S)	TD	TIME DELAY
CONN	CONNECTOR(S)	LOG	LOGARITHMIC TAPER	P/O	POSITIVE NEGATIVE	TFL	TEFLON
CRT	CATHODE-RAY TUBE	LPF	LOWPASS FILTER(S)	PORC	PORCELAIN	TGL	TOGGLE
CW	CLOCKWISE	LVR	LEVER	POT	POTENTIOMETER(S)	TI	TI TUNNEL DIODE(S)
D	DECI(10 <sup>-1</sup> )	M	MILLI(10 <sup>-3</sup> )	POT	POTENTIOMETER(S)	TOL	TOLERANCE
DEPC	DEPOSITED CARBON	MEG	MEGA(10 <sup>6</sup> )	P-P	PEAK-TO-PEAK	TRIM	TRIMMER
DP	DOUBLE POLE	MET FILM	METAL FILM	PRGM	PROGRAM	U	MICRO(10 <sup>-6</sup> )
DT	DOUBLE THROW	MET OX	METAL OXIDE	PS	POLYSTYRENE	V	VOLTS
ELECT	ELECTROLYTIC	MINAT	MINIATURE	PWV	PEAK WORKING VOLTAGE	VAR	VARIABLE
ENCAP	ENCAPSULATED	MOM	MOMENTARY	RECT	RECTIFIER(S)	VDCW	DC WORKING VOLT(S)
EXT	EXTERNAL	MTG	MOUNTING	RF	RADIO FREQUENCY	W	WATT(S)
F	FARAD(S)	MY	MYLAR	RFI	RADIO FREQUENCY INTERFERENCE	W/	WITH
FET	FIELD EFFECT TRANSISTOR(S)	N	NANO(10 <sup>-9</sup> )	RH	ROUND HEAD	WIV	WORKING INVERSE
FH	FLAT HEAD	N/C	NORMALLY CLOSED	RMS	ROOT MEAN SQUARE	W/O	WITHOUT
FIL H	FILLISTER HEAD	NE	NEON	RMO	RACK MOUNT ONLY	WW	WIREWOUND
FXD	FIXED	N/O	NORMALLY OPEN	RMS	ROOT MEAN SQUARE		
G	GIGA(10 <sup>9</sup> )	NOP	NEGATIVE POSITIVE ZERO (ZERO TEMPERATURE COEFFICIENT)				
GE	GERMANIUM						
GL	GLASS						
GRD	GROUND						

Manufacturer's Code Numbers

REF. NO.	MANUFACTURER NAME	ADDRESS	ZIP CODE
G0005	DEUTSCHE VITRUM GMBH & CO	GERMANY	92003
00501	ILLUMINATED PRODUCTS INC	ANAPHEER CA	92109
00774	AMP INC	HARRISBURG PA	17109
01121	ALLEN-BRADLEY CO	MILWAUKEE WI	53212
01295	TEXAS INSTR INC	DALLAS TX	75212
02114	FLUOROCUBE CORP	SAUGERVILLE OH	44877
02125	ACA CORP	SAUGERVILLE OH	44877
02126	ADT ELECTRONIC CORP	PHILADELPHIA PA	19104
02127	ADT ELECTRONIC CORP	PHILADELPHIA PA	19104
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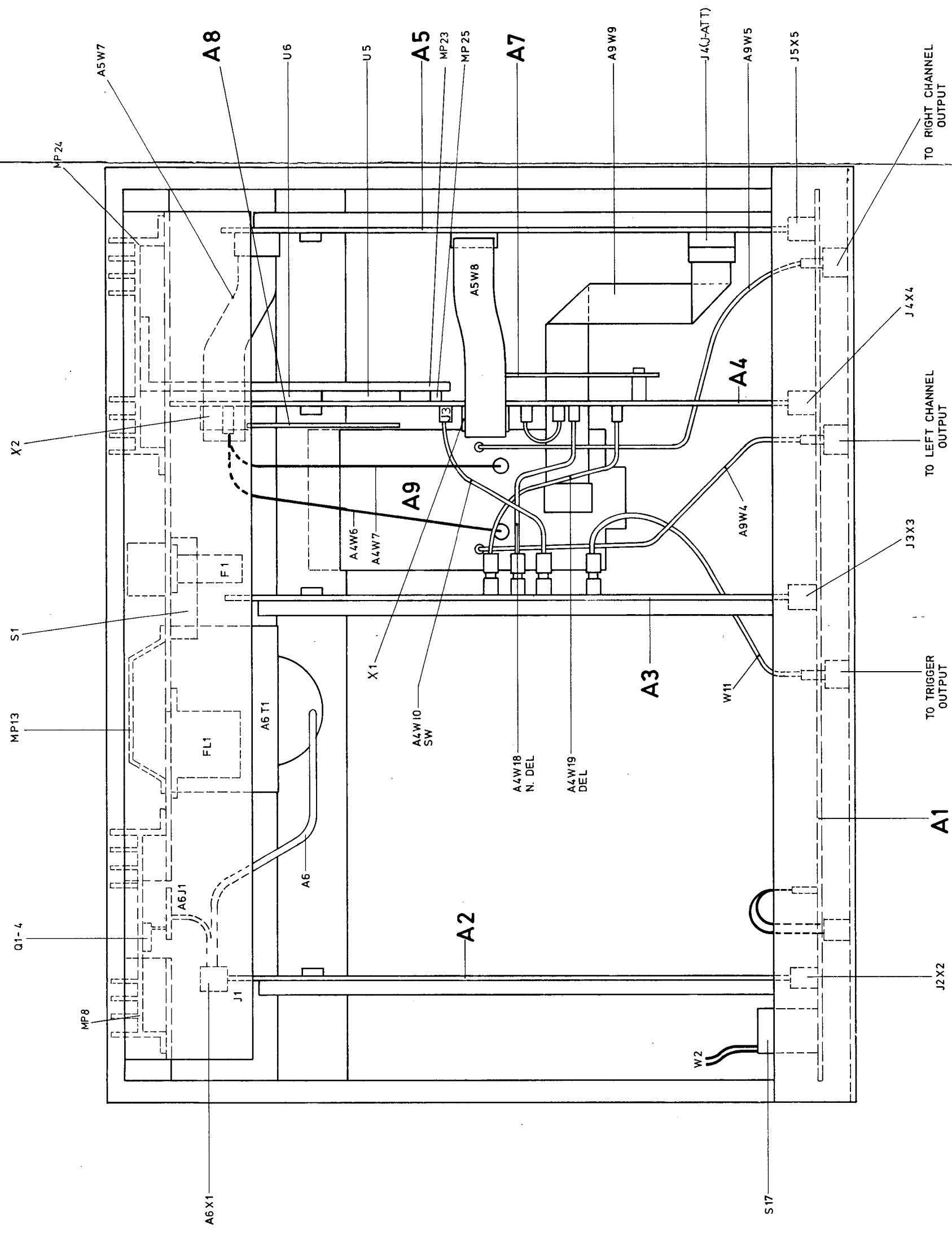


Figure 6-1. (cont'd)

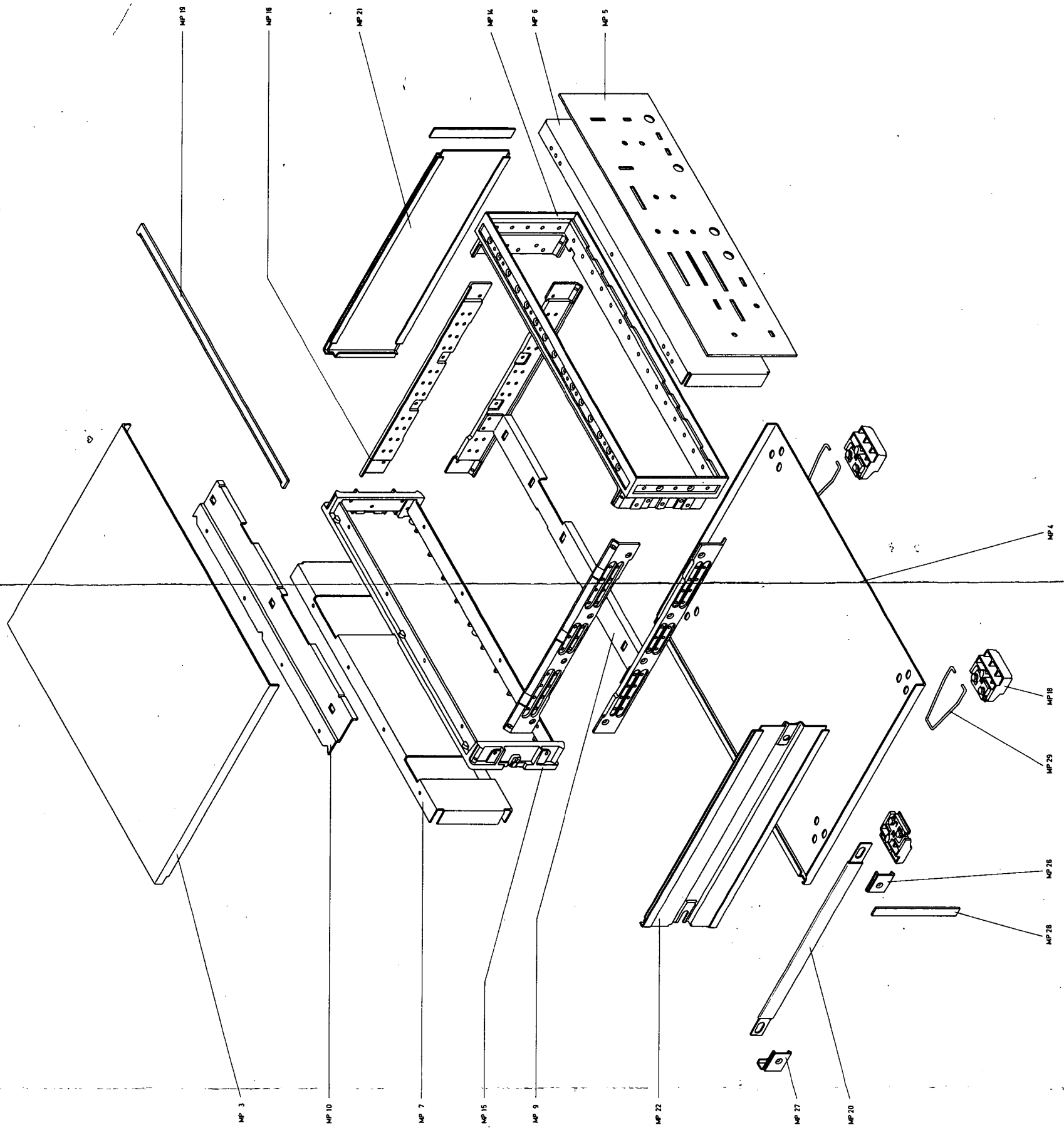


Figure 6-1. (cont'd)





Table 6-3. Replaceable Parts

REFERENCE DESIGNATOR	C H-P PART D NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C H-P PART D NUMBER	DESCRIPTION
A3	C30	C-F 10UF 20V	A3	R10	R-F 75 1% .25W F
A3	C31	C-F 10UF 20V	A3	R11	R-F 750 1% .125W
A3	C32	C-F 6.8UF 35V 1A	A3	R12	R-F 750 1% .125W
A3	C34	C-F 1UF 35V	A3	R13	R-F 205 1% .125W
A3	C36	C-F .010UF 20%	A3	R14	R-F 5.1K1%
A3	C37	C-F .010UF 20%	A3	R15	R-F 3.48K 1%
A3	C38	C-F 1UF 35V	A3	R16	R-F 5.1K1%
A3	C39	C-F 1UF 35V	A3	R17	R-F 750 1% .125W
A3	C40	C-F 1UF 35V	A3	R18	R-F 51.1 1%
A3	C41	C-F .01UF CER	A3	R19	R-F 51.1 1%
A3	C42	C-F 22UF 15V	A3	R20	R-F 51.1 1%
A3	CR1	DIO GE 25V .1A	A3	R21	R-F 464 1% .125W
A3	CR2	DIO SI .05A 30V	A3	R22	R-F 82.5K1%
A3	CR4	DIO SI .05A 30V	A3	R23	R-F 825 1% .125W
A3	CR5	DIO SI .05A 30V	A3	R24	R-F 3.83K1%
A3	CR6	DIO SI .05A 30V	A3	R25	R-F 402 1% .125W
A3	CR7	DIO SI .05A 30V	A3	R26	R-F 402 1% .125W
A3	CR9	DIO GE 25V .1A	A3	R27	R-F 332 1% .125W
A3	CR10	DIO SI .05A 30V	A3	R28	R-F 332 1% .125W
A3	CR11	DIO SI .05A 30V	A3	R29	R-F 19.6K 1% .125W
A3	CR12	DIO SI .05A 30V	A3	R30	R-F 162 1% .25W
A3	J1	JACK RECEPT STRAI	A3	R31	R-F 383 1% .125W
A3	J2	JACK RECEPT STRAI	A3	R32	R-F 10K1% .125W
A3	J3	JACK RECEPT STRAI	A3	R33	R-F 3.01K1%
A3	J4	JACK RECEPT STRAI	A3	R34	R-F 3.01K1%
A3	L1	COIL MOLDED CHOK	A3	R35	R-F 681 1% .125W
A3	L2	INDUCTANCE 2BEAD	A3	R36	R-F 365 1% .125W
A3	L3	INDUCTANCE 2BEAD	A3	R37	R-F 681 1% .125W
A3	L4	INDUCTANCE 2BEAD	A3	R38	R-F 365 1% .125W
A3	L5	INDUCTANCE 2BEAD	A3	R39	R-F 51.1 1%
A3	L6	COIL MOLDED CHOK	A3	R40	R-F 51.1 1%
A3	L7	COIL MOLDED CHOK	A3	R41	R-F 51.1 1%
A3	L8	FERRITE BEAD	A3	R42	R-F 51.1 1%
A3	L9	FERRITE BEAD	A3	R43	R-F 100 1% .125W
A3	L10	FERRITE BEAD	A3	R44	R-F 10K1% .125W
A3	L11	FERRITE BEAD	A3	R45	R-F 1K1% .125W F
A3	L12	FERRITE BEAD	A3	R46	R-F 10K1% .125W
A3	L13	COIL-CHOKE .22UH	A3	R47	R-F 1K1% .125W F
A3	Q1	XSTR SI 2N3904	A3	R48	R-F 10K1% .125W
A3	Q2	XSTR SI 2N3906	A3	R49	R-F 1K1% .125W F
A3	Q3	XSTR SI 2N3906	A3	R50	R-F 10K1% .125W
A3	Q4	XSTR SI 2N3906	A3	R51	R-F 1K1% .125W F
A3	Q5	XSTR SI 2N3904	A3	R52	R-F 51.1 1%
A3	Q6	XSTR SI 2N3904	A3	R53	R-F 274 1% .125W
A3	Q7	XSTR SI 2N3904	A3	R54	R-F 51.1 1%
A3	Q8	XSTR SI 2N3904	A3	R55	R-F 274 1% .125W
A3	Q9	XSTR SI 2N3904	A3	R56	R-F 51.1 1%
A3	Q10	TRANSISTOR	A3	R57	R-F 3.01K1%
A3	Q11	TRANSISTOR	A3	R58	R-F 1.96K1%
A3	Q12	XSTR SI 2N3906	A3	R59	R-F 51.1 1% .25W
A3	Q13	XSTR SI 2N3906	A3	R60	R-F 51.1 1%
A3	Q14	XSTR SI 2N3906	A3	R61	R-F 200 1% .125W
A3	Q15	XSTR SI 2N3906	A3	R62	R-F 100 1% .125W
A3	Q17	XSTR SI 2N3904	A3	R63	R-F 464 1% .125W
A3	R1	R-F 28.7K1%	A3	R64	R-F 1K1% .125W F
A3	R2	R-F 1K1% .125W F	A3	R65	R-F 820K5% .25W
A3	R3	R-F 19.6K 1% .125W	A3	R66	R-F 820K5% .25W
A3	R4	R-F 3.65K1%	A3	R67	R-F 820K5% .25W
A3	R5	R-VAR 5K 10%	A3	R68	R-F 820K5% .25W
A3	R6	R-VAR 5K 10%	A3	R69	R-F 10K1% .125W
A3	R7	R-F 1K1% .125W F	A3	R70	R-F 681 1% .125W
A3	R8	R-F 3.01K1%	A3	R71	R-F 10K1% .125W
A3	R9	R-F 3.01K1%	A3	R72	R-F 681 1% .125W
A3	R9	R-F 3.01K1%	A3	R73	R-F 10K1% .125W
A3	R9	R-F 3.01K1%	A3	R74	R-F 154 1% .125W
A3	R9	R-F 3.01K1%	A3	R75	R-F 1.21K1%

Table 6-3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR	C	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	H-P PART NUMBER	DESCRIPTION
	D				D		
A3	R76	0 0757-0401	R-F 100 1% .125W	A4	C40	4 0160-3470	C-F .01UF 50V
A3	R77	9 0757-0476	R-F 301K 1% .125	A4	C41	4 0160-3470	C-F .01UF 50V
A3	R78	0 0757-0394	R-F 51.1 1%	A4	C42	4 0160-3470	C-F .01UF 50V
A3	R81	0 0757-0394	R-F 51.1 1%	A4	C47	4 0160-3470	C-F .01UF 50V
A3	R82	0 0757-0394	R-F 51.1 1%	A4	C50	4 0160-3470	C-F .01UF 50V
A3	R83	3 0757-0438	R-F 5.11K1%	A4	C52	4 0160-3470	C-F .01UF 50V
A3	R84	0 0757-0394	R-F 51.1 1%	A4	C54	4 0160-3470	C-F .01UF 50V
A3	R85	2 0757-0346	R-F 10 1% .125W	A4	C55	4 0160-3470	C-F .01UF 50V
A3	R86	6 0757-0283	R-F 2K1% .125W F	A4	C57	4 0160-3470	C-F .01UF 50V
A3	R87	1 2100-3207	R-VAR 5K 10%	A4	C58	4 0160-3470	C-F .01UF 50V
A3	R88	0 0757-0394	R-F 51.1 1%	A4	C59	4 0160-3470	C-F .01UF 50V
A3	R89	6 0698-4455	R-F 536 1% .125W	A4	C60	4 0160-3470	C-F .01UF 50V
A3	R90	6 0698-4455	R-F 536 1% .125W	A4	C61	4 0160-3470	C-F .01UF 50V
A3	R91	9 0757-0434	R-F 3.65K1%	A4	C64	4 0160-3470	C-F .01UF 50V
				A4	C65	4 0160-3470	C-F .01UF 50V
A3	S1	3 3101-1341	SW SLIDE SPDT	A4	C66	4 0160-3470	C-F .01UF 50V
A3	U1	6 5081-3011	IC DIG REP RATE	A4	C67	4 0160-3470	C-F .01UF 50V
A3	U2	5 5081-3010	IC SEALED PKG	A4	C69	0 0160-0571	C-F 470PF 20% CER
A3	U3	7 1026-0111	IC-DUAL OP AMPL	A4	C70	0 0160-0571	C-F 470PF 20% CER
A3	U4	7 1826-0111	IC-DUAL OP AMPL	A4	C71	4 0160-3470	C-F .01UF 50V
A3	U5	7 1826-0111	IC-DUAL OP AMPL	A4	C72	4 0160-3470	C-F .01UF 50V
A3	U6	5 1820-0054	IC 7400N EQUIV	A4	C73	4 0160-3470	C-F .01UF 50V
A3	VR3	2 1902-0049	DIO-ZNR 6.19V 5%	A4	C75	8 0180-0197	C-F 2.2UF 20V
A3	VR8	3 1902-3002	DIO 2.37V 5%	A4	C76	4 0160-3470	C-F .01UF 50V
				A4	C77	4 0160-3470	C-F .01UF 50V
				A4	C78	4 0160-3470	C-F .01UF 50V
				A4	C79	4 0160-3470	C-F .01UF 50V
				A4	C81	8 0180-0197	C-F 2.2UF 20V
				A4	C82	8 0180-0197	C-F 2.2UF 20V
				A4	C83	4 0160-3470	C-F .01UF 50V
				A4	C85	4 0160-3470	C-F .01UF 50V
				A4	C86	4 0160-3470	C-F .01UF 50V
				A4	C87	4 0160-3470	C-F .01UF 50V
				A4	C88	4 0160-3470	C-F .01UF 50V
				A4	C90	4 0160-3470	C-F .01UF 50V
A4		08082-66504	BD AY OUTPUT	A4	C91	4 0160-3470	C-F .01UF 50V
A4	C1	4 0160-3470	C-F .01UF 50V	A4	C92	4 0160-3470	C-F .01UF 50V
A4	C2	3 0160-4386	C-F 33PF 5% 200V	A4	C93	4 0160-3470	C-F .01UF 50V
A4	C3	2 0180-0349	C-F .82UF 35V	A4	C94	4 0160-3470	C-F .01UF 50V
A4	C4	6 0180-2050	C-F .082UF 35V	A4	C95	4 0160-3470	C-F .01UF 50V
A4	C5	4 0160-4220	C-F 8200PF 5%	A4	C96	4 0160-3470	C-F .01UF 50V
A4	C6	4 0160-3884	C-F 680PF 100V	A4	C97	4 0160-3470	C-F .01UF 50V
A4	C7	4 0160-3470	C-F .01UF 50V	A4	C98	4 0160-3470	C-F .01UF 50V
A4	C8	4 0160-3470	C-F .01UF 50V	A4	C99	4 0160-3470	C-F .01UF 50V
A4	C9	3 0160-3875	C-F 22PF 5% 200V	A4	C100	4 0160-3470	C-F .01UF 50V
A4	C10	2 0180-0349	C-F .82UF 35V	A4	C101	4 0160-3470	C-F .01UF 50V
A4	C11	6 0180-2050	C-F .082UF 35V	A4	C112	4 0160-4212	C-F .068UF 20%
A4	C12	4 0160-4220	C-F 8200PF 5%	A4	C113	4 0160-4212	C-F .068UF 20%
A4	C13	4 0160-3884	C-F 680PF 100V	A4	C114	4 0160-4212	C-F .068UF 20%
A4	C14	4 0160-3470	C-F .01UF 50V	A4	C118	4 0160-4212	C-F .068UF 20%
A4	C15	2 5080-1089	CAPACITOR-SELECT	A4	C119	4 0160-3470	C-F .01UF 50V
A4	C16	2 5080-1089	CAPACITOR-SELECT	A4	C120	4 0160-4212	C-F .068UF 20%
A4	C17	0 0160-5042	C-F .082UF	A4	C121	4 0160-3470	C-F .01UF 50V
A4	C18	0 0160-5042	C-F .082UF	A4	C122	4 0160-3470	C-F .01UF 50V
A4	C19	4 0160-5278	C-F 8200PF 50V	A4	C123	4 0160-3470	C-F .01UF 50V
A4	C20	4 0160-5278	C-F 8200PF 50V	A4	CR2	1 1901-0040	DIO SI .05A 30V
A4	C21	5 0160-5279	C-F 820PF 50V	A4	CR3	1 1901-0040	DIO SI .05A 30V
A4	C22	5 0160-5279	C-F 820PF 50V	A4	CR4	8 1910-0022	DIO GE 5V 3.5NS
A4	C23	3 0160-4386	C-F 33PF 5% 200V	A4	CR5	1 1901-0040	DIO SI .05A 30V
A4	C25	4 0160-4212	C-F .068UF 20%	A4	CR6	1 1901-0040	DIO SI .05A 30V
A4	C25	4 0160-3470	C-F .01UF 50V				
A4	C29	6 0180-2795	C-F 39UF 15V				
A4	C30	7 0180-0229	C-F 33UF 10V				
A4	C31	6 0180-2795	C-F 39UF 15V				
A4	C32	1 0180-0116	C-F 6.8UF 35V TA				
A4	C35	4 0160-4212	C-F .068UF 20%				

Table 6-3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR	C	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	H-P PART NUMBER	DESCRIPTION
A4 CR7	1	1901-0040	DIO SI .05A 30V	A4 Q20	2	1853-0036	XSTR SI 2N3906
A4 CR9	1	1901-0040	DIO SI .05A 30V	A4 Q21	2	1853-0036	XSTR SI 2N3906
A4 CR10	1	1901-0040	DIO SI .05A 30V	A4 Q22	1	1854-0215	XSTR SI 2N3904
A4 CR11	8	1910-0022	DIO GE 5V 3.5NS	A4 Q23	1	1854-0215	XSTR SI 2N3904
A4 CR12	1	1901-0040	DIO SI .05A 30V	A4 Q24	1	1854-0215	XSTR SI 2N3904
A4 CR13	1	1901-0040	DIO SI .05A 30V	A4 Q25	1	1854-0215	XSTR SI 2N3904
A4 CR15	7	1901-0533	DIO HOT CARR	A4 Q27	1	1854-0215	XSTR SI 2N3904
A4 CR16	7	1901-0533	DIO HOT CARR	A4 Q28	1	1854-0215	XSTR SI 2N3904
A4 CR17	8	1901-0518	DIO HOT CARRIER	A4 Q32	2	1853-0036	XSTR SI 2N3906
A4 CR18	8	1901-0518	DIO HOT CARRIER	A4 Q33	1	1854-0215	XSTR SI 2N3904
A4 CR20	1	1901-0040	DIO SI .05A 30V	A4 Q34	1	1854-0215	XSTR SI 2N3904
A4 CR21	1	1901-0040	DIO SI .05A 30V	A4 Q55	2	1853-0036	XSTR SI 2N3906
A4 CR25	3	1901-0050	DIO SW 80V 200MA	A4 Q56	2	1853-0036	XSTR SI 2N3906
A4 CR26	3	1901-0050	DIO SW 80V 200MA	A4 Q57	2	1853-0036	XSTR SI 2N3906
A4 CR27	3	1901-0050	DIO SW 80V 200MA	A4 Q58	2	1853-0036	XSTR SI 2N3906
A4 CR28	3	1901-0050	DIO SW 80V 200MA	A4 Q59	2	1853-0036	XSTR SI 2N3906
A4 CR32	7	1901-0533	DIO HOT CARR	A4 Q60	2	1853-0036	XSTR SI 2N3906
A4 CR33	7	1901-0533	DIO HOT CARR	A4 Q61	2	1853-0036	XSTR SI 2N3906
A4 CR39	1	1901-0040	DIO SI .05A 30V	A4 Q62	2	1853-0036	XSTR SI 2N3906
A4 CR40	1	1901-0040	DIO SI .05A 30V	A4 Q69	2	1853-0284	TRANSISTOR
A4 CR41	1	1901-0040	DIO SI .05A 30V	A4 Q70	2	1853-0284	TRANSISTOR
A4 L1	4	5081-1972	INDUCTANCE 2BEAD	A4 Q71	2	1853-0036	XSTR SI 2N3906
A4 L2	4	5081-1972	INDUCTANCE 2BEAD	A4 Q72	2	1853-0036	XSTR SI 2N3906
A4 L3	4	5081-1972	INDUCTANCE 2BEAD	A4 Q73	1	1854-0215	XSTR SI 2N3904
A4 L6	4	5081-1972	INDUCTANCE 2BEAD	A4 Q74	2	1853-0036	XSTR SI 2N3906
A4 L7	4	5081-1972	INDUCTANCE 2BEAD	A4 R1	7	0757-0424	R-F 1.1K1% .125W
A4 L8	4	5081-1972	INDUCTANCE 2BEAD	A4 R2	4	0757-0273	R-F 3.01K1%
A4 L9	4	5081-1972	INDUCTANCE 2BEAD	A4 R3	8	0698-3160	R-F 1.1K1%
A4 L10	4	5081-1972	INDUCTANCE 2BEAD	A4 R7	9	0757-0442	R-F 10K1% .125W
A4 L11	8	9140-0118	COIL-CHOKE 500UH	A4 R8	9	0757-0442	R-F 10K1% .125W
A4 L12	8	9140-0118	COIL-CHOKE 500UH	A4 R9	9	0757-0418	R-F 619 1% .125W
A4 L13	8	9140-0118	COIL-CHOKE 500UH	A4 R10	9	0757-0418	R-F 619 1% .125W
A4 L14	8	9140-0118	COIL-CHOKE 500UH	A4 R11	6	0757-0720	R-F 243 1% 1/4W
A4 L15	5	5081-1973	INDUCTANCE 3BEAD	A4 R15	6	0757-0449	R-F 20K1% .125W
A4 L16	5	5081-1973	INDUCTANCE 3BEAD	A4 R16	5	0683-1055	R-F 1M5% .25W CC
A4 L17	5	5081-1973	INDUCTANCE 3BEAD	A4 R17	5	0757-0274	R-F 1.21K1%
A4 L18	5	5081-1973	INDUCTANCE 3BEAD	A4 R18	5	0757-0274	R-F 1.21K1%
A4 L19	5	5081-1973	INDUCTANCE 3BEAD	A4 R19	6	0757-0449	R-F 20K1% .125W
A4 L20	8	9100-1665	COIL-FXD 3.3 MH	A4 R20	5	0683-1055	R-F 1M5% .25W CC
A4 L21	8	9100-1665	COIL-FXD 3.3 MH	A4 R21	5	0683-1055	R-F 1M5% .25W CC
A4 L22	3	9170-0029	FERRITE BEAD	A4 R22	5	0757-0274	R-F 1.21K1%
A4 L23	3	9170-0029	FERRITE BEAD	A4 R23	6	0757-0449	R-F 20K1% .125W
A4 L24	4	5081-1972	INDUCTANCE 2BEAD	A4 R24	5	0683-1055	R-F 1M5% .25W CC
A4 L25	8	9100-1665	COIL-FXD 3.3 MH	A4 R25	6	0757-0449	R-F 20K1% .125W
A4 L26	4	5081-1972	INDUCTANCE 2BEAD	A4 R26	5	0757-0274	R-F 1.21K1%
A4 L27	8	9100-1665	COIL-FXD 3.3 MH	A4 R27	1	0698-3113	R-F 100 5% .125W
A4 L28	3	9170-0029	FERRITE BEAD	A4 R29	0	0757-0394	R-F 51.1 1%
A4 L29	3	9170-0029	FERRITE BEAD	A4 R30	6	0757-0283	R-F 2K1% .125W F
A4 L30	6	9140-0158	COIL-CHOKE 1 UH	A4 R31	4	0757-0273	R-F 3.01K1%
A4 L31	6	9140-0158	COIL-CHOKE 1 UH	A4 R32	6	0757-0720	R-F 243 1% 1/4W
A4 MP3	6	1600-0457	CTCT 14 FINGER	A4 R33	0	0757-0394	R-F 51.1 1%
A4 MP4	6	1600-0457	CTCT 14 FINGER	A4 R34	0	0757-0401	R-F 100 1% .125W
A4 MP5	7	1600-0341	CTCT 9FINGER	A4 R36	9	0698-0084	R-F 2,15K 1%.125
A4 MP6	7	1600-0341	CTCT 9FINGER	A4 R37	9	0698-0084	R-F 2,15K 1%.125
A4 Q3	2	1853-0036	XSTR SI 2N3906	A4 R38	7	0757-0440	R-F 7,5K 1%.125W
A4 Q4	2	1853-0036	XSTR SI 2N3906	A4 R40	8	0698-3441	R-F 215 1% .125W
A4 Q6	1	1854-0215	XSTR SI 2N3904	A4 R41	8	0698-3441	R-F 215 1% .125W
A4 Q7	1	1854-0215	XSTR SI 2N3904	A4 *R42	3	0757-0438	R-F 5.11K1%
A4 Q8	1	1854-0215	XSTR SI 2N3904	A4 R43	2	2100-3274	R-VAR 10K 10%
A4 Q9	1	1854-0215	XSTR SI 2N3904	A4 R44	3	0757-0438	R-F 5.11K1%
A4 Q11	1	1854-0215	XSTR SI 2N3904	A4 R45	2	0757-0289	R-F 13.3K1%
A4 Q12	1	1854-0215	XSTR SI 2N3904	A4 R46	6	0757-0407	R-F 200 1% .125W
A4 Q16	2	1853-0036	XSTR SI 2N3906	A4 R47	6	0757-0283	R-F 2K1% .125W F
				A4 R48	6	0698-3150	R-F 2.37K1%
				A4 R51	6	0757-0283	R-F 2K1% .125W F

Table 6-3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR	C	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	H-P PART NUMBER	DESCRIPTION
A4	R53	0 0698-3378	R-F 51 5% .125W	A4	R168	5 0698-5999	R-F 4.7K5% .125W
A4	R54	0 0698-3378	R-F 51 5% .125W	A4	R169	5 0698-5999	R-F 4.7K5% .125W
A4	R55	0 0757-0394	R-F 51.1 1%	A4	R170	5 0698-5999	R-F 4.7K5% .125W
A4	R56	9 0757-0434	R-F 3.65K1%	A4	R171	8 0698-6750	R-F 220K10%
A4	R57	3 0757-0438	R-F 5.11K1%	A4	R172	3 0698-3454	R-F 215K1% .125W
A4	R58	0 0698-3378	R-F 51 5% .125W	A4	R174	0 0698-3427	R-F 13.3 1%
A4	R59	0 0757-0394	R-F 51.1 1%	A4	R180	0 0698-3435	R-F 38.3 1%
A4	R60	6 0757-0720	R-F 243 1% 1/4W	A4	R186	0 0698-3378	R-F 51 5% .125W
A4	R61	6 0757-0720	R-F 243 1% 1/4W	A4	R187	0 0698-3378	R-F 51 5% .125W
A4	R62	9 0757-0442	R-F 10K1% .125W	A4	R188	8 0698-6750	R-F 220K10%
A4	R65	9 0757-0442	R-F 10K1% .125W	A4	R189	6 0698-5180	R-F 2K5% .125W
A4	R66	9 0757-0442	R-F 10K1% .125W	A4	R190	6 0698-5180	R-F 2K5% .125W
A4	R67	9 0757-0418	R-F 619 1% .125W	A4	R191	4 0698-3447	R-F 422 1% 1/8W
A4	R68	9 0757-0418	R-F 619 1% .125W	A4	R195	0 0698-3378	R-F 51 5% .125W
A4	R69	6 0757-0283	R-F 2K1% .125W	A4	R196	0 0698-3378	R-F 51 5% .125W
A4	R70	8 0698-3160	R-F 31.6K1%	A4	R197	6 0698-4413	R-F 154 1% .125W
A4	R71	4 0757-0273	R-F 3.01K1%	A4	R198	7 0757-0200	R-F 5.62K1%
A4	R72	7 0757-0424	R-F 1.1K1% .125W	A4	R199	0 0698-3154	R-F 4.22K 1%
A4	R76	6 0757-0449	R-F 20K1% .125W	A4	R200	8 0698-6750	R-F 220K10%
A4	R77	6 0757-0449	R-F 20K1% .125W	A4	R201	8 0698-6750	R-F 220K10%
A4	R78	6 0757-0449	R-F 20K1% .125W	A4	R202	7 0757-0416	R-F 511 1% .125W
A4	R79	6 0757-0449	R-F 20K1% .125W	A4	R203	3 0757-0438	R-F 5.11K1%
A4	R80	5 0757-0274	R-F 1.21K1%	A4	R204	3 0698-4428	R-F 1.69K1%
A4	R81	5 0757-0274	R-F 1.21K1%	A4	R206	2 0757-0411	R-F 332 1% .125W
A4	R82	5 0757-0274	R-F 1.21K1%	A4	R207	4 0757-0405	R-F 162 1% .125W
A4	R83	5 0757-0274	R-F 1.21K1%	A4	R208	7 0757-0416	R-F 511 1% .125W
A4	R84	4 0698-4073	R-F 1M10% .125W	A4	R210	6 0757-0449	R-F 20K1% .125W
A4	R85	4 0698-4073	R-F 1M10% .125W	A4	R211	9 0757-0442	R-F 10K1% .125W
A4	R85	3 0757-0438	R-F 5.11K1%	A4	R212	3 0757-0438	R-F 5.11K1%
A4	R86	4 0698-4073	R-F 1M10% .125W	A4	R213	3 0698-3438	R-F 147 1% .125W
A4	R87	4 0698-4073	R-F 1M10% .125W	A4	R214	5 2100-3350	R-VAR 200 10%
A4	R90	8 0698-3441	R-F 215 1% .125W	A4	R216	3 0698-3438	R-F 147 1% .125W
A4	R90	3 0757-0438	R-F 5.11K1%	A4	R217	7 0698-4125	R-F 953 1% .125W
A4	R91	8 0698-3441	R-F 215 1% .125W	A4	R218	7 0698-4125	R-F 953 1% .125W
A4	R92	9 0698-0084	R-F 2,15K 1% .125	A4	R219	5 0757-0290	R-F 6.19K1%
A4	R93	9 0698-0084	R-F 2,15K 1% .125	A4	R220	5 0757-0290	R-F 6.19K1%
A4	R95	2 0757-0289	R-F 13.3K1%	A4	R221	7 0698-0082	R-F 464 1% .125W
A4	R98	9 0757-0434	R-F 3.65K1%	A4	R222	1 0757-0444	R-F 12.1K1% .125W
A4	R100	3 0757-0438	R-F 5.11K1%	A4	R223	9 0757-0442	R-F 10K1% .125W
A4	R101	3 0757-0438	R-F 5.11K1%	A4	R224	9 0757-0442	R-F 10K1% .125W
A4	R102	9 0757-0434	R-F 3.65K1%	A4	R225	6 0757-0069	R-F 121 1% .25W
A4	R103	4 0757-0405	R-F 162 1% .125W	A4	R226	8 0757-1001	R-F 56.2 1% .5W
A4	R106	6 0757-0283	R-F 2K1% .125W F	A4	R227	8 0757-1001	R-F 56.2 1% .5W
A4	R107	6 0698-3150	R-F 2.37K1%	A4	R228	6 0757-0069	R-F 121 1% .25W
A4	R112	9 0757-0442	R-F 10K1% .125W	A4	R229	2 0698-4435	R-F 2.49K1%
A4	R113	9 0757-0442	R-F 10K1% .125W	A4	R230	2 0698-4435	R-F 2.49K1%
A4	R114	9 0757-0442	R-F 10K1% .125W	A4	R232	2 2100-3349	R-VAR 100 +-10%
A4	R115	9 0757-0442	R-F 10K1% .125W	A4	R237	0 0757-0394	R-F 51.1 1%
A4	R116	7 0698-0082	R-F 464 1% .125W	A4	R240	2 2100-3274	R-VAR 10K 10%
A4	R117	7 0698-0082	R-F 464 1% .125W	A4	R241	6 0698-5180	R-F 2K5% .125W
A4	R141	1 0698-3113	R-F 100 5% .125W	A4	R242	9 0698-3111	R-F 30 5% .125W
A4	R146	1 0698-3113	R-F 100 5% .125W	A4	R243	9 0698-3111	R-F 30 5% .125W
A4	R151	4 0698-4073	R-F 1M10% .125W	A4	R244	8 0757-1001	R-F 56.2 1% .5W
A4	R152	4 0698-4073	R-F 1M10% .125W	A4	R245	8 0757-1001	R-F 56.2 1% .5W
A4	R153	4 0698-4073	R-F 1M10% .125W	A4	R252	0 0757-0394	R-F 51.1 1%
A4	R154	4 0698-4073	R-F 1M10% .125W	A4	R253	2 2100-3349	R-VAR 100 +-10%
A4	R155	4 0698-4073	R-F 1M10% .125W	A4	R260	0 0757-0394	R-F 51.1 1%
A4	R156	4 0698-4073	R-F 1M10% .125W	A4	U1	7 1826-0111	IC-DUAL OP AMPL
A4	R157	4 0698-4073	R-F 1M10% .125W	A4	U2	7 1826-0111-5081-3009	IC-DUAL OP AMPL
A4	R158	4 0698-4073	R-F 1M10% .125W	A4	U3	2 5081-3009-1826-0111	IC SEALED PKG
A4	R159	0 0698-5176	R-F 510 5% .125W	A4	U4	2 5081-3009	IC SEALED PKG
A4	R161	0 0698-5176	R-F 510 5% .125W	A4	VR1	6 1902-0126	DIO 2.61V 5% .4W
A4	R163	0 0698-5176	R-F 510 5% .125W	A4	VR8	6 1902-0126	DIO 2.61V 5% .4W
A4	R165	0 0698-5176	R-F 510 5% .125W	A4	VR19	5 1902-3137	DIO 8.06V 2% .4W
A4	R167	5 0698-5999	R-F 4.7K5% .125W	A4	VR22	9 1902-0202	DIO-ZNR 15V 5%
				A4	VR23	9 1902-0202	DIO-ZNR 15V 5%

A4(X1) 5040-9314 LOCK CLIP 14 P01  
 A4(X2) 5040-9316 LOCK CLIP 16 P01

Table 6-3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR	C	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	H-P PART NUMBER	DESCRIPTION	
A4	VR24	6	1902-0126	DIO 2.61V 5% .4W	A5	Q1	3 1853-0045	XSTR 2N4036 SI
A4	VR29	6	1902-3104	DIO 5.62V 5% .4W	A5	Q3	2 1854-0448	XSTR SI NPN
A4	VR30	6	1902-0522	DIO 6V 5% 5W	A5	Q6	3 1853-0045	XSTR 2N4036 SI
A4	VR31	6	1902-0522	DIO 6V 5% 5W	A5	Q8	2 1854-0448	XSTR SI NPN
A4	VR42	1	1902-0064	DIO 7.5V 5% .4W	A5	Q9	2 1853-0036	XSTR SI 2N3906
A4	W3	7	08082-61603	CBL AY-SHLD I	A5	Q10	2 1853-0036	XSTR SI 2N3906
A4	W10	0	08082-61606	CBL AY-SHLD IV	A5	Q12	2 1853-0036	XSTR SI 2N3906
A4	W16	9	08082-61605	CBL AY-SHLD III	A5	Q14	2 1853-0036	XSTR SI 2N3906
A4	W17	9	08082-61605	CBL AY-SHLD III	A5	Q15	2 1853-0036	XSTR SI 2N3906
A4	W18	9	08082-61605	CBL AY-SHLD III	A5	Q17	2 1853-0036	XSTR SI 2N3906
A4	W19	9	08082-61605	CBL AY-SHLD III	A5	Q19	3 1853-0045	XSTR 2N4036 SI
A4	X2-71	8	1200-0548	SKT IC 14CONT 16CONT	A5	Q20	3 1853-0045	XSTR 2N4036 SI
A4	X2	6	1200-0588	SOCKET IC	A5	Q21	2 1853-0036	XSTR SI 2N3906
A5			08082-66505	BD AY OFFSET	A5	Q22	1 1854-0215	XSTR SI 2N3904
A5	C1	4	0180-0309	C-7 4.7UF 10V	A5	Q26	3 1853-0045	XSTR 2N4036 SI
A5	C2	4	0180-0309	C-7 4.7UF 10V	A5	Q27	3 1853-0045	XSTR 2N4036 SI
A5	C3	4	0180-0309	C-7 4.7UF 10V	A5	Q28	3 1853-0045	XSTR 2N4036 SI
A5	C4	4	0180-0309	C-7 4.7UF 10V	A5	Q29	3 1853-0045	XSTR 2N4036 SI
A5	C5	9	0160-4209	C-F .010UF 20%	A5	Q30	7 1854-0039	XSTR 2N3053 SI
A5	C6	9	0160-4209	C-F .010UF 20%	A5	Q31	7 1854-0039	XSTR 2N3053 SI
A5	C7	9	0160-4209	C-F .010UF 20%	A5	Q32	1 1853-0051	XSTR SI 4037
A5	C9	3	0180-0374	C-F 10UF 20V	A5	Q33	1 1854-0215	XSTR SI 2N3904
A5	C10	3	0180-0374	C-F 10UF 20V	A5	Q34	1 1854-0215	XSTR SI 2N3904
A5	C11	7	0180-0039	C-F 100UF 12V	A5	Q35	1 1853-0051	XSTR SI 4037
A5	C12	7	0180-0039	C-F 100UF 12V	A5	Q36	1 1853-0051	XSTR SI 4037
A5	C15	9	0160-4209	C-F .010UF 20%	A5	Q37	2 1853-0036	XSTR SI 2N3906
A5	C16	9	0160-4209	C-F .010UF 20%	A5	Q38	2 1853-0036	XSTR SI 2N3906
A5	C20	9	0160-4209	C-F .010UF 20%	A5	Q39	1 1854-0215	XSTR SI 2N3904
A5	C21	9	0160-4209	C-F .010UF 20%	A5	Q40	1 1854-0215	XSTR SI 2N3904
A5	C22	8	0180-0197	C-F 2.2UF 20V	A5	Q41	1 1854-0215	XSTR SI 2N3904
A5	C23	8	0180-0197	C-F 2.2UF 20V	A5	Q42	1 1854-0215	XSTR SI 2N3904
A5	C24	3	0180-0291	C-F 1UF 35V	A5	Q43	1 1854-0215	XSTR SI 2N3904
A5	C27	0	0180-0058	C-F 50UF 25V	A5	Q44	1 1854-0215	XSTR SI 2N3904
A5	CR4	1	1901-0040	DIO SI .05A 30V	A5	Q45	1 1854-0215	XSTR SI 2N3904
A5	CR6	1	1901-0040	DIO SI .05A 30V	A5	Q46	1 1854-0215	XSTR SI 2N3904
A5	CR8	1	1901-0040	DIO SI .05A 30V	A5	Q47	1 1854-0215	XSTR SI 2N3904
A5	CR10	1	1901-0040	DIO SI .05A 30V	A5	Q48	2 1853-0036	XSTR SI 2N3906
A5	CR12	1	1901-0040	DIO SI .05A 30V	A5	Q49	1 1854-0215	XSTR SI 2N3904
A5	CR13	1	1901-0040	DIO SI .05A 30V	A5	Q50	1 1854-0215	XSTR SI 2N3904
A5	CR26	1	1901-0040	DIO SI .05A 30V	A5	Q51	2 1853-0036	XSTR SI 2N3906
A5	CR27	1	1901-0040	DIO SI .05A 30V	A5	Q52	2 1853-0036	XSTR SI 2N3906
A5	CR28	1	1901-0040	DIO SI .05A 30V	A5	Q53	2 1853-0036	XSTR SI 2N3906
A5	CR29	1	1901-0040	DIO SI .05A 30V	A5	Q54	2 1853-0036	XSTR SI 2N3906
A5	CR30	1	1901-0040	DIO SI .05A 30V	A5	Q55	1 1854-0215	XSTR SI 2N3904
A5	CR31	1	1901-0040	DIO SI .05A 30V	A5	Q56	2 1853-0036	XSTR SI 2N3906
A5	CR32	1	1901-0040	DIO SI .05A 30V	A5	Q57	2 1853-0036	XSTR SI 2N3906
A5	CR33	1	1901-0040	DIO SI .05A 30V	A5	Q58	1 1854-0215	XSTR SI 2N3904
A5	CR34	1	1901-0040	DIO SI .05A 30V	A5	R5	4 0757-0281	R-F 2.74K1%
A5	CR36	1	1901-0040	DIO SI .05A 30V	A5	R6	9 0757-0442	R-F 10K1% .125W
A5	CR37	1	1901-0040	DIO SI .05A 30V	A5	R7	9 0757-0442	R-F 10K1% .125W
A5	MP1	0	1205-0011	HT-SINK XSTR	A5	R8	2 0698-4477	R-F 10.5K1%
A5	MP3	0	1205-0011	HT-SINK XSTR	A5	R9	2 0698-4477	R-F 10.5K1%
A5	MP6	0	1205-0011	HT-SINK XSTR	A5	R10	0 0698-0085	R-F 2.61K1%
A5	MP8	0	1205-0011	HT-SINK XSTR	A5	R11	2 0698-3495	R-F 866 1% .125W
A5	MP26	0	1205-0011	HT-SINK XSTR	A5	R13	8 0757-0384	R-F 20 1% .125W
A5	MP27	0	1205-0011	HT-SINK XSTR	A5	R14	8 0757-0384	R-F 20 1% .125W
A5	MP28	0	1205-0011	HT-SINK XSTR	A5	R15	0 0698-0085	R-F 2.61K1%
A5	MP29	0	1205-0011	HT-SINK XSTR	A5	R17	2 0698-3495	R-F 866 1% .125W
					A5	R18	1 0757-0452	R-F 27.4K1%
					A5	R19	9 0757-0442	R-F 10K1% .125W
					A5	R20	9 0757-0442	R-F 10K1% .125W
					A5	R21	9 0757-0442	R-F 10K1% .125W

Table 6-3. Replaceable Parts (cont'd)

REFERENCE DESIGNATOR	C	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	H-P PART NUMBER	DESCRIPTION
A5	R22	9 0757-0442	R-F 10K1% .125W	A5	R111	0 0698-4433	R-F 2.26K1%
A5	R23	9 0757-0442	R-F 10K1% .125W	A5	R112	2 0757-0346	R-F 10 1% .125W
A5	R24	9 0757-0442	R-F 10K1% .125W	A5	R113	2 0757-0346	R-F 10 1% .125W
A5	R25	9 0757-0442	R-F 10K1% .125W	A5	R114	3 0757-0280	R-F 1K1% .125W F
A5	R26	2 0698-4477	R-F 10.5K1%	A5	R115	1 2100-3273	R-VAR 2K 10%
A5	R27	2 0698-4477	R-F 10.5K1%	A5	R116	0 0757-0419	R-F 681 1% .125W
A5	R28	2 0698-3495	R-F 866 1% .125W	A5	R117	8 0698-3152	R-F 3.48K 1%
A5	R29	0 0698-0085	R-F 2.61K1%	A5	R118	8 0698-3152	R-F 3.48K 1%
A5	R31	8 0757-0384	R-F 20 1% .125W	A5	R120	2 0757-0346	R-F 10 1% .125W
A5	R32	8 0757-0384	R-F 20 1% .125W	A5	R121	2 0757-0346	R-F 10 1% .125W
A5	R33	2 0698-3495	R-F 866 1% .125W	A5	R122	9 0757-0442	R-F 10K1% .125W
A5	R35	0 0698-0085	R-F 2.61K1%	A5	R123	9 0757-0442	R-F 10K1% .125W
A5	R51	7 0757-0317	R-F 1.33K1%	A5	R124	2 0698-4469	R-F 1.15K1%
A5	R52	7 0757-0317	R-F 1.33K1%	A5	R125	9 0757-0442	R-F 10K1% .125W
A5	R53	0 0757-0419	R-F 681 1% .125W	A5	R126	5 0683-6245	R-F 620K5% .25W
A5	R54	2 0698-3437	R-F 133 1% .125W	A5	R130	1 0698-3444	R-F 316 1% .125W
A5	R55	1 0757-0402	R-F 110 1% .125W	A5	R131	9 0757-0418	R-F 619 1% .125W
A5	R56	2 0757-0403	R-F 121 1% .125W	A5	R132	3 0757-0438	R-F 5.11K1%
A5	R57	3 0757-0420	R-F 750 1% .125W	A5	R133	1 0698-3444	R-F 316 1% .125W
A5	R58	1 0757-0452	R-F 27.4K1%	A5	R134	4 0757-0398	R-F 75 1% .125W
A5	R59	1 0757-0452	R-F 27.4K1%	A5	R135	9 0698-4367	R-F 20.5 1%
A5	R60	6 0757-0978	R-F 95.3K1%	A5	R136	6 2100-3351	R-TRMR 500 10%
A5	R61	1 0757-0452	R-F 27.4K1%	A5	R137	6 0757-0407	R-F 200 1% .125W
A5	R62	6 0757-0449	R-F 20K1% .125W	A5	R138	9 0757-0442	R-F 10K1% .125W
A5	R63	1 0757-0452	R-F 27.4K1%	A5	R139	4 0757-0405	R-F 162 1% .125W
A5	R65	9 0757-0442	R-F 10K1% .125W	A5	R140	9 0757-0442	R-F 10K1% .125W
A5	R66	9 0757-0442	R-F 10K1% .125W	A5	R141	1 0698-3262	R-F 40.2 1%
A5	R67	9 0757-0442	R-F 10K1% .125W	A5	*R142	4 0757-0281	R-F 2.74K1%
A5	R68	4 0698-3455	R-F 261K1% .125W	A5	R143	0 0757-0419	R-F 681 1% .125W
A5	R69	6 0757-0465	R-F 100K1% .125W	A5	R144	1 0757-0452	R-F 27.4K1%
A5	R70	6 0757-0449	R-F 20K1% .125W	A5	R145	9 0698-0084	R-F 2.15K 1% .125
A5	R71	3 0757-0470	R-F 162K 1% .125	A5	R146	0 0698-4483	R-F 18.7K1% .125W
A5	R72	3 0757-0454	R-F 33.2K1% .125W	A5	R147	7 2100-3352	R-VAR 1K .5W
A5	R73	6 0757-0449	R-F 20K1% .125W	A5	R148	7 2100-3352	R-VAR 1K .5W
A5	R74	7 0698-0082	R-F 464 1% .125W	A5	R149	2 0698-3156	R-F 14.7K1%
A5	R75	7 0698-0082	R-F 464 1% .125W	A5	R150	7 0757-0416	R-F 511 1% .125W
A5	R76	7 0698-0082	R-F 464 1% .125W	A5	R151	0 0757-0394	R-F 51.1 1%
A5	R77	2 0757-0346	R-F 10 1% .125W	A5	R152	9 0757-0442	R-F 10K1% .125W
A5	R78	2 0757-0346	R-F 10 1% .125W	A5	R153	7 0757-0416	R-F 511 1% .125W
A5	R79	2 0757-0346	R-F 10 1% .125W	A5	R154	6 0757-0069	R-F 121 1% .25W
A5	R80	7 2100-3352	R-VAR 1K .5W	A5	R155	8 0698-3558	R-F 4.02K1%
A5	R81	7 2100-3352	R-VAR 1K .5W	A5	R156	8 0698-3558	R-F 4.02K1%
A5	R82	6 0757-0283	R-F 2K1% .125W F	A5	R157	6 0757-0407	R-F 200 1% .125W
A5	R83	6 0757-0283	R-F 2K1% .125W F	A5	R158	0 0757-0401	R-F 100 1% .125W
A5	R84	8 0698-3558	R-F 4.02K1%	A5	R159	9 0757-0442	R-F 10K1% .125W
A5	R85	7 0698-0082	R-F 464 1% .125W	A5	R160	8 0757-0433	R-F 3.32K1%
A5	R86	7 0698-0082	R-F 464 1% .125W	A5	R161	8 2100-3353	R-VAR 20K .5W
A5	R87	1 0698-3155	R-F 4.64K 1% .125	A5	R162	2 2100-3274	R-VAR 10K 10%
A5	R88	7 0698-3226	R-F 6.49K1%	A5	R163	9 0757-0442	R-F 10K1% .125W
A5	R89	8 0757-0433	R-F 3.32K1%	A5	R164	6 0757-0712	R-F 90.9 1% .25W
A5	R90	7 0757-0200	R-F 5.62K1%	A5	R165	9 0757-0997	R-F 39.2 1% 1/2W
A5	R91	1 0698-4442	R-F 4.42K1%	A5	R166	9 0757-0442	R-F 10K1% .125W
A5	R92	6 0757-0449	R-F 20K1% .125W	A5	R167	9 0757-0442	R-F 10K1% .125W
A5	R93	6 0757-0449	R-F 20K1% .125W	A5	R168	5 0757-0290	R-F 6.19K1%
A5	R94	3 0757-0280	R-F 1K1% .125W F	A5	R169	5 0757-0290	R-F 6.19K1%
A5	R96	8 0757-0417	R-F 562 1% .125W	A5	R170	5 0757-0290	R-F 6.19K1%
A5	R97	8 0757-0417	R-F 562 1% .125W	A5	R171	1 2100-3207	R-VAR 5K 10%
A5	R102	3 0698-4428	R-F 1.69K1%	A5	R172	1 2100-3207	R-VAR 5K 10%
A5	R103	3 0698-4428	R-F 1.69K1%	A5	R173	3 0698-4486	R-F 24.9K1%
A5	R104	6 0757-0449	R-F 20K1% .125W	A5	R174	3 0698-4486	R-F 24.9K1%
A5	R105	6 0757-0449	R-F 20K1% .125W	A5	R175	3 0757-0438	R-F 5.11K1%
A5	R106	8 0757-0417	R-F 562 1% .125W	A5	R176	9 0757-0442	R-F 10K1% .125W
A5	R107	8 0757-0417	R-F 562 1% .125W	A5	R177	6 0757-0407	R-F 200 1% .125W
A5	R108	2 0757-0346	R-F 10 1% .125W	A5	R178	9 0757-0442	R-F 10K1% .125W
A5	R109	2 0757-0346	R-F 10 1% .125W	A5	R179	6 0757-0407	R-F 200 1% .125W
A5	R110	0 0698-4433	R-F 2.26K1%				

Table 6-3. Replaceable Parts (cont'd)

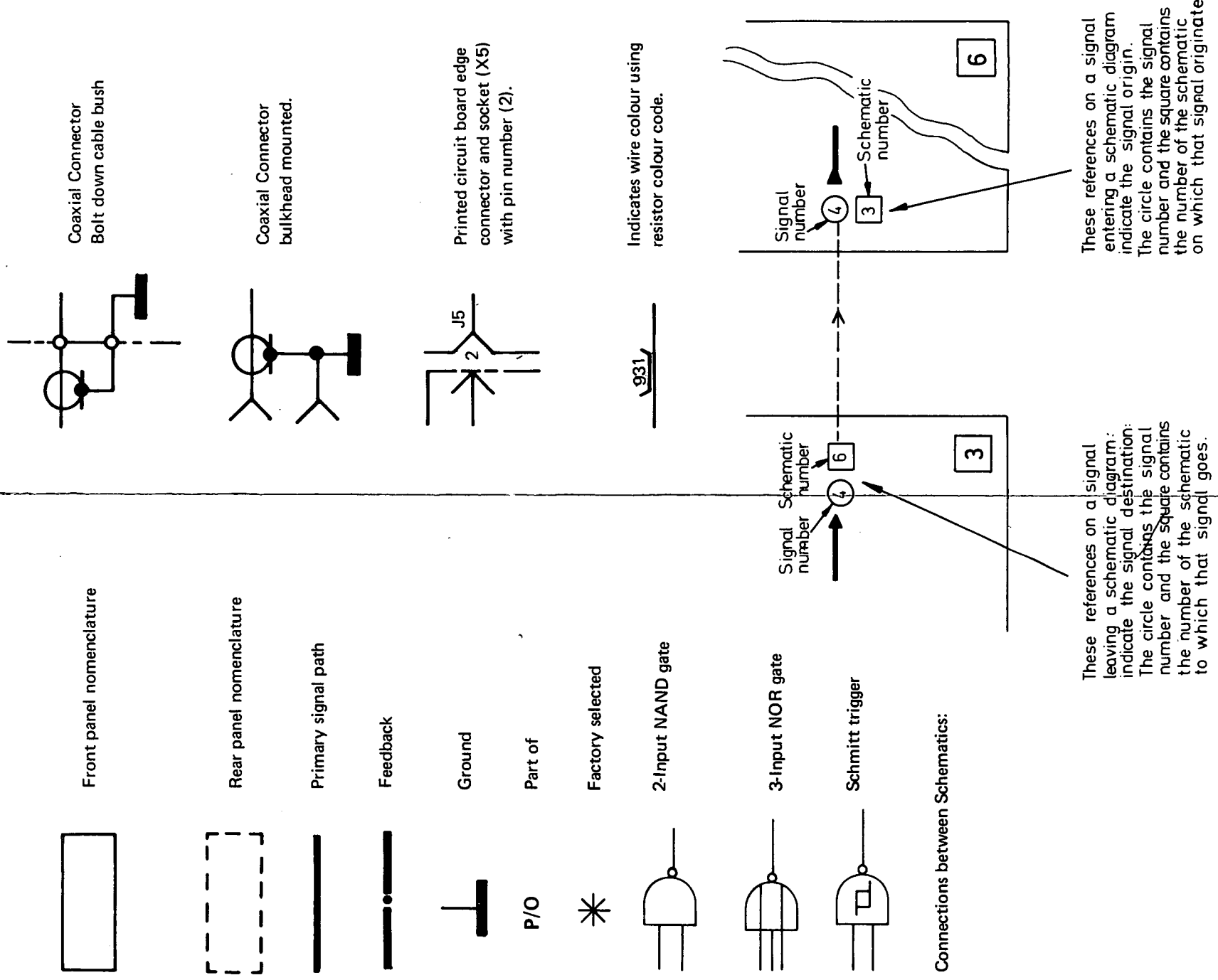
REFERENCE DESIGNATOR	C	H-P PART NUMBER	DESCRIPTION	REFERENCE DESIGNATOR	C	H-P PART NUMBER	DESCRIPTION
A5 R180	2	0698-3156	R-F 14.7K1%	A6		08082-61601	CBL AY-XFMR
A5 R181	1	0757-0428	R-F 1.62K 1%				
A5 R182	9	0757-0278	R-F 1.78K1%	A6 J1	5	08082-26506	BD PC
A5 R183	8	0698-3558	R-F 4.02K1%				
A5 R184	9	0757-0442	R-F 10K1% .125W	A6 T1	4	5080-0984	XFMR-POWER
A5 R185	6	0757-0407	R-F 200 1% .125W	A6 X1	6	1251-0333	CONN PC 20CONT
A5 R186	9	0757-0442	R-F 10K1% .125W				
A5 R187	9	0757-0442	R-F 10K1% .125W				
A5 R188	3	0757-0438	R-F 5.11K1%				
A5 R189	6	0757-0407	R-F 200 1% .125W				
A5 R190	6	0757-0465	R-F 100K1% .125W				
A5 R191	6	0757-0465	R-F 100K1% .125W	A8		08082-66508	BD AY AMP BUFFER
A5 R192	9	0757-1094	R-F 1.47K1%				
A5 R193	3	0698-3446	R-F 383 1% .125W	A8 C1	4	0160-3470	C-F .01UF 50V
A5 R194	0	0698-3435	R-F 38.3 1%	A8 C2	5	0180-1746	C-F 15UF 20V TA
A5 R195	9	0757-0418	R-F 619 1% .125W	A8 C3	4	0160-3470	C-F .01UF 50V
A5 R196	9	0757-0442	R-F 10K1% .125W	A8 C4	5	0180-1746	C-F 15UF 20V TA
A5 R197	3	0757-0438	R-F 5.11K1%	A8 C5	4	0160-3470	C-F .01UF 50V
A5 R198	8	0698-0083	R-F 1.96K1%	A8 C6	4	0160-3470	C-F .01UF 50V
A5 R199	9	0757-0442	R-F 10K1% .125W	A8 C7	4	0160-3470	C-F .01UF 50V
A5 R200	8	0757-0441	R-F 8.25K1%	A8 C9	4	0160-3470	C-F .01UF 50V
A5 R201	3	0757-0438	R-F 5.11K1%	A8 C10	4	0160-3470	C-F .01UF 50V
A5 R202	8	0698-0083	R-F 1.96K1%	A8 C11	4	0160-3470	C-F .01UF 50V
A5 R203	9	0757-0442	R-F 10K1% .125W	A8 CR1	7	1901-0533	DIO HOT CARR
A5 R204	0	0698-3435	R-F 38.3 1%	A8 CR2	7	1901-0533	DIO HOT CARR
A5 R205	3	0698-3446	R-F 383 1% .125W	A8 CR3	7	1901-0533	DIO HOT CARR
A5 R206	9	0757-1094	R-F 1.47K1%	A8 CR4	7	1901-0533	DIO HOT CARR
A5 R207	0	0757-0500	R-F 30.1 1% .25W	A8 MP1	2	1260-0364	CONNECTOR LEAD
A5 R208	7	0698-3440	R-F 196 1% .125W	A8 R1	8	0698-5174	R-F 200 5% .125W
A5 R209	0	0757-0394	R-F 51.1 1%	A8 R2	4	0698-4411	R-F 140 1% .125W
A5 R210	2	2100-3349	R-VAR 100 +-10%	A8 R3	5	0757-0274	R-F 1.21K1%
A5 R211	3	0698-3438	R-F 147 1% .125W	A8 R4	3	0757-0280	R-F 1K1% .125W F
A5 R212	3	0698-3438	R-F 147 1% .125W	A8 R11	3	0757-0280	R-F 1K1% .125W F
A5 R213	2	2100-3274	R-VAR 10K 10%	A8 R12	5	0757-0274	R-F 1.21K1%
A5 R214	6	0757-0283	R-F 2K1% .125W F	A8 R15	4	0698-4411	R-F 140 1% .125W
A5 R215	1	0757-0452	R-F 27.4K1%	A8 R16	5	2100-3350	R-VAR 200 10%
A5 R216	1	0757-0452	R-F 27.4K1%	A8 R17	2	2100-3349	R-VAR 100 +-10%
A5 R217	0	2100-3355	R-VAR 100K	A8 R19	0	0698-5176	R-F 510 5% .125W
A5 R218	9	0757-0723	R-F 365 1% .25W	A8 R20	8	0698-5174	R-F 200 5% .125W
A5 R220	0	0757-0394	R-F 51.1 1%	A8 R21	6	0698-5180	R-F 2K5% .125W
A5 R221	9	0757-0723	R-F 365 1% .25W	A8 R22	6	0698-5180	R-F 2K5% .125W
A5 R222	2	0757-0388	R-F 30.1 1%	A8 R23	4	0757-0273	R-F 3.01K1%
A5 R223	8	0698-3152	R-F 3.48K 1%	A8 R24	4	0757-0273	R-F 3.01K1%
A5 R224	0	0757-0401	R-F 100 1% .125W	A8 R25	5	0698-3381	R-F 150 5% .125W
A5 R225	0	0757-0401	R-F 100 1% .125W	A8 R26	5	0698-3381	R-F 150 5% .125W
A5 R230	2	2100-3274	R-VAR 10K 10%	A8 R13	1	0757-0387	R-F 27.4 1%
A5 R231	8	0698-3152	R-F 3.48K 1%	A8 R14	1	0757-0387	R-F 27.4 1%
A5 U1	7	1826-0111	IC-DUAL OP AMPL	A8 U1	4	5081-3027	IC
A5 U2	7	1826-0111	IC-DUAL OP AMPL				
A5 U3	7	1826-0111	IC-DUAL OP AMPL				
A5 U4	7	1826-0111	IC-DUAL OP AMPL				
A5 U5	7	1826-0111	IC-DUAL OP AMPL				
A5 U6	7	1826-0111	IC-DUAL OP AMPL				
A5 U7	7	1826-0111	IC-DUAL OP AMPL				
A5 U8	7	1826-0111	IC-DUAL OP AMPL				
A5 U9	7	1826-0111	IC-DUAL OP AMPL				
A5 U10	7	1826-0111	IC-DUAL OP AMPL				
A5 VR3	3	1902-3268	DIO 26.1V 5% .4W				
A5 VR24	6	1902-0184	DIO 16.2V 5% .4W				
A5 VR25	7	1902-3139	DIO ZNR 8.25V 5%				
A5 VR35	3	1902-0579	DIO 5.11V 5% 1W				
A5 W7	5	5081-1957	CBL RB 14C 191MM				
A5 W8	4	5081-1956	CBL RB 16C 165MM				
A5 X4	6	1200-0588	SOCKET IC 16cont				

A5(x4) 5040-9316 lock clip 16pol

Table 6-3. Replaceable Parts (cont'd)

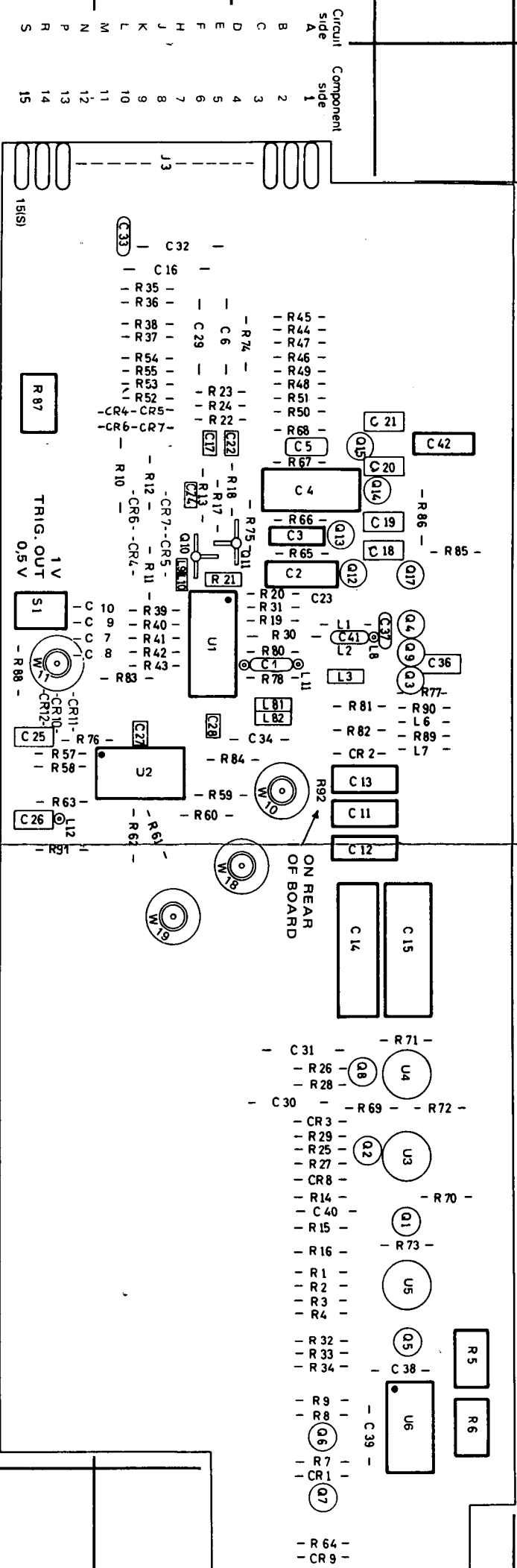
REFERENCE DESIGNATOR	C H-P PART NUMBER	DESCRIPTION
A9	08082-66509	BD AY ATTENUATOR
CR1	1 1901-0040	D10 SI .05A 30V
CR2	1 1901-0040	D10 SI .05A 30V
CR3	1 1901-0040	D10 SI .05A 30V
CR4	1 1901-0040	D10 SI .05A 30V
CR5	1 1901-0040	D10 SI .05A 30V
CR6	1 1901-0040	D10 SI .05A 30V
CR7	1 1901-0040	D10 SI .05A 30V
CR8	1 1901-0040	D10 SI .05A 30V
CR9	1 1901-0040	D10 SI .05A 30V
CR10	1 1901-0040	D10 SI .05A 30V
CR11	1 1901-0040	D10 SI .05A 30V
CR12	1 1901-0040	D10 SI .05A 30V
CR13	1 1901-0040	D10 SI .05A 30V
CR14	1 1901-0040	D10 SI .05A 30V
A9 J1	1 1250-0835	JACK RECEPT STRAI
A9 J2	1 1250-0835	JACK RECEPT STRAI
A9 K1	1 0490-1034	RELAY 12V .5A
A9 K2	1 0490-1034	RELAY 12V .5A
A9 K3	1 0490-1034	RELAY 12V .5A
A9 K4	1 0490-1034	RELAY 12V .5A
A9 L1	0 9100-0346	COIL FXD
A9 L2	0 9100-0346	COIL FXD
A9 L3	0 9100-0346	COIL FXD
A9 L4	0 9100-0346	COIL FXD
A9 L5	5 5081-1973	INDUCTANCE 3BEAD
A9 L6	5 5081-1973	INDUCTANCE 3BEAD
A9 L7	8 9140-0118	COIL-CHOKE 500UH
A9 L8	8 9140-0118	COIL-CHOKE 500UH
A9 R1	7 0757-0284	R-F 150 1% .125W
A9 R2	7 0757-0284	R-F 150 1% .125W
A9 R3	7 0757-0284	R-F 150 1% .125W
A9 R4	7 0757-0284	R-F 150 1% .125W
A9 R5	1 0698-4377	R-F 37.4 1%
A9 R6	1 0698-4377	R-F 37.4 1%
A9 R7	7 0698-4406	R-F 115 1% .125W
A9 R8	7 0698-4406	R-F 115 1% .125W
A9 R9	7 0698-4406	R-F 115 1% .125W
A9 R10	7 0698-4406	R-F 115 1% .125W
A9 R11	8 0757-0706	R-F 51.1 1% .25W
A9 R12	8 0757-0706	R-F 51.1 1% .25W
A9 R13	4 0757-0398	R-F 75 1% .125W
A9 R14	4 0757-0398	R-F 75 1% .125W
A9 R15	8 0757-0384	R-F 20 1% .125W
A9 R16	8 0757-0384	R-F 20 1% .125W
A9 R17	8 0757-0384	R-F 20 1% .125W
A9 R18	8 0757-0384	R-F 20 1% .125W
A9 R19	8 0757-0433	R-F 3.32K1%
A9 R20	8 0757-0433	R-F 3.32K1%
A9 R21	8 0757-0433	R-F 3.32K1%
A9 R22	8 0757-0433	R-F 3.32K1%
A9 R23	1 0757-0337	R-F 432 1% .25W
A9 R24	1 0757-0337	R-F 432 1% .25W
A9 R25	1 0757-0337	R-F 432 1% .25W
A9 R26	1 0757-0337	R-F 432 1% .25W
A9 W9	7 5081-1959	CBL RB 16C 210MM

Table 6-4. Schematic Diagram Notes



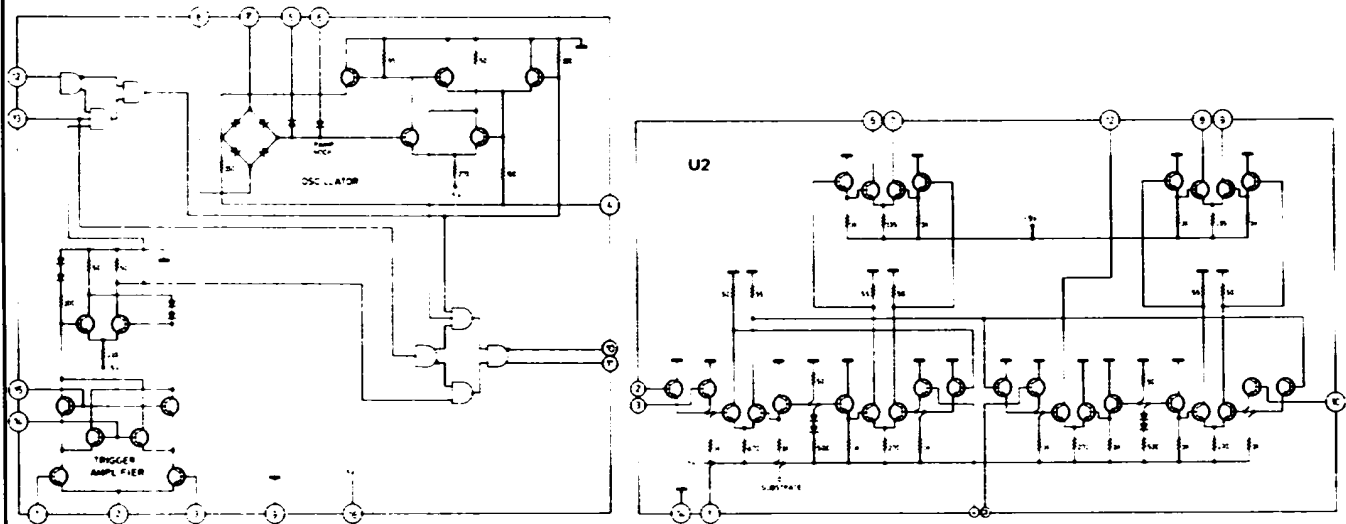


A3 BOARD ASSEMBLY REP. RATE 08082-66503

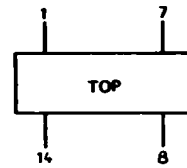
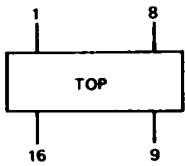


REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C2	E-3	C27	F-4	CR6	E-4	Q1	J-2	R5	K-2	R21	D-2	R39	F-4	R59	G-4	R78	F-3
C3	E-3	C28	D-4	CR7	E-4	Q2	I-3	R6	K-2	R21	E-4	R40	F-4	R60	G-4	R80	F-3
C4	E-3	C29	D-4	CR8	E-4	Q3	F-2	R7	K-3	R22	D-4	R41	F-4	R61	G-4	R81	F-3
C5	D-3	C30	I-3	CR9	L-3	Q4	F-2	R8	K-3	R23	D-4	R42	F-4	R62	G-5	R82	F-3
C6	D-4	C31	I-3	CR9	L-3	Q5	K-2	R9	K-3	R24	D-4	R43	F-4	R63	G-5	R83	F-3
C7	F-3	C32	C-4	CR10	F-5	Q6	K-3	R9	K-3	R25	D-4	R44	F-4	R64	G-5	R84	F-3
C9	F-4	C33	C-4	CR11	F-5	Q7	L-3	R10	E-4	R26	I-3	R45	C-3	R65	E-3	R85	G-4
C10	F-4	C34	F-3	CR12	F-3	Q8	I-3	R11	E-4	R27	I-3	R46	E-3	R66	E-3	R86	E-2
C11	G-3	C36	F-2	L2	F-3	Q8	F-2	R12	E-4	R28	I-3	R47	D-3	R67	D-3	R87	E-2
C12	G-3	C37	L3	L3	F-3	Q9	E-4	R13	E-4	R29	I-3	R48	D-3	R68	D-3	R88	D-5
C13	G-3	C38	L6	L6	F-2	Q10	E-4	R14	E-4	R30	I-3	R49	D-3	R69	I-3	R89	F-5
C14	H-3	C39	L7	L7	F-2	Q11	E-3	R15	J-3	R31	F-3	R50	D-3	R70	J-2	R90	F-5
C15	H-2	C40	J-3	L8	F-3	Q12	E-3	R16	J-3	R32	K-3	R51	D-3	R71	I-2	R91	G-3
C16	H-2	C41	F-3	L9	E-4	Q12	E-3	R17	J-3	R33	K-3	R52	D-4	R72	J-2	R92	F-4
C17	D-4	C42	D-2	L10	E-4	Q14	E-2	R18	E-2	R34	K-3	R53	D-4	R73	I-2	U1	F-4
C22	D-4	CR1	L-3	L11	F-3	Q17	E-2	R18	E-2	R35	K-3	R54	D-4	R74	J-2	U3	I-2
C23	E-3	CR2	G-3	L12	G-5	R1	J-3	R19	E-2	R36	C-4	R54	D-4	R74	D-3	U4	I-2
C24	E-3	CR3	L-3	L81	F-3	R2	J-3	R20	F-3	R37	C-4	R55	D-4	R75	E-3	U6	K-2
C25	E-4	CR4	E-4	L82	F-3	R3	J-3	R20	E-2	R38	D-4	R57	G-5	R76	F-5	U6	K-2
C26	G-5	CR5	E-4	J3	B-4	R4	J-3	R20	E-3	R38	D-4	R58	G-5	R77	F-2	W19	H-4

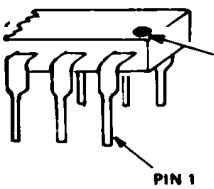
U1, U2



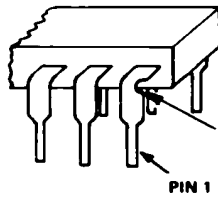
**NOTE**  
1. PINS ARE NUMBERED AS FOLLOWS:



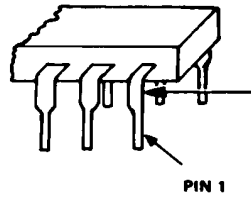
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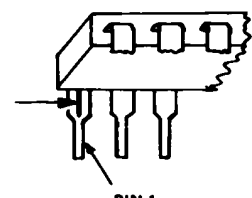
MARK ON CASE



CUT-AWAY



CUT-OUT



SCRATCH

1

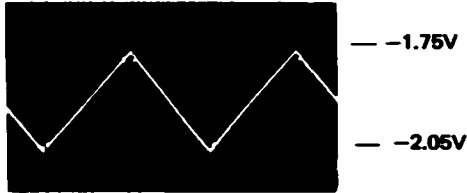
Q10c  
(Q11c is  
complement)



100ns/Div

2

U1-5



100ns/Div

3

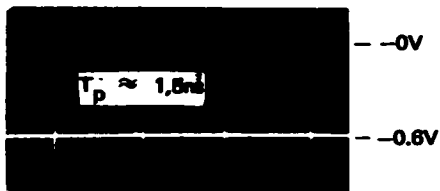
U1-11



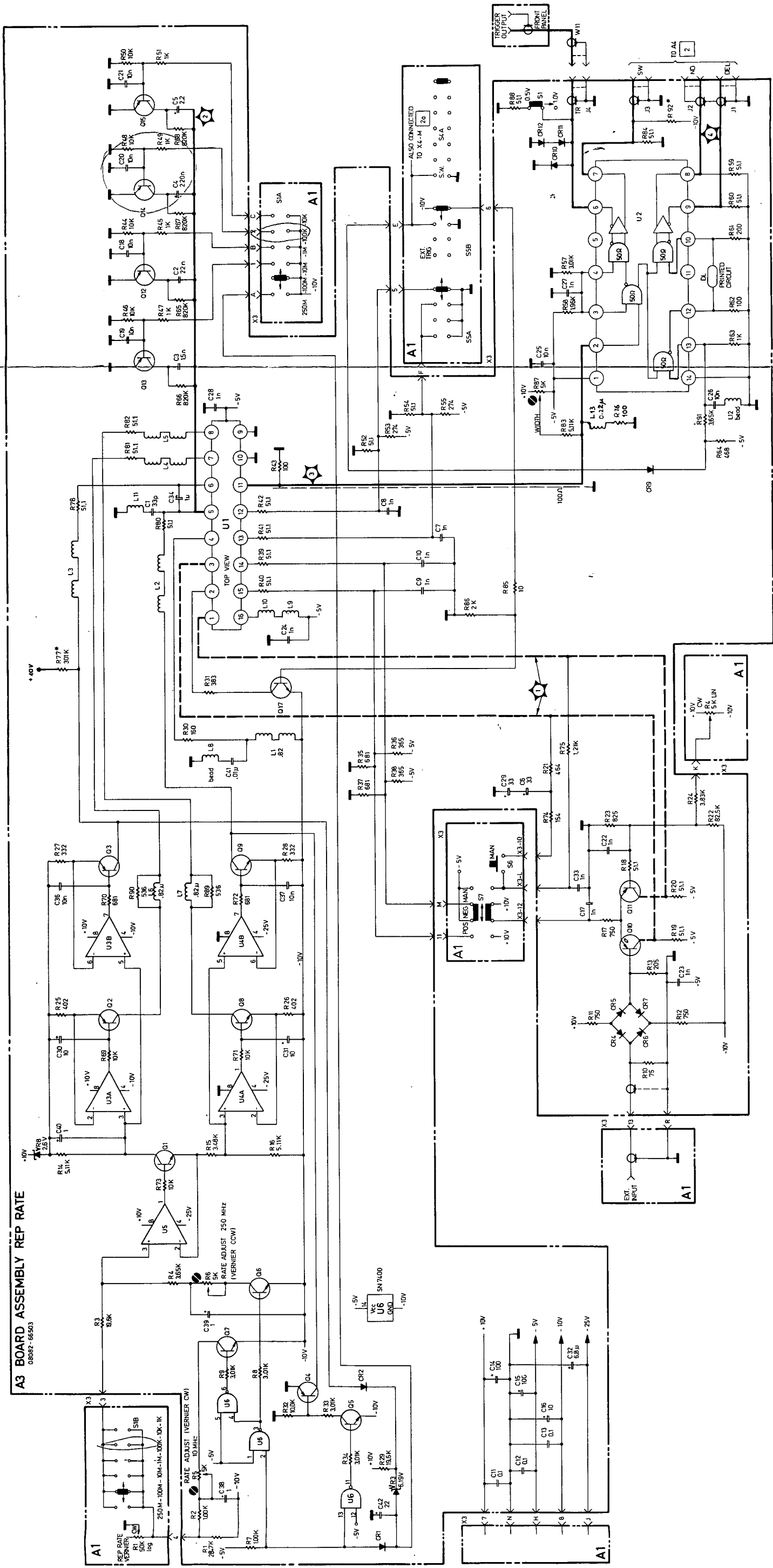
100ns/Div

4

U2-9  
(U2-8 is  
complement)

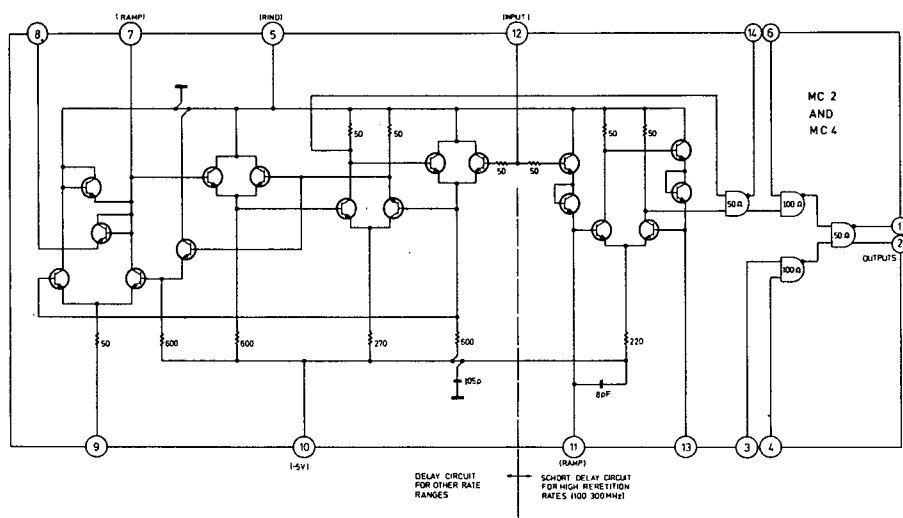


100ns/Div



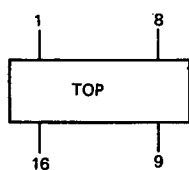


U2, U4

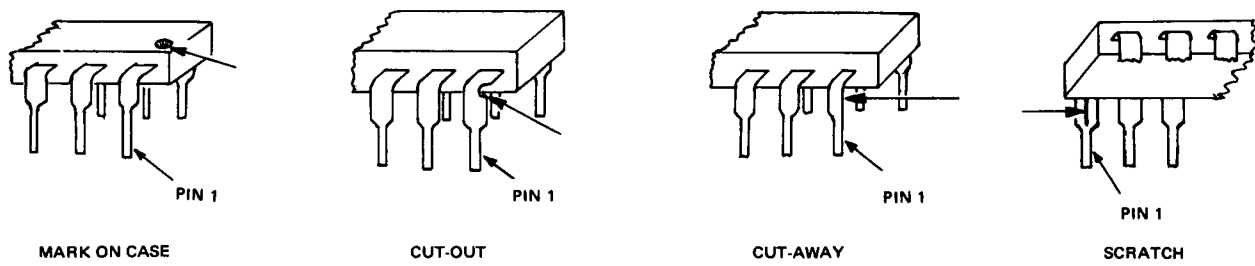


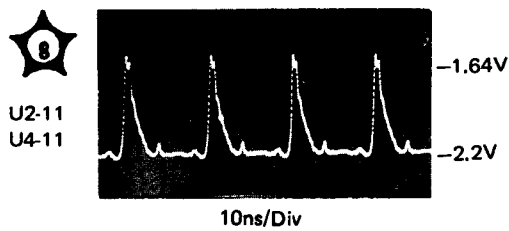
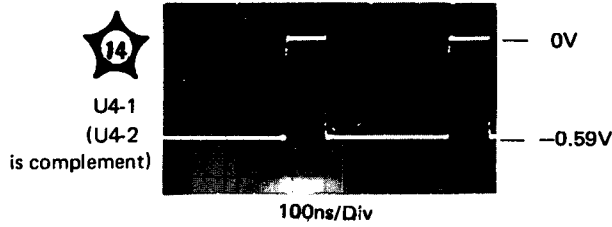
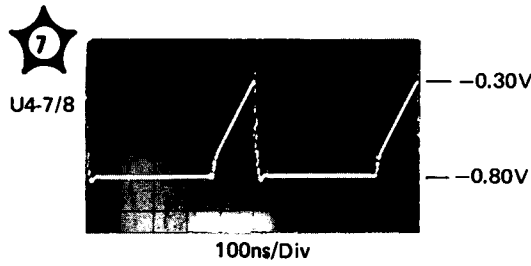
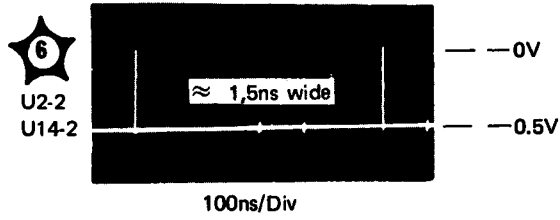
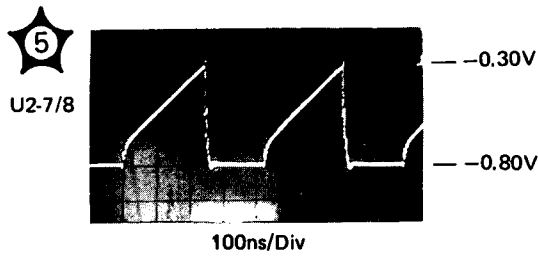
**NOTE**

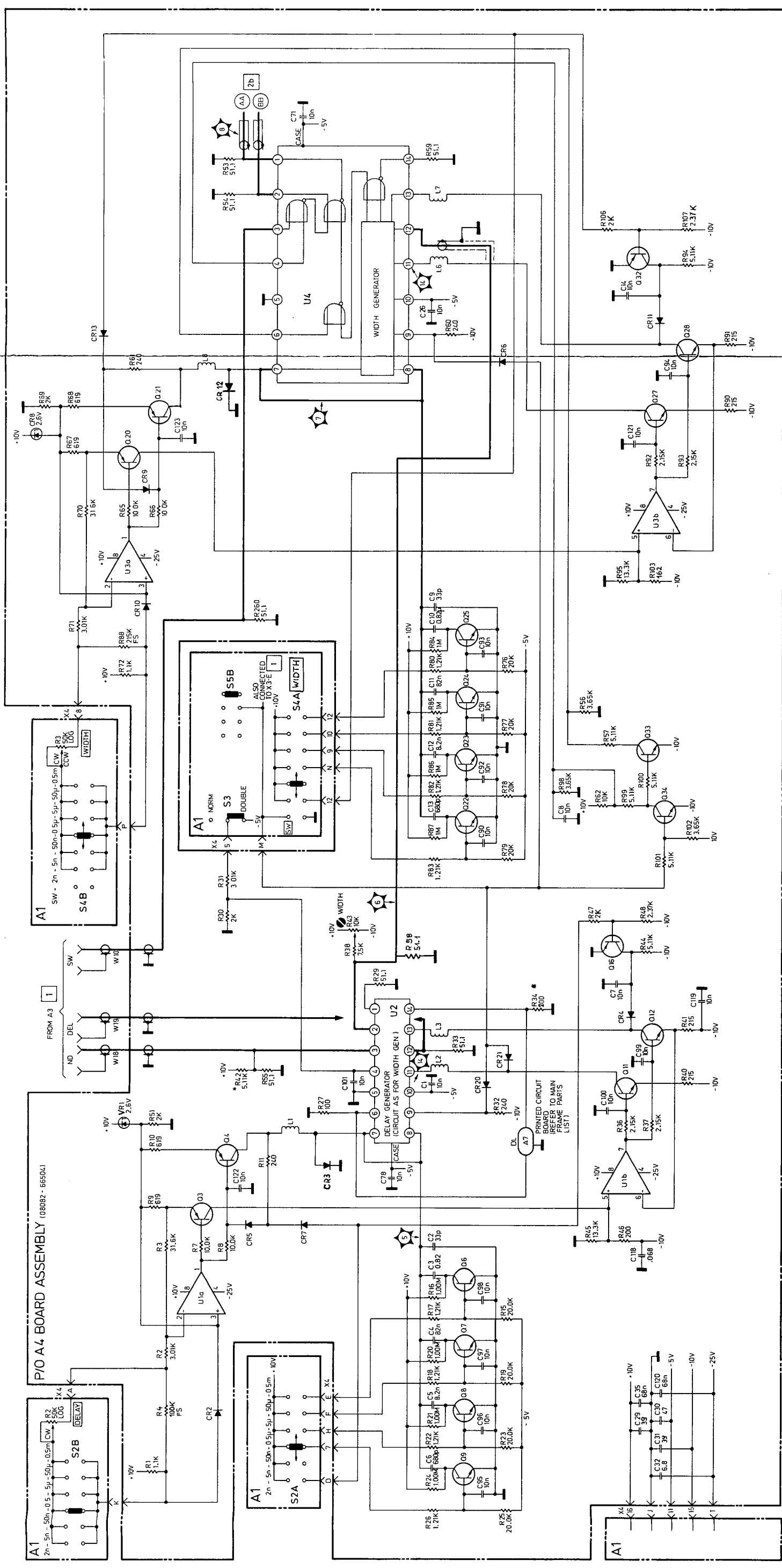
1. PINS ARE NUMBERED AS FOLLOWS:



2. PIN 1 IS IDENTIFIED IN ONE OF THE FOLLOWING WAYS:

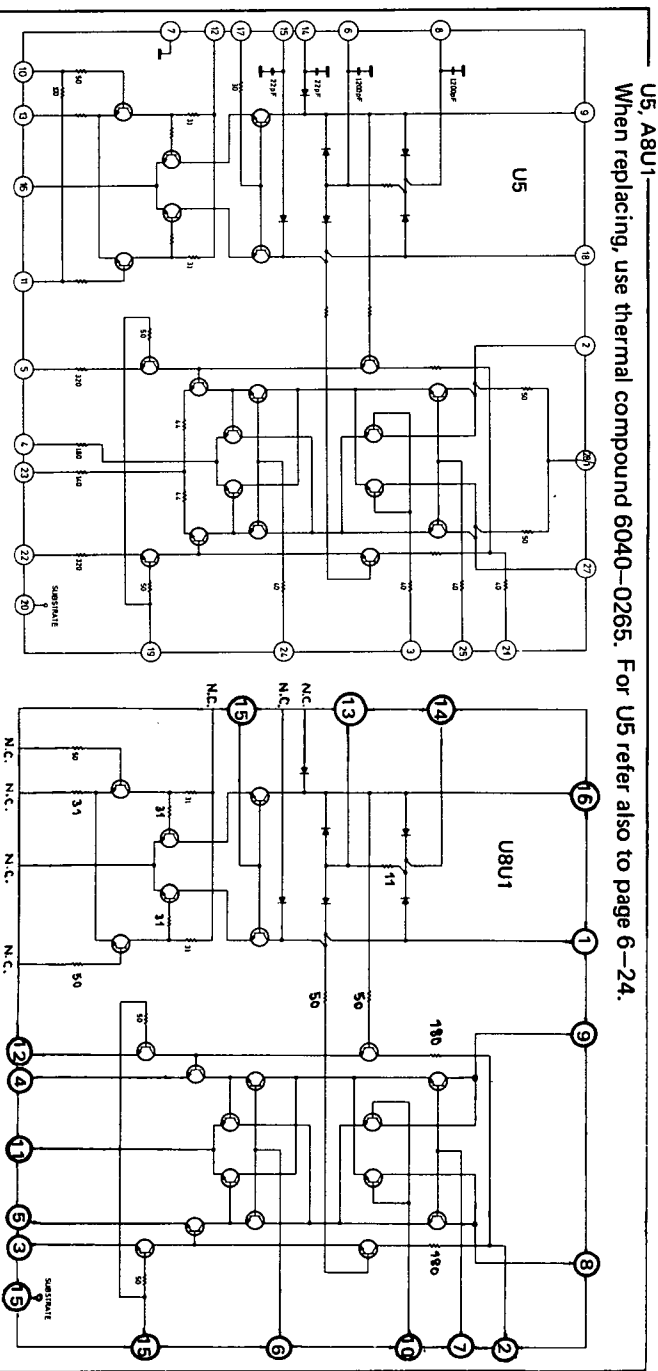
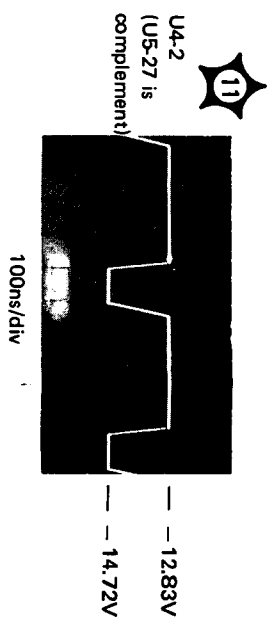
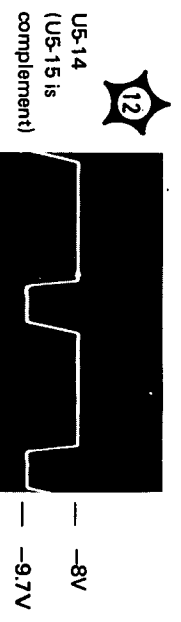
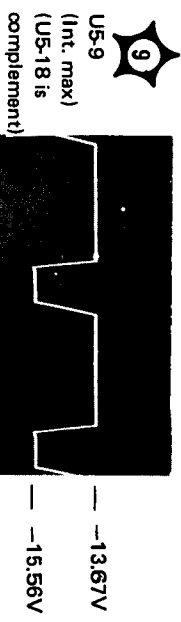
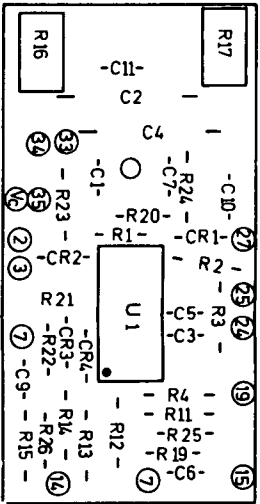






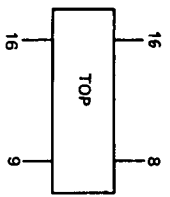


Board A8 - Buffer Amplifier Layout

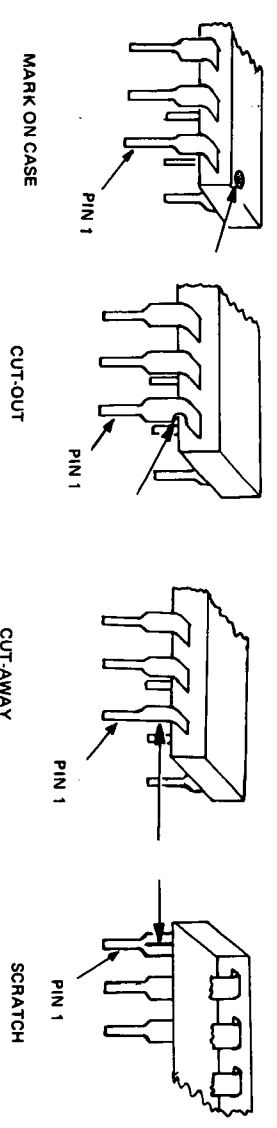


U5, A8U1  
 When replacing, use thermal compound 6040-0265. For U5 refer also to page 6-24.

NOTE  
 1. PINS ARE NUMBERED AS FOLLOWS:

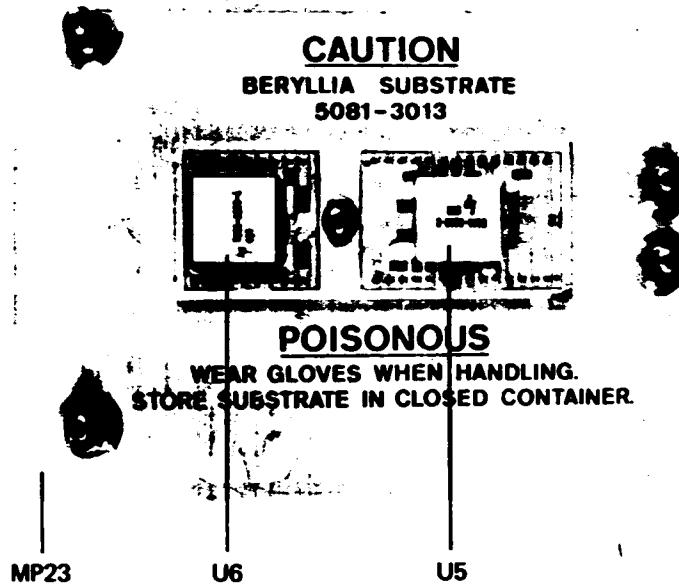


2. PIN 1 IS IDENTIFIED IN ONE OF THE FOLLOWING WAYS:





U5, U6



**CAUTION**  
Ensure U5, U6 are oriented as shown

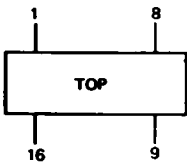
**NOTE:** Disregard poisonous materials CAUTION on MP23. (Beryllia is non-toxic when solid and in fired ceramic). Risk lies in breathing particles. This is only possible if the substrate is:

1. ground with a very hard abrasive
2. heated to 800°C in damp air

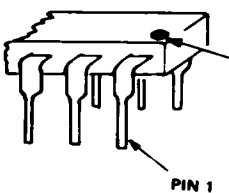
Neither procedure is necessary and both must be avoided.

U6

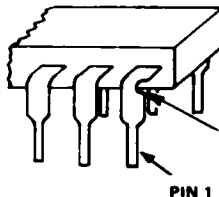
**NOTE**  
1. PINS ARE NUMBERED AS FOLLOWS:



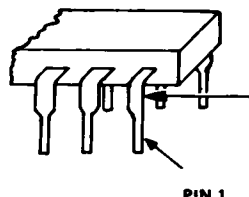
2. PIN 1 IS IDENTIFIED IN ONE OF THE FOLLOWING WAYS:



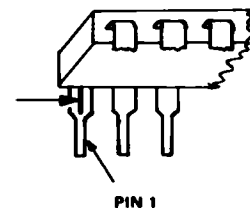
MARK ON CASE



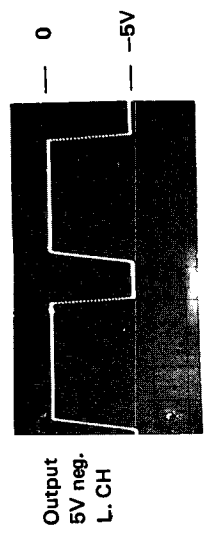
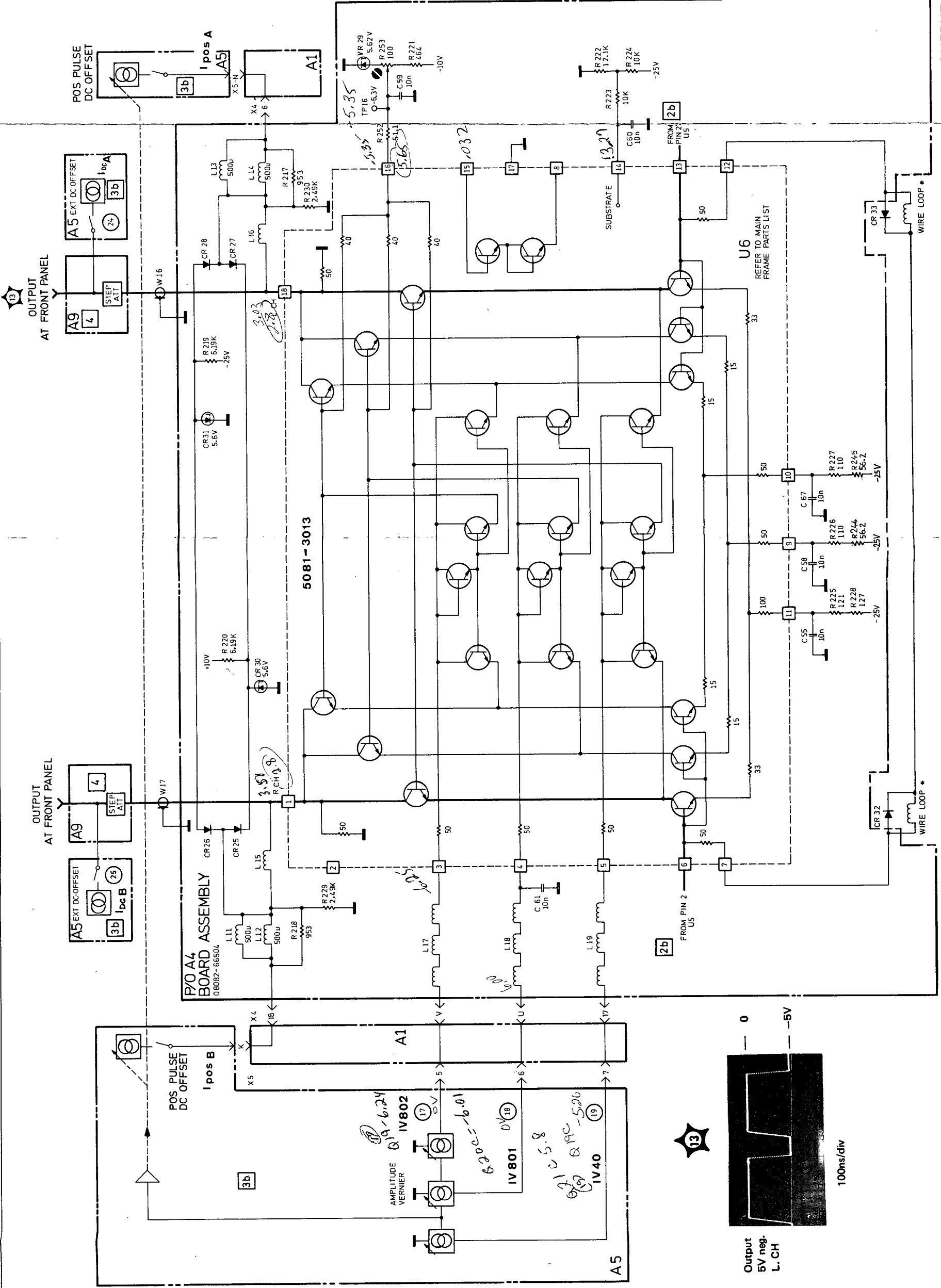
CUT-OUT



CUT-AWAY

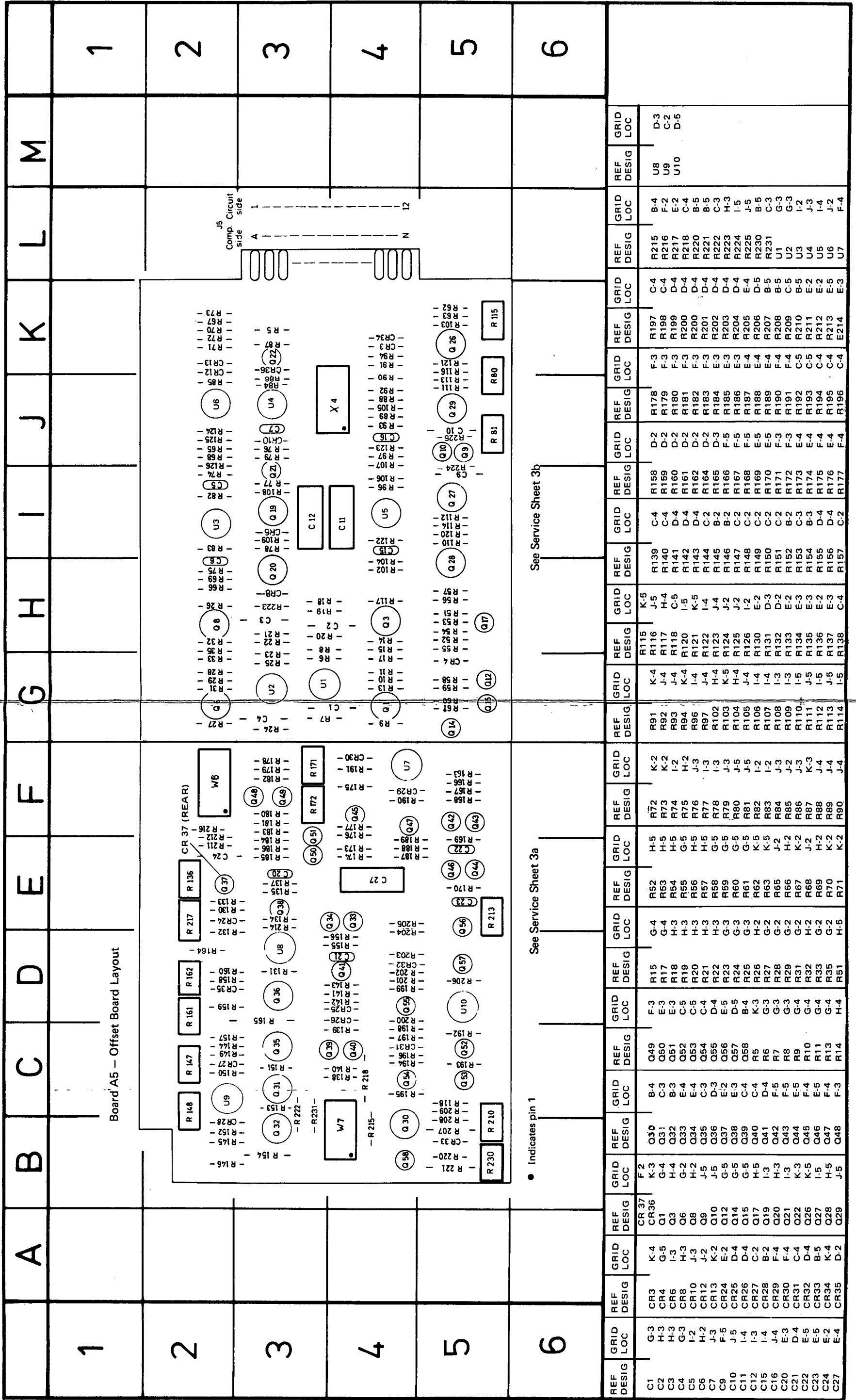


SCRATCH



Output 5V neg. L. CH

100ns/div



Board A5 - Offset Board Layout

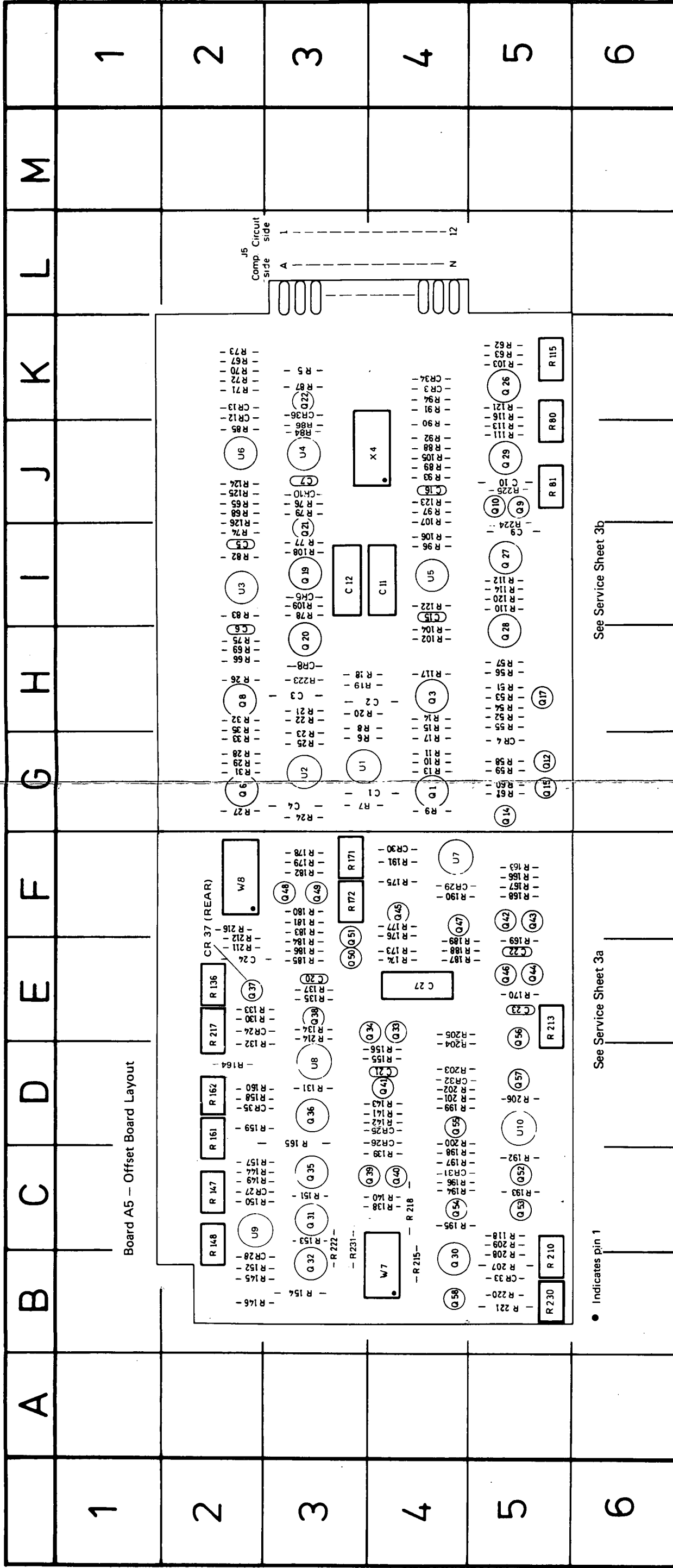
● Indicates pin 1

See Service Sheet 3a

See Service Sheet 3b

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	
C1	G-3	CR37	F-2	R91	K-4	R115	K-5	R139	C-4	R158	D-2	R178	F-3	R197	C-4	R215	B-4	R235	I-5	U8	D-3	
C2	H-3	CR36	K-3	R92	J-4	R116	J-5	R140	C-4	R159	D-2	R179	F-3	R198	C-4	R216	F-2	R230	I-5	U9	C-2	
C3	H-3	Q1	G-4	R93	K-2	R117	H-4	R141	D-4	R160	D-2	R180	F-3	R199	D-4	R217	E-2	R230	I-5	U10	D-5	
C4	G-3	Q3	H-4	R94	I-2	R118	C-5	R142	D-4	R161	D-2	R181	F-3	R200	D-4	R218	C-4	R230	I-5			
C5	I-2	Q6	G-2	R95	H-2	R120	I-5	R143	D-4	R162	D-2	R182	F-3	R200	D-4	R220	B-5	R230	I-5			
C6	H-2	Q8	H-2	R96	J-3	R121	K-5	R144	C-2	R163	D-2	R183	F-3	R201	D-4	R221	B-5	R230	I-5			
C7	H-2	Q9	H-3	R97	I-3	R122	J-4	R145	B-2	R164	D-2	R184	F-3	R202	D-4	R222	H-3	R230	I-5			
C8	J-3	Q10	H-3	R98	J-3	R123	J-2	R146	B-2	R165	F-5	R185	F-5	R203	D-4	R223	H-3	R230	I-5			
C9	F-5	Q12	G-5	R99	J-3	R124	J-2	R147	C-2	R166	F-5	R186	F-5	R204	D-4	R224	I-5	R230	I-5			
C10	J-5	Q14	G-5	R100	J-5	R125	J-2	R148	C-2	R167	F-5	R187	F-5	R205	D-4	R225	J-5	R230	I-5			
C11	I-4	Q15	G-5	R101	J-5	R126	I-2	R149	C-2	R168	F-5	R188	F-5	R206	D-5	R226	B-5	R230	I-5			
C12	I-3	Q17	K-5	R102	I-2	R130	E-2	R150	C-2	R169	E-5	R189	E-4	R207	B-5	R227	B-5	R230	I-5			
C13	I-4	Q19	K-5	R103	I-2	R131	D-3	R151	C-2	R170	E-5	R190	F-4	R208	B-5	R228	B-5	R230	I-5			
C14	H-3	Q20	K-5	R104	I-2	R132	D-2	R152	B-2	R171	F-3	R191	F-4	R209	G-3	R229	G-3	R230	I-5			
C15	I-4	Q21	K-5	R105	J-3	R133	D-2	R153	C-3	R172	F-3	R192	F-4	R210	B-5	R230	G-3	R230	I-5			
C16	J-4	Q22	K-3	R106	J-3	R134	E-3	R154	B-3	R173	E-4	R193	C-5	R211	B-5	R230	G-3	R230	I-5			
C17	I-3	Q23	H-2	R107	J-3	R135	E-3	R155	D-4	R174	E-4	R194	C-4	R212	B-5	R230	G-3	R230	I-5			
C18	I-4	Q24	K-2	R108	J-3	R136	E-2	R156	D-4	R175	F-4	R195	C-4	R213	B-5	R230	G-3	R230	I-5			
C19	J-4	Q25	K-2	R109	J-3	R137	E-2	R157	D-4	R176	F-4	R196	C-4	R214	B-5	R230	G-3	R230	I-5			
C20	E-3	Q26	K-2	R110	J-3	R138	E-3	R158	C-2	R177	F-4	R197	C-4	R215	B-5	R230	G-3	R230	I-5			
C21	D-4	Q27	H-2	R111	J-5	R139	E-3	R159	C-2	R178	F-4	R198	C-4	R216	B-5	R230	G-3	R230	I-5			
C22	E-5	Q28	K-3	R112	J-5	R140	E-2	R160	C-2	R179	F-4	R199	C-4	R217	B-5	R230	G-3	R230	I-5			
C23	E-2	Q29	H-5	R113	J-5	R141	E-2	R161	C-2	R180	F-4	R200	C-4	R218	B-5	R230	G-3	R230	I-5			
C24	E-2	Q28	H-5	R114	J-5	R142	E-3	R162	C-2	R181	F-4	R201	C-4	R219	B-5	R230	G-3	R230	I-5			
C25	E-2	Q27	H-5	R115	J-5	R143	E-3	R163	C-2	R182	F-4	R202	C-4	R220	B-5	R230	G-3	R230	I-5			
C26	E-2	Q27	H-5	R116	J-5	R144	E-3	R164	C-2	R183	F-4	R203	C-4	R221	B-5	R230	G-3	R230	I-5			
C27	E-4	Q29	J-5	R117	J-5	R145	E-3	R165	C-2	R184	F-4	R204	C-4	R222	B-5	R230	G-3	R230	I-5			





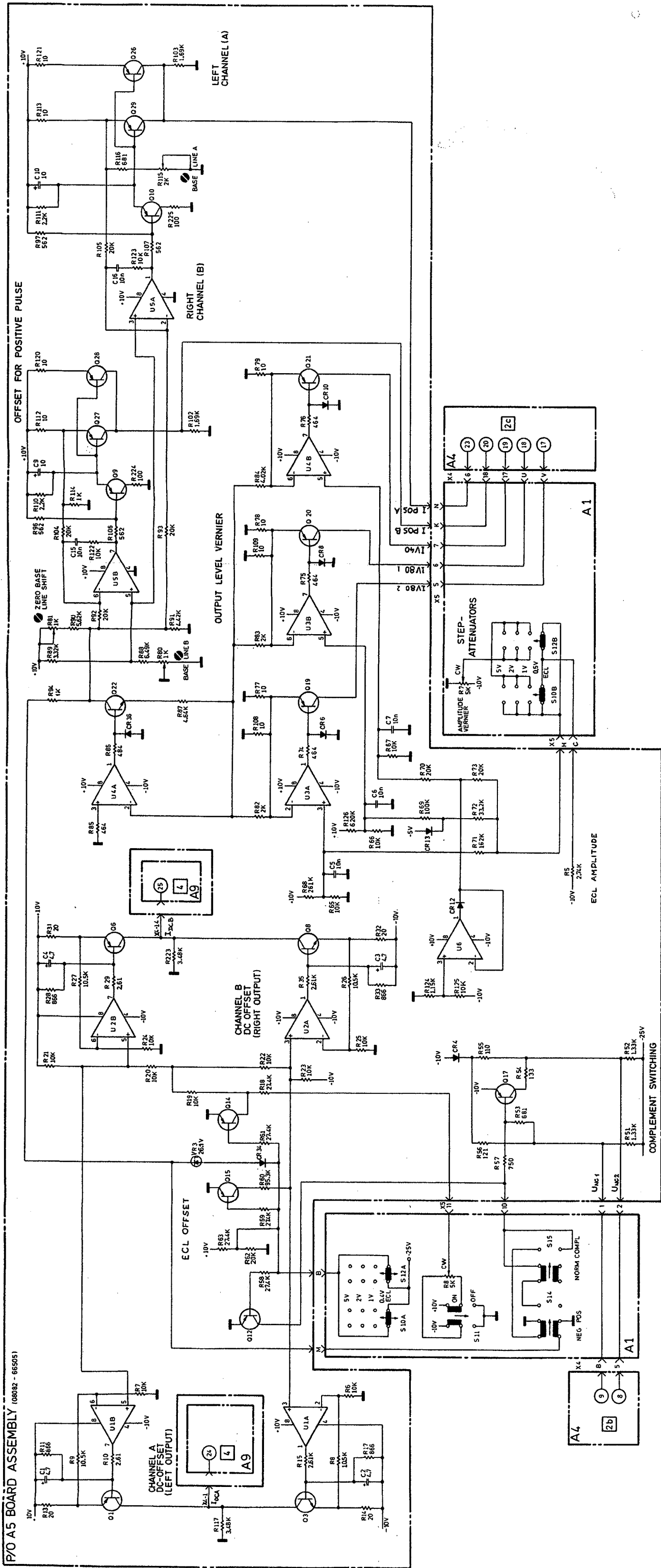
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C1	G-3	CR37	F-2	R91	K-4	R115	K-5	R139	C-4	R158	D-2	R178	F-3	R197	C-4	R215	B-4
C2	H-3	CR36	K-3	R92	J-4	R116	J-5	R140	C-4	R159	D-2	R179	F-3	R198	C-4	R216	F-2
C3	H-3	Q1	G-4	R93	H-4	R117	H-4	R141	D-4	R160	D-2	R180	F-3	R199	D-4	R217	E-2
C4	G-3	Q3	H-4	R94	I-2	R118	C-5	R142	D-4	R161	D-2	R181	F-3	R200	D-4	R218	C-4
C5	I-2	Q6	G-2	R96	H-2	R120	I-5	R143	D-4	R162	D-2	R182	F-3	R200	D-4	R220	B-5
C6	H-2	Q8	H-2	R97	J-3	R121	K-5	R144	D-2	R163	D-2	R183	F-3	R201	D-4	R221	B-5
C7	J-3	Q9	J-5	R99	I-3	R122	J-4	R145	B-2	R164	D-2	R184	F-3	R202	D-4	R222	C-3
C8	H-2	Q10	J-5	R100	I-3	R123	J-4	R146	B-2	R165	D-2	R185	F-3	R203	D-4	R223	H-3
C9	F-5	Q12	G-5	R103	J-3	R124	J-2	R147	C-2	R166	F-5	R186	E-3	R204	D-4	R224	I-5
C10	J-5	Q14	G-5	R104	J-5	R125	J-2	R148	C-2	R167	F-5	R187	E-4	R205	D-4	R225	J-5
C11	I-4	Q15	G-5	R106	J-5	R126	I-2	R149	C-2	R168	F-5	R188	E-4	R206	D-5	R230	B-5
C12	I-3	Q17	H-5	R107	I-2	R130	E-2	R150	C-2	R170	E-5	R189	E-4	R207	B-5	R231	C-3
C15	I-4	Q19	K-5	R108	I-2	R131	D-3	R151	C-2	R171	F-3	R190	F-4	R208	B-5	U1	G-3
C16	J-4	Q20	H-3	R109	J-3	R132	D-2	R152	B-2	R172	F-3	R191	F-4	R209	C-5	U2	G-3
C20	D-4	Q21	G-2	R110	J-2	R133	E-3	R153	C-3	R173	F-3	R192	F-4	R210	B-5	U3	I-2
C21	D-4	Q22	K-3	R111	J-2	R134	E-3	R154	B-3	R174	E-4	R193	C-5	R211	E-2	U4	J-3
C22	E-5	Q26	K-2	R112	K-3	R135	E-3	R155	E-2	R175	E-4	R194	C-4	R212	E-2	U5	I-4
C23	E-5	Q27	H-2	R113	J-4	R136	E-2	R156	D-4	R176	F-4	R195	C-4	R213	E-2	U6	I-4
C24	E-2	Q28	K-2	R114	J-4	R137	E-3	R157	C-2	R177	F-4	R196	C-4	R214	E-5	U7	J-2
C27	E-4	Q29	K-2	R115	J-4	R138	C-4	R158	C-2	R178	F-4	R197	C-4	R215	E-3	U8	F-4

See Service Sheet 3b

See Service Sheet 3a

Indicates pin 1

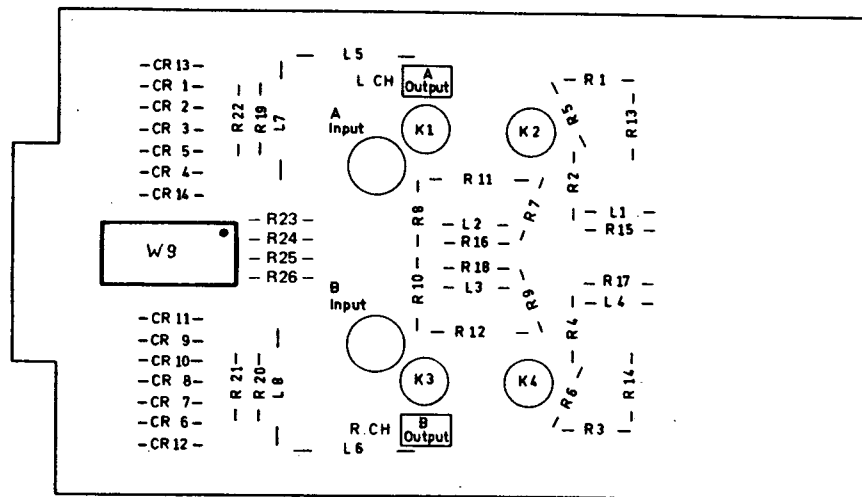
Board A5 - Offset Board Layout

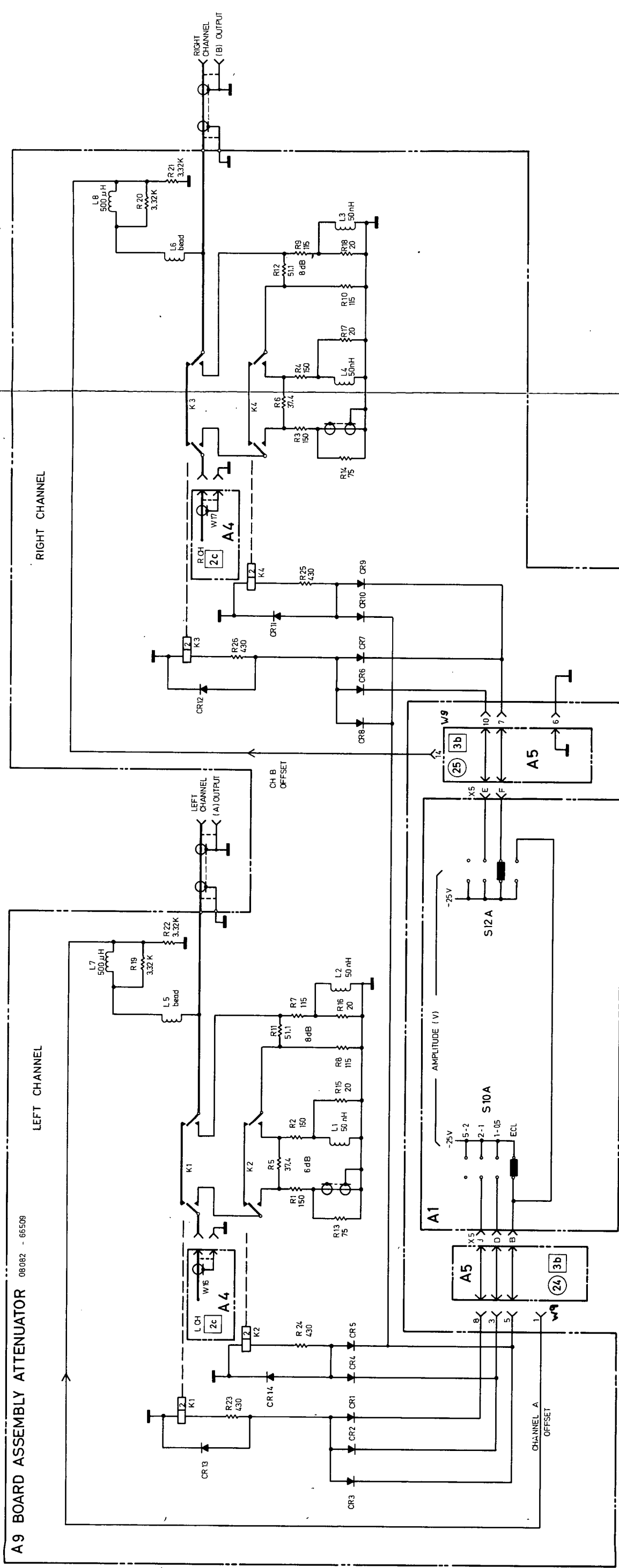


**3b**  
 DC OFFSET AND AMPLITUDE VERNIER—  
 PART OF BOARD A5



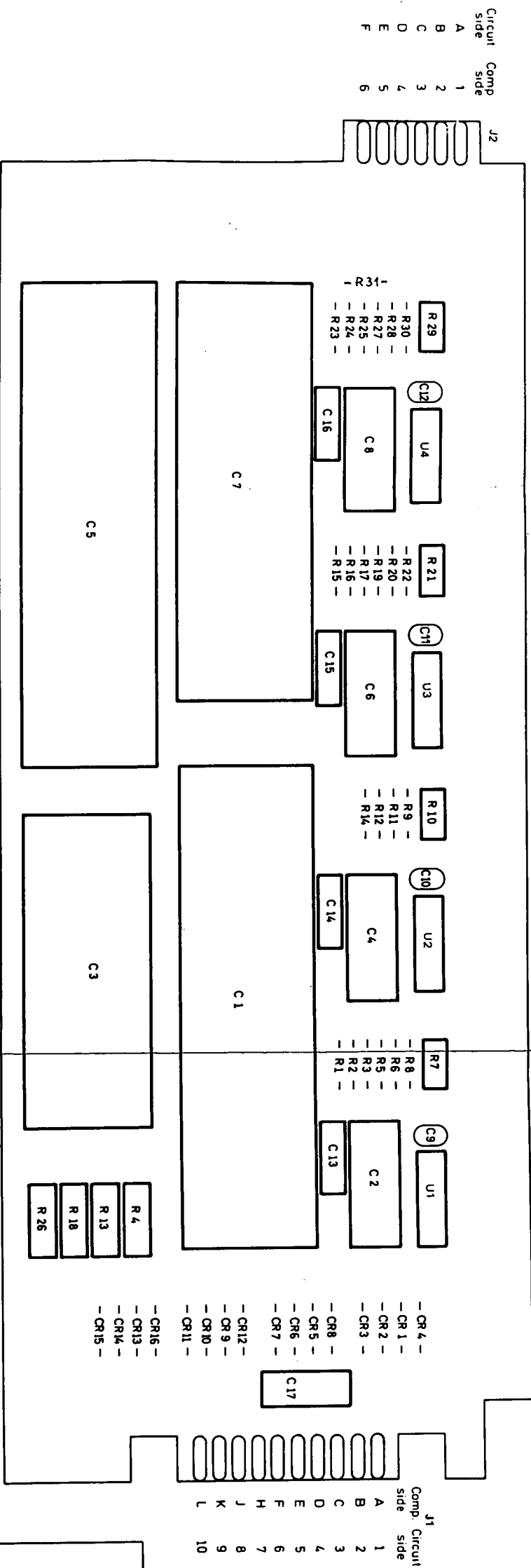
Board A9 – Attenuator Layout



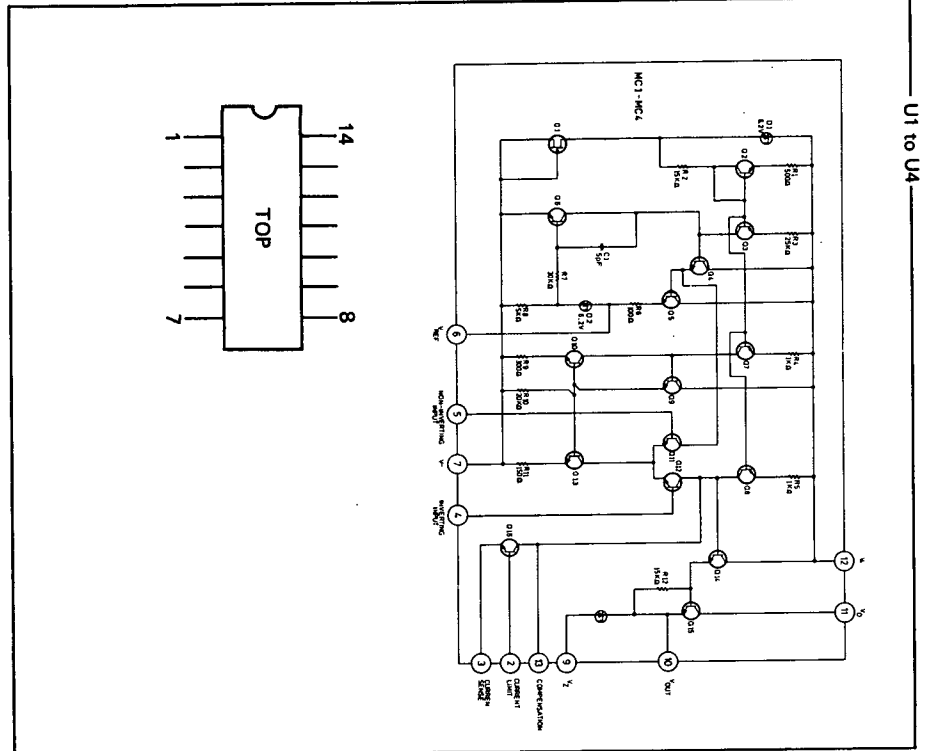


A9 BOARD ASSEMBLY ATTENUATOR 08082 - 66509

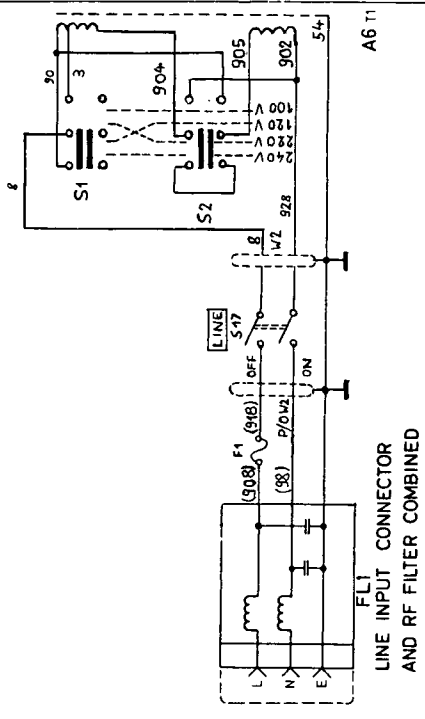
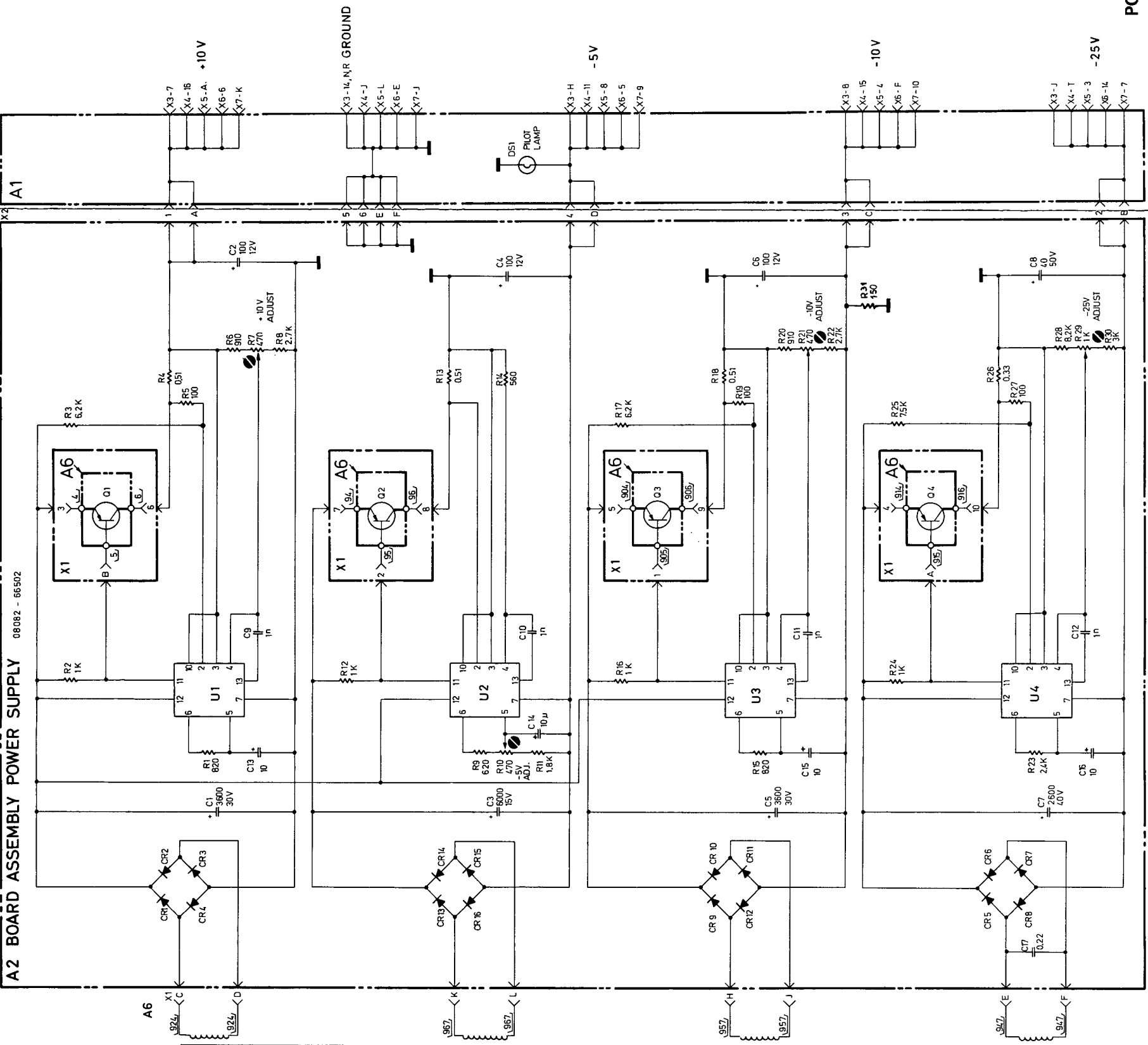
Board A2 - Power Supply Layout



- CR 4-
- CR 1-
- CR 2-
- CR 3-
- CR 8-
- CR 5-
- CR 6-
- CR 7-
- CR 12-
- CR 9-
- CR 10-
- CR 11-
- CR 16-
- CR 13-
- CR 14-
- CR 15-



A2 BOARD ASSEMBLY POWER SUPPLY 08082 - 66502



FL1 LINE INPUT CONNECTOR AND RF FILTER COMBINED

## 7-1 INTRODUCTION

7-2 This section contains backdating information which adapts this manual to instruments with serial numbers lower than that shown on the title page.

7-3 Changes are listed in the serial number order that they occurred in the manufacture of the instrument. However, in adapting this manual to an instrument with serial number lower than that shown on the title page, apply the changes in reverse order. That is, begin with the latest change that applies to the serial number in question. Table 7-1 lists the serial numbers to which each change applies. Where changes to components occur, alter the associated schematic and layout diagram as necessary.

Table 7-1 Manual Backdating Changes.

Serial No.	Changes
1410G00145 and lower	1 to 23
1410G00170 and lower	2 to 23
1410G00270 and lower	3 to 23
1410G00300 and lower	4 to 23
1410G00315 and lower	5 to 23
1410G00350 and lower	6 to 23
1410G00390 and lower	7 to 23
1410G00430 and lower	8 to 23
1410G00500 and lower	9 to 23
1635G00515 and lower	10 to 23
1635G00560 and lower	11 to 23
1635G00575 and lower	12 to 23
1635G00775 and lower	13 to 23
1635G00795 and lower	14 to 23
1635G00905 and lower	15 to 23
1635G00925 and lower	16 to 23
1822G01045 and lower	17 to 23
1822G01205 and lower	18 to 23
1822G01230 and lower	19 to 23
1822G01735 and lower	20 to 23
1822G02125 and lower	21 to 23
1822G02275 and lower	22 to 23
1822G02845 and lower	23

### CHANGE 1 (1410G00145 and below)

A9 R23, 24, 25, 26 are replaced by a wire link. Amplitude switches S10A, S12A (Schematic 4) are connected to -10 V (instead of -25 V as in later models). A9 K1, 2, 3, 4 are of different type but may be replaced by relay part number 0490-1034 (see A9 parts list) used in later models. The following components are different from those in later models:

A5CR3	1902-0025	DIODE ZNR 10V
A5R58-63	0757-0442	R-F 10K 1%
A5R62	0757-0440	R-F 7.5K 1%

### CHANGE 2 (1410G00170 and below)

Change frame parts list to read:

F1	1400-0084	FUSE HOLDER
S6	3101-0124	SW P-BTN SPST

Change A4 parts list to read:

CR17,CR18	1901-0533	DIO HOT CARR.
R204	0757-0283	R-F 2K

### CHANGE 3 (1410G00270 and below)

Change frame parts list to read:

F1	2110-0464	BODY FUSE
----	-----------	-----------

Delete the following from the frame parts list:

F1	1490-0090	WASHER NEOPRANE
F1	2190-0054	WASHER LOCK
F1	2110-0467	NUT HEX. MET
F1	2110-0465	FUSEHOLDER

### CHANGE 4 (1410G00300 and below)

Change A4 parts list to read:

C6	0160-4030	C-F 820 PF
C13	0160-4030	C-F 820 PF
R2	0757-0279	R-F 3.16K
R17	0757-0279	R-F 3.16K

**CHANGE 5 (1410G00315 and below)**

Change A5 parts list to read:

R88	0698-4471	R-F 7.15K
R90	0698-4444	R-F 4.87K

**CHANGE 6 (1410G00350 and below)**

Change A5 parts list to read:

R164	0757-0400	R-F 90.9
------	-----------	----------

**CHANGE 7 (1410G00390 and below)**

Change A5 parts list to read:

CR3	1902-3256	DIO BKDN 23.7V
R94	0757-0273	R-F 3.01K
R142	0757-0273	R-F 3.01K

For these instruments, R142 did not have a factory selected value.

**CHANGE 8 (1410G00430 and below)**

Delete the following components from the A5 parts list, schematics and component layouts:

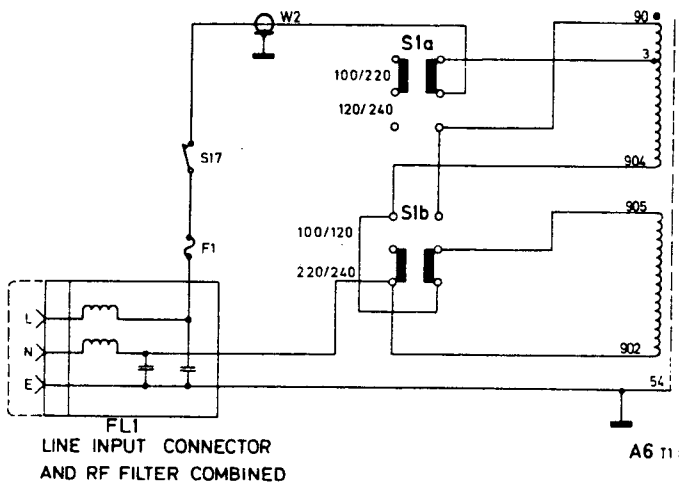
CR23, CR37, R224 and R225

**CHANGE 9 (1410G00500 and below)**

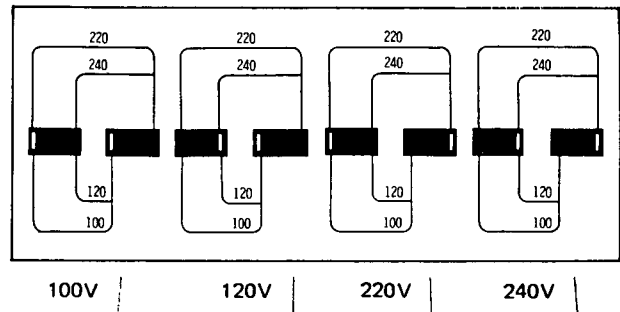
Change frame parts list to read:

MP7	08082-00203	PANEL REAR
S1	3101-1609	SWITCH DPDT DUAL

Page 6-33, change diagram to read:



Page 2-2, replace Figure 2-4 content by:



**CHANGE 10 (1635G00515 and below)**

Change the A3 parts list to read:

L2-L5	9170-0029	CORE SHIELDING BEAD
L6-L10	9170-0029	CORE SHIELDING BEAD
L15-L19	9170-0029	CORE SHIELDING BEAD
L24,L26	9170-0029	CORE SHIELDING BEAD

Change the A9 parts list to read:

L5,L6	9170-0029	CORE SHIELDING BEAD
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**CHANGE 11(1635G00560 and below)**

Delete the following from the frame parts list:  
MP33, MP34, MP35, MP36

**CHANGE 12 (1635G00575)**

Change the A4 parts list to read:

R47,R106	0757-0283	R-FXD 2K 1% .125W
R241	0698-5180	R-FXD 2K 5% .125W

Delete the following components from the A4 parts list, schematic and component layout:  
L30, L31, R242 and R243

**CHANGE 13 (1635G00775 and below)**

Change A3 parts list to read:

R5,R6,R87	2100-2788	R-VAR 4.7K
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**CHANGE 14 (1635G00795 and below)**

Delete A2 R31 from parts list, schematic and component layout.

Change A5 parts list to read:

R165            0698-5890    R-F 39 OHM

**CHANGE 15 (1635G00905 and below)**

Change A2 parts list to read:

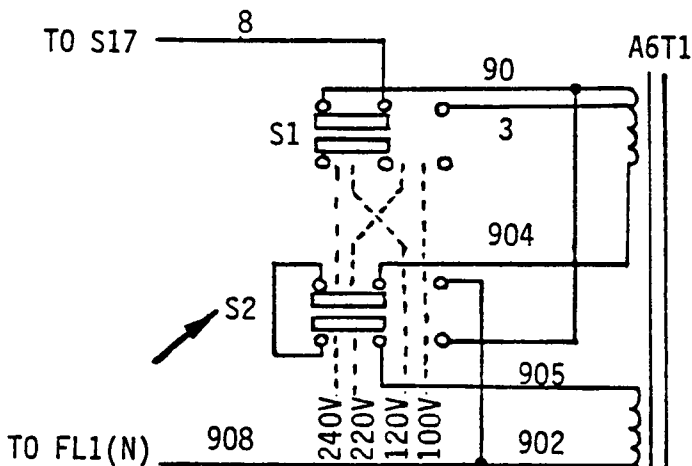
C15            0180-0374    C-F 10 UF 20V

**CHANGE 16 (1635G00925 and below)**

Change frame parts list to read:

W2            08082-61602   CBL AY PWR SHLD

Change schematic 5 as follows:

**CHANGE 17 (1822G01045 and below)**

Change frame parts list to read:

MP7            08082-00204   PANEL REAR

Add the following parts to the frame parts list:

FL1            9135-0035    FILTER LINE  
S1,S2        3101-2298    SW SLIDE

**CHANGE 18 (1822G01205 and below)**

Change A4 parts list to read:

C19,C20       5080-1087    CAP SELECT  
C17,C18       5080-1088    CAP SELECT

**CHANGE 19 (1822G01230 and below)**

Change frame parts list to read:

MP4            08015-04103   COVER BOTTOM

**CHANGE 20 (1822G01735 and below)**

Delete L13 from the A3 parts list, schematic and component layout.

Change the A4 parts list to read:

R103           0757-0407    R-F 200  
R208           0757-0424    R-F 1.1K

Replace VR42 with R209 on A4 parts list, component layout and schematic.

R209           0757-0428    R-F 1.62K

Change A5 parts list to read:

C22,C23       0160-4209    C-F .01UF

**CHANGE 21 (1822G02125 and below)**

Change the frame parts list to read:

R1,R2,R3       2100-3081    RESISTOR VAR. 50K 10%

**CHANGE 22 (1822G02275 and below)**

Change the A4 parts list to read:

R225           0757-0403    R-F 121 1%  
R226,R227    0757-0798    R-F 110 1%  
R228           0698-4409    R-F 127 1%

Delete R224 and R245 from the A4 parts list, component layout and schematic.

**CHANGE 23 (1822G02845 and below)**

Change the A4 parts list to read:

J1            1200-0423    SKT IC 16CON  
J2            1200-0424    SKT IC 14CON