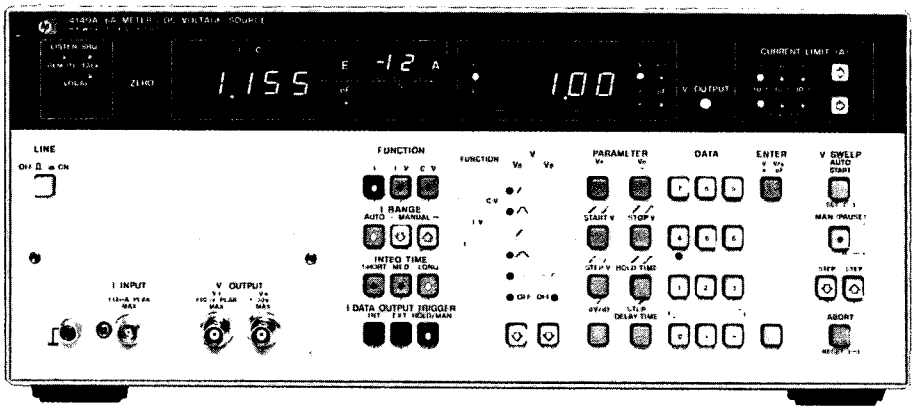
SERVICE MANUAL

4140A
pA METER/DC VOLTAGE SOURCE



HEWLETT PACKARD

HP 4140A

HEWLETT PACKARD

SERVICE MANUAL

MODEL 4140A

pA METER/DC VOLTAGE SOURCE

(including Options 001 and 101)

SERIAL NUMBERS

This manual applies directry to instruments with serial numbers prefixed 1917J

Manual Part No. 04140-90010
Microfiche Part No. 04140-90060

Printed: DEC 1979

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SECTION IV

PERFORMANCE TESTS

4-1. INTRODUCTION

4-2. The procedures in this section test instrument electrical performance using the specifications of Table 1-1 as the performance standards. All tests can be performed without access to the interior of the instrument. A simpler operational test is included in section III under Self Test. The performance test procedures in this section can also be used to do an incoming inspection of the instrument or to verify whether the instrument meets its specified performance after troubleshooting or making adjustments. If specifications are found to be out of limits, check that controls are properly set, and then proceed to adjustments or troubleshooting.

Note

Allow a 60 minute warm up and stabilization period before conducting any performance test.

4-3. EQUIPMENT REQUIRED

4-4. Equipment required for performance tests is listed in Table 4-1 Recommended Performance Test Equipment. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model(s).

Note

Decade resistor and standard resistors should be calibrated by an instrument whose specifications are traceable to NBS, PTB, LNE, NRC, JEMIC or equivalent standards group; or they should be directly calibrated by an authorized calibration organization such as NBS. The calibration cycle should be determined by the stability specification for each resistor.

4-5. TEST RECORD

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

4-7. CALIBRATION CYCLE

4-8. This instrument requires periodic verification of performance. Depending on the use and environmental conditions, the instrument should be checked using the following performance tests at least every six months.

4-9. AUTO SETTING MODES

4-10. The 4140A provides thirteen auto setting modes as given in Table 4-2 for performance tests and adjustments. To set any one of these modes, proceed as follows:

(1) Press "Blue, SELF TEST 1" to set 4140A to Self Test mode.

(2) Press "Blue" and select and press desired control key from Table 4-2 to set the mode.

(3) To cancel any of the above modes, press "Blue, SELF TEST 1".

Table 4-1. Recommended Test Equipment.

Equipment	Critical Specifications	Recommended Model	Use*
DC Voltmeter	Voltage range: 100mV to 1000V f.s. Sensitivity: 1μV min. Accuracy : 0.001% Input impedance: >10MΩ Remote Control: via HP-IB	HP 3455A	P,A,T
Test Leads	Triaxial (Male) - Triaxial (Male) Cable (1ea) BNC (Male) - BNC (Male) Cable (2ea)	HP 16053A	P,A,T
Test Cable	BNC (Male) - Dual Banana Plug Cable	HP 11001A	P,A,T
Adapter	Dual Banana Plug - Alligator Clip Cable	HP 11002A	A,T,
	BNC T Type Adapter	HP Part No.: 1250-0781	P,A,T
	BNC (Female) - Banana Plug Adapter	HP 10111A (2ea)	P,A,T
	BNC (Male) - Triaxial (Female) Adapter	TROMPTER AD-BJ77-E3-PL20	P,A,T
	BNC (Female) - Triaxial (Male) Adapter	TROMPTER AD-BJ20-E3-PL75	A
Decade Resistor	Range: $10^2\Omega \sim 10^7\Omega$ Accuracy: 0.01%	GR1433H	P,A,T
Standard Resistors	Range: $10^9\Omega \sim 10^{13}\Omega$ Accuracy: ±0.2%	KEITHLEY 5155	P,T
Desktop Computer	for HP-IB Controller	HP 9835A with 98332A	P,A
HP-IB Interface Card with Cable	Cable Length: approximately 4 m	HP 98034A	P,A
HP-IB Cable	Cable Length: approximately 0.5m	HP 16031D (2ea)	P,A
Timing Generator	Time Accuracy: ±100ns Pulse Width: >1μs Rise Time: 50ns Remote Control: via HP-IB	HP 59308A	P,A
Extender Board	22pin x 2	HP Part No.: 5060-4025	A,T
Clip-Clip Cable		2ea	A,T
Signature Analyzer		HP 5004A	T
Current Tracer		HP 547A	T
Oscilloscope	Bandwidth: 10MHz min. Voltage Sensitivity: 500mV/div. Horizontal Sweep Rate: 1μs/div.	HP 1220A	T
10:1 Probe	Input Impedance: 10MΩ	HP 10013A	T

*P = Performance Test, A = Adjustment, T = Troubleshooting.

Table 4-2. Auto Setting Modes for Performance Tests and Adjustments.

Mode*	Control key	Description
S-1	V_B m	Both V_A and V_B output 0.00V. With Option 001, both I/C OUTPUT and V_A OUTPUT on the rear panel output 0.000v.
S-2	V_B m	Both V_A and V_B output -0.01V. With Option 001 both I/C OUTPUT and V_A OUTPUT output -0.001V.
S-3	7	Both V_A and V_B output -10.00V. With Option 001, both I/C OUTPUT and V_A OUTPUT output -1.000V.
S-4	8	Both V_A and V_B output +10.00V. With Option 001, both I/C OUTPUT and V_A OUTPUT output +1.000V.
S-5	9	Both V_A and V_B output 0.0V. With Option 001, both I/C OUTPUT and V_A OUTPUT output 0.00V.
S-6	ENTER V_A/V_B	Both V_A and V_B output -100.0V. With Option 001, both I/C OUTPUT and V_A OUTPUT output -10.00V.
S-7	AUTO START SET (-)	Both V_A and V_B output +100.0V. With Option 001, both I/C OUTPUT and V_A OUTPUT output +10.00V.
S-A	START V	Both ZERO and HOLD (pA Meter section control signals) are set to High.
S-H	STOP V	ZERO is set to Low and HOLD is set to High.
S-0	4	ZERO is set to High and Hold is set to Low.
S-F	5	Both ZERO and HOLD are set to High.
S-C	6	Comparator circuit in pA Meter section alternately outputs high or low level signal.
S-P	MAN (PAUSE) 0	The pA Meter section is set to measurement mode with internal trigger and auto range. Both V_A and V_B output +1.800V. With Option 001, both I/C OUTPUT and V_A OUTPUT output +1.800V.

* Mode name is displayed in I·C DISPLAY when its mode is set.

PERFORMANCE TESTS

4-11. VOLTAGE OUTPUT ACCURACY TEST.

4-12. This test verifies DC Voltage Source output voltages for all ranges.

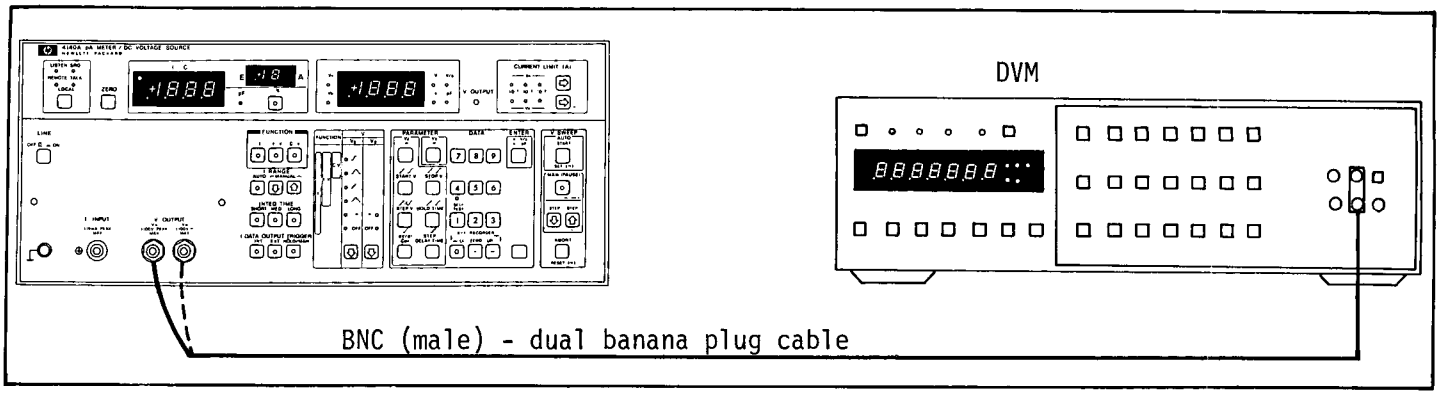

Figure 4-1. Voltage Output Accuracy Test Setup.

EQUIPMENT:

DVM	HP 3455A
BNC (Male) - Dual Banana Plug Cable	HP 11001A

PROCEDURE:

1. Connect BNC (Male) - dual banana plug cable between 4140A V_A OUTPUT connector and DVM (see Figure 4-1).

2. Set DVM controls as follows:

FUNCTION	DCV
RANGE	AUTO
HIGH RESOLUTION	OFF
AUTO CAL	ON
GUARD	ON
TRIGGER	INTERNAL

3. Set 4140A controls as follows:

FUNCTION	I
V_A	⎓ (DC)
V_B	⎓ (DC)
CURRENT LIMIT (V_A and V_B)	10mA

4. Set PARAMETER (⎓) to a voltage in Table 4-3.

5. Press SET (⎓) key and read display output of DVM.

6. Press RESET (⎓) key.

7. Repeat steps 4 thru 6 and confirm that Table 4-3 is satisfied (change output voltage as appropriate).

8. Connect BNC (male) - dual banana plug cable between 4140A V_B OUTPUT and DVM.

9. Repeat steps 4 thru 7.

TEST LIMIT:

Table 4-3. Output Voltage Accuracy Test.

Voltage Setting (V)	Test Limits (V)
+100	+99.80 ∿ +100.20
+10	+9.982 ∿ +10.018
+1	+0.9883 ∿ +1.0117
0	-0.011 ∿ +0.011
-1	-1.0117 ∿ -0.9883
-10	-10.018 ∿ -9.982
-100	-100.20 ∿ -99.80

4-13. CURRENT MEASUREMENT ACCURACY TEST

4-14. This test verifies pA Meter measurement currents for all ranges.

Note

This test uses DC Voltage Source of 4140A. Therefore, Voltage Output Accuracy Test in paragraph 4-11 should be done before this test.

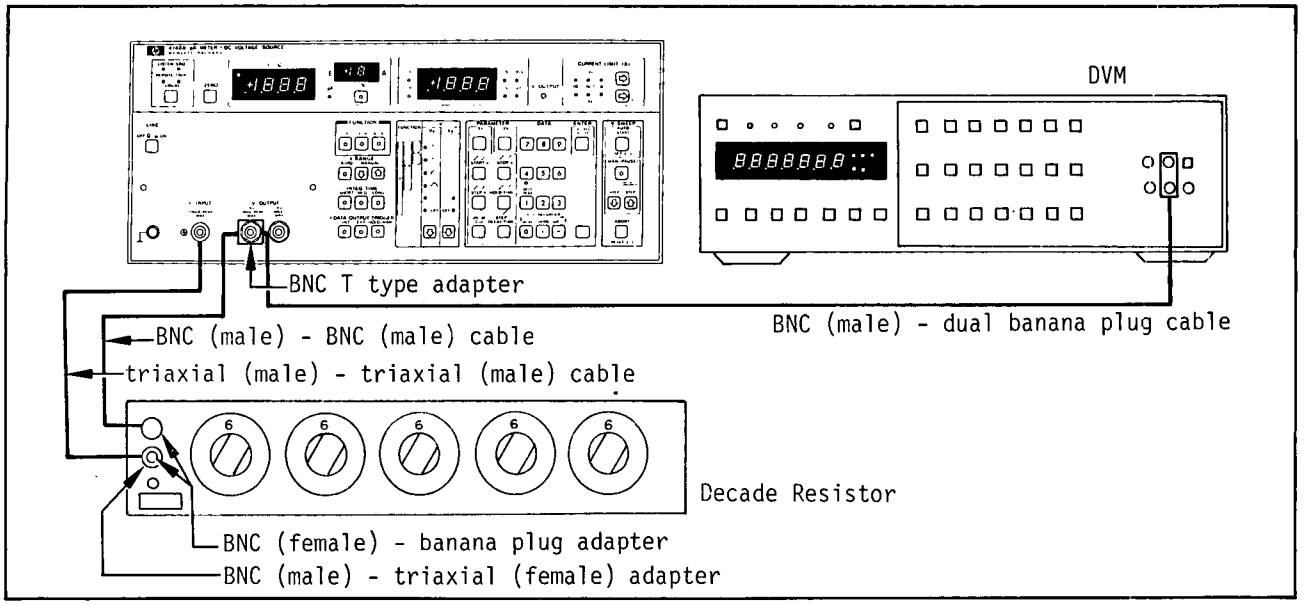

Figure 4-2. Current Measurement Accuracy Test Setup (10^{-2}A∿10^{-7}A Ranges).

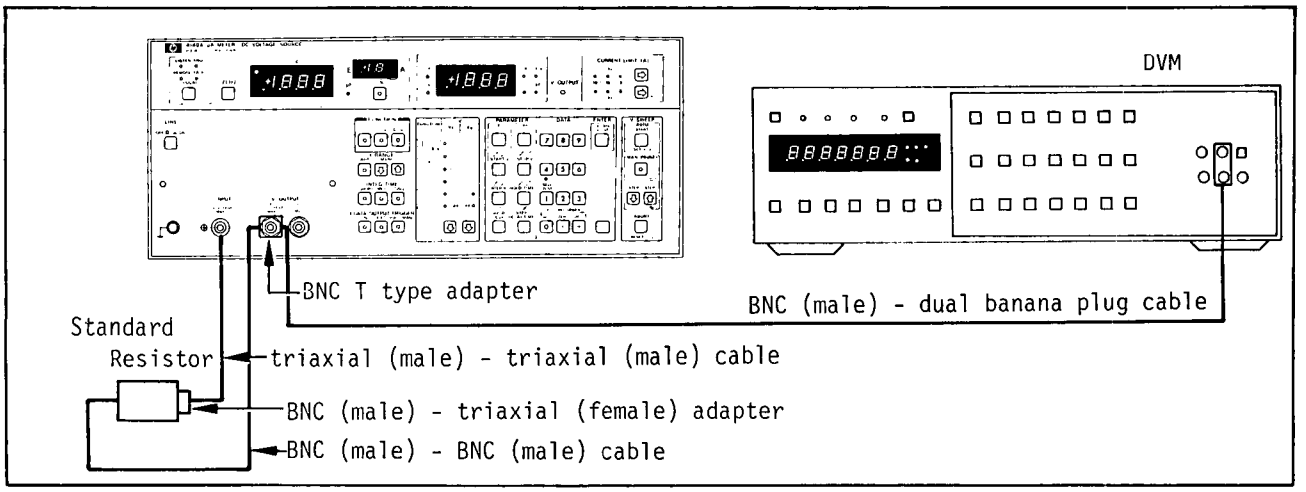

Figure 4-3. Current Accuracy Test Setup (10^{-8}A∿10^{-12}A Ranges).

EQUIPMENT:

Decade Resistor	GR1433H
Standard Resistors	KEITHLEY 5155
BNC T Type Adapter	HP Parts No: 1250-0781
BNC (Female) - Banana Plug Adapter	HP 10111A (2ea)
BNC (Male) - Triaxial (Female) Adapter	TROMPETER AD-BJ77-E3-PL20

Triaxial Cable ..... Part of HP 16053A (HP Part No.: 16053-61002)

BNC (Male) - BNC (Male) Cable ..... Part of HP 16053A (HP Part No.: 16053-61003)

BNC (Male) - Dual Banana Plug Cable ..... HP 11001A

PROCEDURE:

1. Connect 4140A, DVM and Standard Resistor as shown in Figure 4-2 or 4-3

2. Set the DVM as follows:

   FUNCTION ..... DCV
   RANGE ..... AUTO
   HIGH RESOLUTION ..... OFF
   AUTO CAL ..... ON
   GUARD ..... ON
   TRIGGER ..... INTERNAL

3. Set the 4140A as follows:

   FUNCTION I
   I RANGE ..... AUTO
   INTEG TIME ..... LONG
   I DATA OUTPUT TRIGGER ..... INT
   V_A ..... ⎓ (DC)

4. Set PARAMETER (⎓) to a voltage in Table 4-4.

5. Push SET (⎓) key and read display outputs of the DVM and I·C DISPLAY of 4140A.

6. Push RESET (⎓) key.

7. Repeat steps 1 thru 6 and confirm that Table 4-4 is satisfied (change V_A output voltage and standard resistor as appropriate).

TEST LIMIT:

Table 4-4. Current Measurement Accuracy Test.

Current Measurement Range	V_A Output Voltage (V)	Standard Resistor (Ω)	Test Limit
10^{-2} 10^{-3} 10^{-4} 10^{-5} 10^{-6} 10^{-7}	1V	10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7}	S.C.V.* ±7counts
10^{-8} 10^{-9} 10^{-10} 10^{-11} 10^{-12}	10V	10^{9} 10^{10} 10^{11} 10^{12} 10^{13}	} S.C.V.* ±7counts S.C.V.* ±22counts S.C.V.* ±53counts S.C.V.* ±58counts

*S.C.V. (Supplied Current Value) = (Standard Resistor Value)/(Measured Voltage of DVM)

PERFORMANCE TESTS

4-15. CURRENT LIMIT TEST

4-16. This test verifies current limit function of DC Voltage Source for all ranges.

Note

This test uses pA Meter of 4140A. Therefore, Current Measurement Accuracy Test in paragraph 4-13 should be done before this test.

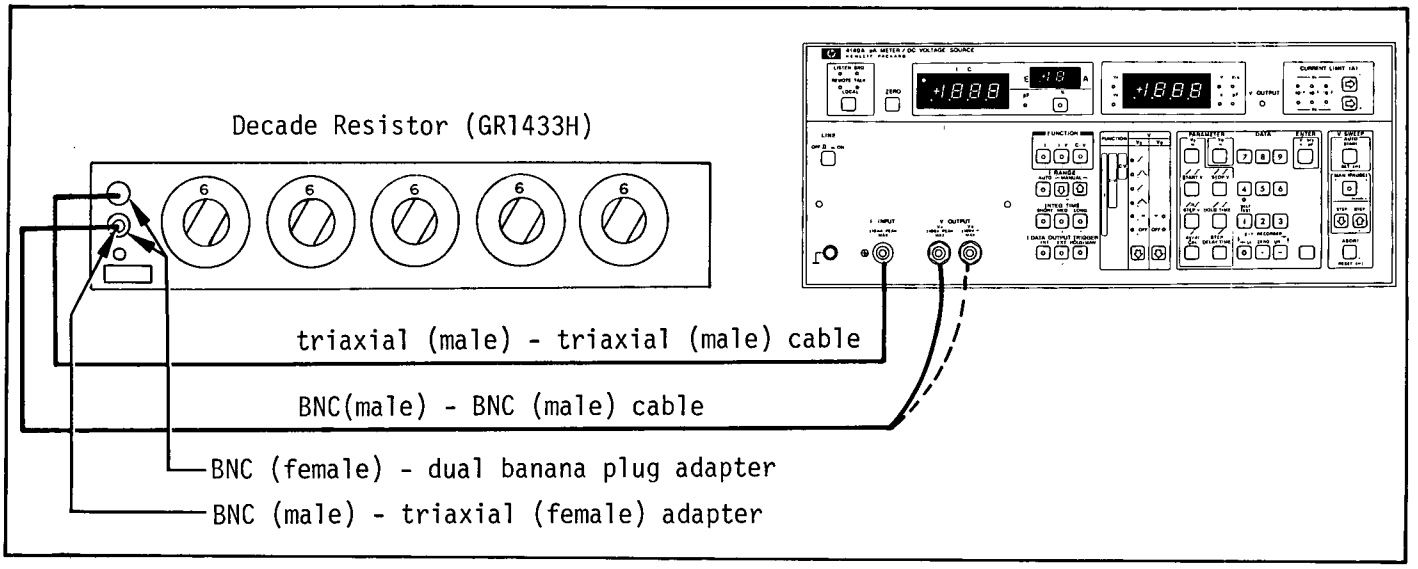

Figure 4-4. Current Limit Test Setup.

EQUIPMENT:

Decade Resistor	GR1433H
BNC (Female) - Banana Plug Adapter	HP 10111A (2ea)
BNC (Male) - Triaxial (Female) Adapter	TROMPETER AD-BJ77-E3-PL20
Triaxial (Male) - Triaxial (Male) Cable	Part of HP 16053A (HP Parts No.: 16053-61002)
BNC (Male) - BNC (Male) Cable	Part of HP 16053A (HP Parts No.: 16053-61003)

PROCEDURE:

1. Connect Decade Resistor between V_A OUTPUT and I INPUT connectors of 4140A as shown in Figure 4-4.

2. Set 4140A as follows:

FUNCTION	I
I RANGE	AUTO
INTEG TIME	LONG
I DATA OUTPUT TRIGGER	INT
V_A	⎓ (DC)
V_B	⎓ (DC)

3. Set CURRENT LIMIT to a current from Table 4-5.

4. Set PARAMETER (⎓) to a voltage from Table 4-5.

5. Push SET (⎓) key and read display output of I•C DISPLAY.

6. Push RESET (⎓) key.

7. Repeat steps 3 thru 6 and confirm that Table 4-5 (change CURRENT LIMIT and setting of V output voltage as appropriate).

8. Connect Decade Resistor between V_B OUTPUT and I INPUT connectors.

9. Repeat steps 3 thru 7.

TEST LIMIT:

Table 4-5. Current Limit Test.

Current Limit (A)	Setting V Output Voltage (V)	Test Limit (A)
10^{-2}	+10	$+0.9 \times 10^{-2} \sim +1.1 \times 10^{-2}$
10^{-3}		$+0.9 \times 10^{-3} \sim +1.1 \times 10^{-3}$
10^{-4}		$+0.9 \times 10^{-4} \sim +1.1 \times 10^{-4}$
10^{-2}	-10	$-1.1 \times 10^{-2} \sim -0.9 \times 10^{-2}$
10^{-3}		$-1.1 \times 10^{-3} \sim -0.9 \times 10^{-3}$
10^{-4}		$-1.1 \times 10^{-4} \sim -0.9 \times 10^{-4}$

4-17. RAMP WAVE START VOLTAGE ACCURACY TEST.

4-18. This test verifies ramp wave start voltage accuracy for the various combinations of start and stop voltages.

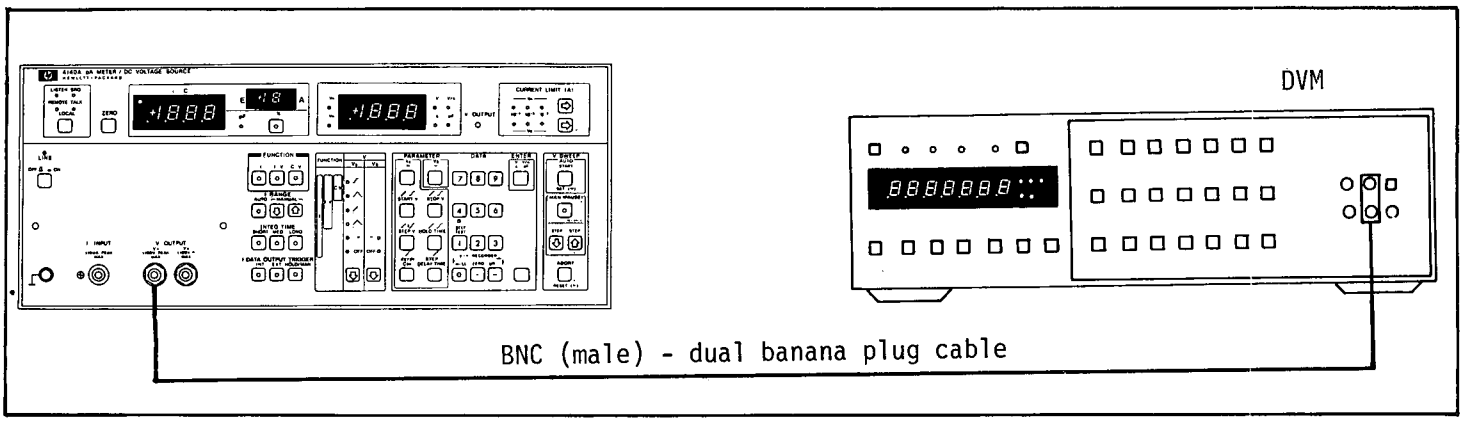

Figure 4-5. Ramp Wave Start Voltage Accuracy Test Setup.

EQUIPMENT:

DVM	HP 3455A
BNC - Dual Banana Plug Cable	HP 11001A

PROCEDURE:

1. Connect BNC (male) - dual banana plug cable between 4140A VA OUTPUT connector and DVM (see Figure 4-5).

2. Set DVM controls as follows:

FUNCTION	DCV
RANGE	AUTO
HIGH RESOLUTION	OFF
GUARD	ON
TRIGGER	INTERNAL

3. Set 4140A controls as follows:

FUNCTION	I
V_A	⎍
V_B	OFF
V_A CURRENT LIMIT	10mA

4. Set V_A parameter as follows:

START V	a voltage from Table 4-6
STOP V	a voltage from Table 4-6
STEP V	0.1V
HOLD TIME	100s
dV/dt	1V/s

5. Press "AUTO START" key and read display output of DVM.

6. Press "ABORT" key.

7. Repeat steps 4 thru 6 and confirm that Table 4-6 is satisfied (change output voltage as appropriate).

TEST LIMIT:

Table 4-6. RAMP WAVE START VOLTAGE ACCURACY TEST.

Start Voltage (V)	Stop Voltage (V)	Test Limit (V)
0.00 +10.00 -10.00	+5.00	-0.02∿+0.02 +9.98∿+10.02 -10.02∿-9.98
0.0 +10.0 -10.0 +100.0 -100.0	+50.0	-0.2∿+0.2 +9.8∿+10.2 -10.2∿-9.8 +99.8∿+100.2 -100.2∿-99.8

4-19. RAMP RATE ACCURACY TEST.

4-20. This test verifies ramp rate accuracy for various combinations of start and stop voltages.

Note

This test requires Option 101 HP-IB Interface as the test is made with the HP-IB system (including HP 9835A Desktop Computer, HP 3455A DVM and HP 59308A Timing Generator, etc.). Therefore, the HP-IB Interface Test in paragraph 4-23 should be done before this test.

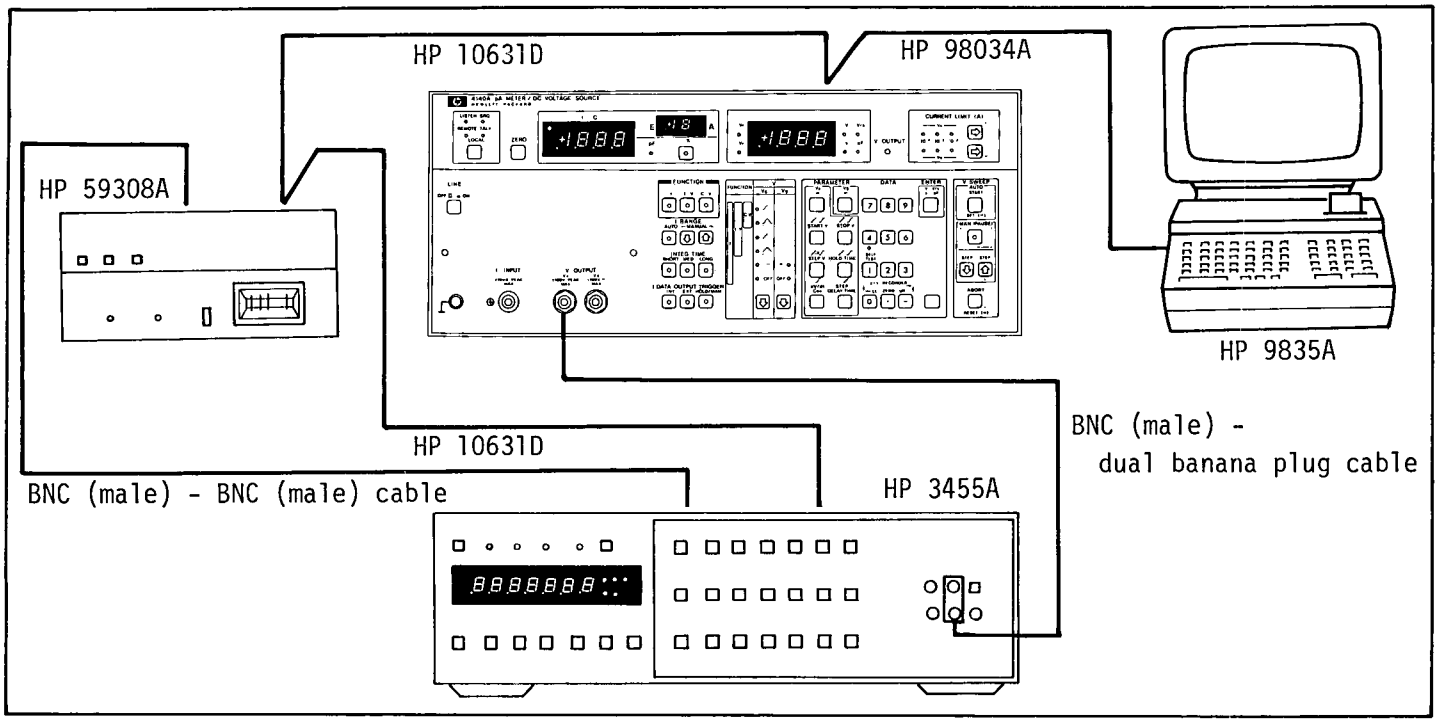

Figure 4-6. Ramp Rate Accuracy Test Setup.

EQUIPMENT:

Desktop Computer	HP 9835A
General I/O ROM	HP 98332A
HP-IB Interface Card with Cable	HP 98034A
HP-IB Cable	HP 10631D (2ea)
DVM (with HP-IB Interface capability)	HP 3455A
Timing Generator (with HP-IB Interface capability)	HP 59308A
BNC (Male) - BNC (Male) Cable	Part of HP 16053A (HP Part No.: 16053-61003)
BNC (Male) - Dual Banana Plug Cable	HP 11001A

PROCEDURE:

1. Turn power switches of 4140A, 9835A, 3455A, and 59308A to OFF.

2. Install Option 101 HP-IB Interface in 4140A. Refer to Option Installation in Section II.

3. Connect 98034A HP-IB Interface Card with Cable between 9835A I/O slot and 4140A rear panel HP-IB connector as shown in Figure 4-6.

4. Install 98332A ROM in 9835A ROM slot.

5. Set 98034A select code switch dial to select code 7 (using a screwdriver).

6. Set HP-IB addresses of instruments as follows:

   4140A: 10001 (17 in binary code).
   3455A: 00110 (6 in binary code).
   59308A: 10000 (16 in binary code).

7. Connect 4140A, 3455A and 59308A with 10631D HP-IB cables as shown in Figure 4-6.

8. Connct BNC (male) - BNC (male) cable between 59308A OUTPUT connector and 3455A EXT TRIGGER INPUT connector as shown in Figure 4-6.

9. Turn 4140A, 9835A, 3455A and 59308A to ON.

10. Load test program (as shown in Figure 4-7) in controller.

11. Execute the program.

12. Check that 9835A CRT is in accord with Table 4-7 Controller Instructions and Operator Responses and confirm that Table 4-8 is satisfied.

[PROGRAMMING]

```
10   ! 4140A RAMP RATE ACCURACY TEST "40RAMP"(21MAY79)
20     DIM A(-1:1)
30     PRINT "RAMP RATE ACCURACY TEST";LIN(1)
40     REMOTE 7
50     ABORTIO 7
60     CLEAR 717
70     IMAGE 2D.6D,"V/s"
80     IMAGE "PS",D,";PT",4D,";PE",.D,";PH",D,";PV",D.3D
90     WAIT 2000
100    OUTPUT 706;"F1T2M3A0H1"
110    OUTPUT 716;"P100E4R"
120    OUTPUT 717;"F1RA1I3T3A1B2L3M3"
130    S=0
140    E=.1
150    H=3
160    FOR I=1 TO 4
170    OUTPUT 706;"R3"
180    IF I=1 THEN T=10
190    IF I=2 THEN T=-10
200    IF I=3 THEN T=100
210    IF I=4 THEN T=-100
220    FOR K=1 TO 4
230    V=10^(1-K)
240    IF K=2 THEN OUTPUT 706;"R2"
250    PRINT USING 80;S,T,E,H,V
260    PAUSE
270    OUTPUT 717 USING 80;S,T,E,H,V
280    OUTPUT 717;"W1"
290    WAIT 5000
300    FOR J=-1 TO 1
310    ENTER 706;A(J)
320    IF J<1 THEN 350
330    PRINT USING 70;A(J)-A(J-1)
340    PRINT LIN(1)
350    NEXT J
360    OUTPUT 717;"W7"
370    NEXT K
380    NEXT I
390    OUTPUT 716;"R"
400    PRINT "END"
410    END
```

(100) Transfers remote program codes from 9835A to 3455A.

(110) Transfers remote program codes from 9835A to 59308A.

(120) Transfers remote program codes from 9835A to 4140A.

(130) Sets START V to 0V.

(140) Sets STEP V to 0.1V.

(150) Sets HOLD TIME to 3s.

(180) ~ (210) Sets STOP V.

(230) Sets dV/dt (Ramp Rate).

(270) Transfers operating parameters from 9835A to 4140A.

(310) Transfers output data from 3455A to 9835A.

Figure 4-7. Ramp Rate Accuracy Test Program Using 9835A.

Table 4-7. Controller Instructions and Operator Responses for Ramp Rate Accuracy Test Program.

Controller Instruction	CRT Area	Operator Response
RAMP RATE ACCURACY TEST	Print	
PSO; PT 10; PE.1; PH3 PV1.000		STOP V = 10V, dV/dt = 1V/S. Press "CONTINUE"
N.NNNNNNV/S		Confirm that Table 4-8 is satisfied
The above two steps are repeated fifteen times more (for each STOP V and dV/dt in Table 4-8).		
END	Print	

TEST LIMIT:

Table 4-8. Ramp Rate Accuracy Test.

STOP V (V)	dV/dt (V/S)	Test Limit (V/S)
+10	1	+0.99799 ∿ +1.00201
	0.1	+0.09979 ∿ +0.10021
	0.01	+0.00997 ∿ +0.01003
	0.001	+0.000988 ∿ +0.001012
-10	1	-1.00201 ∿ -0.99799
	0.1	-0.10021 ∿ -0.09979
	0.01	-0.01003 ∿ -0.00997
	0.001	-0.001012 ∿ -0.000988
+100	1	+0.99792 ∿ +1.00208
	0.1	+0.00990 ∿ +0.10028
	0.01	+0.00990 ∿ +0.01010
	0.001	+0.000918 ∿ +0.001082
	1	-1.00208 ∿ -0.99792
-100	0.1	-0.10028 ∿ -0.09972
	0.01	-0.01010 ∿ -0.00990
	0.001	-0.001082 ∿ -0.000918

PERFORMANCE TESTS

4-21. ANALOG OUTPUT ACCURACY TEST (OPTION 001 ONLY).

4-22. This test verifies that the Option 001 Analog Output outputs specified analog output data to external device (e.g. X-Y Recorder).

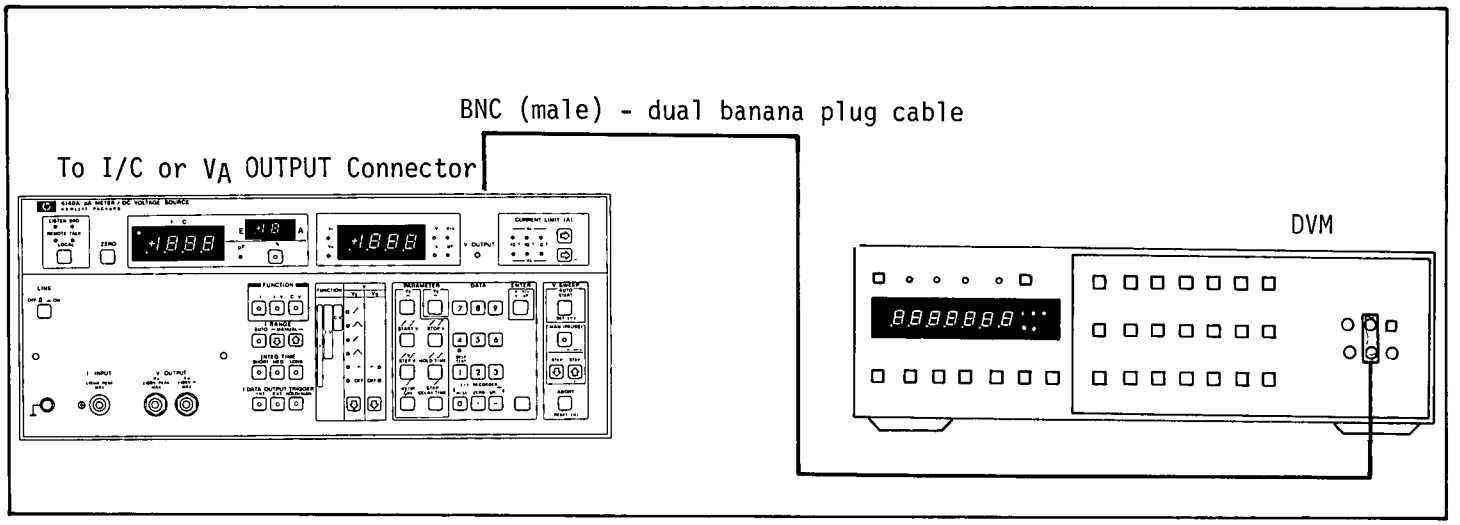

Figure 4-8. Analog Output Accuracy Test Setup.

EQUIPMENT:

DVM	HP 3455A
BNC (Male) - Dual Banana Plug Cable	HP 11001A

PROCEDURE:

1. Connect BNC (male) - dual banana plug cable between the 4140A Option 001 V_A Output connector on rear panel and the DVM (see Figure 4-8).

2. Set the DVM controls as follows:

FUNCTION	DCV
RANGE	AUTO
HIGH RESOLUTION	OFF
AUTO CAL	ON
GUARD	ON
TRIGGER	INTERNAL

3. This test can be made by using auto setting modes of 4140A (refer to paragraph 4-9).

4. Press " Blue , SELF TEST 1 " to set 4140A to Self Test mode.

5. Press " Blue " and a control key from Table 4-9 (to set mode) and read display output of DVM.

6. Repeat step 5 and confirm that the Table 4-9 is satisfied (change auto setting mode as appropriate).

7. Press " Blue , SELF TEST 1 " to cancel auto setting mode.

8. Connect BNC (male) - dual banana plug cable between the 4140A Option 001 I/C OUTPUT connector on rear panel and DUM.

9. Repeat steps 4 thru 7.

TEST LIMITS:

Table 4-9. Analog Output Accuracy Test.

Auto Setting Mode	Control Key	Analog Output Setting (V)	Test Limit (V)
S-1	$V_{\overline{a}}$	0.000	-0.020 ∿ +0.020
S-2	$V_{\overline{a}}$	-0.001	-0.021 ∿ +0.019
S-3	7	-1.000	-1.025 ∿ -0.975
S-4	8	+1.000	+0.975 ∿ +1.025
S-5	9	0.00	-0.02 ∿ +0.02
S-6	ENTER V $V_{\overline{a}}$ Ω	-10.00	-10.07 ∿ -9.93
S-7	AUTO START	+10.00	+9.93 ∿ +10.07

4-23. HP-IB INTERFACE TEST (OPTION 101 ONLY)

4-24. This test verifies that the Option 101 HP-IB Interface has the capabilities (as listed in Table 3-11) to correctly communicate between external HP-IB devices and the 4140A through the interface bus cable.

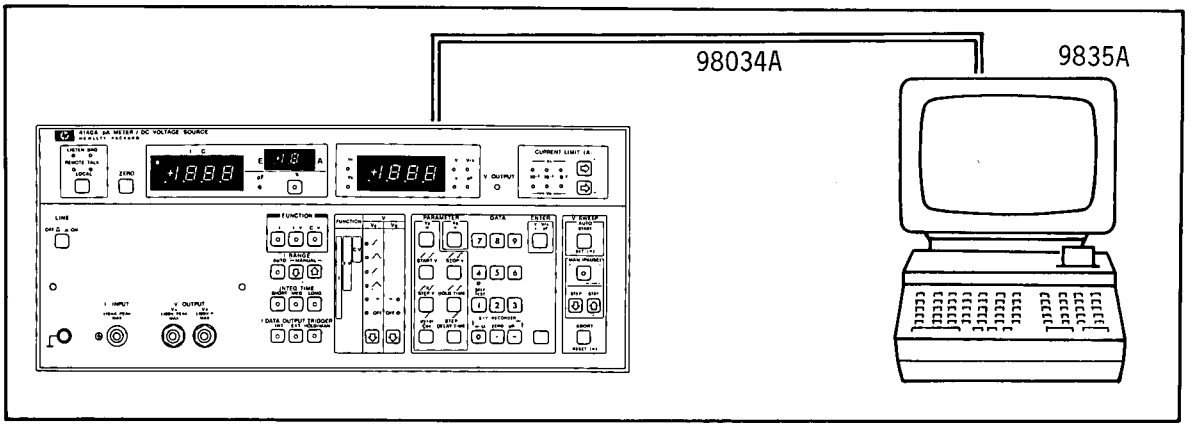

Figure 4-9. HP-IB Interface Test Setup.

EQUIPMENT:

Desktop Computer	HP 9835A
General I/O ROM	HP 98332A
HP-IB Interface Card with cable	HP 98034A

PROCEDURE:

1. Turn power switches of both the 4140A and 9835A to OFF.

2. Connect 98034A HP-IB Interface Card with cable between 9835A I/O slot and 4140A rear panel HP-IB connector as shown in Figure 4-9.

3. Install 98332A ROM in 9835A ROM slot.

4. Set 98034A Select Code Switch dial to select code 7 (using a screwdriver).

5. Set 4140A rear panel HP-IB Control Switch to following settings:

   bit 1∿5: 10001 (17 in binary code).
   bit 6: 0
   bit 7: 0

6. Connect nothing to I.C INPUT and VS OUTPUT connectors.

7. Turn 4140A and 9835A ON.

8. Load test program (given in Figures 4-10 through 4-14) in calculator.

9. Execute the program.

10. Check that 4140A display, 9835A display, and printed data are in accord with Tables 4-10 through 4-14 Controller Instructions and Operator Responses for each test program.

11. Perform steps 9 thru 11 with respect to individual test programs and verify that 4140A and 9835A correctly communicate through the HP-IB interface.

TEST PROGRM 1

[PURPOSE]

This test verifies that 4140A Opt. 101 has the following capabilities:

(1) Remote/Local Capability
(2) Local Lockout
(3) Talk Address Disabled by Listen Address
(4) Listen Address Disabled

[PROGRAMMING]

```
10   ! 4140A REMOTE/LOCAL TEST(20MAR79)
20   DIM A$[1]
30   A=0
40   STATUS 717;B
50   PRINT "REMOTE/LOCAL TEST";LIN(1)
60   REMOTE 7
70   OUTPUT 717;"T1"
80   INPUT "LISTEN=1,TALK=0,REMOTE=1",A$
90   IF A$="N" THEN A=1
100  LOCAL 7
110  INPUT "LISTEN=1,TALK=0,REMOTE=0",A$
120  IF A$="N" THEN A=1
130  ABORTIO 7
140  INPUT "LISTEN=0,TALK=0,REMOTE=0",A$
150  IF A$="N" THEN A=1
160  REMOTE 717
170  INPUT "LISTEN=0,TALK=0,REMOTE=1",A$
180  IF A$="N" THEN A=1
190  LOCAL LOCKOUT 7
200  LOCAL 717
210  INPUT "LISTEN=0,TALK=0,REMOTE=0",A$
220  IF A$="N" THEN A=1
230  OUTPUT 717;"T1"
240  INPUT "LISTEN=1,TALK=0,REMOTE=1",A$
250  IF A$="N" THEN A=1
260  IF A=1 THEN 290
270  PRINT "REMOTE/LOCAL TEST PASS";LIN(1)
280  GOTO 300
290  PRINT "REMOTE/LOCAL TEST FAIL";LIN(1)
300  A=0
310  PRINT "LISTEN/TALK TEST";LIN(1)
320  ENTER 717;A,B
330  INPUT "LISTEN=0,TALK=1,REMOTE=1",A$
340  IF A$="N" THEN A=1
350  OUTPUT 717;"T1"
360  INPUT "LISTEN=1,TALK=0,REMOTE=1",A$
370  IF A$="N" THEN A=1
380  IF A=1 THEN 410
390  PRINT "LISTEN/TALK TEST PASS";LIN(1)
400  GOTO 420
410  PRINT "LISTEN/TALK TEST FAIL";LIN(1)
420  PRINT "END";LIN(1)
430  ABORTIO 7
440  END
```

(40) Clears 4140A SRQ Status Byte.
(60) Sets REN (Remote Enable) line of the bus line to "1". Switches selected devices (Interface Select Code 7) to remote operation allowing parameters and device characteristics to be controlled by data message.
(70) Addresses 9835A to talk and 4140A to listen.
(100) Sets REN to "0". Removes all devices (Interface Select Code 7) from local lockout mode and causes all devices to revert to local.
(130) Sets IFC (Interface Clear) line of the bus line to "1". Unconditionally causes control to pass back to 9835A (independent of the device currently in control) and stops all comunication.
(160) Sets REN to "1". Switches 4140A to remote operation.
(190) Prevents the device operator from switching the unit to manual control
(200) Causes 4140A to revert to manual control for future parameter modifications (REN remains at "1").
(230) Returns to the status of Step 190.
(320) Disables listen address by talk address.
(350) Disables talk address by listen address.

Figure 4-10. HP-IB Interface Test Program 1 Using 9835A.

Table 4-10. Controller Instructions and Operator Responses for Test Program 1.

Controller Instruction	CRT Area	Operator Response
REMOTE/LOCAL TEST	Print	
LISTEN = 1, TALK = 0, REMOTE = 1	Display	If 4140A HP-IB Status Indicators and Controller Instruction are same, press "[Y], [CONTINUE]" for each step. If not, press "[N], [CONTINUE]".
LISTEN = 1, TALK = 0, REMOTE = 0		
LISTEN = 0, TALK = 0, REMOTE = 0		
LISTEN = 0, TALK = 0, REMOTE = 1		
LISTEN = 0, TALK = 0, REMOTE = 0		
LISTEN = 1, TALK = 0, REMOTE = 1		
REMOTE/LOCAL TEST PASS	Print	If all steps are correct, this message is outputted.
REMOTE/LOCAL TEST FAIL		If any step fails, this message is outputted.
LISTEN/TALK TEST	Print	
LISTEN = 0, TALK = 1, REMOTE = 1	Display	If 4140A HP-IB Status Indicators and Controller Instruction are same, press "[Y], [CONTINUE]" for each step. If not, press "[N], [CONTINUE]".
LISTEN = 1, TALK = 0, REMOTE = 1		
LISTEN/TALK TEST PASS	Print	If both steps are correct, this message is outputted.
LISTEN/TALK TEST FAIL		If any step fails, this message is outputted.
END	Print	

TEST PROGRAM 2

[PURPOSE]

This test verifies that 4140A Opt. 101 has following capabilities:

(1) Listener
(2) Device Clear

[PROGRAMMING]

```
10   ! 4140A LISTENER TEST(15MRY79)
20   DIM F$[2],R$[3],I$[2],T$[2],C$[2],A$[2],B$[2],L$[2],M$[2],S$[2],U$[1],X$[50
]
30   PRINT "LISTENER TEST";LIN(1)
40   REMOTE 7
50   ABORTIO 7
60   INPUT "FUNCTION ? (F1 thru F4)",F$
70   PRINT F$
80   IF (F$="F1") OR (F$="F4") THEN F1=1
90   IF F$="F2" THEN F2=1
100  IF F$="F3" THEN F3=1
110  INPUT "I RANGE ? (RA0,RA1,R02 thru R12)",R$
120  PRINT R$
130  INPUT "INTEG TIME ? (I1 thru I3)",I$
140  PRINT I$
150  IF F1=1 THEN INPUT "I DATA OUTPUT TRIGGER ? (T1 thru T3)",T$
160  IF F1=1 THEN PRINT T$
170  IF F3=1 THEN INPUT "pF or % ? (C0 or C1)",C$
180  IF F3=1 THEN PRINT C$
190  IF F1=1 THEN INPUT "VA FUNCTION ? (A1 thru A6)",A$
200  IF F2=1 THEN INPUT "VA FUNCTION ? (A1 thru A4)",A$
210  IF F3=1 THEN INPUT "VA FUNCTION ? (A1 or A2)",A$
220  PRINT A$
230  INPUT "VB FUNCTION ? (B1 or B2)",B$
240  PRINT B$
250  INPUT "VA CURRENT LIMIT ? (L1 thru L3)",L$
260  PRINT L$
270  INPUT "VB CURRENT LIMIT ? (M1 thru M3)",M$
280  PRINT M$
290  INPUT "CONTROL MASK ? (D0 or D7)",D$
300  PRINT D$
310  INPUT "SELF TEST ? (S0 or S1)",S$
320  PRINT S$
330  OUTPUT 717;F$,R$,I$,T$,C$,A$,B$,L$,M$,D$,S$
340  GOSUB K
350  INPUT "Is key status true ? (Y or N)",U$
360  IF U$="N" THEN 390
370  PRINT "LISTENER TEST PASS";LIN(1)
380  GOTO 400
390  PRINT "LISTENER TEST FAIL";LIN(1)
400  PRINT "DEVICE CLEAR TEST";LIN(1)
410  CLEAR 717
420  GOSUB K
430  INPUT "Is key status true ? (Y or N)",U$
440  IF U$="N" THEN 470
450  PRINT "DEVICE CLEAR TEST PASS";LIN(1)
460  GOTO 480
470  PRINT "DEVICE CLEAR TEST FAIL";LIN(1)
480  PRINT "END";LIN(1)
490  END
500 K: OUTPUT 717;"K"
510  ENTER 717;X$
520  PRINT X$;LIN(1)
530  RETURN
```

(330) Transfers remote program codes from 9835A to 4140A.
(410) Initializes device-dependent functions to a predefined state.
(510) Transfers outputted data from 4140A to 9835A.

Figure 4-11. HP-IB Interface Test Program 2 Using 9835A.

Table 4-11. Controller Instructions and Operator Responses for Test Program 2.

Controller Instruction	CRT Area	Operator Response
LISTENER TEST	Print	
FUNCTION? (F1 thru F4)	Display	Input HP-IB program code in each step (see Table 3-12). Example: F3, R10, I2, C1, A2, B1, L2, M3, D2, S0 F3 ..... C-V R10 ..... 10^{-10}A I2 ..... MED C1 ..... % A2 ..... ⩘ B1 ..... ⎓ L2 ..... 10^{-3}A M3 ..... 10^{-4}A D2 ..... See Table 3-12 S0 ..... OFF * This step is only done when FUNCTION is set to I or HSI (High Speed I function). ** This step is only done when FUNCTION is set to I-V. *** This step is only done when FUNCTION is set to C-V.
F3	Print	
I RANGE? (RA0, RA1, R02 thru R12)	Display	
R10	Print	
INTEG TIME? (I1 thru I3)	Display	
I2	Print	
I DATA OUTPUT TRIGGER? (T1 thru T3)*	Display	
T1*	Print	
pF or %? (C0 or C1)***	Display	
C1***	Print	
V_A FUNCTION? (A1 thru A6)*	Display	
V_A FUNCTION? (A1 thru A4)**		
V_A FUNCTION? (A1 or A2)***		
A2	Print	
V_B FUNCTION? (B1 or B2)	Display	
B1	Print	
V_A CURRENT LIMIT? (L1 thru L3)	Display	
L2	Print	
V_B CURRENT LIMIT? (M1 thru M3)	Display	
M3	Print	
CONTROL MASK? (D0 or D7)	Display	
D2	Print	
SELF TEST? (S0 or S1)	Display	
S0	Print	
F3R10I2T1C1A2B1L2M3D2S0	Print	This is the key status data of 4140A when it accepts input remote program codes from controller.
Is key status true? (Y or N)	Display	If input remote codes and outputted key status data are same, press "[Y], [CONTINUE]". If not, press "[N], [CONTINUE]".
LISTENER TEST PASS	Print	
LISTENER TEST FAIL		
DEVICE CLEAK TEST	Print	
F1RA1I3T1C0A3B2L1M1D0S0		This is the key status data of 4140A when it accepts SDC (Selected Device Clear) command from controller.
Is key status true? (Y or N)	Display	If outputted key status data and initial control settings (F1RA1I3T1C0A3B2L1M1D0S0) are same, press "[Y], [CONTINUE]". If not, press "[N], [CONTINUE]".
DEVICE CLEAR TEST PASS	Print	
DIVICE CLEAR TEST FAIL		
END	Print	

TEST PROGRAM 3

[PURPOSE]

This test verifies that 4140A Opt. 101 has following capabilities:

(1) Talker
(2) Device Trigger

[PROGRAMMING]

```
10   ! 4140A TALKER TEST(20MAR79)
20   PRINT "TALKER TEST";LIN(1)
30   PRINT "DATA OUTPUT TEST"
40   DIM A$[30],B$[30],C$[30],F$[1]
50   STATUS 717;C
60   LOCAL 7
70   FLOAT 5
80   REMOTE 7
90   ABORTIO 7
100  CLEAR 717
110  OUTPUT 717;"F1I1T3A5"
120  OUTPUT 717;"PA-10"
130  OUTPUT 717;"W1E"
140  ENTER 717;A,B
150  PRINT A,B;LIN(1)
160  INPUT "Is output data true ? (Y or N)",F$
170  IF F$="N" THEN 200
180  PRINT "DATA OUTPUT TEST PASS";LIN(1)
190  GOTO 210
200  PRINT "DATA OUTPUT TEST FAIL";LIN(1)
210  PRINT "COMPLETE DATA OUTPUT TEST"
220  OUTPUT 717;"E"
230  ENTER 717;A$
240  PRINT A$;LIN(1)
250  INPUT "Is output data true ? (Y or N)",F$
260  IF F$="N" THEN 290
270  PRINT "COMPLETE DATA OUTPUT TEST";LIN(1)
280  GOTO 300
290  PRINT "COMPLETE DATA OUTPUT TEST PASS";LIN(1)
300  PRINT "DEVICE TRIGGER TEST"
310  TRIGGER 717
320  ENTER 717;B$
330  PRINT B$;LIN(1)
340  INPUT "Is output data true ? (Y or N)",F$
350  IF F$="N" THEN 380
360  PRINT "DEVICE TRIGGER TEST PASS";LIN(1)
370  GOTO 390
380  PRINT "DEVICE TRIGGER TEST FAIL";LIN(1)
390  PRINT "PARAMETER OUTPUT TEST"
400  OUTPUT 717;"PA"
410  ENTER 717;C$
420  PRINT C$;LIN(1)
430  INPUT "Is output data true ? (Y or N)",F$
440  IF F$="N" THEN 470
450  PRINT "PARAMETER OUTPUT TEST PASS";LIN(1)
460  GOTO 480
470  PRINT "PARAMETER OUTPUT TEST FAIL";LIN(1)
480  PRINT "END"
490  END
```

(310) Causes 4140A to simultaneously initiate a device - dependent action.

Figure 4-12. HP-IB Interface Test Program 3 Using 9835A.

Table 4-12. Controller Instructions and Operator Responses for Test Program 3.

Controller Instruction	CRT Area	Operator Response
TALKER TEST	Print	
DATA OUTPUT TEST	Print	
±N.NNNE-NN ±NNN.NN	Print	
Is output data true? (Y or N)	Display	If outputted data and values of I.C DISPLAY and VS DISPLAY are same, press "[Y], [CONTINUE]". If not, press "[N], [CONTINUE]".
DATA OUTPUT TEST PASS	Print	
DATA OUTPUT TEST FAIL		
COMPLETE DATA OUTPUT TEST	Print	
XX±N.NNNE-NN,A±NNN.NN	Print	
Is output data true? (Y or N)	Display	If outputted data is true, press "[Y], [CONTINUE]". If not, press "[N]. [CONTINUE]".
COMPLETE DATA OUTPUT TEST PASS	Print	
COMPLETE DATA OUTPUT TEST FAIL		
DEVICE TRIGGER TEST	Print	
XX±N.NNNE-NN,A±NNN.NN	Print	
Is output data true? (Y or N)	Display	If outputted data is true, press "[Y], [CONTINUE]". If not, press "[N], [CONTINUE]".
DEVICE TRIGGER TEST PASS	Print	
DEVICE TRIGGER TEST FAIL		
PARAMETER OUTPUT TEST	Print	
XX±NNNN.NNN	Print	
Is output data true? (Y or N)	Display	If outputted data is true, press "[Y], [CONTINUE]". If not, press "[N], [CONTINUE]".
PARAMETER OUTPUT TEST PASS	Print	
PARAMETER OUTPUT TEST FAIL		
END	Print	

TEST PROGRAM 4

[PURPOSE]

This test program verifies that 4140A Opt. 101 has following capabilities:

(1) Service Request
(2) Serial Poll

[PROGRAMMING]

```
10   ! 4140A SRQ TEST(15MAY79)
20   PRINT "SRQ TEST";LIN(1)
30   FIXED 0
40   ON INT #7 GOSUB Srq
50   REMOTE 7
60   ABORTIO 7
70   CLEAR 717
80   STATUS 717;A
90   A=0
100  PRINT "DATA READY"
110  OUTPUT 717;"T3D7E"
120  GOSUB Loop
130  A=0
140  PRINT "SELF TEST END"
150  OUTPUT 717;"S1"
160  OUTPUT 717;"S0"
170  GOSUB Loop
180  A=0
190  PRINT "SYNTAX ERROR"
200  OUTPUT 717;"D0S0I5"
210  GOSUB Loop
220  A=0
230  PRINT "PARAMETER OVER FLOW ERROR"
240  OUTPUT 717;"PA1000;"
250  GOSUB Loop
260  A=0
270  PRINT "ILLEGAL ERROR"
280  OUTPUT 717;"W1"
290  GOSUB Loop
300  PRINT "END"
310  END
320 Loop: CONTROL MASK 7;128
330  CARD ENABLE 7
340  IF BIT(A,0)=1 THEN 380
350  IF BIT(A,2)=1 THEN 380
360  IF BIT(A,3)=1 THEN 380
370  GOTO Loop
380  PRINT A;LIN(1)
390  RETURN
400 Srq: STATUS 717;A
410  IF BIT(A,6)=1 THEN 430
420  PRINT "OTHER DEVICE SRQ";LIN(1)
430  RETURN
```

(40) Designates label (SRQ) for service routing to be performed when an instrument is set by a device on select code 7 bus line.

(320) ∿ (330) Labels Loop. Enables service request to be sent from device on select code 7 bus line. Checks status of SRQ line on the bus line.

Figure 4-13. HP-IB Interface Test Program 4 Using 9835A.

Table 4-13. Controller Instructions and Operator Responses for Test Program 4.

Controller Instruction	CRT Area	Operator Response
SRQ TEST	Print	
DATA READY		Outputted SRQ Status Byte data should be 65 (=01000001).
65		
SELF TEST END		Outputted SRQ Status Byte data should be 68 (=01000100).
68		
SYNTAX ERROR		Outputted SRQ Status Byte data should be 72 (=010010000).
72		
PARAMETER OVER FLOW ERROR		Outputted SRQ Status Byte data should be 72 (=010010000).
72		
ILLEGAL ERROR		Outputted SRQ Status Byte data should be 72 (=01001000).
72		
END		

TEST PROGRAM 5

[PURPOSE]

This test verifies 4140A HP-IB Control Switch has the following capabilities:

(1) Address
(2) Output Format B

[PROGRAMMING]

```
10   ! 4140A HP-IB CONTROL SWITCH TEST(15MAY79)
20   PRINT "HP-IB CONTROL SWITCH TEST";LIN(1)
30   DIM A$[7],B$[1],C$[30],D$[30]
40   PRINT "ADDRESS TEST"
50   L=0
60   FOR I=1 TO 6
70   IF I=1 THEN A=700
80   IF I=1 THEN A$="0000000"
90   IF I=2 THEN A=701
100  IF I=2 THEN A$="0000001"
110  IF I=3 THEN A=702
120  IF I=3 THEN A$="0000010"
130  IF I=4 THEN A=704
140  IF I=4 THEN A$="0000100"
150  IF I=5 THEN A=708
160  IF I=5 THEN A$="0001000"
170  IF I=6 THEN A=716
180  IF I=6 THEN A$="0010000"
190  DISP "Turn off 4140A"
200  BEEP
210  PAUSE
220  DISP "Set HP-IB control switch to ",A$
230  BEEP
240  PAUSE
250  DISP "Turn on 4140A"
260  BEEP
270  PAUSE
280  WAIT 1000
290  OUTPUT A;"I1"
300  INPUT "LISTEN=1,TALK=0,REMOTE=1",B$
310  IF B$="N" THEN L=1
320  ENTER A;M,N
330  INPUT "LISTEN=0,TALK=1,REMOTE=1",B$
340  IF B$="N" THEN L=1
350  NEXT I
360  IF L=1 THEN 390
370  PRINT "ADDRESS TEST PASS";LIN(1)
380  GOTO 400
390  PRINT "ADDRESS TEST FAIL";LIN(1)
400  PRINT "OUTPUT DATA FORMAT B TEST"
410  DISP "Turn off 4140A"
420  BEEP
430  PAUSE
440  DISP "Set HP-IB control switch to 0110001"
450  BEEP
460  PAUSE
470  DISP "Turn on 4140A"
480  BEEP
490  PAUSE
500  WAIT 1000
510  ENTER 717;C$,D$
520  PRINT C$
530  PRINT D$
540  INPUT "Is output data true ? (Y or N)",B$
550  IF B$="N" THEN 580
560  PRINT "OUTPUT DATA FORMAT B TEST PASS";LIN(1)
570  GOTO 620
580  PRINT "OUTPUT DATA FORMAT B TEST FAIL";LIN(1)
590  DISP "Turn off 4140A"
600  BEEP
610  PAUSE
620  DISP "Set HP-IB control switch to 0010001"
630  BEEP
640  PAUSE
650  PRINT "END"
660  END
```

Figure 4-14. HP-IB Interface Test Program 5 Using 9835A.

Table 4-14. Controller Instructions and Operator Responses for Test Program 5.

Controller Instrction	CRT Area	Operator Response
HP-IB CONTROL SWITCH TEST	Print	
ADDRESS TEST	Print	
Turn off 4140A	Display	Turn the 4140A OFF and press " [CONTINUE] "
Set HP-IB control switch to 0000000		Set HP-IB Control Switch to "0000000" and press " [CONTINUE] ".
Turn on 4140A		Turn the 4140A ON and Press " [CONTINUE] ".
LISTEN = 1, TALK = 0, REMOTE = 1 LISTEN = 0, TALK = 1, REMOTE = 1		If 4140A HP-IB Status Indicators and Controller Instruction are same, press " [Y] , [CONTINUE] " in each step. If not, press " [N] , [CONTINUE] ".
The above five steps are repeated five more times (for each of the following addresses): (1) 0000001 (2) 0000010 (3) 0000100 (4) 0001000 (5) 0010000		
ADDRESS TEST PASS	Print	If all steps are correct, this message is outputted.
ADDRESS TEST FAIL		If any step fails, this message is outputted.
OUTPUT DATA FORMAT B TEST	Print	
Turn off 4140A	Display	Turn the 4140A OFF and press " [CONTINUE] ".
Set HP-IB control switch to 0110001		Set HP-IB Control switch to "0110001" and press " [CONTINUE] ".
Turn on 4140A		Turn the 4140A ON and press " [CONTINUE] ".
XXN.NNN-NN A±NNN.NN	Print	
Is output data true? (Y or N)	Display	If outputted data is true, press " [Y] , [CONTINUE] ". If not, press " [N] , [CONTINUE] ".
OUTPUT DATA FORMAT B TEST PASS	Print	
OUTPUT DATA FORMAT B TEST FAIL		
Turn off 4140A	Display	Turn the 4140A OFF and press " [CONTINUE] ".
Set HP-IB Control switch to 0010001		Set HP-IB Control Switch to "0010001" and press " [CONTINUE] ".
END		

PERFORMANCE TEST RECORD

Hewlett-Packard
Model 4140A
pA METER/DC VOLTAGE SOURCE
Serial No.

Tested by

Date

Paragraph Number	TEST	Results		
		Minimum	Actual	Maximum
4-11	VOLTAGE OUTPUT ACCURACY TEST			
	Voltage Setting			
	+100V	+99.80V		+100.20V
	+10V	+9.982V		+10.018V
	+1V	0.9883V		+1.0117V
	0V	-0.011V		0.011V
	-1V	-1.0117V		-9.883V
	-10V	-10.018V		-9.982V
	-100V	-100.20V		-99.80V
4-13.	CURRENT MEASUREMENT ACCURACY TEST			
	Current Measurement Range Setting			
	10^{-2}A	S.C.V. -7counts		S.C.V. +7counts
	10^{-3}A	S.C.V. -7counts		S.C.V. +7counts
	10^{-4}A	S.C.V. -7counts		S.C.V. +7counts
	10^{-5}A	S.C.V. -7counts		S.C.V. +7counts
	10^{-6}A	S.C.V. -7counts		S.C.V. +7counts
	10^{-7}A	S.C.V. -7counts		S.C.V. +7counts
	10^{-8}A	S.C.V. -7counts		S.C.V. +7counts
	10^{-9}A	S.C.V. -7counts		S.C.V. +7counts
	10^{-10}A	S.C.V.-22counts		S.C.V.+22counts
	10^{-11}A	S.C.V.-53counts		S.C.V.+53counts
	10^{-12}A	S.C.V.-58counts		S.C.V.+58counts
4-15	CURRENT LIMIT TEST			
	Current Limit Setting			
	$+10^{-2}$A	$+0.9\times10^{-2}$A		$+1.1\times10^{-2}$A
	$+10^{-3}$A	$+0.9\times10^{-3}$A		$+1.1\times10^{-3}$A
	$+10^{-4}$A	$+0.9\times10^{-4}$A		$+1.1\times10^{-4}$A
	-10^{-2}A	-1.1×10^{-2}A		-0.9×10^{-2}A
	-10^{-3}A	-1.1×10^{-3}A		-0.9×10^{-3}A
	-10^{-4}A	-1.1×10^{-4}A		-0.9×10^{-4}A
4-17	RAMP WAVE START VOLTAGE ACCURACY TEST			
	Start Voltage Setting			
	0.00V	-0.02V		+0.02V
	+10.00V	+9.98V		+10.02V

PERFORMANCE TEST RECORD

Paragraph Number	TEST		Results		
			Minimum	Actual	Maximum
4-17	RAMP WAVE START VOLTAGE ACCURACY TEST (Continued)				
		-10.00V	-10.02V		-9.98V
		0.0V	-0.2V		+0.2V
		+10.0V	+9.8V		+10.2V
		-10.0V	-10.2V		-9.8V
		+100.0V	+99.8V		+100.2V
		-100.0V	-100.2V		-99.8V
4-19	RAMP RATE ACCURACY TEST				
	dV/dt Setting				
	STOP V = +10V	1V/s	+0.99799V/s		+1.00201V/s
		0.1V/s	+0.09979V/s		+0.10021V/s
		0.01V/s	+0.00997V/s		+0.01003V/s
		0.001V/s	+0.000998V/s		+0.001012V/s
	STOP V = -10V	1V/s	-1.00201V/s		-0.99799V/s
		0.1V/s	-0.10021V/s		-0.09979V/s
		0.01V/s	-0.01003V/s		-0.00997V/s
		0.001V/s	-0.001012V/s		-0.000988V/s
	STOP V = +100V	1V/s	+0.99792V/s		+1.00208V/s
		0.1V/s	+0.09972V/s		+0.10028V/s
		0.01V/s	+0.00990V/s		+0.01010V/s
		0.001V/s	+0.000918V/s		+0.001082V/s
	STOP V = -100V	1V/s	-1.00208V/s		-0.99792V/s
		0.1V/s	0.10028V/s		-0.09972V/s
		0.01V/s	-0.01010V/s		-0.00990V/s
		0.001V/s	-0.001082V/s		-0.000918V/s
4-21	ANALOG OUTPUT ACCURACY TEST (OPTION 001 ONLY)				
	Analog Output Setting				
		0.000V	-0.020V		+0.020V
		-0.001V	-0.021V		+0.019V
		-1.000V	-1.025V		-0.975V
		+1.000V	+0.975V		-0.975V
		0.00V	-0.02V		+0.002V
		-10.00V	-10.07V		-9.93V
		+10.00V	+9.93V		+10.07V

SECTION V
ADJUSTMENT

5-1. INTRODUCTION.

5-2. This section provides the information needed to adjust the 4140A to its specifications (listed in Table 1-1). Prime purpose of adjustment is to return the instrument to its peak operating capabilities after repairs have been made. The instrument should be tested and adjusted when a part or component has been replaced. Adjustments sometimes restore an instrument to its normal operating conditions without the necessity of repairs. Adjustment procedures can also be performed periodically to maintain top operating performance. Recommended adjustment schedule for the 4140A is every six months. All adjustable components referred to individual tests are summarized in Table 5-1 and adjustment locations are identified pictorially on the foldout sheets in Section VIII. If proper performance cannot be achieved after adjustment procedures have been performed, refer to troubleshooting in Section VIII.

Note

Before performing any adjustments, warm up instrument for more than 60 minutes to stabilize operating conditions.

5-3. SAFETY REQUIREMENTS.

5-4. Although the instrument has been designed in accordance with international safety standards, this manual contains information, cautions, and warnings which must be followed to ensure safe operation and to keep the instrument in safe condition (see Sections II and III). Adjustments described in this section should be performed only by qualified service personnel.

WARNING

ANY INTERRUPTION OF THE PROTECTIVE (GROUNDED) CONDUCTOR (INSIDE OR OUTSIDE THE INSTRUMENT) OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL IS LIKELY TO MAKE THE INSTRUMENT DANGEROUS. INTENTIONAL INTERRUPTION IS PROHIBITED.

5-5. The opening of covers for removal of parts, except those to which access can be gained by hand, is likely to expose line parts. Accessible terminals may also be live.

5-6. Capacitors inside instrument may still be charged even if instrument has been disconnected from its source of supply.

WARNING

ADJUSTMENTS DESCRIBED HEREIN ARE PERFORMED WITH POWER SUPPLIED TO THE INSTRUMENT AFTER PROTECTIVE COVERS HAVE BEEN REMOVED. ENERGY EXISTING AT MANY POINTS MAY, IF CONTACTED, RESULT IN PERSONAL INJURY.

5-7. EQUIPMENT REQUIRED.

5-8. The equipment needed to adjust the Model 4140A is listed in Table 4-1. This equipment should always be calibrated to satisfy its own specifications and those of the required characteristics. If the recommended model is not available, any instrument that has specifications equal to or better than required specifications may be substituted.

5-9. ADJUSTMENT RELATIONSHIPS.

5-10. The adjustment procedures, beginning with paragraph 5-15, should be performed in step sequence as they are interactive. Neglecting or changing procedures may make it impossible to gain best 4140A performance. Table 5-2 shows alignment procedures required when repairing the instrument (replacement of a component or board). The adjustments in Table 5-2 assume that no other adjustments were attempted prior to board or component replacement.

5-11. ADJUSTMENT LOCATIONS.

5-12. For reference, overall adjustment location illustrations are given in Section VIII. The locations of individual board assemblies are denoted in board assembly component location illustrations included on each foldout service sheet.

Table 5-1. Adjustable Components.

Reference Designator	Name of Control	Purpose
A1R5 (Para. 5-17)	SWS R ADJ	To eliminate any dc voltage offset in integrator circuit of DC amplifier.
A1R24 (Para. 5-17)	OFFSET ADJ	To eliminate any dc voltage offset in DC amplifier of I-V Converter.
A2R20 (Para. 5-19)	pA GAIN	To adjust total gain of I-V Converter for pA Meter.
A5R19 (Para. 5-21)	x10 ZERO	To eliminate any dc voltage offset in V_A power amplifier on x10 range.
A5R24 (Para. 5-21)	x1 ZERO	To eliminate any dc voltage offset in V_A power amplifier.
A5R31 (Para. 5-21)	x10 GAIN	To adjust V_A power amplifier gain on x10 range.
A5R64 (Para. 5-21)	x10 ZERO	To eliminate any dc voltage offset in V_B power amplifier on x10 range.
A5R69 (Para. 5-21)	x1 ZERO	To eliminate any dc voltage offset in V_B power amplifier.
A5R76 (Para. 5-21)	x10 GAIN	To adjust V_B power amplifier gain on x10 range.
A5R91 (Para. 5-21)	DA ZERO	To eliminate any dc voltage offset in DAC (D-A Converter) for DC voltage source.
A5R94 (Para. 5-21)	DA GAIN	To adjust gain of DAC for DC voltage source.
A6R11 (Para. 5-23)	COMP ZERO	To eliminate any dc voltage offset in comparator.
A6R12 (Para. 5-23)	dV/dt BUF ZERO	To eliminate any dc voltage offset in dV/dt buffer amplifier.
A6R13 (Para. 5-25)	dV/dt ADJ	To adjust ramp rate (dV/dt) of ramp wave in V_A ramp generator.
A7R1 (Para. 5-15)	-15VF	To set output of regulated, floated -15V dc power supply.
A7R2 (Para. 5-15)	+15VF	To set output of regulated, floated +15V dc power supply.
A31R4 (Para. 5-27)	ZERO	To eliminate any dc voltage offset in DAC for analog output (Option 001 only).
A31R5 (Para. 5-27)	GAIN	To adjust gain of DAC for analog output (Option 001 only).
A32R5 (Para. 5-27)	x1/10 ZERO	To eliminate any dc voltage offset in 1/10 amplifier (Option 001 only).

5-13. TOP COVER REMOVAL.

5-14. Remove top cover to locate and to gain access to the adjustment controls as follows:

(1) Loosen the retaining screw at rear of top cover until screw is free.

(2) Pull top cover towards the rear and lift off.

WARNING

WHEN TOP COVER IS REMOVED, LIVE PARTS ARE EXPOSED.

WARNING

TO INSURE PERSONAL SAFETY FROM POSSIBLE ELECTRICAL SHOCK HAZARDS AND RESULTANT INJURY, USE INSULATED ADJUSTMENT TOOL.

Table 5-2. Adjustment Requirements.

Assembly Repaired or Replaced	Required Adjustment
A1 I-V Converter (HP Part No.: 04140-66501)	Paragraph 5-17. pA Meter Amplifier Offset Adjustment. Paragraph 5-19. pA Meter Gain Adjustment.
A2 A-D Converter (HP Part No.: 04140-66502)	Paragraph 5-19. pA Meter Gain Adjustment.
A3 MPU (HP Part No.: 04140-66513)	None.
A4 I/O Control (HP Part No.: 04140-66504)	
A5 VS Output (HP Part No.: 04140-66505)	Paragraph 5-21. VS (Voltage Source) DC Adjustment.
A6 Ramp Generator (HP Part No.: 04140-66506)	Paragraph 5-23. VS Ramp Generator Adjustment. Paragraph 5-25. VS Ramp Rate Adjustment.
A7 Power Supply (HP Part No.: 04140-66507)	Paragraph 5-15. DC Power Supply Adjustment.
A8 Display (HP Part No.: 04140-66508)	None.
A9 Mother board (HP Part No.: 04140-66509)	
A21 HP-IB Interface (HP Part No.: 04140-66521)	
A31 Analog Output Control (HP Part No.: 04140-66531)	Paragraph 5-27. Analog Output Adjustment.
A32 Analog Output Distributor (HP Part No.: 04140-66532)	

ADJUSTMENTS

5-15. DC POWER SUPPLY ADJUSTMENT.

5-16. This adjustment adjusts regulated, floated ±15V DC Supply (A7).

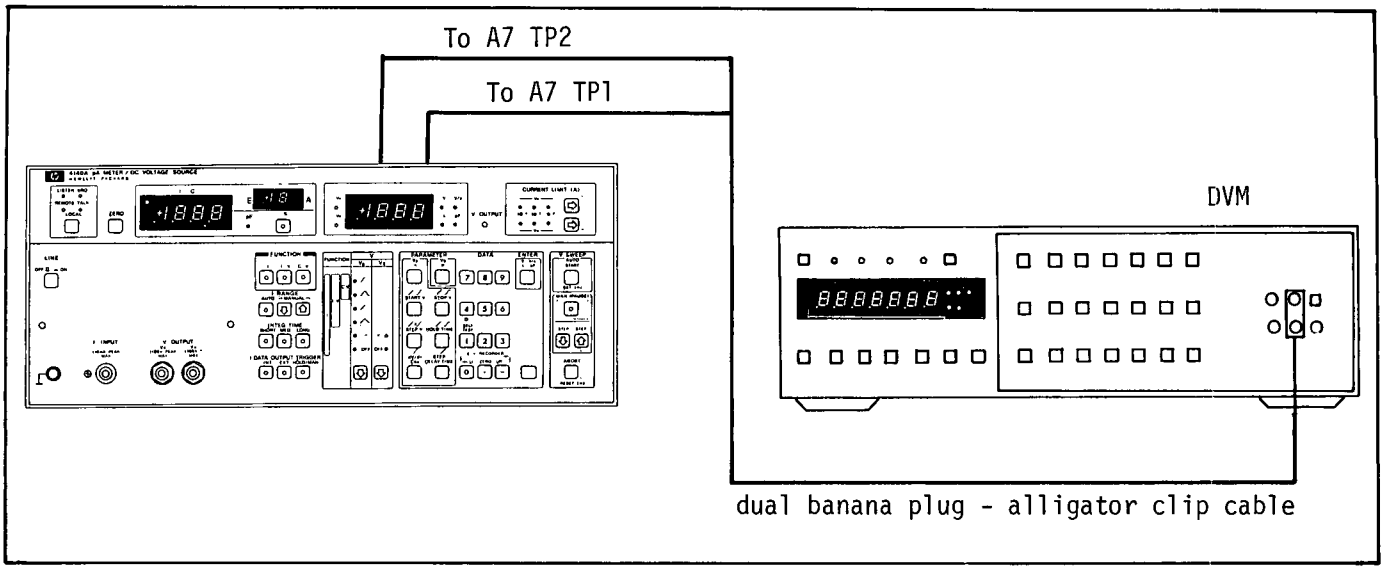

Figure 5-1. Power Supply Voltage Adjustment Setup.

EQUIPMENT:

DVM	HP 3455A
Dual Banana Plug - Alligator Clip Cable	HP 11002A

PROCEDURE:

1. Connect DVM plus input to A7TP2 (-15VF) and minus input to A7TP1 (F COMM) with dual banana plug - alligator clip cable. See Figure 5-1.

2. Set the DVM as follows:

FUNCTION	DCV
RANGE	AUTO
HIGH RESOLUTION	OFF
AUTO CAL	ON
GUARD	ON
TRIGGER	INTERNAL

3. Adjust "-15VF" potentiometer A7R1 for -15volts ±0.1volts (see Figure 8-22 for location).

4. Connect DVM plus input to A7TP3 (+15VF) and minus input to A7TP1 (F COMM).

5. Adjust "+15VF" potentiometer A7R2 for +15volts ±0.1volts (see Figure 8-22 for location).

6. Connect DVM plus input to test points listed in Table 5-3 and minus input to 4140A chassis.

7. Confirm the dc voltages at test points listed in Table 5-3.

Table 5-3. DC Voltage Check at Test Points.

Test Points	Voltage Limits
A7TP6 (+5V)	+4.85V ∿ +5.20V
A7TP4 (+15V)	+14.10V ∿ +15.90V
A7TP5 (-15V)	-15.90V ∿ -14.10V
A7TP7 (+120V)	+115.0V ∿ +127.0V
A7TP8 (-120V)	-130.7V ∿ -118.3V

ADJUSTMENTS

5-17. pA METER AMPLIFIER OFFSET ADJUSTMENT.

5-18. This adjustment eliminates any DC amplifier offset in pA Meter (A1).

Note

Allow a 30 minute warm up and stabilization period before this adjustment.

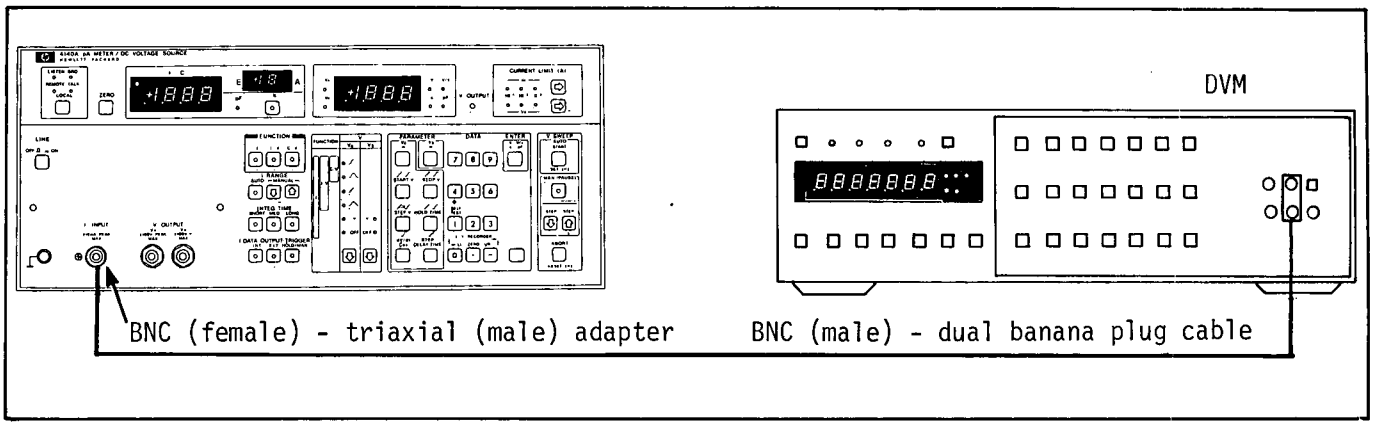

Figure 5-2. pA Meter Amplifier Offset Adjustment Setup.

EQUIPMENT:

DVM ..... HP 3455A
BNC (Female) - Triaxial (Male) Adapter ... TROMPETER AD-BJ20-E3-PL75
BNC (Male) -Dual Banana Plug Cable ..... HP 11001A

PROCEDURE:

1. Connect DVM input and the 4140A I INPUT connector with BNC (female) - triaxial (male) adapter and BNC (male) - dual banana plug cable. See Figure 5-2.

2. Set DVM as follows:

FUNCTION	DCV
RANGE E	AUTO
HIGH RESOLUTION	OFF
AUTO CAL	ON
GUARD	ON
TRIGGER	INTERNAL

3. Set 4140A I RANGE to 10^{-6}.

4. Set 4140A A1S1 and S2 to right hand position (see Figure 8-25 for location).

5. Adjust "SWS R ADJ" potentiometer A1R5 for 0 volts ±1.0 millivolts (see Figure 8-22 for location).

6. Reset 4140A A1S1 and S2 to left hand position.

7. Adjust "OFFSET ADJ" potentiometer A1R24 for 0 volts ±0.020 millivolts (see Figure 8-22 for location).

Note

After this adjustment, the 4140A switches A1S1 and S2 should be in their left hand positions.

5-19. pA METER GAIN ADJUSTMENT.

5-20. This adjustment adjusts DC amplifier gain of pA Meter (A2).

Note

Allow a 30 minute warm up and stabilization period before this adjustment.

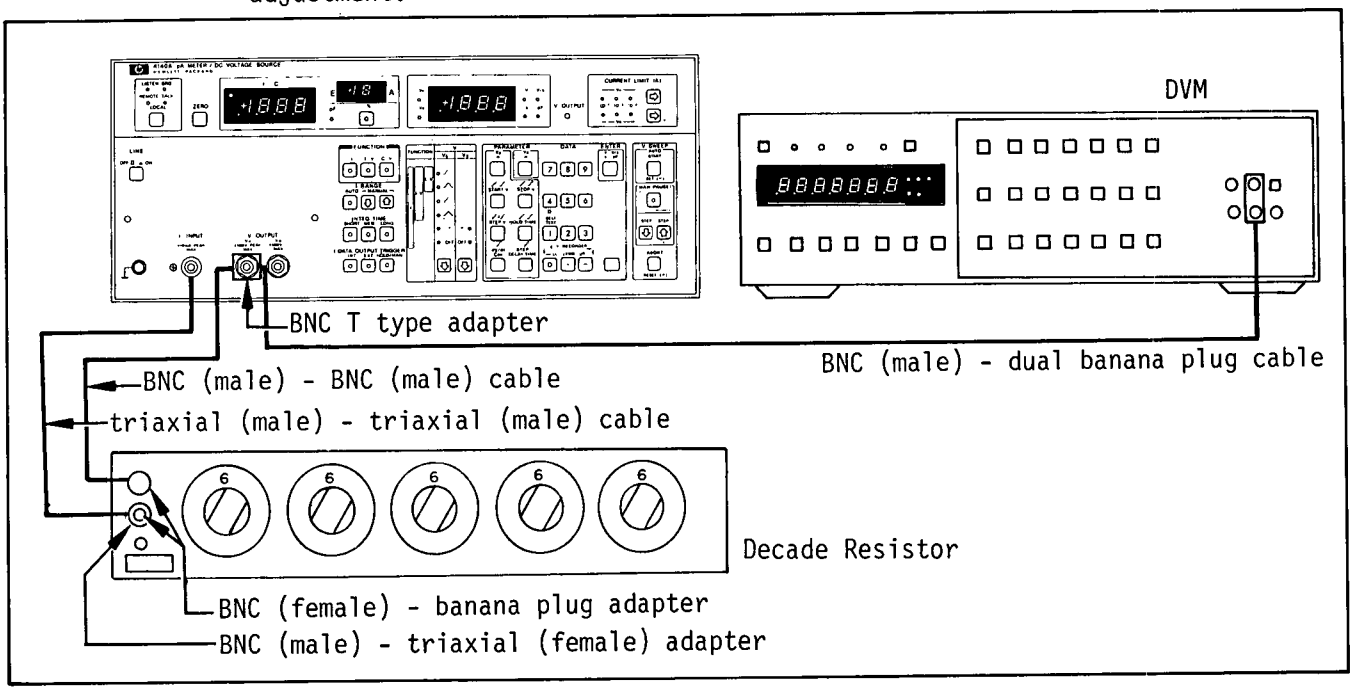

Figure 5-3. pA Meter Gain Adjustment Setup.

EQUIPMENT:

DVM	HP 3455A
Decade Resistor	GR 1433A
BNC T Type Adapter	HP Part No.: 1250-0781
BNC (Female) - Banana Plug Adapter	HP 10111A (2ea)
BNC (Male) - Triaxial (Female) Adapter	TROMPTER AD-BJ77-E3-PL20
Triaxial (Male) - Triaxial (Male) Cable	Part of HP 16053A (HP Part No.: 16053-61002)
BNC (Male) - BNC (Male) Cable	Part of HP 16053A (HP Part No.: 16053-61003)
BNC (Male) - Dual Banana Plug Cable	HP 11001A

PROCEDURE:

1. Connect 4140A, DVM and Decade Resistor as shown in Figure 5-3.

2. Set the DVM as follows:

FUNCTION	DCV
RANGE	AUTO
HIGH RESOLUTION	OFF
AUTO CAL	ON
GUARD	ON
TRIGGER	INTERNAL

3. Set the 4140A as follows:

FUNCTION	I
I RANGE	AUTO
INTEG TIME	LONG
I DATA OUTPUT TRIGGER	INT
V_A	⎓ (DC)

4. Set the Decade Resistor to $10^4\Omega$.

5. Set PARAMETER (⎓) to 1.8 volts.

6. Push SET (⎓) key and read display outputs of the DVM and I·C DISPLAY of 4140A.

7. Adjust "pA GAIN" potentiometer A2R20 for *S.C.V. ±1 count (See Figure 8-22 for location) on I·C DISPLAY.

   *S.C.V. (Supplied Current Value) = (Decade Resistor Value)/(Measured Voltage Value of DVM).

8. Set the Decade Resistor to $10^5\Omega$.

9. Read display outputs and confirm that the I·C DISPLAY displays S.C.V. ±1 count.

10. If not, adjust "pA GAIN" potentiometer A2R20 for S.C.V. ±1 count and repeat steps 7 thru 9.

ADJUSTMENTS

5-21. VS (VOLTAGE SOURCE) DC ADJUSTMENT.

5-22. This adjustment adjusts DC voltage sources (V_A and V_B) (A5). The adjustment is divided into five parts, which are:

(1) V_A Amplifier Offset Zero Adjustment.
(2) V_B Amplifier Offset Zero Adjustment.
(3) DAC Adjustment.
(4) V_A Amplifier Gain Adjustment.
(5) V_B Amplifier Gain Adjustment.

Note

Allow a 15 minute warm up and stabilization period before these adjustments.

Note

This adjustment should be done with no air blowing across the instrument.

WARNING

THE A5 BOARD IS EXTENDED WITH THE EXTENDER BOARD FOR THIS ADJUSTMENT SO THAT THE 120V DC LINES APPEAR. TO AVOID AN ELECTRIC SHOCK, DON'T TOUCH ANY COMPONENTS EXCEPT THOSE TO BE ADJUSTED!

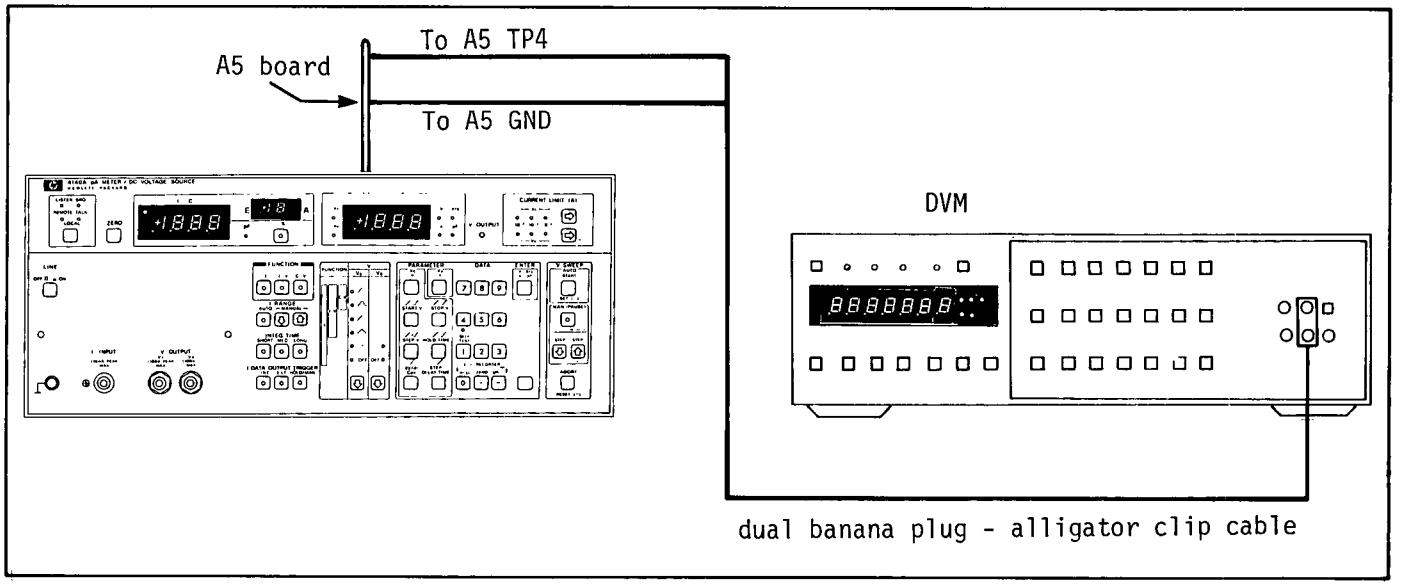

Figure 5-4. VS (Voltage Source) DC Adjustment Setup.

ADJUSTMENTS

EQUIPMENT:

DVM ..... HP 3455A
Dual Banana Plug - Alligator Clip Cable ..... HP 11002A
Extender Board (22pin x 2) ..... HP Part No.: 5060-4025
Clip - Clip Cable

PROCDURE:

(1) V_A Amplifier Offset Zero Adjustment

1. Turn 4140A power switch to OFF. Remove A5 board from 4140A.

2. Install extender board in place of A5 board. Put A5 Board in extender. Set power 4140A switch to on.

3. Connect DVM plus input to A5TP4 (see Figure 8-42 for location) and minus input to A5GND pin with dual banana plug - alligator clip cable. See Figure 5-4.

4. Set the DVM as follows:

   FUNCTION ..... DCV
   RANGE ..... AUTO
   HIGH RESOLUTION ..... OFF
   AUTO CAL ..... ON
   GUARD ..... ON
   TRIGGER ..... INTERNAL

5. Short leads of the 1 F capacitor A5 C13 with a clip-to-clip cable (see Figure 8-42 for location).

6. This adjustment can be made by using auto setting mode of 4140A (refer to paragraph 4-9).

7. Press " Blue , SELF TEST 1 " to set 4140A to Self Test mode.

8. Press " Blue , V_A " to set 4140A to " S-1 " mode.

9. Adjust "X1ZERO" potentiometer A5R24 for 0 volts ±0.1 millivolt (see Figure 8-42 for location).

10. Press " Blue , 9 " to set 4140A to " S-5 " mode.

11. Adjust "X10ZERO" potentiometer A5R19 for 0 volts ±1 millivolt (see Figure 8-42 for location).

12. Remove clip-to-clip cable from A5C13.

(2) V_B Amplifier Offset Zero Adjustment.

13. Connect DVM plus input to A5TP9 (see Figure 8-42 for location) and minus input to A5GND pin with dual banana plug-to-alligator clip cable.

14. Short leads of the 1 F capacitor A5C27 with clip-to-clip cable (see Figure 8-42 for location).

15. Press " Blue , V_B " to set 4140A to " S-1 " mode.

16. Adjust "X1ZERO" potentiometer A5R69 for 0 volts ±0.1 millivolt (see Figure 8-42 for location).

17. Press " Blue , 9 " to set 4140A to " S-5 " mode.

18. Adjust "X10ZERO" potentiometer A5R64 for 0 volts ±1 millivolt (see Figure 8-42 for location).

19. Remove clip-to-clip cable.

(3) DAC Adjustment

20. Connect DVM plus input to "VA IN" A5TP3 (see Figure 8-42 for location and minus input to A5 GND pin with dual banana plug-to-alligator clip cable.

21. Press " Blue , V_B " to set 4140A to " S-1 " mode.

22. Adjust "DA ZERO" potentiometer A5R91 for 0 volts ±0.2 millivolts (see Figure 8-42 for location).

23. Press " Blue , V_B " to set 4140A to " S-2 " mode.

24. Adjust "DA ZERO" potentiometer A5R91 for -10 millivolts ±1 millivolt.

25. Press " Blue , 7 " to set 4140A to " S-3 " mode.

26. Adjust "DA GAIN" potentiometer A5R94 for -10 volts ±1 millivolt.

(4) V_A Amplifier Gain Adjustment.

27. Connect DVM plus input to A5TP4 (see Figure 8-42 for location) and minus input to A5GND pin with dual banana plug-to-alligator clip cable.

28. Press " Blue , ENTER " to set 4140A to " S-6 " mode.

29. Adjust "x10 GAIN" potentiometer A5R31 for -100 volts ±10 millivolts (see Figure 8-42 for location).

(5) V_B Amplifier Gain Adjustment.

30. Connect DVM plus input to A5TP9 (see Figure 8-42 for location) and minus input to A5 GND pin with dual banana plug-to-alligator clip cable.

31. Adjust "x10 GAIN" potentiometer A5R76 for -100 volts ±10 millivolts (see Figure 8-42 for location).

ADJUSTMENTS

5-23. VS (VOLTAGE SOURCE) RAMP GENERATOR ADJUSTMENT

5-24. This adjutment adjusts ramp generator of V_A (A6). The adjustment is divided into two parts:

(1) dV/dt Buffer Zero Adjustment.
(2) Comparator Zero Adjustment.

Note

Allow a 15 minute warm up and stabilization period before this adjustment.

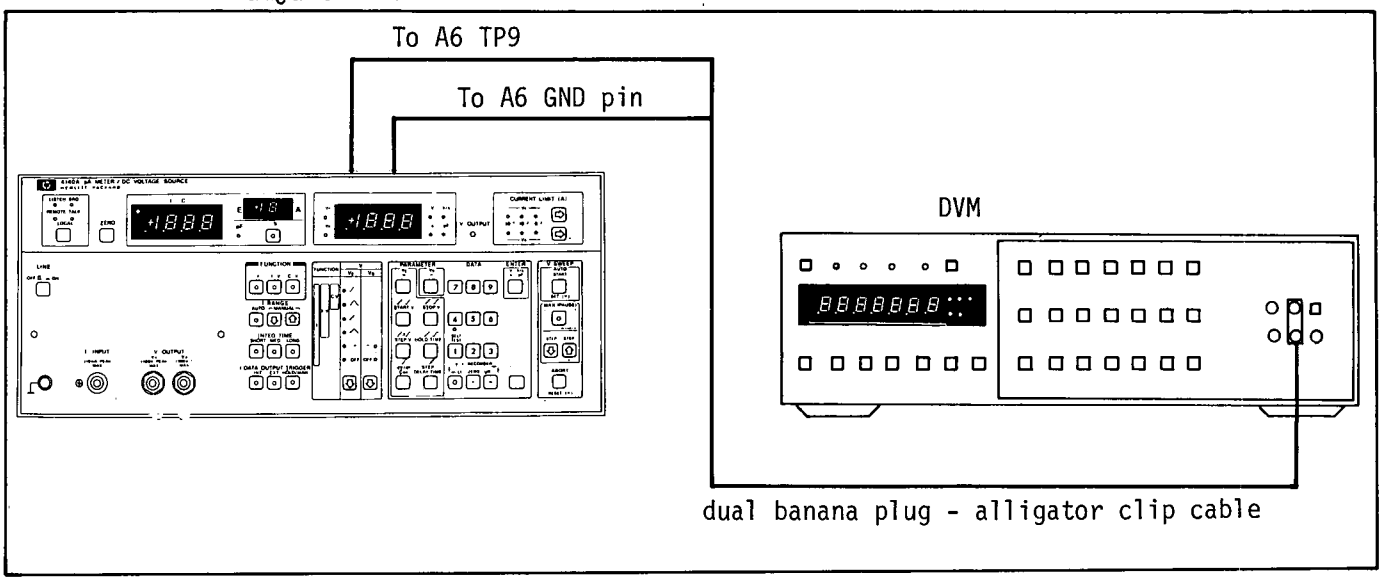

Figure 5-5. VS (Voltage Source) Ramp Generator Adjustment Setup.

EQUIPMENT:

DVM ..... HP 3455A
Dual Banana Plug-to-Alligator Clip Cable ..... HP 11002A
Clip-to-Clip Cable (2ea)

PROCEDURE:

(1) dV/dt Buffer Zero Adjustment.

1. Set 4140A power switch to OFF. Remove A5 board from 4140A.
2. Connect A5TP5, A5TP7 and A5GND pin with clip-to-clip cables.
3. Reinstall A5 board in 4140A. Set 4140A power switch to ON.
4. Connect DVM plus input to "dV/dt BUF. OUT" A6TP9 (see Figure 8-22 for location) and minus input to A6GND pin with dual banana plug to alligator clip cable. See Figure 5-5.
5. Set the DVM as follows:

FUNCTION	DCV
RANGE	AUTO
HIGH RESOLUTION	OFF
AUTO CAL	ON
GUARD	ON
TRIGGER	INTERNAL

6. Adjust "dV/dt BUF ZERO" potentiometer A6R12 for 0 volts ±0.2 millivolts (see Figure 8-22 for location).

(2) Comparator Zero Adjustment.

7. Connect DVM plus input to "RAMP OUT" A6TP7 (see Figure 8-45 for location) and minus input to A6 GND pin with dual banana plug to alligator clip cable.
8. Press "ABORT" key.
9. Adjust "COMP ZERO" potentiometer A6R11 for 0 volts ±0.2 millivolts (see Figure 8-22 for location).
10. Set 4140A power switch to OFF. Remove A5 board from 4140A.
11. Remove clip-to-clip cables and reinstall A5 board in 4140A.

5-25. VS (VOLTAGE SOURCE) RAMP RATE ADJUSTMENT.

5-26. This adjustment adjusts ramp rate for ramp wave (⟋ , ⟋⟍) in the VA ramp generator (A6).

Note

This adjustment requires Option 101 HP-IB Interface as the adjustment is made with the HP-IB system (including HP 9835A Desktop computer, HP 3455A DVM and HP 59308A Timing Generator, etc.).

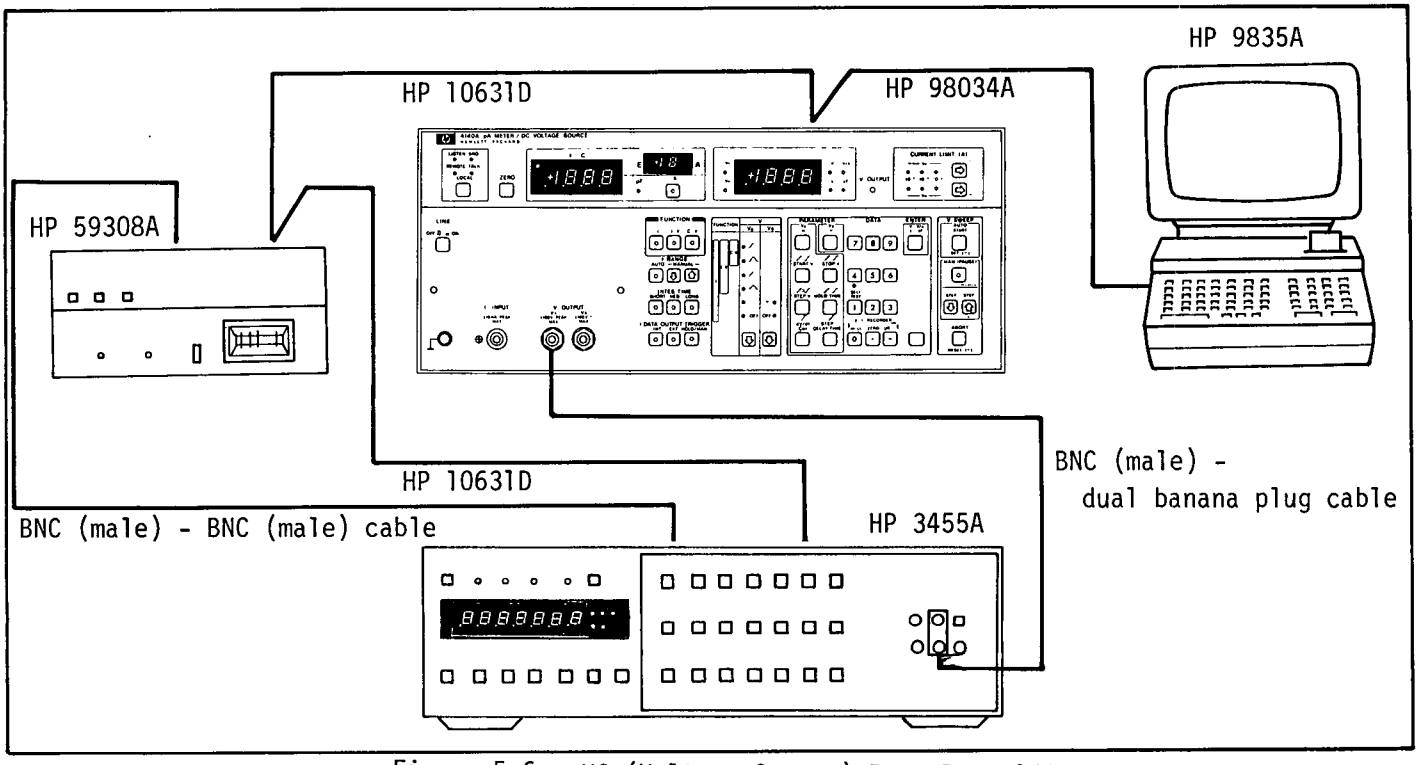

Figure 5-6. VS (Voltage Source) Ramp Rate Adjustment Setup.

EQUIPMENT:

Desktop Computer	HP 9835A
General I/O ROM	HP 98332A
HP-IB Interface Card with Cable	HP 98034A
HP-IB Cable	HP 10631D (2ea)
DVM (with HP-IB Interface capability)	HP 3455A
Timing Generator (with HP-IB Interface capability)	HP 59308A
BNC (Male)-to-BNC (Male) Cable	Part of HP 16053A (HP Part No.: 16053-61003)
BNC (Male)-to-Dual Banana Plug Cable	HP 11001A

PROCEDURE:

1. Turn power switches of 4140A, 9835A, 3455A and 59308A to OFF.
2. Install Option 101 HP-IB Interface in 4140A. Refer to Option Installation in Section II.
3. Connect 98034A HP-IB Interface Card with Cable between 9835A I/O slot and 4140A rear panel HP-IB connector as shown in Figure 5-6.
4. Install 98332A ROM in 9835A ROM slot.
5. Set 98034A Selct Code switch dial to select code 7 (using a screwdriver).
6. Set HP-IB addresses of instruments as follows:

   4140A: 10001 (17 in binary code).
   3455A: 00110 (6 in binary code).
   59308A: 10000 (16 in binary code).

7. Connect 4140A, 3455A and 59308A with 10631D HP-IB cables as shown in Figure 5-6.
8. Connect BNC (male) to BNC (male) cable between 59308A OUTPUT connector and 3455A EXT TRIGGER INPUT connector as shown in Figure 5-6.
9. Set 4140A 9835A, 3455A and 59308A power switches to ON.
10. Load test program (as shown in Figure 5-7) in controller.
11. Execute the program.
12. Check that 9835A CRT is in accord with Table 5-4 Controller Instructions and Operator Responses and adjust ramp rate of the V_A ramp generator in accord with programmed instructions.

```
   [PROGRAMMING]


10    ! 4140A RAMP RATE ADJUSTMENT "40RADJ" (26JUL79)
20      DIM A(-4:400)
30      PRINT PAGE
40      PRINT "RAMP RATE ADJUSTMENT";LIN(1)
50      REMOTE 7
60      ABORTIO 7
70      CLEAR 717
80      IMAGE 3DX,2D.4D,"V/s"
90      WAIT 2000
100     OUTPUT 706;"F1R3T2M3A0H0"
110     OUTPUT 716;"P200E3R"
120     OUTPUT 717;"F1RA1I3T3A2B2L3M3"
130     OUTPUT 717;"PS-10;PT10;PE.5;PV.5;PH3"
140     OUTPUT 717;"W1"
150     B=0
160     FOR J=-4 TO 400
170     ENTER 706;A(J)
180     IF J<1 THEN 250
190     IF J=50 THEN DISP "Adjust ramp rate to .4999 - .5001V/s with A6R13 (dV/dt
 ADJ)"
200     IF J<201 THEN PRINT USING 80;J,A(J)-A(J-5)
210     IF (J=200) AND ((A(J)-A(J-5)<.4999) OR (A(J)-A(J-5)>.5001)) THEN B=1
220     IF J=201 THEN DISP "Waiting"
230     IF (J>250) AND ((A(J)-A(J-5)>-.4995) OR (A(J)-A(J-5)<-.5005)) THEN B=1
240     IF B=1 THEN 260
250     NEXT J
260     OUTPUT 717;"W7"
270     OUTPUT 716;"R"
280     IF B=1 THEN DISP "Adjust again!!"
290     IF B=1 THEN 30
300     PRINT PAGE
310     DISP "END"
320     END
```

Figure 5-7. Ramp Rate Adjustment Program Using 9835A.

Table 5-4. Controller Instructions and Operator Responses for Ramp Rate Adjustment Program.

Controller Instruction	CRT Area	Operator Response
RAMP RATE ADJUSTMENT	Print	
Adjust ramp rate to .4999-.5001 V/s with A6R13 (dV/dt ADJ)	Display	Adjust ramp rate to .4999 .5001V/s with AR13 (dV/dt ADJ) potentiometer.
NNN NN.NNNNV/s	Print	
WAITING	Display	Stop ramp rate adjustment and wait.
Adjust again!!		If ramp rate adjustment is not completed, this annunciation is displayed. In this case, press " RUN " and try ramp rate adjustment again.
END		

ADJUSTMENTS

5-27. ANALOG OUTPUT ADJUSTMENT (OPTION 001 ONLY).

5-28. This adjustment adjusts the Option 001 Analog Output (A31 and A32). The adjustment is divided into three parts:

(1) DAC (D-A Converter) Zero adjustment.
(2) x1/10 Buffer Zero Adjustment.
(3) DAC Gain Adjustment.

Note

Allow a 15 minute warm up and stabilization period before this adjustment.

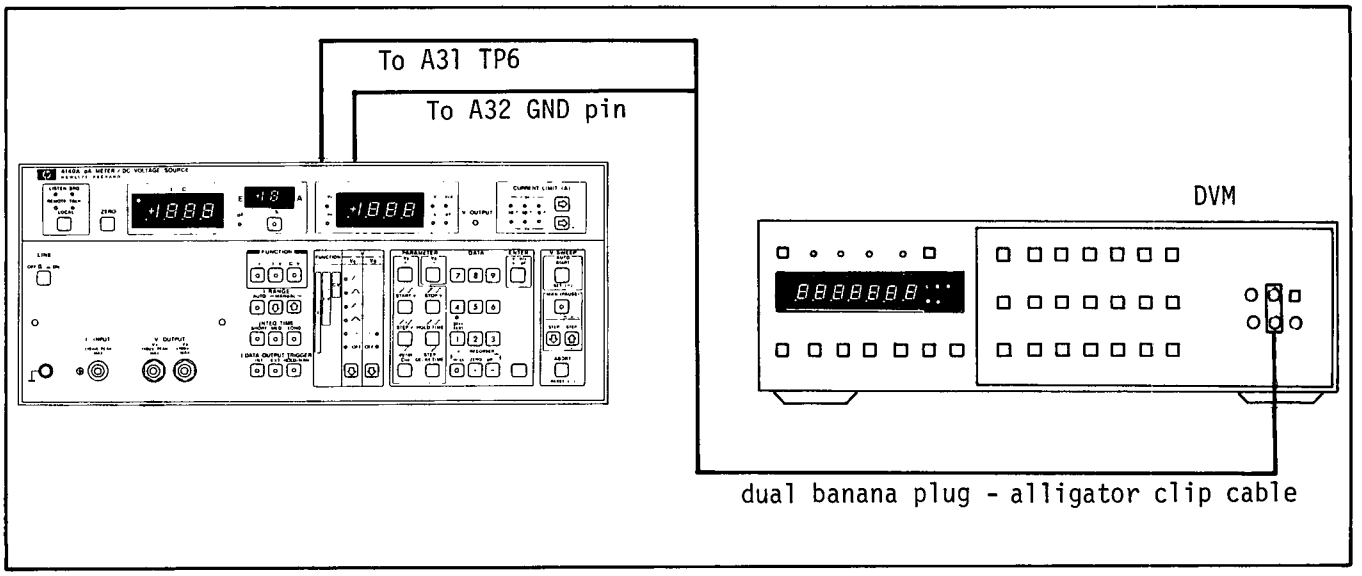

Figure 5-8. Analog Output Adjustment Setup.

EQUIPMENT:

DVM ..... HP 3455A
Dual Banana Plug-to-Alligator Clip Cable ..... HP 11002A

PROCEDURE:

(1) DAC Zero Adjustment

1. Connect DVM plus input to A31TP6 and minus input to A32GND pin with dual banana plug to alligator clip cable. See Figure 5-8.

2. Set the DVM as follows:

FUNCTION	DCV
RANGE	AUTO
HIGH RESOLUTION	OFF
AUTO CAL	ON
GUARD	ON
TRIGGER	INTERNAL

3. This adjustment can be made by using auto setting modes of 4140A (refer to paragraph 4-9).

4. Press " [blue] , [SELF TEST 1] " to set 4140A to Self Test mode.

5. Press " [blue] , [9] " to set 4140A to " S-5 " mode.

6. Adjust "ZERO" potentiometer A31R4 for 0 volts ±0.5 millivolts (see Figure 8-22 for location).

(2) x1/10 Buffer Zero Adjustment

7. Connect DVM plus input to A32TP1 and minus input to A32GND pin with dual banana plug to alligator clip cable.

8. Adjust "x1/10 ZERO" potentiometer A32R5 for 0 volts ±0.5 millivolts (see Figure 8-22 for location).

(3) DAC Gain Adjustment

9. Connect DVM plus input to A31TP6 and minus input to A32GND pin with dual banana plug to alligator clip cable.

10. Press " [blue] , [ENTER] " to set 4140A to " S-6 " mode.

11. Adjust "GAIN" potentiometer A31R5 for -10 volts ±1 millivolt (see Figure 8-22 for location).

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering parts. Table 6-1 lists abbreviations used in the parts list and throughout the manual. Table 6-3 lists all replaceable parts in reference designator order. Table 6-2 contains the names and addresses that correspond to the manufacturer's code numbers.

6-3. ABBREVIATIONS.

6-4. Table 6-1 lists abbreviations used in parts list, schematics and throughout the manual. In some cases, two forms of abbreviations are used, one in all capital letters, and one in partial capitals or no capitals. This occurs because the abbreviations in parts list are always all capitals. However, in the schematics and in other parts of the manual, other abbreviation forms with both lower case and upper case letters are used.

6-5. REPLACEABLE PARTS LIST.

6-6. Table 6-3 is a list of replaceable parts and is organized as follows:

a. Electrical assemblies and their components in alphanumerical order by reference designation.

b. Chassis-mounted parts in alphanumerical order by reference designation.

c. Miscellaneous parts.

d. Illustrated parts breakdowns, if appropriate.

The information for each part includes:

a. The Hewlett-Packard part number.

b. The total quantity (Qty) in the instrument.

Table 6-1. List of Reference Designators and Abbreviations

REFERENCE DESIGNATORS

A	= assembly	E	= misc electronic part	P	= plug	U	= integrated circuit
B	= motor	F	= fuse	Q	= transistor	V	= vacuum, tube, neon bulb, photocell, etc.
BT	= battery	FL	= filter	R	= resistor		
C	= capacitor	J	= jack	RT	= thermistor	VR	= voltage regulator
CP	= coupler	K	= relay	S	= switch	W	= cable
CR	= diode	L	= inductor	T	= transformer	X	= socket
DL	= delay line	M	= meter	TB	= terminal board	Y	= crystal
DS	= device signaling (lamp)	MP	= mechanical part	TP	= test point		

ABBREVIATIONS

A	= amperes	H	= henries	NPN	= negative-positive-negative	RWV	= reverse working voltage
A. F. C.	= automatic frequency control	HEX	= hexagonal	NRFR	= not recommended for field replacement		
AMPL	= amplifier	HG	= mercury	NSR	= not separately replaceable	S-B	= slow-blow
B. F. O.	= beat frequency oscillator	HR	= hour(s)			SCR	= screw
BE CU	= beryllium copper	Hz	= hertz			SE	= selenium
BH	= binder head	IF	= intermediate freq.	OBD	= order by description	SECT	= section(s)
BP	= bandpass	IMPG	= impregnated	OH	= oval head	SEMICON	= semiconductor
BRS	= brass	INCD	= incandescent	OX	= oxide	SI	= silicon
BWO	= backward wave oscillator	INCL	= include(s)			SIL	= silver
CCW	= counter-clockwise	INS	= insulation(ed)	P	= peak	SL	= slide
CER	= ceramic	INT	= internal	PC	= printed circuit	SPG	= spring
CMO	= cabinet mount only	k	= kilo = 1000	p	= pico = 10^{-12}	SPL	= special
COEF	= coefficient	LH	= left hand	PH BRZ	= phosphor bronze	SST	= stainless steel
COM	= common	LIN	= linear taper	PHL	= Phillips	SR	= split ring
COMP	= composition	LK WASH	= lock washer	PIV	= peak inverse voltage	STL	= steel
COMPL	= complete	LOG	= logarithmic taper	PNP	= positive-negative-positive	TA	= tantalum
CONN	= connector	LPF	= low pass filter	P/O	= part of	TD	= time delay
CP	= cadmium plate	m	= milli = 10^{-3}	POLY	= polystyrene	TGL	= toggle
CRT	= cathode-ray tube	M	= meg = 10^{6}	PORC	= porcelain	THD	= thread
CW	= clockwise	MET FLM	= metal film	POS	= position(s)	TI	= titanium
DEPC	= deposited carbon	MET OX	= metallic oxide	POT	= potentiometer	TOL	= tolerance
DR	= drive	MFR	= manufacturer	PP	= peak-to-peak	TRIM	= trimmer
ELECT	= electrolytic	MINAT	= miniature	PT	= point	TWT	= traveling wave tube
ENCAP	= encapsulated	MOM	= momentary	PWV	= peak working voltage	μ	= micro = 10^{-6}
EXT	= external	MTG	= mounting			VAR	= variable
F	= farads	MY	= "mylar"	RECT	= rectifier	VDCW	= dc working volts
f	= femto = 10^{-15}	n	= nano = 10^{-9}	RF	= radio frequency	W/	= with
FH	= flat head	N/C	= normally closed	RH	= round head or right hand	W	= watts
FIL H	= fillister head	NE	= neon	RMO	= rack mount only	WIV	= working inverse voltage
FXD	= fixed	NI PL	= nickel plate	RMS	= root-mean square	WW	= wirewound
G	= giga = 10^{9}	N/O	= normally open			W/O	= without
GE	= germanium	NPO	= negative positive zero (zero temperature coefficient)				
GL	= glass						
GRD	= ground(ed)						

0001-9700

c. A description of the part.

d. A typical manufacturer of the part in a five-digit code.

e. The manufacturer's number for the part.

The total quantity for each part is given only once at the first appearance of the part number in the list.

6-7. ORDERING INFORMATION.

6-8. To order a part listed in the replaceable parts table, give the Hewlett-Packard part number, indicate the quantity required, and address the order to the nearest Hewlett-Packard office.

6-9. To order a part that is not listed in the replaceable parts table, state the full instrument model and serial number, the description and function of the part, and the number of parts required. Address your order to the nearest Hewlett-Packard office.

6-10. SPARE PARTS KIT.

6-11. Stocking spare parts for an instrument is often done to insure quick return to service after a malfunction occurs. Hewlett-Packard has a Spare Parts Kit available for this purpose. The kit consists of selected replaceable assemblies and components for this instrument. The contents of the kit and the Recommended Spares List are based on failure reports and repair data, and parts support for one year. A complimentary Recommended Spares List for this instrument may be obtained on request and the Spare Parts Kit may be ordered through your nearest Hewlett-Packard office.

6-12. DIRECT MAIL ORDER SYSTEM.

6-13. Within the USA, Hewlett-Packard can supply parts through a direct mail order system. Advantages of using the system are:

a. Direct ordering and shipment from the HP Parts Center in Mountain View, California.

b. No maximum or minimum on any mail order (there is a minimum order amount for parts ordered through a local HP Office when the orders require billing and invoicing).

c. Prepaid transportation (there is a small handling change for each order).

d. No invoices --- to provide these advantages, a check or money order must accompany each order.

6-14. Mail order forms and specific ordering information is available through your local HP Office. Addresses and phone numbers are located at the back of this manual.

Table 6-2. Manufacturers Code Lists.

MFR NO.	MANUFACTURER NAME	ADDRESS		ZIP CODE
00000	ANY SATISFACTORY SUPPLIER			
01121	ALLEN-BRADLEY CO	MILWAUKEE	WI	53204
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS	TX	75222
01928	RCA CORP SOLID STATE DIV	SOMERVILLE	NJ	08876
02111	SPECTROL ELECTRONICS CORP	CITY OF IND	CA	91745
03888	KDI PYROFILM CORP	WHIPPANY	NJ	07981
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85062
07933	RAYTHEON CO SEMICONDUCTOR DIV HQ	MOUNTAIN VIEW	CA	94040
19701	MEPCO/ELECTRA CORP	MINERAL WELLS	TX	76067
24355	ANALOG DEVICES INC	NORWOOD	MA	02062
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA	95051
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
32997	BOURNS INC TRIMPOT PROD DIV	RIVERSIDE	CA	92507
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
71279	CAMBRIDGE THERMIONIC CORP	CAMBRIDGE	MA	02138
72136	ELECTRO MOTIVE CORP SUB IEC	WILLIMANTIC	CT	06226
75042	TRW INC PHILADELPHIA DIV	PHILADELPHIA	RA	19108
75915	LITTELFUSE INC	DES PLAINES	IL	60016
8E175	BURR BROWN CO	HUNTSVILLE	AL	35801
98291	SEALECTRO CORP	MAMARONECK	NY	10544

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	04140-66501	7	1	PC BOARD, I/V CONVERTER	28480	04140-66501
A1C1	0160-2204	0	1	CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A1C2	0150-0121	5	8	CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A1C3	0160-2117	4	1	CAPACITOR-FXD .12UF +-10% 200VDC POLYE	28480	0160-2117
A1C4	0160-4084	8	1	CAPACITOR-FXD .1UF +-20% 50VDC CER	28480	0160-4084
A1C5	0180-1083	3	6	CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A1C6	0180-1083	3		CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A1C7	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A1C8	0180-1083	3		CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A1C9	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A1C10	0180-1083	3		CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A1C11	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A1C12	0160-0127	2	2	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A1C13	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A1C14	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A1C15	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A1C16	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A1C17	0160-0157	8	1	CAPACITOR-FXD 4700PF +-10% 200VDC POLYE	28480	0160-0157
A1C18	0180-1083	3		CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A1C19	0180-1083	3		CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A1C20	0160-1583	6	1	CAPACITOR-FXD 20pF +-10% 125V	28480	0160-1583
A1C21	0160-0127	2		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A1C22	0160-1688	2	1	CAPACITOR-FXD 2pF +-5% 150WVDC PULTE	28480	0160-1688
A1C23	0160-5064	6	1	CAPACITOR-FXD 51pF +-5% 125WVDC	28480	0160-5064
A1C24	0160-0153	4	1	CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0160-0153
A1CR1	1902-0041	4	3	DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	28480	1902-0041
A1CR2	1902-0041	4		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	28480	1902-0041
A1CR3	1901-0025	2	9	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A1CR4	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A1CR5	1902-0041	4		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=-.009%	28480	1902-0041
A1CR6	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A1CR7	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A1CR8	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A1CR9	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A1CR10	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A1CR11	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A1CR12	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A1K1	0490-0191	9	3	COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0801	8	3	SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0801
A1K2	0490-0191	9		COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0801	8		SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0801
A1K3	0490-0191	9		COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0801	8		SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0801
A1K4	0490-1137	5	3	RELAY-REED 1A 500MA 200VAC 5VDC-COIL	28480	0490-1137
A1K5	0490-1137	5		RELAY-REED 1A 500MA 200VAC 5VDC-COIL	28480	0490-1137
A1K6	0490-1137	5		RELAY-REED 1A 500MA 200VAC 5VDC-COIL	28480	0490-1137
A1L1	9140-0137	1	3	COIL-MLD 1MH 5% Q=60 .19DX.44LG-NOM	28480	9140-0137
A1L2	9170-0029	3	1	CORE-SHIELDING BEAD	28480	9170-0029
A1L3	9140-0137	1		COIL-MLD 1MH 5% Q=60 .19DX.44LG-NOM	28480	9140-0137
A1L4	9140-0137	1		COIL-MLD 1MH 5% Q=60 .19DX.44LG-NOM	28480	9140-0137
A1P1	1250-0687	1	1	CONNECTOR-RF TRAXL FEM SGL-HOLE-RR	28480	1250-0687
A1Q1	1855-0112	9	4	TSTR;FET (2SK23A)	28480	1855-0112
A1Q2	1855-0112	9		TSTR;FET (2SK23A)	28480	1855-0112
A1Q3	1855-0112	9		TSTR;FET (2SK23A)	28480	1855-0112
A1Q4	1855-0112	9		TSTR;FET (2SK23A)	28480	1855-0112
A1Q5	1854-0071	7	9	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q6	1853-0020	4	2	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A1Q7	1853-0020	4		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A1Q8	5080-3063	5	1	DUAL J-FET N-CH Silicon PD=300mWmax	28480	5080-3063
A1Q9	1855-0119	6	1	J-FET N-CHANNEL Silicon	28480	1855-0119
A1Q10	1853-0354	7	2	TRANSISTOR PNP SI TO-92 PD=350MW	28480	1853-0354
A1Q11	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q12	1853-0354	7		TRANSISTOR PNP SI TO-92 PD=350MW	28480	1853-0354
A1Q13	1854-0296	8	1	TRANSISTOR NPN SI TO-92 PD=310MW	28480	1854-0296
A1Q14	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q15	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q16	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q17	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q18	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q19	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1Q20	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A1R1	0683-1535	6	3	RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A1R2	0757-0401	0	2	RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A1R3	0698-3160	8	4	RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A1R4	0698-3160	8		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A1R5	2100-3306	1	1	RESISTOR-TRMR 50K 10% C SIDE-ADJ 17-TRN	28480	2100-3306

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1R6	0698-0083	8	5	RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A1R7	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A1R8	0683-3955	8	1	RESISTOR 3.9M 5% .25W FC TC=-900/+1100	01121	CB3955
A1R9	0683-1045	3	1	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A1R10	0683-1535	6		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A1R11	0683-1535	6		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A1R12	0683-1015	7	2	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A1R13	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A1R14	0698-3160	8		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A1R15	0757-1090	5	1	RESISTOR 261 1% .5W F TC=0+-100	28480	0757-1090
A1R16	0683-0275	9	2	RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A1R17	0683-0275	9		RESISTOR 2.7 5% .25W FC TC=-400/+500	01121	CB27G5
A1R18	0757-0346	2	3	RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A1R19	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A1R20	0757-0274	5	2	RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1213-F
A1R21	0757-0274	5		RESISTOR 1.21K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1213-F
A1R22	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A1R23	0757-0346	2		RESISTOR 10 1% .125W F TC=0+-100	24546	C4-1/8-T0-10R0-F
A1R24	2100-3154	7	1	RESISTOR-TRMR 1K 10% C SIDE-ADJ 17-TRN	02111	43P102
A1R25	0683-3325	6	3	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A1R26	0683-3325	6		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A1R27	0683-3325	6		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A1R28	0683-3315	4	2	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A1R29	0683-1525	4	2	RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A1R30	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A1R31	0683-1525	4		RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A1R32	0757-0420	3	2	RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A1R33	0757-0420	3		RESISTOR 750 1% .125W F TC=0+-100	24546	C4-1/8-T0-751-F
A1R34	0757-0317	7	1	RESISTOR 1.33K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1331-F
A1R35	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A1R36	0757-0394	0	1	RESISTOR 51.1 1% .125W F TC=0+-100	24546	C4-1/8-T0-51R1-F
A1R37	0698-3151	7	1	RESISTOR 2.87K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2871-F
A1R38	0698-3150	6	1	RESISTOR 2.37K 1% .125W F TC=0+-100	24546	C4-1/8-T0-2371-F
A1R39	0757-0401	0		RESISTOR 100 1% .125W F TC=0+-100	24546	C4-1/8-T0-101-F
A1R40	0757-0428	1	1	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A1R41	0757-0438	3	2	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A1R42	0698-3154	0	1	RESISTOR 4.22K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4221-F
A1R43	0757-0280	3	1	RESISTOR 1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1001-F
A1R44	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A1R45	0683-1065	7	1	RESISTOR 10M 5% .25W FC TC=-900/+1100	01121	CB1065
A1R46	0698-0082	7	1	RESISTOR 464 1% .125W F TC=0+-100	24546	C4-1/8-T0-4640-F
A1R47	0698-0083	8		RESISTOR 1.96K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1961-F
A1R48	0757-0416	7	1	RESISTOR 511 1% .125W F TC=0+-100	24546	C4-1/8-T0-511R-F
A1R49	0698-3429	2	1	RESISTOR 19.6 1% .125W F TC=0+-100	03888	PME55-1/8-T0-19R6-F
A1R50	0757-0279	0	1	RESISTOR 3.16K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3161-F
A1R51	0757-0488	3	1	RESISTOR 909K 1% .125W F TC=0+-100	28480	0757-0488
A1R52	0699-0420	9	1	RESISTOR-FXD 99 +-1% 3W	28480	0699-0420
A1R53	0699-0423	2	1	RESISTOR-FXD 11G +-1% 1W	28480	0699-0423
A1R54	0699-0488	3	1	RESISTOR-FXD 100M +-.1% 1W	28480	0699-0488
A1R55	0698-6369	5	1	RESISTOR 1M .1% .25W F TC=0+-25	28480	0698-6369
A1R56	0698-6360	6	1	RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A1R57	0698-1381	1	1	RESISTOR-FXD 100 +-.1% 1/2W	28480	0698-1381
A1R58	0698-3160	8		RESISTOR 31.6K 1% .125W F TC=0+-100	24546	C4-1/8-T0-3162-F
A1R59	0683-1025	9	3	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R60	0683-2235	5	6	RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A1R61	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R62	0683-2235	5		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A1R63	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A1R64	0683-2235	5		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A1R65	0683-2235	5		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A1R66	0683-2235	5		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A1R67	0683-2235	5		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A1S1	3101-2125	3	2	SWITCH-SL SPDT SUBMIN .3A 125VAC PC	28480	3101-2125
A1S2	3101-2125	3		SWITCH-SL SPDT SUBMIN .3A 125VAC PC	28480	3101-2125
A1T1	9100-0820	5	2	TRANSFORMER:PULSE	28480	9100-0820
A1T2	9100-0820	5		TRANSFORMER:PULSE	28480	9100-0820
A1T3	9100-0822	7	2	TRANSFORMER:PULSE(11307)	28480	9100-0822
A1T4	9100-0822	7		TRANSFORMER:PULSE(11307)	28480	9100-0822
A1U1	1826-0319	7	1	IC OP AMP TO-99	27014	LF356H
A1U2	1820-1112	8	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A1U3	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A1U4	1820-1197	9	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
	0410-0465	2	1	CRYSTAL-QUARTZ 4.00000 MHZ	28480	0410-0465
				MISCELLANEOUS PARTS		

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
	0340-0060	4	1	TERMINAL-STUD SPCL-FDTHRU PRESS-MTG	98291	011-6809-00-0-200
	0340-0078	4	9	TERMINAL-STUD FKD-TUR PRESS-MTG	28480	0340-0078
	0380-0584	1	3	STANDOFF-RVT-ON .875-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
	1251-0600	0	4	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-BZ SQ	28480	1251-0600
	1400-0249	0	1	CABLE TIE .062-.625-DIA .091-WD NYL	28480	1400-0249
	2200-0105	4	5	SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2360-0115	4	6	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2360-0123	4	3	SCREW-MACH 6-32 .625-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2360-0194	9	1	SCREW-MACH 6-32 .312-IN-LG 100 DEG	00000	ORDER BY DESCRIPTION
	8150-0447	6		WIRE 24AWG BK 300V PVC 7X32 80C	28480	8150-0447
	8150-0448	7		WIRE 24AWG BR 300V PVC 7X32 80C	28480	8150-0448
	8150-0449	8		WIRE 24AWG R 300V PVC 7X32 80C	28480	8150-0449
	8150-0450	1		WIRE 24AWG O 300V PVC 7X32 80C	28480	8150-0450
	8150-0451	2		WIRE 24AWG Y 300V PVC 7X32 80C	28480	8150-0451
	8150-0452	3		WIRE 24AWG G 300V PVC 7X32 80C	28480	8150-0452
	04140-00603	2	1	PLATE	28480	04140-00603
	04140-00604	3	1	SHIELD	28480	04140-00604
	04140-00605	4	1	SHIELD	28480	04140-00605
	04140-00606	5	1	COVER, SHIELD	28480	04140-00606
	04140-00607	6	1	PLATE	28480	04140-00607
	04140-01202	9	1	ANGLE	28480	04140-01202
	04140-01203	0	1	ANGLE	28480	04140-01203
	04140-20001	6	6	HOUSING	28480	04140-20001
	04140-21001	8	6	SCREW	28480	04140-21001
	04140-21002	9	1	BUSHING	28480	04140-21002
	04140-23001	2	3	SHAFT	28480	04140-23001
	04140-24001	4	1	SPACER	28480	04140-24001
	04140-26501	3	1	PC BOARD, BLANK-A1	28480	04140-26501
	04140-40003	0	1	INSULATOR	28480	04140-40003

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2	04140-66502	8	1	A-D CONVERTER BOARD ASSEMBLY	28480	04140-66502
A2C1	0150-0121	5	2	CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A2C2	0180-1083	3	3	CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A2C3	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A2C4	0180-1083	3		CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A2C5	0180-1083	3		CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A2C6	0160-5063	5	1	CAPACITOR-FXD .015uF +-10% 150WVDC POLYE	28480	0160-5063
A2C7	0140-0198	5	2	CAPACITOR-FXD 200PF +-5% 300VDC MICA	72136	DM15F201J0300WV1CR
A2C8	0140-0198	5		CAPACITOR-FXD 200PF +-5% 300VDC MICA	72136	DM15F201J0300WV1CR
A2CR1	1901-0040	1	6	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR3	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR4	1902-3182	0	1	DIODE-ZNR 12.1V 5% DO-7 PD=.4W TC=+.064%	28480	1902-3182
A2CR5	1902-3136	4	1	DIODE-ZNR 8.06V 5% DO-7 PD=.4W TC=+.052%	28480	1902-3136
A2CR6	1902-0057	2	1	DIODE-ZNR 6.49V 5% DO-7 PD=.4W TC=+.029%	28480	1902-0057
A2CR7	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR8	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR9	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A2CR10	1902-3171	8	2	DIODE-ZNR 11V 5% DO-7 PD=.4W TC=+.062%	28480	1902-3171
A2CR11	1902-3171	8		DIODE-ZNR 11V 5% DO-7 PD=.4W TC=+.062%	28480	1902-3171
A2IC1	1820-1486	9	2	IC GATE CMOS AND QUAD 2-INP	01928	CD40818F
A2IC5	1820-1486	9		IC GATE CMOS AND QUAD 2-INP	01928	CD40818F
A2IC11	1820-1746	4	1	IC BFR CMOS INV HEX	04713	MC14049UBCP
A2K1	0490-0240	9	1	RELAY-REED .1AMAX 50VMAX	28480	0490-0240
A2Q1	1854-0071	7	7	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A2Q2	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A2Q3	1854-0019	3	3	TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A2Q4	1853-0354	7	3	TRANSISTOR PNP SI TO-92 PD=350MW	28480	1853-0354
A2Q5	1854-0019	3		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A2Q6	1853-0354	7		TRANSISTOR PNP SI TO-92 PD=350MW	28480	1853-0354
A2Q7	1854-0019	3		TRANSISTOR NPN SI TO-18 PD=360MW	28480	1854-0019
A2Q8	1853-0354	7		TRANSISTOR PNP SI TO-92 PD=350MW	28480	1853-0354
A2Q9	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A2Q10	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A2Q11	1855-0093	5	1	TRANSISTOR J-FET N-CHAN D-MODE TO-18 SI	28480	1855-0093
A2Q12	1855-0081	1	3	TRANSISTOR J-FET N-CHAN D-MODE SI	01295	2N5245
A2Q13	1853-0020	4	2	TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A2Q14	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A2Q15	1855-0081	1		TRANSISTOR J-FET N-CHAN D-MODE SI	01295	2N5245
A2Q16	1855-0081	1		TRANSISTOR J-FET N-CHAN D-MODE SI	01295	2N5245
A2Q17	1853-0020	4		TRANSISTOR PNP SI PD=300MW FT=150MHZ	28480	1853-0020
A2Q18	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A2Q19	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A2R1	0683-1535	6	12	RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A2R2	0683-3335	8	8	RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A2R3	0683-3325	6	2	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A2R4	0683-2215	1	3	RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A2R5	0683-2725	8	3	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A2R6	0683-4725	2	3	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R7	0683-2215	1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A2R8	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A2R9	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R10	0683-2215	1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A2R11	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A2R12	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A2R13	0683-3325	6		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A2R14	0683-1015	7	3	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R15	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R16	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A2R17	0683-5615	1	1	RESISTOR 560 5% .25W FC TC=-400/+600	01121	CB5615
A2R18	0683-1525	4	1	RESISTOR 1.5K 5% .25W FC TC=-400/+700	01121	CB1525
A2R19	0683-1065	7	1	RESISTOR 10M 5% .25W FC TC=-900/+1100	01121	CB1065
A2R20	2100-3355	0	1	RESISTOR-TRMR 100K 10% C SIDE-ADJ 1-TRN	28480	2100-3355
A2R21	0683-3335	8		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A2R22	0698-6360	6	3	RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A2R23	0698-7847	6	1	RESISTOR 1.111K .1% .125W F TC=0+-25	19701	MF4C1/8-T9-1111R-B
A2R24	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A2R25	0698-7681	6	1	RESISTOR 15.33K .1% .125W F TC=0+-50	19701	MF4C1/8-T2-15331-B
A2R26	0698-3458	7	1	RESISTOR 348K 1% .125W F TC=0+-100	28480	0698-3458
A2R27	0698-6360	6		RESISTOR 10K .1% .125W F TC=0+-25	28480	0698-6360
A2R28	0683-3335	8		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A2R29	0683-1535	6		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A2R30	0683-5625	3	2	RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A2R31	0683-1535	6		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A2R32	0683-1535	6		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A2R33	0683-3335	8		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A2R34	0683-1535	6		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A2R35	0683-1535	6		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A2R36	0683-1535	6		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A2R37	0683-1535	6		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A2R38	0683-4705	8	2	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A2R39	0683-5625	3		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A2R40	0683-1535	6		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A2R41	0683-1055	5	1	RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A2R42	0683-1535	6		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A2R43	0683-3335	8		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A2R44	0683-1535	6		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A2R45	0683-1535	6		RESISTOR 15K 5% .25W FC TC=-400/+800	01121	CB1535
A2R46	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A2R47	0683-3335	8		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A2R48	0683-3335	8		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A2R49	0683-3335	8		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
R50	0683-1045			100KΩ		
R51	0683-1045			100KΩ		
R52	0683-1045			100KΩ		
A2U2	1820-1956	8	4	IC LCH CMOS COM CLOCK QUAD	01928	CD40428E
A2U3	1820-1956	8		IC LCH CMOS COM CLOCK QUAD	01928	CD40428E
A2U4	1820-1962	6	2	IC DCDR CMOS BCD-TO-DEC	04713	MC140288CP
A2U6	1820-1956	8		IC LCH CMOS COM CLOCK QUAD	01928	CD40428E
A2U7	1820-1956	8		IC LCH CMOS COM CLOCK QUAD	01928	CD40428E
A2U8	1820-2008	3	1	IC SHF-RGTR CMOS D-M/S SERIAL-IN PRL-OUT	04713	MC140158CP
A2U9	1820-1963	7	1	IC FF CMOS D-TYPE POS-EDGE-TRIG DUAL	01928	CD40138AE
A2U10	1820-1962	6		IC DCDR CMOS BCD-TO-DEC	04713	MC140288CP
A2U12	1990-0444	6	4	OPTO-ISOLATOR LED-PDIO/X8TR IF=25MA-MAX	28480	6N136
A2U13	1990-0444	6		OPTO-ISOLATOR LED-PDIO/X8TR IF=25MA-MAX	28480	6N136
A2U14	1990-0444	6		OPTO-ISOLATOR LED-PDIO/X8TR IF=25MA-MAX	28480	6N136
A2U15	1990-0444	6		OPTO-ISOLATOR LED-PDIO/X8TR IF=25MA-MAX	28480	6N136
A2U16	1826-0065	0	1	IC COMPARATOR PRCN 8-DIP-P	01295	SN72311P
A2U17	1826-0319	7	1	IC OP AMP TO-99	27014	LF356M
A2U18	1826-0326	6	1	IC OP AMP GP DUAL 8-DIP-P	07933	RC4558NB
A2U19	1813-0105	2	1	IC CONV 12-B-D/A 24-DIP-C	8E175	DAC80-CBI-V
				MISCELLANEOUS PARTS		
	1200-0541	1	1	SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
	1251-0600	0	10	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-8Z SQ	28480	1251-0600
	1480-0116	8	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
	4040-0748	3	1	EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	4040-0750	7	1	EXTR-PC BD RED POLYC .062-BD-THKNS	28480	4040-0750
	04140-26502	4	1	PC BOARD, BLANK-A2	28480	04140-26502
	6340-1244	4	1	INSULATOR	28480	6340-1244

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3	04140-66513	1	1	MPU BOARD ASSEMBLY	28480	04140-66513
A3C1	0160-2055	9	9	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C2	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C3	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C4	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C5	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C7	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C8	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C9	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A3C10	0160-0134	1	2	CAPACITOR-FXD 220PF +-5% 300VDC MICA	28480	0160-0134
A3C11	0150-0121	5	2	CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A3C12	0160-2150	5	2	CAPACITOR-FXD 33PF +-5% 300VDC MICA	28480	0160-2150
A3C13	0160-0134	1		CAPACITOR-FXD 220PF +-5% 300VDC MICA	28480	0160-0134
A3C14	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A3C15	0160-2150	5		CAPACITOR-FXD 33PF +-5% 300VDC MICA	28480	0160-2150
A3C16	0180-0228	6	1	CAPACITOR-FXD 22UF+-10% 15VDC TA	56289	150D226X9015B2
A3C17	0180-1085	5	9	CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A3C18	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A3C19	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A3C20	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A3C21	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A3C22	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A3C23	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A3C24	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A3C25	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A3C26	0160-0127	2	1	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A3CR1	1901-0040	1	3	DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR2	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3CR3	1901-0040	1		DIODE-SWITCHING 30V 50MA 2NS DO-35	28480	1901-0040
A3Q1	1853-0015	7	2	TRANSISTOR PNP SI PD=200MW FT=500MHZ	28480	1853-0015
A3Q2	1854-0071	7	2	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3Q3	1853-0015	7		TRANSISTOR PNP SI PD=200MW FT=500MHZ	28480	1853-0015
A3Q4	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A3R1	0683-4725	2	9	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R2	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R3	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R4	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R5	0683-2715	6	3	RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A3R6	0683-1005	5	2	RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A3R7	0683-1035	1	2	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R8	0683-2205	9	2	RESISTOR 22 5% .25W FC TC=-400/+500	01121	CB2205
A3R9	0683-3325	6	2	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A3R10	0683-1025	9	2	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R11	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R12	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A3R13	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R14	0683-2715	6		RESISTOR 270 5% .25W FC TC=-400/+600	01121	CB2715
A3R15	0683-1005	5		RESISTOR 10 5% .25W FC TC=-400/+500	01121	CB1005
A3R16	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A3R17	0683-2205	9		RESISTOR 22 5% .25W FC TC=-400/+500	01121	CB2205
A3R18	0683-3325	6		RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A3R19	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A3R20	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R21	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R22	0683-4735	4	1	RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A3R23	0683-1245	5	1	RESISTOR 120K 5% .25W FC TC=-800/+900	01121	CB1245
A3R24	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A3R25	0683-3925	2	1	RESISTOR 3.9K 5% .25W FC TC=-400/+700	01121	CB3925
A3R26	0683-2225	3	1	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A3R30	1810-0279	5	1	NETWORK-RES 10-SIP4.7K OHM X 9	01121	210A472
A3U3	04140-85003	4	1	IC, P-ROM	28480	04140-85003
A3U4	04140-85004	5	1	IC, P-ROM	28480	04140-85004
A3U5	04140-85005	6	1	IC, P-ROM	28480	04140-85005
A3U6	04140-85006	7	1	IC, P-ROM	28480	04140-85006
A3U7	04140-85007	8	1	IC, P-ROM	28480	04140-85007
A3U8	04140-85008	9	1	IC, P-ROM	28480	04140-85008
A3U9	1820-2075	4	2	IC MISC TTL LS	01295	SN74LS245N
A3U10	1818-0438	4	2	IC NMOS 4K RAM STAT 450-NS 3-S	01295	TM84045-45JL
A3U11	1818-0438	4		IC NMOS 4K RAM STAT 450-NS 3-S	01295	TM84045-45JL
A3U12	1820-2024	3	2	IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3U13	1820-1480	3	1	IC MICPROC NMOS 8-BIT	04713	MC6800L
A3U14	1820-2075	4		IC MISC TTL LS	01295	SN74LS245N
A3U15	1820-1568	8	2	IC BFR TTL LS BUS QUAD	01295	SN74LS125AN
A3U16	1820-1112	8	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A3U17	1820-1211	8	1	IC GATE TTL LS EXCL-OR QUAD 2-INP	01295	SN74LS86N
A3U18	1820-1975	1	1	IC SHF-RGTR TTL LS NEG-EDGE-TRIG PRL-IN	01295	SN74LS165N
A3U19	1820-1216	3	2	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A3U20	1820-1216	3		IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A3U21	1820-2024	3		IC DRVR TTL LS LINE DRVR OCTL	01295	SN74LS244N
A3U22	1820-1197	9	3	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A3U23	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A3U24	1820-1202	7	1	IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A3U25	1820-1443	8	1	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS293N
A3U26	1820-1197	9		IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A3U27	1820-1199	1	3	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A3U28	1820-1568	8		IC BFR TTL LS BUS QUAD	01295	SN74LS125AN
A3U29	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A3U30	1820-1199	1		IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A3U31	1820-0471	0	1	IC INV TTL HEX 1-INP	01295	SN7406N
A3U32	1820-1425	6	1	IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	01295	SN74LS132N
				MISCELLANEOUS PARTS		
	1200-0608	1	1	SOCKET INTEGRATOR CIRCUIT	28480	1200-0608
	1480-0116	8	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
	4040-0748	3	1	EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	4040-0751	8	1	EXTR-PC BD ORN POLYC .062-BD-THKNS	28480	4040-0751
	7120-7673	0	1	LABEL, IDNET -66513	28480	7120-7673
	04140-26503	5	1	PC BOARD, BLANK-A3	28480	04140-26503

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4	04140-66504	0	1	I/O BOARD ASSEMBLY	28480	04140-66504
A4C1	0140-0192	0	1	CAPACITOR-FXD 68PF +-5% 300VDC MICA		
A4C2	0160-2199	2	1	CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A4C3	0160-2055	9	6	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C4	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C5	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C6	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C7	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C8	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A4C9	0180-1085	5	11	CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A4C10	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A4C11	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A4C12	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A4C13	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A4C14	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A4C15	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A4C16	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A4C17	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A4C18	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A4C19	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A4C20	0160-2204			CAPACITOR-FXD 100pF 300VW		
A4CR1	1902-0041	4	1	DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=.009%	28480	1902-0041
A4J1	1251-0541	8	1	CONNECTOR 34-PIN M RECTANGULAR	28480	1251-0541
A4R1	0683-4725	2	6	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A4R2	0683-5625	3	2	RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A4R3	0683-5625	3		RESISTOR 5.6K 5% .25W FC TC=-400/+700	01121	CB5625
A4R4	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A4R5	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A4R6	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A4R7	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A4R8	0683-4725	2		RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A4R9	0683-1825	7	1	RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A4R10	0683-3325	6	1	RESISTOR 3.3K 5% .25W FC TC=-400/+700	01121	CB3325
A4R30	1810-0279	5	3	NETWORK-RES 10-8IP4.7K OHM X 9	01121	210A472
A4R31	1810-0279	5		NETWORK-RES 10-8IP4.7K OHM X 9	01121	210A472
A4R32	1810-0279	5		NETWORK-RES 10-8IP4.7K OHM X 9	01121	210A472
A4U1	1820-1204	9	1	IC GATE TTL LS NAND DUAL 4-INP	01295	SN74L820N
A4U2	1820-1197	9	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74L800N
A4U3	1820-1416	5	4	IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74L814N
A4U4	1820-1144	6	2	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74L802N
A4U5	1820-1112	8	4	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A4U6	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A4U7	1820-1198	0	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74L803N
A4U8	1820-0628	9	3	IC TTL 64-BIT RAM 60-NS 0-C	01295	SN7489N
A4U9	1820-0628	9		IC TTL 64-BIT RAM 60-NS 0-C	01295	SN7489N
A4U10	1820-0628	9		IC TTL 64-BIT RAM 60-NS 0-C	01295	SN7489N
A4U11	1820-1416	5		IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74L814N
A4U12	1820-1470	1	1	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74L8157N
A4U13	1820-1443	8	4	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74L8293N
A4U14	1820-1443	8		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74L8293N
A4U15	1820-1443	8		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74L8293N
A4U16	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A4U17	1820-1199	1	1	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A4U18	1820-1423	4	1	IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N
A4U19	1820-1436	9	3	IC TTL LS 16-BIT RAM 45-NS 0-C	01295	SN74LS170N
A4U20	1820-1443	8		IC CNTR TTL LS BIN ASYNCHRO	01295	SN74L8293N
A4U21	1820-1245	8	1	IC DCDR TTL LS 2-TO-4-LINE DUAL 2-INP	01295	SN74LS155N
A4U22	1820-1216	3	1	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A4U23	1820-1201	6	2	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A4U24	1820-1217	4	1	IC MUXR/DATA-SEL TTL LS 8-TO-1-LINE	01295	SN74LS151N
A4U25	1820-1416	5		IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A4U26	1820-1201	6		IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A4U27	1820-1442	7	1	IC CNTR TTL LS DECD ASYNCHRO	01295	SN74LS290N
A4U28	1820-1202	7	1	IC GATE TTL LS NAND TPL 3-INP	01295	SN74LS10N
A4U29	1820-1112	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A4U30	1820-1436	9		IC TTL LS 16-BIT RAM 45-NS 0-C	01295	SN74LS170N
A4U31	1820-1436	9		IC TTL LS 16-BIT RAM 45-NS 0-C	01295	SN74LS170N
A4U32	1820-1196	8	4	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A4U33	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A4U34	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N
A4U35	1820-1196	8		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS174N

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A4U36	1820-1438	1	2	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257AN
A4U37	1820-1438	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257AN
A4U38	1820-1416	5		IC SCHMITT-TRIG TTL LS INV HEX 1-INP	01295	SN74LS14N
A4U39	1820-1144	6		IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A4U40	1820-1211	8	1	IC GATE TTL LS EXCL-OR QUAD 2-INP	01295	SN74LS86N
				MISCELLANEOUS PARTS		
	1251-0600	0	14	CONNECTOR-SGL CONT PIN 1.14-MM-SSC-SZ SD	28480	1251-0600
	1480-0116	8	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
	4040-0748	3	1	EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	4040-0752	9	1	EXTR-PC BD YEL POLYC .062-BD-THKNS	28480	4040-0752
	04140-26504	6	1	PC BOARD, BLANK-A4	28480	04140-26504

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5	04140-66505	1	1	DAC OUTPUT BOARD ASSEMBLY	28480	04140-66505
A5C1	0160-3456	6	4	CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A5C2	0160-3456	6		CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A5C3	0160-2055	9	4	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C4	0150-0121	5	6	CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A5C5	0160-2204	0	2	CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A5C6	0160-0127	2	4	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A5C7	0160-0137	4	2	CAPACITOR-FXD .33UF +-20% 25VDC CER	28480	0160-0137
A5C8	0160-2230	2	2	CAPACITOR-FXD 3300PF +-5% 300VDC MICA	28480	0160-2230
A5C9	0160-0127	2		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A5C10	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C13	0160-1676	8	2	CAPACITOR, FXD 1 MF 5% 100V	28480	0160-1676
A5C14	0160-2199	2	2	CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A5C15	0160-3456	6		CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A5C16	0160-3456	6		CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A5C17	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C18	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A5C19	0160-2204	0		CAPACITOR-FXD 100PF +-5% 300VDC MICA	28480	0160-2204
A5C20	0160-0127	2		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A5C21	0160-0137	4		CAPACITOR-FXD .33UF +-20% 25VDC CER	28480	0160-0137
A5C22	0160-2230	2		CAPACITOR-FXD 3300PF +-5% 300VDC MICA	28480	0160-2230
A5C23	0160-0127	2		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A5C24	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A5C25	0160-2144	7	2	CAPACITOR-FXD 3300PF +80-20% 1KVDC CER	28480	0160-2144
A5C27	0160-1676	8		CAPACITOR, FXD 1 MF 5% 100V	28480	0160-1676
A5C28	0160-2199	2		CAPACITOR-FXD 30PF +-5% 300VDC MICA	28480	0160-2199
A5C29	0180-1083	3	3	CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A5C30	0180-1083	3		CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A5C31	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A5C32	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A5C33	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A5C34	0150-0121	5		CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A5C35	0180-1083	3		CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A5C61	0160-2144	7		CAPACITOR-FXD 3300PF +80-20% 1KVDC CER	28480	0160-2144
A5CR1	1901-0025	2	14	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5CR2	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5CR3	1902-0049	2	2	DIODE-ZNR 6.19V 5% DO-7 PD=.4W TC=+.022%	28480	1902-0049
A5CR4	1902-3104	6	2	DIODE-ZNR 5.62V 5% DO-7 PD=.4W TC=+.016%	28480	1902-3104
A5CR7	5080-3064	4	4	DIODE-ZNR 10V 2% DO-7 PD=.4W TC=+.06%	28480	5080-3064
A5CR8	5080-3064	4		DIODE-ZNR 10V 2% DO-7 PD=.4W TC=+.06%	28480	5080-3064
A5CR9	1902-3193	3	4	DIODE-ZNR 13.3V 5% DO-7 PD=.4W TC=+.059%	28480	1902-3193
A5CR10	1902-3193	3		DIODE-ZNR 13.3V 5% DO-7 PD=.4W TC=+.059%	28480	1902-3193
A5CR11	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5CR12	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5CR13	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5CR14	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5CR15	1902-0041	4	2	DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=+.009%	28480	1902-0041
A5CR16	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5CR17	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5CR18	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5CR19	1902-0049	2		DIODE-ZNR 6.19V 5% DO-7 PD=.4W TC=+.022%	28480	1902-0049
A5CR20	1902-3104	6		DIODE-ZNR 5.62V 5% DO-7 PD=.4W TC=+.016%	28480	1902-3104
A5CR21	1901-0033	2	2	DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A5CR22	1901-0033	2		DIODE-GEN PRP 180V 200MA DO-7	28480	1901-0033
A5CR23	5060-3064	4		DIODE-ZNR 10V 2% DO-7 PD=.4W TC=+.06%	28480	5080-3064
A5CR24	5060-3064	4		DIODE-ZNR 10V 2% DO-7 PD=.4W TC=+.06%	28480	5080-3064
A5CR25	1902-3193	3		DIODE-ZNR 13.3V 5% DO-7 PD=.4W TC=+.059%	28480	1902-3193
A5CR26	1902-3193	3		DIODE-ZNR 13.3V 5% DO-7 PD=.4W TC=+.059%	28480	1902-3193
A5CR27	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5CR28	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5CR29	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5CR30	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5CR31	1902-0041	4		DIODE-ZNR 5.11V 5% DO-7 PD=.4W TC=+.009%	28480	1902-0041
A5CR32	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A5K1	0490-0191	9	8	COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0189	8	6	SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0189
A5K2	0490-0191	9		COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0189	8		SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0189
A5K3	0490-0191	9		COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0189	8		SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0189
A5K4	0490-0234	1	2	RELAY, REED	28480	0490-0234
A5K5	0490-0191	9		COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0801	8	2	SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0801
A5K6	0490-0191	9		COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0189	8		SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0189

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5K7	0490-0191	9		COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0189	8		SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0189
A5K8	0490-0191	9		COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0189	8		SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0189
A5K9	0490-0234	1		RELAY, REED	28480	0490-0234
A5K10	0490-0191	9		COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0801	8		SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0801
A5Q1	1853-0336	5	6	TRANSISTOR PNP SI PD=625MW FT=50MHZ	04713	MPSA92
A5Q2	1854-0575	6	16	TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q3	1854-0232	2	2	TRANSISTOR NPN SI TO-39 PD=1W FT=15MHZ	28480	1854-0232
A5Q4	1853-0221	7	2	TRANSISTOR PNP 2N5416 SI TO-5 PD=1W	01928	2N5416
A5Q5	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q6	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q7	1855-0049	1	2	TRANSISTOR-JFET DUAL N-CHAN D-MODE SI	28480	1855-0049
A5Q8	1853-0336	5		TRANSISTOR PNP SI PD=625MW FT=50MHZ	04713	MPSA92
A5Q9	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q10	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q11	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q12	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q13	1853-0015	7	2	TRANSISTOR PNP SI PD=200MW FT=500MHZ	28480	1853-0015
A5Q14	1853-0336	5		TRANSISTOR PNP SI PD=625MW FT=50MHZ	04713	MPSA92
A5Q15	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q16	1854-0092	2	2	TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A5Q17	1854-0071	7	4	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A5Q18	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A5Q19	1853-0281	9	2	TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A5Q20	1853-0336	5		TRANSISTOR PNP SI PD=625MW FT=50MHZ	04713	MPSA92
A5Q21	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q22	1854-0232	2		TRANSISTOR NPN SI TO-39 PD=1W FT=15MHZ	28480	1854-0232
A5Q23	1853-0221	7		TRANSISTOR PNP 2N5416 SI TO-5 PD=1W	01928	2N5416
A5Q24	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q25	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q26	1855-0049	1		TRANSISTOR-JFET DUAL N-CHAN D-MODE SI	28480	1855-0049
A5Q27	1853-0336	5		TRANSISTOR PNP SI PD=625MW FT=50MHZ	04713	MPSA92
A5Q28	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q29	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q30	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q31	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q32	1853-0015	7		TRANSISTOR PNP SI PD=200MW FT=500MHZ	28480	1853-0015
A5Q33	1853-0336	5		TRANSISTOR PNP SI PD=625MW FT=50MHZ	04713	MPSA92
A5Q34	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A5Q35	1854-0092	2		TRANSISTOR NPN SI PD=200MW FT=600MHZ	28480	1854-0092
A5Q36	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A5Q37	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A5Q38	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A5R1	0683-1235	3	2	RESISTOR 12K 5% .25W FC TC=-400/+800	01121	CB1235
A5R2	0683-1225	1	2	RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1225
A5R3	0683-1015	7	4	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A5R4	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A5R5	0757-0465	6	2	RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A5R6	0757-0442	9	2	RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R7	0757-0424	7	2	RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A5R8	0683-1035	1	5	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R9	0683-1055	5	4	RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R10	0683-2735	0	2	RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A5R11	0683-2745	2	2	RESISTOR 270K 5% .25W FC TC=-800/+900	01121	CB2745
A5R12	0683-1025	9	15	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R13	0683-1055	5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R14	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R15	0683-3935	4	2	RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A5R16	0683-2215	1	4	RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A5R17	0683-1545	8	4	RESISTOR 150K 5% .25W FC TC=-800/+900	01121	CB1545
A5R18	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R19	2100-0554	5	4	RESISTOR-TRMR 500 10% C TOP-ADJ 1-TRN	28480	2100-0554
A5R20	0683-2235	5	8	RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A5R21	0683-5635	5	2	RESISTOR 56K 5% .25W FC TC=-400/+800	01121	CB5635
A5R22	0683-2235	5		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A5R23	0683-3345	0	2	RESISTOR 330K 5% .25W FC TC=-800/+900	01121	CB3345
A5R24	2100-0558	9	2	RESISTOR-TRMR 20K 10% C TOP-ADJ 1-TRN	28480	2100-0558
A5R25	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R26	0683-3945	6	8	RESISTOR 390K 5% .25W FC TC=-800/+900	01121	CB3945
A5R27	0683-1545	8		RESISTOR 150K 5% .25W FC TC=-800/+900	01121	CB1545
A5R28	0683-3945	6		RESISTOR 390K 5% .25W FC TC=-800/+900	01121	CB3945
A5R29	0683-3945	6		RESISTOR 390K 5% .25W FC TC=-800/+900	01121	CB3945
A5R30	0683-5655	9	2	RESISTOR 5.6M 5% .25W FC TC=-900/+1100	01121	CB5655

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5R31	2100-0554	5		RESISTOR-TRMR 500 10% C TOP-ADJ 1-TRN	28480	2100-0554
A5R32	0698-6688	1	2	RESISTOR 99.8K .1% .125W F TC=0+-25	28480	0698-6688
A5R33	0698-6305	9	2	RESISTOR 900K .1% .25W F TC=0+-25	28480	0698-6305
A5R34	0683-1825	7	2	RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A5R35	0683-2235	5		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A5R36	0683-3945	6		RESISTOR 390K 5% .25W FC TC=-800/+900	01121	CB3945
A5R37	0683-2235	5		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A5R38	0683-3335	8	2	RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A5R39	0683-4735	4	2	RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A5R40	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R41	0683-3315	4	2	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A5R42	0683-2215	1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A5R43	0683-1515	2	8	RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A5R44	0683-1515	2		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A5R45	0683-1515	2		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A5R46	0683-1235	3		RESISTOR 12K 5% .25W FC TC=-400/+800	01121	CB1235
A5R47	0683-1225	1		RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1225
A5R48	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A5R49	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A5R50	0757-0465	6		RESISTOR 100K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1003-F
A5R51	0757-0442	9		RESISTOR 10K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1002-F
A5R52	0757-0424	7		RESISTOR 1.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1101-F
A5R53	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R54	0683-1055	5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R55	0683-2735	0		RESISTOR 27K 5% .25W FC TC=-400/+800	01121	CB2735
A5R56	0683-2745	2		RESISTOR 270K 5% .25W FC TC=-800/+900	01121	CB2745
A5R57	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R58	0683-1055	5		RESISTOR 1M 5% .25W FC TC=-800/+900	01121	CB1055
A5R59	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R60	0683-3935	4		RESISTOR 39K 5% .25W FC TC=-400/+800	01121	CB3935
A5R61	0683-2215	1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A5R62	0683-1545	8		RESISTOR 150K 5% .25W FC TC=-800/+900	01121	CB1545
A5R63	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R64	2100-0554	5		RESISTOR-TRMR 500 10% C TOP-ADJ 1-TRN	28480	2100-0554
A5R65	0683-2235	5		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A5R66	0683-5635	5		RESISTOR 56K 5% .25W FC TC=-400/+800	01121	CB5635
A5R67	0683-2235	5		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A5R68	0683-3345	0		RESISTOR 330K 5% .25W FC TC=-800/+900	01121	CB3345
A5R69	2100-0558	9		RESISTOR-TRMR 20K 10% C TOP-ADJ 1-TRN	28480	2100-0558
A5R70	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R71	0683-3945	6		RESISTOR 390K 5% .25W FC TC=-800/+900	01121	CB3945
A5R72	0683-1545	8		RESISTOR 150K 5% .25W FC TC=-800/+900	01121	CB1545
A5R73	0683-3945	6		RESISTOR 390K 5% .25W FC TC=-800/+900	01121	CB3945
A5R74	0683-3945	6		RESISTOR 390K 5% .25W FC TC=-800/+900	01121	CB3945
A5R75	0683-5655	9		RESISTOR 5.6M 5% .25W FC TC=-900/+1100	01121	CB5655
A5R76	2100-0554	5		RESISTOR-TRMR 500 10% C TOP-ADJ 1-TRN	28480	2100-0554
A5R77	0698-6688	1		RESISTOR 99.8K .1% .125W F TC=0+-25	28480	0698-6688
A5R78	0698-6305	9		RESISTOR 900K .1% .25W F TC=0+-25	28480	0698-6305
A5R79	0683-1825	7		RESISTOR 1.8K 5% .25W FC TC=-400/+700	01121	CB1825
A5R80	0683-2235	5		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A5R81	0683-3945	6		RESISTOR 390K 5% .25W FC TC=-800/+900	01121	CB3945
A5R82	0683-2235	5		RESISTOR 22K 5% .25W FC TC=-400/+800	01121	CB2235
A5R83	0683-3335	8		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A5R84	0683-4735	4		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A5R85	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R86	0683-3315	4		RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A5R87	0683-2215	1		RESISTOR 220 5% .25W FC TC=-400/+600	01121	CB2215
A5R88	0683-1515	2		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A5R89	0683-1515	2		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A5R90	0683-1515	2		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A5R91	2100-3214	0	1	RESISTOR-TRMR 100K 10% C TOP-ADJ 1-TRN	28480	2100-3214
A5R92	0683-2265	1	1	RESISTOR 22M 5% .25W FC TC=-900/+1200	01121	CB2265
A5R93	0698-3438	3	1	RESISTOR 147 1% .125W F TC=0+-100	24546	C4-1/8-T0-147R-F
A5R94	2100-3212	8	1	RESISTOR-TRMR 200 10% C TOP-ADJ 1-TRN	28480	2100-3212
A5R95	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A5R96	0683-1515	2		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A5R97	0683-1515	2		RESISTOR 150 5% .25W FC TC=-400/+600	01121	CB1515
A5R98	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R99	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R100	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R101	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R102	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R103	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A5R104	0683-1025	9		RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A5U1	5080-3061	4	2	OP AMP, 100PA MAX	28480	5080-3061
A5U2	5080-3061	4		OP AMP, 100PA MAX	28480	5080-3061
A5U3	1813-0105	2	1	IC CONV 12-B-D/A 24-DIP-C	8E175	DAC80-CBI-V
A5U4	1820-1199	1	1	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A5U5	1820-0471	0	2	IC INV TTL HEX 1-INP	01295	SN7406N
A5U6	1820-0471	0		IC INV TTL HEX 1-INP	01295	SN7406N
A5U7	1820-1425	6	1	IC SCHMITT-TRIG TTL LS NAND QUAD 2-INP	01295	SN74LS132N
A5U8	1820-1374	4	2	IC SWITCH ANLG QUAD 16-DIP-P	24355	AD7510DIJN
A5U9	1820-1374	4		IC SWITCH ANLG QUAD 16-DIP-P	24355	AD7510DIJN
				MISCELLANEOUS PARTS		
	0340-0060	4	2	TERMINAL-STUD SPCL-FDTHRU PRESS-MTG	98291	011-6809-00-0-200
	1200-0541	1	1	SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
	1205-0095	6	4	HEAT SINK	28480	1205-0095
	1250-0835	1	2	CONNECTOR-RF SMC M PC 50-OHM	28480	1250-0835
	1251-0600	0	13	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
	04140-26505	7	1	PC BOARD, BLANK-A5	28480	04140-26505
	4040-0748	3	1	EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	4040-0753	0	1	EXTR-PC BD GRN POLYC .062-BD-THKNS	28480	4040-0753

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6	04140-66506	2	1	RAMP GENERATOR BOARD ASSEMBLY	28480	04140-66506
A6C1	0180-1085	5	1	CAPACITOR-FXD 33pF -10+75% 25WVDC	28480	0180-1085
A6C2	0150-0121	5	1	CAPACITOR-FXD .1UF +80-20% 50VDC CER	28480	0150-0121
A6C3	0160-2150	5	5	CAPACITOR-FXD 33PF +-5% 300VDC MICA	28480	0160-2150
A6C4	0160-0127	2	2	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A6C5	0160-3456	6	1	CAPACITOR-FXD 1000PF +-10% 1KVDC CER	28480	0160-3456
A6C6	0160-0889	3	1	CAPACITOR-FXD .33UF +-10% 80VDC POLYE	28480	0160-0889
A6C7	0160-1673	5	1	CAPACITOR-FXD .33uF +-.5% 50WVDC POLYE	28480	0160-1673
A6C8	0160-1676	8	1	CAPACITOR, FXD 1 MF 5% 100V	28480	0160-1676
A6C9	0160-1103	6	1	C-F 500P 35V K	28480	0160-1103
A6C10	0160-2150	5		CAPACITOR-FXD 33PF +-5% 300VDC MICA	28480	0160-2150
A6C11	0160-2150	5		CAPACITOR-FXD 33PF +-5% 300VDC MICA	28480	0160-2150
A6C12	0160-2150	5		CAPACITOR-FXD 33PF +-5% 300VDC MICA	28480	0160-2150
A6C13	0160-2150	5		CAPACITOR-FXD 33PF +-5% 300VDC MICA	28480	0160-2150
A6C14	0180-1066	2	6	CAPACITOR, FXD 47 MF AL	28480	0180-1066
A6C15	0180-1066	2		CAPACITOR, FXD 47 MF AL	28480	0180-1066
A6C16	0180-1066	2		CAPACITOR, FXD 47 MF AL	28480	0180-1066
A6C17	0180-1066	2		CAPACITOR, FXD 47 MF AL	28480	0180-1066
A6C18	0160-1548	3	3	C:FXD MY 0.22 UF 10% 100VDCW	28480	0160-1548
A6C19	0160-1548	3		C:FXD MY 0.22 UF 10% 100VDCW	28480	0160-1548
A6C20	0160-1548	3		C:FXD MY 0.22 UF 10% 100VDCW	28480	0160-1548
A6C21	0160-0127	2		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A6C22	0180-1066	2		CAPACITOR, FXD 47 MF AL	28480	0180-1066
A6C23	0180-1066	2		CAPACITOR, FXD 47 MF AL	28480	0180-1066
A6CR1	1902-3205	8	1	DIODE-ZNR 15V 5% DO-7 PD=.4W TC=+.057%	28480	1902-3205
A6CR2	1901-0025	2	5	DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A6CR3	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A6CR4	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A6CR5	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A6CR6	1901-0025	2		DIODE-GEN PRP 100V 200MA DO-7	28480	1901-0025
A6CR7	1902-0049	2	4	DIODE-ZNR 6.19V 5% DO-7 PD=.4W TC=+.022%	28480	1902-0049
A6CR8	1902-0049	2		DIODE-ZNR 6.19V 5% DO-7 PD=.4W TC=+.022%	28480	1902-0049
A6CR9	1902-3129	5	2	DIODE-ZNR 7.5V 2% DO-7 PD=.4W TC=+.05%	28480	1902-3129
A6CR10	1902-3129	5		DIODE-ZNR 7.5V 2% DO-7 PD=.4W TC=+.05%	28480	1902-3129
A6CR11	1902-0049	2		DIODE-ZNR 6.19V 5% DO-7 PD=.4W TC=+.022%	28480	1902-0049
A6CR12	1902-0049	2		DIODE-ZNR 6.19V 5% DO-7 PD=.4W TC=+.022%	28480	1902-0049
A6K1	0490-0191	9	5	COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0801	8	5	SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0801
A6K2	0490-0191	9		COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0801	8		SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0801
A6K3	0490-0191	9		COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0801	8		SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0801
A6K4	0490-0191	9		COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0801	8		SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0801
A6K5	0490-0191	9		COIL-REED RELAY MAG REED; 12 VDC; 6300	28480	0490-0191
	0490-0801	8		SWITCH-REED 1A DRY 1A 300V 35-AT	28480	0490-0801
A6Q1	1853-0281	9	3	TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A6Q2	1854-0477	7	3	TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
A6Q3	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A6Q4	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
A6Q5	1853-0281	9		TRANSISTOR PNP 2N2907A SI TO-18 PD=400MW	04713	2N2907A
A6Q6	1854-0477	7		TRANSISTOR NPN 2N2222A SI TO-18 PD=500MW	04713	2N2222A
A6R1	0683-1035	1	9	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A6R2	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A6R3	0683-1045	3	1	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A6R4	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A6R5	0683-3335	8	1	RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A6R6	0683-1025	9	1	RESISTOR 1K 5% .25W FC TC=-400/+600	01121	CB1025
A6R7	0683-2725	8	2	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A6R8	0683-4755	8	2	RESISTOR 4.7M 5% .25W FC TC=-900/+1100	01121	CB4755
A6R9	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A6R10	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A6R11	2100-3207	1	1	RESISTOR-TRMR 5K 10% C SIDE-ADJ 1-TRN	28480	2100-3207
A6R12	2100-3353	8	1	RESISTOR-TRMR 20K 10% C SIDE-ADJ 1-TRN	32997	3386X-Y46-203
A6R13	2100-3349	2	1	RESISTOR-TRMR 100 10% C SIDE-ADJ 1-TRN	28480	2100-3349
A6R14	0683-1225	1	5	RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1225
A6R15	0683-1225	1		RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1225
A6R16	0683-1225	1		RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1225
A6R17	0683-1225	1		RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1225
A6R18	0683-1225	1		RESISTOR 1.2K 5% .25W FC TC=-400/+700	01121	CB1225
A6R19	0683-4705	8	1	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A6R20	0683-1015	7	2	RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A6R21	0683-1065	7	1	RESISTOR 10M 5% .25W FC TC=-900/+1100	01121	CB1065
A6R22	0683-4755	8		RESISTOR 4.7M 5% .25W FC TC=-900/+1100	01121	CB4755
A6R23	0699-0421	0	1	R-FXD 20.8M 1%	28480	0699-0421
A6R24	0683-4715	0	2	RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A6R25	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A6R26	0683-1015	7		RESISTOR 100 5% .25W FC TC=-400/+500	01121	CB1015
A6R27	0699-0422	1	1	RESISTOR-FXD 100 +-5% .25W	28480	0699-0422
A6R28	0698-3488	3	1	RESISTOR 442 1% .125W F TC=0+-100	24546	C4-1/8-T0-422R-F
A6R29	0757-0428	1	1	RESISTOR 1.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-1621-F
A6R30	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A6R31	0683-5635	5	2	RESISTOR 56K 5% .25W FC TC=-400/+800	01121	CB5635
A6R32	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A6R33	0683-4735	4	2	RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A6R34	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A6R35	0683-5635	5		RESISTOR 56K 5% .25W FC TC=-400/+800	01121	CB5635
A6R36	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A6R37	0683-4735	4		RESISTOR 47K 5% .25W FC TC=-400/+800	01121	CB4735
A6R38	0683-2225	3	4	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A6R39	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A6R40	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A6R41	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A6R42	0698-3260	9	3	RESISTOR 464K 1% .125W F TC=0+-100	28480	0698-3260
A6R43	0683-4715	0		RESISTOR 470 5% .25W FC TC=-400/+600	01121	CB4715
A6R44	0683-3305	2	1	RESISTOR 33 5% .25W FC TC=-400/+500	01121	CB3305
A6R45	0698-3260	9		RESISTOR 464K 1% .125W F TC=0+-100	28480	0698-3260
A6R46	0698-3260	9		RESISTOR 464K 1% .125W F TC=0+-100	28480	0698-3260
A6U1	1820-0471	0	1	IC INV TTL HEX 1-INP	01295	SN7406N
A6U2	1826-0065	0	1	IC COMPARATOR PRCN 8-DIP-P	01295	SN72311P
A6U3	1826-0319	7	2	IC OP AMP TO-99	27014	LF356H
A6U4	1826-0319	7		IC OP AMP TO-99	27014	LF356H
A6U5	5080-3065	5	1	IC-LINEAR OP-AMP Vos=30MVmax Ig=1pAmax	28480	5080-3065
A6U6	1820-1144	6	1	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A6U7	1820-1958	0	1	IC SWITCH ANLG QUAD 14-DIP-P	01928	CD4016BE
				MISCELLANEOUS PARTS		
	0340-0060	4	3	TERMINAL-STUD SPCL-FDTHRU PRESS-MTG	98291	011-6809-00-0-200
	0340-0078	4	5	TERMINAL-STUD FKD-TUR PRESS-MTG	28480	0340-0078
	0360-1819	5	5	TERMINAL-STUD FKD-TUR SWGFRM-MTG	71279	1025-2
	1200-0474	9	1	SOCKET-IC 14-CONT DIP-SLDR	28480	1200-0474
	1251-0600	0	12	CONNECTOR-SGL CONT PIN 1.14-MM-88C-SZ SQ	28480	1251-0600
	1400-0493	6	1	CABLE TIE .062-1.25-DIA .14-WD NYL	28480	1400-0493
	1480-0116	8	2	PIN-GRV .062-IN-DIA .25-IN-LG STL	28480	1480-0116
	2200-0105	4	4	SCREW-MACH 4-40 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	4040-0748	3	1	EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	4040-0754	1	1	EXTR-PC BD BLU POLYC .062-BD-THKNS	28480	4040-0754
	7174-0215	5	12	FUSE .5A 250V	28480	7174-0215
	04140-00608	7	1	PLATE, SHIELD	28480	04140-00608
	04140-26506	8	1	PC BOARD, BLANK-A6	28480	04140-26506

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A7	04140-66507	3	1	DC POWER SUPPLY BOARD ASSEMBLY	28480	04140-66507
A7C1	0160-0362	7	4	CAPACITOR-FXD 510PF +-5% 300VDC MICA	28480	0160-0362
A7C2	0160-0362	7		CAPACITOR-FXD 510PF +-5% 300VDC MICA	28480	0160-0362
A7C3	0160-0362	7		CAPACITOR-FXD 510PF +-5% 300VDC MICA	28480	0160-0362
A7C4	0160-0362	7		CAPACITOR-FXD 510PF +-5% 300VDC MICA	28480	0160-0362
A7C5	0180-1056	0	4	CAPACITOR-FXD 1000 UF 25VDC AL ELECT	28480	0180-1056
A7C6	0180-1056	0		CAPACITOR-FXD 1000 UF 25VDC AL ELECT	28480	0180-1056
A7C7	0180-1056	0		CAPACITOR-FXD 1000 UF 25VDC AL ELECT	28480	0180-1056
A7C8	0180-3003	1	4	CAPACITOR-FXD 33uF -10+100% 250VDC	28480	0180-3003
A7C9	0180-3003	1		CAPACITOR-FXD 33uF -10+100% 250VDC	28480	0180-3003
A7C10	0180-0094	4	4	CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A7C11	0180-0094	4		CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A7C12	0180-0094	4		CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A7C13	0180-0094	4		CAPACITOR-FXD 100UF+75-10% 25VDC AL	56289	30D107G025DD2
A7C14	0180-3003	1		CAPACITOR-FXD 33uF -10+100% 250VDC	28480	0180-3003
A7C15	0180-3003	1		CAPACITOR-FXD 33uF -10+100% 250VDC	28480	0180-3003
A7C16	0160-0166	9	2	CAPACITOR-FXD .068UF +-10% 200VDC POLYE	28480	0160-0166
A7C17	0160-0166	9		CAPACITOR-FXD .068UF +-10% 200VDC POLYE	28480	0160-0166
A7C18	0180-1057	1	1	CAPACITOR-FXD 2200 UF 16VDCW AL ELECT	28480	0180-1057
A7C19	0160-0159	0	1	CAPACITOR-FXD 6800PF +-10% 200VDC POLYE	28480	0160-0159
A7C20	0180-1056	0		CAPACITOR-FXD 1000 UF 25VDC AL ELECT	28480	0180-1056
A7CR1	1902-3346	8	2	DIODE-ZNR 51.1V 2% DO-7 PD=.4W TC=+.081%	28480	1902-3346
A7CR2	1902-3346	8		DIODE-ZNR 51.1V 2% DO-7 PD=.4W TC=+.081%	28480	1902-3346
A7CR3	1902-3234	3	2	DIODE-ZNR 19.6V 5% DO-7 PD=.4W TC=+.073%	28480	1902-3234
A7CR4	1902-1292	9	4	DIODE-ZNR 1N53728 62V 5% PD=5W IR=500NA	04713	1N53728
A7CR5	1902-1292	9		DIODE-ZNR 1N53728 62V 5% PD=5W IR=500NA	04713	1N53728
A7CR6	1902-3234	3		DIODE-ZNR 19.6V 5% DO-7 PD=.4W TC=+.073%	28480	1902-3234
A7CR7	1902-1292	9		DIODE-ZNR 1N53728 62V 5% PD=5W IR=500NA	04713	1N53728
A7CR8	1902-1292	9		DIODE-ZNR 1N53728 62V 5% PD=5W IR=500NA	04713	1N53728
A7CR9	1902-3094	3	1	DIODE-ZNR 5.11V 2% DO-7 PD=.4W TC=-.009%	28480	1902-3094
A7CR10	1901-0237	8	4	DIODE-SI, RECTIFIER BRIDGE, 200V	28480	1901-0237
A7CR11	1901-0237	8		DIODE-SI, RECTIFIER BRIDGE, 200V	28480	1901-0237
A7CR12	1901-0237	8		DIODE-SI, RECTIFIER BRIDGE, 200V	28480	1901-0237
A7CR13	1901-0237	8		DIODE-SI, RECTIFIER BRIDGE, 200V	28480	1901-0237
A7CR14	1901-0028	5	8	DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A7CR15	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A7CR16	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A7CR17	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A7CR18	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A7CR19	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A7CR20	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A7CR21	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A7CR22	1902-0040	3	2	DIODE-ZNR 14V 5% DO-7 PD=.4W TC=+.056%	28480	1902-0040
A7CR23	1902-0040	3		DIODE-ZNR 14V 5% DO-7 PD=.4W TC=+.056%	28480	1902-0040
A7CR24	1902-1217	8	1	DIODE-ZNR 6.2V 5% DO-4 PD=10W TC=+.035%	28480	1902-1217
A7F1	2110-0107	5	4	FUSE .5A 250V	28480	2110-0107
A7F2	2110-0107	5		FUSE .5A 250V	28480	2110-0107
A7F3	2110-0422	7	1	FUSE 6.25A 250V SLO-BLO 1.25X.25 UL IEC	28480	2110-0422
A7F4	2110-0107	5		FUSE .5A 250V	28480	2110-0107
A7F5	2110-0107	5		FUSE .5A 250V	28480	2110-0107
A7F6	2110-0201	0	2	FUSE .25A 250V SLO-BLO 1.25X.25 UL	75915	313.250
A7F7	2110-0201	0		FUSE .25A 250V SLO-BLO 1.25X.25 UL	75915	313.250
A7Q1	1854-0389	0	5	TRANSISTOR NPN 2N4922 SI PD=30W FT=3MHZ	04713	2N4922
A7Q2	1854-0389	0		TRANSISTOR NPN 2N4922 SI PD=30W FT=3MHZ	04713	2N4922
A7Q3	1854-0389	0		TRANSISTOR NPN 2N4922 SI PD=30W FT=3MHZ	04713	2N4922
A7Q4	1854-0389	0		TRANSISTOR NPN 2N4922 SI PD=30W FT=3MHZ	04713	2N4922
A7Q5	1854-0389	0		TRANSISTOR NPN 2N4922 SI PD=30W FT=3MHZ	04713	2N4922
A7Q6	1854-0330	1	2	TRANSISTOR NPN SI PD=21W FT=10MHZ	28480	1854-0330
A7Q7	1854-0330	1		TRANSISTOR NPN SI PD=21W FT=10MHZ	28480	1854-0330
A7Q8	1854-0575	6	2	TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A7Q9	1854-0232	2	4	TRANSISTOR NPN SI TO-39 PD=1W FT=15MHZ	28480	1854-0232
A7Q10	1854-0232	2		TRANSISTOR NPN SI TO-39 PD=1W FT=15MHZ	28480	1854-0232
A7Q11	1854-0575	6		TRANSISTOR NPN SI PD=625MW FT=50MHZ	04713	MPS-A42
A7Q12	1854-0232	2		TRANSISTOR NPN SI TO-39 PD=1W FT=15MHZ	28480	1854-0232
A7Q13	1854-0232	2		TRANSISTOR NPN SI TO-39 PD=1W FT=15MHZ	28480	1854-0232
A7R1	2100-3352	7	2	RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN	28480	2100-3352
A7R2	2100-3352	7		RESISTOR-TRMR 1K 10% C SIDE-ADJ 1-TRN	28480	2100-3352
A7R3	0811-1670	3	4	RESISTOR 2.2 5% 2W PW TC=0+-400	75042	BWH2-2R2-J
A7R4	0811-1670	3		RESISTOR 2.2 5% 2W PW TC=0+-400	75042	BWH2-2R2-J
A7R5	0811-1670	3		RESISTOR 2.2 5% 2W PW TC=0+-400	75042	BWH2-2R2-J

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A7R6	0811-1670	3		RESISTOR 2.2 5% 2W PW TC=0+-400	75042	BWH2-2R2-J
A7R7	0757-0438	3	4	RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R8	0757-0200	7	2	RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A7R9	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R10	0698-3155	1	2	RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A7R11	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R12	0698-3155	1		RESISTOR 4.64K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4641-F
A7R13	0757-0438	3		RESISTOR 5.11K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5111-F
A7R14	0757-0200	7		RESISTOR 5.62K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5621-F
A7R15	0757-0458	7	1	RESISTOR 51.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-5112-F
A7R16	0757-0461	2	2	RESISTOR 68.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6812-F
A7R17	0683-3335	8	2	RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A7R18	0683-5635	5	2	RESISTOR 56K 5% .25W FC TC=-400/+800	01121	CB5635
A7R19	0686-1505	6	2	RESISTOR 15 5% .5W CC TC=0+412	01121	EB1505
A7R20	0764-0012	4	2	RESISTOR 6.8K 5% 2W MO TC=0+-200	28480	0764-0012
A7R21	0757-0461	2		RESISTOR 68.1K 1% .125W F TC=0+-100	24546	C4-1/8-T0-6812-F
A7R22	0686-1505	6		RESISTOR 15 5% .5W CC TC=0+412	01121	EB1505
A7R23	0764-0012	4		RESISTOR 6.8K 5% 2W MO TC=0+-200	28480	0764-0012
A7R24	0683-5635	5		RESISTOR 56K 5% .25W FC TC=-400/+800	01121	CB5635
A7R25	0683-3335	8		RESISTOR 33K 5% .25W FC TC=-400/+800	01121	CB3335
A7R28	0683-4725	2	1	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A7R29	0683-2225	3	3	RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A7R30	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A7R31	0683-2225	3		RESISTOR 2.2K 5% .25W FC TC=-400/+700	01121	CB2225
A7R32	0698-4497	6	1	RESISTOR 48.7K 1% .125W F TC=0+-100	24546	C4-1/8-T0-4872-F
A7R33	0811-2490	7	1	RESISTOR .1 3% 5W PW TC=0+-50	28480	0811-2490
A7U1	1820-0196	6	5	IC 723 V RGLTR TO-100	04713	MC1723CG
A7U2	1820-0196	6		IC 723 V RGLTR TO-100	04713	MC1723CG
A7U3	1820-0196	6		IC 723 V RGLTR TO-100	04713	MC1723CG
A7U4	1820-0196	6		IC 723 V RGLTR TO-100	04713	MC1723CG
A7U5	1826-0065	0	1	IC COMPARATOR PRCN 8-DIP-P	01295	SN72311P
A7U6	1820-0196	6		IC 723 V RGLTR TO-100	04713	MC1723CG
				MISCELLANEOUS PARTS		
	1251-0600	0	9	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
	2110-0269	0	14	FUSEHOLDER-CLIP TYPE.25D-FUSE	28480	2110-0269
	2200-0107	6	8	SCREW-MACH 4-40 .375-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2260-0009	3	8	NUT-HEX-W/LKWR 4-40-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
	2740-0003	5	1	NUT-HEX-W/LKWR 10-32-THD .125-IN-THK	00000	ORDER BY DESCRIPTION
	3050-0239	2	1	WASHER-FLAT	28480	3050-0239
	3050-0250	2	7	WASHER-FL NM NO. 4 .13-IN-ID .5-IN-OD	28480	3050-0250
	4040-0748	3	1	EXTR-PC BD BLK POLYC .062-BD-THKNS	28480	4040-0748
	4040-0755	2	1	EXTR-PC BD VIO POLYC .062-BD-THKNS	28480	4040-0755
	04140-01204	1	1	HEAT SINK	28480	04140-01204
	04140-26507	9	1	PC BOARD, BLANK-A7	28480	04140-26507
	8159-0005	0	1	WIRE 22AWG W PVC 1X22 80C	28480	8159-0005

See introduction to this section for ordering information
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Table 6-3. Replaceable Parts (Cont'd).

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8	04140-66508	4	1	KEY & DISPLAY BOARD ASSEMBLY	28480	04140-66508
A8C1	0160-2055	9	4	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C2	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C3	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C4	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A8C5	0180-1051	5	1	CAPACITOR, FXD 100 UF 16V M	28480	0180-1051
A8C6	0180-1743	2	1	CAPACITOR-FXD .1UF+-10% 35VDC TA	56289	150D104X9035A2
A8D81	1990-0487	7	38	LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D82	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D83	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D84	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D85	1990-0486	6	1	LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4684
A8D86	1990-0681	3	2	DISPLAY-AN-SEG 1-CHAR .408-H RED	28480	5082-7656
A8D87	1990-0540	3	6	DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7650
A8D88	1990-0540	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7650
A8D89	1990-0540	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7650
A8D810	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D811	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D812	1990-0649	3	1	DISPLAY-NUM-SEG	28480	5082-7616
A8D813	1990-0531	2	1	DISPLAY-NUM-SEG 1-CHAR .3-H	28480	5082-7610
A8D814	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D815	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D816	1990-0681	3		DISPLAY-AN-SEG 1-CHAR .408-H RED	28480	5082-7656
A8D817	1990-0540	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7650
A8D818	1990-0540	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7650
A8D819	1990-0540	3		DISPLAY-NUM-SEG 1-CHAR .43-H	28480	5082-7650
A8D820	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D821	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D822	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D823	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D824	1990-0517	4	1	LED-VISIBLE LUM-INT=3MCD IF=20MA-MAX	28480	5082-4655
A8D825	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D826	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D827	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D828	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D829	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D830	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D831	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D832	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D833	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D834	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D835	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D836	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D837	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D838	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D839	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D840	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D841	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D842	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D843	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D844	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D845	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D846	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D847	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D848	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D849	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8D850	1990-0487	7		LED-VISIBLE LUM-INT=1MCD IF=20MA-MAX	28480	5082-4584
A8Q1	1854-0071	7	12	TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q2	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q3	1853-0318	3	16	TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MPS6562
A8Q4	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MPS6562
A8Q5	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MPS6562
A8Q6	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MPS6562
A8Q7	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MPS6562
A8Q8	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MPS6562
A8Q9	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MPS6562
A8Q10	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MPS6562
A8Q11	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MPS6562
A8Q12	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MPS6562
A8Q13	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MPS6562
A8Q14	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MPS6562
A8Q15	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MPS6562

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8Q16	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MP86562
A8Q17	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MP86562
A8Q18	1853-0318	3		TRANSISTOR PNP SI PD=500MW FT=60MHZ	04713	MP86562
A8Q19	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q20	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q21	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q22	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q23	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q24	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q25	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q26	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q27	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8Q28	1854-0071	7		TRANSISTOR NPN SI PD=300MW FT=200MHZ	28480	1854-0071
A8R1	0683-4705	8	12	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R2	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R3	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R4	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R5	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R6	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R7	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R8	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R9	0683-3315	4	1	RESISTOR 330 5% .25W FC TC=-400/+600	01121	CB3315
A8R10	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R11	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R12	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R13	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A8R14	0683-4725	2	1	RESISTOR 4.7K 5% .25W FC TC=-400/+700	01121	CB4725
A8R15	0683-1045	3	1	RESISTOR 100K 5% .25W FC TC=-400/+800	01121	CB1045
A8R30	1810-0275	1	3	NETWORK-RES 10-SIP1.0K OHM X 9	01121	210A102
A8R31	1810-0283	1	2	NETWORK-RES 16-DIP270.0 OHM X 8	28480	1810-0283
A8R32	1810-0283	1		NETWORK-RES 16-DIP270.0 OHM X 8	28480	1810-0283
A8R33	1810-0275	1		NETWORK-RES 10-SIP1.0K OHM X 9	01121	210A102
A8R34	1810-0275	1		NETWORK-RES 10-SIP1.0K OHM X 9	01121	210A102
A8S1	5060-9436	7	46	PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0408	5	1	KEY CAP	28480	5041-0408
A8S2	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0375	5	1	KEY CAP, QUARTER, SMK-RES DIP	28480	5041-0375
A8S3	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0384	6	5	KEY CAP, QUARTER, SMOKE GRAY	28480	5041-0384
A8S4	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0922	8	8	KEY CAP, QUARTER, EBY PEARL	28480	5041-0922
A8S5	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0922	8		KEY CAP, QUARTER, EBY PEARL	28480	5041-0922
A8S6	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0384	6		KEY CAP, QUARTER, SMOKE GRAY	28480	5041-0384
A8S7	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0318	6	6	KEY CAP	28480	5041-0318
A8S8	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0318	6		KEY CAP	28480	5041-0318
A8S9	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0318	6		KEY CAP	28480	5041-0318
A8S10	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0922	8		KEY CAP, QUARTER, EBY PEARL	28480	5041-0922
A8S11	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0922	8		KEY CAP, QUARTER, EBY PEARL	28480	5041-0922
A8S12	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0318	6		KEY CAP	28480	5041-0318
A8S13	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0318	6		KEY CAP	28480	5041-0318
A8S14	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0318	6		KEY CAP	28480	5041-0318
A8S15	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0384	6		KEY CAP, QUARTER, SMOKE GRAY	28480	5041-0384
A8S16	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0384	6		KEY CAP, QUARTER, SMOKE GRAY	28480	5041-0384
A8S17	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0384	6		KEY CAP, QUARTER, SMOKE GRAY	28480	5041-0384
A8S18	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0922	8		KEY CAP, QUARTER, EBY PEARL	28480	5041-0922
A8S19	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0922	8		KEY CAP, QUARTER, EBY PEARL	28480	5041-0922
A8S20	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0309	5	10	KEY CAP	28480	5041-0309
A8S21	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0309	5		KEY CAP	28480	5041-0309

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A8S22	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1763	7	1	KEY CAP, QUARTER, EBY PEARL	28480	5041-1763
A8S23	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1764	8	1	KEY CAP, QUARTER, EBY PEARL	28480	5041-1764
A8S24	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1762	6	2	KEY CAP, QUARTER, EBY PEARL	28480	5041-1762
A8S25	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0309	5		KEY CAP	28480	5041-0309
A8S26	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0474	5	1	KEY CAP, QUARTER, BSC	28480	5041-0474
A8S27	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0309	5		KEY CAP	28480	5041-0309
A8S28	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0309	5		KEY CAP	28480	5041-0309
A8S29	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1760	4	1	KEY CAP, QUARTER, EBY PEARL	28480	5041-1760
A8S30	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1761	5	1	KEY CAP, QUARTER, EBY PEARL	28480	5041-1761
A8S31	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1762	6		KEY CAP, QUARTER, EBY PEARL	28480	5041-1762
A8S32	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0285	6	1	KEY CAP, QUARTER, LITE PEARL	28480	5041-0285
A8S33	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0309	5		KEY CAP	28480	5041-0309
A8S34	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0309	5		KEY CAP	28480	5041-0309
A8S35	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1757	9	1	KEY CAP, QUARTER, EBY PEARL	28480	5041-1757
A8S36	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1758	0	1	KEY CAP, QUARTER, EBY PEARL	28480	5041-1758
A8S37	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1759	1	1	KEY CAP, QUARTER, EBY PEARL	28480	5041-1759
A8S38	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0922	8		KEY CAP, QUARTER, EBY PEARL	28480	5041-0922
A8S39	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0922	8		KEY CAP, QUARTER, EBY PEARL	28480	5041-0922
A8S40	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0309	5		KEY CAP	28480	5041-0309
A8S41	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0309	5		KEY CAP	28480	5041-0309
A8S42	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1756	8	1	KEY CAP, QUARTER, EBY PEARL	28480	5041-1756
A8S43	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1755	7	1	KEY CAP, QUARTER, EBY PEARL	28480	5041-1755
A8S44	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-1770	6	1	KEY CAP, QUARTER, EBY PEARL	28480	5041-1770
A8S45	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0441	6	1	KEY CAP, QUARTER, SKY BLUE	28480	5041-0441
A8S46	5060-9436	7		PUSHBUTTON SWITCH P.C. MOUNT	28480	5060-9436
	5041-0309	5		KEY CAP	28480	5041-0309
A8U1	1820-0495	8	1	IC DCDR TTL 4-TO-16-LINE 4-INP	01295	SN74154N
A8U2	1820-1443	8	1	IC CNTR TTL LS BIN ASYNCHRO	01295	SN74LS293N
A8U3	1820-1216	3	1	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A8U4	1820-1197	9	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A8U5	1820-1473	4	1	IC ENCDR TTL 8-INP	01295	SN74148N
A8U6	1820-1423	4	1	IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74LS123N
A8W1	04140-61604	1	1	CABLE ASSEMBLY	28480	04140-61604
	0360-1901	6	1	CABLE, TRANSITION	28480	0360-1901
				MISCELLANEOUS PARTS		
	1251-1998	1	2	CONNECTOR-SGL CONT SKT .025-IN-BSC-SZ	28480	1251-1998
	04140-26508	0	1	PC BOARD, BLANK-A8	28480	04140-26508
	04140-40002	9	3	INSULATOR	28480	04140-40002
	04274-40003	1	5	INSULATOR	28480	04274-40003
	04262-25003	5	1	INSULATOR	28480	04262-25003

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A9	04140-66509	5	1	MOTHER BOARD ASSEMBLY	28480	04140-66509
	1251-2034	8	1	CONNECTOR-PC EDGE 10-CONT/ROW 2-ROWS	28480	1251-2034
	1251-3197	6	1	CONNECTOR 12-PIN M POST TYPE	28480	1251-3197
	1251-3198	7	1	CONNECTOR 15-PIN M POST TYPE	28480	1251-3198
	1251-5564	5	9	CONNECTOR-PC EDGE 22-CONT/ROW 2-ROWS	28480	1251-5564
	04140-26509	1	1	PC BOARD, BLANK-A9	28480	04140-26509
	04140-40001	8	4	GUIDE	28480	04140-40001

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A21	04140-66521	1	1	HP-IB BOARD ASSEMBLY (OPTION 101 ONLY)	28480	04140-66521
A21C1	0180-1085	5	3	CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A21C2	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A21C3	0180-1085	5		CAPACITOR-FXD 4.7uF +-20% 16WVDC SOLID TANTALUM	28480	0180-1085
A21J1	1200-0485	2	1	SOCKET-IC 14-CONT DIP DIP-SLDR	28480	1200-0485
A21J3	1251-3283	1	1	CONNECTOR 24-PIN F MICRORIBBON	28480	1251-3283
A21J4	1200-0608	1	1	SOCKET INTEGRATOR CIRCUIT	28480	1200-0608
A21R1	1810-0275	1	1	NETWORK-RES 10-SIP1.0K OHM X 9	01121	210A102
A2181	3101-1973	7	1	SWITCH-SL 7-1A DIP-SLIDE-ASSY .1A 50VDC	28480	3101-1973
A21U1	1820-1759	9	1	IC BFR TTL LS NON-INV OCTL	27014	DM81L897N
A21U2	1820-1199	1	1	IC INV TTL LS HEX 1-INP	01295	SN74LS04N
A21U3	1820-2113	1	1	IC MICPROC-ACCESS NMOS	04713	MC68488L
A21U4	1820-2058	3	4	IC MISC TTL S QUAD	28480	1820-2058
A21U5	1820-2058	3		IC MISC TTL S QUAD	28480	1820-2058
A21U6	1820-2058	3		IC MISC TTL S QUAD	28480	1820-2058
A21U7	1820-2058	3		IC MISC TTL S QUAD	28480	1820-2058
				MISCELLANEOUS PARTS		
	0361-0079	9	2	RIVET-SEMITUBULAR	28480	0361-0079
	0380-0643	3	2	STANDOFF-HEX .255-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
	1530-1098	4	2	CLEVIS 0.070-IN W SLT: 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION
	2190-0017	4	2	WASHER-LK HLCL NO. 8 .168-IN-ID	28480	2190-0017
	04140-00610	1	1	PLATE, OPTION 101	28480	04140-00610
	04140-26521	7	1	PC BOARD, BLANK-A21	28480	04140-26521
	8159-0005	0	1	WIRE 22AWG W PVC 1X22 80C	28480	8159-0005

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A31	04140-66531	3	1	ANALOG OUTPUT CONTROL BOARD ASSEMBLY (OPTION 001 ONLY)	28480	04140-66531
A31C1	0160-2055	9	4	CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A31C2	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A31C3	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A31C4	0140-0196	3	1	CAPACITOR-FXD 150PF +-5% 300VDC MICA	72136	DM15F151J0300WV1CR
A31C5	0160-2055	9		CAPACITOR-FXD .01UF +80-20% 100VDC CER	28480	0160-2055
A31J1	1251-1959	4	1	CONNECTOR-PC EDGE 15-CONT/ROW 2-ROWS	28480	1251-1959
A31J2	1251-4695	1	1	CONNECTOR 10-PIN M POST TYPE	28480	1251-4695
A31J3	1251-0600	0	6	CONNECTOR-SGL CONT PIN 1.14-MM-BSC-SZ SQ	28480	1251-0600
A31R1	0683-1035	1	1	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A31R2	0683-4755	8	1	RESISTOR 4.7M 5% .25W FC TC=-900/+1100	01121	CB4755
A31R3	0698-3438	3	1	RESISTOR 147 1% .125W F TC=0+-100	24546	C4-1/8-T0-147R-F
A31R4	2100-3355	0	1	RESISTOR-TRMR 100K 10% C SIDE-ADJ 1-TRN	28480	2100-3355
A31R5	2100-3350	5	1	RESISTOR-TRMR 200 10% C SIDE-ADJ 1-TRN	28480	2100-3350
A31U1	1820-1201	6	1	IC GATE TTL LS AND QUAD 2-INP	01295	SN74LS08N
A31U2	1820-1195	7	3	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A31U3	1820-1112	8	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A31U4	1820-1144	6	1	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A31U5	1820-1216	3	1	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
A31U6	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A31U7	1820-1195	7		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS175N
A31U8	1820-1438	1	3	IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257AN
A31U9	1813-0105	2	1	IC CONV 12-B-D/A 24-DIP-C	8E175	DAC80-CBI-V
A31U10	1820-1730	6	2	IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A31U11	1820-1730	6		IC FF TTL LS D-TYPE POS-EDGE-TRIG COM	01295	SN74LS273N
A31U12	1820-1438	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257AN
A31U13	1820-1438	1		IC MUXR/DATA-SEL TTL LS 2-TO-1-LINE QUAD	01295	SN74LS257AN
				MISCELLANEOUS PARTS		
	0361-0079	9	2	RIVET-SEMITUBULAR	28480	0361-0079
	1200-0541	1	1	SOCKET-IC 24-CONT DIP DIP-SLDR	28480	1200-0541
	1530-1098	4	2	CLEVIS 0.070-IN W SLT; 0.454-IN PIN CTR	00000	ORDER BY DESCRIPTION
	04140-26531	9	1	PC BOARD, BLANK-A31	28480	04140-26531
	5020-3742	2	1	BOARD, BLANK (STANDARD B)	28480	5020-3742

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A32	04140-66532	4	1	ANALOG OUTPUT BOARD ASSEMBLY (OPTION 001 ONLY)	28480	04140-66532
A32C1	0160-0153	4	2	CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0160-0153
A32C2	0160-1548	3	2	CAPACITOR-FXD MY 0.22 UF 10% 100VDCW	28480	0160-1548
A32C3	0160-1603	1	2	CAPACITOR-FXD MY 1 UF 10% 100VDCW	28480	0160-1603
A32C4	0160-0127	2	2	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A32C5	0160-0127	2		CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A32C6	0160-0153	4		CAPACITOR-FXD 1000PF +-10% 200VDC POLYE	28480	0160-0153
A32C7	0160-1548	3		CAPACITOR-FXD MY 0.22 UF 10% 100VDCW	28480	0160-1548
A32C8	0160-1603	1		CAPACITOR-FXD MY 1 UF 10% 100VDCW	28480	0160-1603
A32C9	0180-1083	3	2	CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A32C10	0180-1083	3		CAPACITOR-FXD 33uF -10+75% 25WVDC	28480	0180-1083
A32R1	0683-1055	5	2	RESISTOR 1M 5% .25W FC TC=800/+900	01121	CB1055
A32R2	0683-1025	9	2	RESISTOR 1K 5% .25W FC TC=400/+600	01121	CB1025
A32R3	0683-1055	5		RESISTOR 1M 5% .25W FC TC=800/+900	01121	CB1055
A32R4	0683-1025	9		RESISTOR 1K 5% .25W FC TC=400/+600	01121	CB1025
A32R5	2100-3353	8	1	RESISTOR-TRMR 20K 10% C SIDE-ADJ 1-TRN	32997	3386X-Y46-203
A32R6	0698-3491	8	1	RESISTOR 1K .1% .125W F TC=0+-50	28480	0698-3491
A32R7	0698-5454	7	1	RESISTOR 9K .1% .125W F TC=0+-50	28480	0698-5454
A3281	3101-1951	1	1	SWITCH-SL DP3T MINTR .5A 125VAC/DC PC	28480	3101-1951
A32U1	1826-0319	7	3	IC OP AMP TO-99	27014	LF356H
A32U2	1826-0319	7		IC OP AMP TO-99	27014	LF356H
A32U3	1820-1374	4	1	IC SWITCH ANLG QUAD 16-DIP-P	24355	AD7510DIJN
A32U4	1826-0319	7		IC OP AMP TO-99	27014	LF356H
				MISCELLANEOUS PARTS		
	0380-0111	0	3	STANDOFF-RVT-ON .25-IN-LG 6-32THD	00000	ORDER BY DESCRIPTION
	1251-0600	0	4	CONNECTOR-SGL CONT PIN 1.14-MM-BBC-BZ BQ	28480	1251-0600
	1251-3361	6	1	CONNECTOR 10-PIN F POST TYPE	28480	1251-3361
	04140-26532	0	1	PC BOARD, BLANK-A32	28480	04140-26532
	5020-3742	2	1	BOARD, BLANK (STANDARD B)	28480	5020-3742

See introduction to this section for ordering information
*Indicates factory selected value

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

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A31	04140-66531	3		ANALOG OUTPUT CONTROL BOARD ASSEMBLY	28480	04140-66531
A32	04140-66532	4		ANALOG OUTPUT BOARD ASSEMBLY	28480	04140-66532
				MISCELLANEOUS PARTS		
	0361-0079	9	2	RIVET-SEMITUBULAR	28480	0361-0079
	0510-0741	9	2	BRACKET-RTANG .344-LG X .407-LG .312-WD	28480	0510-0741
	1250-0083	1	3	CONNECTOR-RF BNC FEM SGL-HOLE-FR 50-OHM	28480	1250-0083
	2190-0016	3	3	WASHER-LK INTL T 3/8 IN .377-IN-ID	28480	2190-0016
	2360-0115	4	7	SCREW-MACH 6-32 .312-IN-LG PAN-HD-POZI	00000	ORDER BY DESCRIPTION
	2950-0001	8	3	NUT-HEX-DBL-CHAM 3/8-32-THD .094-IN-THK	00000	ORDER BY DESCRIPTION
	8150-0456	7	3	WIRE 24AWG W 300V PVC 7X32 80C	28480	8150-0456
	04140-00611	2	1	PLATE (OPTION 001)	28480	04140-00611

See introduction to this section for ordering information
*Indicates factory selected value

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

Ref.	HP Part No.	Q'ty	Description
1	2360-0115		SCREW-MACHINE
2	2510-0192		SCREW-MACHINE
3	5020-8837		CORNER STRUT 18"
4	04274-40002		GUIDE BLACK
5	2510-0192		SCREW-MACHINE
6	2360-0115		SCREW-MACHINE
7	04274-01202		ANGLE
8	5020-8837		CORNER STRUT 18"
9	04274-40002		GUIDE BLACK
10	04274-40002		GUIDE BLACK
11	5040-7219		STRAP HDL CAP FRONT
12	2680-0172		SCREW-MACHINE
13	5060-9942		COVER-SIDE-PERF
14	5060-9804		STRP HNDL AY 18"
15	2680-0172		SCREW-MACHINE
16	5040-7220		STRAP HDL CAP REAR
17	2110-0569		NUT-FUSEHOLDER
18	0570-0368		SCREW
19	3050-0235		WASHER-FLAT
20	2110-0565		FUSEHOLDER CAP
21	2110-0564		FUSE HOLDER BODY
22	2950-0001		NUT-HEXAGONAL
23	2190-0016		WASHER-LOCK
24	2360-0113		SCREW-MACHINE
25(C1)	0180-3004		CAPACITOR-FXD .022F -10+50% 25VDDC ALMINUM
26	1250-0001		CONNECTER-BF BNC
27	2190-0008		WASHER-LOCK
28	0624-0260		SCREW-TAPPIONG
29	04140-00609		PLATE REAR
30	2360-0115		SCREW-MACHINE
31	04140-00609		PLATE REAR
32	2360-0115		SCREW-MACHINE
33	2360-0115		SCREW-MACHINE
34	04140-04001		COVER FAN
35	2360-0115		SCREW-MACHINE
36	0624-0260		SCREW-TAPPIONG
37	2190-0008		WASHER-LOCK
38	1854-0063		TRANSISTOR NPN PD=115Wmax FT=800kHzmax
39	0340-0458		INSLATOR-TRANSISTOR MICA
40	2740-0003		NUT-HEXAGONAL
41	2740-0003		NUT-HEXAGONAL
42	3050-0226		WASHER-FLAT
43	3050-0226		WASHER-FLAT
44	1200-0080		WASHER-INSULATING
45	1200-0080		WASHER-INSULATING

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

Ref.	HP Part No.	Q'ty	Description
46	2360-0117		SCREW-MACHINE
47	04140-00204		PANNEL-REAR
48	2420-0006		NUT-HEX-W/LOCKWASHER
49	1200-0080		WASHER-INSULATING
50	1200-0080		WASHER-INSULATING
51	5000-4207		LUG-SHORTING
52 (CR1,CR2)	1901-0496		DIODE-RECTIFIER Silicon
53	2510-0045		SCREW-MACHINE
54	3160-0209		FAN-TUBEAXIAL
55(T1)	9100-0886		XFMR-POWER
56	2360-0113		SCREW-MACHINE
57	5020-8806		REAR FRAME 7"FM
58	2360-0115		SCREW-MACHINE
59(A1)	04140-66501		PCBD-I-V CONV
60	2360-0115		SCREW-MACHINE
61	5060-9835		COVER TOP 18"FM
62	2360-0333		SCREW-MACHINE
63	04140-00612		PLATE
64	2200-0107		SCREW-MACHINE
65	04140-01206		ANGLE
66	2360-0333		SCREW-MACHINE
67	5020-8805		FRT-FRA 7xFM
68	04140-60203		PANNEL FRONT SUB
69	04140-00201		PANNEL-FRONT
69	04140-00202		PANNEL-REAR
70	0360-1158		TERMINAL-SOLDER LUG
71	04271-50024		INSULATOR-BNC
72	2950-0035		NUT-HEXAGONAL
73	3050-0010		WASHER-FLAT
74	2360-0115		SCREW-MACHINE
75	1510-0038		BINDING POST ASSEMBLY
76	3050-0014		WASHER-FLAT
77	3050-0014		WASHER-FLAT
78	3050-0014		WASHER-FLAT
79	0360-1158		TERMINAL-SOLDER LUG
80	2190-0054		WASHER-LOCK
81	1250-1579		CONNECTER-RF BNC
82	2190-0084		WASHER-LOCK
83	2950-0006		NUT-HEXAGONAL
84	5040-7021		FOOT FL & HF MOD
85	1460-1345		WIRE FORM
86	5060-9847		COVER BOTTOM 18"FM

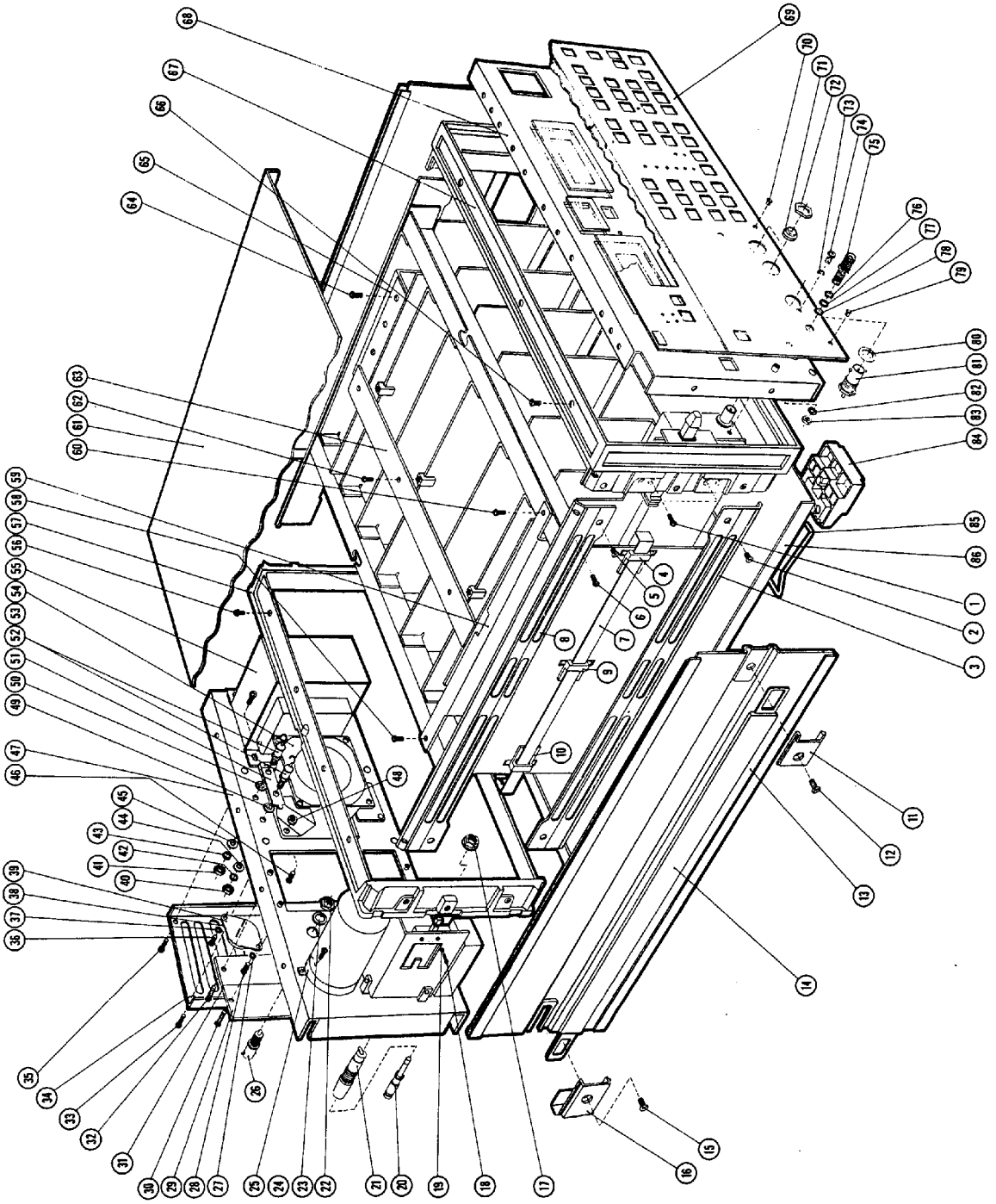


Figure 6-1. Major Mechanical Parts (Exploded View)

SECTION VII
MANUAL CHANGES

7-1. INTRODUCTION

7-2. This section contains information for adapting this manual to instruments for which the content does not apply directly. In addition, information about recommended modifications for improvements to the instruments is provided.

7-3. MANUAL CHANGES

7-4. To adapt this manual to your instrument refer to Table 7-1 and make all of the manual changes listed opposite your instrument serial number. Perform these changes in the sequence listed. Table 7-2 gives a manual changes summary by assembly.

7-5. If your instrument serial number is not listed on the title page of this manual or in Table 7-1 below, it may be documented in a yellow MANUAL CHANGES supplement. For additional information about serial number coverage refer to INSTRUMENTS COVERED BY MANUAL in Section I.

Table 7-1. Manual Changes by Serial Number

Serial Prefix or Number	Make Manual Changes
1917J 00110 and below	A, B, C, D
1917J 00145 and below	B, C, D
1917J 00170 and below	C, D
1917J 00195 and below	D

Table 7-2. Summary of Changes by Assembly.

Change	Assembly												
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A21	A31	A32	No plefix
A	Q8			C20	K1∿3 6∿8		CR1, 2						
B				C1	CR7, 8,23, 24								
C	R54				Heat Sink								
D		R50∿ 52	R31			U5							

CHANGE A

Page 6-3, Table 6-3, Replaceable Parts,
Delete following part:
A1Q8; HP P/N: 5080-3063, DUAL J-FET, N-CH.
Add following part:
A1Q8; HP P/N: 1855-0126, DUAL J-FET, N-CH.

Page 6-10, Table 6-3, Replaceable Parts,

Page 8-31, Figure 8-36, Component Locations,

Page 8-33, Figure 8-39, Component Locations,

Page 8-33, Figure 8-40, Schematic Diagram,
Delete following part:
A4C20; HP P/N: 0160-2204, C-FXD 100pF 300VW.

Page 6-12, 13, Table 6-3, Replaceable Parts,
Delete following parts:
A5K1~3, 6~8; HP P/N: 0490-0189, SWITCH-REED.
Add following parts:
A5K1~3, 6~8; HP P/N: 0490-0801, SWITCH-REED.

Page 6-18, Table 6-3, Replaceable Parts,
Delete following parts:
A7CR1, 2; HP P/N: 1902-3346, DIO-ZNR, 51.1V, 2%.
Add following parts:
A7CR1, 2; HP P/N: 1902-3345, DIO-ZNR, 51.1V, 5%.

CHANGE B

Page 6-10, Table 6-3, Replaceable Parts,

Page 8-31, Figure 8-37, Schematic Diagram,
Delete following part:
A4C1; HP P/N: 0140-0192, C-FXD, 68pF.
Add following part:
A4C1; HP P/N: 0140-0193, C-FXD, 82pF.

Page 6-12, Table 6-3, Replaceable Parts,
Delete following parts:
A5CR7, 8, 23, 24; HP P/N: 5080-3064, DIO-ZNR, 10V.
Add following part:
A5CR7, 8, 23, 24; HP P/N: 1902-3160, DIO-ZNR, 10V.

CHANGE C

Page 6-4, Table 6-3, Replaceable Parts,
Delete following part:
A1R54; HP P/N: 0699-0488, R-FXD, 100MΩ, 0.1%.
Add following part:
A1R54; HP P/N: 0699-0424, R-RXD, 100MΩ, 0.25%.

Page 6-15, Table 6-3, Replaceable Parts,
Delete following parts:
Heat Sink (4ea); HP P/N: 1205-0095.
Add following parts:
Heat Sink (4ea); HP P/N: 1205-0033.

CHANGE D

Page 6-7, Table 6-3, Replaceable Rarts,

Page 8-27, Figure 8-28, Component Location,

Page 8-27, Figure 8-29, Schematic Diagram,
Delete following parts:
A2R50~52; HP P/N: 0683-1045, R-FXD, 100KΩ.

Page 6-8, Table 6-3, Replaceable Parts,

Page 8-29, Figure 8-32, Component Locations,

Page 8-29, Figure 8-33, Schematic Diagram,
Delete following part:
A3R31; HP P/N: 1810-0279, R-NETWORK, 4.7KΩ.

Page 6-17, Table 6-3, Replaceable Parts,
Delete following part:
A6U5; HP P/N: 5080-3065, IC-LIN.
Add following part:
A6U5; HP P/N: 1826-0664, IC-LIN.

SECTION VIII
SERVICE

8-1. INTRODUCTION

8-2. This section provides the information and instructions required for servicing the Model 4140A pA Meter/DC Voltage Source. Included are the Theory of Operation and Troubleshooting Guide with Circuit Schematics. The Theory of Operation describes fundamental principles and circuit operating theory of the 4140A with block diagrams. Circuit schematics, locator illustrations, troubleshooting guide, circuit analysis and other technical data necessary for repairs are integrated into the service sheet foldouts. An illustration of the instrument interior is shown in Figure 8-23.

Note

When the instrument circuitry includes expanded capabilities provided by optional equipment, refer to paragraph entitled OPTIONS for specific option service information.

8-3. SAFETY CONSIDERATIONS.

8-4. This section contain warnings and cautions that must be followed for your protection and to avoid damage to the equipment.

WARNING

MAINTENANCE DESCRIBED HEREIN IS PERFORMED WITH POWER SUPPLIED TO THE INSTRUMENT AND PROTECTIVE COVERS REMOVED. SUCH MAINTENANCE SHOULD BE PERFORMED ONLY BY SERVICE-TRAINED PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED (FOR EXAMPLE, FIRE AND ELECTRICAL SHOCK). WHERE MAINTENANCE CAN BE PERFORMED WITHOUT POWER APPLIED, THE POWER SHOULD BE REMOVED.

BEFORE ANY REPAIR IS COMPLETED, ENSURE THAT ALL SAFETY FEATURES ARE INTACT AND FUNCTIONING AND THAT ALL NECESSARY PARTS ARE CONNECTED TO THEIR MEANS OF PROTECTIVE GROUNDING.

8-5. THEORY OF OPERATION.

8-6. This theory of operation has been organized into three sections: basic theory, block diagram discussions, and circuit analysis. The basic theory, beginning with paragraph 8-13, explains the concepts and fundamental theory of the 4140A instrument technique adapted for accurately measuring the DUT and for fully achieving automated measurement performance. The block diagram discussion describes the overall circuit operating theory of the 4140A with block-to-block signal flow. Included are block and timing diagrams. The circuit analysis provides a detailed description of how the circuit on each board functions. For reference convenience when servicing the instrument, a circuit description is included in the service sheets.

8-7. RECOMMENDED TEST EQUIPMENT.

8-8. The test equipment required to perform operations outlined in this section is listed in Table 4-1 (Page 4-2). The table includes: type of instrument required, critical specifications, use, and recommended model. If the recommended model is not available, equipment which meets or exceeds critical specifications listed may be substituted.

8-9. TROUBLESHOOTING.

8-10. This troubleshooting guide provides instructions and information for locating a faulty circuit instrument component that requires service. All instructions consider the safety of service personnel who will perform the procedures. These diagnostic guides are in the form of step-by-step procedures with flow diagrams. The board level troubleshooting diagrams are the procedures for isolating the problem to an individual malfunctioning circuit board assembly. The guides for locating a defective component are given on the individual board service sheets and integrate service support data--test point locations, waveform illustrations, voltage data, timing diagrams, and other technical information in addition to providing schematic diagrams for each board. To facilitate easy troubleshooting of the 4140A

digital section, the troubleshooting guide for the logic circuit employs a signature analysis technique incorporating the concept of data stream analysis. A guideline to signature analysis is provided in Figure 8-20.

8-11. REPAIR.

8-12. Repair explanations tell how to replace defective circuit components. The recommended replacement procedures for components and parts which require special repair, replacement tools, or test equipment should be observed. Correct disassembly and the exchange procedures for such special parts are outlined in Paragraphs 8-64 through 8-68. To prevent damage from improper repair procedure, refer to the appropriate manual section before proceeding with repair.

8-13. BASIC THEORY.

8-14. Figure 8-1 is the Basic Block Diagram of the Model 4140A pA Meter DC Voltage Source. In the following several paragraphs, the 4140A basic theory is explained. The explanation is separated into the following two parts: Current Measurement and DC Voltage Output. The explanation of the actual circuitry of the 4140A is described in paragraphs 8-47 thru 8-61, Block Diagram Discussion.

8-15. Current Measurement.

8-16. The 4140A Current Measurement is done in three stages: I-V Conversion, A-D Conversion with successive approximation technique and digital integration using a moving average technique.

(1) I-V Converter.

The basic circuit of the I-V Converter of the 4140A pA meter section is given in Figure 8-2. If operational amplifier A is an ideal amplifier (gain = ∞, input impedance = ∞), the circuit satisfies the following equation:

$$Vo = \frac{Rr}{Rx} Vx \quad (\because Vi = 0, \text{ virtual ground})$$

$$\therefore Ix = \frac{Vx}{Rx} = \frac{Vo}{Rr}$$

Where Ix: Unknown current.
Rx: Source resistance.
Vx: Source voltage.
Rr: Range resistance.
Vo: Output voltage.

Therefore, Ix can be calculated from the measured Vo value.

(2) A-D Converter with Successive Approximation Technique.

The Basic circuit of the 4140A A-D converter section is given in Figure 8-3. A-D conversion is done in the following manner:

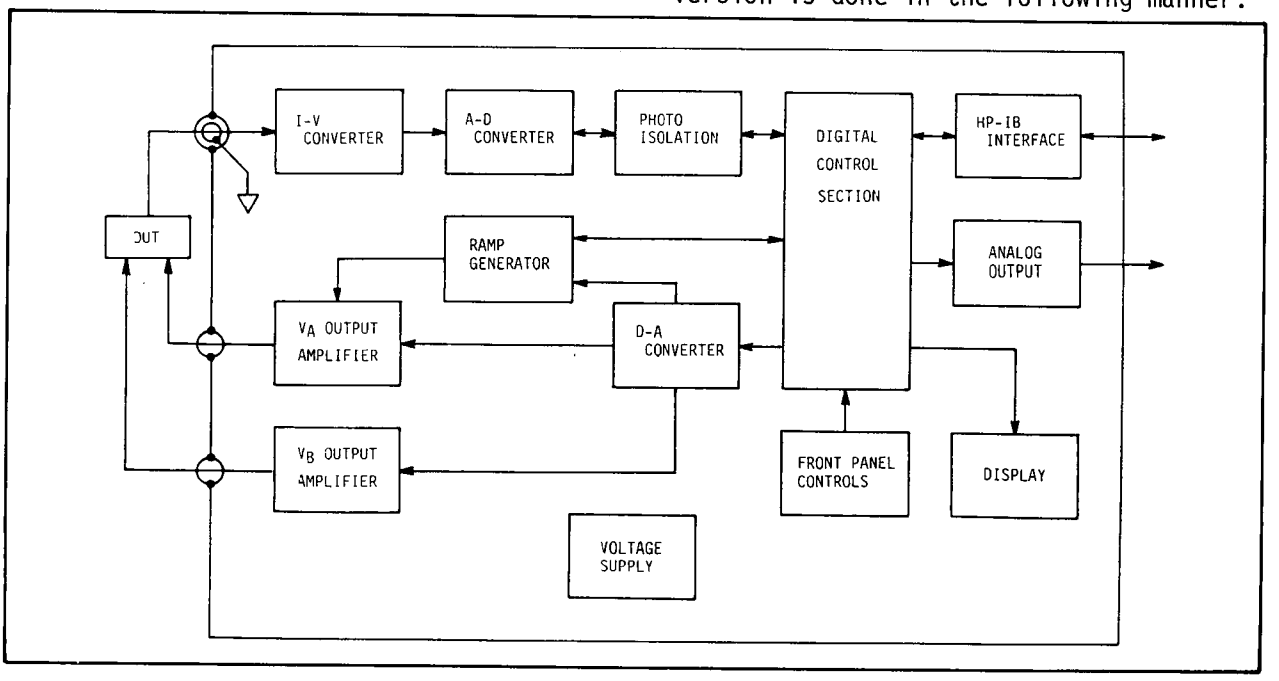


Figure 8-1. Model 4140A Basic Block Diagram.

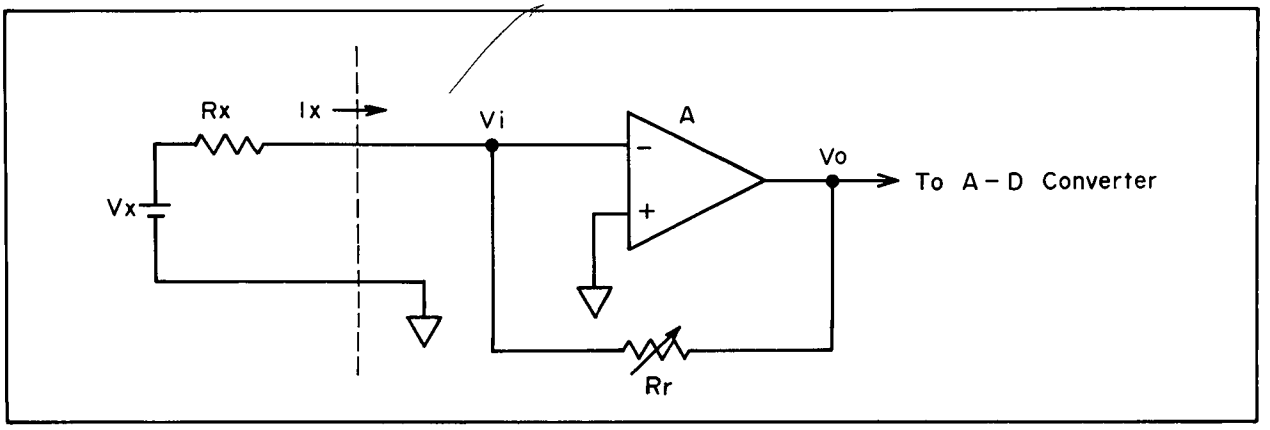


Figure 8-2. I-v Converter.

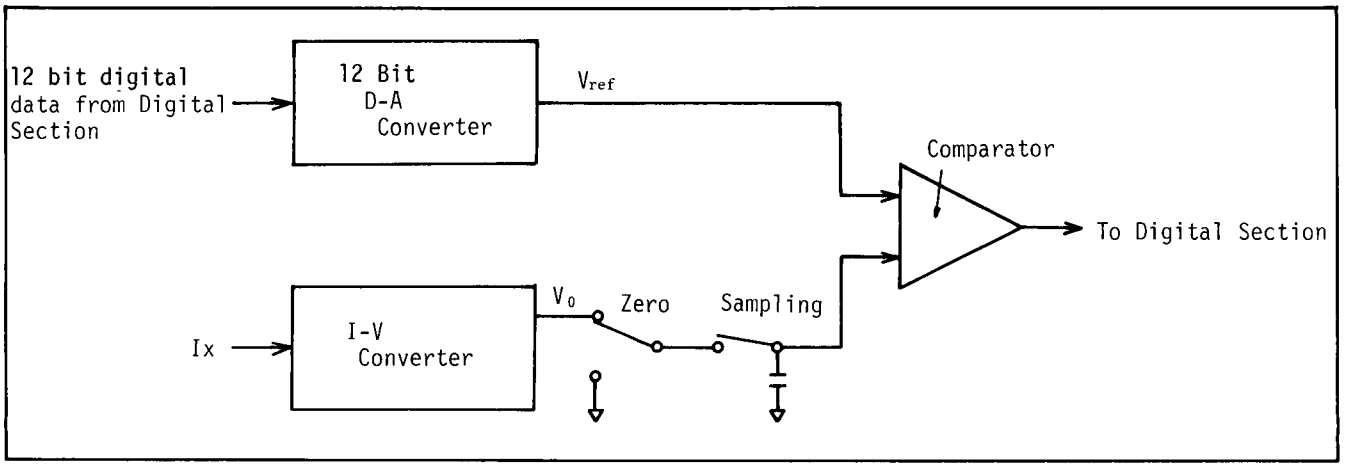


Figure 8-3. A-D Converter.

Table 8-1. Successive Approximation.

I-V Converter Output Voltage (V)	Comparator Result	D-A Converter	
		Analog Output (V)*	Digital Input
3.65	>	0.0000	011111111111
	>	2.5000	001111111111
	<	3.7500	000111111111
	>	3.1250	001011111111
	>	3.4375	001001111111
	>	3.5938	001000111111
	<	3.6719	001000011111
	>	3.6328	001000101111
	<	3.6523	001000100111
	>	3.6426	001000101011
	>	3.6475	001000101001
	>	3.6499	001000101000

* Typical Values.

① Vo (I-V converter output voltage) which is proportional to Ix (unknown current) is sampled with the sample/hold circuit (sampling interval = 10ms*).
*at 50Hz line frequency (8.3ms at 60Hz).

② V_{ref} (DAC output voltage) is set to 0V.

③ Vo is compared with V_{ref} and the polarity (+ or -) of Vo is detected.

④ Each bit is changed from MSB and Vo is compared with V_{ref} in each step. An Example of this process is given in Table 8-1 [Vo = 3.65V, Ix = 1.495×10^{N} A (N = -2 ∿ -12)].

⑤ Steps 1 thru 4 are done when the A-D Converter is connected to circuit common instead of the I-V converter. This result is used to compensate the A-D converter for offset voltage error.

(3) Digital Integration with Moving Average Technique.

Current measurement Digital data which is sampled in the D-A Converter is stored in a RAM (Address: 0 ∿ 255). This data is digitally integrated by the following procedure (see Figure 8-4.):

① Number for digital integration (2 ∿ 256) is fixed (example in Figure 8-4 is 4).

② First current measurement data, Io, is stored in the RAM (Address: 0).

③ Currents I_1 thru I_3 are stored in the RAM (Address: 1 ∿ 3) in order.

④ Ia (result of moving average) is calculated by the following formula:

$$Ia = \frac{I_0 + I_1 + I_2 + I_3}{4}$$

⑤ Steps ②∿④ are repeated every 10 (8.3)ms.

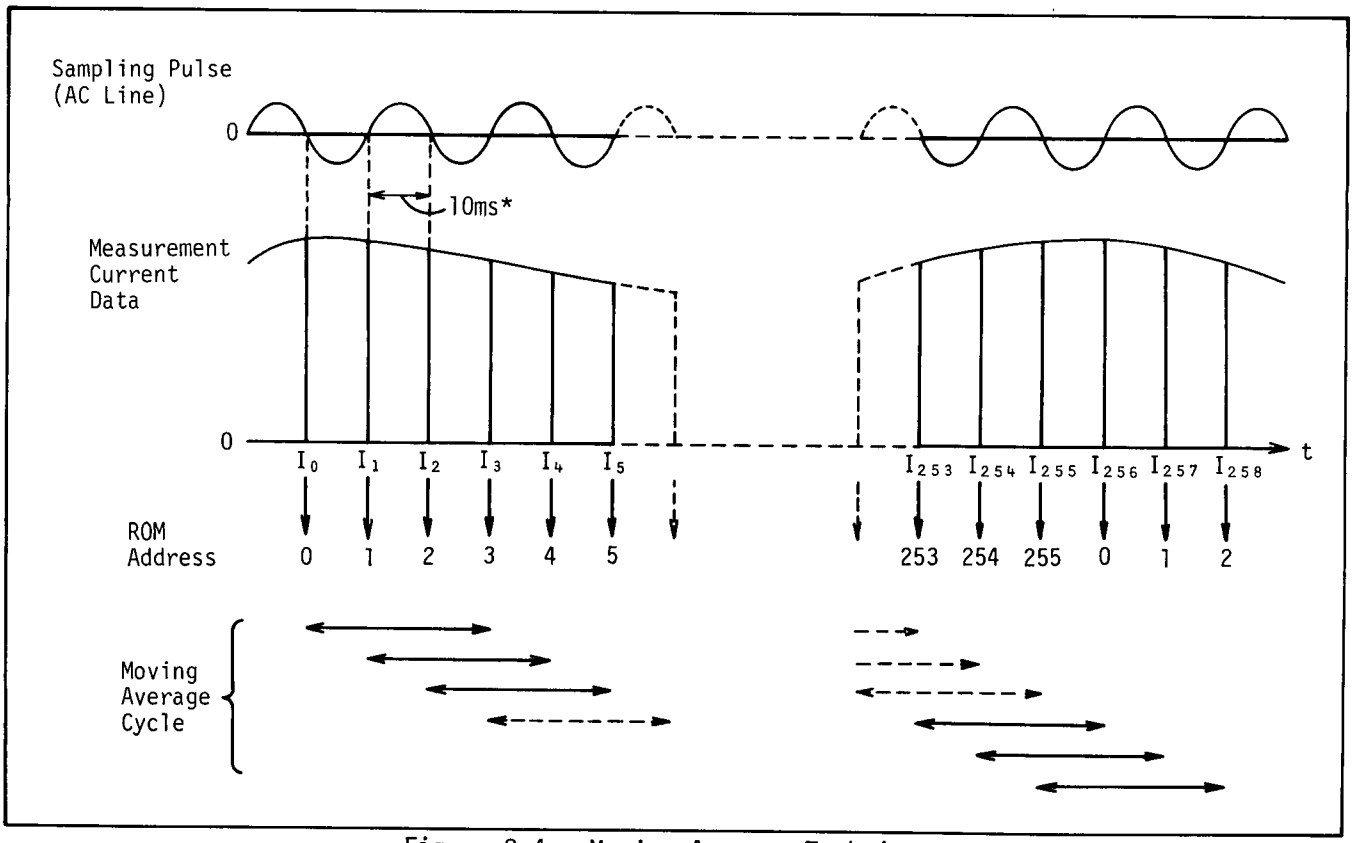


Figure 8-4. Moving Average Technique.

8-17. DC Voltage Output.

8-18. Basic circuit of V_A (V_B) DC Voltage Source is given in Figure 8-5. The DC voltage output is accomplished by three stages: a D-A Converter, V_A (V_B) power amplifier and a current limiter.

(1) D-A Converter.
This 12 Bit DAC is controlled by a digital input (see Table 8-2). Its output is a dc voltage (±10 Vmax).

Table 8-2. D-A Converter.

Digital Input*	Output Voltage (V)
000000101111	+10.00
000000110001	+9.99
011111111101	+0.01
011111111111	0.00
100000000001	-0.01
111111001101	-9.99
111111001111	-10.00

*12 bits, complementary two's complement, MSB is on inverted input.

(2) V_A (V_B) Power Amplifier.
The output voltage of the V_A (V_B) DC voltage source is fixed by the DAC output voltage and amplitude gain of the V_A (V_B) Power Amplifier as given in Table 8-3.

Table 8-3. V_A (V_B) Output Voltage.

V_A (V_B) Output Voltage (V)	DAC Output Voltage (V)	V_A (V_B) Power Amplifier Gain
100.0	10.00	10
10.1	1.01	
10.00	10.00	1

(3) Current Limiter.
The V_A (V_B) DC Voltage Source is a constant voltage supply. However, if the output current exceeds the current limit (10^{-2}, 10^{-3}, 10^{-4}A), the output V_A (V_B) is controlled by the Current Limiter and V_A (V_B) operates as a sort of constant current source.

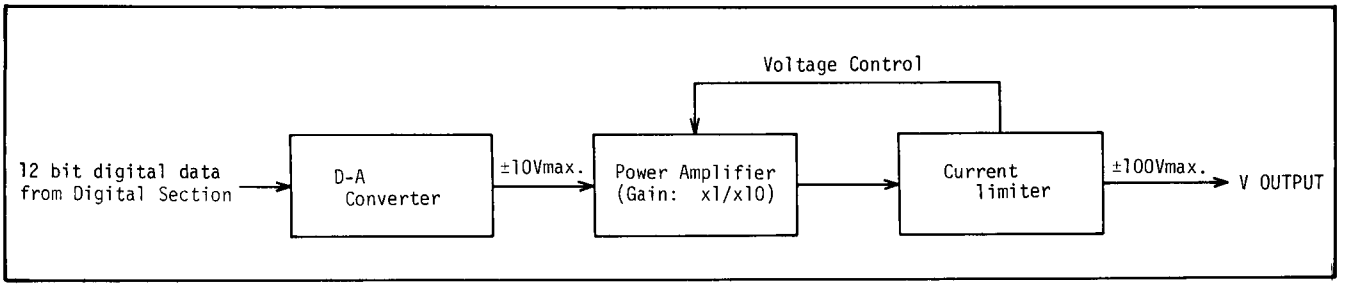


Figure 8-5. V_A (V_B) DC Voltage Source.

8-19. BLOCK DIAGRAM DISCUSSION.

8-20. In the following several paragraphs, block diagrams and explanations of the pA Meter section, Voltage Source section, Digital section and Options are provided. The construction of these diagrams and the explanations are based on the actual printed circuit board assemblies. These are useful for board level troubleshooting.

8-21. pA METER SECTION.

8-22. Figure 8-6 is a detailed block diagram of the 4140A pA Meter Section. The 4140A pA Meter Section is made up of the A1 I-V Converter board and the A2 A-D Converter board. This section produces the stable measurement of very small currents and sends the current measurement data to the Digital section.

8-23. A1 I-V Converter.

8-24. The Converter board stably detects the very small unknown current and generates a voltage which is proportional to the unknown current. The I-V Converter board contains a High Input Impedance Amplifier, Oscillator, Range Resistor, and other related circuitry.
High Input Impedance Amplifier (A1Q1∿6, 8∿14, A1U1, A1T1, 3, 4, etc.) is a high input impedance, small bias current, low offset voltage amplifier. The amplifier has a high gain to maintain the low input inpedance (for the pA Meter) and low noise to ensure stable measurements. A more specific explanation of this amplifier is given in Service Sheet 1.
Oscillator (A1Y1, U2∿4, etc) is used in both the pA Meter section and the Digital section. The output of 4MHz Quartz Oscillator is divided down to a 1MHz square wave by Frequency Divider (A1U3). This square wave is transmitted to the Digital Section to be used as the clock signal. In addition, the 1MHz signal is further divided down to 500kHz by Frequency Divider (A1U2) and supplied to Phase Detector (A1Q1∿4) and the Varactor circuit (A1Q8, A1T3, 4). The 500kHz signal, which is supplied to the Varactor circuit, is attenuated 20mVp-p by an attenuator (A1R18∿24). A1U2 and A1U2 use -5V power for driving the Phase Detector directly.
Range Resistor (A1R52∿58) of the 4140A is selected so as to cause voltage at A2TP8 to be 2.44V (typical) when 4140A I·C DISPLAY shows "1.000". Relationship between Range Resistor and current measurement range is given in Table 8-5.

Table 8-4. Relationship between Range Resistor and Current Measurement Range.

Current Measurement Range [A]	Relay Switch Range Resistor*						Range Resistor [Ω]
	K1	K2	K3	K4	K5	K6	
10^{-2}** 10^{-3}***	O	O	O	O	O	X	99G
10^{-4}** 10^{-5}***	O	O	O	O	X	X	9.9K
10^{-6}** 10^{-7}***	O	O	O	X	X	O	990K
10^{-8}** 10^{-9}***	O	O	X	O	X	O	99M
10^{-10}** 10^{-11}***	O	X	O	O	X	O	9.9G
10^{-12}***	X	O	O	O	X	O	99G

* o: Relay switch is ON.
x: Relay switch is OFF.

** On these ranges, A2K1 is ON (gain of X1/X10 Amplifier on A2 board is 1).

*** On these ranges, A2K1 is ON (gain of X1/X10 Amplifier on A2 board is 10).

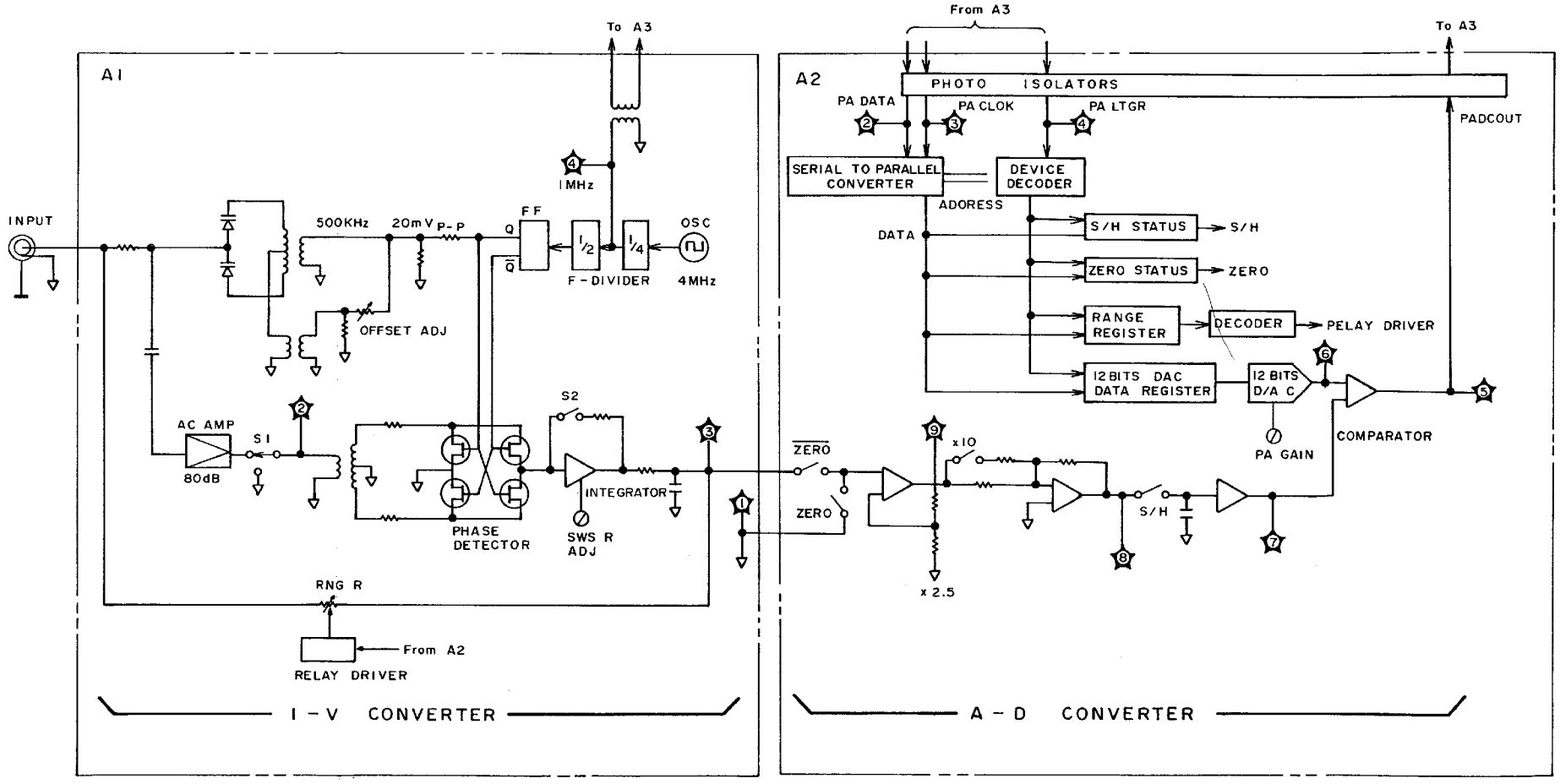


Figure 8-6. pA Meter Section Block Diagram.

8-25. A2 A-D Converter.

8-26. The A-D Converter board does a stable and fast A-D conversion using a successive approximation technique with auto zero compensation (refer to paragraph 8-15). The A-D converter board contains a Photo Isolator, Serial-to-Parallel Converter, Device Decoder, Sample/Hold Status Register, Zero Status Register, Range Status Register and Decoder, 12 Bit DAC Data Register, 12 Bit DAC (Digital-to-Parallel Converter), Auto Zero circuit, X1/X10 Amplifier, Sample/Hold circuit, Comparator, and related circuitry.

Photo Isolator (A2U12∿15) provides electric isolation between the Digital section and the pA Meter section for suppressing noise from the Digital section which would increase current measurement error. The common signal circuit in the isolator floats. The Serial-to-Parallel Converter (A2U8) changes the serial data from the Digital section ($\overline{\text{PADATA}}$) to parallel data which is separated into 4 bit data and a 3 bit address for the Device Decoder. The Device Decoder (A2U4) receives the 3 bit address and selects either the Sample/Hold Status Register, Zero Status Register, Range Status Register or the 12 Bit DAC Data Register. The Sample/Hold Status Register (A2U9) generates a signal (S/$\overline{\text{H}}$) for the Sample/Hold circuit which is synchronized with $\overline{\text{PALTGR}}$. Specific timing for S/$\overline{\text{H}}$ is given in Figure 8-7.

The Zero Status Register (A2U9) generates a signal ($\overline{\text{Zero}}$) for the Auto Zero circuit which is synchronized with $\overline{\text{PALTGR}}$. Specific timing of $\overline{\text{Zero}}$ is given in Figure 8-7. Range Status Register (A2U6) and Decoder (A2U10) generate signals (SW1∿7) to operate relay switches (A1K1∿6, A2K2) in the Range Register on the A1 board which are synchronized with $\overline{\text{PALTGR}}$. Relationships between the Range Resistors (relay switches) and the current measurement ranges are given in Table 8-5.

A 12 Bit DAC Data Register (A1U2, 3, 7) provides 12 bits of DAC data which is synchronized with $\overline{\text{PALTGR}}$.
The 12 Bit DAC (A1U16) converts the 12 bit digital data to analog data (±10Vmax) which is compared with a voltage which is proportional to the unknown current value.
An Auto Zero circuit (A2U19, A2Q15∿19) compensates the circuit to produce a zero offset error in the A-D Converter. THe A-D Converter is disconnected from the I-V Converter on the A1 board (A2U16: off) and is connected to circuit common (A2Q15: ON) for about 1.5ms. The zero offset error is measured during time interval Ⓑ in Figure 8-7. This zero offset error data is stored in the Digital section and used to correct the measured value of the unknown current during time interval Ⓐ.
X1/X10 Amplifier (A2U19, etc.) selects its amplitude gain (1 or 10) to cause the voltage at A2TP8 to be 2.44V (typical) when the 4140A I C DISPLAY shows "1.000". Relationship between this amplitude gain and current measurement range is given in Table 8-5.
Sample/Hold circuit (A2U18, A2Q11 14, etc.) holds the voltage (which is proportional to unknown current) between sucssessive approximation periods. When this circuit is set to SAMPLE (A2Q12: ON), memory capacitor A2C7 is charged with voltage which is proportional to the unknown current. Subsequently, when this circuit is set to HOLD, (A2Q12: OFF) between 1.2ms (time interval Ⓐ in Figure 8-7), voltage across A2C7 is held to a constant value and converted to digital data by the succsessive approximation technique.
Comparator (A2U17, etc.) compares the voltages which are proportional to the unknown current with the 12 Bit DAC output voltage and sends the result of this comparison to the Digital section.

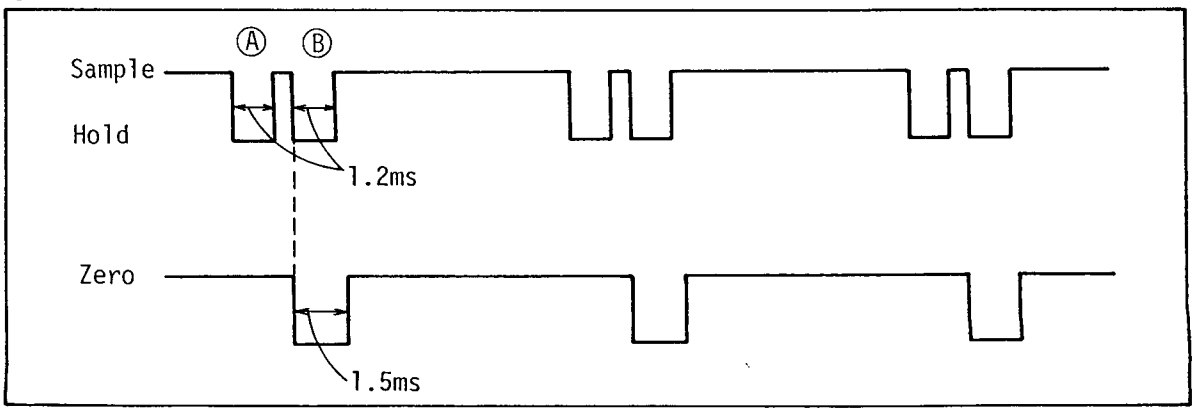


Figure 8-7. Sample Hold and Zero Timing Signal.

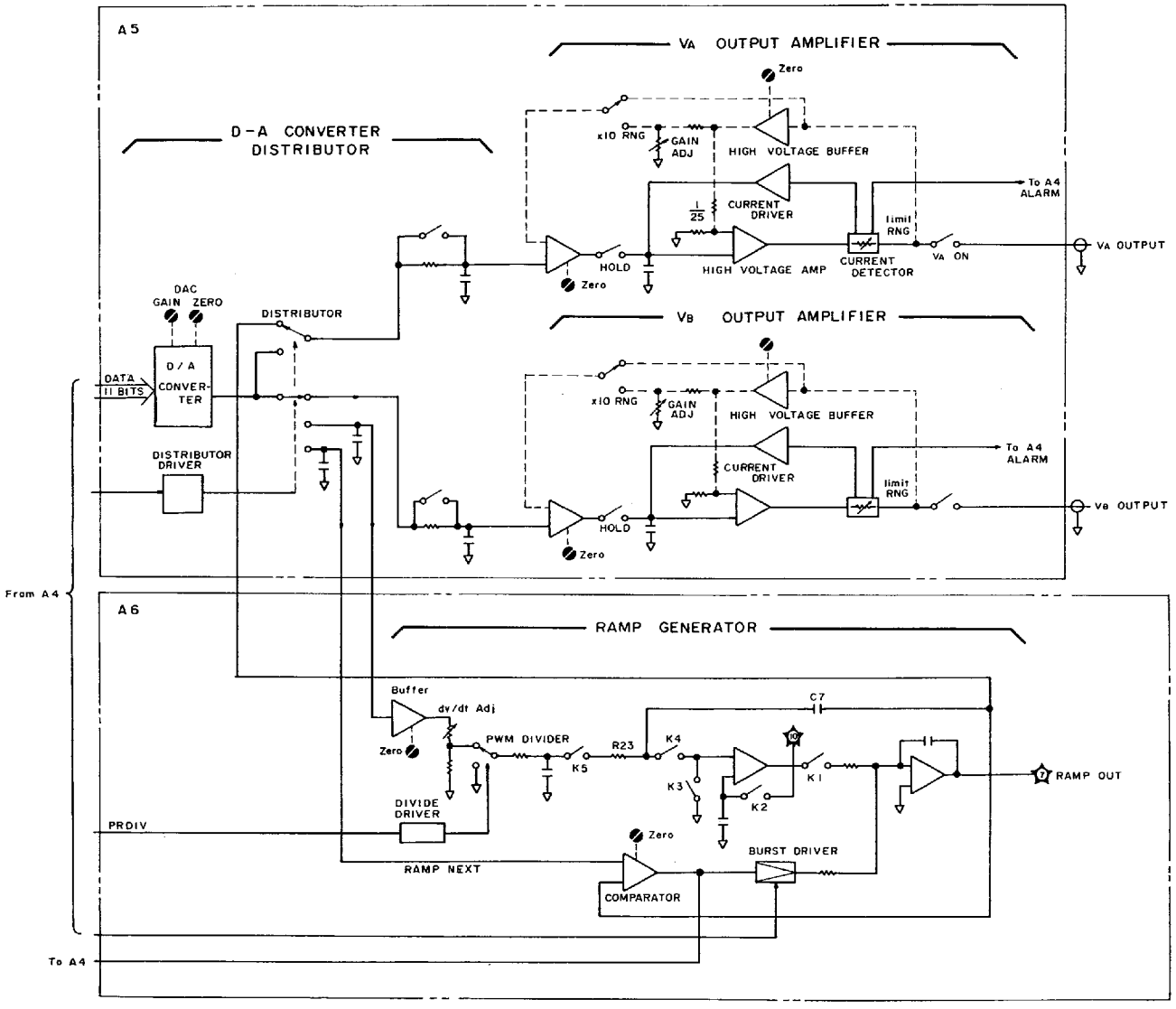


Figure 8-8. VS Section Block Diagram.

8-27. VOLTAGE SOURCE SECTION.

8-28. Figure 8-8 is a detailed block diagram of the 4140A VS (Voltage Source) section. This section is made up of the A5 VS Output board and the A6 Ramp Generator board. The section generates two DC voltage outputs (V_A and V_B). In addition, one of the voltage sources (V_A) generates not only a DC voltage, but also a staircase/ramp wave.

8-29. A5 VS (Voltage Source) Output.

8-30. The VS Output board outputs DC voltage (V_A and V_B) and the staircase/ramp wave (V only). The board contains a 12 Bit DAC (Digital-to-Analog Converter), Distributor, V_A (V_B) LPF (Low Pass Filter), V_A (V_B) Power Amplifier, and V_A (V_B) Current Limiter. The 12 Bit DAC (A5U3) converts 12 bit digital data from the Digital section to analog data (±10Vmax) which has four separate parts: V_A, V_B, dV/dt and Next Ramp data (refer to Figure 8-9). The Distributor (A5U4, 7∿9, etc.) distributes the four pieces of analog data from the DAC to the V_A Power Amplifier, V_B Power Amplifier or A6 Ramp Generator as in Figure 8-9. These analog data (V_A, V_B, dV/dt or Next Ramp) are each held in a charged capacitor (A5C31 ∿ 34). The V_A (V_B) LPF (A5R30, A5C13, A5R75, A5C27) is a 10sec LPF (low pass filter) to reduce the DAC output voltage noise before supplying it to the V_A (V_B) Amplifier. If the input voltage value of the V_A (V_B) Power Amplifier (part of DAC output voltage) changes, a 10sec LPF is shorted for between 20 ∿ 30msec by switch A5K5(K10) to improve the response of V_A (V_B) Power Amplifier.
V_A (V_B) Power Amplifier (A5U1, A5Q1 ∿ 12, A5U2, A5Q20∿31, etc.) operates as a voltage follower when the output voltage is within ±10V. If output voltage is more than ±10V, the amplitude gain of this amplifier is set to 10. In addition, V_A (V_B) Amplifier provides a Hold circuit (A5U8, A5C7; A5U9, A5C21) to reduce spike noise which is generated when V_A (V_B) output voltage range is changed. More specific explanation of this circuit is given in Service Sheet 5.

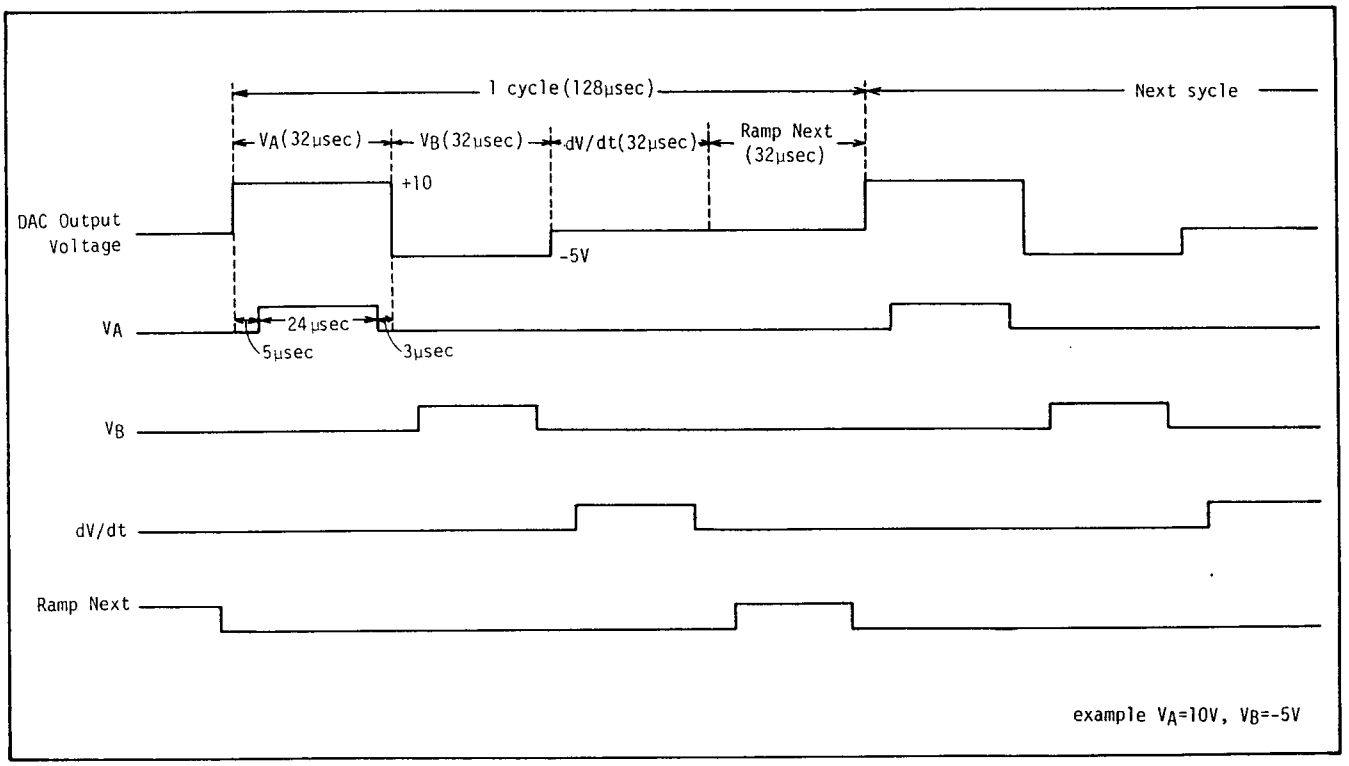


Figure 8-9. Dynamics of DAC is VS section.

8-31. A6 Ramp Generator.

8-32. The Ramp Generator board generates an accurate ramp wave which has various ramp rates (from 0.001V/s to 1V/s). The Ramp Generator board contains a P.W.M. Divider (Pulse Width Modulation Divider), Auto Offset Voltage Compensated Integrator, Ramp Comparator, and a Burst Driver. The P.W.M. Divider (A6U7, A6Q3 ∿ 6) generates a voltage which determines the ramp rate of the ramp generator output wave. If the DAC output voltage (dV/dt) is used directly as ramp rate data, the DAC noise error would increase the error of ramp rate accuracy for small DAC output voltage values. Therefore, the DAC output voltage is set to an $X2^N$ value of the true ramp rate data (N = 0, 1, 2, ..., 7). This value, through dV/dt Buffer (A6U3) is attenuated to $X1/2^N$ value in the P.W.M. Divider as in Figure 8-10. This value is also attenuated to X1/10 value when ramp wave START V or STOP V is set to more than ±10V (see Figure 8-10). In this case, the output voltage of Ramp Generator (RAMP OUT) is amplified to X10 value in the V_A Power Amplifier on the A5 board. This voltage is supplied to the Integrator via a smoothing circuit (A6R42 ∿ 46, A6C18 ∿ 20). An Auto Offset-Voltage Compensated-Integrator (A6U1, 4, 5, A6K1 ∿5) generates an accurate ramp wave by minimizing its offset voltage error. The generated ramp wave (RAMP OUT) is outputted through V_A Power Amplifier or A5 board. More specific explanation for this integrator is given in Service Sheet 6. Ramp Comparator (A6U2, etc.) compares the output voltage of Ramp Generator (RAMP OUT) with the reference signal from A5 board (NEXT RAMP) and sends result of this comparison to Digital section. This result is used to determine timing of VS DISPLAY changes.

Burst Driver (A6U1, 6, A6Q1, 2) sets RAMP OUT to START V by setting the voltage at A6TP6 MAX RAMP) to +15V or -15V. In like manner, this circuit also sets RAMP OUT to 0V when ramp wave generation is complete. MAX RAMP is held to 0V during the time that the ramp wave is being generated. Similarly, the circuit is also used to hold RAMP OUT to 0V by setting RAMP NEXT to 0V when the Ramp Generator isn't being used.

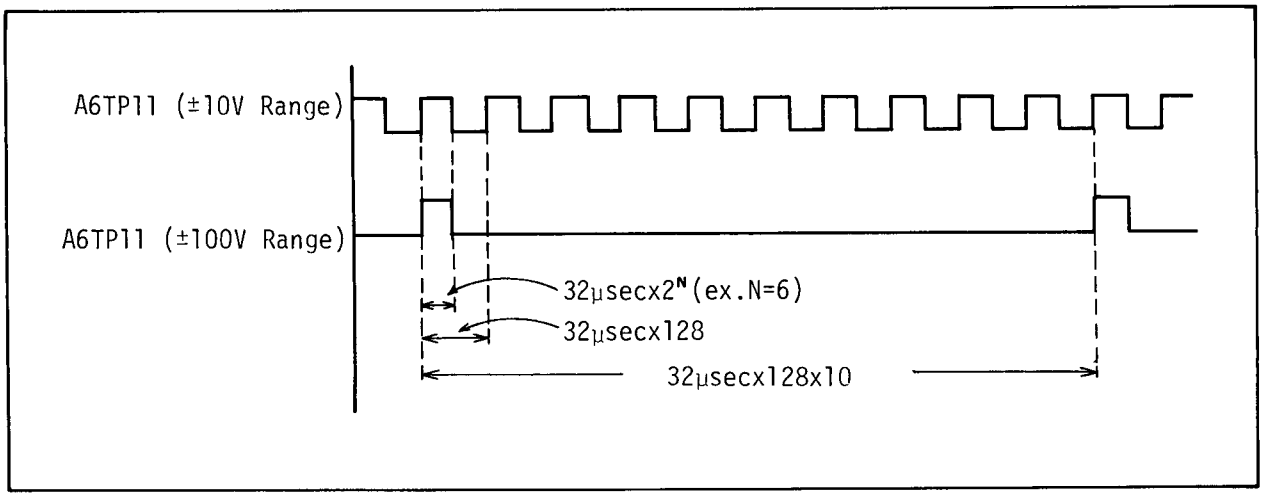


Figure 8-10. Duty Cycle of P.W.M. Divider.

8-33. DIGITAL SECTION.

8-34. Figure 8-11 is a detailed block diagram of the 4140A Digital section. The 4140A Digital section is made up of the A3 MPU board and the A4 I/O Control board. This section controls all 4140A operations and boards, the A1 I-V Converter, A2 A-D Converter, A5 VS Output, A6 Ramp Generator, A8 Key & Display, A21 HP-IB (option 101), A31 Analog Output Control (Option 001) and A32 Analog Output (Option 001).

8-35. A3 MPU.

8-36. The MPU board is the main digital control circuit and consists of the MPU (Micro Processing Unit) itself, ROM (Read Only Memory), RAM (Random Access Memory), Bus Buffer, Device Decoder, and related circuitry. This board also contains the Clock circuit, Reset circuit, Interrupt Receiver, Data Bus Extender, and pA Interface Parallel/Serial Converter.
The MPU (A3U13) handles the central control functions of the 4140A digital circuitry. In addition, the MPU includes a bidirectional 3-state 8 bit parallel data bus for transferring data to and from the memory and peripheral devices, a 3-state 16 bit parallel address bus for addressing the memory (max. 65K bytes), and other I/O lines.
The ROM's (A3U3∿8) are six 2K X 8 bit memories for storing various management instructions for the 4140A operations. These include:

a. pA Meter section control.
b. VS (Voltage Source) section control.
c. Timing control for I-V/C-V measurements.
d. Key control.
e. Display control.
f. Utility program.
g. Mathematic pack.
h. Computation program.
i. Look-up table.
j. Main program.
k. Analog output control.
l. HP-IB control.

The RAM's (A3U10, 11) are two 512 X 8 bit memories for storing the data (e. g. current measurement data, digital data for DAC, etc.).
The Bus Buffer consists of two 8 bit address bus buffers (A3U12, 21) and one 8 bit data bus transceiver (A3U14). THe Address bus buffers transfer address bus signals from the MPU to the memory and peripheral devices. Data bus buffer transfers data bus signals from/to MPU to/from the memory and peripheral devices.

Device Decoders (A3U19, 20) select ROM's, RAM's and peripheral devices to be addressed by the MPU. The Clock circuit (A3U22, 29, etc.) modifies the 1MHz Clock signal from the A1 board to a 2-phase Clock pulse (ϕ1, ϕ2) for use in the MPU. The Clock circuit also supplies a DBE (Data Bus Enable) signal for the MPU.

A Reset circuit (A3U32, A3CR3, A3R22, 23, A3C16) generates a $\overline{\text{RESET}}$ signal to restart the MPU when the instrument is turned on. The Data Bus Extender (A3U9) is an 8 bit bidirectional 3 state bus extender for transferring data bus signals from/to A3 MPU board to/from A4 I/O Control board. The pA Interface Parallel/Serial Converter (A3U16, 18, 23 ∿ 25, 30, 31, etc.) generates control signals ($\overline{\text{PACLK}}$, $\overline{\text{PADATA}}$, $\overline{\text{PALTRG}}$) for the pA Meter section. In particular, the Parallel/Serial Converter (A3U18) changes the 8 bit parallel data (EBD 0 ∿ 7 = Extended Buffered Data) to serial data (PADATA).

8-37. A4 I/O Control.

8-38. The A4 I/O Control board receives 8 bit data signals (EBD 0∿7 = Extended Buffered Data), 5 bit address signals (BA 0 ∿ 4 = Buffered Address) and other control signals from the A3 MPU board and generates control signals for the VS section, Control keys and Displays. The I/O Control board also contains a Frequency Divider, Blanking circuit, Display Address Selector, Display Refresh Memory, Interrupt Control Circuit, trigger LED latch, Data Input Buffer, VS Register Selector, Distributor Control, VS Control Status Register, VS DAC Data Register, and VS Precision Divider Strobe Generator. Frequency Divider (A4U13 15, 17, 18, 38, 39, etc.) modifies the clock pulse Bϕ2 (Buffered ϕ2) to 11 clock pulses (244Hz ∿ 500KHz) for use in peripheral devices as clock signals. The Blanking circuit (A4U1,11) generates a BLANK signal for the A8 Key & Display board. Display Address Selector (A4U12) is used to select Display Refresh Memory and Anode Driver Selector on A8 board.
Display Refresh Memory (A4U8 ∿ 10) controls Cathode Driver on A8 board.

Interrupt Control Circuit (A4U2 ∿ 7, 16, 17, 28, 39, 40) receives interrupt signals (e. g KIRQ, EXTRG, $\overline{\text{LFC}}$, etc.) and generates interrupt signals ($\overline{\text{BIRQ}}$) for the MPU on the A3 board.

Trigger LED Latch (A4U29) generates control signals for the TRIGGER LED lamp on the A8 board. Data Input Buffer (A4U36, 37) receives front panel key status data, interrupt data, current Limiter data and changes it to 8 bit parallel data for use in the MPU on the A3 board.

VS Register Selector (A4U22) is used to select VS Control Status Register and VS DAC Data Register. Distributor Control (A4U2 ∿ 4, 20, 21) generates control signals for the Distributor on the A5 VS Output board. VS Control Status Register (A4U32 ∿ 35) generates control signals for the A5 VS Output board and A6 Ramp Generator board.
VS Precision Divider Strobe Generator (A4U23, 24, 26, 27, 38) generates divide duty cycle data for Precision Divider on A6 board.

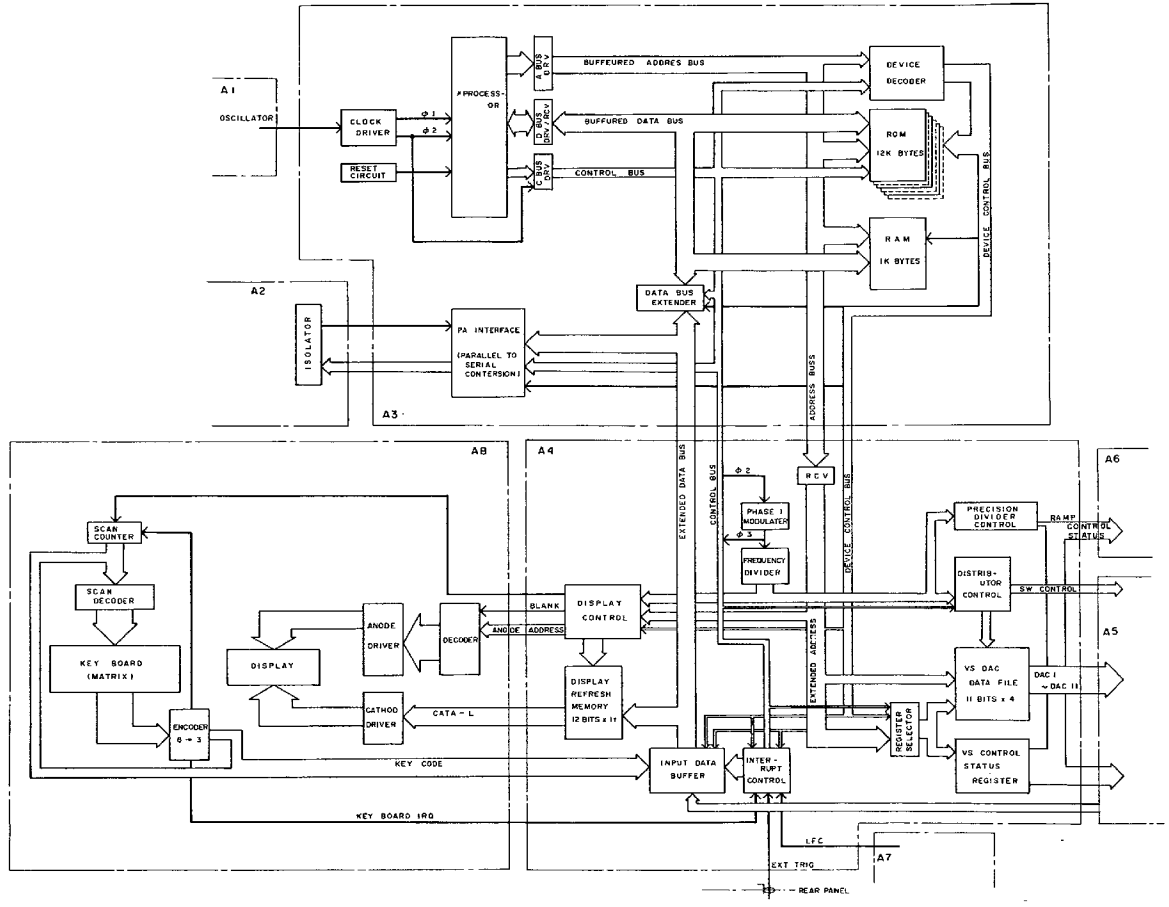


Figure 8-11. Digital Section Block Diagram.

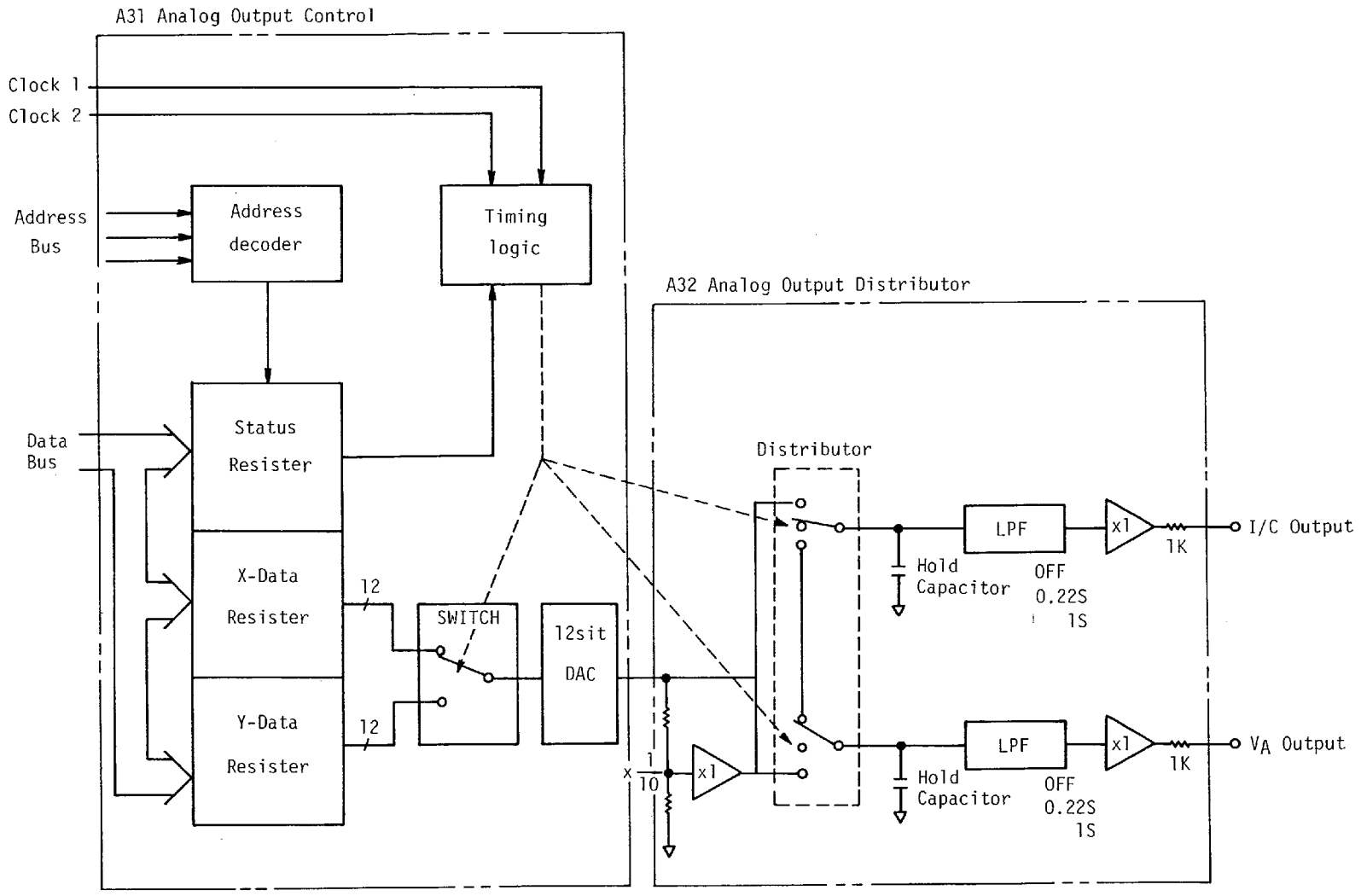


Figure 8-12. Option 001 Analog Output Block Diagram.

8-39. OPTIONS.

8-40. The Model 4140A pA Meter/DC Voltage Source provides two options: Option 001 Analog Output and Option 101 HP-IB interface. Option 001 contains two boards, the A31 Analog Output Control board and the A32 Analog Output board. Option 101 contains, the A21 HP-IB board.

8-41. A31 Analog Output Control (Option 001).

8-42. Figure 8-12 is a detailed block diagram of the Option 001 Analog Output. A31 Analog Output Control board does Digital-to-Analog conversion of the Analog Output data and generates control signals for the A32 Analog Output board. A31 board contains an Address Decoder, Status Register, Distributor Timing Control, X Data Register, Y Data Register, Multiplexer and the 12 Bit DAC (Digital-to-Analog Converter).
Address Decoder (A31U5) selects Status Register, X Data Register or Y Data Register. Status Register (A31U2) generates control signals for Distributor Timing Control and supplies pen up/down signals.
Distributor Timing Control (A31U1, 3, 4) generates control signals for the Distributor on the A32 board.

X Data Register (A31U6, 10) provides X-axis (I/C Analog Output) digital data for the 12 Bit DAC. Y Data Register (A31U7, 11) provides Y-axis (V_A Analog Output) digital data for the 12 Bit DAC. Multiplexer (A31U8, 12, 13) selects digital data for the 12 bit DAC, and X or Y-axis information. The 12 Bit DAC (A31U9) converts 12 bit digital data to analog data (±10Vmax).

8-43. A32 Analog Output Distributor (Option 001).

8-44. The Analog Output board modifies the analog data from the 12 Bit DAC on A31 board to two analog outputs: An I/C Analog Output or a V_A Analog Output. THe A32 board contain a X 1/10 Buffer, Distributor, LPE (Low Pass Filter) and a Buffer. The X 1/10 Buffer (A31U4, etc.) amplifies (gain = 1/10) analog data from the 12 Bit DAC on the A31 board when output voltage is smaller than ±1V.

The Distributor (A32U3) distributes the analog data from the 12 Bit DAC on the A31 board to either the I/C Analog Output or the V_A Analog Output. The LPF (A32S1, R1,3, C1∿8) reduces the noise on both the I/C and V_A Analog Output data. The Buffer (A32U1,2) lowers the output impedances of both the I/C and V_A Analog Output data.

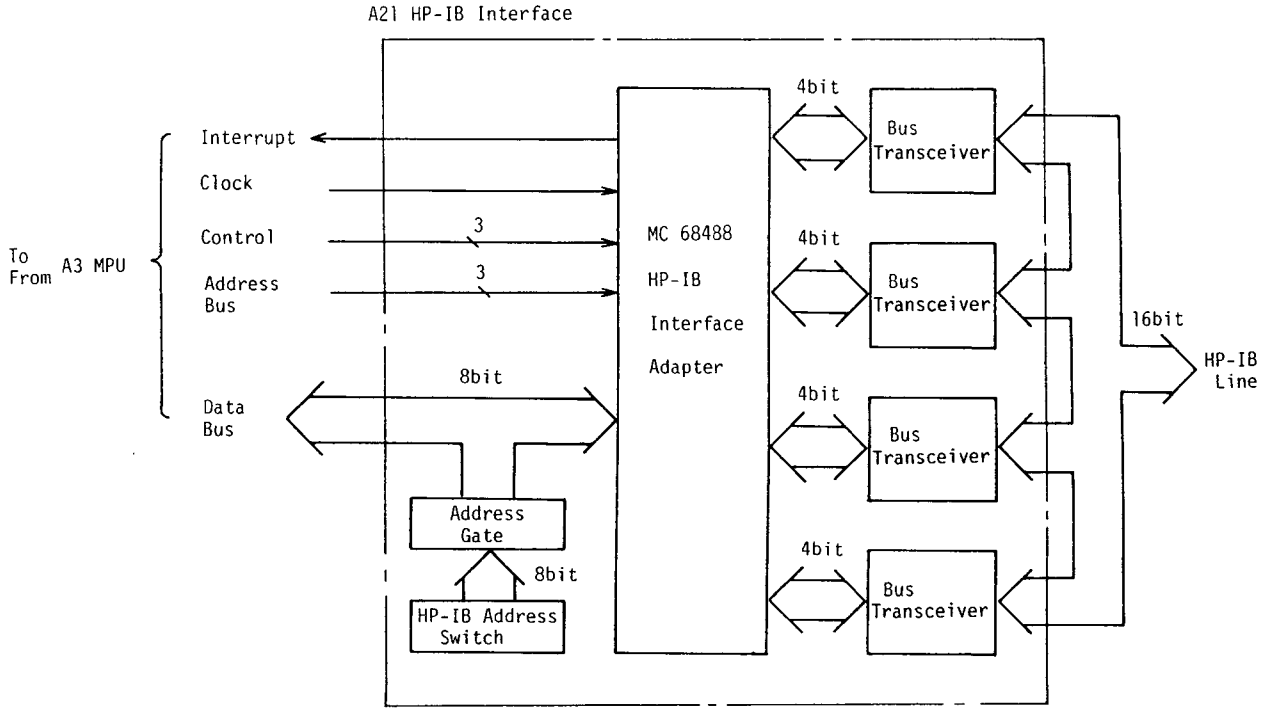


Figure 8-13. Opition 101 HP-IB Interface Block Diagram.

8-45. A21 HP-IB Interface (Option 101).

8-46. Figure 8-13 is a detailed block diagram of the Option 101 HP-IB Interface. A21 HP-IB transfers remote control program from HP-IB Controller to MPU on A3 board and measurement data from MPU to an HP-IB device (e. g. controller, Listen Only devices, etc.). A21 board contains MC68488 HP-IB Interface Adapter (A21U3), HP-IB Bus Transceiver (A21U4~7), HP-IB Address Switch (A21S1), etc. The Hewlett-Packard Interface Bus (HP-IB) is a carefully defined instrumentation interface which simplifies the integration of instruments, calculators, and computers into systems. The HP-IB employs a 16-line Bus to interconnect up to 15 instruments. Normally, this Bus is the sole communication link between the interconnected units. Each instrument on the Bus is connected in parallel to the 16 Bus lines. Eight of the lines are used to transmit data while the remaining eight lines are used for communication timing (Handshake) and control. Data is transmitted on the eight data lines as a series of eight-bit characters ("bytes"). Normally, a seven-bit ASCII code is used with an eighth bit available for a parity check. Data is transferred by means of an interlocked "handshake" technique which permits asynchronous communication over a wide range of data rates. Figure 8-14 illustrates the HP-IB interface connections and overall Bus structure. Bus communication is controlled by the five general interface management (control) lines. These lines determine how information will be interpreter by devices on the Bus. The data bus (lines DI01 through DI08) is used to transfer information between devices on the Bus. The three data byte transfer control (handshake) lines permit synchronization of the data transfer on the data bus.

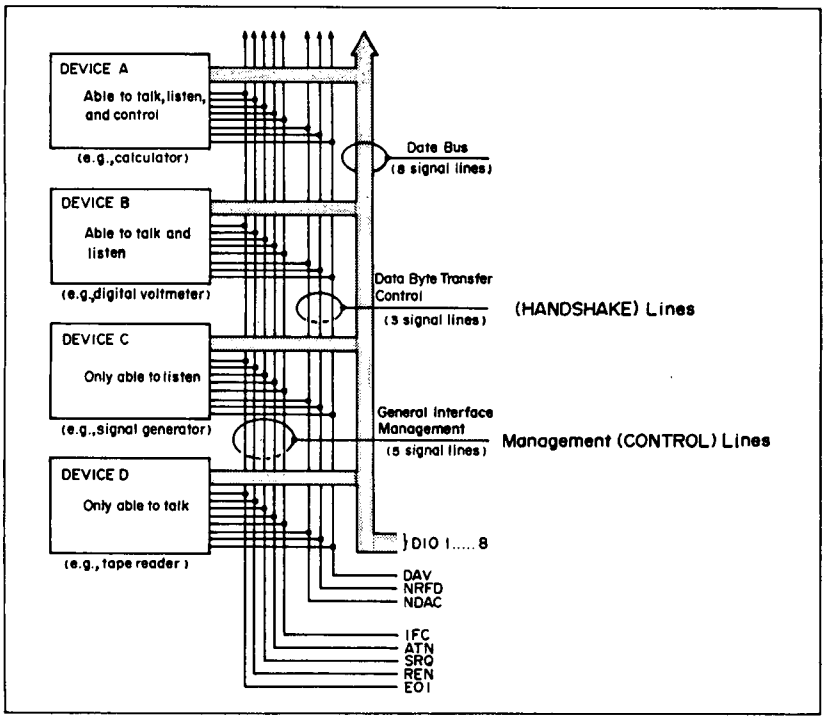


Figure 8-14. Interface Connections and Bus Structure.

8-47. TROUBLESHOOTING.

CAUTION

THE OPENING OF COVERS OR THE REMOVAL OF PARTS, EXCEPT THOSE TO WHICH ACCESS CAN BE GAINED BY HAND, IS LIKELY TO EXPOSE LIVE PARTS. IN ADDITION, ACCESSIBLE TERMINALS MAY ALSO BE LIVE.

THE APPARATUS SHALL BE DISCONNECTED FROM ALL VOLTAGE SOURCES BEFORE ANY ANY ADJUSTMENT, PARTS REPLACEMENT, OR MAINTENANCE AND REPAIR ARE PERFORMED FOR WHICH THE INSTRUMENT MUST BE OPENED. IF, AFTERWARDS, ANY ADJUSTMENT, MAINTENANCE OR REPAIR OF THE OPENED INSTRUMENT UNDER VOLTAGE IS REQUIRED, IT SHALL BE CARRED OUT ONLY BY A SKILLED PERSON WHO IS AWARE OF THE HAZARD INVOLVED.

8-48. Troubleshooting guide.

8-49. Figure 8-15 is helpful when starting to troubleshoot the 4140A. This flow diagram shows the fundamental procedures which breakdown the trouble possibilities to the component level.

8-50. Power Supply Isolation Procedure (P/O Figure 8-16.)

8-51. The Power Supply Isolation Procedure is basically used for checking the internal power supply voltages of the instrument. A guide for checking the power supply section is included in Figure 8-16.

8-52. Option Section Isolation Procedure (P/O Figure 8-16).

8-53. The Option Section Isolation Procedure, which is used to isolate the option section from the overall unit, is included in Figure 8-16. If the instrument is a standard unit equipped with no option, omit this procedure.

8-54. Circuit Block Isolation Procedure (Figure 8-16).

8-55. The troubleshooting guide in Figure 8-16 describes how to distinguish whether the faulty assembly is located in the pA Meter section, VS (Voltage Source) section or Digital section.

8-56. Digital Section Troubleshooting Procedure (Figure 8-17).

8-57. The troubleshooting flow diagram in Figure 8-17 helps to isolate a faulty board assembly in the VS (Voltage Source) Section. Component level troubleshooting guides are provided for each assembly in the Service sheets.

8-58. pA Section Troubleshooting Procedure (Figure 8-18).

8-59. The troubleshooting flow diagram in Figure 8-18 helps to isolate a faulty board assembly in the pA Meter section. Component level troubleshooting guides are provided for each assembly in the Service Sheets.

8-60. VS Section Troubleshooting Procedure (Figure 8-19).

8-61. The troubleshooting flow diagram in Figure 8-19 helps to isolate a faulty board assembly in the VS (Voltage Source) section. Component level troubleshooting guides are provided for each assembly in the Service Sheets.

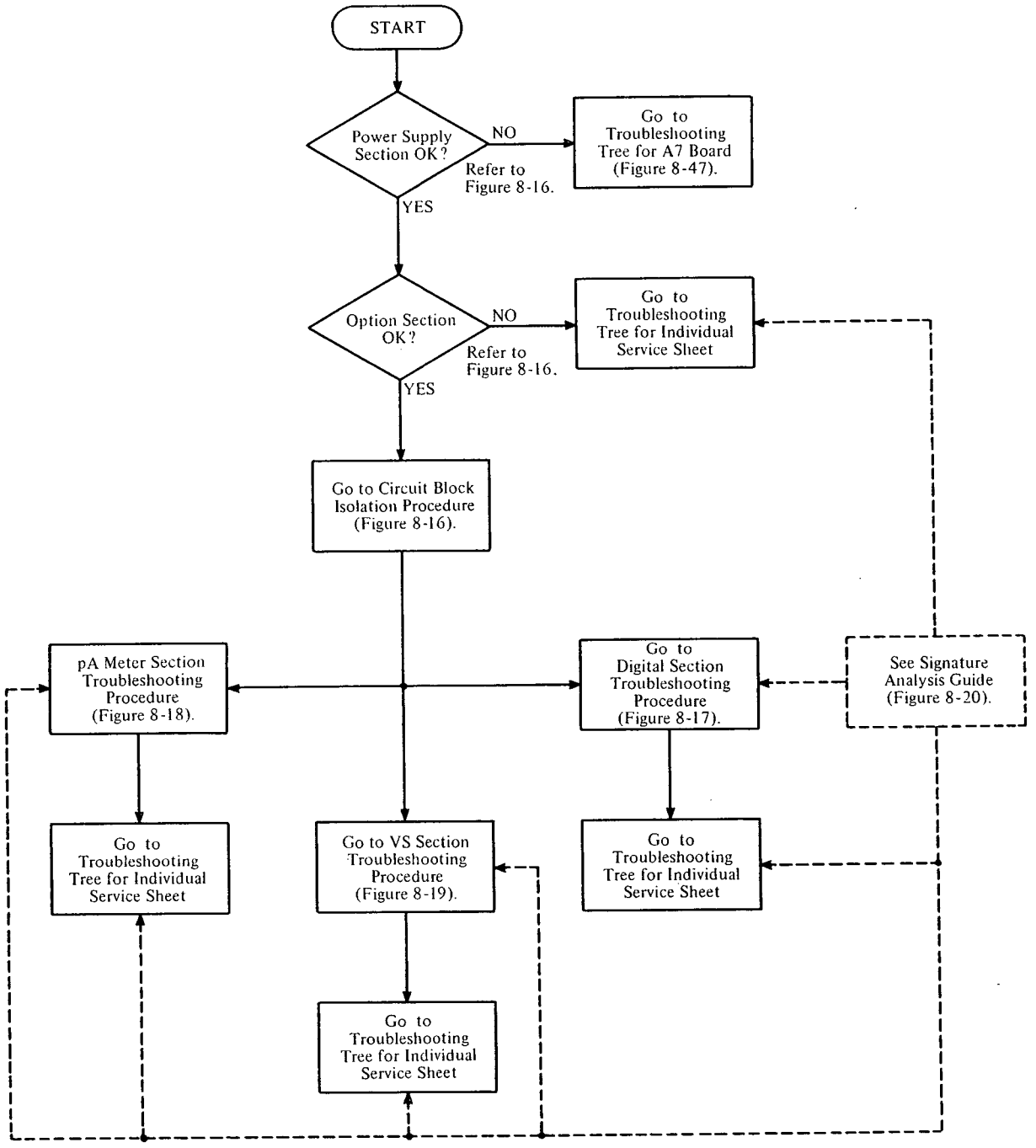


Figure 8-15. How to Use Troubleshooting Flow.

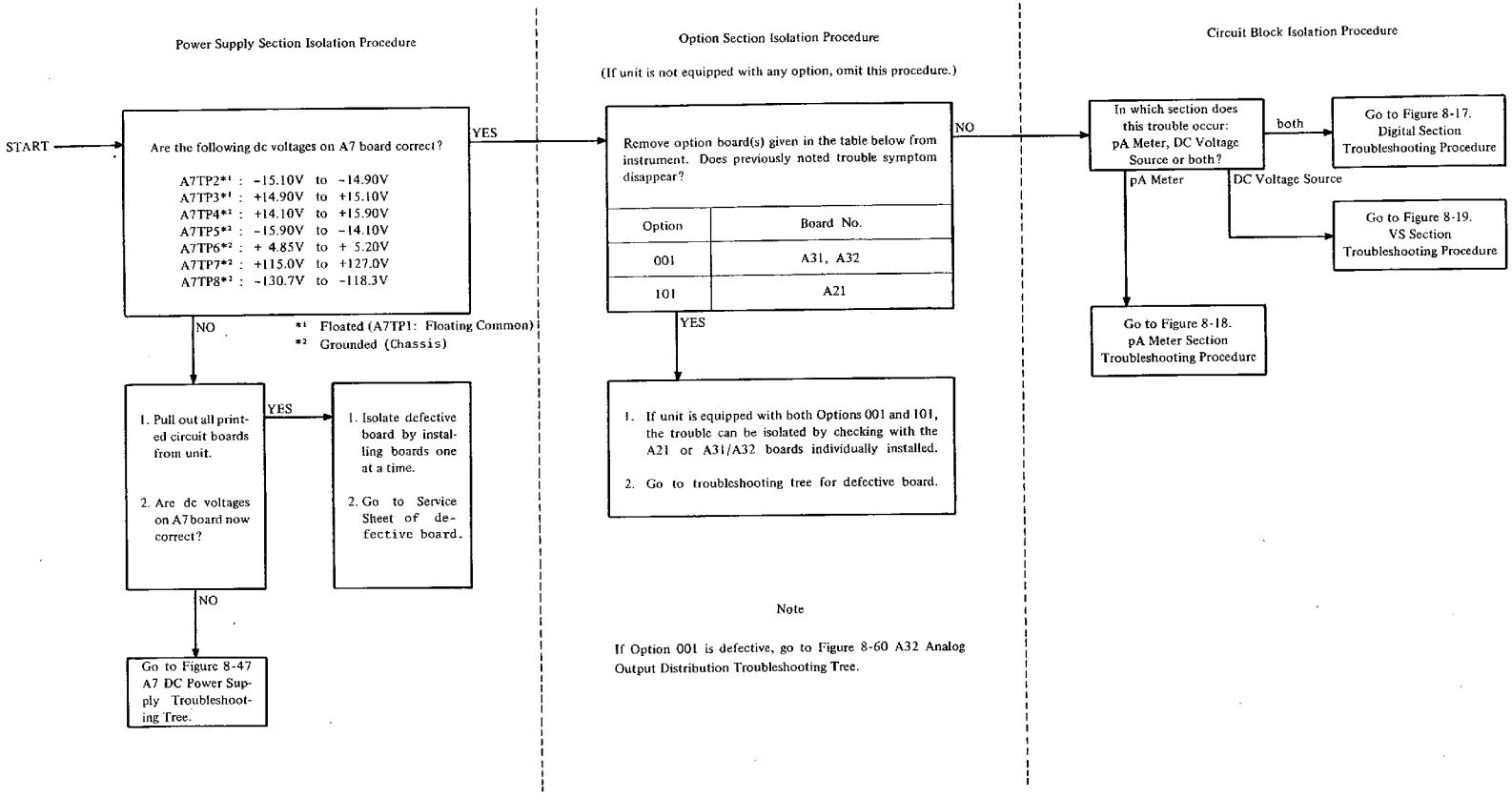


Figure 8-16. Circuit Block Isolation Procedure.

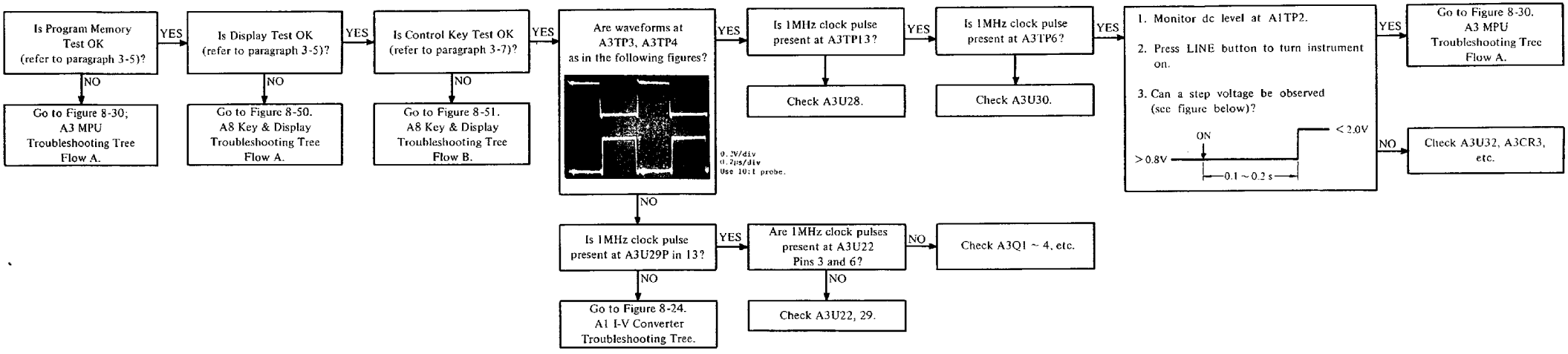


Figure 8-17. Digital Section Isolation Procedure.

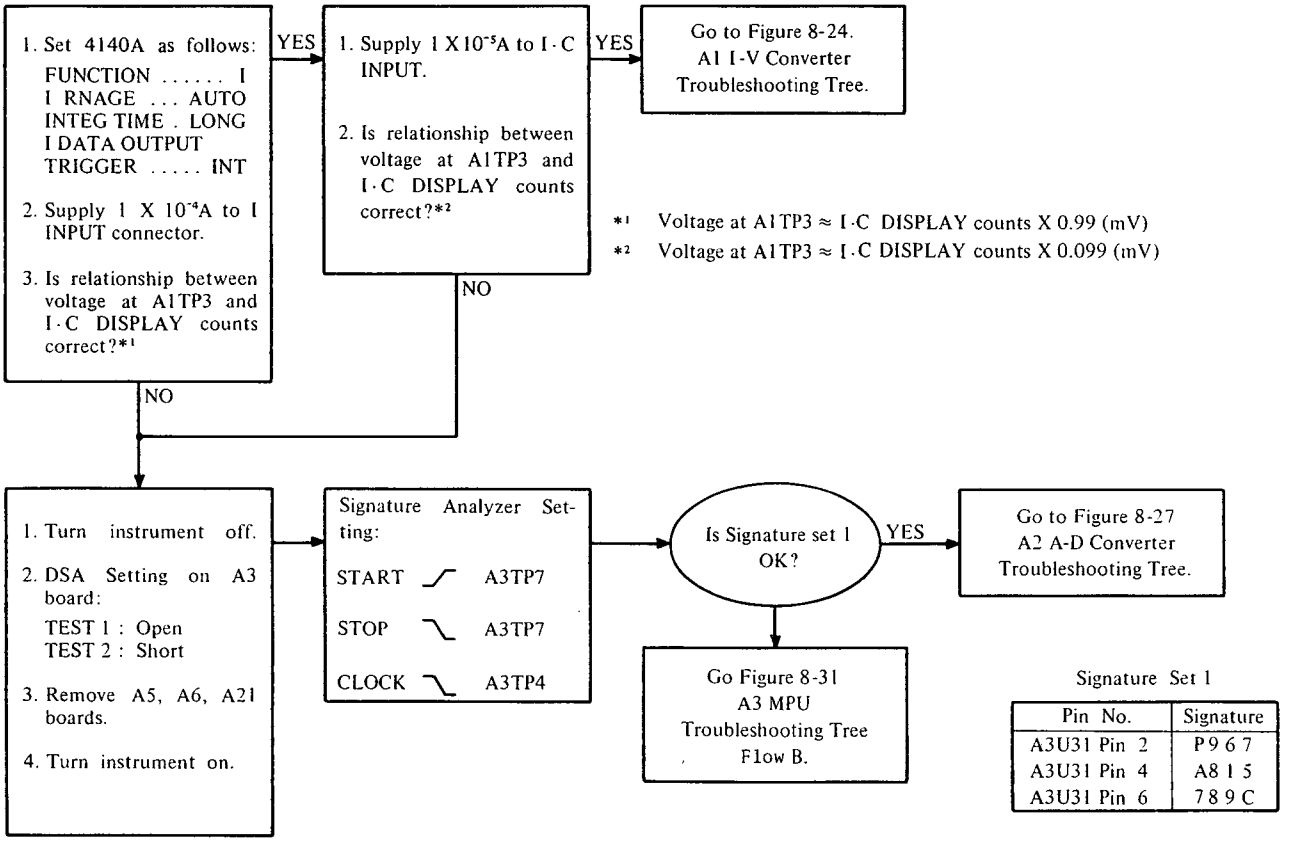
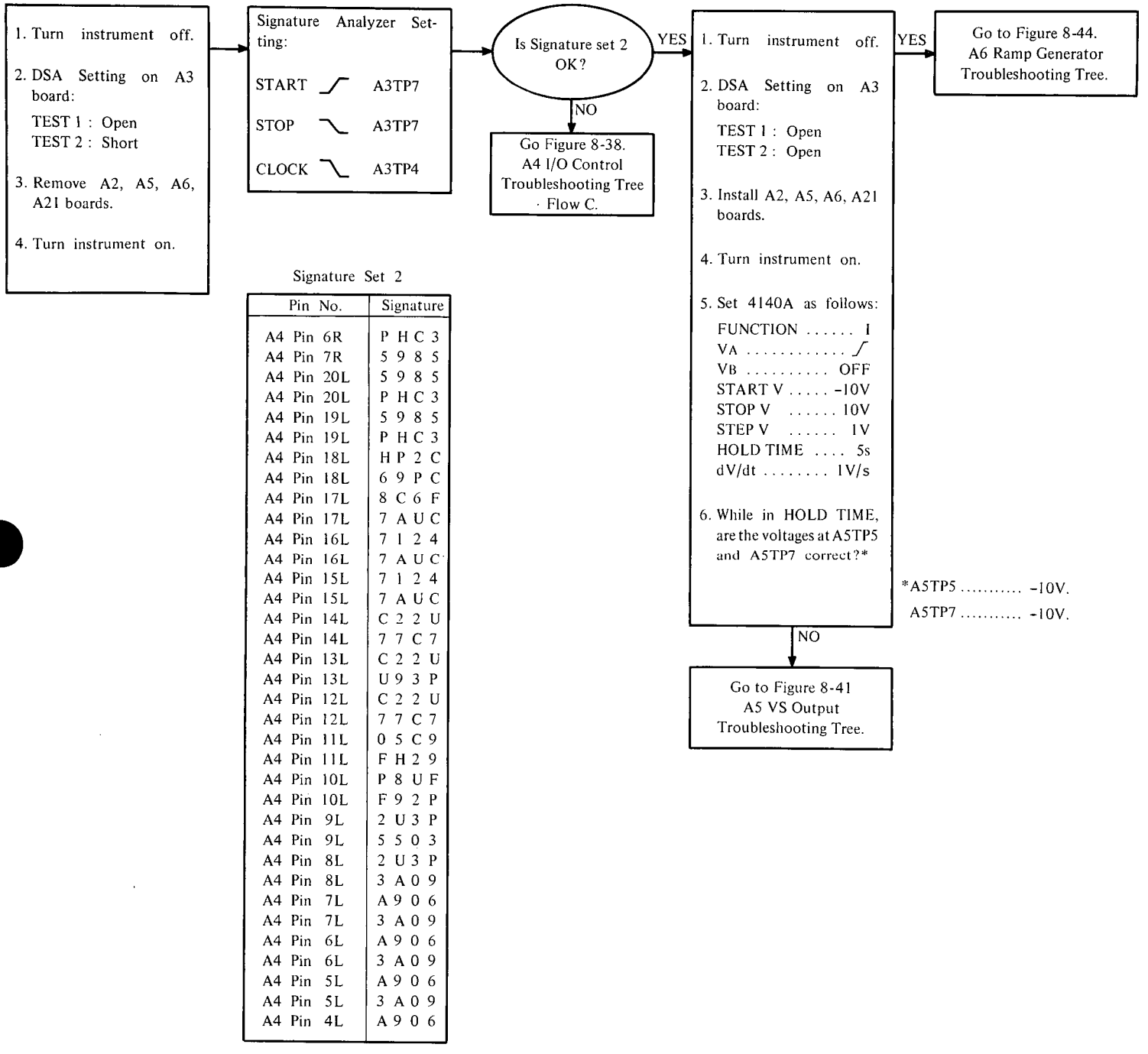


Figure 8-18. pA Meter Section Isolation Procedure.



Signature Set 2

Pin No.	Signature
A4 Pin 6R	P H C 3
A4 Pin 7R	5 9 8 5
A4 Pin 20L	5 9 8 5
A4 Pin 20L	P H C 3
A4 Pin 19L	5 9 8 5
A4 Pin 19L	P H C 3
A4 Pin 18L	H P 2 C
A4 Pin 18L	6 9 P C
A4 Pin 17L	8 C 6 F
A4 Pin 17L	7 A U C
A4 Pin 16L	7 1 2 4
A4 Pin 16L	7 A U C
A4 Pin 15L	7 1 2 4
A4 Pin 15L	7 A U C
A4 Pin 14L	C 2 2 U
A4 Pin 14L	7 7 C 7
A4 Pin 13L	C 2 2 U
A4 Pin 13L	U 9 3 P
A4 Pin 12L	C 2 2 U
A4 Pin 12L	7 7 C 7
A4 Pin 11L	0 5 C 9
A4 Pin 11L	F H 2 9
A4 Pin 10L	P 8 U F
A4 Pin 10L	F 9 2 P
A4 Pin 9L	2 U 3 P
A4 Pin 9L	5 5 0 3
A4 Pin 8L	2 U 3 P
A4 Pin 8L	3 A 0 9
A4 Pin 7L	A 9 0 6
A4 Pin 7L	3 A 0 9
A4 Pin 6L	A 9 0 6
A4 Pin 6L	3 A 0 9
A4 Pin 5L	A 9 0 6
A4 Pin 5L	3 A 0 9
A4 Pin 4L	A 9 0 6

Figure 8-19. VS Section Isolation Procedure.

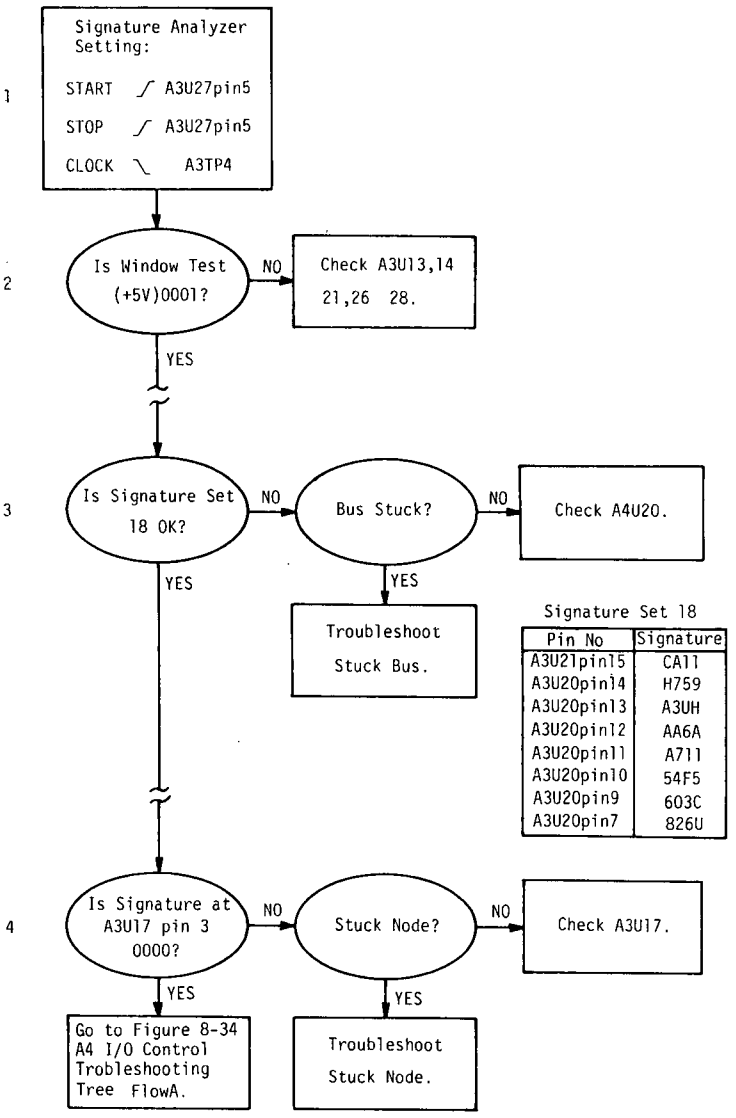
8-62. Digital Circuit Troubleshooting Using Signature Analysis

8-63. Troubleshooting of the 4140A digital circuit uses "Signature Analysis". The advantage of troubleshooting based on "Signature Analysis" is accuracy and ease in finding failures. It is generally difficult to search for an error by means of observing waveforms on an oscilloscope for the reason that bit trains in a digital circuit seem to be much the same whichever is observed. Specifically, to find the errors in streams of large bit size (or word length) data takes much time and requires the use of an instrument such as a logic state analyzer. Hewlett-Packard has proposed a method called "Signature Analysis" which recognizes the bit pattern measured in a 4 digit hexa-decimal code (signature) for running an easy diagnostic test program. With the Signature Analyzer (HP 5004A), the signatures are displayed in a readable 4 digit-figure set of alphanumeric figures (0 1 2 3 4 5 6 7 8 9 A C F H P U). The signature analysis is based the usual signal tracing method followed in troubleshooting an analog circuit. According to signature analysis, devices in a digital circuit are checked with the signal input and output signatures to and from each device for the "correct" signature denoted in the service manual signature map. If a signature is not identical, the troubleshooter need only trace the bit train in opposite direction to the signal flow and, when a device is noted which generates an erratic signature despite a correct input, the component may be regarded as faulty. Refer to Figure 8-20 for "Signature Analysis" guidelines.

SIGNATURE ANALYZER TECHNIQUE

An active digital hand-held logic tracer coupled with an active pod (with four miniature clip connection leads) is sufficient for detecting the test signal and for development of the signature on the Signature Analyzer display. The active probe has access to the desired node in the circuit being tested and transfers this input data to the analyzer. The four input leads of the test cable active pod connect the gate signals - START, STOP, and CLOCK - from the instrument being tested to the analyzer. The remaining lead is connected to instrument GND. The START signal is an open "window" (measurement gate) signal which causes the signature analyzer to prepare for receiving data via the active probe. The STOP signal causes the window to close. The CLOCK is taken from the time base of the instrument and permits receiving input data and gate signals in synchronization. Polarity of the gate signal active (enable) edges (positive or negative) can be selected by the front panel controls of the signature analyzer. Probing points and connection locations of START, STOP and CLOCK leads are designated on the troubleshooting flow diagrams.

Figure 8-20. Signature Analysis Guide. (Sheet 1 of 2)



1. Both START and STOP signals are taken from A3U27 Pin 5. CLOCK signal is taken from A3TP4. Front panel control settings for Signature Analyzer are:

   START button: released (▀▁)

   STOP button: released (▀▁)

   CLOCK button: depressed (▁▀)

2. Checks that signature of +5V supply is 0001.

3. Compares actual signatures with signature set 18 in the table and on the signature map (see Figure B). If incorrect, use a HP Model 547A Current Tracer to correct a "stuck" bus.

4. Checks that signature of A3U17 pin 3 is 0000. If incorrect, use the Current Tracer to find "stuck" node. If correct, go to Figure 8-34 I/O Control Troubleshooting Tree Flow A.

Figure A. Signature Analysis Diagnostic Flow Diagram Notes.

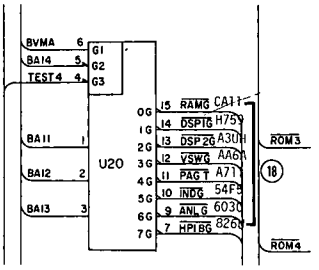


Figure B. Signature Map Notes on Schematic Diagram.

Figure 8-20. Signature Analysis Guide. (Sheet 2 of 2)

8-64. BOARD REMOVAL PROCEDURE.

8-65. A1 Board Removal:

a. Fully loosen top cover retaining screw located at rear of instrument and lift off top cover.

b. Remove board support mounting screws (3) and take off board support.

c. Remove the A1 board mounting screws (2).

d. Remove the screw next to I INPUT Connector.

e. Lift off A1 board from motherboard.

f. Pull out the A1 board from front panel.

8-66. A3 and A21 Boards Removal (Opt. 101 Only):

a. Fully loosen top cover retaining screw located at rear of instrument and lift off top cover.

b. Remove A21 board mounting screws (2) located at rear panel.

c. Remove A21 board from rear edge connection on the A3 board.

d. Remove board support mounting screw (3) and take off board support.

e. Remove the A3 board.

8-67. A4 and Analog Output Assembly Removal (Opt. 001 Only):

a. Fully loosen top cover retaining screw located at rear of instrument and lift off top cover.

b. Remove Analog Output Assembly (HP Part No: 04140-61001) mounting screws (2) located at rear panel.

c. Remove Analog Output Assembly from rear edge connector on the A4 board.

d. Remove board support mounting screws (3) and take off board support.

e. Remove the A4 board.

8-68. A8 Board Removal:

a. Fully loosen top cover retaining screw located at rear of instrument and lift off top cover.

b. Remove the screw next to I INPUT Connector.

c. Carefully strip off adhesive-backed trim strips from left side of front frame.

d. Remove the two screws from left side of front frame.

e. Carefully remove trim strip from top of front frame (without bending trim strip).

f. Remove the three (3) screws from top of front frame.

g. Remove the two (2) foot assemblies and the three screws from bottom of front frame.

h. Press front panel assembly forward (from inside) without adding stress to the cable assemblies which are connected between front panel and main body.

i. Remove the A8 board mounting screws (8).

j. Remove the A8 board.

8-69. PRODUCT SAFETY CHECKS.

WARNING

WHENEVER IT APPEARS LIKELY THAT SAFETY PROTECTIVE PROVISIONS HAVE BEEN IMPAIRED, THE APPARATUS SHALL BE MADE INOPERATIVE AND BE SECURED AGAINST ANY UNINTENDED OPERATION. THE PROTECTION IS LIKELY TO BE COMPROMISED IF, FOR EXAMPLE:

--- THE APPARATUS SHOWS VISIBLE DAMAGE.

--- THE INSTRUMENT FAILS TO PERFORM THE INTENDED MEASUREMENT.

--- THE UNIT HAS UNDERGONE PROLONGED STORAGE UNDER UNFAVORABLE CONDITIONS.

--- THE INSTRUMENT HAS SUFFERED SEVERE TRANSPORT STRESS.

8-70. The following five checks are recommended to verify the product safety of the 4140A pA Meter/DC Voltage Source (these checks may also be done to check for product safety after troubleshooting and repair). When such checks are needed, perform the following:

1. Visually inspect interior of instrument for any signs of abnormal internally generated heat such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and remedy cause of any such condition.

2. Using a suitable ohmmeter, check resistance from instrument enclosure to ground pin on power cord plug. The reading must be less than 0.5ohm. Flex the power cord while making this measurement to determine whether intermittent discontinuities exist.

3. Check GUARD terminal on front panel using Procedure (2).

4. Disconnect instrument from power source. Turn power switch to on. Check resistance from instrument enclosure to line and neutral (tied together). The minimum acceptable resistance is two megohms. Replace any component which fails or causes a failure.

5. Check line fuse to verify that a correctly rated fuse is installed.

8-71. GENERAL NOTES.

a. Unless otherwise indicated, resistance is in ohms, capacitance in microfarads and inductance in microhenries.

b. Components assigned an asterisk (*) are factory selected with average values shown.

c. The components mounted on chassis or mainframe parts are not assigned an assembly designation (e.g. R1, Q1, etc.). Within an assembly, (A1, A2 ----etc.) use assembly designation as prefix to form complete designation (e.g. R1, in A1 assembly is A1R1).

8-72. Additional notes are shown in Figure 8-21.

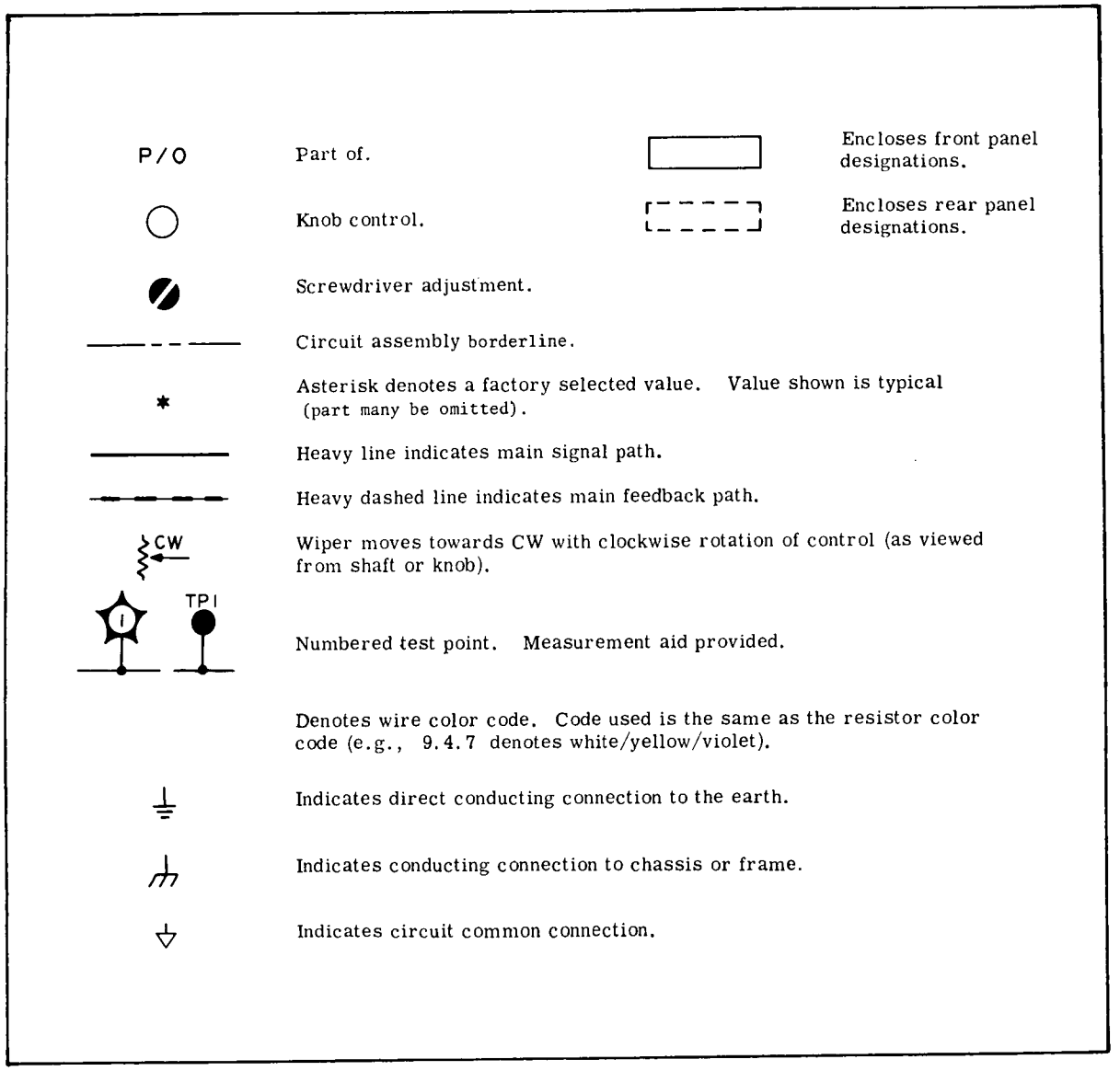
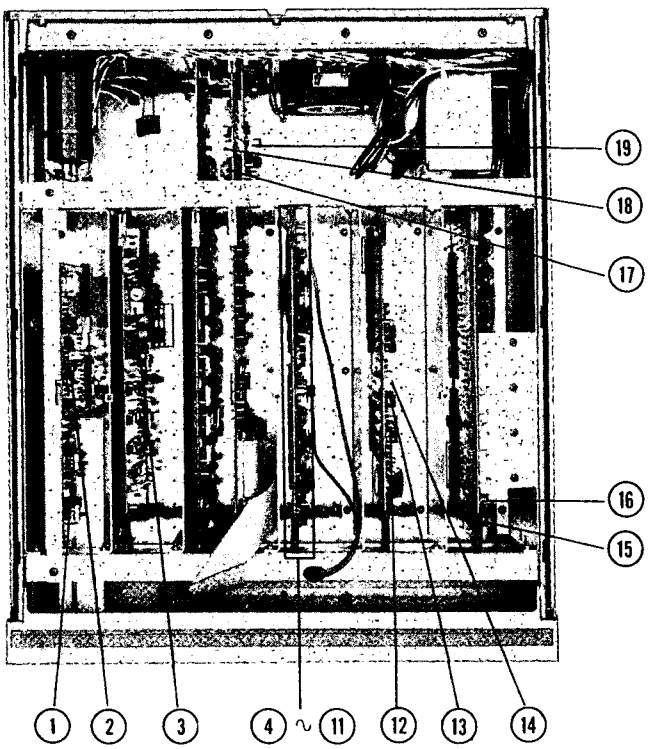
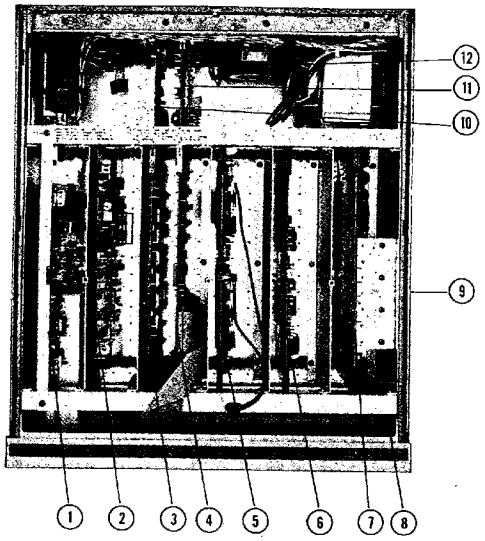


Figure 8-21. Schematic Diagram Notes.



1	A1R5	(SWS R ADJ)
2	A1R24	(OFFSET ADJ)
3	A2R20	(pA GAIN)
4	A5R19	(x10 ZERO)
5	A5R24	(x1 ZERO)
6	A5R31	(x10 GAIN)
7	A5R64	(x10 ZERO)
8	A5R69	(x1 ZERO)
9	A5R76	(x10 GAIN)
10	A5R91	(DA ZERO)
11	A5R94	(DA GAIN)
12	A6R11	(COMP ZERO)
13	A6R12	(dV/dt BUF ZERO)
14	A6R13	(dV/dt ADJ)
15	A7R1	(-15VF)
16	A7R2	(+15VF)
17	A31R4	(ZERO)
18	A31R5	(GAIN)
19	A32R5	(x1/10 ZERO)

Figure 8-22. Adjustment Location.



(1) A1 I-V Converter (HP Part No.: 04140-66501)
(2) A2 A-D Converter (HP Part No.: 04140-66502)
(3) A3 MPU (HP Part No.: 04140-66513)
(4) A4 I/O Control (HP Part No.: 04140-66504)
(5) A5 DAC & Power Amplifiers (HP Part No.: 04140-66505)
(6) A6 Ramp Generator (HP Part No.: 04140-66506)
(7) A7 Power Supply (HP Part No.: 04140-66507)
(8) A8 Display (HP Part No.: 04140-66508)
(9) A9 Mother board (HP Part No.: 04140-66509)
(10) A21 HP-IB Interface (HP Part No.: 04140-66521)
(11) A31 Analog Output Control (HP Part No.: 04140-66531)
(12) A32 Analog Output Amplifier (HP Part No.: 04140-66532)

Figure 8-23. Assembly Location.

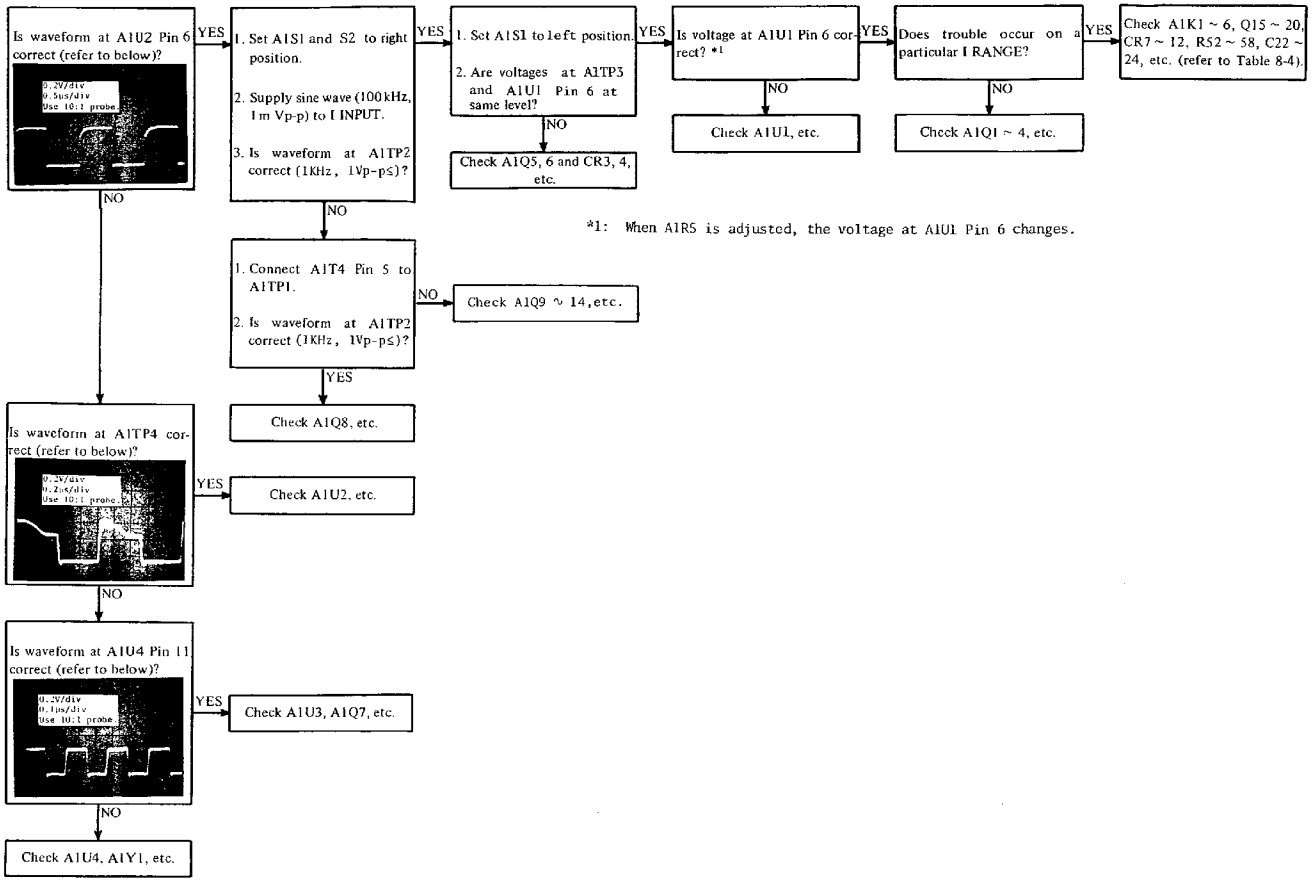


Figure 8-24. A1 I-V Converter Troubleshooting Tree.

High Input Impedance Amplifier

Amplifiers for small current detection require high input impedances, small bias currents as well as low offset voltages. In addition, high gain is required to maintain the low input impedance of the pA-Meter as well as low noise circuitry for stable measurement. The 4140A features such a high input impedance amplifier as shown in Figure A as its current detector. C1 and C2 are the gate capacitances of a dual-junction FET and these two capacitors change differentially to each other with the bias voltage. The capacitance bridge consists of C1 and C2 and center tapped transformer T1 which is driven by a 20mVp-p 500KHz AC Signal. Initial adjustments to T2 are made in the bridge to satisfy the equation below when the input DC bias (Vi) is zero:

$$C1\ V1 + C2\ V2 = 0$$

When Vi is applied, the bridge is unbalanced and generates unbalance voltage Vx which is proportional to input DC bias Vi. Vx is amplified by AC amplifier A1 whose gain is approximately 80dB. This signal is converted to a DC voltage by a 500KHz P.S.D. (phase sensitive detector) and generates DC output voltage Vo through integrator A2. Total gain of this amplifier (Vo/Vi) is more than 100 dB.

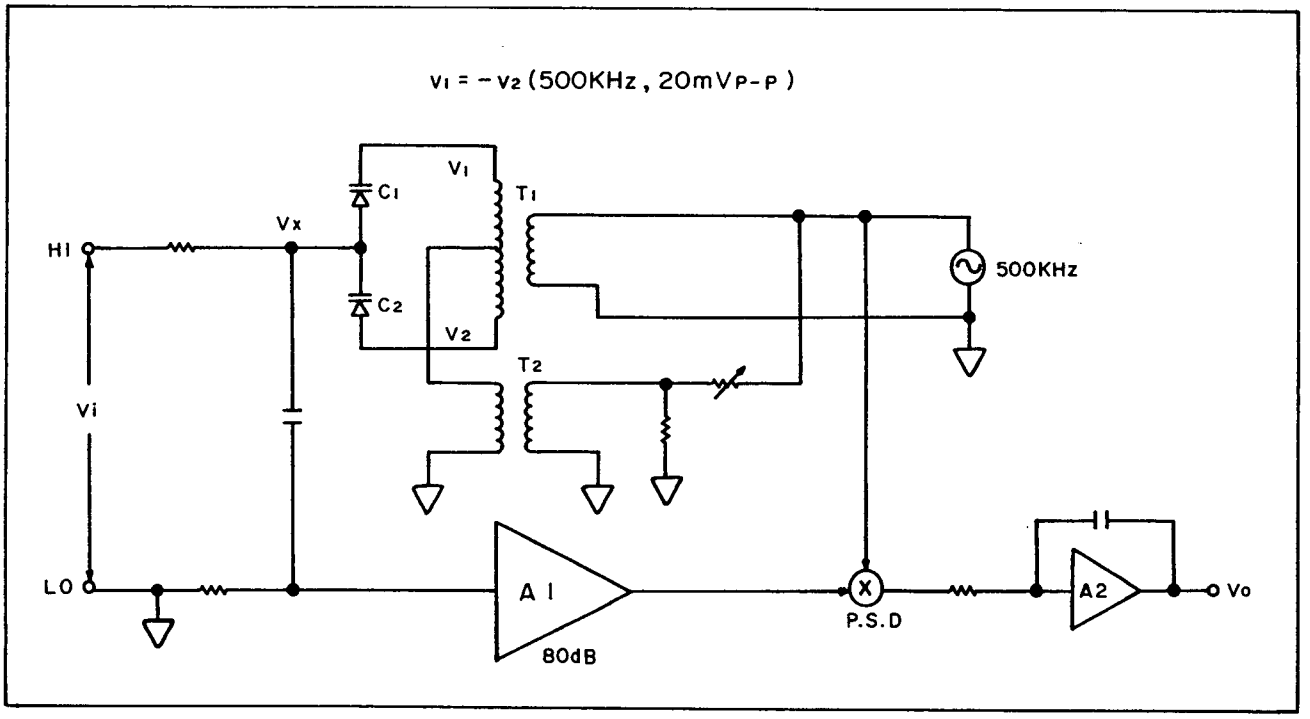


Figure A

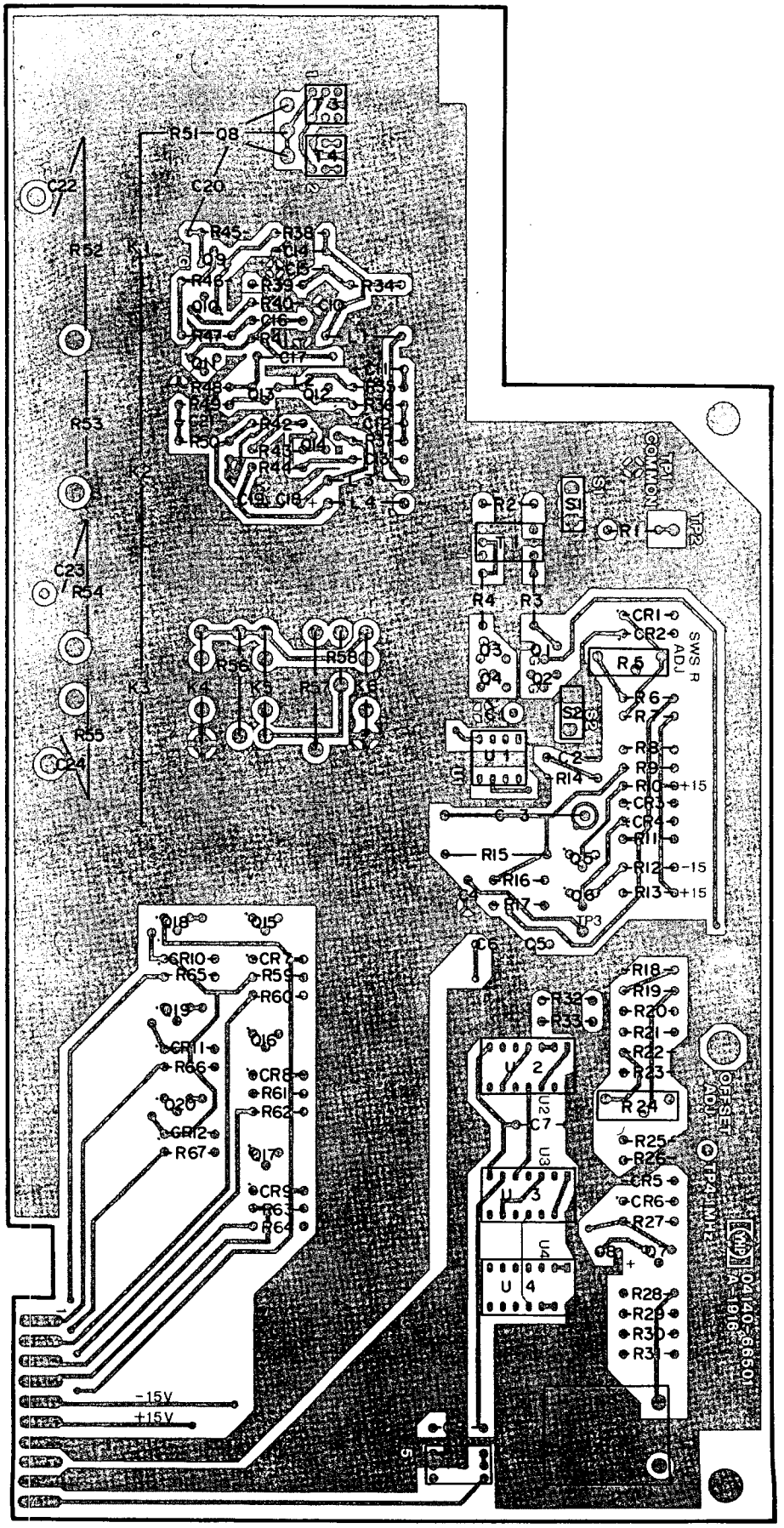


Figure 8-25. A1 I-V Converter Assembly Component Locations.

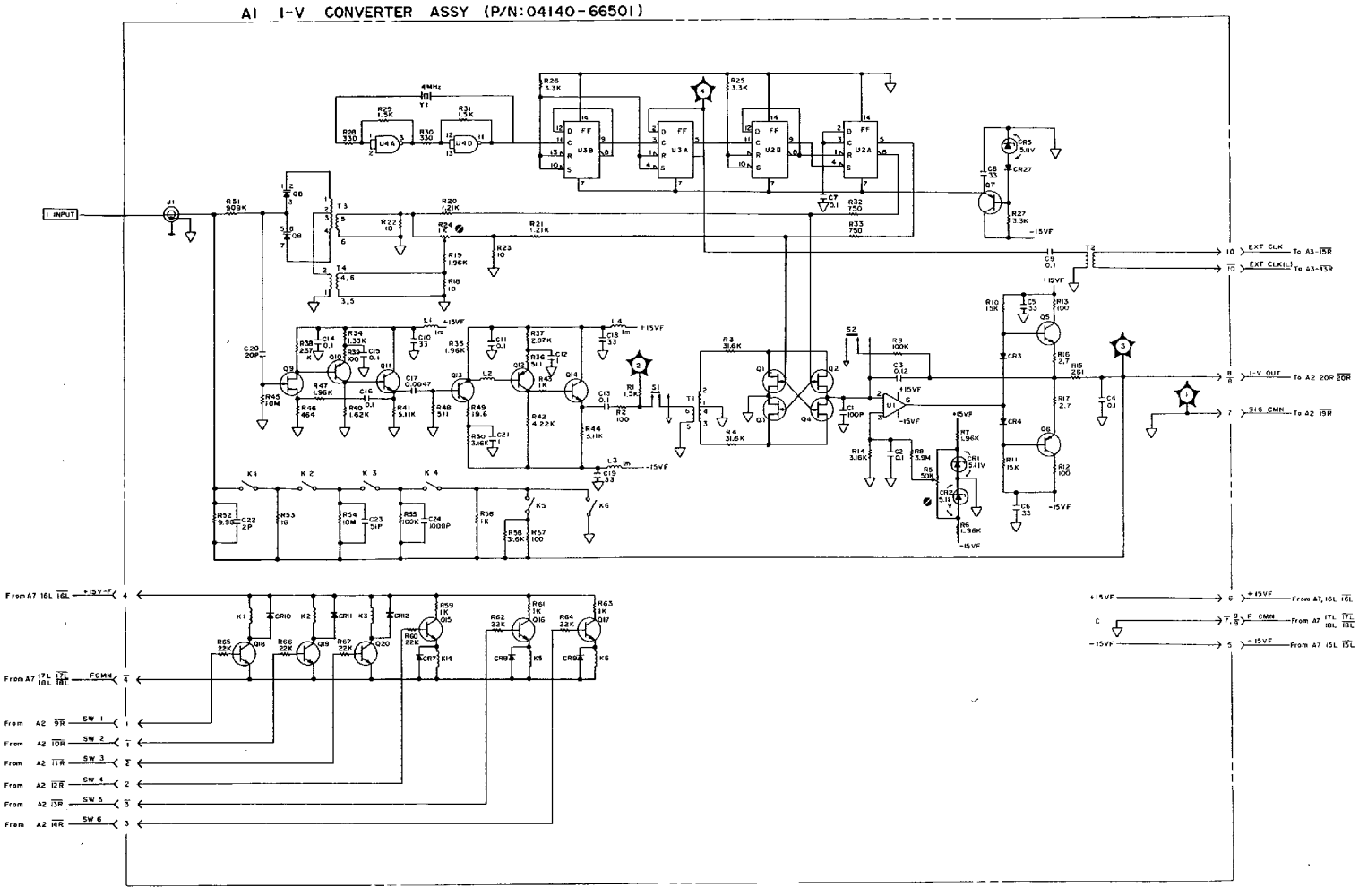


Figure 8-26. A1 I-V Converter Assembly Schematic Diagram.

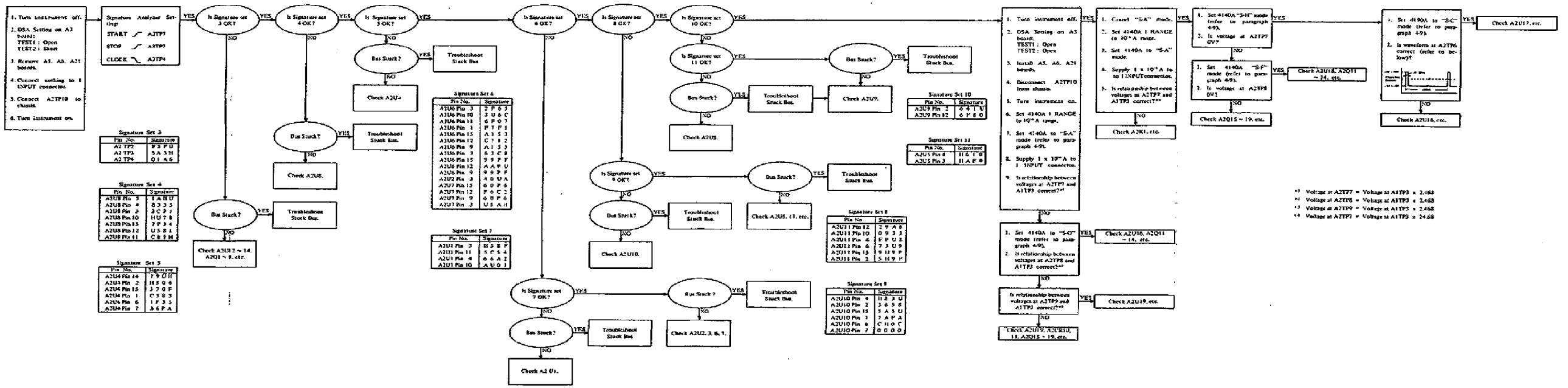


Figure 8-27. A2 A-D Converter Troubleshooting Tree.

I-V Converter
SERVICE SHEET 1
SEE INSIDE

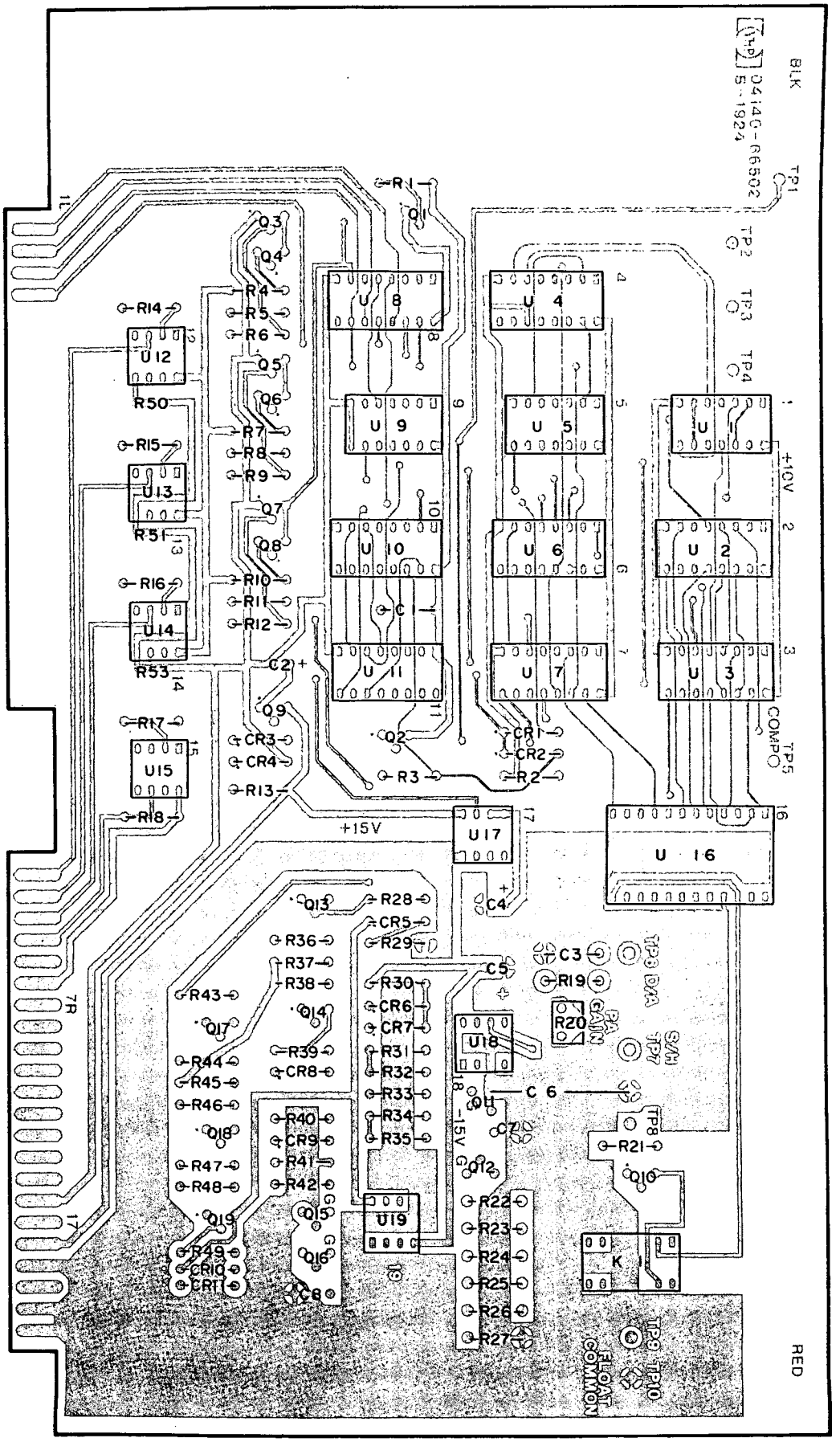


Figure 8-28. A2 A-D Converter Assembly Component Locations.

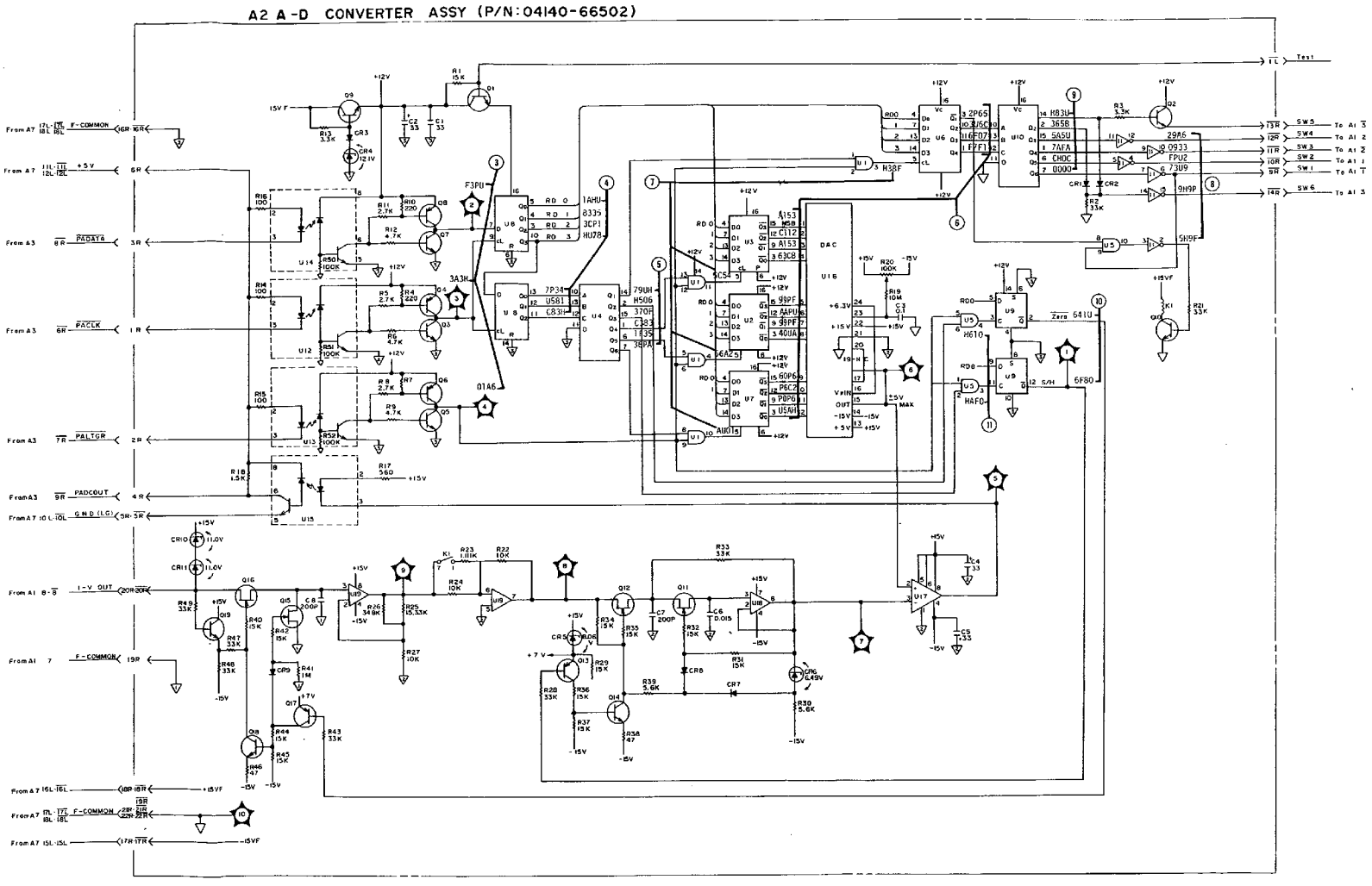


Figure 8-29. A2 A-D Converter Assembly Schematic Diagram.

Figure 8-30. A3 MPU Troubleshooting Tree Flow A.

Figure 8-31. A3 MPU Troubleshooting Tree Flow B.

Section VIII
Figures 8-30 and 8-31

Model 4140A

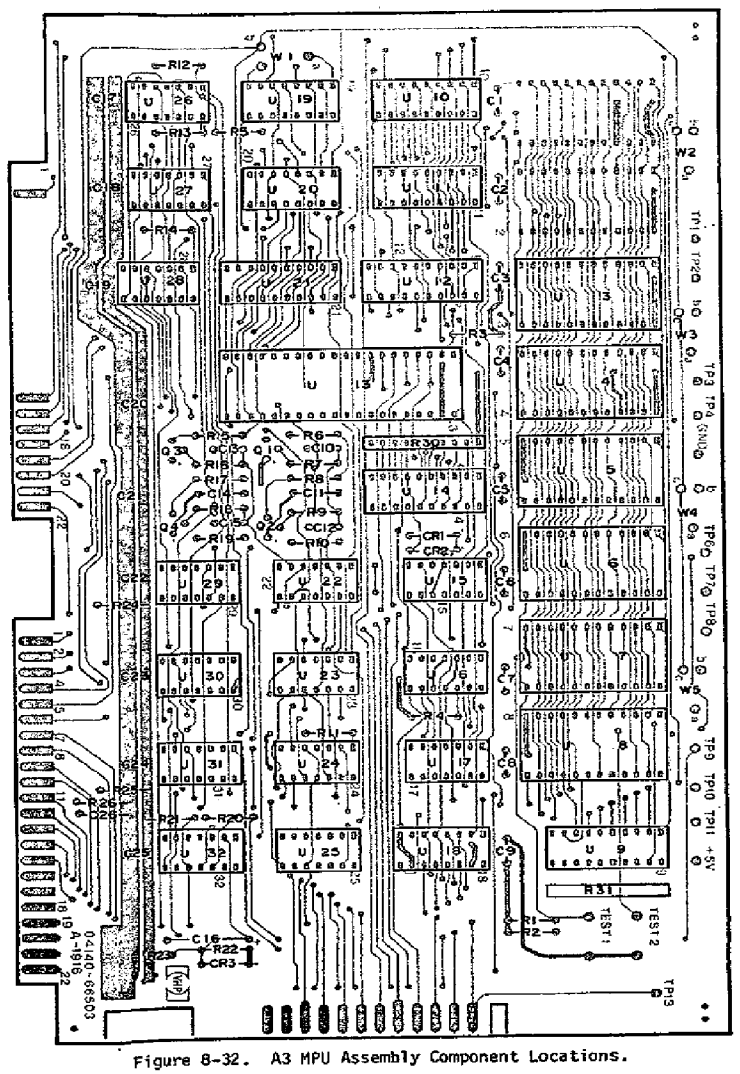


Figure 8-32. A3 MPU Assembly Component Locations.

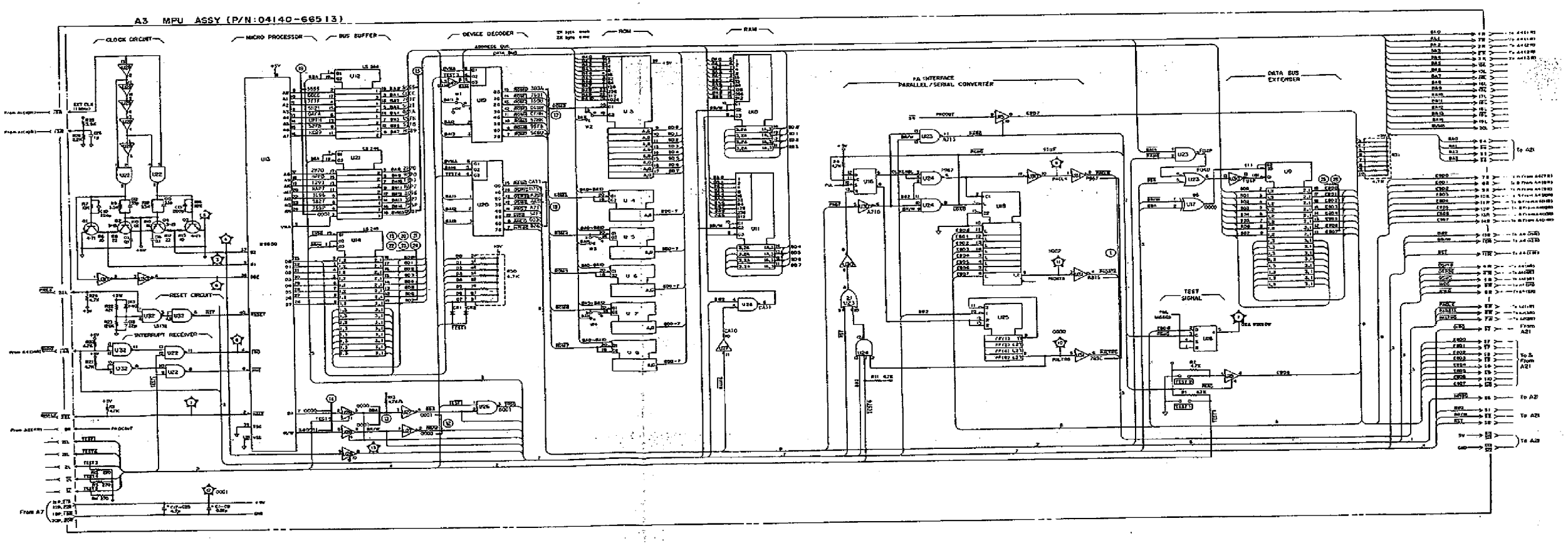


Figure 8-33. A3 MPU Assembly Schematic Diagram.

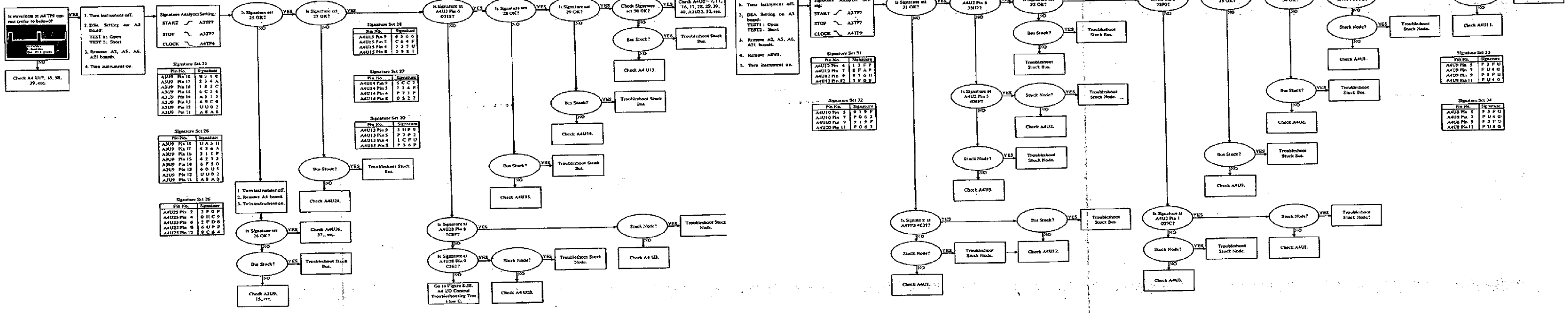


Figure 8-34. A4 I/O Control Troubleshooting Tree Flow A.

Figure 8-35. A4 I/O Control Troubleshooting Tree Flow B.

MPU
SERVICE SHEET 3
SEE INSIDE

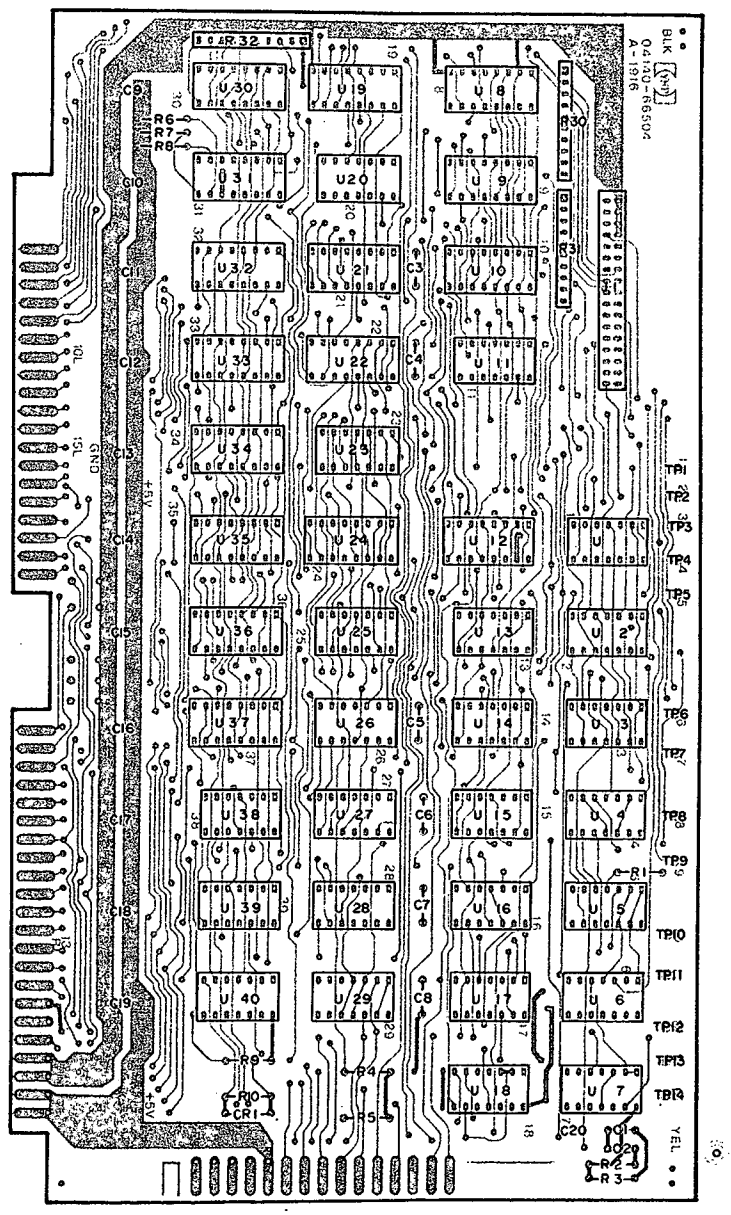


Figure 8-36. A4 I/O Control Assembly Component Locations.

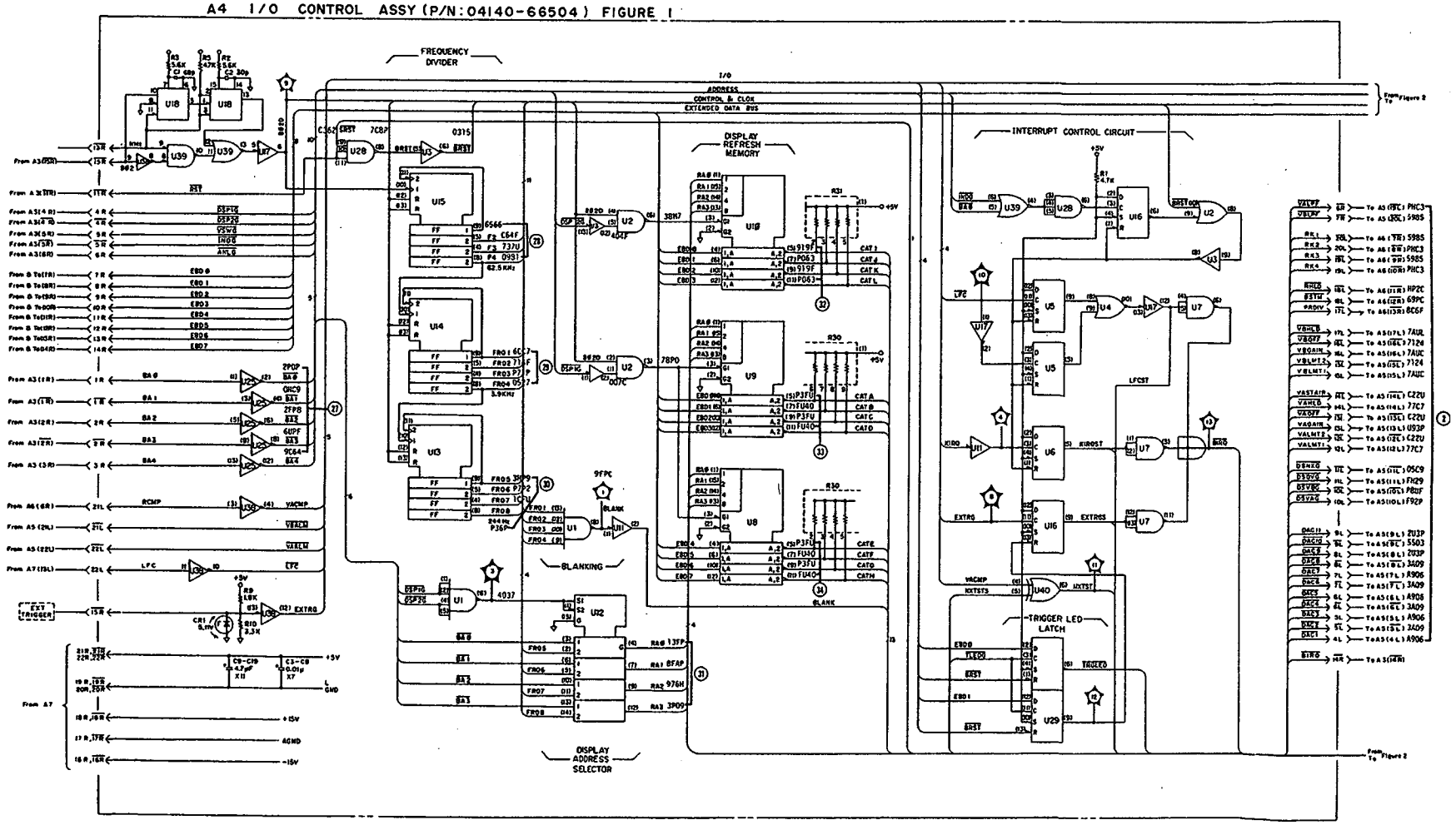


Figure 8-37. A4 I/O Control Assembly Schematic Diagram Figure 1.

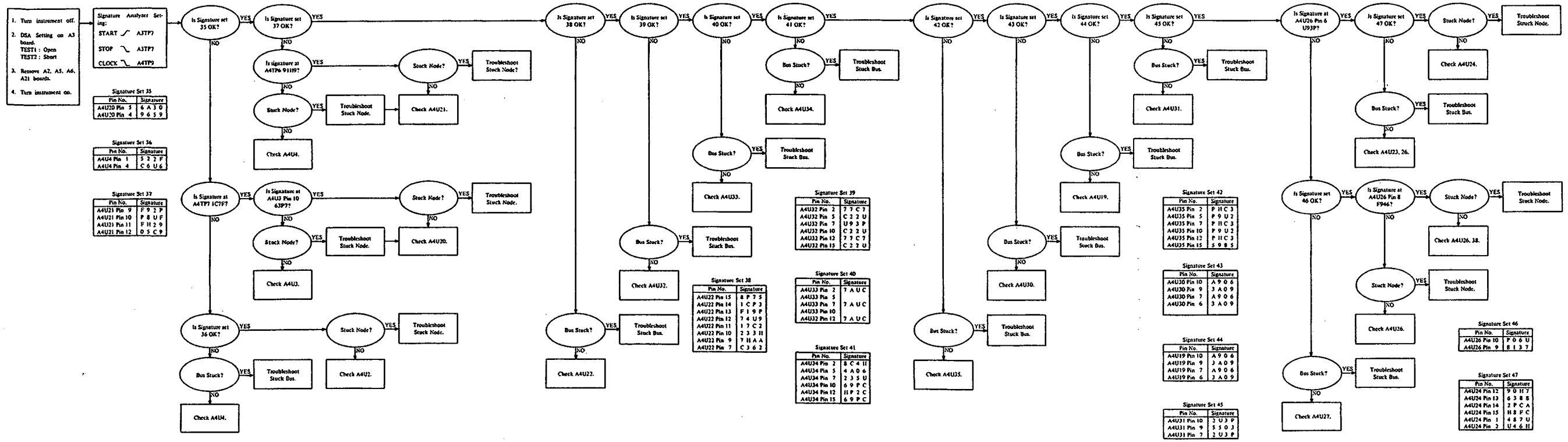


Figure 8-38. A4 I/O Control Troubleshooting Tree Flow C.

I/O Control
SERVICE SHEET 4-1
SEE INSIDE

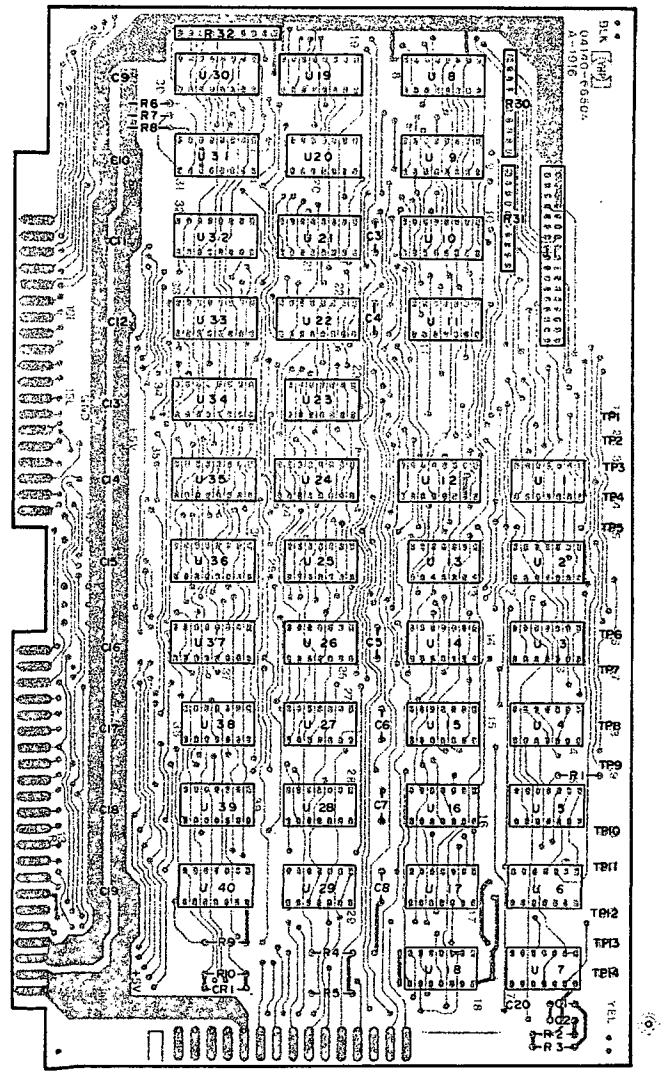


Figure 8-39. A4 I/O Control Assembly Component Locations.

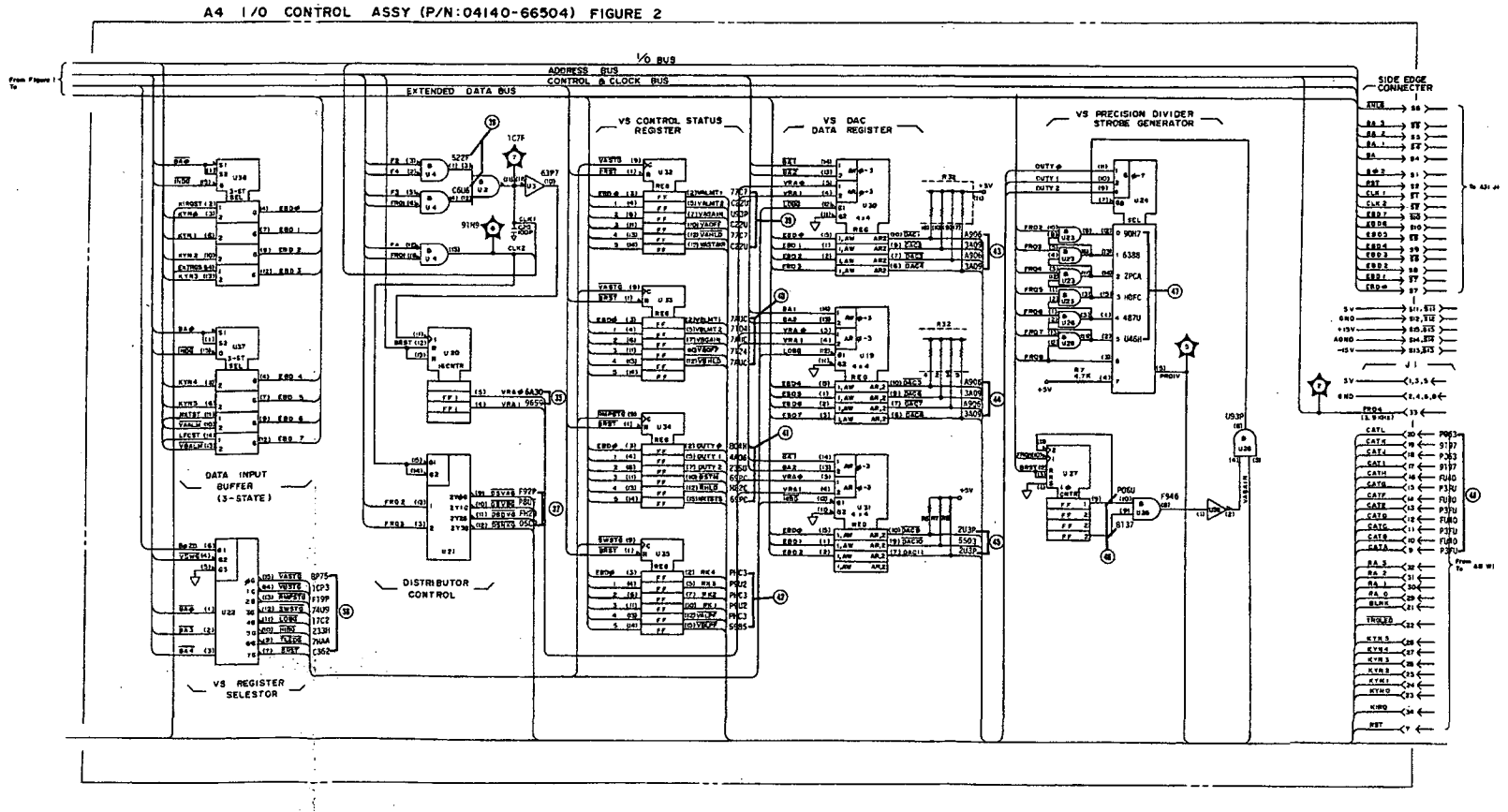


Figure 8-40. A4 I/O Control Assembly Schematic Diagram Figure 2.

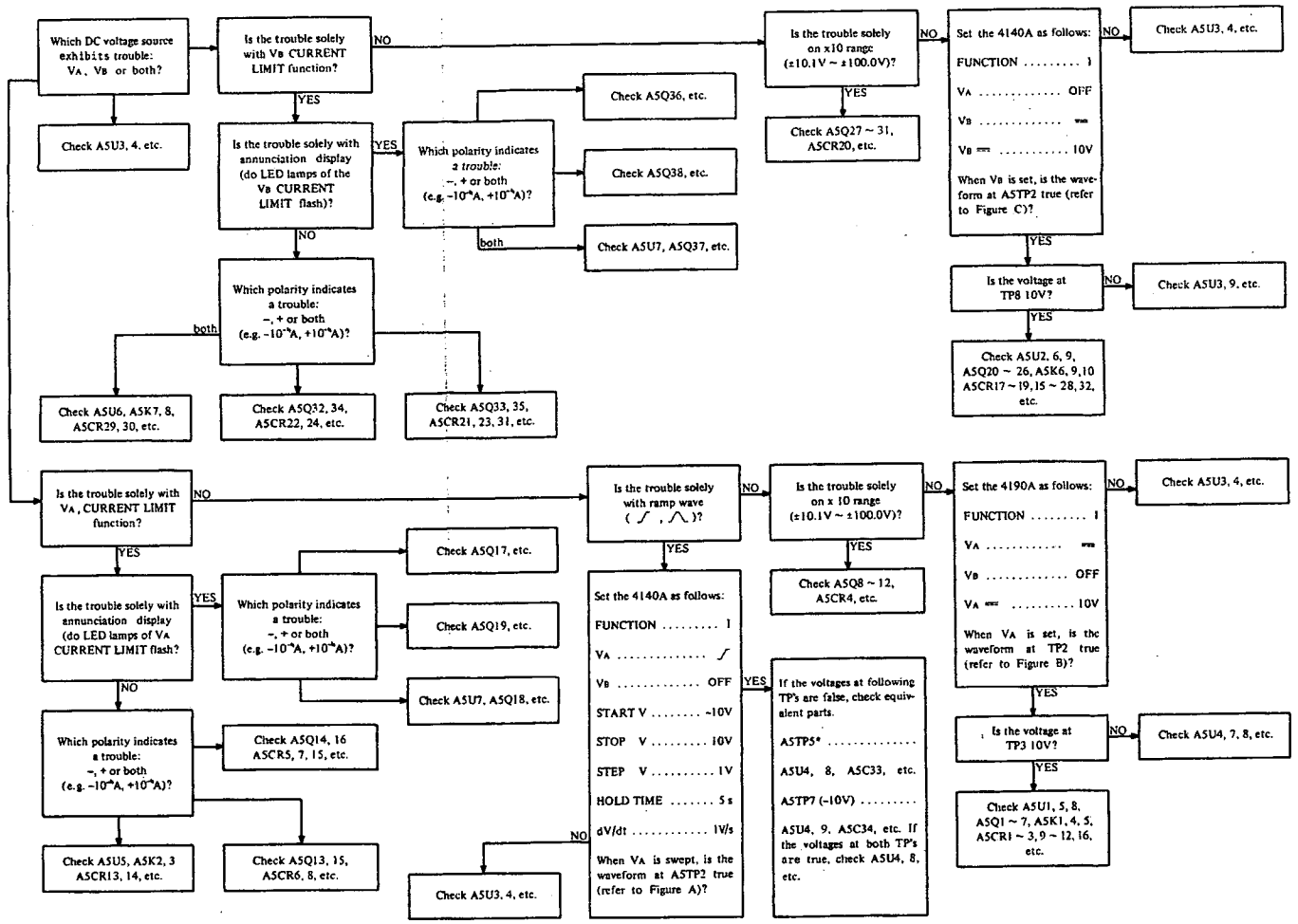


Figure 8-41. A5 VS Output Troubleshooting Tree.

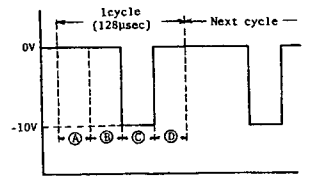


Figure A

*This voltage changes step-by-step from -10V to +10V.

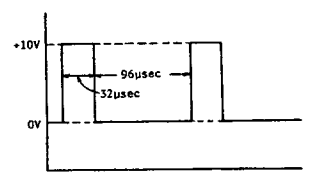


Figure B

Section VIII
Circuit Description

Power Amplifier with Hold Circuit

VA (VB) power amplifier includes a hold circuit to reduce spike noise which is generated when VA (VB) output voltage range is changed. Figure A is a simplified block diagram of the VA (VB) power amplifier with hold circuit and Figure B is a timing chart of this circuit during range changing. For explanation, the VA (VB) OUTPUT voltage is assumed to be changing from +10.00V to +10.1V. Firstly, S1 is set to "X 10" position and S2 is set to ON and DAC OUTPUT voltage is set to +10.00V. Here, A1 and A2 amplifiers collectively work as a voltage follower to bring the VA (VB) OUTPUT voltage to +10.00V. At this time, the voltage at both ends of C (voltage hold capacitor) is +0.4V (+10.00/25). Next, S2 is set to OFF before the DAC OUTPUT voltage is set to +1.01V and S1 is set to its "X 10) position. At this time, the VA (VB) OUTPUT voltage is held at +10.00V by C. S2 is set to OFF after the DAC OUTPUT is stabilized. Total amplification is 10 times and brings the VA (VB) OUTPUT voltage to +10.1V. If this hold circuit is not provided, spike noise as shown by the dotted line in Figure B is generated.

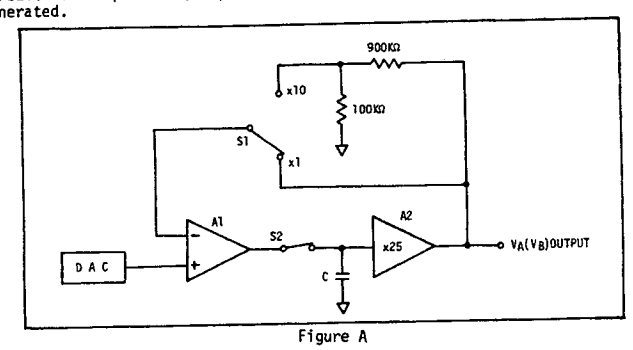


Figure A

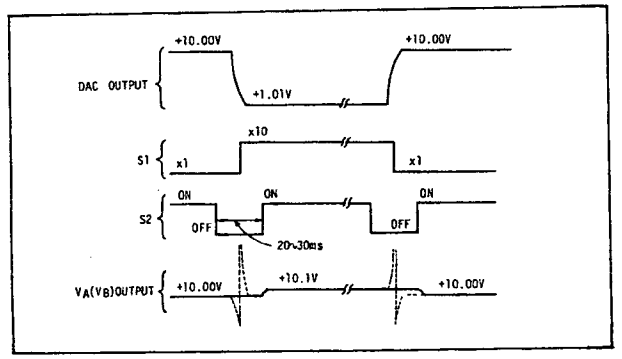


Figure B

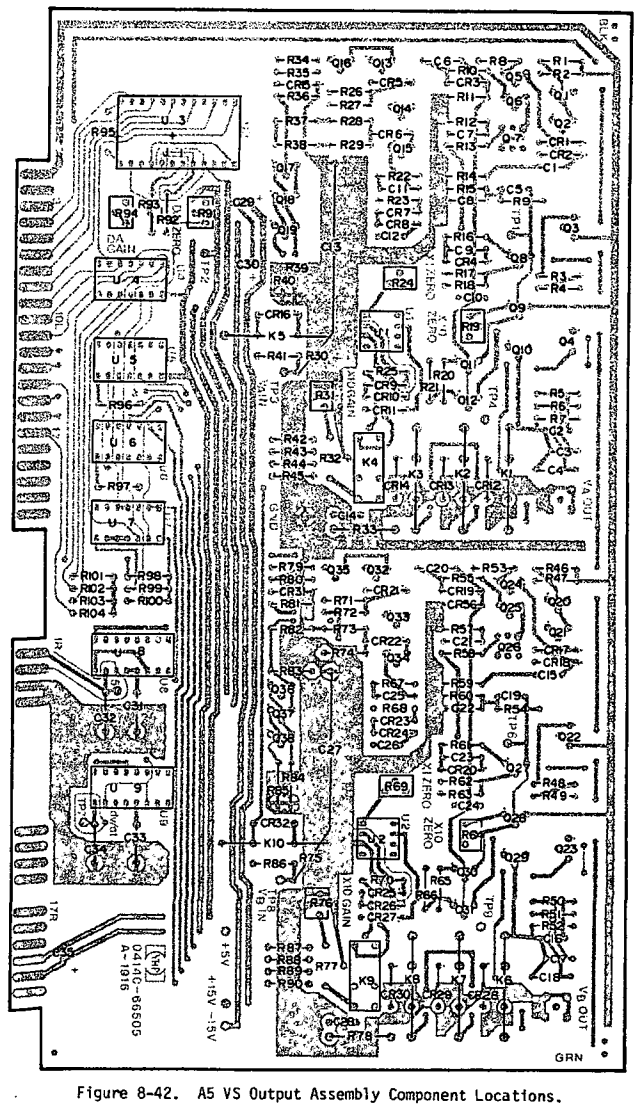


Figure 8-42. A5 VS Output Assembly Component Locations.

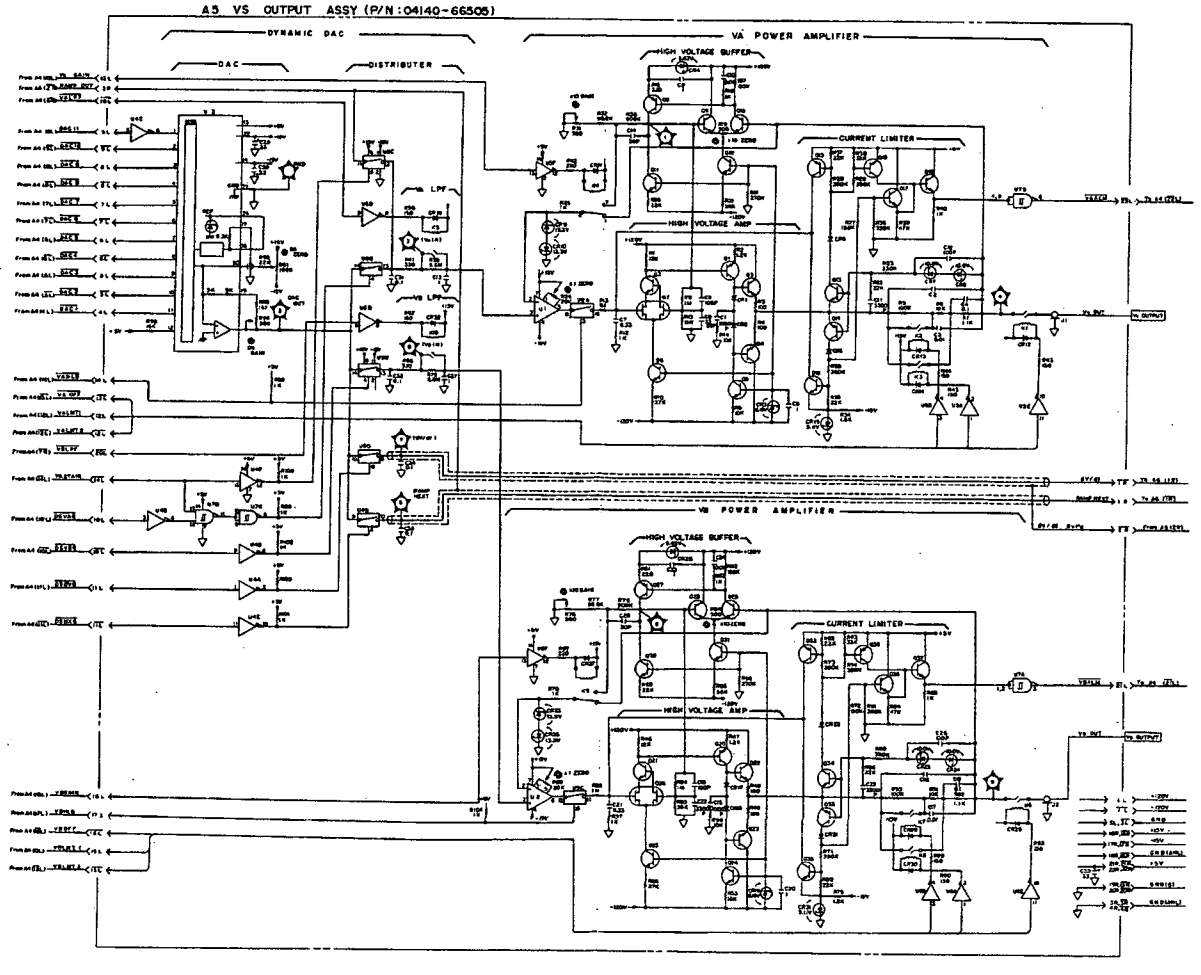


Figure 8-43. A5 VS Output Assembly Schematic Diagram.

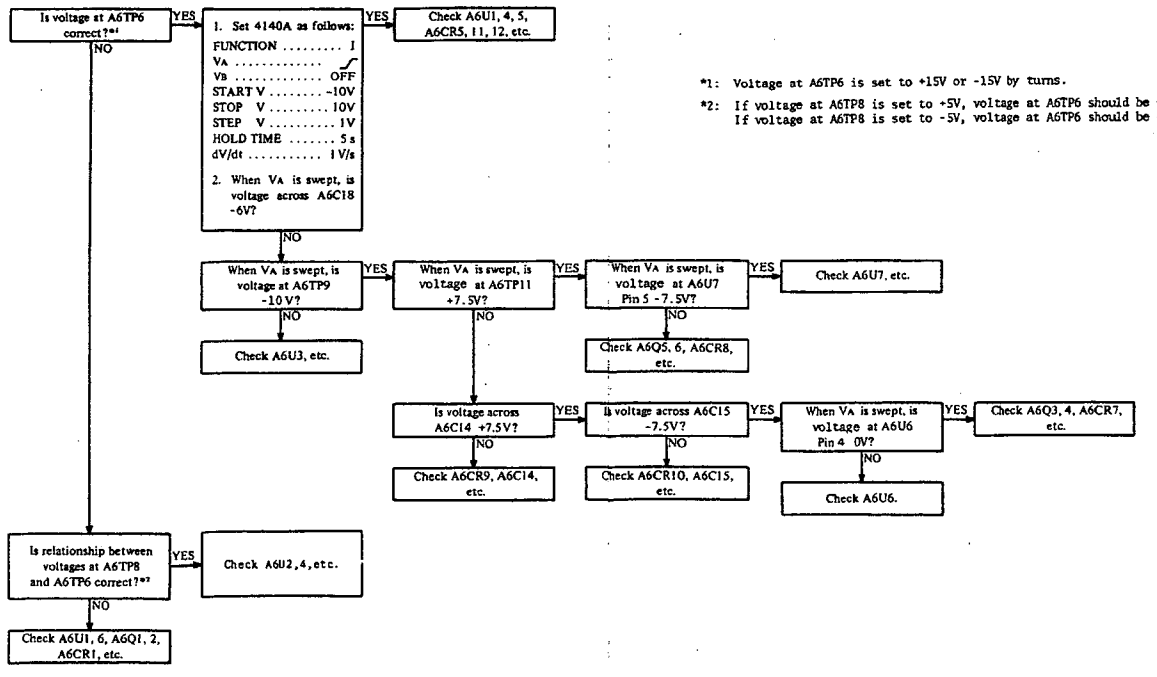


Figure 8-44. A6 Ramp Generator Troubleshooting Tree.

*1: Voltage at A6TP6 is set to +15V or -15V by turns.

*2: If voltage at A6TP8 is set to +5V, voltage at A6TP6 should be +15V.
If voltage at A6TP8 is set to -5V, voltage at A6TP6 should be -15V.

VS Output
SERVICE SHEET 5
SEE INSIDE

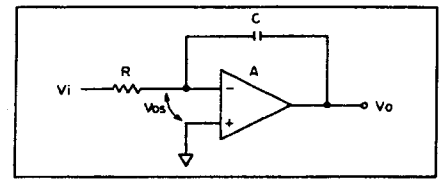


Figure A

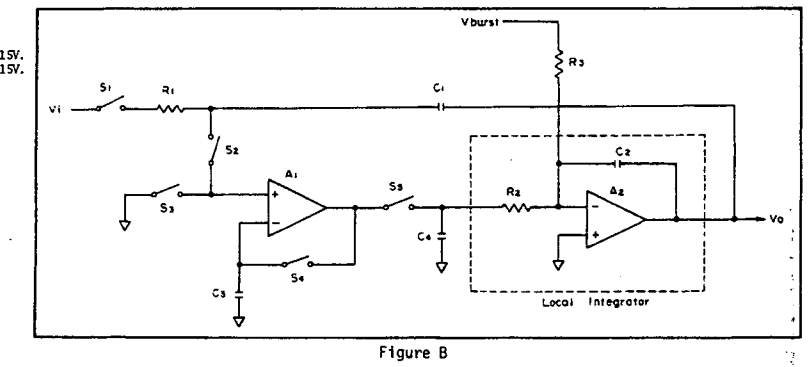


Figure B

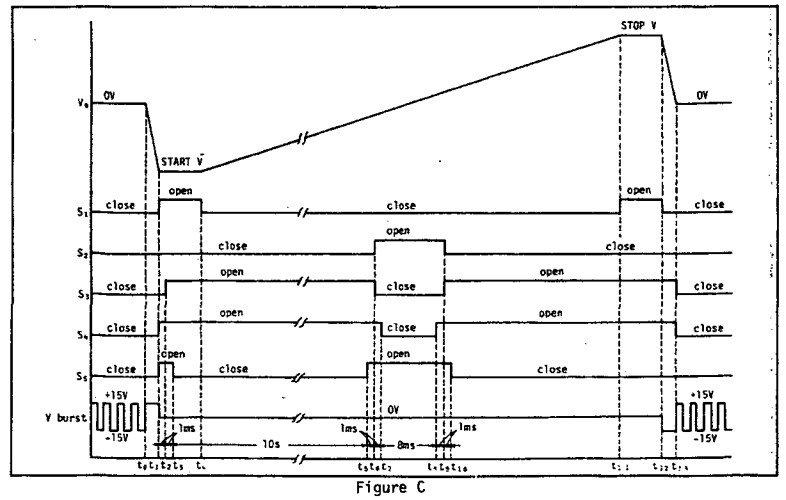


Figure C

Auto Offset voltage Compensated Integrator

A block diagram of a typical integrator circuit is given as Figure A. If this integrator does ideal integration, the ramp rate of output voltage is:

$$\frac{dVo}{dt} = -\frac{Vi}{CR}$$

But an actual integrator includes some errors such as:

$$\frac{dVo}{dt} = -\frac{Vi}{CR}\left(1 - \frac{Vos}{Vi} + \frac{Vo}{AVi}\right)$$

Where Vos: Offset voltage of amplifier

A: Gain of amplifier

Therefore, the 4140A, without halting the ramp, incorporates an auto offset voltage compensated integrator to minimize offset error as shown in Figure B. Figure C is the timing chart for this circuit:

t1: All switches are closed and the A1 amplifier output voltage, which is generated by the offset voltage, is stored in C3.

t1~t4: S1 is opened and Vo is held to START V. S3 and S4 are opened and S2 and S1 are still closed.

t4,t5: S1 is closed and ramp wave Vo is generated. Ramp rate depends on the values of R1. Offset voltage error is compensated by the charge voltage stored in C3.

t5~t10: S5 is opened. A1 amplifier output voltage is held in C4 and a ramp wave is generated by local integrator using voltage VO (during this period).

t6: S2 is opened and S3 is closed.

t7~t8: S4 is closed. A1 amplifier output voltage, which is generated by offset voltage, is stored in C3 during this period.

t8: S4 is opened.

t9: S2 is closed and S3 is opened.

t10: S5 is opened. The integrator is returned to its normal ramp wave generating mode (t4, t5).

t10,t11: The integrator generates a ramp wave and repeats the auto zero mode (t5~t10) every ten seconds.

t11,t12: S1 is opened and Vo is held at STOP V.

t13: All switches are closed.

Additionally, A1 and A2 maintain the main loop gain at an extremely high level which, consequently, contributes to minimize the nonlinearity of the ramp wave.

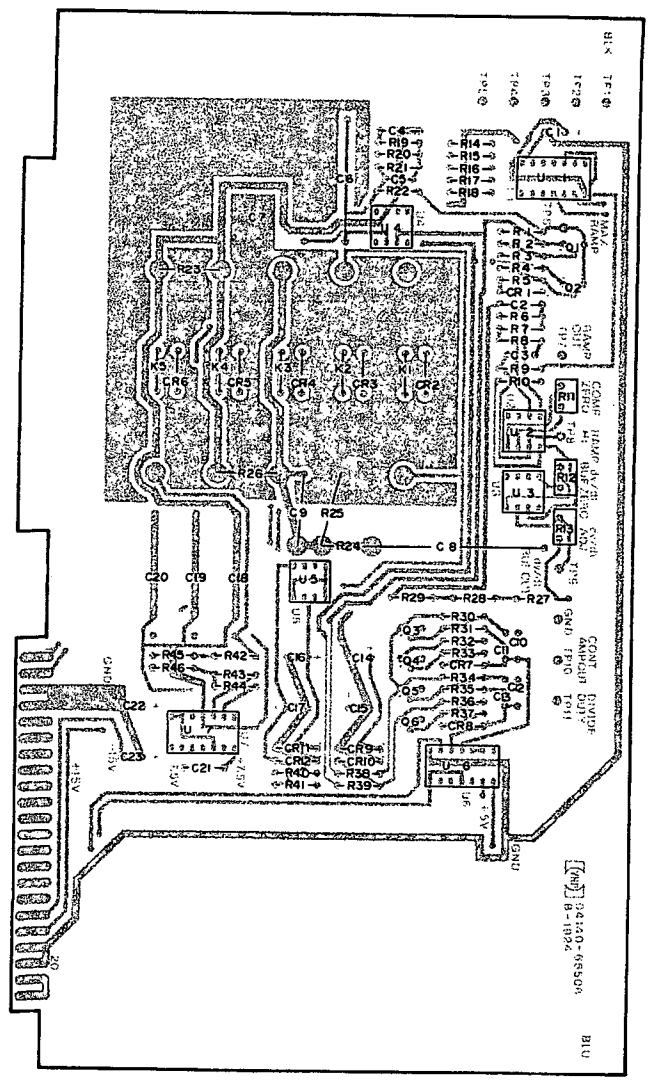


Figure 8-45. A6 Ramp Generator Assembly Component Locations.

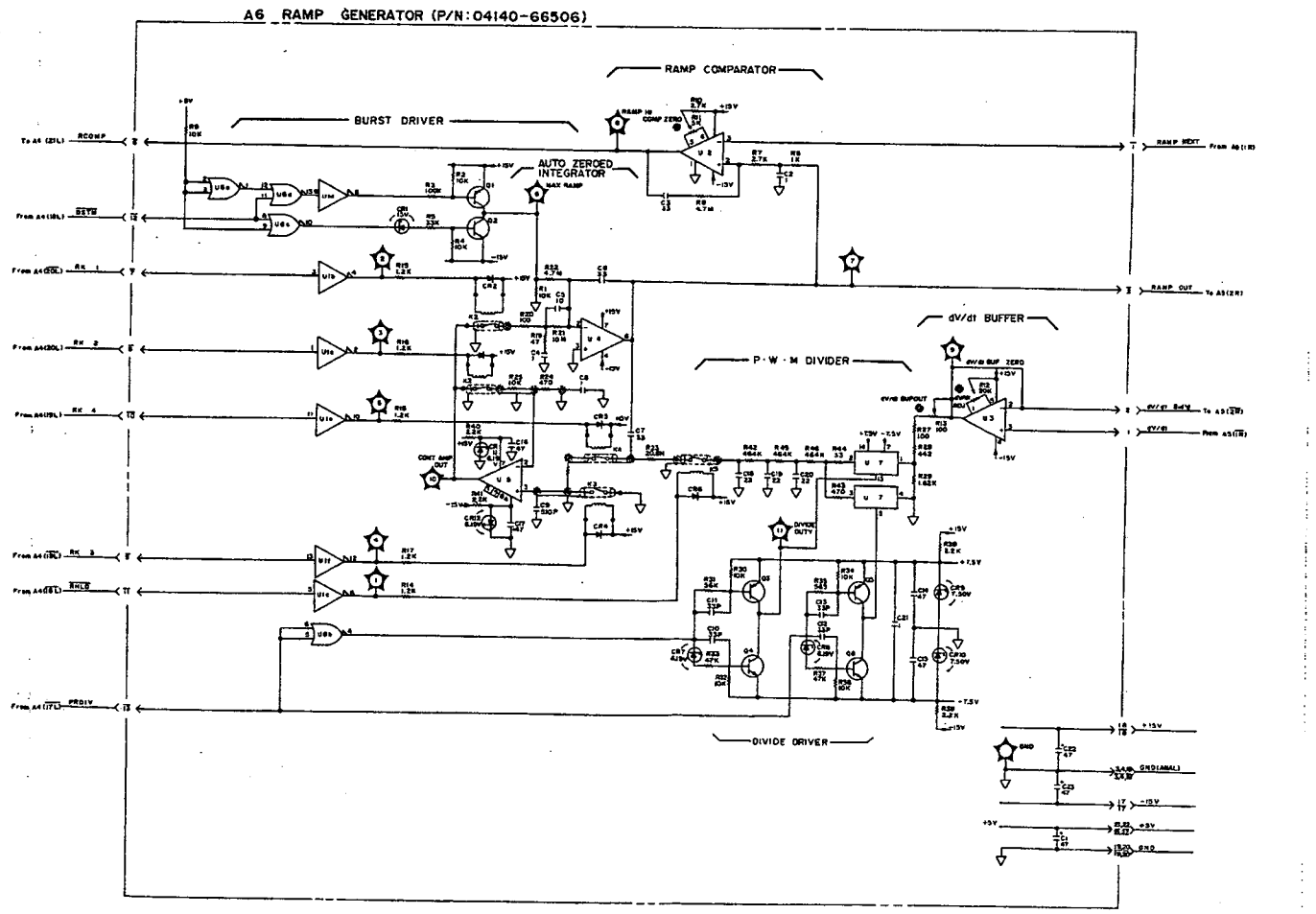
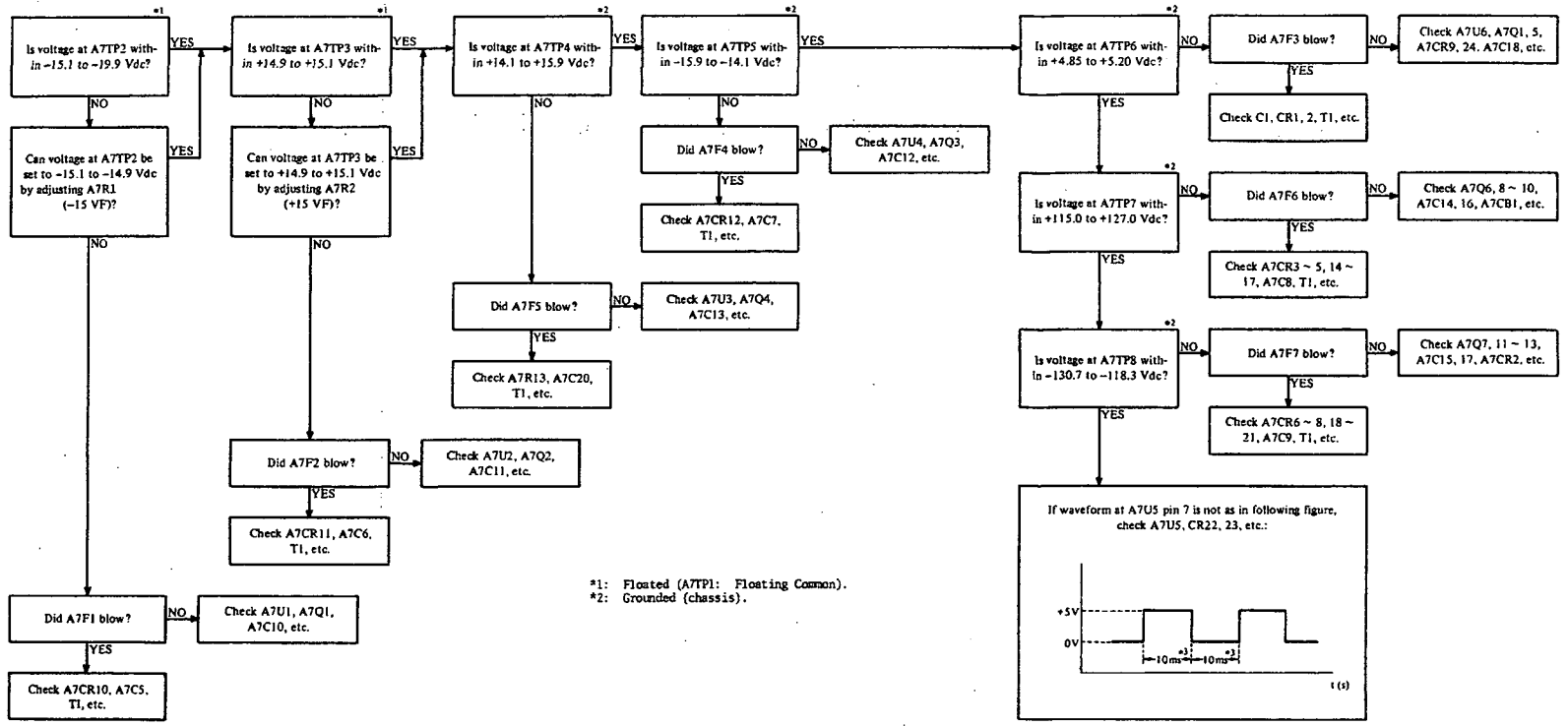


Figure 8-46. A6 Ramp Generator Assembly Schematic Diaagram.



*1: Floated (A7TP1: Floating Common).
*2: Grounded (chassis).

*3: at the 50Hz line frequency (8.3ms at the 60Hz).

Figure 8-47. A7 DC Volatage Supply Troubleshooting Tree.

Ramp Generator
SERVICE SHEET 6
SEE INSIDE

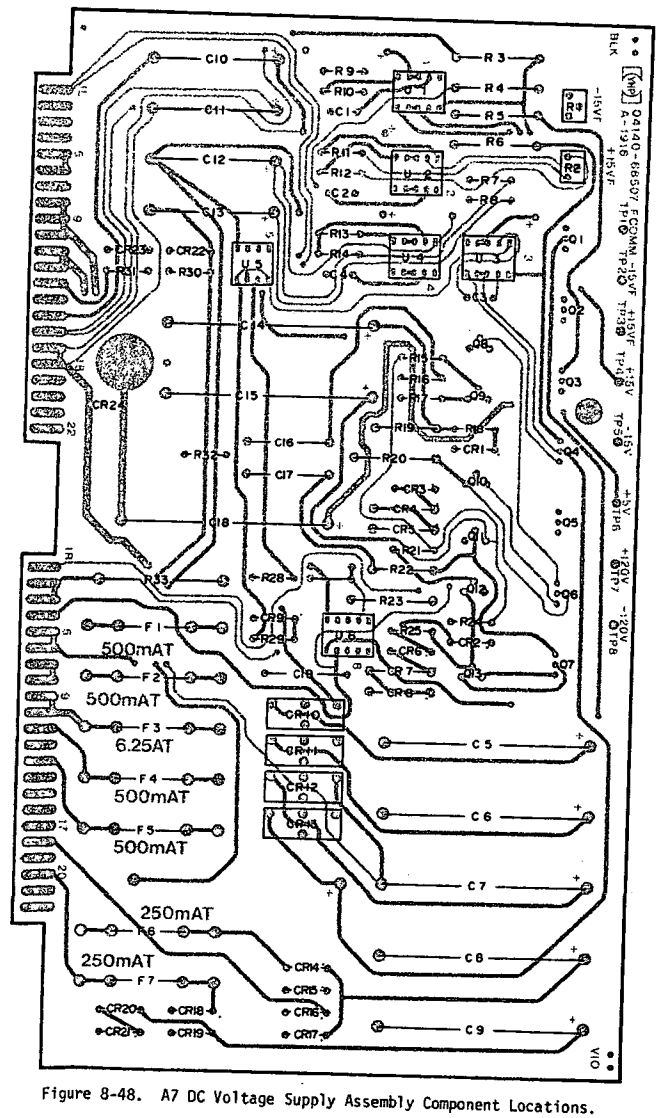


Figure 8-48. A7 DC Voltage Supply Assembly Component Locations.

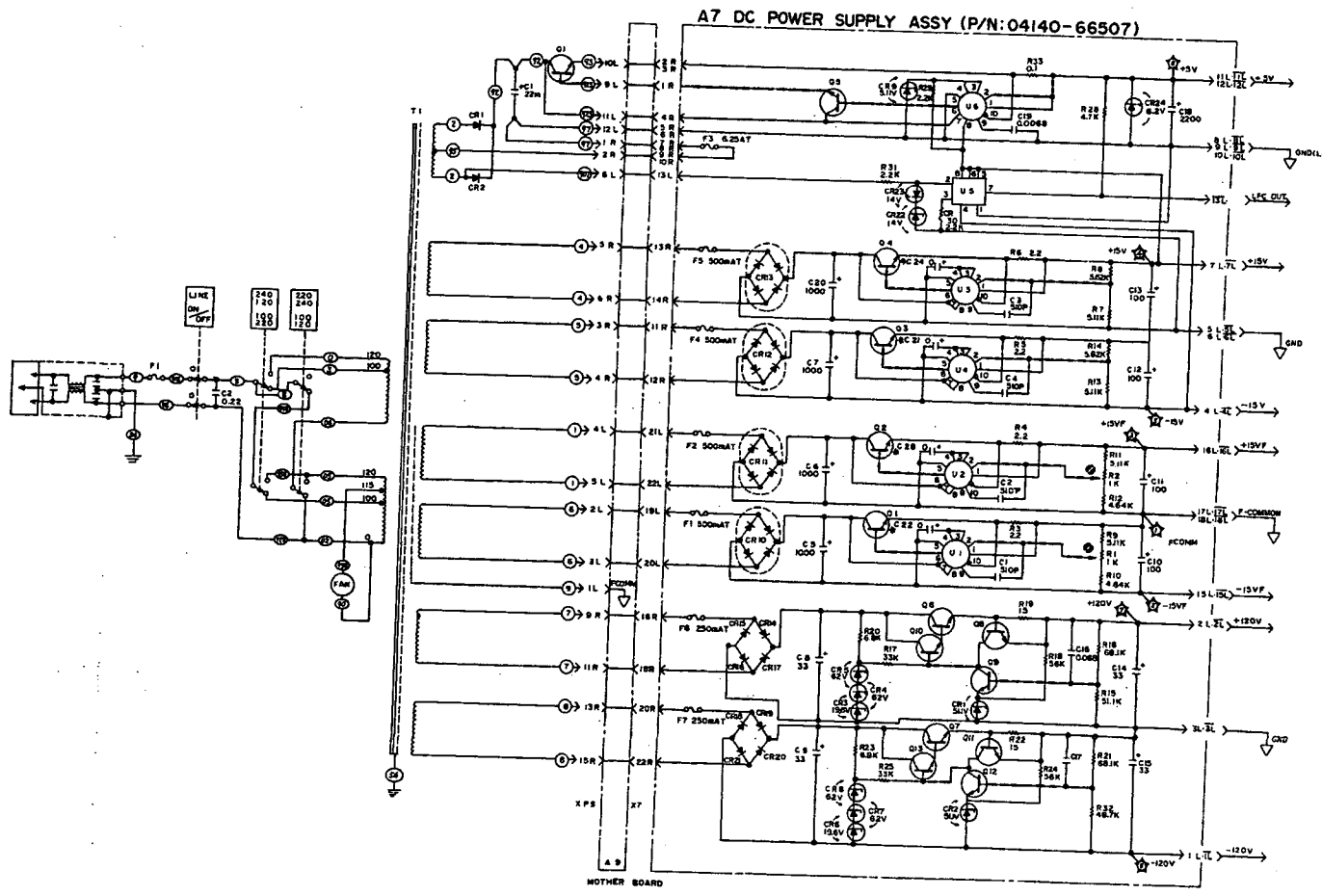


Figure 8-49. A7 DC Voltage Supply Assembly Schematic Diagram.

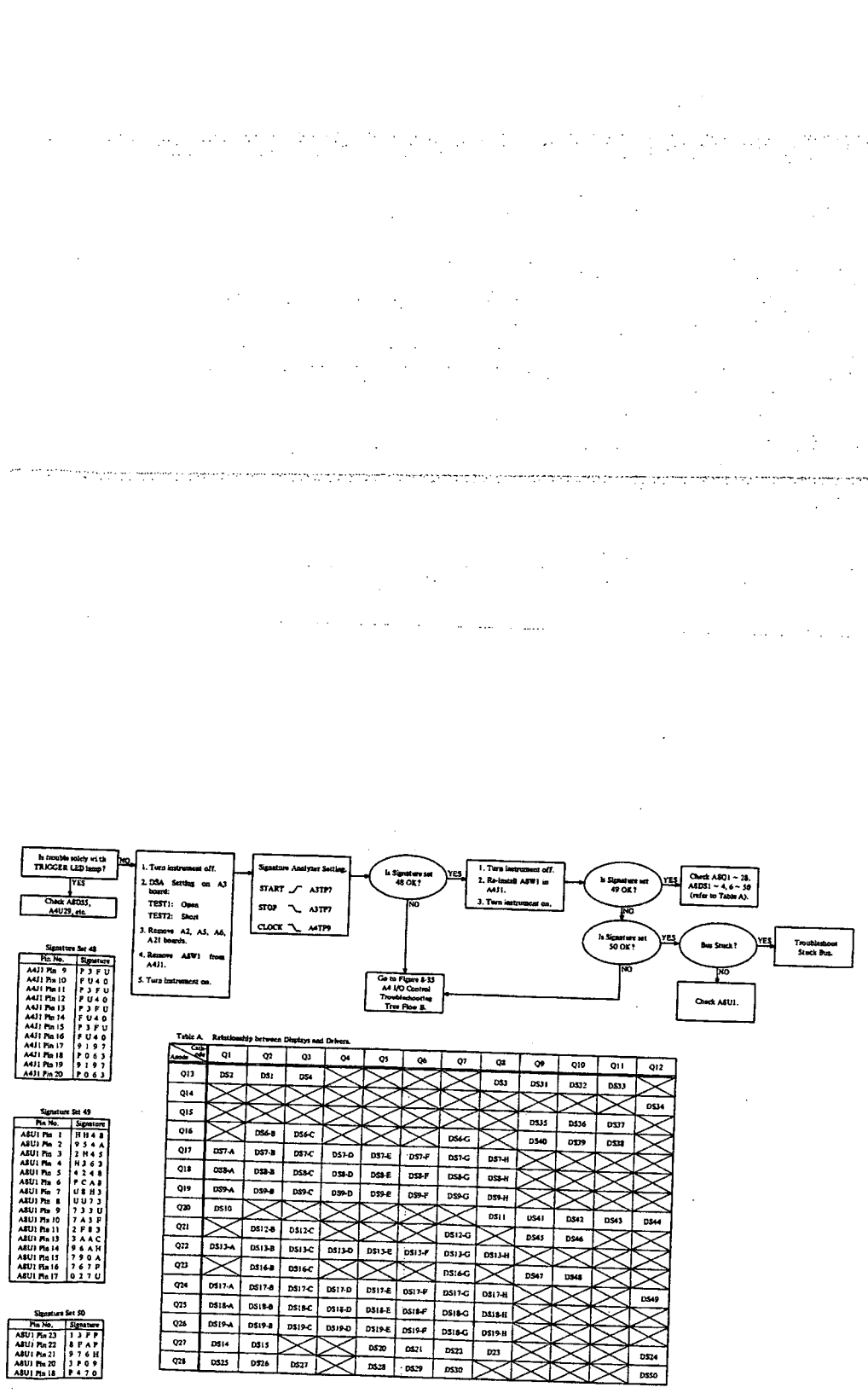


Table A. Relationship between Displays and Drivers.

Anode / Cathode	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Q13	DS2	DS1	DS6					DS3	DS31	DS32	DS33	
Q14												DS34
Q15												
Q16									DS35	DS36	DS37	
Q17	DS7-A	DS7-B	DS7-C	DS7-D	DS7-E	DS7-F	DS7-G	DS7-H	DS40	DS29	DS28	
Q18	DS8-A	DS8-B	DS8-C	DS8-D	DS8-E	DS8-F	DS8-G	DS8-H				
Q19	DS9-A	DS9-B	DS9-C	DS9-D	DS9-E	DS9-F	DS9-G	DS9-H				
Q20	DS10							DS11	DS41	DS42	DS43	DS44
Q21		DS12-B	DS12-C				DS12-G		DS45	DS46		
Q22	DS13-A	DS13-B	DS13-C	DS13-D	DS13-E	DS13-F	DS13-G	DS13-H				
Q23		DS16-B	DS16-C				DS16-G		DS47	DS48		
Q24	DS17-A	DS17-B	DS17-C	DS17-D	DS17-E	DS17-F	DS17-G	DS17-H				DS49
Q25	DS18-A	DS18-B	DS18-C	DS18-D	DS18-E	DS18-F	DS18-G	DS18-H				
Q26	DS19-A	DS19-B	DS19-C	DS19-D	DS19-E	DS19-F	DS18-G	DS19-H				
Q27	DS14	DS15			DS20	DS21	DS22	D23				DS24
Q28	DS25	DS26	DS27		DS28	DS29	DS30					DS50

Figure 8-50. A8 Key & Display Troubleshooting Tree Flow A.

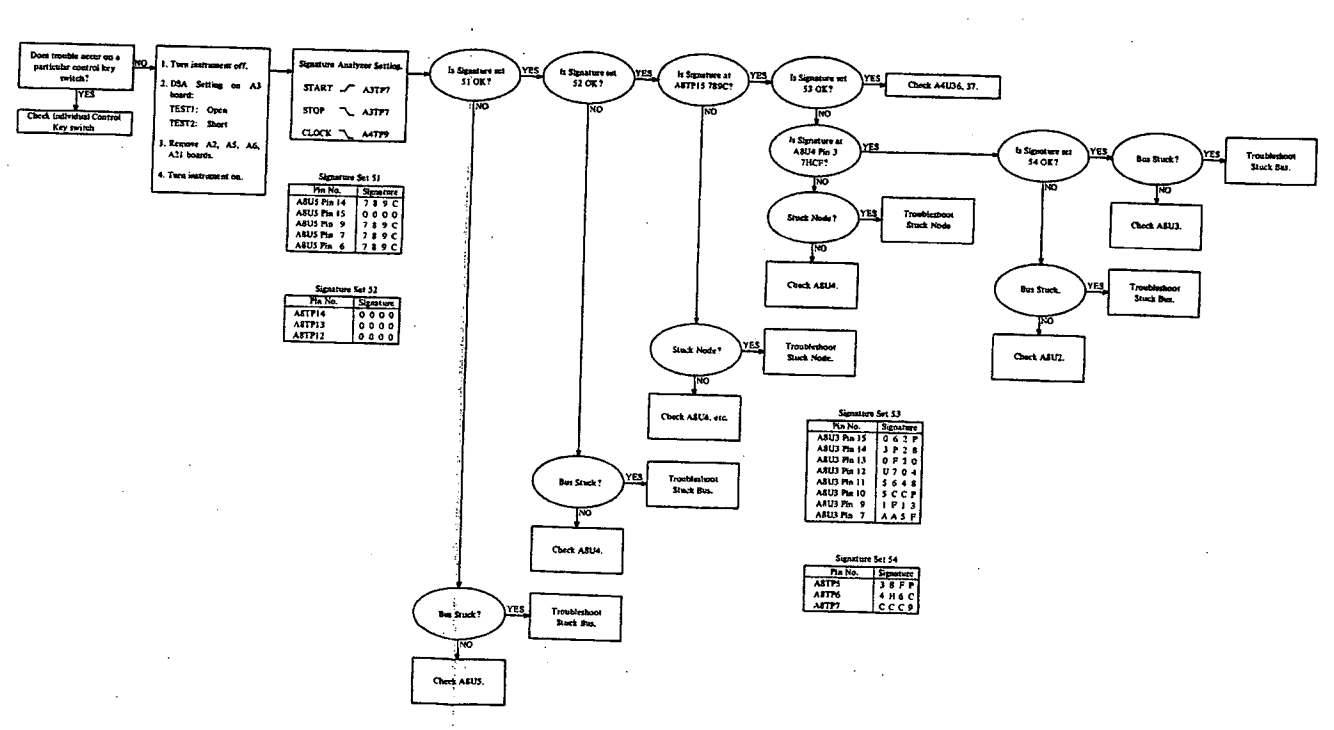


Figure 8-51. A8 Key & Display Troubleshooting Tree Flow B.

DC Power Supply
SERVICE SHEET 7
SEE INSIDE

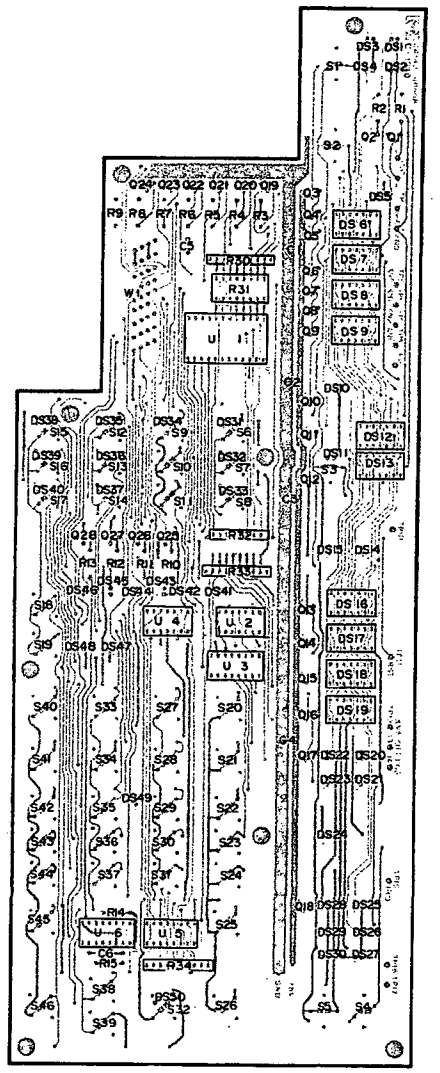


Figure 8-52. A8 Key & Display Assembly Component Locations.

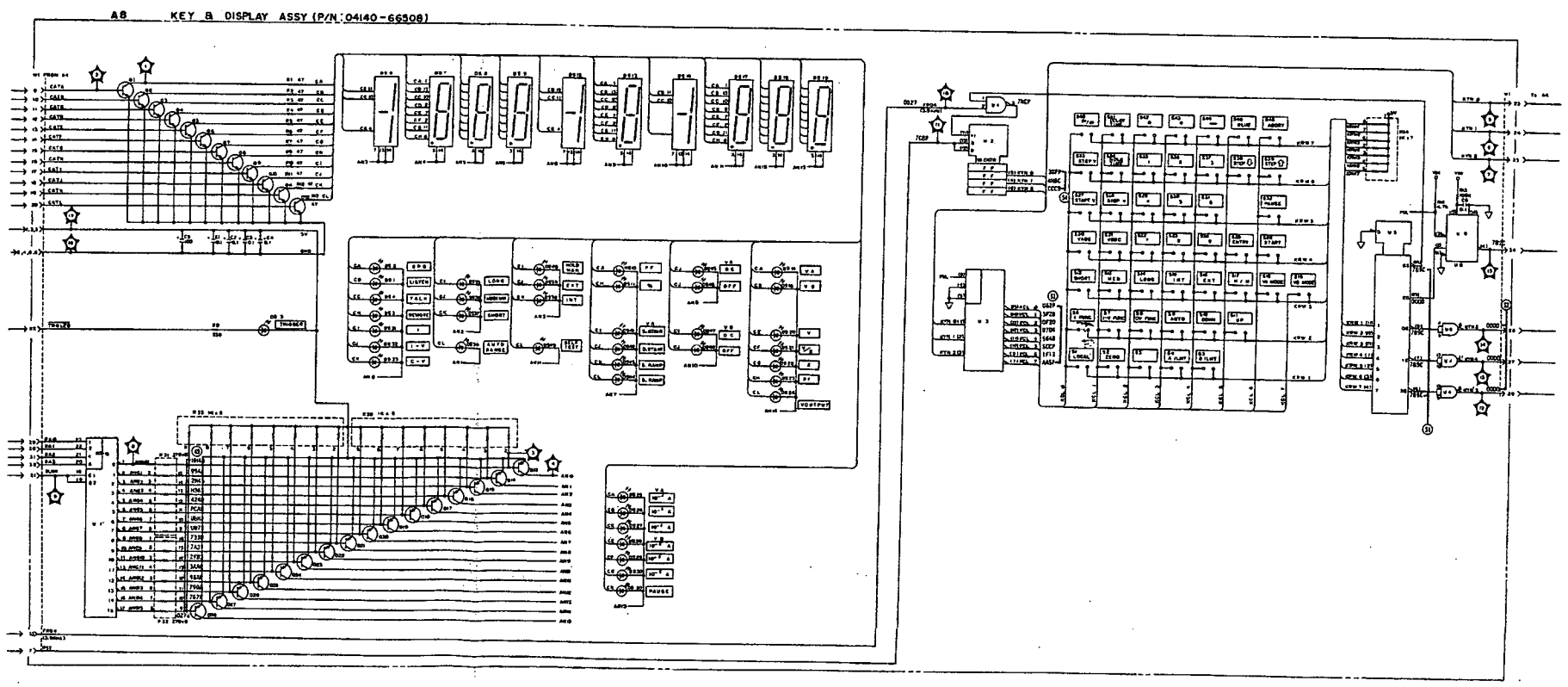


Figure 8-53. A8 Key & Display Assembly Schematic Diagram.

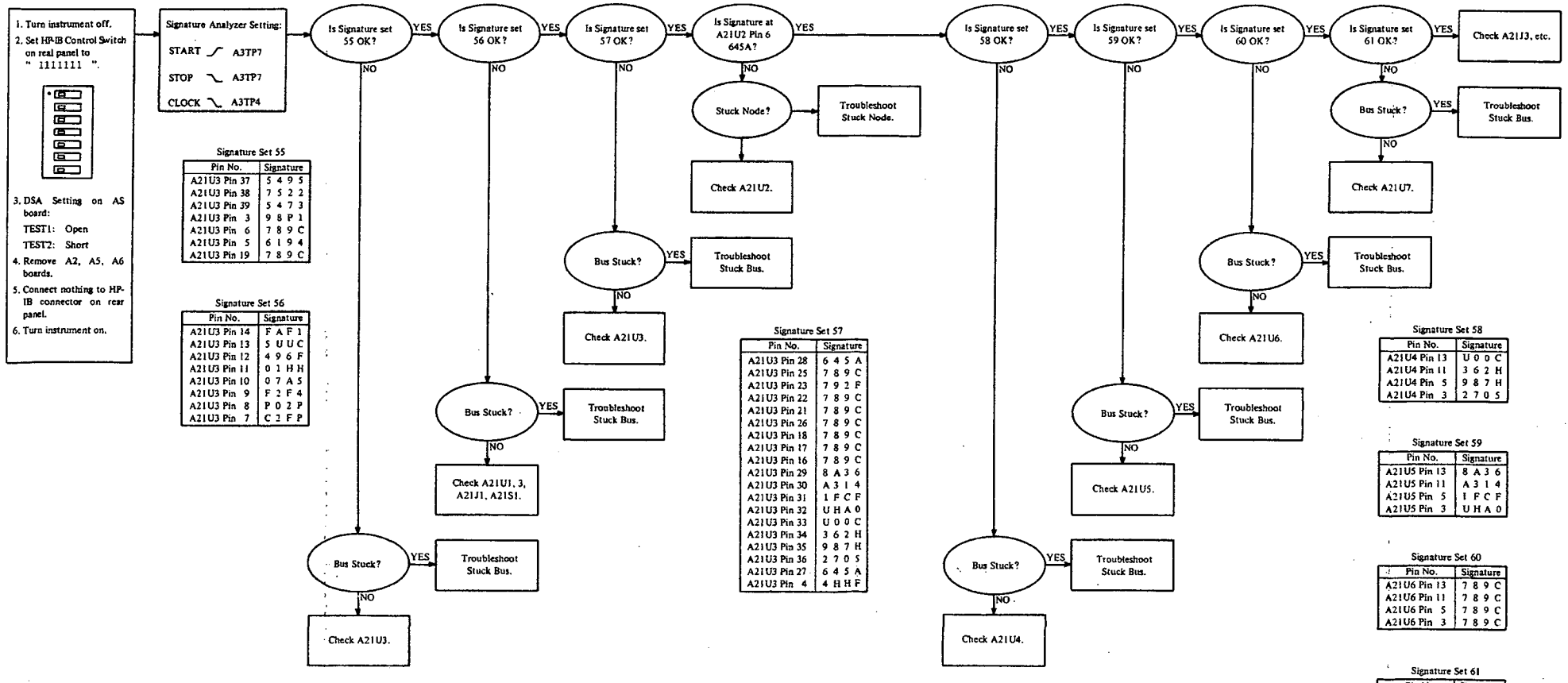


Figure 8-54. A21 HP-IB Interface Troubleshooting Tree.

Key & Display
SERVICE SHEET 8
SEE INSIDE

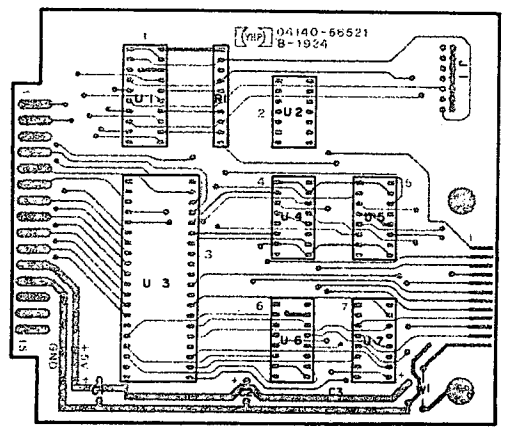


Figure 8-55. A21 HP-IB Interface Assembly Component Locations.

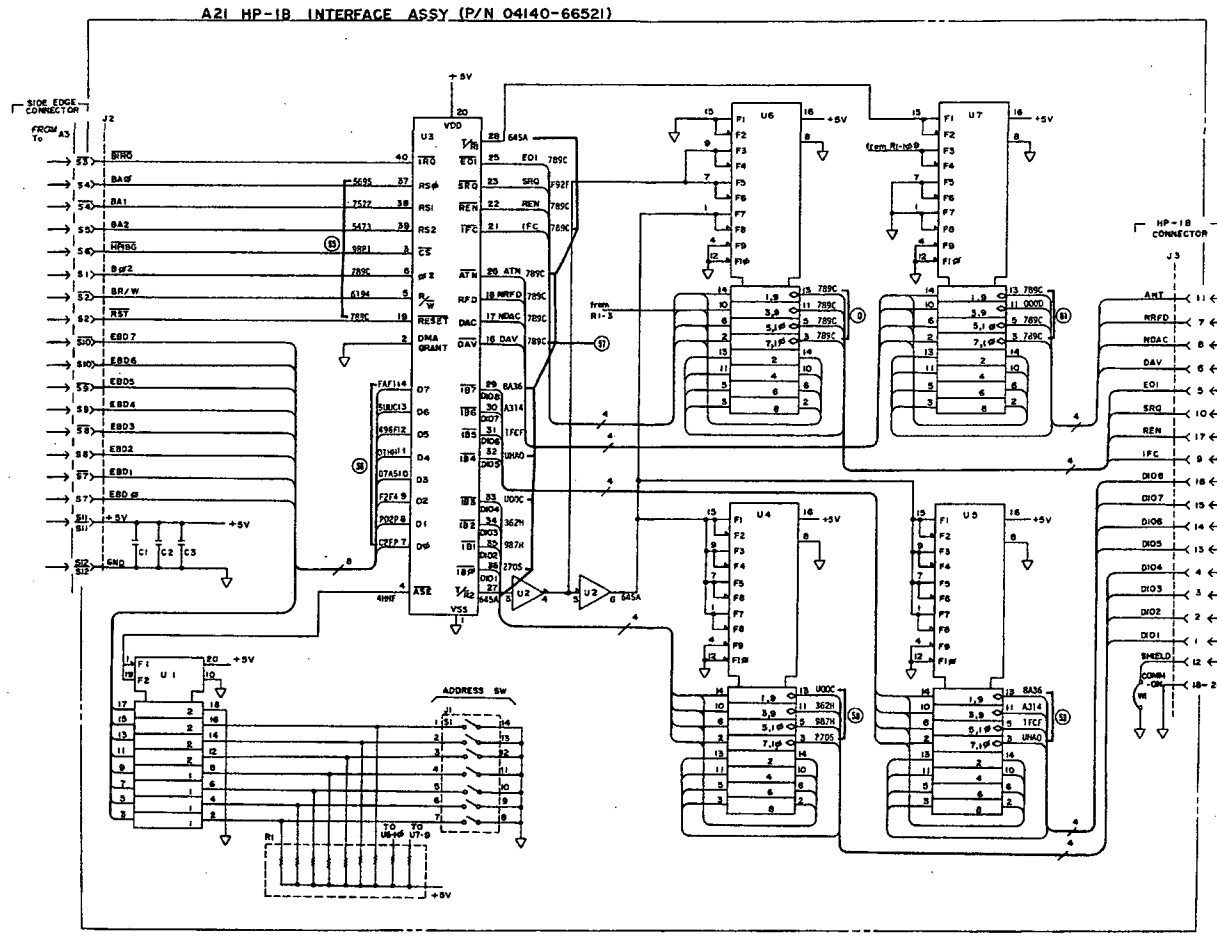


Figure 8-56. A21 HP-IB Interface Assembly Schematic Diagram.

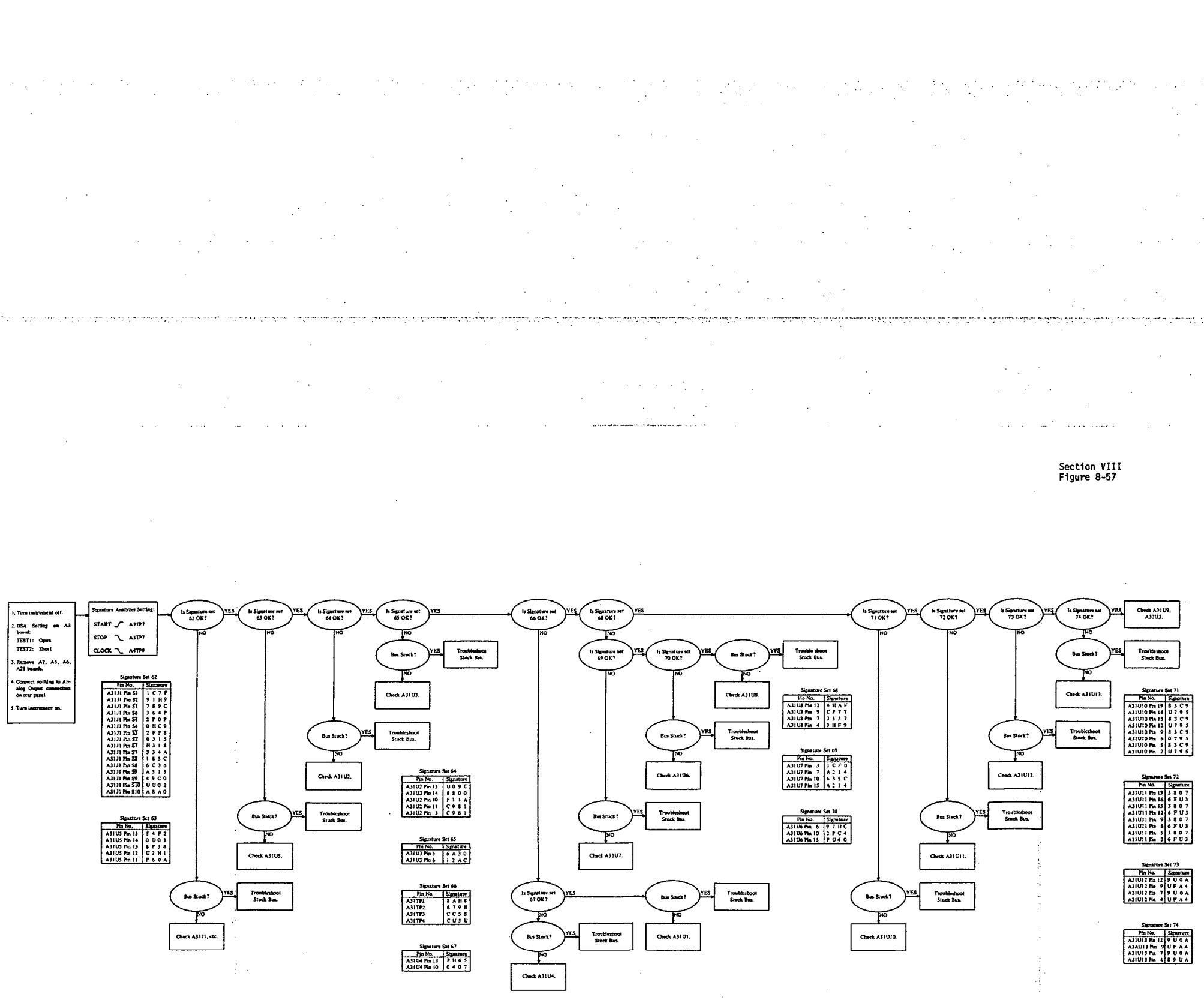


Figure 8-57. A31 Analog Output Control Troubleshooting Tree.

HP-IB Interface
SERVICE SHEET 21
SEE INSIDE

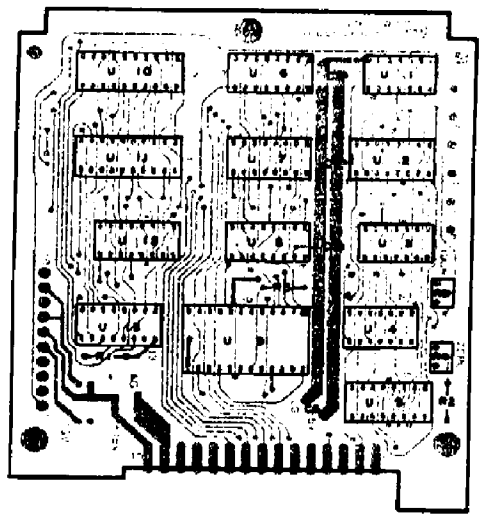


Figure 8-58. A31 Analog Output Control Assembly Component Locations.

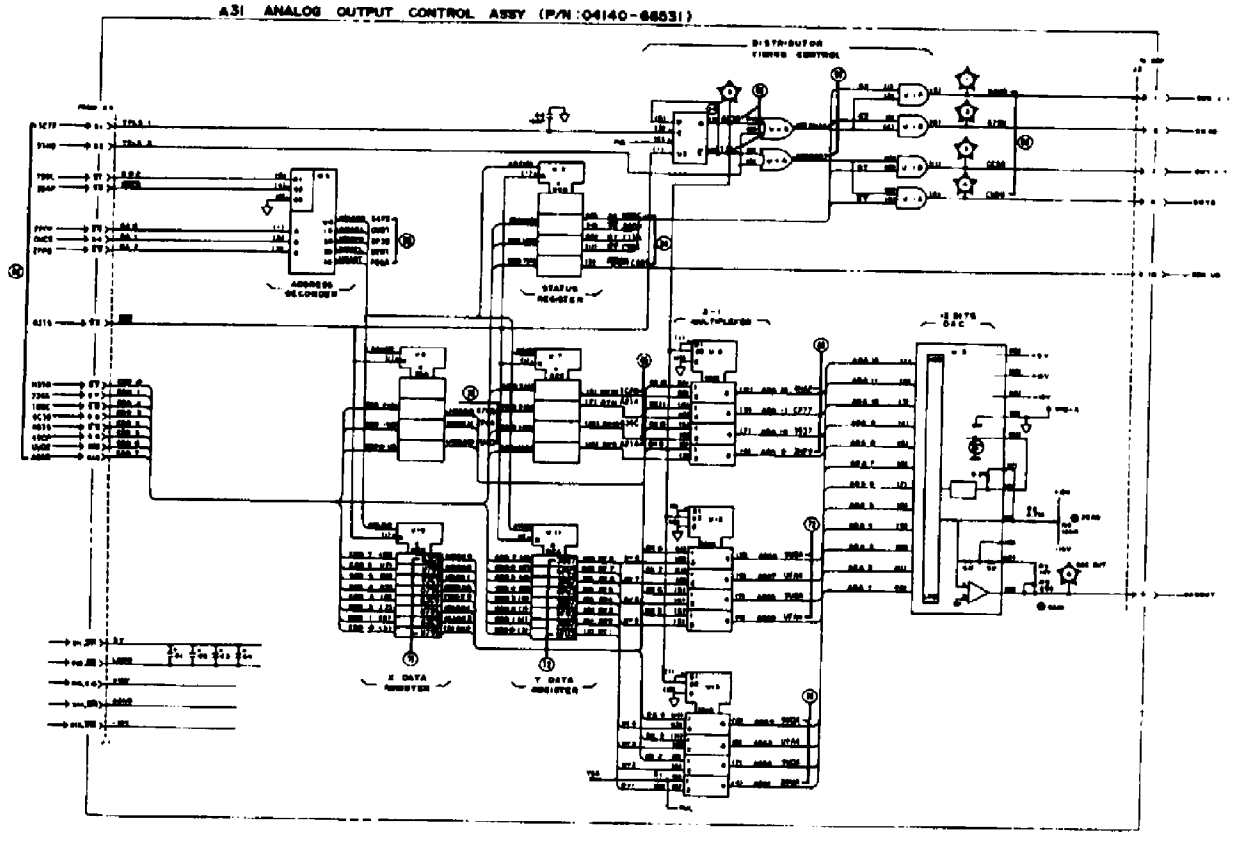
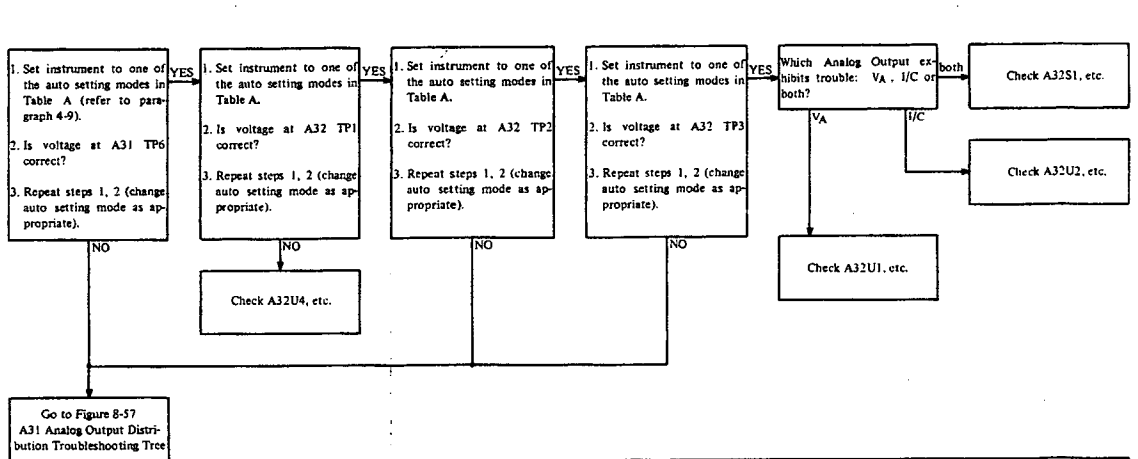


Figure 8-59. A31 Analog Output Control Assembly Schematic Diagram.



Auto Setting Mode	A31TP6 Test Limits (V)	A32TP1 Test Limits (V)	A32TP2 Test Limits (V)	A32TP3 Test Limits (V)
S – 1	– 0.02 ~ + 0.02	–0.020 ~ +0.020	– 0.020 ~ + 0.020	– 0.020 ~ + 0.020
S – 2	– 0.03 ~ + 0.01	–0.021 ~ +0.019	– 0.021 ~ + 0.019	– 0.021 ~ + 0.019
S – 3	–10.07 ~ – 9.93	–1.025 ~ –0.975	– 1.025 ~ – 0.975	– 1.025 ~ – 0.975
S – 4	+ 9.93 ~ +10.07	+0.975 ~ +1.025	+ 0.975 ~ – 1.025	+ 0.975 ~ – 1.025
S – 5	– 0.02 ~ + 0.02	–0.020 ~ +0.020	– 0.02 ~ + 0.02	– 0.02 ~ + 0.02
S – 6	–10.07 ~ – 9.93	–1.025 ~ –0.975	–10.07 ~ – 9.93	–10.07 ~ – 9.93
S – 7	+ 9.93 ~ +10.07	+0.975 ~ +1.025	+ 9.93 ~ +10.07	+ 9.93 ~ +10.07

Figure 8-60. A32 Analog Output Distributor Troubleshooting Tree.

SEE INSIDE
Analog Output Control
SERVICE SHEET 31

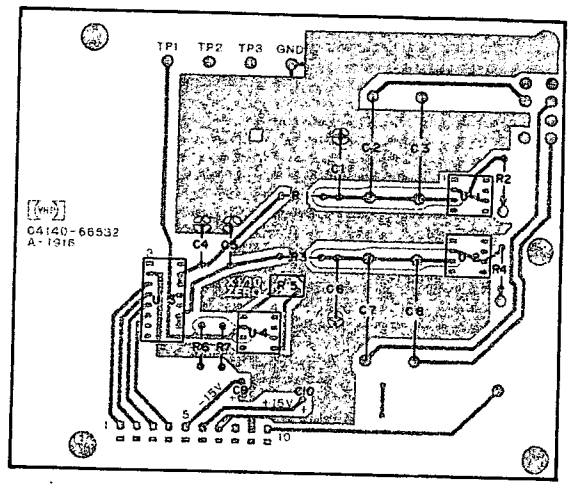


Figure 8-61. A32 Analog Output Distributor Assembly Component Locations.

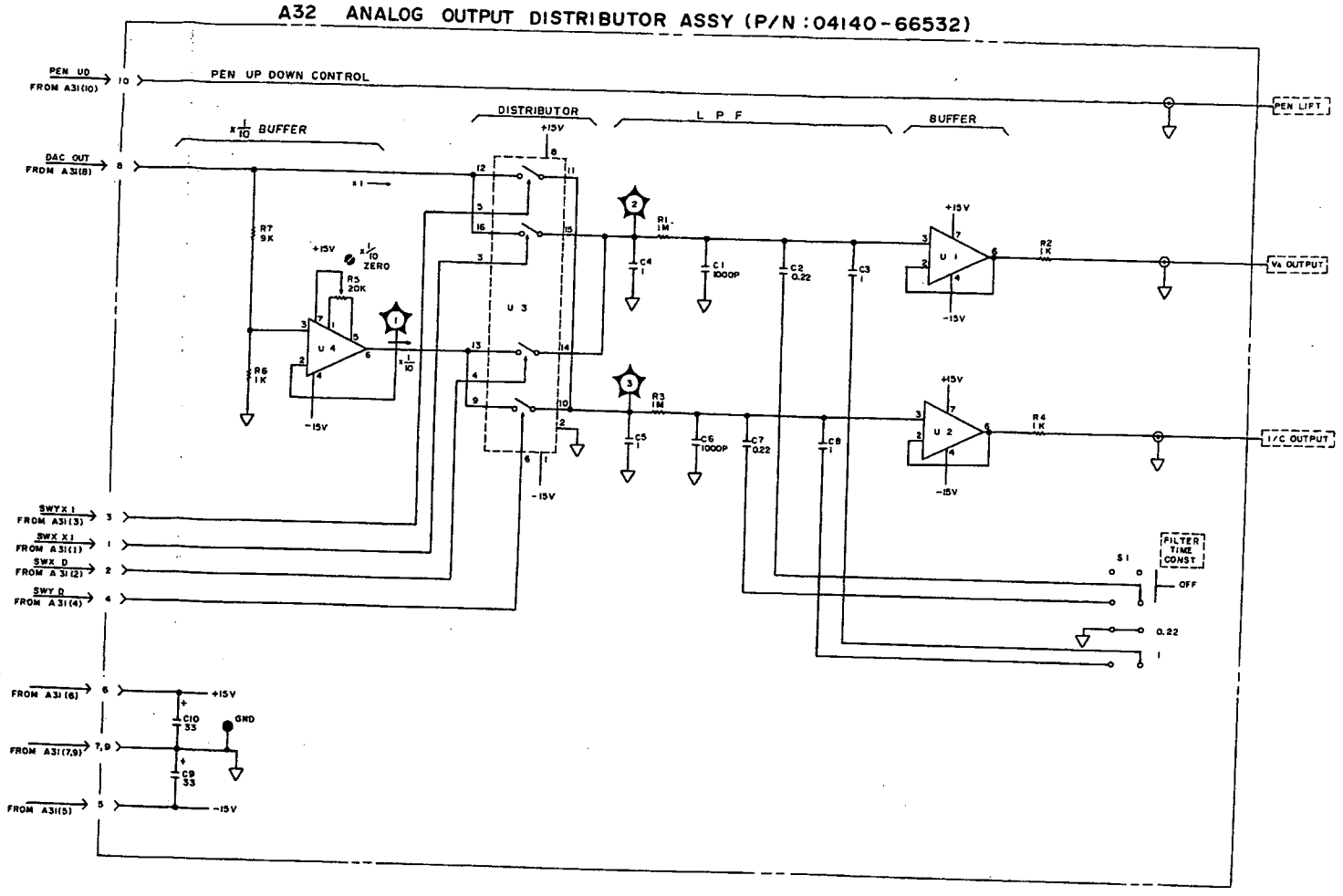


Figure 8-62. A32 Analog Output Distributor Assembly Schematic Diagram.

Analog Output Distributor
SERVICE SHEET 32

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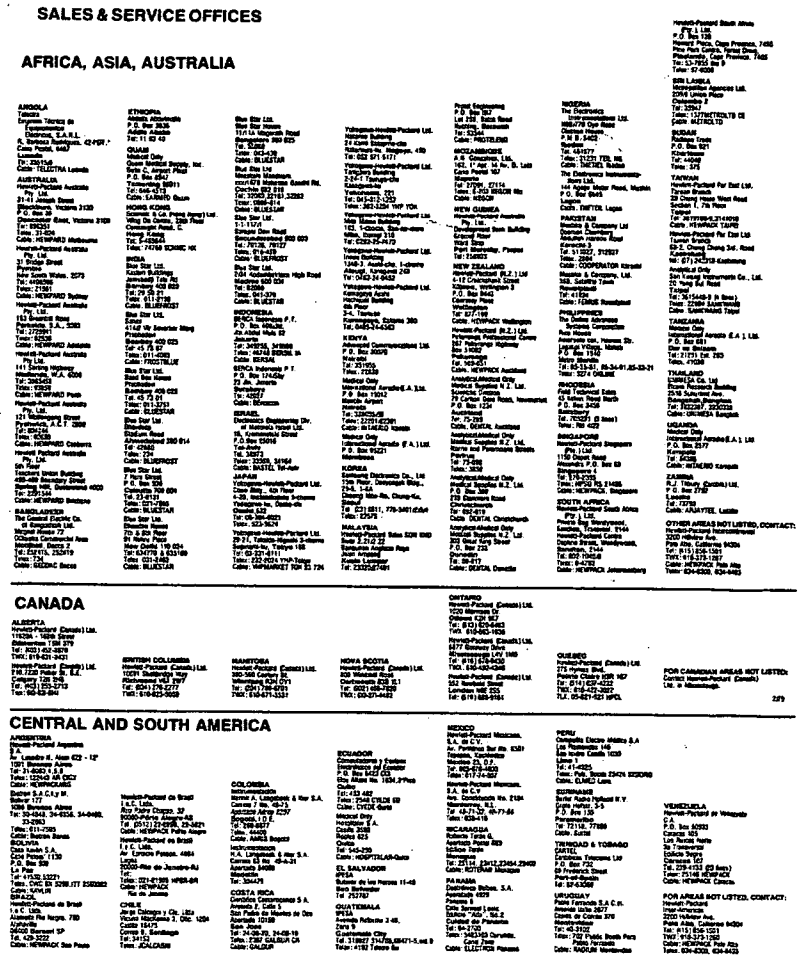

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