Errata

Title & Document Type: 6632/33/34A Power Supplies
Service Manual

Manual Part Number: 5957-6365

Revision Date: November 1987

HP References in this Manual

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

About this Manual

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

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

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

Agilent Technologies

SERVICE MANUAL

HP-IB SYSTEM
DC POWER SUPPLIES
HP MODEL 6632A, 6633A, 6634A

HP Part No 5957-6365

HEWLETT PACKARD

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SERVICE MANUAL

HP-IB SYSTEM
DC POWER SUPPLIES
HP MODEL 6632A, 6633A, 6634A

HP Part No 5957-6365

HP Model 6632A, Serials 2715A-00224 and Above*
HP Model 6633A, Serials 2715A-00129 and Above*
HP Model 6634A, Serials 2715A-00129 and Above*

* For instruments with higher Serial Numbers, a change page may be included.

* For instruments with lower Serial Numbers, refer to Appendix A.

Microfiche Part No. 5957-6366

Printed in USA: November, 1987

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard hardware product is warranted against defects in material and workmanship for a period of three years from date of delivery. HP software and firmware products, which are designated by HP for use with a hardware product and when properly installed on that hardware product, are warranted not to fail to execute their programming instructions due to defects in material and workmanship for a period of 90 days from date of delivery. During the warranty period Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective. HP does not warrant that the operation for the software firmware, or hardware shall be uninterrupted or error free.

For warranty service, with the exception of warranty options, this product must be returned to a service facility designated by HP. Customer shall prepay shipping charges by (and shall pay all duty and taxes) for products returned to HP for warranty service. Except for products returned to Customer from another country, HP shall pay for return of products to Customer.

Warranty services outside the country of initial purchase are included in HP's product price, only if Customer pays HP international prices (defined as destination local currency price, or U.S. or Geneva Export price).

If HP is unable, within a reasonable time to repair or replace any product to condition as warranted, the Customer shall be entitled to a refund of the purchase price upon return of the product to HP.

LIMITATION OF WARRANTY

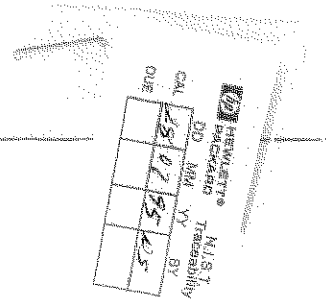
The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the Customer, Customer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation and maintenance. NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE THE CUSTOMER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

The above statements apply only to the standard product warranty. Warranty options, extended support contacts, product maintenance agreements and customer assistance agreements are also available. Contact your nearest Hewlett-Packard Sales and Service office for further information on HP's full line of Support Programs.



HEWLETT PACKARD

Certificate of Calibration

Model No/System No: 6634A
Serial No: 3503A03695
Description: System Power Supply

At the time of manufacture, this certifies that the above product was calibrated in accordance with applicable Hewlett-Packard procedures which are in compliance with relevant clauses of ISO 9001/2.

At planned intervals, Hewlett-Packard measurement standards are calibrated by comparison to or measurement against national standards, natural physical constants, consensus standards, or by ratio-type measurements using self-calibrating techniques.

National standards are administered by NIST (National Institute of Standards and Technology) or other recognized national standards laboratories.

At the time of shipment, your instrument met its published operating specifications.

The environment in which this instrument was calibrated is maintained within the operating specifications of the instrument and the standards.

Supporting documentation relative to traceability is on file and is available for examination upon request.

Calibration Date:
DD/MM/YY

280795

Electrical Inspector

MANUAL CHANGES
HP-IB SYSTEM DC POWER SUPPLIES
HP MODELS 6632A, 6633A, 6634A
Service Manual HP P/N 5957-6365
Manual Print Date: 11/87
Change Date: 1/24/95

Make all corrections in the manual according to errata below, then check the following table for your power supply serial number and enter any listed change(s) in the manual.

MODEL	SERIAL Prefix	SERIAL Number	MAKE CHANGES
ALL			ERRATA
6632A	2747A	00724-00943	1
	2806A	00944-01403	1,3,5
	2838A	01404-01723	1,3,5-6
	2851A	01724-02203	1,3,5,6,8
	2919A	02204-02383	1,3,5-8
	2921A	02284-02303	1,3,5-8,10
	2924A	02304-02575	1,3,5,6-10
	2924A	02576-02583	1,3,5,6-11
	2933A	02584-02623	1,3,5,6-11
	2935A	02624-02923	1,3,5-12
	2948A	02924-02983	1,3,5-13
	3002A	02984-05163	1,3,5-14
	3145A	05164-07143	1,3,5-15
	3326A	07144-10063	1,3,5-16,18*
	3326A	10064-10143	1,3,5-16,18
	3503A	10144-up	1,3,5-16,18
ALL			ERRATA
6633A	2746A	00499-00578	1
	2752A	00579-00718	1,2
	2808A	00719-00898	1-3
	2838A	00899-01118	1-3,6
	2851A	01119-01418	1-3,6,8
	2918A	01419-01458	1-3,6-8
	2925A	01459-01478	1-3,6-9
	2926A	01479-01678	1-3,6-10
	2933A	01679-01758	1-3,6-11
	2935A	01759-02018	1-3,6-12
	2946A	02019-02138	1-3,6-13
	3004A	02139-03578	1-3,6-14
	3145A	03579-04418	1-3,6-15
	3325A	04419-05338	1-3,6-16
	3449A	05339-05378	1,3,6-17
	3449A	05379-05398	1,3,5-18
	3504A	05399-up	1,3,5-19

* Change 18 does not apply to all units in this group. See change 18 for the list of applicable serial numbers.

MODEL	SERIAL Prefix	SERIAL Number	MAKE CHANGES
ALL			ERRATA
6634A	2747A	00369-00448	1
	2814A	00449-00468	1,3
	2822A	00469-00648	1,3,4
	2841A	00649-00708	1,3,4,6
	2849A	00709-00908	1,3,4,6,8
	2925A	00909-01028	1,3,4,6,8,9
	2919A	01029-01068	1,3,4,6-9
	2926A	01069-01413	1,3,4,6-10
	2932A	01149-01188	1,3,4,6-11
	2936A	01189-01289	1,3,4,6-12
	2936A	01290	1,3,4,6-13
	2936A	01291,01292	1,3,4,6-12
	2936A	01293-01297	1,3,4,6-13
	2936A	01298	1,3,4,6-12
	2936A	01299	1,3,4,6-13
	2936A	01300	1,3,4,6-12
	2936A	01301-01305	1,3,4,6-13
	2936A	01306	1,3,4,6-12
	2936A	01307,01308	1,3,4,6-13
	2949A	01309-01348	1,3,4,6-13
	3004A	01349-02278	1,3,4,6-14
	3145A	02279-02788	1,3,4,6-15
	3326A	02789-03368	1,3,4,6-16
	3326A	03369-03428	1,3,4,6-16,18
	3503A	03429-up	1,3,4,6-16,18

ERRATA:

On page 5-14 change B1, Fan, to HP P/N 06632-60002.

On page 5-12, change U103 to HP P/N 1826-0122. Change XT1P7 (connector DFI/RI) to HP P/N 1252-0718. XT1P8 (connector - option board) to HP P/N 1252-2665.

On page 5-13, change Insulator, Ref Q105-108 to HP P/N 0340-0458 (qty 4). Also, add Capacitor Insulator (for C134), HP P/N 0340-1316 (qty 1).

On page 6-6 in Figure 6-4, change R163 to 47.5K as indicated in the parts list.

On page 4-16 in Table 4-4, change the signatures to read as follows:

U2-35	8H82	or	90UA
U3-32	8H82	or	90UA
U3-9	8H82	or	90UA

On page 4-17 in Table 4-5, change the signatures to read as follows:

U11-4	3166	or	59A9
U11-6	3166	or	59A9
U11-7	3166	or	59A9
U11-8	3166	or	59A9
U11-9	3166	or	59A9
U11-11	3166	or	59A9
U11-12	3166	or	59A9
U11-13	U0AF	or	2C3H
U11-14	F366	or	H9A2
U11-16	FHPF	or	7C30
U11-18	8832	or	0F9H
U11-19	3166	or	59A9
U11-20	3166	or	59A9
U11-21	3166	or	59A9
U11-22	3166	or	59A9
U11-23	3166	or	59A9
U11-25	88U6	or	3H9C
U11-26	9488	or	221H
U11-27	H750	or	H415
U11-28	66HF	or	C708
U11-29	8C5P	or	H7C4
U11-30	0229	or	8A59
U11-31	P545	or	5166
U11-32	PIFU	or	73PI
U11-33	8A2F	or	8C26
U11-34	40A4	or	2914
U11-35	79F9	or	7264
U11-36	87PP	or	UCC4
U11-37	9U68	or	HA03
U11-38	3166	or	59A9
U11-39	3166	or	59A9

On page 4-20 in Table 4-8, change the signatures to read as follows:

	--- 6632A ----		
+ 5V signature	C353	or	H4HH
U15-1	8P09	or	825P
U15-2	HCU7	or	UHHF
U15-3	U661	or	9867
U15-4	5A5P	or	979C
	--- 6633A ----		
+ 5V signature	66A6	or	A9CC
U15-1	780C	or	02UA
U15-2	22H8	or	C634
U15-3	PFF3	or	30FP
U15-4	3F5F	or	1724
	--- 6634A ----		
+ 5V signature	66A6	or	A9CC
U15-1	780C	or	02UA
U15-2	PUU7	or	UHF1
U15-3	PFF3	or	30FP
U15-4	4UF1	or	U074

CHANGE 1:

On page 5-13 add Front Panel Screened Option 020 (6632A) HP P/N 06632-00011, Front Panel Screened Option 020 (6633A) HP P/N 06633-00004, and Front Panel Screened Option 020 HP P/N 06634-00004

CHANGE 2:

In the parts list, page 5-13 change Screened Front Panel (6632) to HP P/N 06633-00003. Below ASSY-LCD (REF FRONT PANEL) add: WINDOW (HP P/N 1000-0842), and Washer-flat non metallic (HP P/N 3050-0003) (qty 2).

CHANGE 3:

Make the following changes in the parts list (table 5-4) and on the schematic:
Change R214 from 100K to 5.11K 1% 1/8W HP P/N 0757-0438.
Change R215 from 14.7K to 750 ohms 5% 1/2W HP P/N 0686-7515.
Change U1 to HP P/N 5080-2125.
Change U11 to HP P/N 5080-2126.
Add C162 15pF 5% 100V (HP P/N 0160-4789). C162 is electrically connected across pins 2 and 6 of U108 and located between R164 and R165 on the pc board.
Add R157 100K 1% 1/8W (HP P?N 0757-0465. R157 is electrically connected between the bases of Q113 and Q114 and located next to R137.

On page 4-17, change the signature for U11 Pin 14 to "3166". Change the signature for U11 Pin 15 to "A6PH".

CHANGE 4:

In the parts list, page 5-13, change the Screened Front Panel (6634A) to HP P/N 06634-00003. Also add: Window HP P/N 1000-0842, and Washer - flat non-metallic HP P/N 3050-0003. (qty 2).

CHANGE 5:

In the parts list, page 5-13, change the Screened Front Panel (6632A) to HP P/N 06632-00009. Also add: Window HP P/N 1000-0842, and Washer - flat non-metallic HP P/N 3050-0003. (qty 2).

CHANGE 6:

In the parts list, on page 5-13 change the part number for ASSY-LCD (REF FRONT PANEL) to HP P/N 5061-1190 (qty 1.)

CHANGE 7:

On Model 6632A, change F7 to 10A, HP P/N 2110-0713.
On Model 6633A, change F7 to 5A, HP P/N 2110-0699.
On Model 6634A, change F7 to 3A, HP P/N 2110-0688.

CHANGE 8:

In the replaceable parts list, change the following parts as shown.

Description	from:	to:
Cover, Top (qty 1)	06632-00002	06632-00012
Trim, Sides (qty 2)	5001-0438	5001-0538
Feet, Plastic (qty 4)	5040-7201	5041-8801
Strap, Handle Assy (qty 1)	5060-9802	5062-3702
Retainer, Cap Strap Handle (qty 1)	5041-6820	5041-8820
Retainer, Cap Strap Handle (qty 1)	5041-6819	5041-8819
Front Frame, Plastic (qty 1)	06632-40005	06632-40007
For Model 6632A:		
Lettered Ft Pnl (qty 1)	06632-00009	06632-00015
Lettered Ft Pnl (Opt 020 (qty 1)	06632-00011	06632-00013
For Model 6633A:		
Lettered Ft Pnl (qty 1)	06633-00003	06633-00006
Lettered Ft Pnl (Opt 020) (qty 1)	06633-00004	06633-00005
For Model 6634A:		
Lettered Ft Pnl (qty 1)	06634-00003	06634-00006
Lettered Ft Pnl (Opt 020) (qty 1)	06634-00004	06634-00005
Opt 908 - Rack Mt Kit W/Hadls (qty 1)	5061-9674	5062-3974
Opt 909 - Rack Mt Kit W/Hndls (qty 1)	5061-9675	5062-3975

CHANGE 9:

This only changes the serial number prefix.

CHANGE 10:

In the parts list, change the part number for Connector-header, 5 position, XT1P7 to HP P/N 1251-8676.

CHANGE 11:

In the parts list, change U1 to MPU-Masked HP P/N 1820-6359 (qty 1).

On page 4-16 in Table 4-8 change the signatures to read as follows:

PINS	U1	U2	U3
1	0000	20F9	0000
2	----	----	85C5
3	----	0000	90CP
4	8627	0000	39HH
5	0000	----	HH09
6	8627	----	UU81
7	8627	8627	A2A2
8	0000	0000	3287
9	8627	9917	CPC2
10	9294	6F9F	8627

change 11 continued

PINS	U1	U2	U3
11	8627	----	20F9
12	8627	610U	P0P2
13	3P25	3520	8627
14	888H	90AH	633C
15	U3F1	7H32	8627
16	9917	89HH	8627
17	382P	UH50	8627
18	C303	4994	8627
19	6H5C	792P	8627
20	6F07	0000	0000
21	8627	3P25	0000
22	8627	888H	8627
23	H150	U3F1	8627
24	8170	8627	8627
25	7F20	8627	P0P2
26	97HH	8627	8627
27	5636	P0P2	8627
28	12U7	85C5	8627
29	1U6F	90CP	8627
30	661P	39HH	8627
31	56A4	HH09	633C
32	P260	UU81	CP2C
33	96PH	A2A2	HH09
34	6202	3287	3287
35	8U9H	CPC2	39HH
36	2A10	8627	A2A2
37	7P3U	8627	90CP
38	6F9F	8627	UU81
39	8627	633C	85C5
40	0000	8627	8627

*U1-1 to U1-40 are TTL levels
*U3-24 to U3-40 are TTL levels

The +5 Vp signature is CH6C or 8627.

CHANGE 12:

In the parts list, delete Resistor Network, R7, Single-In-Line, 8x4.7k (HP P/N 1810-0305) (qty 1).

CHANGE 13:

In the parts list, change U11 to MPU-Masked (HP P/N 1820-6358) (qty 1).

CHANGE 14:

In the parts list and on the schematic, change F7 on all models to: Jumper, HP P/N 8159-0005 (qty 1)

CHANGE 15:

In the parts list and on the schematic, add capacitor C163, 1000 pF, HP P/N 0160-4822. C163 is electrically connected between the base of Q115C (pin 9) and common. Note that C163 is incorrectly designated C162 on the pc board.

CHANGE 16:

In the parts list on page 5-11 and on the schematic Figure 6-1, add resistor R300, 1M 1% 1/8W HP p/n 0698-8827. On the schematic, indicate that R300 is electrically connected across C131.

CHANGE 17:

In the parts list on page 5-6, change D109 through D112 from p/n 1901-0719 to p/n 1901-1130.

CHANGE 18:

In the parts list on page 5-11 and on the schematic Figure 6-3, add pull-up resistor R310, 10K 1% 1/8W HP p/n 0757-0442. On the schematic, indicate that R300 is electrically between U19 pin 17 and +5Vs. R310 is located in grid D9 in the components location diagram.

This change also applies to HP 6632A units with the following serial numbers:
08692, 08693, 08754, 08778, 08814, 08827, 08828, 09111, 09140, 09144, 09245, 09302, 09368--09370, 09499, 09541, 09542, 09555, 09561, 09606, 09607, 09640, 09651, 09652, 09655, 09686, 09694, 09750, 09762, 09804, 09819, 09847, 09851, 09852, 09861, 09870' 09875, 09888--09890, 09892--09895, 09898, 09899, 09900--09902, 09907, 09927, 09949, 09950, 09953--09959, 09969, 09974--09976, 09978, 09979, 09981--09983, 09985, 09990, 09993--09996, 09998, 10000, 10002, 10005--10009, 10011--10014, 10017--10021, 10023

CHANGE 19:

In the parts list on page 5-7, change Q113,114 (Model 6633A only) to HP p/n 1854-0474. If either transistor needs replacement, replace both with the new part number.

SAFETY SUMMARY

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

BEFORE APPLYING POWER.

Verify that the product is set to match the available line voltage and the correct fuse is installed.

GROUND THE INSTRUMENT.

This product is a Safety Class 1 instrument (provided with a protective earth terminal). To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument must be connected to the ac power supply mains through a three-conductor power cable, with the third wire firmly connected to an electrical ground (safety ground) at the power outlet. For instruments designed to be hard-wired to the ac power lines (supply mains), connect the protective earth terminal to a protective conductor before any other connection is made. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury. If the instrument is to be energized via an external autotransformer for voltage reduction, be certain that the autotransformer common terminal is connected to the neutral (earthed pole) of the ac power lines (supply mains).

FUSES

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short circuited fuseholders. To do so could cause a shock or fire hazard.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.

Do not operate the instrument in the presence of flammable gases or fumes.

KEEP AWAY FROM LIVE CIRCUITS.

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

DO NOT SERVICE OR ADJUST ALONE.

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

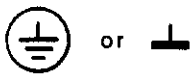
DO NOT EXCEED INPUT RATINGS.

This instrument may be equipped with a line filter to reduce electromagnetic interference and must be connected to a properly grounded receptacle to minimize electric shock hazard. Operation at line voltages or frequencies in excess of those stated on the data plate may cause leakage currents in excess of 5.0 mA peak.

SAFETY SYMBOLS.

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual (refer to Table of Contents).

Indicates hazardous voltages.



or

Indicate earth (ground) terminal.

WARNING

or

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

CAUTION

or

Caution

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

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.

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

Instruments which appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

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Section I
INTRODUCTION

1-1 SCOPE

This manual contains principles of operation, verification, and troubleshooting information for the HP 6632A-6634A series of HP-IB System Power Supplies. A replaceable parts list and circuit diagrams are also provided. Installation, operation, programming, and calibration procedures as well as detailed specifications are given in a separate Operating Manual, HP Part No. 5957-6360.

Wherever applicable, the service instructions given in this manual refer to pertinent information provided in the Operating Manual. Both manuals cover Models HP 6632A-6634A; differences between models are described as required.

The following is a listing of the information contained in this manual with a brief description concerning its scope and purpose.

Principles of Operation: Section II provides block diagram level descriptions of the supply's circuits. The primary interface, secondary interface, and the power mesh and control circuits are described. These descriptions are intended as an aid in troubleshooting.

Verification: Section III contains test procedures that check the operation of the supply to ensure that it meets the specifications given in Section I of the Operating manual.

Troubleshooting: Section IV contains troubleshooting procedures to isolate a malfunction to a defective component on the main circuit board or to a defective assembly (front panel, power transformer, or cable assembly). Board and assembly level removal and replacement procedures are also given in this section.

NOTE

Calibration is generally required after a repair is made. Software calibration procedures are given in Appendix A of the Operating Manual. After calibration is completed, perform the applicable test(s) given in Section III of this manual to ensure that the supply meets all specifications.

Replaceable Parts: Section V provides a listing of replaceable parts for all electronic components and mechanical assemblies that comprise Models HP 6632A-6634A.

Circuit Diagrams: Section VI contains functional schematics and component location diagrams for all HP 6632A-6634A circuits. The names that appear on the functional schematics also appear on the block diagrams in Section II. Thus, the descriptions in Section II can be correlated with both the block diagrams and the schematics.

Manual Backdating: Appendix A describes changes necessary to adapt this manual to earlier Models HP 6632A-6634A.

Logic Symbology: Appendix B gives a brief derscription of the logic symbols used on the functional schematics.

1-2 SAFETY CONSIDERATIONS

This product is a Safety Class 1 instrument, which means that it is provided with a protective earth terminal. The instrument and this manual should be reviewed for safety markings and instructions before operation.

Refer to the Safety Summary page at the beginning of this manual for a summary of general safety information. Safety information for specific procedures is located at appropriate places in the manual.

1-3 INSTRUMENT AND MANUAL IDENTIFICATION

Hewlett-Packard instruments are identified by a two-part serial number, i.e. 2701A-00101. The first part of the serial number (the prefix) is a number/letter combination that denotes either the date of manufacture or the date of a significant design change. It also indicates the country of manufacture. The first two digits indicate the year (26 = 1986, 27 = 1987, etc), the second two digits indicate the week, and the "A" designates the U.S.A. The second part of the serial number is a different sequential number assigned to each instrument.

If the serial number prefix on your power supply differs from that shown on the title page of this manual, a yellow Manual Change sheet that is supplied with the manual and/or manual backdating changes in Appendix A of this manual define the differences between your supply and the supply described in this manual. The yellow change sheet may also contain information for correcting errors in the manual.

1-4 FIRMWARE REVISIONS

The primary and secondary interface microcomputer chips inside of your supply are identified with labels that specify the revision of the supply's firmware (see paragraph 4-17).

Section II
PRINCIPLES OF OPERATION

2-1 INTRODUCTION

The following paragraphs provide block diagram level descriptions of the HP 6632A-6634A series of HP-IB System DC Power Supplies. Differences between the models are given as required. The descriptions provide a basic understanding of circuit operation and are intended as an aid in troubleshooting. It is assumed in the following discussions that you are familiar with the operating and programming instructions presented in the Operating Manual (HP Part No. 5957-6360).

2-2 OVERALL BLOCK DIAGRAM DESCRIPTION (FIGURE 2-1)

Figure 2-1 is a block diagram that illustrates the major circuits contained within a HP Model 6632A-6634A HP-IB System Power Supply. As shown in the Figure, each supply includes ac input circuits, a primary interface, front panel display and keyboard, a secondary interface, and power mesh and control circuits.

2-3 AC Input Circuit

The ac input circuit consists of line fuse F1 in the rear of the supply, front panel ON/OFF switch S1, power transformer T1 (located in the front of the chassis), and line voltage select switches S2 and S3 (located on the main board assembly near F1). The line voltage select switches select the applicable ac input line voltage: 100 Vac, 120 Vac, 220 Vac, or 240 Vac. The switch settings must match the nominal line voltage that is connected to the supply. The proper value line fuse F1 must also be installed. A 4A fuse (normal blow) must be installed for a 100/120 Vac input; a 2 A fuse(normal blow) must be installed for a 220/240 Vac input.

The ac line input is applied to power transformer T1 through the line voltage select switches when S1 is ON. Power transformer T1 provides the main ac input to the power mesh and also provides ac inputs to the dc bias supplies and start-up circuits for the primary and secondary interfaces. The power to operate the dc fan is derived from the secondary bias supply. Ac power distribution as well as the dc bias supplies and start up circuits are shown in detail in Figure 6-1 in the back of this manual.

2-4 Primary Interface

This circuit provides the interface between the user and the power supply. It allows the user to control the power supply from an HP-IB controller or from the supply's front panel. The primary interface circuit interprets commands from the HP-IB or from the front panel keypad to control the power supply output. This circuit also processes measurement and status data received from the power mesh and control circuits via the secondary interface circuits. This data may be read back to the controller over the HP-IB and/or displayed on the supply's front panel. The power supply can be calibrated over the HP-IB using the calibration commands (see Appendix A in the Operating Manual). The primary interface circuits are described in greater detail in paragraph 2-8.

2-5 Front Panel

Most of the remote operations that can be performed via the HP-IB can also be performed from the supply's front panel. In addition to the ac line switch already mentioned, the front panel contains an LCD display and a keypad. The LCD display consists of an alphanumeric display and status annunciators. The LCD normally displays the power supply's measured output voltage and current. When programming from the front panel keyboard, the function being programmed and the present value will be displayed. The annunciators give HP-IB and power supply status information. The keypad allows control of the supply's system functions as well as control of the supply's output. Note that the power supply's HP-IB address must be set via the front panel; it cannot be set via the HP-IB. Detailed instructions on using the front panel display and keyboard are given in the Operating Manual.

2-6 Isolation

Data is transferred serially between the primary interface and secondary interface via optical isolators (U9 and U10). As shown in Figure 2-1, the primary interface circuits are referenced to earth ground while the secondary interface circuits are referenced to power supply common. Either power supply output terminal (+ or −) may be floated up to ±240 Vdc (including the supply's output voltage) from earth ground.

2-7 Secondary Interface

The secondary interface circuit receives digital signals from the primary interface circuits and converts them to analog signals which are sent to the power control circuits in order to program the supply's output voltage, current, and overvoltage. The supply can also be commanded to send measurement and status data back to the HP-IB controller and/or the LCD display on the front panel. The data is processed and sent back via the secondary and primary interface circuits.

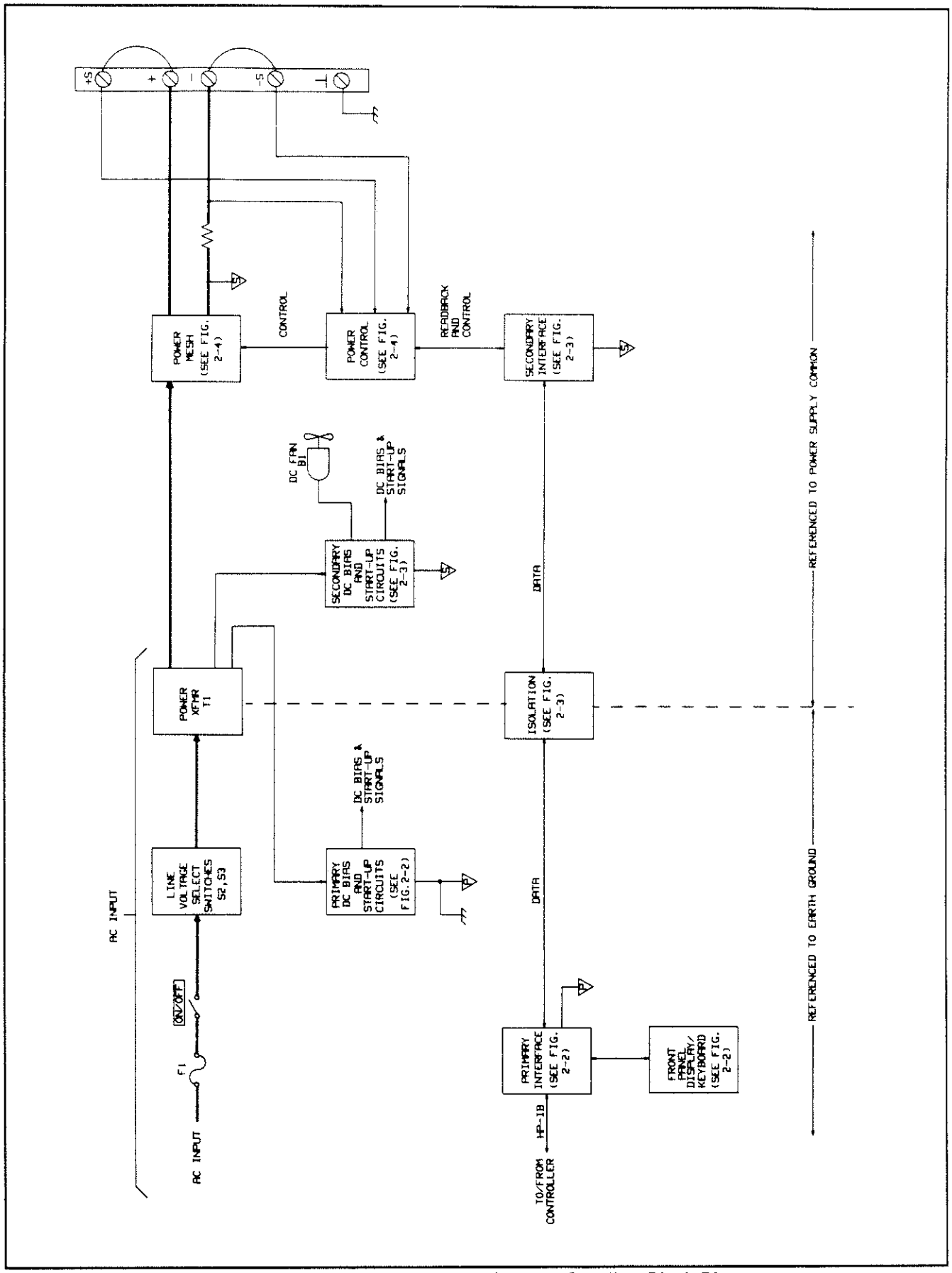


Figure 2-1. HP 6632A-6634A System DC Power Supplies, Block Diagram

2-8 Power Mesh and Control

The ac input to the power mesh is rectified and filtered before being applied to the output stage which regulates the output voltage or current. The output stage is connected in series with the load and operates in the linear region (between saturation and cutoff) of the transistor characteristic curve. Regulation is achieved by varying the conduction of the output stage in response to changes in the line voltage or the load.

The power control circuit contains voltage and current control circuits which allow the supply to operate in either the constant voltage (CV) or constant current (CC+) mode. Transfer between these two modes is accomplished automatically at a value of load resistance equal to the ratio of the programmed output voltage value to the programmed current value.

The voltage control circuit compares the supply's output voltage with the programmed voltage value and generates a control signal which varies the conduction of the output stage in the power mesh to raise or lower the output voltage as required. Current control circuits compare the supply's output current with the programmed current value and likewise vary the conduction of the output stage to raise or lower the output current as required. Current sinking and downprogramming are also achieved through the output stage in the power mesh. A negative current (CC-) control circuit controls the amount of current that the supply can sink. The voltage and current control circuits are described in detail in paragraphs 2-31 through 2-33.

2-9 PRIMARY INTERFACE (FIGURE 2-2)

Figure 2-2 is a block diagram illustrating the circuits that comprise the primary interface. Complete circuit details are shown on the functional schematic, Figure 6-2, in the back of this manual. The functional names on the block diagram correspond with those on the schematic so that the diagrams can be correlated. As shown in Figure 2-2, the major circuits consist of the HP-IB interface and the primary interface microcomputer. The block diagram also shows the bias supply/start-up circuits and the front panel display and keyboard.

2-10 HP-IB Interface

These circuits consist of the HP-IB bus connector (J1), transceivers (U3) for the 8 data lines and 8 control lines, and the talker/listener chip (U2). All HP-IB (IEEE-488) functions are implemented by this chip which handles data transfers between the the microcomputer and the HP-IB as well as handshake protocol, and talker/listener addressing procedures. The talker/listener chip is connected to the data bus and appears as memory locations to the microcomputer.

The eight data lines (DIO1-DIO8) of the HP-IB are reserved for the transfer of data and other messages in a parallel manner. Data and message transfer is asynchronous, coordinated by the three handshake lines (DAV, NRFD, NDAC). The controller dictates the role of an HP-IB device by setting the ATN (attention) line true and sending talk or listen addresses on the data lines. The power supply's HP-IB address is stored in EEPROM (U15) in the secondary interface (see paragraph 2-13). You can find out your supply's HP-IB address (or you can change it) by using the front panel ADDR key as described in the Operating Manual. As shipped from the factory, the power supply's address is set to 5. Any address from 0 through 30 is a valid address. Make sure you do not select an address that is already in use.

There are five HP-IB control lines: ATN, IFC, REN, SRQ, and EOI. When the controller sets the ATN line true, all devices on the bus must "listen" to the addresses and universal commands placed on the bus. When ATN is false, only devices that are addressed will actively send or receive data. All unaddressed devices will ignore the data lines when ATN is false.

2-11 Primary Microcomputer

The primary microcomputer circuit consists of microcomputer chip (U1), data latches (U6), inverter (Q1C), and test header TP1. The 8-bit microcomputer chip includes a microprocessor unit (MPU), ROM, and RAM. These internal circuits decode and execute all instructions and control all data transfers between the secondary interface, the HP-IB controller, and the front panel. Ceramic resonator Y1 provides a 2V p/p 4 MHz signal for the microcomputer.

The microcomputer uses an 8-bit parallel bi-directional data bus (PD0-7) and several control lines to transfer data to and from the HP-IB interface. The microcomputer also uses the data bus to send data to the front panel display via latches (U6). The data from the latches is fed directly to the front panel LCD display. The microcomputer determines when to update the display and sets the WRITE signal high to transfer display data into the latches. When the WRITE signal goes low, the latches will retain the data.

The COLUMN and ROW signals allow the power supply to be controlled from the keyboard. The microcomputer successively drives each of the four ROW signals and monitors the seven COLUMN signals from the keyboard to determine which key was pressed. It then generates the proper commands to the power supply.

Data is transferred serially between the primary interface and the secondary interface. As shown in Figure 2-2, serial data is transmitted from the primary interface microcomputer on the PTX (primary transmit) signal line; serial data is received by the primary interface microcomputer on the PRX (primary receive) signal line. Inverter Q1C provides the proper PRX signal levels. Opto-isolators (see paragraph 2-14) are used to electrically isolate the primary interface circuits from the secondary interface circuits.

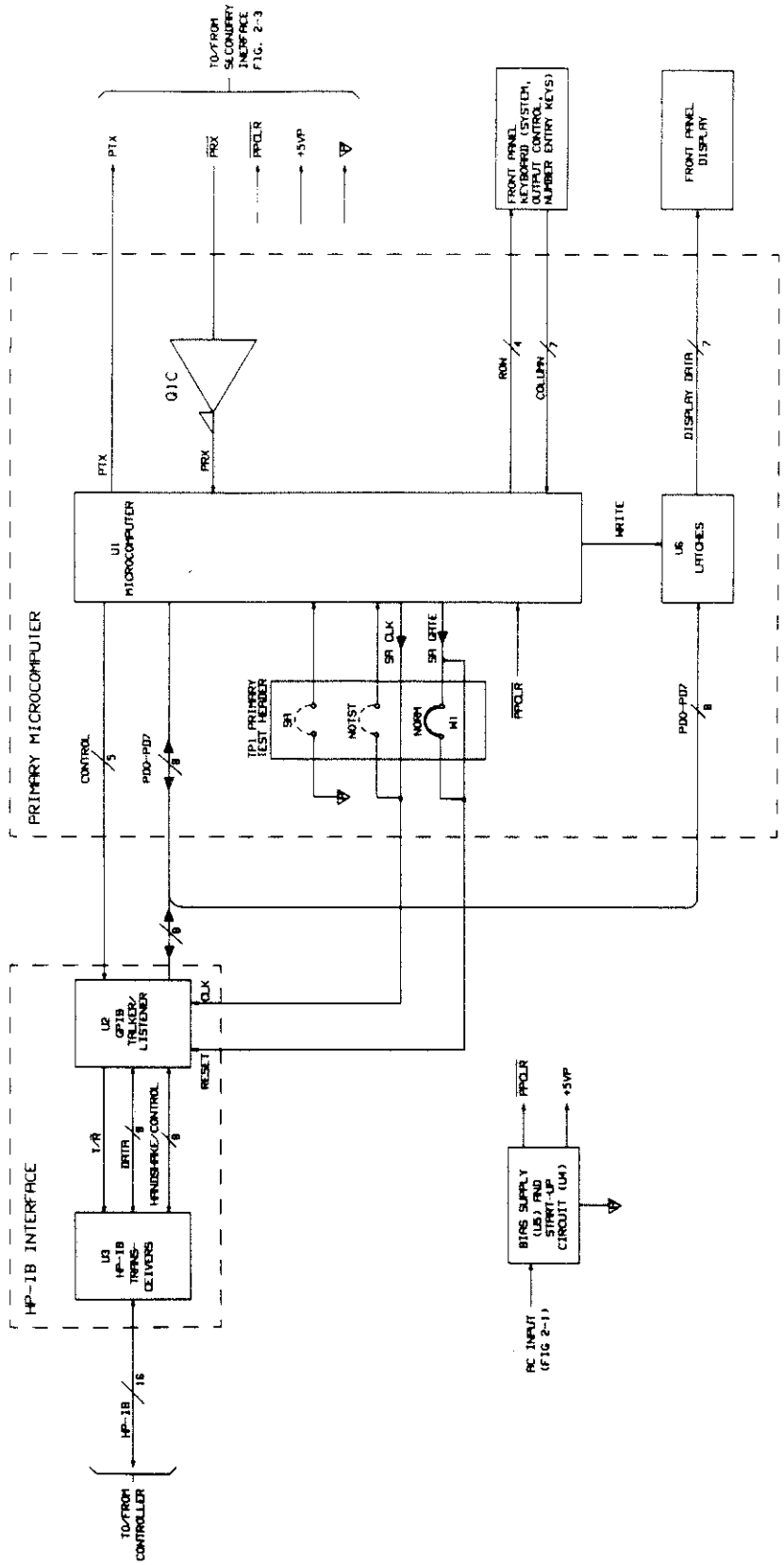


Figure 2-2. Primary Interface Circuits, Block Diagram

The primary test header TP1 provides jumper positions for testing the primary interface circuits (see Section IV). The function of each jumper position is explained as follows:

SA (Signature Analysis) — With jumper W1 installed, the primary interface microcomputer is placed in the signature analysis mode (see Section IV). Removing W1 takes the primary interface microcomputer out of the signature analysis mode.

NO TST (No Self Test) — With jumper W1 installed, the primary interface microcomputer will not perform a self test at power on. With W1 removed, the primary interface microcomputer will perform a self test at power on.

NORM (Normal Run) — Jumper W1 is stored in this position for normal operations. Both pins of this jumper postion are connected to the SA GATE signal from the microcomputer. The NORM jumper pins can be used as test points for the primary SA GATE signal during signature analysis testing.

The SA GATE output from the microcomputer is also used to reset the talker/listener chip (U2). When RESET is high, U2 is placed in an "idle" (initialization) mode. The SA CLK output (1 MHz) from the microcomputer is the external clock input to the talker/listener chip.

2-12 Primary Bias Supply and Start-Up Circuit

The bias supply (U5) provides +5 V bias voltage (designated +5Vp) for the circuits that comprise the primary interface. The start-up circuit (U4) generates the PPCLR (primary power clear) signal at power on. The PPCLR signal initializes microcomputer U1 and prevents data transfer to the secondary interface until +5Vp has stabilized. After the +5Vp bias voltage has stabilized (in approx. 110 mS), PPCLR goes high, the microcomputer is initialized, the program starts running, and the optical isolators are ready to transfer data. The +5Vp bias supply and start-up circuit are shown schematically in Figure 6-1 in the back of this manual.

2-13 SECONDARY INTERFACE (FIGURE 2-3)

Figure 2-3 is a block diagram illustrating the circuits that comprise the secondary interface. Complete circuit details are shown on the functional schematic, Figure 6-3, in the back of this manual. The functional names on the block diagram correspond with those on the schematic so that the the diagrams can be correlated. As shown in Figure 2-3, the major circuits consist of the secondary interface microcomputer, digital-to-analog converter (DAC) circuits , and readback circuits. Figure 2-3 also shows the optical isolators as well as the bias supplies and start-up circuits for the secondary interface.

2-14 Optical Isolators

Optical isolator U10 transfers the serial data PTX/ $\overline{\text{SRX}}$ from the primary interface into the secondary interface; isolator U9 transfers the serial data STX/ $\overline{\text{PRX}}$ from the secondary interface into the primary interface.

On the primary interface side, the isolators are powered by +5Vp and $\overline{\text{PPCLR}}$ which are referenced to earth ground. Note that the $\overline{\text{PPCLR}}$ is held low at power on for approximately 110 ms to prevent the erroneous transfer of data from the primary interface to the secondary interface. On the secondary interface side, the isolators are powered by +5Vs which is referenced to power supply common.

2-15 Secondary Microcomputer

The secondary microcomputer is comprised of microcomputer chip (U11), serial EEPROM (U15), inverter(U12C), and test header TP2. Microcomputer chip (U11) is an 8-bit microcomputer chip that includes a microprocessor unit (MPU), ROM, and RAM. These internal circuits process all data that is transferred between the primary interface and the power control circuits. Data is transferred serially between the primary and secondary interfaces via isolators U9 and U10 as described previously. Inverter U12C provides the proper signal levels for the serial data received on the SRX (secondary receive) signal line. Serial data is transmitted from the secondary interface on the STX (secondary transmit) signal line.

On the power control side, microcomputer U11 uses an 8-bit (SD0-SD7) parallel bidirectional data bus and select signals to program DAC's which control the output voltage, output current, and overvoltage settings. Also, various status and operating conditions are read back to microcomputer U11 via the readback circuits shown on Figure 2-3. Microcomputer U11 generates the appropriate secondary chip select signal ($\overline{\text{SCS0}}$-$\overline{\text{SCS6}}$) to select which circuit sends or receives data on the secondary data bus lines ($\overline{\text{SD0}}$-$\overline{\text{SD7}}$). The microcomputer also generates the H/ $\overline{\text{L}}$, $\overline{\text{OS3}}$, OVCLEAR, $\overline{\text{INHIBIT}}$, and $\overline{\text{SCR}}$ signals which are described later in this section.

The 256-bit serial EEPROM (electrically eraseable programmable memory),U15, stores the power supply's HP-IB address and model number as well as other data such as the calibration constants. The EEPROM is non-volatile allowing it to retain the stored information after power has been cycled on and off. The SELECT and CLOCK signals are used by the microcomputer to control the EEPROM's programming modes. At power-on, the EEPON signal holds the CLOCK signal off for 110 ms to protect against accidental data writes.

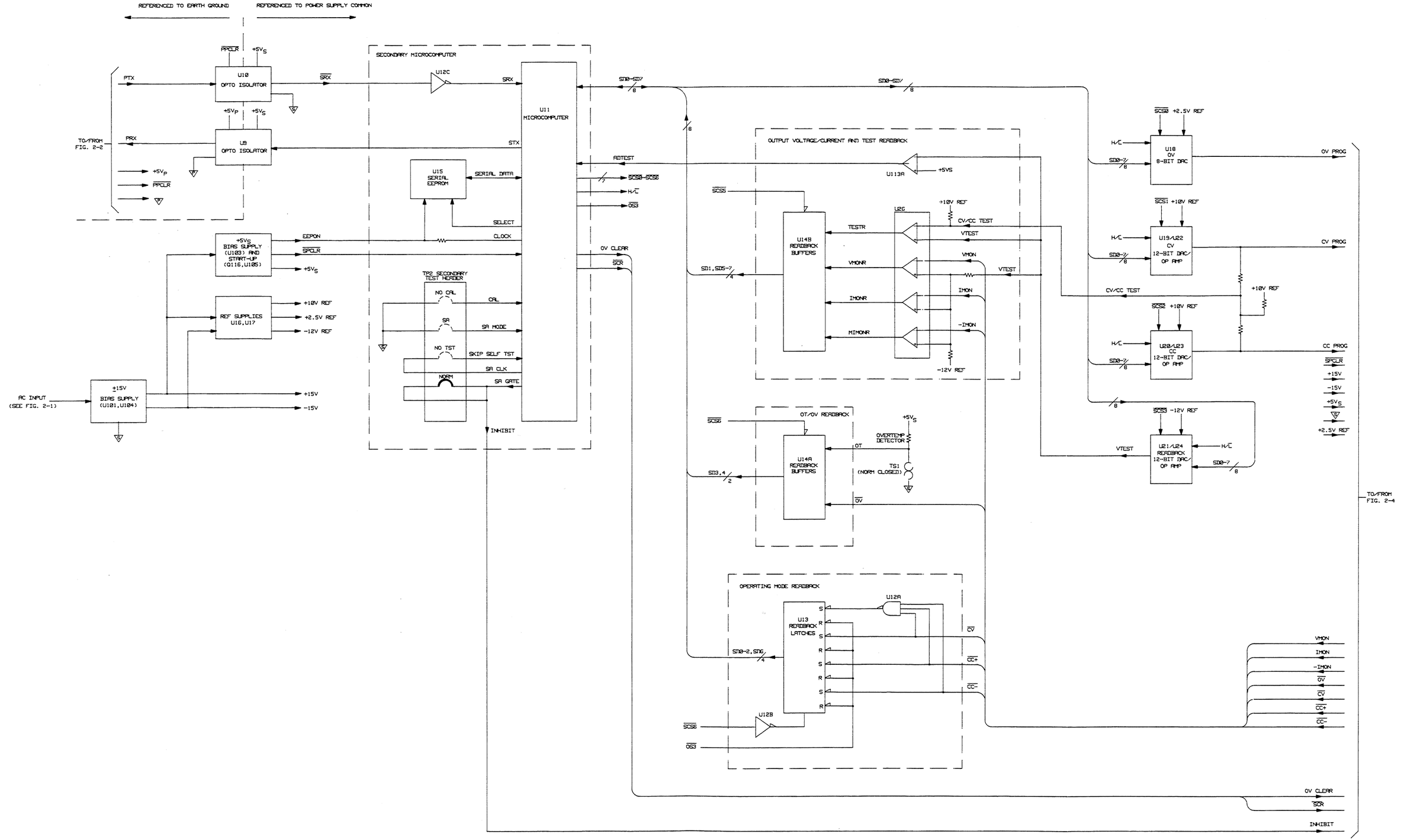


Figure 2-3. Secondary Interface Circuits, Block Diagram

Secondary test header TP2 provides jumper positions for testing the secondary interface circuits (see Section IV). The function of each jumper position is as follows:

NO CAL (No Calibration) With jumper W2 installed, the secondary microcomputer will not accept calibration commands. With W2 removed, the microcomputer will respond to calibration commands (see Appendix A in Operating Manual).

SA (Signature Analysis) With jumper W2 installed, the secondary interface microcomputer is placed in the signature analysis mode (see Section IV). Removing W2 takes the microcomputer out of the SA mode.

NO TST (No Self Test) With jumper W2 installed, the secondary interface microcomputer will not perform a self test at power on. With W2 removed, the secondary interface microcomputer will perform a self test at power on.

NORM (Normal Run) Jumper W2 is stored in this position for normal operations. Both jumper pins are connected to the SA GATE signal from the microcomputer. The NORM jumper pins can be used as test points for SA GATE during SA testing (see Section IV).

The SA GATE/INHIBIT output from the microcomputer is also sent to the power control circuits (see paragraph 2-35) as the INHIBIT signal to prevent the power mesh circuits from turning on during SA testing, at power-on, or during an OV (overvoltage condition).

2-16 Overvoltage DAC

The 8-bit overvoltage (OV) DAC, U18, converts the digital input on data bus lines SD0-SD7 into an analog signal (OV PROG) in the range of 0 to +2.5 V. The OV DAC is selected to receive the data when the microcomputer sets $\overline{SCS0}$ Low.

When the microcomputer sets $\overline{SCS0}$ Low and H/$\overline{L}$ High, the data on the bus lines is loaded into an input buffer register (in U18). The data is latched into the input buffer when $\overline{SCS0}$ is High. When the microcomputer sets $\overline{SCS0}$ Low and H/$\overline{L}$ Low, the data which is available in the input buffer is transferred into the second buffer (DAC register in U18) and converted into the OV PROG analog signal. Note that the OV PROG output is taken at U18-8 (VREF pin) and the 2.5 V Ref is connected to U18-11 (IOUT 1 pin). The OV PROG signal is applied to the overvoltage detection and control circuit (see paragraph 2-33).

2-17 Constant Voltage (CV) DAC

The constant voltage (CV) 12-bit DAC (U19) and amplifier (U22) convert the digital input on data bus lines SD0-SD7 into an analog signal (CV PROG) in the range of 0 to −10 V. This signal is sent to the voltage control circuits (see paragraph 2-30) to set the output voltage to the programmed value. A zero volt CV PROG signal sets the output voltage to zero and a −10 V CV PROG signal sets the output voltage to full scale.

DAC (U19) is selected to receive data when the microcomputer sets the $\overline{SCS1}$ signal Low. The 12-bit DAC internally formulates the the 12-bit data from the 8-bit (SD0-SD7) data bus. Bits SD4-SD7 are transferred into DAC bit positions 0-3 when the microcomputer sets the H/$\overline{L}$ signal low. Bits SD0-SD7 are transferred into DAC bit positions 4-11 when the microcomputer sets the H/$\overline{L}$ signal High.

The CV PROG signal is also sent to the readback circuits along with the CC PROG signal (see next paragraph) via the CV/CC TEST line to test the CV and CC DAC's during self test.

2-18 Constant Current (CC) DAC

The constant current (CC) 12-bit DAC (U20) and amplifier (U23) convert the digital input on data bus lines SD0-SD7 into an analog signal (CC PROG) in the range of 0 to −10 V. This signal is sent to the current control circuits (see paragraph 2-31) to set the output current (and sink current) to the programmed value. A zero volt CC PROG signal sets the output current for 0 amps (approx.) and a −10 V CC PROG signal sets the output current for ± full scale current.

DAC (U20) is selected to receive data when the microcomputer sets the $\overline{SCS2}$ signal Low. The CC DAC internally formulates the 12-bit data from the 8-bit data bus in the same manner as previously described for the CV DAC.

2-19 Readback DAC

The readback 12-bit DAC (U21) and amplifier (U24) convert the digital input on data bus lines SD0-SD7 into an analog signal (VTEST) in the range of 0 to +12 V. DAC (U21) is selected to receive data when the microcomputer sets $\overline{SCS3}$ Low. The readback DAC internally formulates the 12-bit data from the 8-bit data bus in the same manner as described for the CV DAC.

The VTEST signal is sent directly to the test readback circuit (with an added offset to the voltage/current readback circuit) to generate the readback signals (see next paragraph).

2-20 Output Voltage/Current Readback and Test Readback

The readback DAC (U21), amplifier (U24), comparators (U26 and U113A), and readback buffers (U14B) along with microcomputer (U11) form an analog-to-digital converter (ADC) which monitors the power supply's output voltage

and current as well as certain test signals. The monitored signals are simultaneously applied to comparators along with the VTEST signal from the readback DAC.

The VTEST signal output from the readback DAC, under control of microcomputer U11, successively approximates the value of the monitored signal to a 12-bit resolution. Starting with the most significant bit, each monitored signal is successively compared to the VTEST signal. VTEST is applied to all inputs simultaneously with the microcomputer selecting the appropriate output of the comparators. Each bit is kept or discarded depending upon whether the monitored signal is less than or greater than the VTEST signal. The next less significant bit is added to the sum of the previous kept bits and another comparison is made until all 12 bits have been compared. The microcomputer maintains a running total of the comparisons. When the comparisons are completed, the sum of the kept bits represents the digital value of the monitored analog signal.

At power on, the microcomputer performs a self test which includes tests of the readback DAC and the CV/CC DAC's. The microcomputer first tests the readback DAC by successively comparing the VTEST signal and the +5 Vs bias voltage inputs to comparator U113A. The comparisons are sent directly to the microcomputer on the ADTEST signal line. If this test fails, the microcomputer will display TEST ERR 16 (A/D test reads high) or TEST ERR 17 (A/D test reads low). See Table 6-7 in the Operating Manual.

If the readback DAC test passes, the microcomputer assumes that the successive approximator is operating properly and then tests the CV and CC DAC's by successively comparing the VTEST signal and the CV/CC TEST inputs to comparator U26. The microcomputer programs the CV DAC, the CC DAC, and the readback DAC to test the zero and full scale programming accuracy of the CV and the CC DAC's. These tests are sent to the microcomputer on data bus line SD5 via a readback buffer in U14B when the microcomputer sets the $\overline{SCS5}$ line low. If any of these tests fail, the microcomputer will display the applicable error code (18 through 23), see Table 6-7 in the Operating Manual. A failure stops the self test with the DAC's programmed.

The supply's output voltage, source current, and sink current are also monitored by comparators in U26. The VMON signal (0 to +10 V range), proportional to the output, represents the output voltage. The VMON signal is generated by the voltage monitor circuit (see paragraph 2-31). Either the IMON (source current) signal (−10 V to +10 V range) or the −IMON (sink current) signal (−10 V to +10 V range) from the current monitor circuit represents the output current. The successive approximation circuits can only read positive voltages. The IMON signal is positive when the supply is sourcing current and the −IMON signal is positive when the supply is sinking current.

The microcomputer measures these signals by successively comparing each one with the VTEST signal (with an added offset, see Figure 2-3). The comparisons are sent to the microcomputer on data bus lines SD4, SD6, and SD7 via readback buffers in U14B when the microcomputer sets the $\overline{SCS5}$ line Low. The VMON comparisons are sent on data bus line SD7; IMON comparisons are sent on SD4; −IMON comparisons are sent on SD6.

2-21 Overtemperature/Overvoltage Readback

This circuit consists of readback buffers U14A and overtemperature (OT) detection thermal switch TS1 (mounted on the output heatsink assembly). Switch TS1 is normally closed (no OT condition) providing a Low level OT signal to the readback buffer. When TS1 detects an OT condition, it opens causing the OT signal to go High. The microcomputer reads the OT status on data bus line SD4 when $\overline{SCS6}$ is Low.

The overvoltage ($\overline{OV}$) signal from the overvoltage detection circuit (see paragraph 2-34) is normally a High level indicating that no OV condition exists. When an OV condition is detected, a Low level ($\overline{OV}$) signal is sent to U14A. The microcomputer reads the OV status on data bus line SD3 when it sets $\overline{SCS6}$ Low.

If an OV or OT condition is detected, the output of the supply is disabled and the appropriate front panel annunciator comes on. If an overtemperature returns to normal, the supply will automatically return to the programmed output values.

2-22 Operating Mode Readback

This circuit consists of readback latches U13, NAND gate U12A, and inverter U12B. The operating mode status signals $\overline{CV}$, CC+, and $\overline{CC-}$ are applied directly to the set input of the latches from analog comparators U113C, B, and D in the voltage and current control circuits (see paragraphs 2-31 through 2-33). The appropriate latch is set when the corresponding mode signal goes Low. Inverter U12B provides the proper enable input (High level) to the latches.

If none of the operating mode signals are true (Low levels), this condition is decoded by NAND gate U12A and stored in the appropriate U13 latch. This indicates that the supply is not regulated by a CV, CC+, or CC− control loop.

Thus, readback latches (U13) provide a record of whether any of the conditions (CV, CC+, CC−, or not regulating) existed since the last time the latches were reset. The microcomputer periodically reads the latches and then sets the $\overline{OS3}$ line Low to reset the latches.

2-23 Secondary Bias Supplies and Start-Up Circuit

As shown in Figure 2-3, these circuits consist of the ±15 V and +5Vs bias supplies, the start-up circuit, and the +10 V, −12V, and +2.5 V precision reference supplies. These circuits are shown schematically on Figure 6-1 in the back of this manual.

The ± 15 V supply (U101, U104) provides operating voltage for the DAC's and operational amplifiers and also provides the power to the +5 Vs and reference voltage supplies. The dc fan voltage is regulated by VR101 and Q119.

The +10 V, −12 V, and +2.5 V reference supplies (U16, U17) provide the precision reference voltages to the DAC's. The +5 Vs supply (U103) is used by the digital circuits in the secondary interface and power control circuits.

The start-up circuit (U105, Q116B,D,E) generates the $\overline{\text{SPCLR}}$ (secondary power clear) and EEPON ($\overline{\text{EEPROM}}$ power on) signals when power is turned on. The $\overline{\text{SPCLR}}$ signal is held low at for 110 ms at power on to initialize microcomputer (U11) and to initially disable the SCR and turn-on control circuits (see paragraphs 2-35 and 2-36) until the control circuits stabilize. With these circuits disabled, power is removed from the supply's output terminals. EEPON is held High at power on to disable the EEPROM clock to protect against accidental data writes as previously described in paragraph 2-15.

If the line voltage drops after the supply has been turned-on, the start-up circuit will again generate the signals to initialize the secondary microcomputer, disable the supply's output, and protect against accidental EEPROM data writes.

2-24 POWER MESH AND CONTROL (FIGURE 2-4)

Figure 2-4 is a block diagram that illustrates the major circuits that comprise the power mesh and control circuits. Complete cicuit details for each model are shown schematically in the back of the manual in: Figure 6-4 for HP Model 6632A, Figure 6-5 for Model 6633A, and Figure 6-6 for HP Model 6634A. The functional names on the block diagram correspond with those on the schematics.

The power mesh circuit, shown in the upper half of Figure 2-4, converts the ac from power transformer T1 to a regulated dc output power. These circuits, under control of the circuits shown in the lower half of Figure 2-4, generate a constant voltage (CV) or constant current (CC+) output or provide a current sink (CC−) at the output. In addition to controlling the output stages, the control circuit sends measurement and status signals back to the HP-IB and/or the front panel via the secondary and primary interface circuits.

The following paragraphs describe circuit operation. An overview discussing how regulation is achieved is given first followed by a description of each circuit shown on Figure 2-4.

2-25 Overview

The voltage gain stage and the output stage in the power mesh section in conjunction with the voltage and current circuits in the control circuit section (see Figure 2-4) are the main regulating elements. The output stage is comprised of emitter follower output transistors and driver transistors. The driver transistors provide current gain to buffer the voltage gain stage from the output transistors.

The voltage gain stage provides voltage level translation as well as voltage gain. Voltage gain is driven by one of three control loop inputs (CV, CC+, or CC−) from the voltage or current control circuits. The selection of which loop will be the "regulating loop" is determined by a diode network located between the voltage/current control circuits and the voltage gain stage. The decoding of the diode network is such that when the supply is sourcing current, only the CV loop (voltage control circuit) or the CC+ (current control circuit) can be regulating the output. The loop that requires the output stage to deliver the least amount of output power to the connected load will dominate and regulate its output parameter (voltage or current). This is the way the supply operates when it is sourcing current.

When the supply is sinking current, only the CV loop (voltage control circuit) or the CC− loop (negative current control circuit) can be active. In this case, the supply is acting as a load instead of a power source and will attempt to pull the output voltage down by drawing off current from the externally applied source. It will regulate the output voltage if the current required to reduce the voltage is less than the programmed value (CC− value tracks the programmed CC+ setting plus an offset). The available current to be drawn from the externally applied source is determined by the CC+ programmed value. If the value of current is not large enough to allow the output voltage to reach the programmed voltage, then the CC− loop (negative current control circuit) will take over and regulate the current at its programmed value and the output voltage will be above that of the programmed voltage setting.

2-26 Rectifier and Filter

This circuit consists of two full-wave rectifier circuits with filter capacitors. The proper ac voltage levels are applied to the rectifiers via secondary windings of power transformer T1. The rectifiers and filter capacitors C101-C103 provide raw dc to the regulator circuits at two levels (+Rail and −Rail). The +Rail rectifier (D109, D110) generates a positive voltage and the −Rail rectifier (D111,D112) generates a negative voltage.

2-27 Output Stage

As shown in the simplified schematic of Figure 2-5, the output stage is comprised of emitter follower output transistors (Q101-Q108) and driver transistors (Q109 and Q110). NPN transistors Q101 to Q104 are connected between the +Rail and the + output and are driven to conduct more by a positive going signal from NPN driver Q109. PNP transistors Q105-Q108 are connected between the −Rail and the + output and are driven to conduct more by a negative going signal from PNP driver Q110.

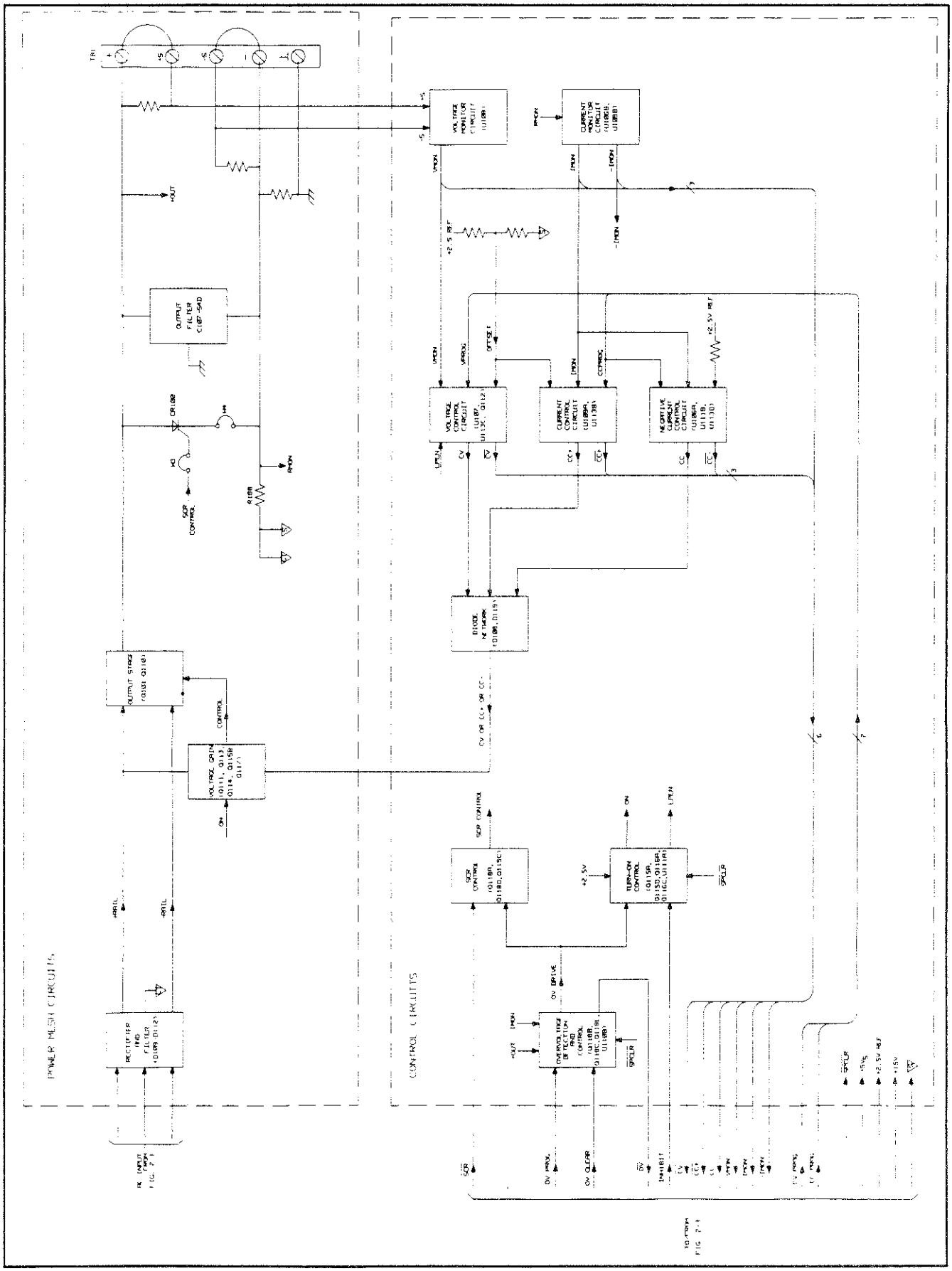


Figure 2-4. Power Mesh and Control Circuits, Block Diagram

2-28 Voltage Gain Stage

The voltage gain stage consists of transistors Q111, Q113, Q114, Q115B, and Q117 (see Figure 2-5). Transistor Q115B provides a current sink for Q113 and Q114. Q115B is turned on when a High level ON signal is received from the turn-on control circuits (see paragraph 2-35).

With Q115B turned on, a positive going control signal (CV, CC+, or CC−, see paragraphs 2-31 to 2-33) at the base of Q113 will cause Q113 to conduct more and Q114 to conduct less. When Q113 increases conduction, it causes Q111 to conduct more at the same time that Q114 conducts less. This raises the voltage at the bases of drivers Q109 and Q110 in the output stage making the output more positive.

A negative going control signal at the base of Q113 causes Q113 to conduct less and the opposite occurs. This lowers the voltage at the bases of drivers Q109 and Q110 in the output stage making the output less positive.

Transistor Q117 provides a fixed voltage from the base of Q109 to the base of Q110 so that the output stages are never completely turned-off. This keeps the output stages conducting under light or no load conditions. Thus, Q117 maintains a bleed current through both the positive and negative sections of the output stage.

2-29 SCR Crowbar

Crowbar SCR (CR100) , connected across the output (see Figure 2-4), is fired if the output voltage exceeds the programmed overvoltage value. When fired, CR100 shorts the output. A High level SCR GATE signal from the SCR control circuit (see paragraph 2-35) will fire the SCR. As shown in Figure 2-4, SCR GATE is connected to the SCR via jumper W3. Jumper W4 connects the SCR to the − output line. For certain operations, these jumpers can be removed to disconnect the SCR from the output (see paragraph 4-15 in the Operating Manual). With the SCR removed, the output will not be shorted when an overvoltage condition occurs, but the output stage will be disabled.

2-30 Output Filter

Output filter capacitors are connected across the output. The amount of capacitance is determined by the NORM/FAST mode switch S4. In the FAST position, the amount of output capacitance is decreased and the voltage programming time is shorter than it is for the NORMAL mode of operation (see paragraph 4-4 in the Operating Manual).

2-31 Voltage Control Circuit

When the supply is operating in the constant voltage mode, this circuit generates the CV (analog) and $\overline{CV}$ (digital) control signals (see Figure 2-4). The CV signal controls (via diodes D123 and D108) the input of the voltage gain stage in order to regulate the output voltage. When D123 is conducting, a Low level $\overline{CV}$ status signal is sent back to the secondary interface circuits by U113C to indicate that the supply is in the constant voltage mode of operation.

The output voltage is monitored by amplifier U108 which produces a 0 to +10V signal (VMON) which is proportional to the output voltage. The voltage control circuit compares the VMON signal to the programmable reference voltage (CV PROG) to produce the CV control signal. Note that VMON is also sent back to the secondary interface in order to read back the magnitude of the output voltage.

As shown in the simplified schematic of Figure 2-6, the output voltage (VMON, 0 to +10V), the CV PROG signal (0 to −10 V), and an offset voltage (+1.25V) are fed through scaling resistors into summing junction S1 of CV error amplifier U107. The offset voltage allows the the voltage control circuits to be calibrated at zero volts.

If the output voltage exceeds the programmed voltage, VMON goes High and summing junction S1 goes positive causing U107 to produce a more negative going CV signal. This reduces the input voltage to the voltage gain stage and hence lowers the output voltage.

If the output voltage is less than the programmed voltage, S1 goes negative causing U107 to produce a more positive going CV signal. This action drives the output of the voltage gain stage higher causing the output stage to increase the output voltage.

Diodes D118 and D123 form a gate for the CV or CC+ control signals and diodes D108 and D119 form a gate for the CV/CC+ or the CC− control signals. The CC+ and CC− signals are discussed in the next two paragraphs.

Note that the voltage control circuit includes a feedback path which is controlled by FET switch Q112 and the LPEN signal from the turn-on control circuit (see paragraph 2-34). At power-on, the LPEN (Loop Enable) signal is a High level which turns on Q112. With Q112 turned on, R137 and R138 are in parallel with the U107 circuit and the output voltage feedback is doubled. This stabilizes the CV loop during turn-on. After power has stabilized in 110 mS, LPEN goes Low and FET Q112 is turned off. With Q112 turned off, the voltage feedback is switched back to normal. The voltage control circuit and feedback loop is shown in detail on the appropriated power mesh and control schematic diagram : Figure 6-4 (HP Model 6632A), Figure 6-5 (HP Model 6633A, and Figure 6-6 (HP Model 6634A).

2-32 Current Control Circuit

When the supply is operating in the constant current mode, this circuit generates the CC+ (analog) and $\overline{CC+}$ (digital) signals (see Figure 2-4). The CC+ signal controls (via diodes D118 and D108) the input of the voltage gain stage in order to regulate the output current. When D118 is conducting, comparator U113B output goes low and the $\overline{CC+}$ signal is sent back to the secondary interface microcomputer to indicate that the supply is in the constant current mode of operation.

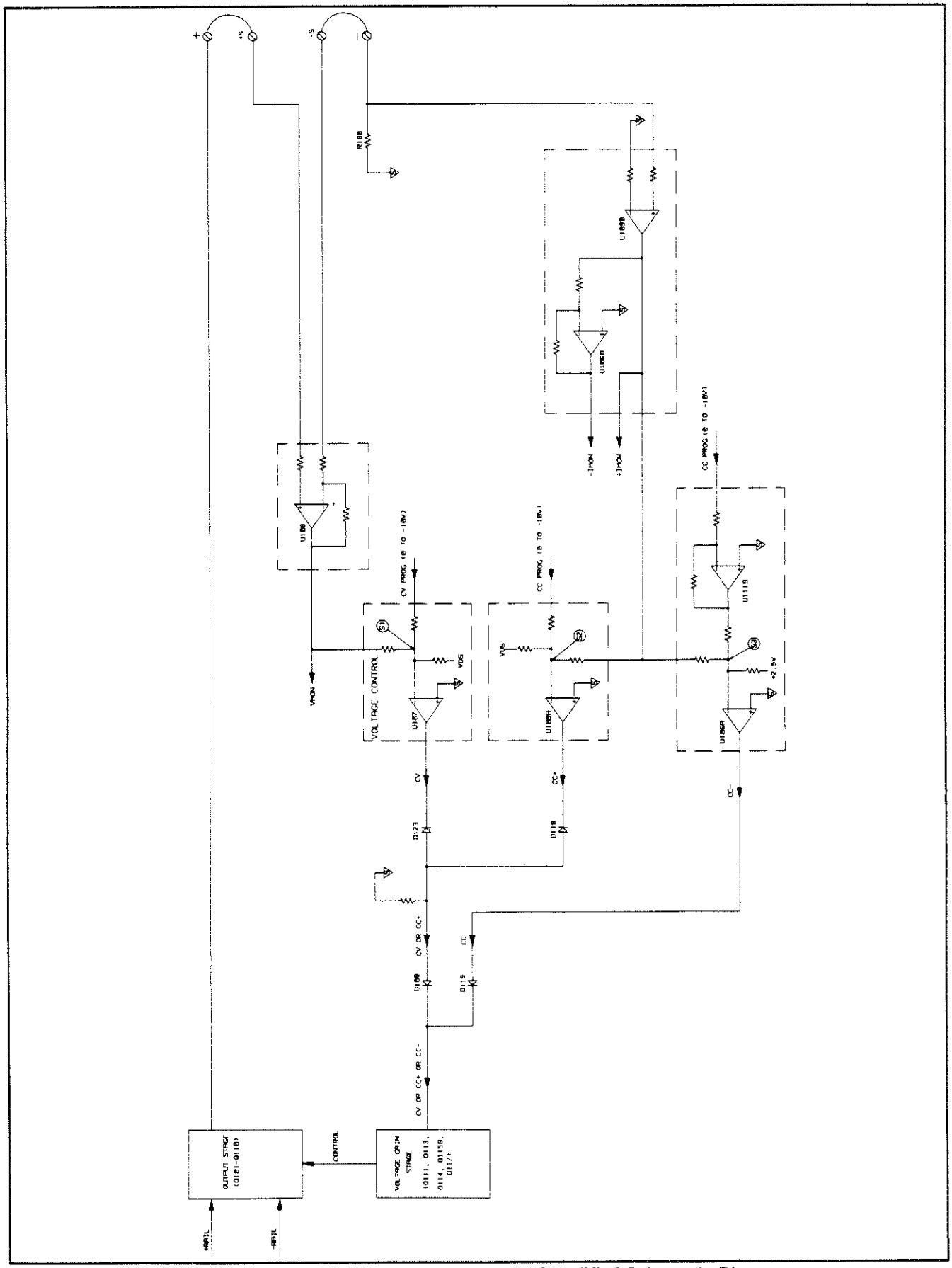


Figure 2-5. Voltage Gain and Output Stages, Simplified Schematic Diagram

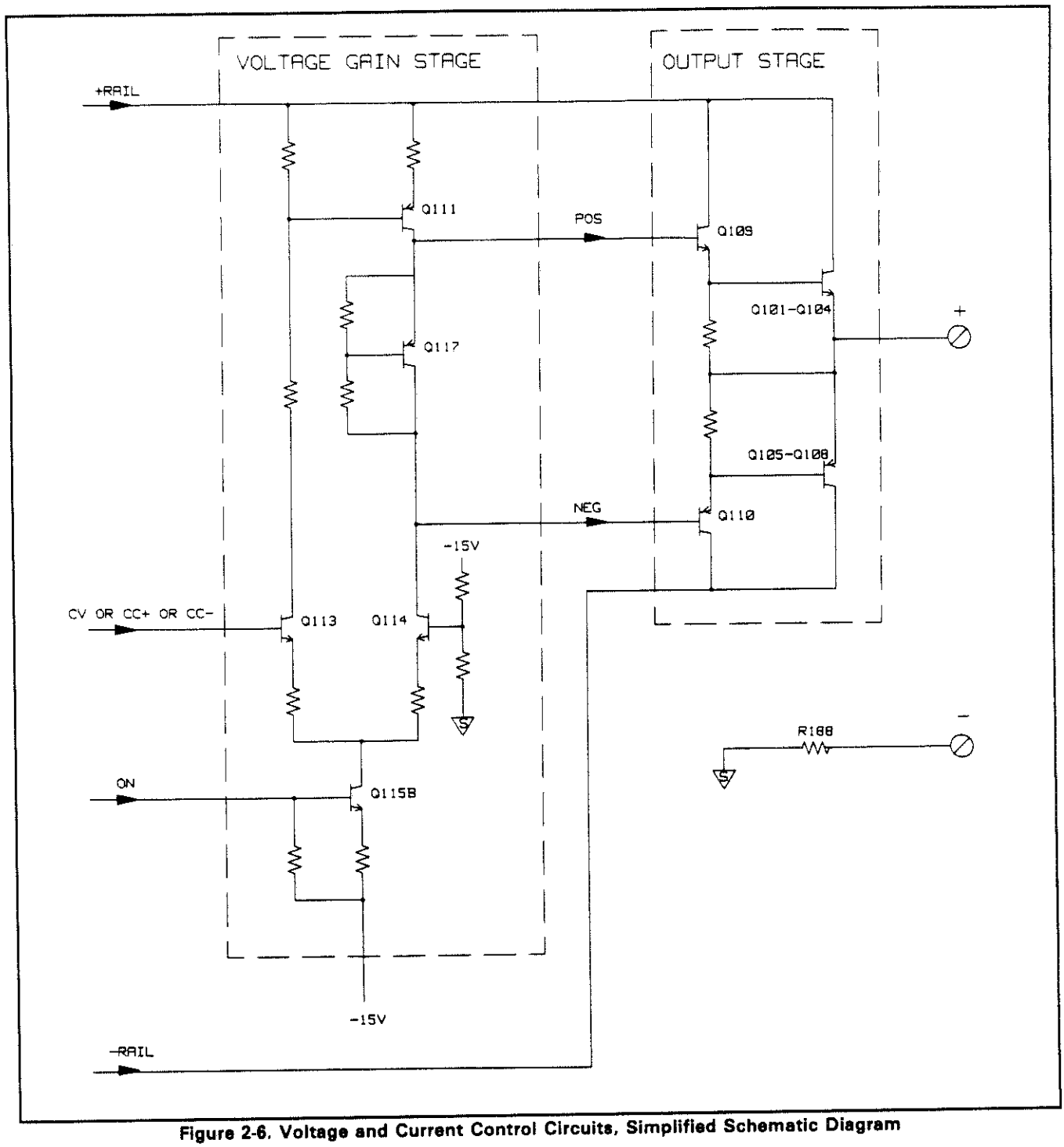


Figure 2-6. Voltage and Current Control Circuits, Simplified Schematic Diagram

The current monitor circuit (U109B) monitors the voltage (RMON) across current monitoring resistor R188. Amplifier U109B produces the IMON signal which is proportional to the current in R188. The IMON signal represents the amount of output current. The current control circuit compares the IMON signal to the programmable reference current (CC PROG) to produce the CC + control signal. When the supply is in the CV or CC + mode, IMON is in the 0 to + 10V range. When the supply is sinking current, current flows through R188 in the opposite direction and the IMON signal is in the 0 to − 10 V range (− IMON produced by U106B is in the 0 to + 10V range).

In addition to being applied to the current control circuit, IMON and − IMON are sent back to the secondary interface microcomputer in order to read back the magnitude of the output current.

As shown in the simplified schematic of Figure 2-6, the output current (IMON, 0 to +10V), the CC PROG signal (0 to −10 V), and the offset voltage (1.25V) are fed through scaling resistors to summing point S2 of CC+ error amplifier U109A. The offset voltage allows the current control circuits to be calibrated at zero.

Based on the summing action at S2, U109A generates the CC+ control signal which controls the conduction of the output stage in the same way as described previously for the voltage control circuit. During CC+ operation, D118 is forward biased and diverts current away from the base of Q113 in the voltage gain stage.

2-33 Negative Current Control

This circuit controls the amount of current that the supply can sink. The circuit is activated if a current source such as another power supply (or energy storage capacitor) is connected across the output terminals and its voltage is greater than the programmed voltage.

The negative current control circuit (CC− loop) generates the CC− (analog) and $\overline{\text{CC}-}$ (digital) signals when the voltage control circuit (CV loop) cannot regulate the output voltage while the supply is sinking current. When this occurs, the CC− signal controls (via diode D119) the conduction of the voltage gain stage and the state of comparator U113C. When D119 is conducting, a Low level $\overline{\text{CC}-}$ status signal is sent back to the secondary interface from U113C to indicate that the supply is in the −CC mode.

The negative current control circuit compares the sink current (IMON) to the inverted programmable current reference (CC PROG) to produce the CC− analog control signal. As shown in the simplified schematic of Figure 2-6, this circuit is comprised mainly of −CC error amplifier U106A and inverter U111B. The IMON signal, representing the voltage drop across the current monitoring resistor is applied to summing junction S3 of CC error amplifier U106A through R189. As described previously, when the supply is sinking current, IMON is in the 0 to −10 V range. The CC PROG signal (0 to −10 V range) is inverted (0 to +10V range) by U111B before it is applied to S3 through R190 and R194.

Based on the summing action at S3, U106A generates the CC− control signal which controls the conduction of the output stage in the same way as previously described for the voltage control circuits.

2-34 Overvoltage Detection and Control

When the output voltage exceeds the programmed OV voltage, this circuit generates the OV DRIVE signal which inhibits the output stage and fires the the SCR crowbar (CR100) shorting the output of the supply. At the same time, it generates the $\overline{\text{OV}}$ status signal which notifies the microcomputer that an overvoltage condition has occurred. The overvoltage detection and control circuit is comprised of voltage comparator IC U110 and transistor array Q118. IC U110A compares the output voltage to the programmable overvoltage reference (OV PROG). The −IMON input to U110A provides an offset to compensate for the voltage drop across the current monitor resistor.

If the output voltage (+OUT) exceeds OV PROG, U110A produces a negative going signal which sets the latch fromed by Q118E and Q118B. This results in a high level OV DRIVE signal and a low level $\overline{\text{OV}}$ signal. The $\overline{\text{OV}}$ signal is sent to the secondary interface microcomputer. As shown in Figure 2-4, the OV DRIVE signal is applied to the SCR control and turn-on control circuits. This causes the SCR control circuit to fire the SCR and the turn-on control circuit to turn off (inhibit) the output stage.

The secondary interface microcomputer resets the latch by pulsing the OV CLEAR signal High for about 100 μS. This is done when the RST front panel key is pressed or the RST command is sent via the HP-IB.

At turn-on, the $\overline{\text{SPCLR}}$ signal is low for 110 mS before it goes High and enables the overvoltage protection and control circuit. This ensures that the overvoltage protection circuit is not activated until the circuits have stabilized.

2-35 Turn-On Control

This circuit generates the ON signal to turn on the driver circuit and the LPEN signal to control a feedback network in the voltage control circuits (see paragraph 2-31). The turn-on circuit consists of transistor stages Q115 (A and D), Q116 (A and C), and voltage comparator IC U111A.

When power is turned-on, the $\overline{\text{SPCLR}}$ signal is a Low level that inhibits operation of the turn-on circuit. After the bias supplies have stabilized (in approximately 100 mS), $\overline{\text{SPCLR}}$ goes high and enables the turn-on circuit. Note that at turn-on, the microcomputer will set INHIBIT active (High) for more than 110 mS inhibiting the turn-on circuit while the microcomputer is initializing various circuits. During the time the circuit is inhibited, the ON signal is held Low and the LPEN signal is held at common potential.

With the ON signal Low, the output stage is turned off preventing the supply from generating an output. With the LPEN signal at common potential, the voltage control feedback loop is modified.

When INHIBIT goes Low, the turn-on control circuit generates the ON signal (High level) at the collector of Q115D and sets the LPEN signal (output of U111A) Low. The High level ON signal turns on transistor Q115B in the voltage gain stage allowing the output stages to conduct and produce an output. The Low level LPEN signal switches the voltage control loop back to normal gain.

2-36 SCR Control

This circuit generates the SCR GATE signal that fires the SCR crowbar. The circuit consists of transistor stages Q115C,

Q118A, and Q118D. When the OV DRIVE signal (High) is received and the $\overline{SCR}$ input to the circuit is Low, a High level SCR GATE signal is generated by C159 discharging through Q115C. The SCR GATE signal fires crowbar CR100 (see paragraph 2-29).

Note that a High level $\overline{SCR}$ signal prevents the SCR crowbar from being fired. The microcomputer sets the SCR signal high when power is turned on and sets it Low once power has stabilized.

SCR0 and SCR1 commands can be used to enable (SCR1) and disable (SCR0) the SCR control circuit for troubleshooting purposes.

Section III
VERIFICATION

3-1 INTRODUCTION

This section contains test procedures that check the operation of Power Supply Models 6632A-6634A. Four types of procedures are provided: Operation Verification Tests, Performance Tests, Extended Tests, and Temperature Coefficient Tests.

The Operation Verification Tests comprise a short procedure to verify that the supply is performing properly, without testing all specified parameters. The Performance Tests provide a more complete test of the supply by testing most of the specifications listed in Table 1-1 in the Operating Manual (HP Part No. 5957-6360).

The Extended and Temperature Coefficient tests are similar to the Performance tests except that they are conducted in a controlled environment and require a longer duration to complete each test or are tests of other specifications not tested in the performance test section. If failures are encountered or out of specification test results are observed, refer to the Troubleshooting Procedures in Section IV in this manual. The troubleshooting procedures will determine if repair and/or calibration is required. Calibration procedures are provided in Appendix A of the Operating Manual.

3-2 TEST EQUIPMENT REQUIRED

Table 3-1 lists the equipment required to perform the tests in this section. Some of the tests are performed by sending commands to and receiving data from the supply under test via the HP-IB. An HP 9825, series 80, or series 200/300 computer can be used as the HP-IB controller. Most of the tests can also be performed manually from the supply's front panel and, consequently do not require use of a controller.

CAUTION

The tests should only be performed by qualified personnel. During the performance of these tests, hazardous voltages may be present at the output of the supply.

3-3 OPERATION VERIFICATION TESTS

To assure that the supply is operating properly, without testing all specified parameters, perform the following test procedures:

a. Perform the turn-on and checkout procedures given in Section III of the Operating Manual. These procedures include a power-on self test.

b. Perform the performance tests listed below.
   Voltage Programming and Readback Accuracy (paragraph 3-12)
   CV Load Effect (paragraph 3-13)
   CV Noise (paragraph 3-15)
   Programmable OV Accuracy Test (paragraph 3-19)
   Current Programming and Readback Accuracy (paragraph 3-22)
   CC Load Effect (paragraph 3-24)

3-4 PERFORMANCE TESTS

3-5 Introduction

The following paragraphs provide test procedures for verifying the supply's compliance with the specifications listed in Table 1-1 of the Operating manual. The procedures cover Models 6632A through 6634A. All of the performance test specifications for Models 6632A-6634A are listed in the Performance Test Record (see Table 3-2). You can record the actual measured values in the column provided.

3-6 Measurement Techniques

3-7 Setup for All Tests. All tests are performed at the rear terminals. Measure the dc voltage directly at the + S and − S terminals. Connect the output for local sensing and use adequate wire gauge for load leads as described in Section IV of the Operating Manual.

NOTE

All tests are performed with the MODE switch on the rear panel set to the NORM position.

Many of the test procedures require the use of a variable load resistor capable of dissipating the required power (see Table 3-1). Using a variable load resistor requires that switches be used to connect, disconnect, and short the load resistor. For some tests, an electronic load can be used in place of a variable load resistor and switches. The electronic load is considerably easier to use than load resistors but it may not be fast enough to test transient recovery time and programming speed and may be too noisy for the noise (PARD) tests. Fixed load resistors may be used in place of a variable load resistor, with minor changes to the test procedures in this section. Also, if computer controlled test setups are used, the relatively slow (compared to computers and system voltmeters) settling times and slow rates of the power supply may have to be taken into account. "Wait" statements can be used in the test program if the test system is faster than the supply.

Table 3-1. Test Equipment Required for Verification

Type	Required Characteristics	Recommended Model
HP-IB Controller	Full HP-IB capabilities	HP 9825, series 80, or series 200/300 computer
Oscilloscope	Dual Channel Sensitivity: 1 mV Bandwidth Limit: 20 MHz Probe: 1:1 with RF tip	HP 1741A
RMS Voltmeter	True RMS: Bandwidth 20 MHz Sensitivity: 100 μV	Rohde and Schwarz Model URE
Digital Voltmeter (6½ digit)	Resolution: 100 mV @ 1 V Accuracy: 0.0035%	HP 3455A, 3456A, or 3457A
Current Monitor Resistor (Figures 3-2 and 3-9)	Value: 0.1 Ω, 10 amp Accuracy: 0.05% or better	Leeds and Northrup 4221-B or HP 0811-3775
Resistor (Figures 3-3 and 3-5	10 K Ω, 3 W, ±5%	HP 0811-1816
Diodes (2) (Figures 3-3 and 3-5)	100 V 3 A Silicon diode	HP 1901-0719 or HP 1901-1087
Variable Voltage Transformer	Adjustable from −13% to +6% of input voltage range. 500 VA minimum	
DC Power Supplies (Figures 3-5 and 3-9)	0 to 100 V, High stability 5 V @ 6 A	HP 6115A HP 6023A/6263B
Current Probe with Amplifier and Power Supply (Figure 3-10)	This test setup gives a sensitivity of 1 mA/10 mV to 50 MHz with less than 300 μA of noise to 5 MHZ.	Tektronix A6302 (probe), AM503 (probe amplifier), and TM501 (probe power supply)
Current Monitor Resistors (Figure 3-10B)	Must be non-inductive: 1 Ω, 25 W min. (HP 6632A) 1 Ω, 4 W min. (HP 6633A) 1 Ω, 1 W min. (HP 6634A)	HP 0811-2967 HP 0811-1340 HP 0811-1046
Electronic Load*	Voltage and Current range must exceed range of supply under test. Power Range: 100 W min.	Transistor Dev. DLP 130-15-750
Variable (or fixed) Load resistors	8 Ω, 100 W, 2 each (HP 6632A) 50 Ω 100 W, 2 each (HP 6633A) 200 Ω, 100 W, 2 each (HP 6634A)	
Load Switch (Figure 3-7):	5 A, switchable at line freq.; consists of: Relay Capacitor 0.47 μF, 100 V Resistor 1.5 Ω, 3 W Diodes (2) 400 V, 1 A Resistor 10 K, 3 W Resistor, var., 25 K, 2 W	 Clare HGP 1002 HP 0160-5286 HP 0811-1220 HP 1901-0719 or HP 1901-1087 HP 0811-1816 HP 2100-3272

* An electronic load may introduce too much ripple to perform an accurate CC PARD test and may not slew fast enough to perform the Transient Response and Programming Speed tests.

Table 3-2. Performance Test Record for Models HP 6632A-6634A

Model _____ Temperature _____ Pre Cal _____ Post Cal _____

Serial No. _____ Humidity _____ Test Performed By _____

Date _____

Para.	Test (All tests performed in the NORMAL mode)	Specification HP 6632A	Specification HP 6633A	Specification HP 6634A	Actual
3-12	CV PROGRAMMING @ 0 VOLTS Output Accuracy (DVM Reading) Display Accuracy and Readback Accuracy	0V ± 10 mV DVM ± 15 mV	0 ± 20 mV DVM ± 30 mV	0 ± 50 mV DVM ± 70 mV	____
3-12	CV PROGRAMMING @ FULL SCALE Output Accuracy (DVM Reading) Display Accuracy and Readback Accuracy	20 V ± 20 mV DVM ± 29 mV	50 V ± 50 mV DVM ± 65 mV	100 V ± 100 mV DVM ± 130 mV	____ ____
3-13	CV LOAD EFFECT	2 mV	4 mV	5 mV	____
3-14	CV SOURCE EFFECT	0.5 mV	1 mV	1 mV	____
3-15	CV NOISE (PARD) Peak to Peak Rms	3 mV 300 μV	3 mV 500 μV	3 mV 500 μV	____ ____
3-16	CV DOWN PROG. SPEED 90% to 10% To < 1 LSB (0.025%)	15 mS 60 mS	15 mS 60 mS	15 mS 60 mS	____ ____
3-17	CV UP PROG. SPEED 10% to 90% To < 1 LSB (0.025%)	15 mS 60 mS	15 mS 60 mS	15 mS 60 mS	____ ____
3-18	TRANSIENT RECOVERY TO 0.1%	100 μS	100 μS	100 μS	____
3-19	OVERVOLTAGE PROTECTION Set at Should fire between	19 V 18.285-19.716 V	49 V 47.18-50.82 V	98 V 94.35-101.65 V	____ Yes/No
3-22	CC PROGRAMMING @ 0 AMPS Output Accuracy (Io) Display Accuracy and Readback Accuracy	20 mA ± 7 mA Io ± 9 mA	8 mA ± 2 mA Io ± 3 mA	4 mA ± 1 mA Io ± 2 mA	____ ____
3-22	CC PROGRAMMING @ FULL SCALE Output Accuracy (Io) Display Accuracy and Readback Accuracy	5 A ± 14.5 mA Io ± 18 mA	2 A ± 5 mA Io ± 6.4 mA	1 A ± 2.5 mA Io ± 3.5 mA	____ ____
3-23	– CC – Current Limit (Is) Display Accuracy and Readback Accuracy	– 5.25A ± 192 mA Is ± 40 mA	– 2.10A ± 77 mA Is ± 17 mA	– 1.05 A ± 38 mA Is ± 11 mA	____ ____
3-24	CC LOAD EFFECT	1 mA	1 mA	1 mA	____
3-25	CC SOURCE EFFECT	0.5 mA	0.25 mA	0.25 mA	____
3-26	CC NOISE (RMS)	2 mA	2 mA	2 mA	____

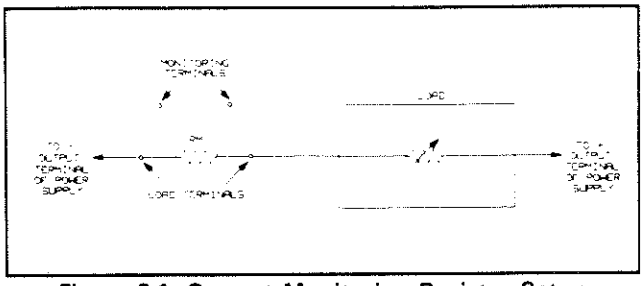


Figure 3-1. Current Monitoring Resistor Setup

3-8 Current-Monitoring Resistor. To eliminate output current measurement error caused by voltage drops in the leads and connections, connect the current monitoring resistor between the—output and the load as a four-terminal device. Figure 3-1 shows the connections. Connect the current-monitoring leads inside the load-lead connections directly at the monitoring points on the resistor element.

3-9 Programming. You can program the supply from the front panel keypad or from an HP-IB controller when performing the tests. The test procedures are written assuming that you know how to program the supply remotely from an HP-IB controller or locally using the control keys and indicators on the supply's front panel. Complete instructions on remote and local programming are given in the Operating Manual.

NOTE

In the test programs that follow, the brackets < > indicate a number to be sent. The voltage and current values which are sent to a specific model are given in Table 3-3.

3-10 Constant Voltage (CV) Tests

3-11 CV Setup. If more than one meter or a meter and an oscilloscope are used, connect each to the terminals by a separate pair of leads to avoid mutual coupling effects. For DC tests, connect only to +S and −S because the unit regulates the output voltage that appears between +S and −S, not between + and − output terminals. Use coaxial cable or shielded 2-wire cable to avoid noise pickup on the test leads.

3-12 Voltage Programming and Readback Accuracy. This test verifies that the voltage programming, HP-IB readback, and front panel display functions are within specifications. Note that the values read back over the HP-IB should be identical to those displayed on the front panel.

a. Turn off the supply and connect a digital voltmeter between the +S and −S terminals.

b. Turn on the supply. It should start up at zero volts output.

c. Record the output voltage readings on the digital voltmeter (DVM) and the front panel display. The readings should be within the limits specified in Table 3-2, CV PROGRAMMING @ 0 Volts, for the particular model being tested. Also, note that the CV annunciator is on. The output current reading should be approximately zero because there is no load connected.

d. Program the output voltage to Full Scale:

VSET <20, 50, or 100>

e. Record the output voltage readings on the DVM and the front panel display. The readings should be within the limits specified in Table 3-2, CV PROGRAMMING @ FULL SCALE, for the particular model being tested.

3-13 CV Load Effect. This test measures the change in output voltage resulting from a change in output current from full load to no load.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-2 with the DVM connected between the +S and −S terminals, the Load switch closed, and the Short switch opened.

b. Turn on the suppy and program the current to the maximum programmable value and the output voltage to the full scale value (see Table 3-3):

ISET <5.1188, 2.0475, or 1.0238>
VSET <20, 50, or 100>

c. Adjust the load for the full scale current value (see Table 3-3) as indicated on the front panel display. The CV annunciator on the front panel must be on. If it is not, adjust the load down slightly.

d. Record the output voltage reading on the DVM connected to +S and −S.

e. Open the Load switch and again record the DVM voltage reading. The difference between the DVM readings in steps d and e is the load effect voltage and should not exceed those listed in Table 3-2, CV LOAD EFFECT, for the model being tested.

Table 3-3. Voltage and Current Values

Model	Full Scale Voltage	Max. Prog. Voltage	Full Scale Current	Max. Prog. Current	Min. Prog. *Current	Max. Prog. Overvoltage
6632A	20 V	20.475 V	5 A	5.1188 A	0.02 A	22 V
6633A	50 V	51.188 V	2 A	2.0475 A	.008 A	55 V
6634A	100 V	102.38 V	1 A	1.0238 A	0.004 A	110 V

* The supply cannot be programmed to 0 amps. If the supply receives a command to go to 0 amps (or any positive current below the minimum programmable value), it will set itself to the minimum programmable value.

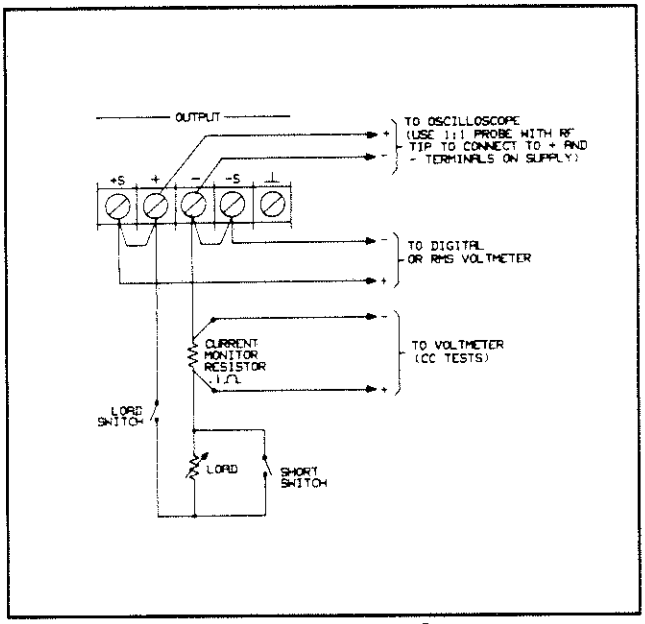


Figure 3-2. Basic Test Setup

3-14 CV Source Effect. This test measures the change in output voltage that results from a change in ac line voltage from the minimum to maximum value within the line voltage specifications.

a. Turn off the supply and connect the ac power line through a variable voltage transformer.

b. Connect the output as shown in Figure 3-2 with the DVM connected between the +S and −S terminals, the Load switch closed, and the Short switch opened. Set the transformer to the nominal line voltage.

c. Turn on the supply and program the current to the maximum programmable value and the output voltage to the full scale value (see Table 3-3):

ISET <5.1188, 2.0475, or 1.0238>
VSET <20, 50, or 100>

d. Adjust the load for the full scale current value (see Table 3-3) as indicated on the front panel display. The CV annunciator on the front panel must be on. If it is not, adjust the load down slightly.

e. Adjust the transformer to 13% below the nominal line voltage (e.g., 104.4 Vac for a 120 Vac nominal line voltage input).

f. Record the output voltage reading on the DVM.

g. Adjust the transformer to 6% above the nominal line voltage (e.g., 127.2 Vac for 120 Vac nominal line voltage input).

h. Record the output voltage reading on the DVM. The difference between the DVM readings in steps f and h is the source effect voltage and should not exceed the values listed in Table 3-2, CV SOURCE EFFECT.

3-15 CV Noise (PARD). Periodic and random deviations (PARD) in the output (ripple and noise) combine to produce a residual ac voltage superimposed on the dc output voltage. CV PARD is specified as the rms or peak-to-peak output voltage in a frequency range from 20 Hz to 20 MHz.

a. Turn off the supply and connect the output as shown in Figure 3-2 to an oscilloscope (ac coupled) between the + and − terminals. Use only a resistive load for this test. Close the load switch and open the short switch. Set the oscilloscope's 20 MHz bandwidth limit on and use an RF tip on the oscilloscope probe. Also, make sure that the OUTPUT MODE switch on the supply's rear panel is in the NORMAL position.

b. Turn on the supply and program the current to the maximum programmable value and the output voltage to the full scale value (see Table 3-3):

ISET <5.1188, 2.0475, or 1.0238>
VSET <20, 50, or 100>

c. Adjust the load for the full scale current value (see Table 3-3) as indicated on the front panel display. The CV annunciator on the front panel must be on. If it is not, adjust the load down slightly.

d. Note that the waveform on the oscilloscope should not exceed the limits in Table 3-2, CV NOISE (PARD).

e. Disconnect the oscilloscope and connect an AC rms voltmeter in its place. The rms voltage reading should not exceed the limits in Table 3-2, CV NOISE (PARD).

3-16 CV Down Programming Speed. This test measures the time required for the output voltage to change from 90% of the full scale voltage value to 10% of the full scale voltage value in the normal output mode (OUTPUT MODE switch set to the NORMAL position). Also measured is the time an output takes to change from full scale to 1 LSB.

a. Turn off the supply and connect the output as shown in Figure 3-3.

b. Turn on the supply and program the current to full scale (see Table 3-3) and the output voltage to zero:

ISET <5, 2, or 1>
VSET 0

c. Using Channel A and auto trigger, set the scope's volts/division switch to 2 V/div (6632A), 5 V/div (HP 6633A), or 10 V/div (HP 6634A), dc coupled and position the trace on the bottom horizontal line (or 0% line if using the HP1741A).

d. Using Channel B on the oscilloscope, set the volts/division switch to 10 mV/div dc coupled and position the trace on the bottom horizontal line (or 0% line). Set the time base to 10 ms/div.

e. Set the output voltage to full scale (see Table 3-3). Adjust Channel A vertical vernier for top line (or 100% line).

f. Using an HP-IB controller, program the output voltage in a loop which alternately programs the output voltage between 0 and the full scale value (see Table 3-3), pausing for 100 milliseconds at each value.

```
10 OUTPUT 705;"VSET 0"
20 WAIT .1
30 OUTPUT 705;"VSET <20, 50, or 100>"
40 WAIT .1
50 GOTO 10
60 END
```

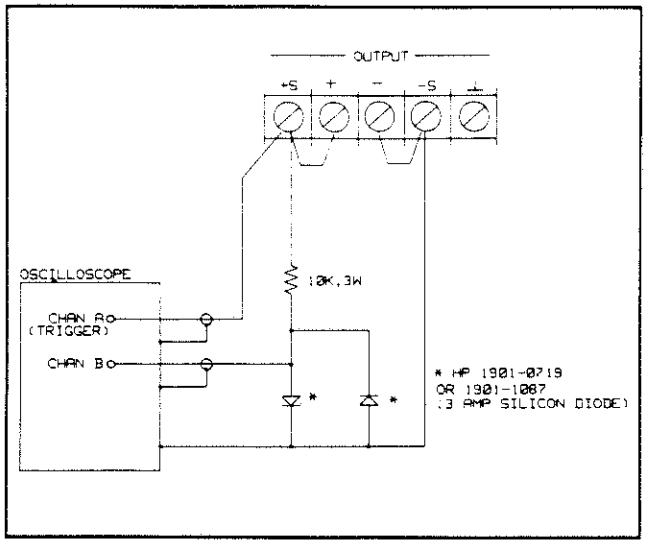


Figure 3-3. Down Programming Speed Test Setup

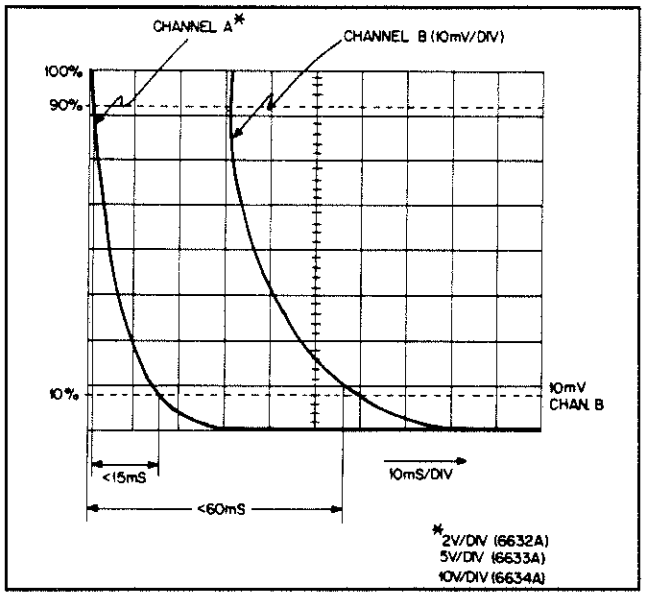


Figure 3-4. CV Down Programming Speed Test Waveforms

NOTE

The CV annunciator should remain on at all times while the test is in progress.

g. Set the oscilloscope to normal trigger, observe Channel A on the oscilloscope, and adjust for a stationary waveform by using Channel A as the trigger source, set to trigger on a negative edge. Be sure to trigger as close as possible to the time when the output voltage just begins to fall.

h. On Channel A, observe the output voltage transition from 90% of full scale voltage to 10% of full scale voltage. It should take place in less than the time specified in Table 3-2, CV PROG SPEED. Look for a smooth waveform with no "kinks" or aberrations. Refer to the Channel A waveform shown in Figure 3-4.

i. Now observe Channel B on the oscilloscope while maintaining the trigger on Channel A as in step f. Note that the diode clamp, used in the test setup of Figure 3-3, prevents gross overload of Channel B (which is set at 10 mV/div) allowing examination of the "tail" of the waveform. The output voltage should be within 1 LSB (5 mV for HP 6632A, 12.5 mV for HP 6633A, 25 mV for HP 6634A) of its final settling value on the bottom horizontal line in less than the time specified in Table 3-2, CV PROGRAMMING SPEED. Refer to the Channel B waveform in Figure 3-4. The 1 LSB value for the particular model being tested is listed Table 3-2.

3-17 CV Up Programming Speed. This test measures the time required for the output voltage to rise from 10% to 90% of the full scale value. Also measured is the time the output takes to change from zero volts to within 1 LSB of the full scale voltage value.

a. Turn off the supply and connect the output as shown in Figure 3-5.

b. Turn on the supply and program the output voltage and current to the full scale values (see Table 3-3):

ISET <5, 2, or 1>
VSET <20, 50, or 100>

c. Set the vertical sensitivity switch of Channel A on the oscilloscope to 2 V/div (HP 6632A), 5 V/div (HP 6633A), or 10 V/div (HP 6634A). With the scope's input switch in the GND position and with the scope set for normal trigger and chopped display, adjust the trace to the bottom (or 0%) line. Then set the input switch to the dc coupled position and adjust vertical vernier for top (or 100%) line. Set the vertical sensitivity switch on Channel B of the oscilloscope to 10 mV/div and the input switch to the GND position.

d. Adjust the Channel B trace to the top (100%) line of the oscilloscope and move the input switch to the DC position.

e. Adjust the bucking supply to approximately full scale output voltage (see Table 3-3) until the B trace is as close as possible (within 1 division) to the top 100% line and then use the scope vertical adjust to fine adjust the trace to the top horizontal line.

f. Set the time base to 10 mS/div.

g. Use an HP-IB controller to program the output voltage in a loop which alternately programs the voltage between 0 V and the full scale value (see Table 3-3), pausing for 100 milliseconds at each value:

```
10 OUTPUT 705;"VSET 0"
20 WAIT .1
30 OUTPUT 705;"VSET <20, 50, 100>"
40 WAIT .1
50 GOTO 10
60 END
```

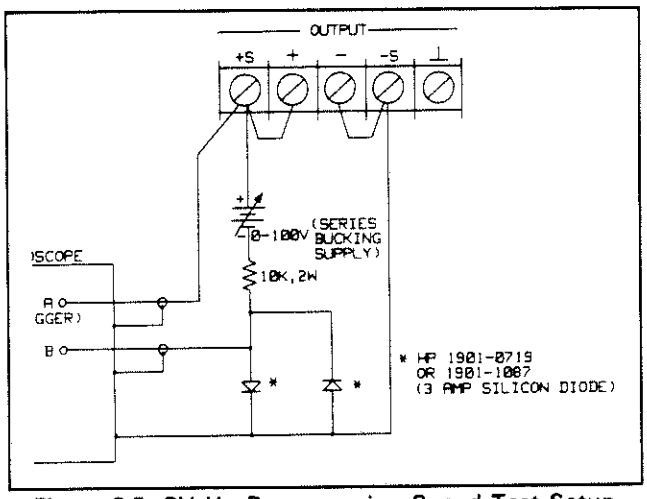


Figure 3-5. CV Up Programming Speed Test Setup

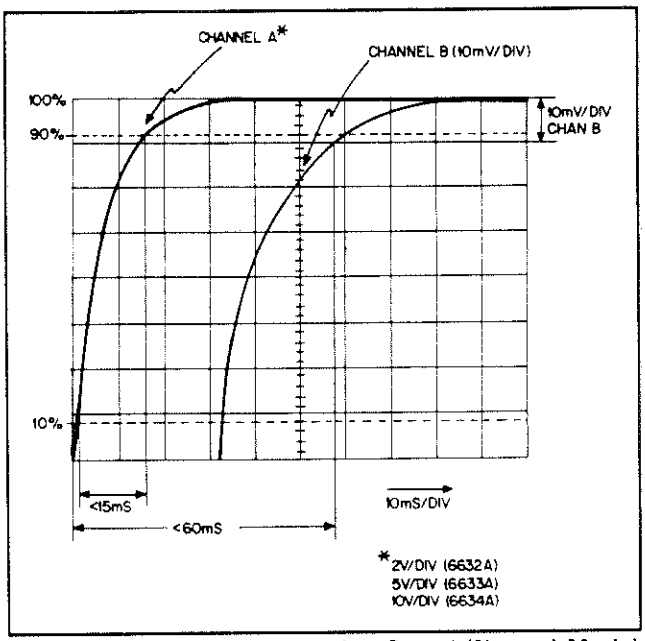


Figure 3-6. CV Up Programming Speed (Normal Mode) Test Waveforms

NOTE

The CV Annunicator should remain on at all times while the test is in progress.

h. Observe Channel A on the oscilloscope and adjust for a stationary waveform by using Channel A as the trigger source set to trigger on a positive edge. Be sure to trigger as close as possible to the time when the output voltage just begins to rise.

i. On Channel A, observe the output voltage transition from the scope's 10% horizontal line to 90% of full scale voltage. It should take place in less than the time specified in Table 3-2, CV PROGRAMMING SPEED. Look for a smooth waveform with no "kinks" or aberrations. Refer to the Channel A waveform in Figure 3-6.

j. Now observe Channel B on the oscilloscope while maintaining the trigger on Channel A as in step h. Note the series supply bucks out the full scale output voltage and that the waveform is clamped at approximately 0.6 V and rises to the top horizontal line when the output voltage is at full scale. The diodes (see Figure 3-5) prevent gross overload of Channel B (which is set at 10 mV division) allowing examination of the "tail" of the waveform. The output voltage should be within 1 LSB (5 mV for HP 6632A, 12.5 mV for HP 6633A, 25 mV for HP 6634A) of its final settling value on the top horizontal line in less than the time specified in Table 3-2, CV PROGRAMMING SPEED.

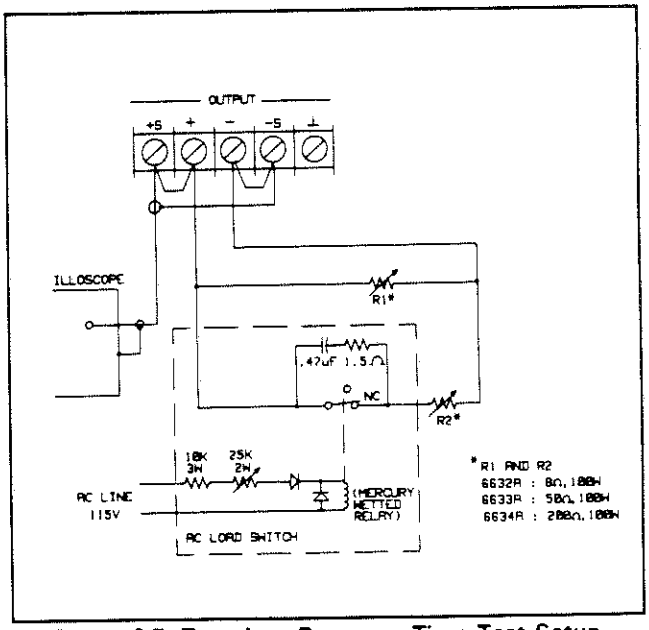


Figure 3-7. Transient Recovery Time Test Setup

3-18 Transient Recovery Time. This test measures the time for the output voltage to recover to within the specified value following a change from ½ load to the full scale current value.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-7. Make sure that the OUTPUT MODE switch on the rear of the supply is in the NORM position.

b. Turn on the supply and program the output voltage to the full scale value and the current to the maximum programmable value (see Table 3-3).

c. With R2 disconnected, adjust R1 for ½ full scale current as indicated on the front panel display.

d. Connect R2 and adjust to read the full scale current value on the front panel display. Note that the CV annunciator should be on. If it is not on, readjust R2 until it is on.

e. Set the oscilloscope to 20 mV/div (HP 6632A) or 50 mV/div(HP 6633A, HP 6634A), ac coupled, 20 μS/div, internal trigger, normal, and − slope.

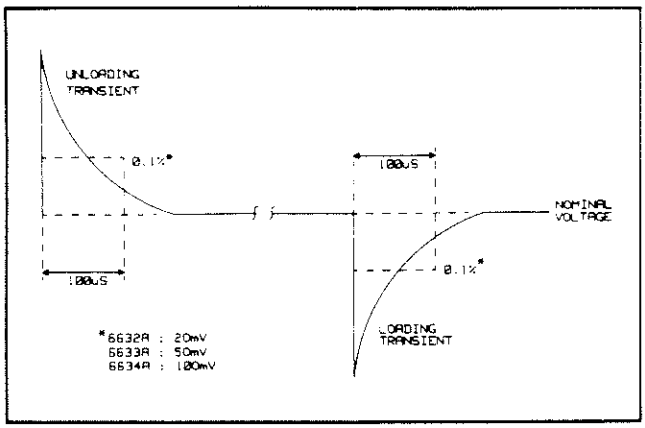


Figure 3-8. Transient Response Waveform

f. Turn on the AC load switch to perform the transient response test. Note that if an electronic load is used, the load's current rise time must be less than 25 μsec in order to perform an adequate test.

g. Adjust the oscilloscope trigger level for a stationary waveform as shown in Figure 3-8 and check that the loading transient is within 0.1% (20 mV for HP 6632A, 50 mV for HP 6633A, or 100 mV for HP 6634A) of its final value in less than the time specified in Table 3-2, TRANSIENT RECOVERY TO 0.1%.

h. Change the oscilloscope settings to + slope and repeat steps f and g for the unloading transient (see Figure 3-8).

3-19 Programmable OV Accuracy Test. This test checks the overvoltage (OV) programming accuracy.

a. Turn off the supply and disconnect all loads and test equipment.

b. Turn on the supply and program the current to full scale (see Table 3-3) and the OV setting given in Table 3-2, OVERVOLTAGE PROTECTION.

ISET <5, 2, or 1>
OVSET <19, 49 or 98>

c. Program the output voltage to the lower limit given in Table 3-2, OVERVOLTAGE PROTECTION.

VSET <18.285, 47.18, or 94.35>

d. Note that the overvoltage should not trip and the front panel should display the programmed output voltage and no current.

e. Program the output voltage to the upper limit given in Table 3-2, OVERVOLTAGE PROTECTION.

VSET <19.716, 50.82, or 101.65>

f. Note that the overvoltage has tripped as indicated by the OV annunciator being on and the output voltage being near zero volts.

g. Set the OV to the maximum programmable value (see Table 3-3) and reset the output:

OVSET <22, 55, or 110>
RST

i. Check that the front panel again displays the programmed output voltage and no current.

3-20 Constant Current (CC) Tests

3-21 CC Setup. Follow the general setup instructions of paragraphs 3-5 through 3-9 and the specific instructions given in the following paragraphs.

3-22 Current Programming and Readback Accuracy. This test verifies that the current programming and readback are within specification. The accuracy of the current monitoring resistor must be 0.05% or better.

a. Turn off the supply and connect a 0.1 ohm current monitoring resistor across the output and a DVM across the resistor (see paragraph 3-8). Note that resistance values other than 0.1 ohm can be used in this test. If a different value is used, the calculations in steps c and e must be changed accordingly.

b. Turn on the supply and program the output voltage to 5 V and the current to the minimum programmable value:

VSET 5
ISET 0

NOTE

The output cannot be programmed to 0 amps. If the supply receives a command to go to 0 amps (or any positive current below the minimum programmable current), it will set itself to the minimum value (see Table 3-3).

c. Divide the voltage drop (DVM reading) across the current monitoring resistor by 0.1 ohms to convert to amps and record this value (Io). Note also the current reading on the front panel display. The readings should be within the limits specified in Table 3-2, CC PROGRAMMING @ 0 AMPS, for the particular model being tested.

d. Program the output voltage to 5 V and the current to full scale (see Table 3-3):

VSET 5
ISET <5, 2, or 1>

e. Divide the voltage drop (DVM reading) across the current monitoring resistor by 0.1 ohms to convert to amps and record this value (Io). Also, record the current reading that appears on the front panel display. The readings should be within the limits specified in Table 3-2, CC PROGRAMMING @ FULL SCALE, for the particular model being tested. Note that because the current monitoring resistor has 0.05% accuracy, an error (2.5 mA for HP 6632A, 1 mA for HP 6633A, 0.5 mA for HP 6634A) must be added to the (14.5 mA, 5 mA, 2.5 mA) listed in Table 3-2, CC PROGRAMMING @ FULL SCALE.

3-23 Negative Constant Current (CC –) Operation. This test verifies that negative current operation and readback.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-9.

b. Set the external power supply to 5 V and its current limit to 1.2 times (approx.) the full scale current value (see Table 3-3) of the supply under test. For example, if the full scale current value is 2 A, set the external supply's current limit to about 2.4 A.

c. Turn on the supply and program the output voltage to zero and the current to the value specified in Table 3-2.

VSET 0
ISET <5, 2, or 1>

d. Divide the voltage drop across the current monitoring resistor by 0.1 ohms to obtain the current sink value (Is) in amps and record the value. Record also the current reading on the display. The readings should be within the limits specified in Table 3-2, – CC, for the particular model being tested.

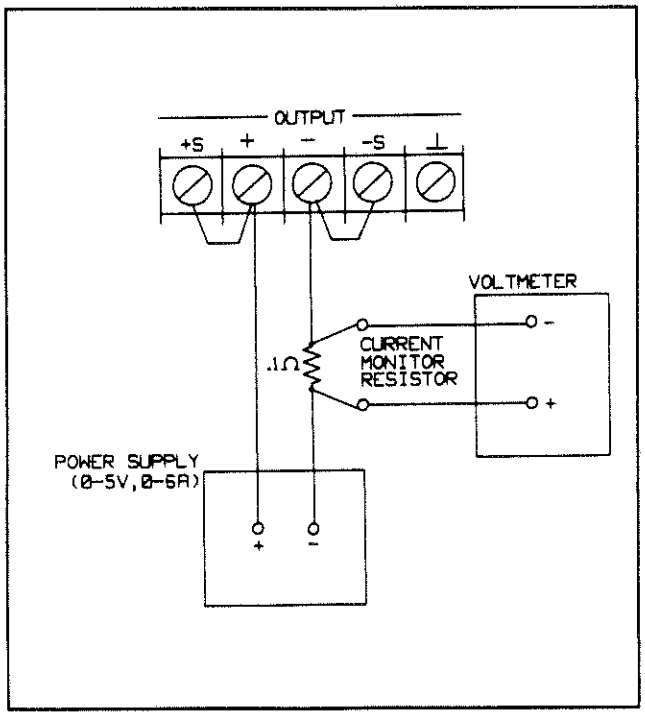


Figure 3-9. Negative Current Readback Accuracy, Test Setup

3-24 CC Load Effect. This test measures the change in output current for a change in the load from full scale output voltage to short circuit.

a. Turn off the supply and connect the output to be tested as shown in Figure 3-2 with the DVM connected across the current monitoring resistor, the load switch closed, and the short switch opened.

b. Turn on the supply and program the current to the full scale current value and the output voltage to the maximum programmable voltage value (see Table 3-3):

ISET <5, 2, or 1>
VSET <20.475, 51.188, or 102.38>

c. Adjust the load for full scale voltage as indicated on the front panel display. Check that the CC annunciator is on. If it is not, adjust the load so the the output voltage drops slightly.

d. Record the output current reading (DVM reading/0.1 ohm).

e. Close the short switch and record the output current reading. The difference in the current readings in steps d and e is the load effect and should not exceed the limit specified in Table 3-2, CC LOAD EFFECT.

3-25 CC Source Effect. This test measures the change in output current that results when the ac line voltage changes from the minimum to the maximum value within the specifications.

a. Turn off the supply and connect the ac power line through a variable voltage transformer.

b. Connect the output terminals as shown in Figure 3-2 with the DVM connected across the current monitoring resistor, the load switch closed, and the short switch opened. Set the transformer at nominal line. The DVM must be in the high resolution mode (6½ digits).

c. Turn on the supply and program the current to the full scale value and the output voltage to the maximum programmable value (see Table 3-3):

ISET <5, 2, or 1>
VSET <20.475, 51.188, or 102.38>

d. Adjust the load for full scale voltage as indicated on the front panel display. Check that the CC annunciator is on. If it is not, adjust the load so that the output voltage drops slightly.

e. Adjust the transformer to 13% below tahe nominal line voltage.

f. Record the output current reading (DVM reading/0.1 ohm)

g. Adjust the transformer to 6% above the nominal line voltage.

h. Record the output current reading again. The difference in the current readings in steps f and h is the CC source effect and should not exceed the values listed in Table 3-2, CC SOURCE EFFECT.

3-26 CC Noise (PARD). Periodic and random deviations (PARD) in the output (ripple and noise) combine to produce a residual ac current as well as an ac voltage superimposed on the dc output. The ac voltage is measured as CV Noise (PARD), see paragraph 3-15. Constant current (CC) PARD is specified as the rms output current in a frequency range

20 Hz to 20 MHz with the supply in CC operation. Two tests are provided below for measuring CC rms noise. The first test, the preferred test, uses a current probe (Figure 3-10A) to make the measurement. The second test, an alternate method (not as accurate), takes the measurement across a current monitoring resistor (Figure 3-10B).

Preferred Test (Figure 3-10A)

a. Turn off the supply, and connect the test setup using the load resistor, probe, amplifier, and rms voltmeter as shown in Figure 3-10A. Set the amplifier to 1 mA, AC, full bandwidth. Use only a resistive load for this test.

b. Turn on the supply and program the current to full scale and the output voltage to the maximum programmable value:

ISET <5, 2, or 1>
VSET <20.475, 51.188, 102.38>

c. The output voltage and current should be approximately at the full scale rating with the CC annunciator on. If the annunicator is not on, program, the current to a slightly lower value until it does come on.

d. Using the specified current probe, the rms voltmeter will read 10 mV for each milliamp of AC ripple. The reading should not exceed 2 mA (20mV).

Alternate Test (Figure 3-10B)

a. Turn off the supply and connect the test setup using the load resistor and rms voltmeter as shown in Figure 3-10B. Leads should be as short as possible to reduce noise pick-up. Use only a resistive load for this test.

b. Check the test setup for noise with the supply turned off. Other equipment (e.g. computers, DMM, etc.) may affect the reading.

c. Turn on the supply and program the current to full scale and the output voltage to the maximum programmable value. Same as step b above.

d. The output voltage and current should be approximately at the full scale rating with the CC annunciator on. If the annunicator is not on, program the current to a slightly lower value unitl it does come on.

e. The reading should not exceed 2 mA. The equivalent voltmeter reading is given below.

8 mV (HP 6632A)
50 mV (HP 6633A)
200 mV (HP 6634A)

3-27 EXTENDED TESTS

These tests are similar to the Performance Tests except that they have a much longer duration and are conducted with controlled temperature conditions.

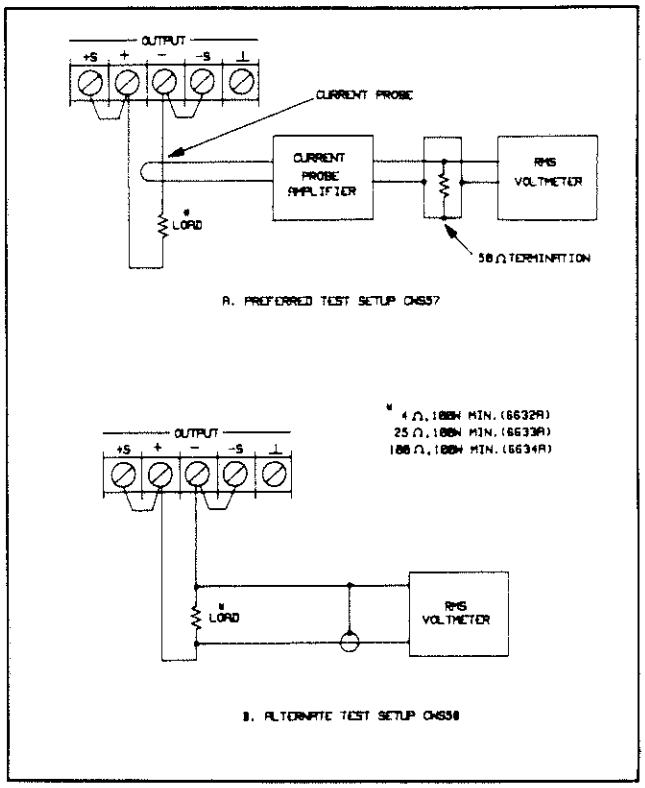


Figure 3-10. CC RMS Noise Measurement Test Setup

3-28 Voltage Drift Test

This test measures the output voltage drift over an 8 hour period under constant load, line and ambient temperature. Place the supply to be tested in a temperature chamber or in a temperature controlled environment such as a standards room.

a. Turn off the supply and connect the output as shown in Figure 3-2 with the DVM connected across the + S and − S terminals, the load switch closed, and the short switch opened.

b. Turn on the supply and program the current to the maximum programmable value and the output voltage to the full scale value (see Table 3-3).

c. Adjust the load for full scale current as read on the display. Check that the CV annunciator is on.

d. Wait 30 minutes and record the output voltage reading on the DVM.

e. Observe and record the output voltage reading periodically over an 8 hour period. The difference between any two readings is the voltage drift and should not exceed the values listed below.

HP Model	Drift
6632A	2.5 mV
6633A	6.0 mV
6634A	11 mV

3-29 Current Drift

This test measures the output current drift over an 8 hour period under constant load, line, and ambient temperature. Place the supply to be tested in a temperature chamber or in a temperature controlled environment such as a standards room.

a. Turn off the supply and connect the output as shown in Figure 3-2 with the DVM connected across the current monitoring resistor, the load switch closed, and the short switch opened.

b. Turn on the supply and program the current to the full scale value and the output voltage to the maximum programmable value (see Table 3-3).

c. Adjust the load until the output enters the CC mode with the displayed output voltage equal to the full scale voltage rating as read on the front panel display. Check that the CC annunciator is on.

d. Wait 30 minutes and record the output current (DVM reading/0.1 ohm).

e. Observe and record the output current reading periodically over an 8 hour period. The difference between any two readings should be less than the value listed below.

HP Model	Drift
6632A	1.5 mA
6633A	0.7 mA
6634A	0.4 mA

3-30 TEMPERATURE COEFFICIENT (TC) TESTS

These tests check temperature coefficient specifications with the supply placed in a temperature controlled oven that provides an even temperature distribution. The temperature is varied within the supply's operating range and changes in output voltage and current are measured. The supply is left in the oven for 30 minutes to ensure stability. Note that the test equipment, e.g. current monitor resistor, DVM, load, etc., is located outside of the oven.

3-31 Output Voltage and Readback Voltage TC

a. Turn off the supply and connect the output as shown in Figure 3-2 with the DVM connected across the +S and −S terminals, the load switch closed, and the short switch opened.

b. Turn on the supply and program the current to the maximum programmable value and the output voltage to the full scale value (see Table 3-3).

c. Adjust the load for full scale Current as read on the display. Check that the CV annunciator is on.

e. Set the temperature chamber to 30°C and allow 30 minutes for the output to stabilize.

f. Record the output voltage on the DVM.

g. Readback the output voltage over the HP-IB or from the display and record the value.

h. Increase the temperature to 40°C and allow 30 minutes for the output to stabilize.

i. Repeat steps f and g. Note the difference between the values read before and after the temperature change. The difference between the readings should be less than those listed below.

HP Model	TC Spec Output Voltage (ΔV)	Voltage Readback TC Spec
6632A	16.5 mV	ΔV ±24 mV
6633A	40 mV	ΔV ±60 mV
6634A	80 mV	ΔV ±120 mV

3-32 Output Current and Readback Current TC

a. Repeat steps a through c of paragraph 3-29.

b. Set the temperature chamber to 30°C and allow 30 minutes for the output to stabilize.

c. Record the output current (DVM reading/0.1 ohm).

d. Readback the output current over the HP-IB or from the display and record the value.

e. Increase the temperature to 40°C and wait 30 minutes for the output to stabilize.

f. Repeat steps c and d. Note the difference between the values read before and after the temperature change. The differences should not be more than those listed below.

HP Model	Current TC Spec (Δ-I)	Current Readback TC Spec
6632A	12.5 mA	Δ-I ±12.5 mA
6633A	4.5 mA	Δ-I ±4 mA
6634A	2.25 mA	Δ-I ±2.1 mA

3-33 Negative Current (−CC) Readback TC

a. Repeat steps a through c of paragraph 3-23.

b. Set the temperature chamber to 30°C and allow 30 minutes for the output to stabilize.

c. Record the negative current value (DVM reading/0.1 ohm).

d. Readback the current over the HP-IB or from the display and record this value.

e. Increase the temperature to 40°C and wait 30 minutes for the output to stabilize.

f. Repeat steps c and d. Note the difference between the values read before and after the temperature change. The differences should not be more than those listed below.

HP Model	−Current Limit TC (Δ-I)	−Current Readback TC Spec
6632A	20.5 mA	Δ-I ±19.6 mA
6633A	7.2 mA	Δ-I ±6.45 mA
6634A	3.6 mA	Δ-I ±3.3 mA

Section IV
TROUBLESHOOTING

WARNING

Most of the maintenance procedures given in this section are performed with power applied and protective covers removed. Such maintenance should be performed only by service-trained personnel who are aware of the hazards (for example, fire and electrical shock).

4-1 INTRODUCTION

This section provides troubleshooting and repair information for HP Model 6632A–6634A power supplies. Initial troubleshooting procedures are provided to isolate a problem to a functional area of circuitry. Once the fault has been isolated to a functional area, additional troubleshooting procedures are given for the faulty circuit area to isolate the problem to the defective component(s).

Before attempting to troubleshoot the supply, ensure that the fault is with the supply itself and not with an associated circuit, load, or power line. The verification tests described in Section III enable this to be determined without having to remove the covers from the supply.

The most important aspect of troubleshooting is the formulation of a logical approach to locating the source of trouble. A good understanding of the principles of operation is particularly helpful and it is recommended that you review Section II of this manual and the operating and programming instructions in the Operating Manual (HP Part No. 5957-6360) before you attempt to troubleshoot the unit.

If a component is found to be defective, replace it, recalibrate the supply (using Appendix A in the Operating Manual), then conduct the performance tests given in Section III of this manual.

Section V in this manual lists all of the replaceable parts for the supplies.

4-2 ELECTROSTATIC PROTECTION

CAUTION

This instrument uses components which can be damaged by static charge. Most semiconductors can suffer serious damage by static charge. Most can suffer serious performance degradation as a result of static charge, even though complete failure may not occur. The following precautions should be observed when handling static-sensitive devices.

a. Always turn power off before removing or installing printed circuit boards or components.

b. Always store or transport static-sensitive devices (all semiconductors and thin-filmed devices) in conductive material. Attach warning labels to the container or bag enclosing the device.

c. Handle static-sensitive devices only at static-free work stations. These work stations should include special conductive work surfaces (such as HP Part No. 9300-0797) grounded through a one-meghom resistor. Note that metal table tops and highly conductive carbon-impregnated plastic surfaces are too conductive; they can shunt charges too quickly. The work surfaces should have distributed resistance between 10^6 and 10^{12} ohms per square.

d. Ground all conductive equipment or devices that may come in contact with static-sensitive devices or assemblies.

e. Where direct grounding of objects in the work area is impractical, a static neutralizer should be used (ionized air blower directed at work). Note that this method is considerably less effective than direct grounding and provides less protection for static-sensitive devices.

f. While working with equipment on which no point exceeds 500 volts, use a conductive wrist strap in contact with skin. The wrist strap should be connected to ground through a one-megohm resistor. A wrist strap with insulated cord and built-in resistor is recommended, such as 3M Co. No. 1066 (HP part No. 9300-0969 (small wrists) and 9300-0970 (large wrists)).

WARNING

Do not wear a conductive wrist strap when working with potentials in excess of 500 volts; the one Meghom resistor will provide insufficient current limiting for personal safety.

g. All grounding (device being repaired, test equipment, soldering iron, work surface, wrist strap, etc.) should be done to the same point.

h. Do not wear synthetic (e.g. nylon) clothing. Keep clothing of any kind from coming within 12 inches of static-sensitive devices and assemblies.

i. Low-impedance test equipment (signal generators, logic pulsers, etc.) should be connected to static sensitive inputs only while the components are powered.

j. Use a mildly activated rosin core solder (such as Alpha Metal Reliacor No. 1, HP Part No 8090-0098) for repair. The flux residue of this type of solder can be left on the printed circuit board. Generally, it is safer not to use Freon or other types of spray cleaners. If necessary, the printed-circuit board can be brushed using a natural-bristle brush only. Do not use nylon-bristle or other synthetic-bristle brushes. Do not use high velocity air blowers (unless ionized).

k. Keep the work area free of non-conductive objects such as Styrofoamtype cups, polystyrene foam, polyethylene bags, and plastic wrappers. Nonconductive devices that are necessary in the area can be kept from building up a static charge by spraying them with an anti-static chemical (HP Part No.8500-3397).

l. Do not allow long hair to come in contact with static sensitive assemblies.

4-3 REMOVAL AND REPLACEMENT

The major assemblies within the power supply are illustrated in Figure 4-1. The following paragraphs provide instructions for removing certain assemblies and components for which the procedure may not be obvious upon inspection. Replacement procedures are essentially the same as the corresponding removal procedure except that they are performed in the reverse order.

WARNING

To avoid the possibility of personal injury, remove the power supply from operation before removing the covers. Turn off ac power and disconnect the line cord, HP-IB cable, loads, and remote sense leads before attempting any repair or replacement.

CAUTION

All of the attaching hardware is metric. Use of other types of fasteners will damage threaded inserts. When removing or installing screws use a No. 1 or a No. 2 Pozidriv screwdriver.

4-4 Top Cover Removal

The top cover must be removed to gain access to the inside of the supply. To remove the cover, refer to Figure 4-1 and proceed as follows:

a. Remove the two screws on the right side which hold the carrying strap (Figure 4-1B).Remove two similarly located screws on the left side.

b. Remove the screw near the top rear of the cover.

c. Spread the bottom rear of the cover slightly and pull back to disengage it from the front panel.

d. Remove the top cover and place it aside.

4-5 Main Board Removal

After removing the cover, place the power supply on a workbench with the front panel facing you and refer to Figure 4-1.

a. Remove the two chassis bracket screws A and B.

b. Locate the power transformer in the front left area of the supply.

c. Loosen transformer mounting screws A and B (located below the lip of the chassis bracket) two turns. These two screws are mounted in keyholes and will not have to be removed from the transformer to gain clearance to remove the main board.

d. Disengage the wires from the plastic cable guide attached to the chassis bracket.

e. Holding the chassis bracket, gently slide it first toward the front panel, then to the right clearing the keyholes. Tighten the transformer mounting screws all the way in.

f. Tighten the transformer mounting screws A and B all the way in.

g. Remove the chassis bracket from the power supply and place it aside.

h. Locate the three main board mounting screws A, B, and C, and remove them.

i. Remove the main board chassis ground wire from the rear left lip of the chassis.

j. Remove the two hex standoffs from the HP-IB connector J1 on the rear panel of the power supply using a 7MM nut driver. Disengage the wires from the cable clamp attached in front of the chassis.

k. Disengage the wires from the cable clamp attached to the front chassis.

l. Disconnect the cables from XT1P1, XT1P2, XT1P3, XT1P4, and XT1P6 on the main board. Note the routing of cables (for re-assembly) since position may affect the ripple performance of the power supply.

m. Disconnect the keyboard ribbon cable from J2.

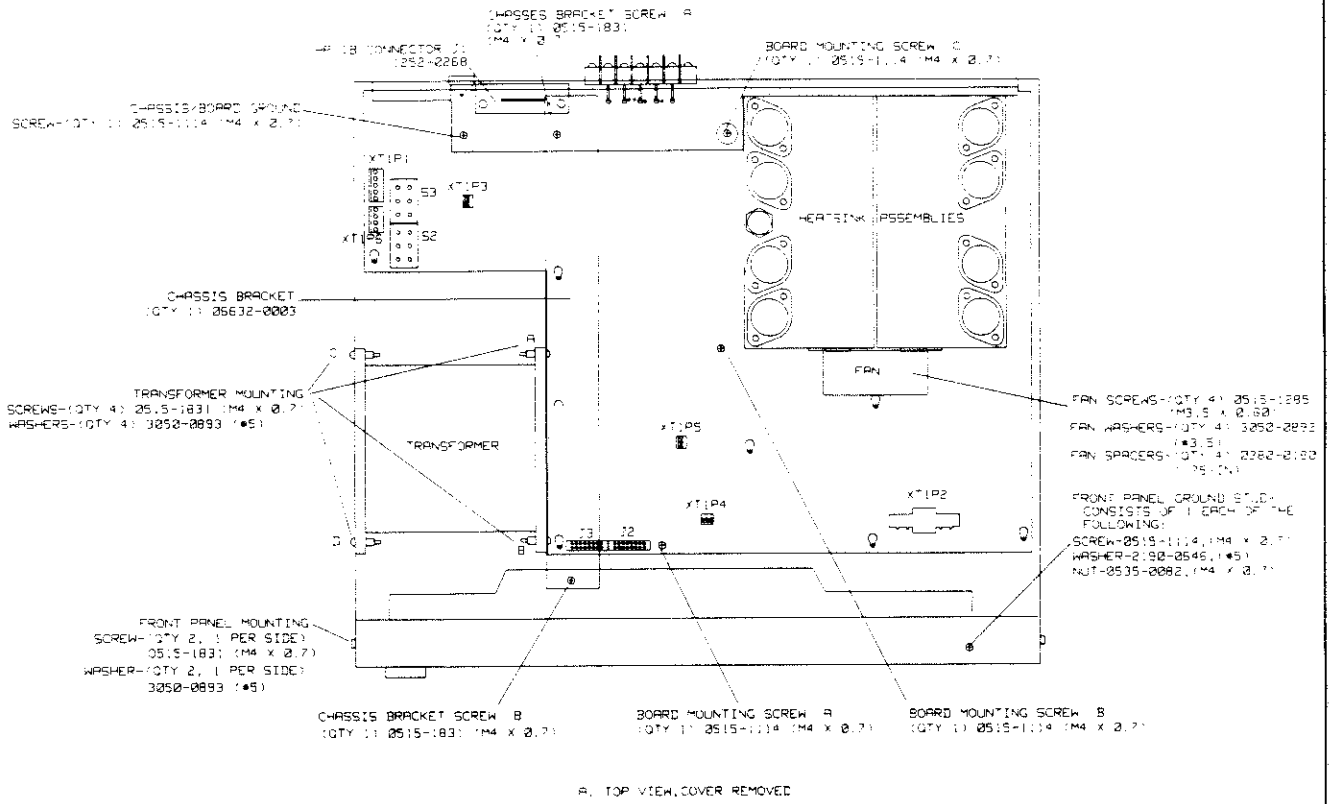
n. Disconnect the display ribbon cable from J3. Make sure all cables are not pinched in any way when they are re-connected.

o. If the unit contains front panel binding posts (Option 020), remove the two connections to the + and − lugs on the main board.

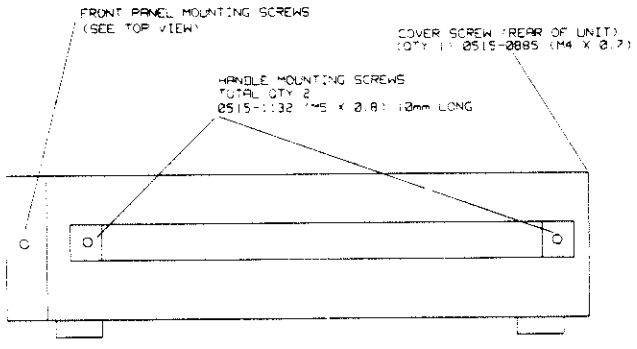
WARNING

The heatsink may be hot.

m. Locate the output transistor heatsink assembly in the rear-right area of the power supply. This assembly contains the output transistors and cooling fan. It is connected to the main board via the output transistor hardware and solder connections. Holding the assembly, slide it and the main board toward the front panel until the main board disengages from the keyed standoffs.



A. TOP VIEW,COVER REMOVED



B. SIDE VIEW

Figure 4-1. Removal and Replacement

n. Lift the main board up and to the right to remove it from chassis. Be careful not to damage any connectors or cabling on the rear of the transformer.

4-6 Front Panel Removal

The front panel contains the keyboard assembly, Liquid Crystal Display (LCD) and line switch (S1). You must remove the front panel to gain access to these components. To remove the front panel, proceed as follows:

a. Remove the top cover.
b. Place the open unit on a workbench with the front panel facing you and refer to Figure 4-1.
c. If the unit contains rack handles (Option 908 or 909), remove them.
d. Locate the front panel mounting screws and remove them.
e. Remove the keyboard ribbon cable from J2 on the main board.
f. Remove the display ribbon cable from J3 on the main board.
g. Remove the line switch cable from XT1P6 on the main board.
h. If the unit contains front panel binding posts (Option 020), remove the two connectors to the + and—lugs on the main board.
i. Remove the ground nut on the rear, right-hand side of the front panel. Do not overtighten this nut when reinstalling the front panel.
j. Holding the front panel at each end, pull it forward and away from the chassis.

CAUTION

To avoid damage when replacing the front panel, make sure that flat washers are installed before the mounting screws are tightened.

4-7 Transformer Removal

a. Remove the top cover.
b. Place the open unit on a workbench with the front panel facing you and refer to Figure 4-1A.
c. Remove the chassis bracket as described in a through g of paragraph 4-5.
d. Remove transformer mounting screws C and D.

CAUTION

To avoid breaking transformer tabs (lugs), do not bend the transformer tabs. When disconnecting a lead, pull the lead connector straight back from the tab. When reconnecting a lead, push the connector straight forward onto the transformer tab. Do not flex the leads or tabs when making connections or disconnections.

f. Disconnect all wires from the rear of the transformer. Note the routing of the cabling (for re-assembly) since position may affect the ripple performance of the power supply. Refer to Figure 4-2 when reconnecting the wires to the transformer.
g. Lift the transformer up and out of the chassis.

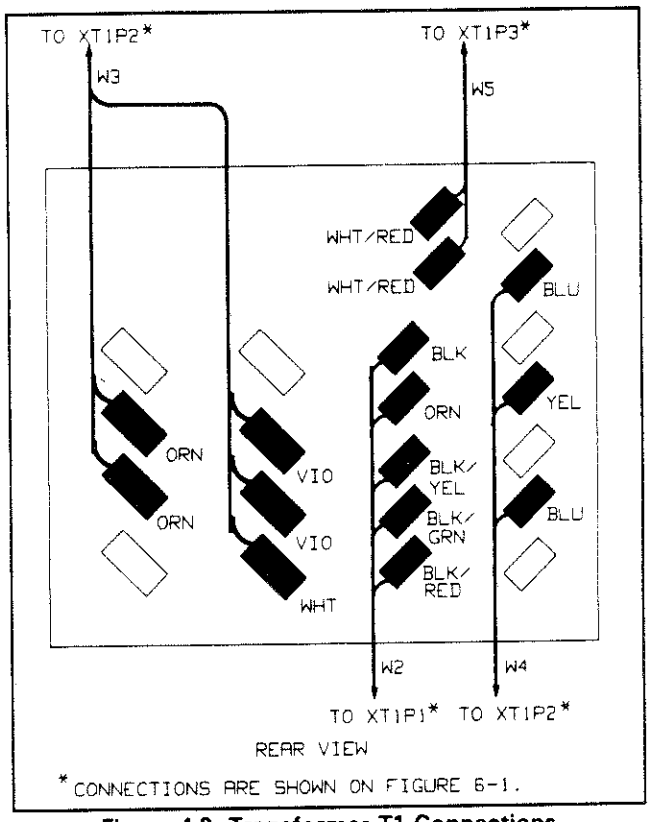


Figure 4-2. Transformer T1 Connections

4-8 TEST EQUIPMENT REQUIRED

Table 4-1 lists the test equipment required to troubleshoot the HP Model 6632A-6634A supplies. Recommended models are listed.

4-9 FUSE REPLACEMENT

Table 4-2 gives the rating of the fuses in the supplies. The ac line fuse is located in the rear of the supply. Line voltage select switches (S2 and S3), located inside of the supply on the main circuit board, must be set to the appropriate ac input (100, 120, 220, or 240 Vac). Refer to Section II in the Operating Manual (HP Part No. 5957-6360).

Figure 4-3 shows the location of all the fuses in the supply. As stated above, ac line fuse F1 is accessible from the rear of the unit. The remaining fuses F2-F8 are located inside of the supply on the main board. Note that in HP Model 6632A, F2 is an 8A fuse in the + output line; whereas HP HP Models 6633A and 6634A use a fuseable resistor (R219) in place of F2.

Table 4-1. Test Equipment Required for Troubleshooting

Type	Purpose	Recommended Model
HP-IB Controller	Communicate with the supply via the HP-IB	HP 9825, Series 85, or Series 200/300 Controller
Signature Analyzer	Test most of the primary and secondary interface circuits.	HP 5005A/B
Digital Voltmeter	Check various voltage levels	HP 3456A
Power Supply (5 V and must have current rating = 1.5 X output rating of supply)	Check current sink operation	HP 6263B, HP 6002A
Logic Probe	Check data bus lines	HP 545A
Oscilloscope	Check waveforms and signal levels	HP 1741A
Frequency Counter	To 10 MHz	HP 5384A
Load Resistors	8 ohms, 100W (HP 6632A) 50 ohms, 100W (HP 6633A) 200 ohms, 100W (HP 6634A)	

Table 4-2. Fuses

Ref. Desig	Description	Rating	HP Part No.
F1	Main ac line fuse	For 100/120 Vac 4 A, 250 V (normal blow) or For 220/240 Vac 2 A, 250 V (normal blow)	2110-0055 2110-0002
F2/R219	Model 6632A uses fuse F2 in the + output	8 A, 32 V	2110-0777
	Model 6633A uses fuseable resistor R219 in the + output	0.15 ohm, 5 W	0811-3777
	Model 6634A uses fuseable resistor R219 in the + output	0.5 ohm, 5 W	0811-3776
F3, F8	±15 V bias supply fuses	4 A, 125 V	2110-0712
F4	+5 Vp bias supply fuse	5 A, 125 V	2110-0699
F5, F6	Main rectifier fuses	Models 6632A & 6633A 15 A 32 V Model 6634A: 7 A, 125 V	2110-0697 2110-0685
F7	+Rail fuse	Model 6632A: 7 A, 125 V Model 6633A: 4 A, 125 V Model 6634A: 2 A, 125 V	2110-0685 2110-0712 2110-0684

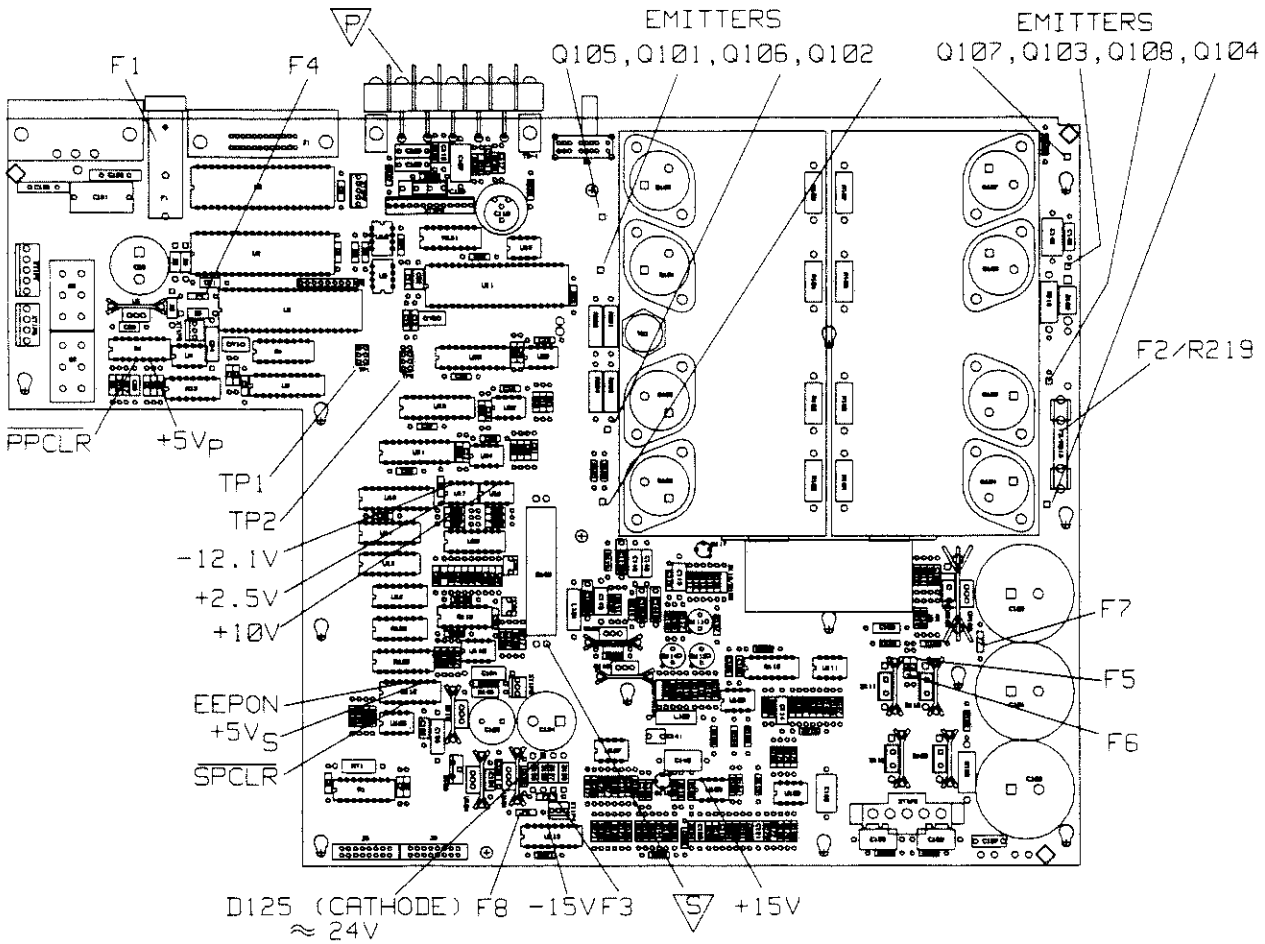


Figure 4-3. Fuse and Test Point Locations

The ac line fuse (F1) and bias supply fuses (F3,F4, and F8) are shown schematically on Figure 6-1. The + output fuse (F2/R219), the +Rail fuse (F7), and main rectifier fuses (F5 and F6) are shown schematically in Figure 6-4 (HP Model 6632A), Figure 6-5 (HP Model 6633A), and Figure 6-6 (HP Model 6634A) in the back of this manual.

4-10 INITIAL TROUBLESHOOTING

Initial troubleshooting procedures for the HP Model 6632A-6634A supplies are given in the flow chart of Figure 4-4. The procedures first ensure that an ac input failure is not causing the problem and that the supply passes the power-on self test (no error messages). The normal power-on self test indications are described in Section III of the Operating Manual.

If the supply passes self test, the procedures in Figure 4-4 check to see if the supply's output voltage and current can be programmed from the front panel. Next the supply's overvoltage protection feature is checked. The procedures also check to see if the supply can be programmed from an HP-IB controller and also if it can sink current (operate in the CC− Mode).

If the supply fails any of the tests, Figure 4-4 directs you to troubleshoot or calibrate the supply as applicable.

4-11 Power-On Self Test

NOTE

The self-test will not be performed if jumpers W1 and W2 are installed in the NO TST positions (see paragraph 4-12).

The power-on self test sequence consists of tests on both the primary (HP-IB) and secondary (power supply) interface circuits. If the supply fails the power-on self-test, the output will remain disabled and the display will indicate the type of failure. Error codes 1-5 indicate a failure in the primary interface (HP-IB and front panel interface) circuits; error codes 11-25 indicate a failure in the secondary interface (power supply interface) circuits.

Table 4-3 lists all of the power-on self-test error codes that can appear on the front panel display. The table is used in conjunction with Figure 4-4 and other troubleshooting flow charts provided in this section.

4-12 Test Header Jumper Positions

The power supply contains two test headers (connectors TP1 and TP2,see Figure 4-3) with jumper positions that are used for normal operation or for troubleshooting the power supply. Each jumper position is described as follows:

Primary Test Header TP1 (Jumper W1)

NORM (Normal):	This position is the normal running position. Jumper W1 is installed in this position when the supply is shipped from the factory.
NO TST (Skip Self Test):	This position causes the supply to skip (not perform) the primary interface self test. This allows the primary interface circuits to power on all circuits in the supply even if the primary interface would not have passed self test.
SA (Signature Analysis):	This position allows you to perform signature analysis testing and troubleshooting of the primary interface circuits.

Secondary Test Header TP2 (Jumper W2)

NORM (Normal):	This position is the normal running position. Jumper W2 is installed in this position when the supply is shipped from the factory.
NO TST (Skip Self Test):	This position causes the supply to skip (not perform) the secondary interface self tests.
SA (Signature: Analysis):	This position is used to perform SA on the secondary interface circuits and to observe DAC output test waveforms.
NO CAL (No Calibration):	This position is an alternate to the NORM position and is used to ensure against accidental calibration of the supply. With W2 installed in this position, error code 52 (calibration mode disabled) is generated if an attempt is made to turn on the calibration mode (see Appendix A in the Operating Manual).

4-13 POST REPAIR CALIBRATION

Calibration is required annually and whenever certain components are replaced. If certain control circuit components (DAC's/amplifiers, voltage/current control circuit amplifiers) or readback circuit components (buffers, comparators, DAC/amplifier) are replaced, the supply must be recalibrated as described in Appendix A of the Operating Manual. Note that if the serial EEPROM chip U15 is replaced, the supply must be initialized (see next paragraph) first and then recalibrated.

Table 4-3. Power-On Self Test Failures

Type of Failure	Code	Description
None	0	No failure; passed self-test
Primary Interface Circuit Failures	1	ROM test failure. Microcomputer chip (U1) is probably defective.
	2	RAM test failure. Microcomputer chip (U1) is probably defective.
	3	HP-IB Interface circuit failure. Talker/Listener chip (U2) or microcomputer chip (U1) defective.
	4	Microcomputer (U1) internal clock is slow
	5	Microcomputer (U1) internal clock is fast
Secondary Interface Circuit Failures	11	ROM check-sum failure. Microcomputer chip (U11) is probably defective.
	12	RAM test failure. Microcomputer chip (U11) is probably defective.
	14	Microcomputer (U11) internal clock is slow or microcomputer chip (U11) is probably defective.
	15	Microcomputer (U11) internal clock is fast or microcomputer chip (U11) is probably defective.
	16	A/D test reads high. Readback DAC circuit (U21,U24), comparator U113, or microcomputer (U11) defective; or +5 Vs supply is too high.
	17	A/D test reads low. Readback DAC circuit (U21/U24), comparator (U113), or microcomputer (U11) defective; or + 5Vs supply is too low.
	18	CV/CC zero too high. CV or CC DAC probably defective (see Figure 4-11
	19	CV/CC zero too low. CV or CC DAC probably defective (see Figure 4-11)
	20	CV Ref. Full Scale too high. CV DAC probably defective (see Figure 4-13)
	21	CV Ref. Full Scale too low. CV DAC probably defective (see Figure 4-13)
	22	CC Ref. Full Scale too high. CC DAC probably defective (see Figure 4-13)
	23	CC Ref. Full Scale too low. CC DAC probably defective (see Figure 4-13)
	24	DAC TEST failed during execution of TEST?
	* "EEROM FAILED"	EEROM checksum failed. Serial EEPROM U15 probably defective. (See paragraph 4-14).

* If the EEPROM is bad, error code 51 is used in response to TEST?
If the EEPROM is found to be bad during the power-on self test, the "EEROM" message is displayed.

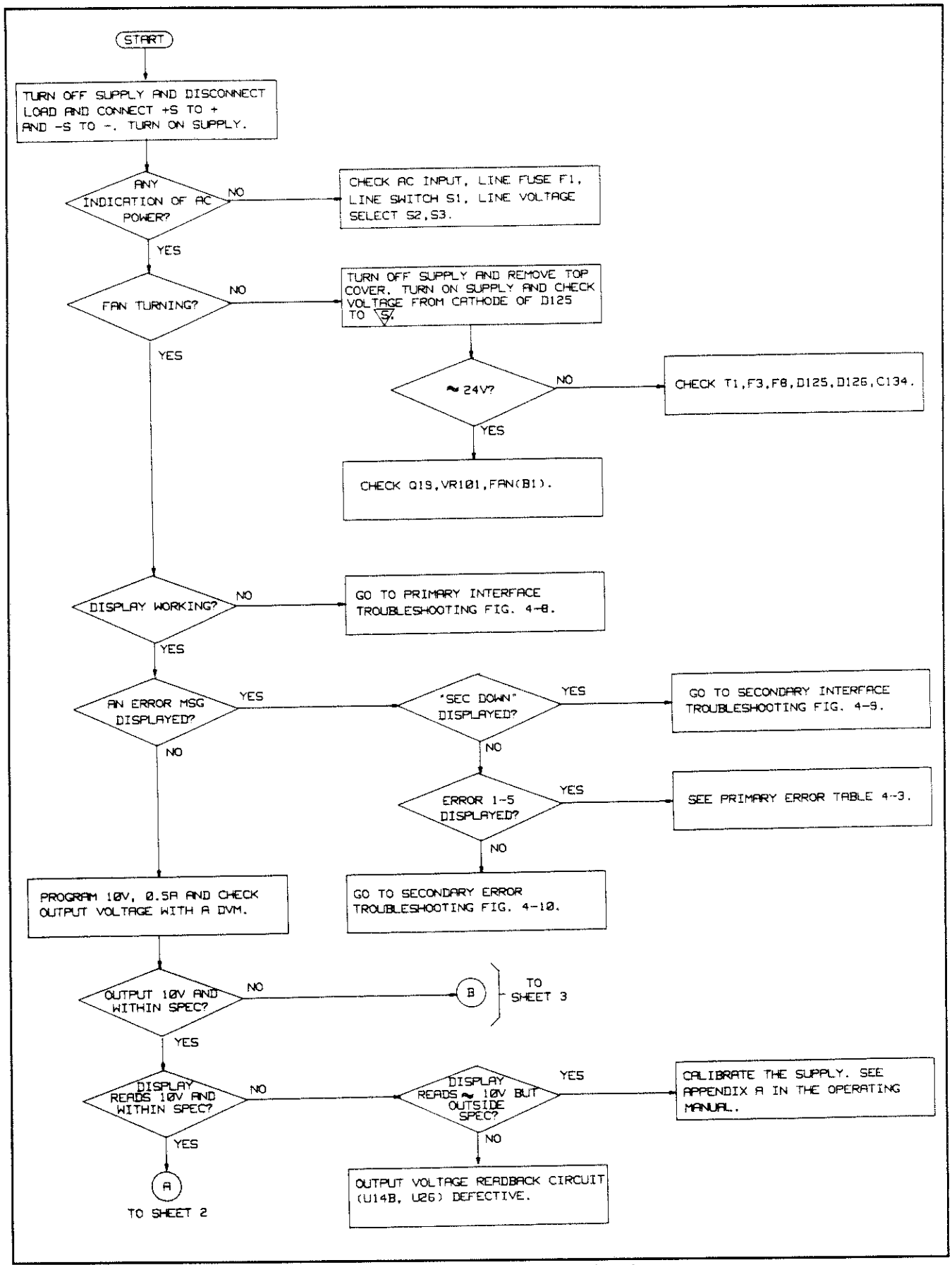


Figure 4-4 (Sheet 1). Initial Troubleshooting

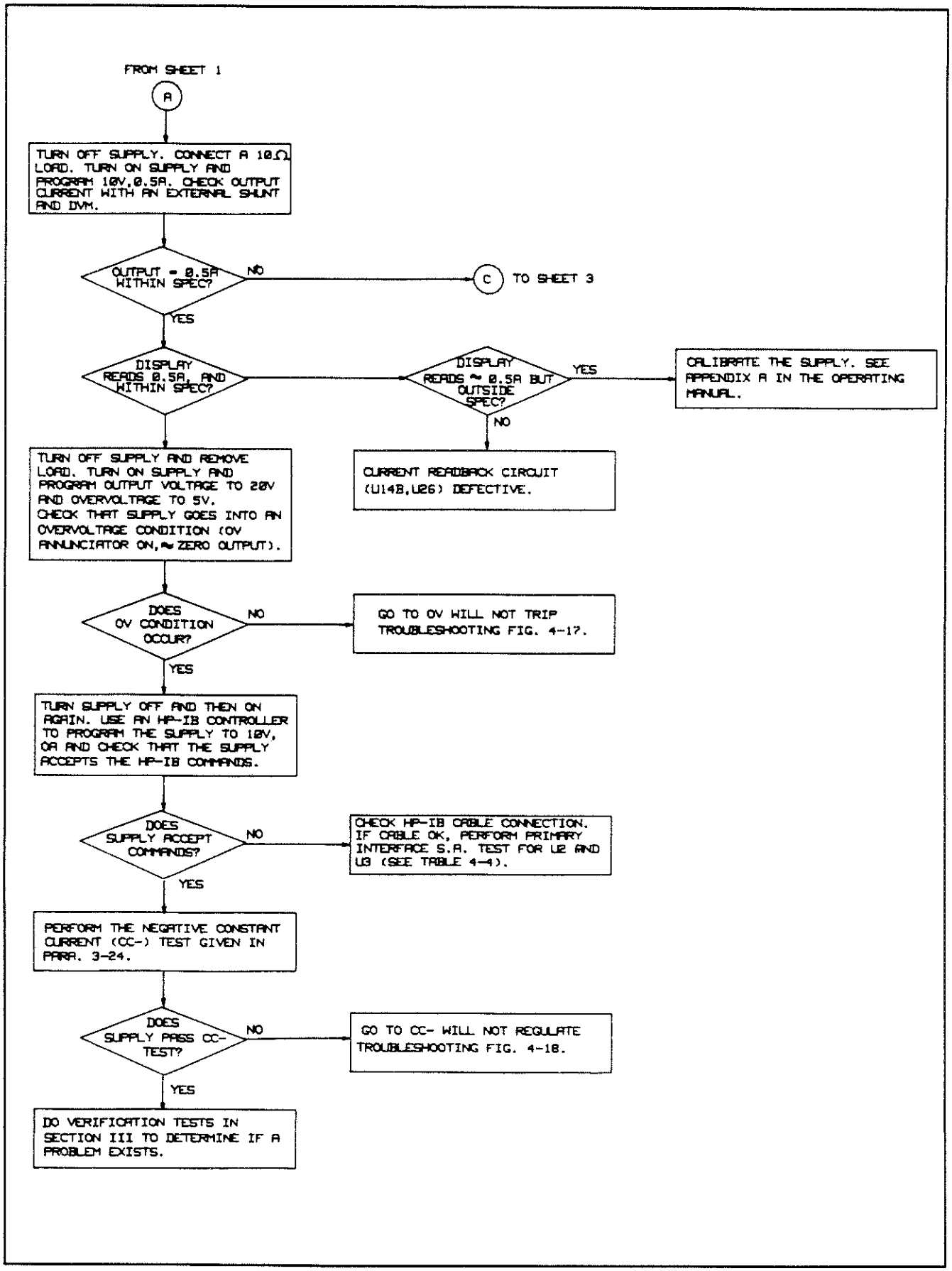


Figure 4-4 (Sheet 2). Initial Troubleshooting

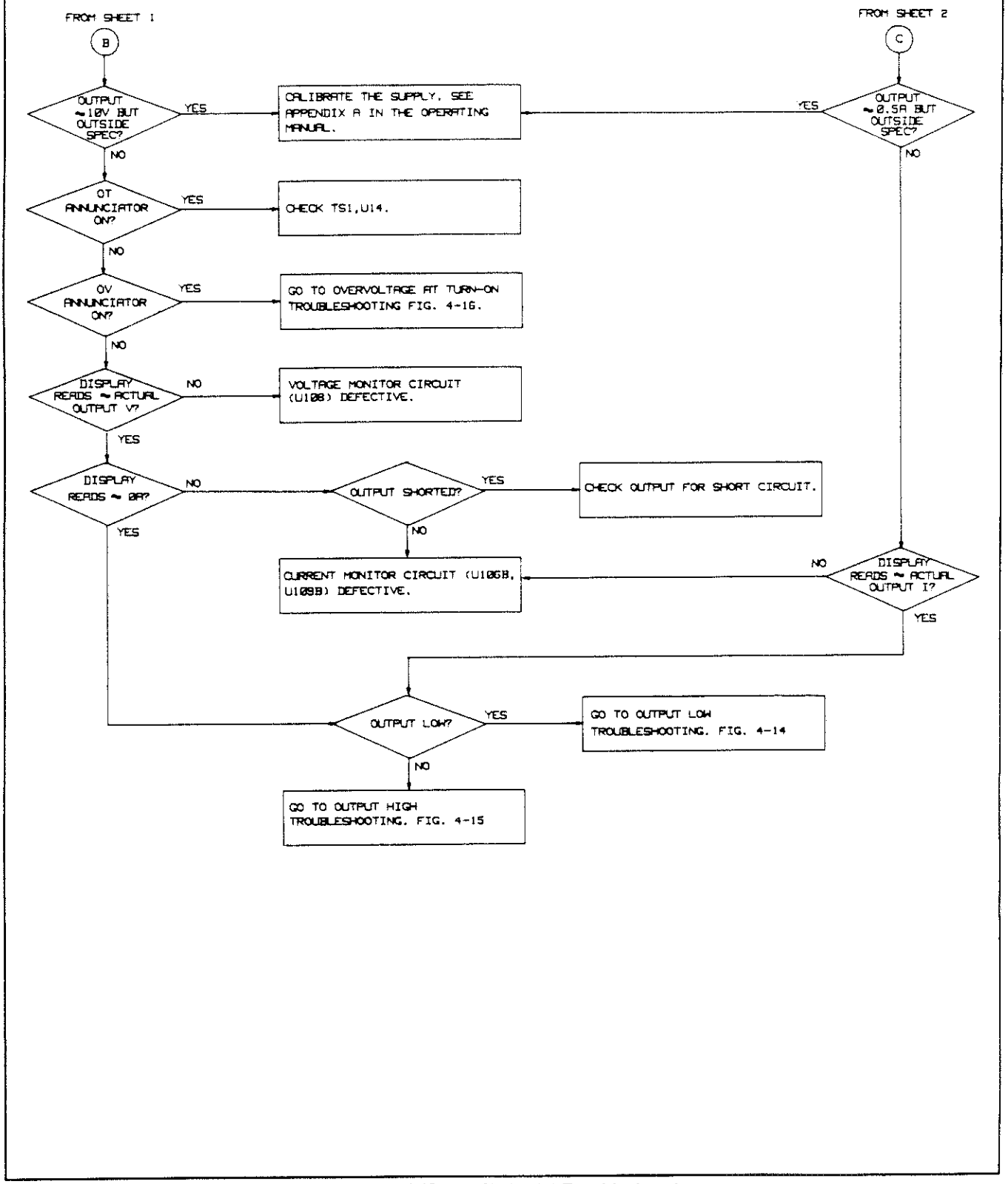


Figure 4-4 (Sheet 3). Initial Troubleshooting

4-14 INITIALIZATION

Serial EEPROM chip U15 stores the supply's HP-IB address and model number as well as other constants. These constants are required to program the supply correctly and to calibrate the supply. The supply was initialized (the EEPROM programmed) with the proper constants before the supply was shipped from the factory. If the main board assembly or EEPROM chip U15 is replaced in the course of troubleshooting, the supply must be reinitialized with the proper constants by running the program listed in Figure 4-5. After the supply has been initialized, it must be recalibrated as described in Appendix A of the Operating Manual.

4-15 SIGNATURE ANALYSIS

The easiest and most efficient method of troubleshooting microprocessor-based instruments is signature analysis (S.A). The S.A. technique is similar to signal tracing with an oscilloscope in linear circuits. Part of microcomputer memory is dedicated to signature analysis and a known bit stream is generated to stimulate as many nodes as possible within the circuit. However, because it is virtually impossible to analyze a bit stream with an oscilloscope, a signature analyzer is used to compress the bit stream into a four character signature. By comparing signatures of the IC under test to the correct signatures for each node, faults can usually be isolated to one or two components.

Signature analysis tests are provided for most of the components in the primary and secondary interface circuits. The primary interface circuit S.A. test is given in Table 4-4. Secondary interface circuit tests 1 through 4 are given in Tables 4-5 through 4-8, respectively. The supply must pass the primary interface test before the secondary interface tests can be performed. Secondary S.A. tests 1 through 4 should be performed in sequence. Note that the signatures listed in Table 4-4 are given for primary microcomputer chip U1 revision A.01; the signatures listed in Tables 4-5 through 4-8 are given for secondary microcomputer chip U11 revison A.01 (see paragraph 4-17). A change page will provide the signatures for later revisions.

References are made to the appropriate S.A. test table from the troubleshooting flow charts. The test setup for S.A. tests (see Figure 4-6) is described in the next paragraph. The following general notes apply to signature analysis tests of the primary and secondary interface circuits.

1. Be sure to use the correct test setup connections for the specific test.
2. Note the signatures for Vcc (+ 5 V) and ground on the IC being examined. If an incorrect signature is the same as that of Vcc or ground, that point is probably shorted to Vcc or ground.
3. If two pins have identical signatures, they are probably shorted together.
4. If two signatures are similar, it is only a coincidence.
5. If a signature is incorrect at an input pin, but is correct at its source (output of the previous IC), check for printed circuit and soldering problems.
6. An incorrect signature at an output could be caused by a faulty component producing that output. It can also be caused by an input short circuit in another component on the board.

4-16 Test Setup for S.A.

Figures 4-6 and 4-7 illustrate the general test setup for the signature analysis tests given in Tables 4-4 through 4-8. Figure 4-6 shows the general test setup and Figure 4-7 illustrates the Test Header TP1 and TP2 connections required to perform the S.A. tests.

The following is a description of the test set up. Specific signature analyzer connections and test setup requirements for a specific test are given in the applicable S.A. Test Table.

a. Turn off the supply and gain access to the main board by removing the top cover (see para. 4-4). Be sure that the supply is turned off before continuing with the following steps.
b. Connect jumper W1 in the SA position (across pins 1 and 2) of primary test header TP1 and connect jumper W2 in the SA position (across pins 3 and 4) of the secondary test header TP2. Refer to Figure 4-7.
c. Set the signature analyzer START, STOP, CLOCK, and GND edge settings and make signature analyzer connections as described in the table for the specific test.
d. Make any other setup connections that may be given in the applicable S.A. Test Table. Use AP Products No. LTC clip to short IC pins together.
e. Turn on the supply and use the signature analyzer probe to take signatures at the applicable IC test points given in the Test Table.
f. Upon completion of the S.A. tests, return jumpers W1 and W2 to the NORM positions of TP1 and TP2 (see Figure 4-7) and remove any short circuits or other connections required by the specific test.

4-17 Firmware Revisions

The primary interface microcomputer chip (U1) and the secondary interface microcomputer chip (U11) are identified with labels that specify the revision of your supply's firmware. You can also identify the revision of the firmware using the ROM? command in the program listed below.

```
10 OUTPUT 705;"ROM?"
20 ENTER 705;L$
30 DISP L$
40 END
```

The computer should display the firmware revisions for both the primary and the secondary interface microcomputers as follows:

```
A01    A01
```

The primary interface revision is displayed on the left and the secondary interface revision is displayed on the right as shown above. These revisions should agree with the labels on each chip (U1 and U11). Note that the signatures in Tables 4-4 through 4-8 are valid for revision A.01.

```
10 !  PROGRAM NAME  "INIT_663XA"
20 !  REV DATE SEP 10,1987
30 !  REV A.0!
40 !  INITIALIZATION PROGRAM FOR HP MODELS
50 !  6632A, 6633A AND 6634A
60 !
70 !
80 Begin:LOOP
90    ASSIGN @Ps TO 705              !SETS SUPPLY ADDRESS TO 705
100   ALLOCATE Data_init(0:17)       !ALLOCATES MEMORY FOR INITIALIZATION DATA
110   PRINTER IS 1                   !PRINT ON CRT
120   PRINT CHR$(12)                 !CLEARS CRT
130!
140!
150   ENABLE INTR 7;2                !INTERRUPT ROUTINE FOR POWER SUPPLY ERROR
160   ON INTR 7 RECOVER Error
170   Err=128
180   OUTPUT @Ps;"UNMASK";Err;";SRQ 1"
190 !
200 !
210 Start:!
220   INPUT "ENTER MODEL # OF UNIT TO BE INITIALIZED (663_A)",Model$
230 !
240 !
250   PRINT CHR$(12)                 !CLEARS CRT
260 !
270 !
280   SELECT Model$                  !ROUTINE TO GET INIT DATA 0 TO 8
290   CASE "6632A"
300     RESTORE D6632
310   CASE "6633A"
320     RESTORE D6633
330   CASE "6634A"
340     RESTORE D6634
350   CASE ELSE
360     PRINT "MODEL NUMBER NOT RECOGNIZED"
370     PRINT "PROGRAM INITIALIZES MODELS 6632A,"
380     PRINT "6633A AND 6634A ONLY"
390     BEEP
400     GOTO Start
410   END SELECT
420 !
430   FOR I=0 TO 8
440     READ Data_init(I)
450   NEXT I
460 !
470 !
480   SELECT Model$                  !ROUTINE TO GET INIT DATA 9 TO 17
490   CASE "6632A"
500     RESTORE Dd6632
510   CASE "6633A"
520     RESTORE Dd6633
530   CASE "6634A"
540     RESTORE Dd6634
550   END SELECT
560 !
570   FOR I=9 TO 17
580     READ Data_init(I)
590   NEXT I
600 !
```

Figure 4-5. (Sheet 1). Initialization Program

```
610 !
620 !
630 !                              DATA FOR MODEL 6632A
640 !              0      1       2      3      4       5       6      7      8
650 !           VPMAX VPGAIN VPEX+OF VPMIN VRGAIN VREX+OF  IPMAX IPGAIN IPEX+OF
660 D6632:DATA 20475, 12519,  53297,    0, 11265,  53248, 51188,  4831,  50146
670 D6633:DATA 51188,  5008,  53371,    0,  4506,  53248, 20475, 12077,  49850
680 D6634:DATA 10238, 25039,  57369,    0, 22529,  57344, 10238, 24153,  49351
690 !
700 !              9     10      11     12     13      14      15     16     17
710 !           IPMIN IRGAIN IREX+OF OVMAX OVGAIN OVEX+OF IDBUFFER DELAY HPIBADDR
720 Dd6632:DATA  0,    4506, 49152, 22000,  668,  53248,    6632,   532,    5
730 Dd6633:DATA  0,   11265, 49152, 55000,  257,  53248,    6633,   532,    5
740 Dd6634:DATA  0,   22529, 49152, 11000, 1311,  57344,    6634,   532,    5
750 !
760 !
770 !
780   OUTPUT @Ps;"CMODE 1"            !TURNS CAL MODE ON
790 !
800 !
810   FOR I=0 TO 17                   !ROUTINE TO SEND DATA TO SUPPLY
820     OUTPUT @Ps;"INIT";I;",";Data_init(I)
830   NEXT I
840 !
850 !
860   OUTPUT @Ps;"CMODE 0"            !TURNS CAL MODE OFF
870   OUTPUT @Ps;"CSAVE"              !SAVES CAL DATA
880 !
890 !
900   DISP "INITIALIZATION COMPLETE"
910 !
920   STOP
930 !
940 !
950 Error:                            !ERROR READ AND PRINT ROUTINE
960   OUTPUT @Ps;"ERR?"
970   ENTER @Ps;Error
980   PRINT "ERROR #";Error;" OCCURRED"
990   SELECT Error
1000  CASE 1
1010    PRINT "EEROM SAVE FAILED"
1020  CASE 50
1030    PRINT "SECOND CAL AFTER PON"
1040  CASE 56
1050    PRINT "INIT ATTEMPTED WITH CAL JUMPER IN"
1060  CASE 57
1070    PRINT "INIT CHAN OUT OF RANGE"
1080  CASE 58
1090    PRINT "INIT DATA OUT OF RANGE"
1100  CASE 59
1110    PRINT "ATTEMPT TO ENABLE CAL WITH CAL JUMPER IN"
1120  CASE ELSE
1130    PRINT "SEE MANUAL FOR ERROR DESCRIPTION"
1140  END SELECT
1150  PRINT "CORRECT ERROR AND START OVER  BY PRESSING CONTINUE"
1160  PAUSE
1170  END LOOP
1180  END
```

Figure 4-5. (Sheet 2). Initialization Program

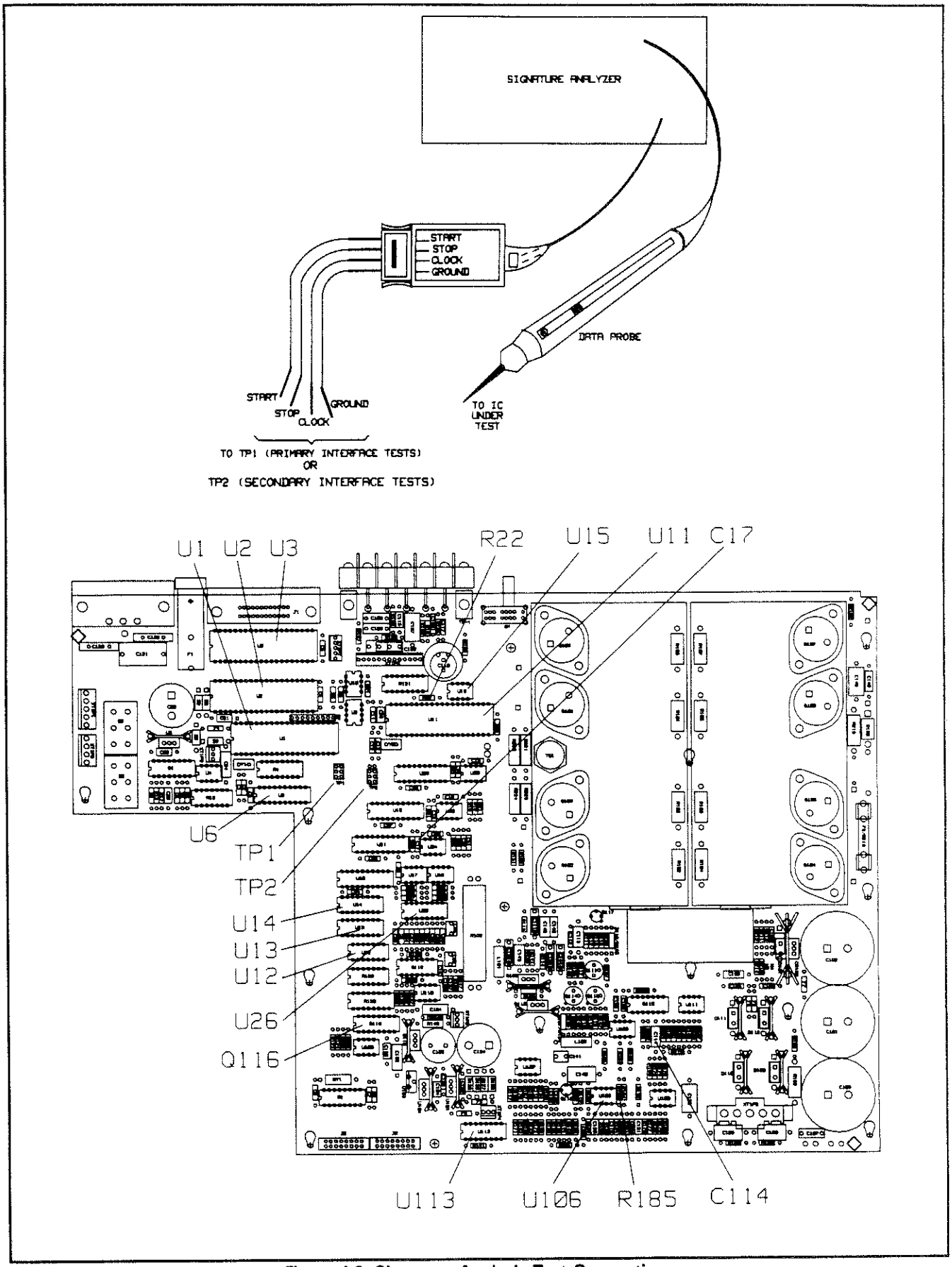


Figure 4-6. Signature Analysis Test Connections

Table 4-4. Primary Interface S.A. Test

Description: This test checks the primary interface circuits: Microcomputer U1, talker/listener chip U2, HP-IB transceivers U3, and display data latches U6.

Test Setup: (see Figures 4-6 and 4-7)

a. Use the test setup described in paragraph 4-16.

b. Connect jumpers W1 and W2 in the SA positions of TP1 and TP2 and connect the CLOCK, START, STOP, and GND signature analyzer inputs to test header TP1 as shown in Figure 4-7.

c. Set up the signature analyzer's CLOCK, START, STOP, and GND inputs edge settings as follows:

Signature Analyzer Input	Edge Setting	TP1 Connection
CLOCK	⌐	4
START	¬	5
STOP	⌐	6
GND	—	2

d. Make sure that the signature analyzer is set up properly for CMOS or TTL measurements as indicated below.

Measurements: Use the data probe to take signatures for each circuit at the pins listed below. These signatures apply to primary firmware revision A.01 (see paragraph 4-17). Note that all pins are CMOS levels except U3 pin 24 to U3 pin 40 are TTL levels. The +5 Vp signature is CH6C.

Pins	U1	U2	U3	U6	Pins	U1	U2	U3
1	0000	H8PU	0000	0000	21	CH6C	7F85	0000
2	—	—	4FH3	332F	22	CH6C	U45H	CH6C
3	—	0000	F3CH	9F96	23	0461	84C4	CH6C
4	CH6C	0000	A8PH	A12P	24	0219	CH6C	CH6C*
5	0000	—	AU96	U911	25	0F15	CH6C	H0P1*
6	CH6C	—	45UU	CHUC	26	F209	CH6C	CH6C*
7	CH6C	CH6C	05U0	0F6H	27	7595	H0P1	CH6C*
8	0000	0000	9H77	24A3	28	52UA	4FH3	CH6C*
9	CH6C	U033	8H82	A915	29	C16C	F3CH	CH6C*
10	U359	1FA1	CH6C	0000	30	P781	A8PH	CH6C*
11	CH6C	—	H8PU	U359	31	3659	AU96	449U*
12	CH6C	9F96	H0P1	0180	32	C81A	45UU	8H82*
13	7F85	A12P	CH6C	C827	33	C827	05U0	AU96*
14	U45H	0F6H	449U	C81A	34	24A3	9H77	9H77*
15	84C4	24A3	CH6C	2AA7	35	0F6H	8H82	A8PH*
16	U033	C827	CH6C	C03U	36	A12P	CH6C	05U0*
17	U4PH	C81A	CH6C	3659	37	9F96	CH6C	F3CH*
18	8PH1	3659	CH6C	P781	38	1FA1	CH6C	45UU*
19	7717	P781	CH6C	792P	39	CH6C	449U	4FH3*
20	8CP2	0000	0000	CH6C	40	0000	CH6C	CH6C*

*U3-24 to U3-40 are TTL levels.

Table 4-5. Secondary Interface S.A. Test No. 1

Description: This test checks the secondary interface microcomputer chip U11.

Test Setup: (see Figures 4-6 and 4-7)

a. Use the test setup described in paragraph 4-16.

b. Connect jumpers W1 and W2 in the SA positions of TP1 and TP2 and connect the CLOCK, START, STOP, and GND inputs to test header TP2 as shown in Figure 4-7.

c. Short the EEPON signal (Q116 pin 12) to +5Vs (Q116 pin 10).

d. Short the EEDO signal (U15 pin 4) to (S).

e. Set up the signature analyzer's CLOCK, START, STOP, and GND inputs as follows:

Signature Analyzer Input	Edge Setting	TP2 Connection
CLOCK		6
START		7
STOP		8
GND	—	3

f. Make sure that the signature analyzer is set up to measure CMOS levels.

Measurements: Use the data probe to take the signatures at each pin of U11 as listed below. These signatures apply to secondary firmware revision A.01. All pins have CMOS levels. The +5Vs signature is 3166.

U11-1	0000	U11-21	3166
U11-2	—	U11-22	3166
U11-3	—	U11-23	3166
U11-4	3166	U11-24	—
U11-5	0000	U11-25	88U6
U11-6	3166	U11-26	9488
U11-7	3166	U11-27	H750
U11-8	3166	U11-28	66HF
U11-9	3166	U11-29	8C5P
U11-10	P181	U11-30	0229
U11-11	3166	U11-31	P545
U11-12	3166	U11-32	P1FU
U11-13	U0AF	U11-33	8A2F
U11-14	F366	U11-34	40A4
U11-15	0000	U11-35	79F9
U11-16	FHPF	U11-36	87PP
U11-17	—	U11-37	9U68
U11-18	8832	U11-38	3166
U11-19	3166	U11-39	3166
U11-20	3166*	U11-40	0000

*Reads 3166 with mode switch S4 in normal position; Reads 0000 with S4 in fast position.

Table 4-6. Secondary Interface S.A. Test No. 2

Description: This test checks the secondary interface readback circuits (all bits low test).

Test Setup: (see Figures 4-6 and 4-7)

a. Use the test setup described in paragraph 4-16.

b. Connect jumpers W1 and W2 in the SA positions of TP1 and TP2 and connect the CLOCK, START, STOP, and GND inputs to test header TP2 as shown in Figure 4-7.

c. Short U26 pins 2, 3, 14, and 15 to ⏚ (U26 pin 16).

d. Short U113 pins 2, 3, 14 and 15 to ⏚ (U113 pin 16).

e. Set up the signature analyzer's CLOCK, START, STOP, and GND inputs as follows:

Signature Analyzer Input	Edge Setting	TP2 Connection
CLOCK	⌐	6
START	¬	7
STOP	⌐	8
GND	—	3

f. Make sure that the signature analyzer is set up to measure CMOS levels.

Measurements: Use the data probe to take the signatures at each pin listed below. These signatures apply to secondary firmware revision A.01. All pins have CMOS levels. The +5Vs signature is HA5C.

U11-17	0000	U14-1	2HP2
		U14-2	0000
U12-1	0000	U14-3	2F3C
U12-2	0000	U14-4	0000
U12-3	HA5C	U14-5	0000
U12-4	HA5C	U14-6	0000
U12-5	CA5H	U14-7	2356
U12-6	6006	U14-9	0000
U12-13	0000	U14-10	0000
U13-1	0000		
U13-3	0000		
U13-7	0000		
U13-9	2356		
U13-10	2356		
U13-11	0000		
U13-13	2356		
U13-15	HA5C		

Table 4-7. Secondary Interface S.A. Test No. 3

Description: This test checks the secondary interface readback circuits (all bits high test).

Test Setup: (see Figures 4-6 and 4-7)

a. Use the test setup described in paragraph 4-16.

b. Connect jumpers W1 and W2 in the SA positions of TP1 and TP2 and connect the CLOCK, START, STOP, and GND inputs to test header TP2 as shown in Figure 4-7.

c. Short circuit (connect jumpers across) the following components: C17, C114, R185.

d. Connect U113 pin 7 to −15V (U113 pin 13).

e. Connect U106 pin 2 to −15 V (U106 pin 4).

f. Set up the signature analyzer's CLOCK, START, STOP, and GND inputs as follows:

Signature Analyzer Input	Edge Setting	TP2 Connection
CLOCK		6
START		7
STOP		8
GND	—	3

Measurements: Use the data probe to take the signatures at each pin listed below. These signatures apply to secondary firmware revision A.01. All pins have CMOS levels. The +5Vs signature is HA5C.

U11-17 HA5C

U12-1 HA5C
U12-2 HA5C
U12-3 HA5C
U12-4 HA5C
U12-5 CA5H
U12-6 6006
U12-13 HA5C

U13-1 2356
U13-3 HA5C
U13-7 HA5C
U13-9 0000
U13-10 7064
U13-11 HA5C
U13-13 0000
U13-15 0000

U14-1 2HP2
U14-2 HA5C
U14-3 5F5U
U14-4 HA5C
U14-5 7064
U14-6 HA5C
U14-7 7064
U14-9 7064
U14-10 HA5C

Table 4-8. Secondary Interface S.A. Test No. 4

Description: This test checks EEPROM chip U15.

Test Setup: (see Figures 4-6 and 4-7)

a. Use the test setup described in paragraph 4-16.

b. Connect jumpers W1 and W2 in the SA positions of TP1 and TP2 and connect the CLOCK, START, STOP, and GND analyzer inputs to test header TP2 as shown in Figure 4-7.

c. Short circuit (connect a jumper across) R22.

d. Set up the signature analyzer's CLOCK, START, STOP, and GND inputs as follows:

Signature Analyzer Input	Edge Setting	TP2 Connection
CLOCK	⌐/	6
START	⌐/	7
STOP	¬\	8
GND	—	3

e. Make sure that the signature analyzer is set up to measure TTL levels.

Measurements: Use the data probe to take the signatures at each pin listed below. These signatures apply to secondary firmware revision A.01. All pins have TTL levels. Note that signatures are model dependent. If EEPROM U15 must be replaced, the supply must be re-initialized as described in paragraph 4-14 and re-calibrated as described in Appendix A of the Operating Manual.

	6632A	6633A	6634A
+5Vs signature	C353	66A6	66A6
U15-1	8P09	780C	780C
U15-2	HCU7	22H8	PUU7
U15-3	U661	PFF3	PFF3
U15-4	5A5P	3F5F	4UF1

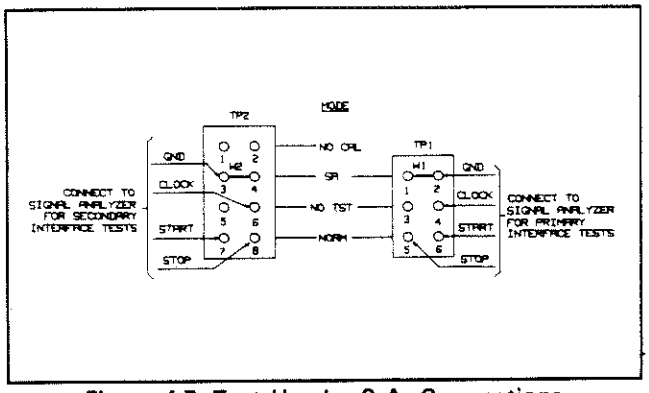


Figure 4-7. Test Header S.A. Connections

4-18 TROUBLESHOOTING PROCEDURES

Troubleshooting flow charts for all of the circuits are given in Figures 4-8 through 4-11 and 4-13 through 4-18. The appropriate flow chart is used when a fault has already been isolated to a particular group of circuits by the initial troubleshooting procedures of Figure 4-4. troubleshooting procedures of Figure 4-4.

Figure 4-8 troubleshoots the primary interface circuits and Figure 4-9 isolates faults in the secondary interface circuits. Figure 4-10 provides troubleshooting procedures for secondary error codes while Figure 4-11 troubleshoots the DAC circuits. Figure 4-12 provides waveforms that will aid you in troubleshooting each of the DAC circuits (CV, CC, OV, and Readback). Figure 4-13 isolates faults to either the DAC or amplifier component in the CV and CC DAC/amplifier circuits. Figures 4-14 through 4-18 provide troubleshooting procedures for various trouble symptoms which may be encountered.

4-19 Bias and Reference Supplies Troubleshooting

Most of the troubleshooting flow charts start by checking the bias and/or reference voltages to make sure that they are not causing the problem. Table 4-9 lists the bias and reference voltages. Figure 6-1 in the back of the manual is the functional schematic for the bias and reference supplies. The schematic includes ac and dc voltage measurements at various circuit points to help isolate a defective circuit. Additional ac voltage measurements for the main rectifier/filter circuits are provided on Figure 6-4 (Model 6632A), Figure 6-5 (Model 6633A), and Figure 6-6 (Model 6634A).

Table 4-9. Bias and Reference Voltages

Supply	Voltage	Test Point (Figure 4-3)	Common (Figure 4-3)
+5 Vp (Primary)	+5 V ± 0.2 V	Q1-6	P
$\overline{\text{PPCLR}}$	≈ +5 V	Q1-4	P
+5 Vs (Secondary)	+5 V ± 0.2 V	Q116-10	S
+15 V Bias	+15 V ± 0.6 V	U106-8	S
−15 V Bias	−15 V ± 0.6 V	U113-13	S
+10 V Reference	+10 V ± 0.05 V	U16-6	S
−12.1 V Reference	−12.1 V ± 0.3 V	U17-7	S
+2.5 V Reference	±2.5 V + 0.02 V	D4-cathode	S
$\overline{\text{SPCLR}}$	≈ +5 V	Q116-4	S

4-20 Status Annunciators Troubleshooting

When troubleshooting the $\overline{\text{STATUS}}$ annunciators or status readback circuits, first measure the voltage drop across the gating diodes D118 (CC+), D119 (CC−), and D123 (CV). A conducting diode indicates an active (ON) control circuit. This foward drop is applied to the input of the associated status comparator (U113A B, or C) and drives the output low. The low signal indicates an active status which is sent to the secondary microcomputer U11 through U12A and U13. These circuits are shown in Figure 6-3 and Figures 6-4 (Model 6632A), 6-5 (Model 6633A), or 6-6 (Model 6634A).

The front panel CV annunicator indicates when the CV mode is active ($\overline{\text{CV}}$ low). The front panel CC annunicator indicates when the CC+ mode ($\overline{\text{CC+}}$ low) or CC− mode (combination of $\overline{\text{CV}}$ low and $\overline{\text{CC−}}$) is active. Unregulated is defined as neither $\overline{\text{CV}}$, $\overline{\text{CC+}}$, nor $\overline{\text{CC−}}$.

The operating mode status readback latches (U13) can be checked using Secondary S.A. Test Nos. 2 (see Table 4-6) and 3 (see Table 4-7) or by using a dual channel oscilloscope. Connect the oscilloscope trigger input to U13-5 (positive trigger) and check the inputs and outputs of the readback latches (U13) for high (H) and low (L) levels as given in Table 4-10 when the enable line is High.

Table 4-10. Operating Status Readback Levels

	U13 Pin Pin No.	Status			
		CC+	CV	CC−	UNR
Input	3	H	L	L	H
	7	L	H	H	H
	11	H	H	L	H
	15	H	H	H	L
Output	13	L	H	H	L
	9	H	L	L	L
	10	L	L	H	L
	1	L	L	L	H

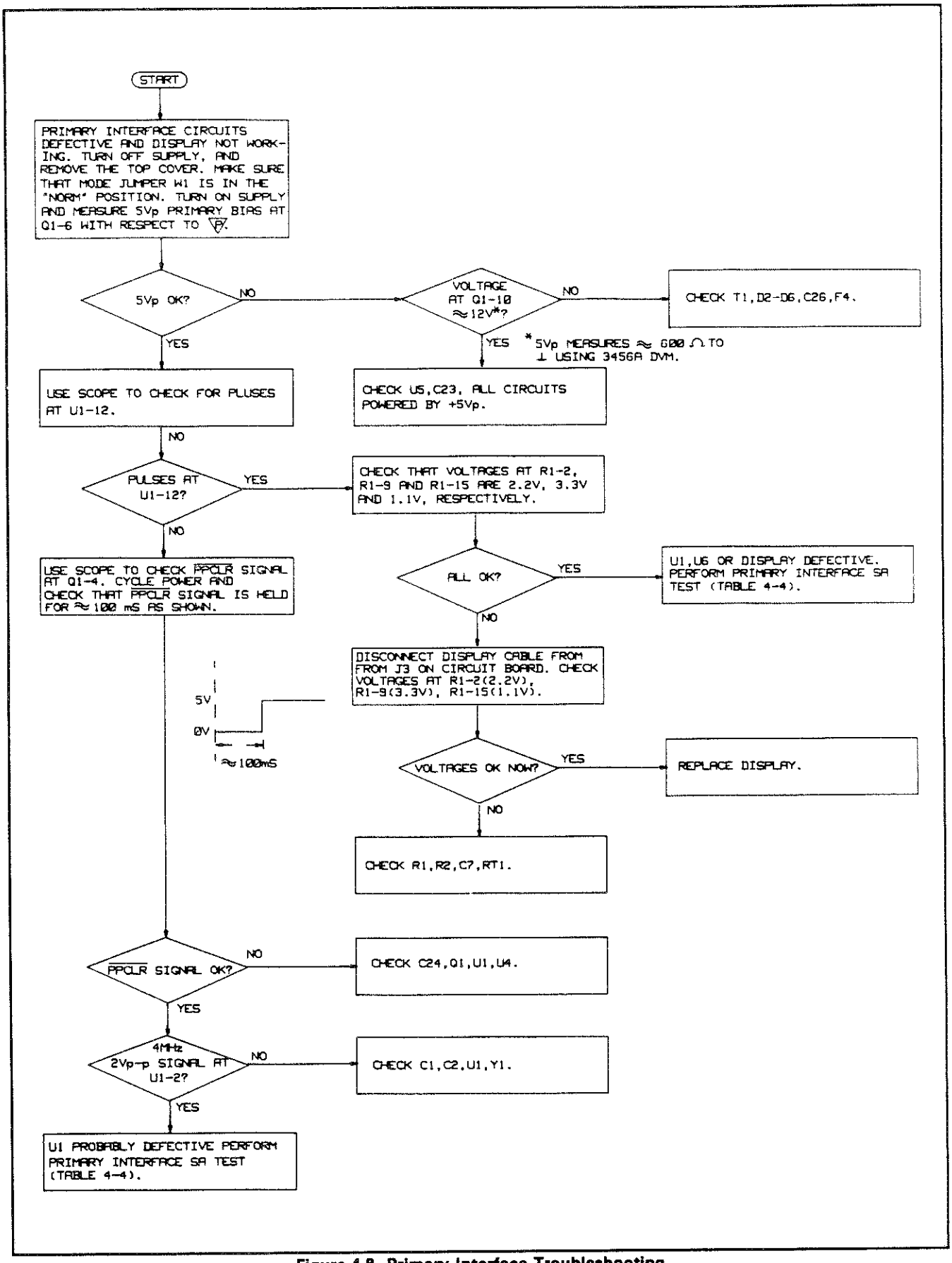


Figure 4-8. Primary Interface Troubleshooting

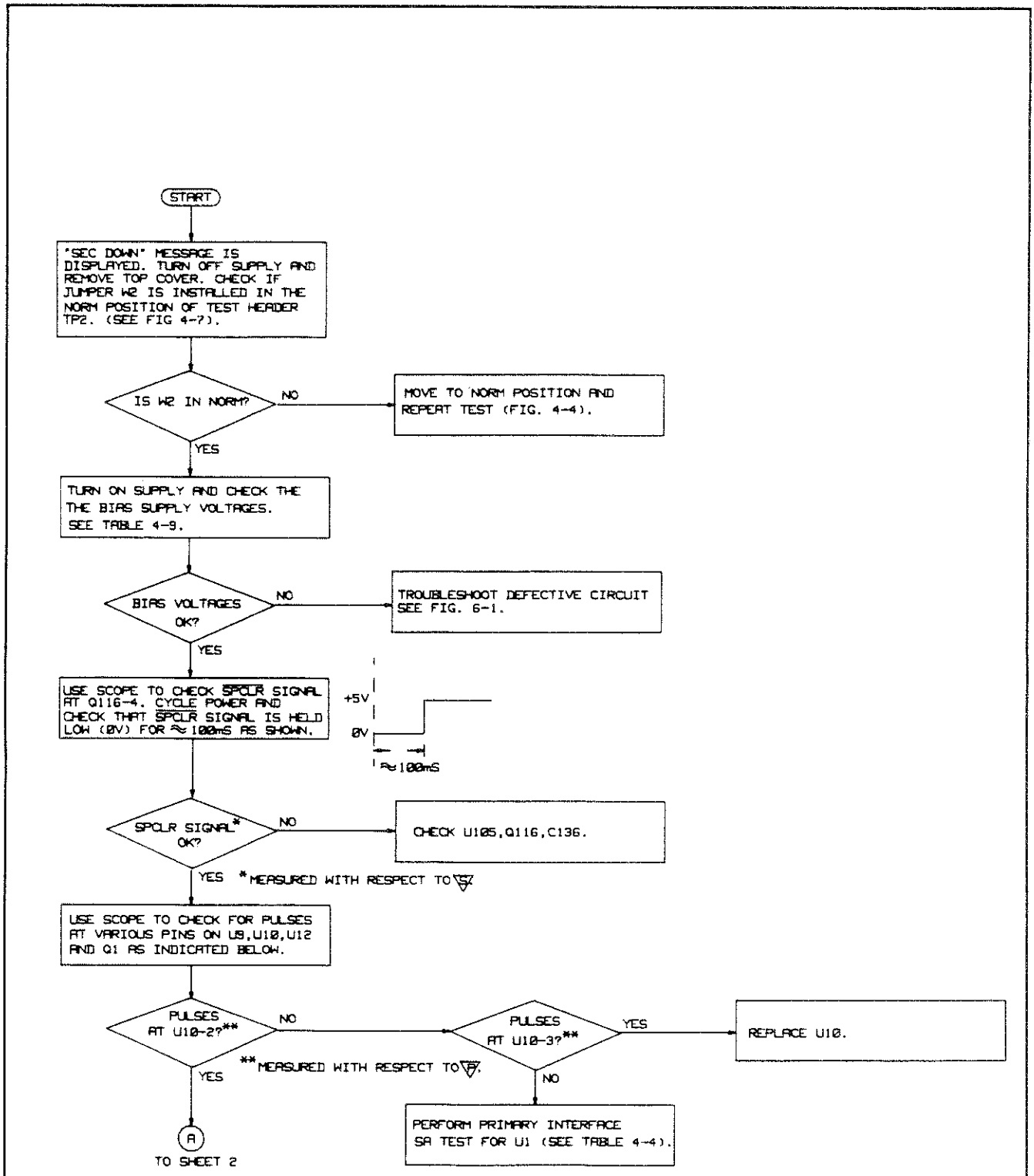


Figure 4-9 (Sheet 1). Secondary Interface Troubleshooting

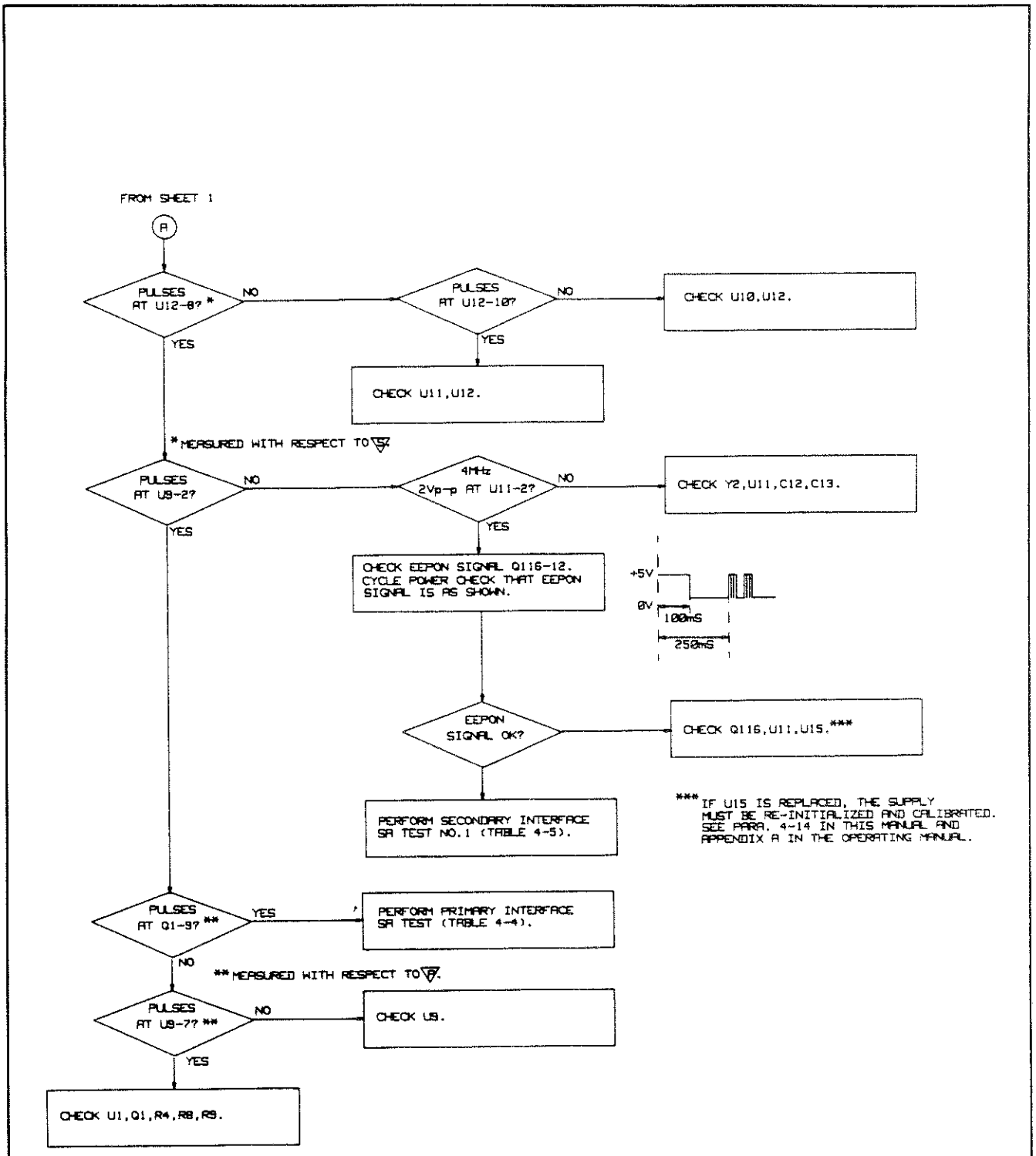


Figure 4-9 (Sheet 2). Secondary Interface Troubleshooting

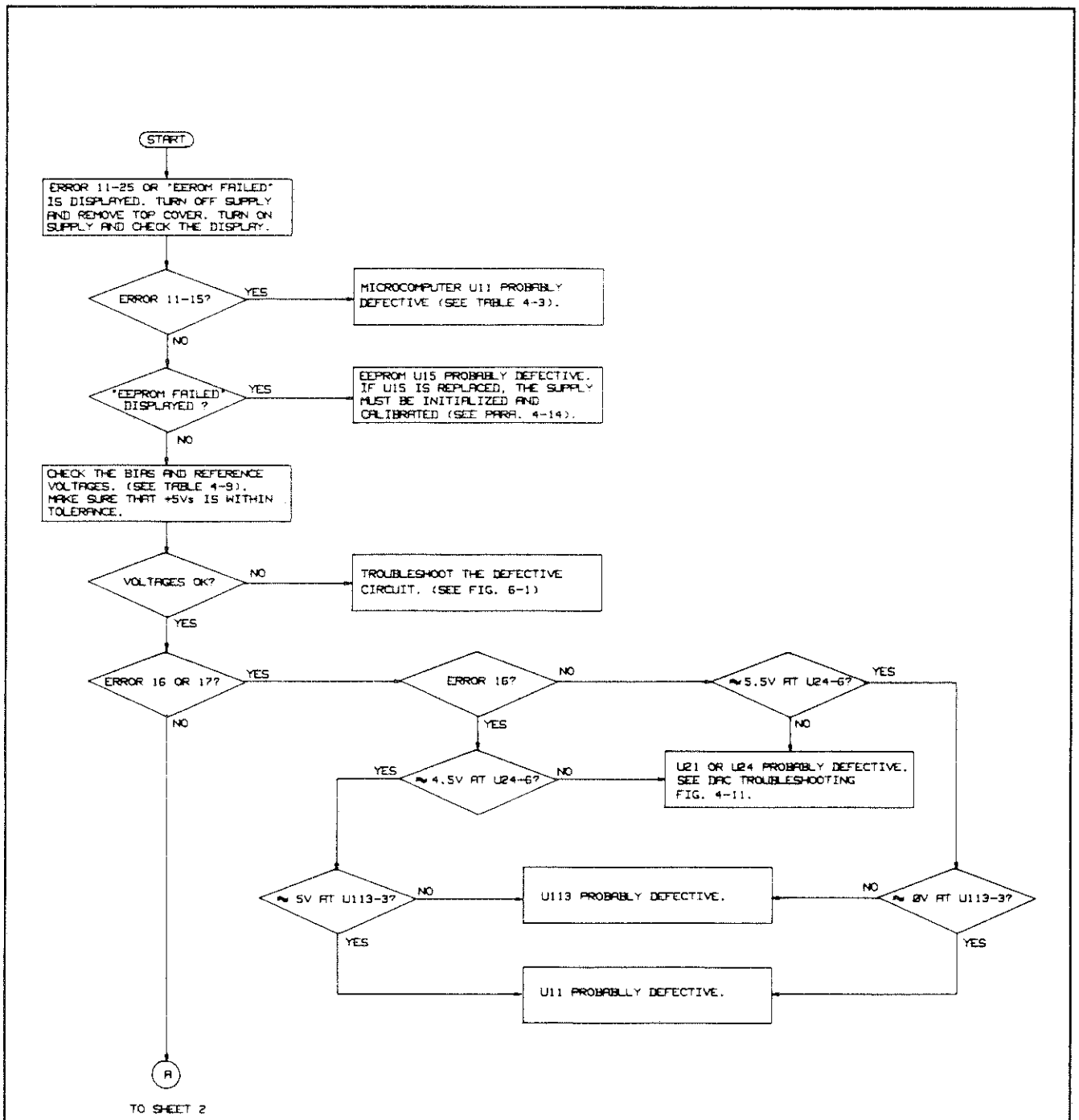


Figure 4-10 (Sheet 1). Secondary Errors Troubleshooting

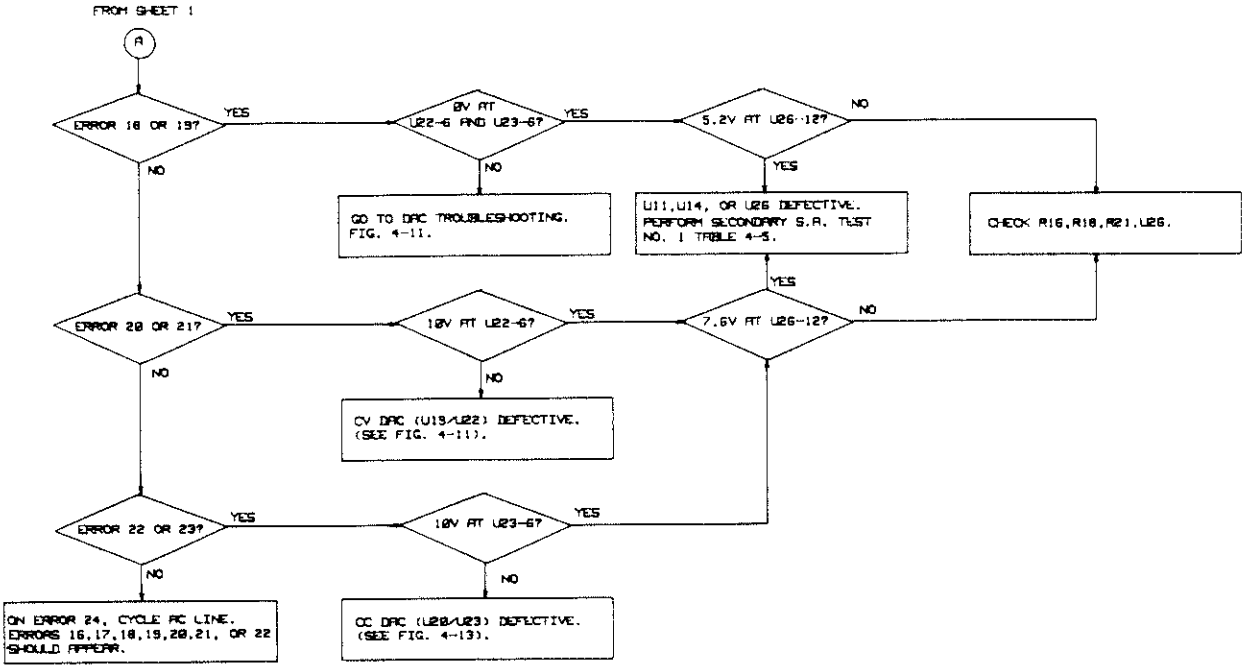


Figure 4-10 (Sheet 2). Secondary Errors Troubleshooting

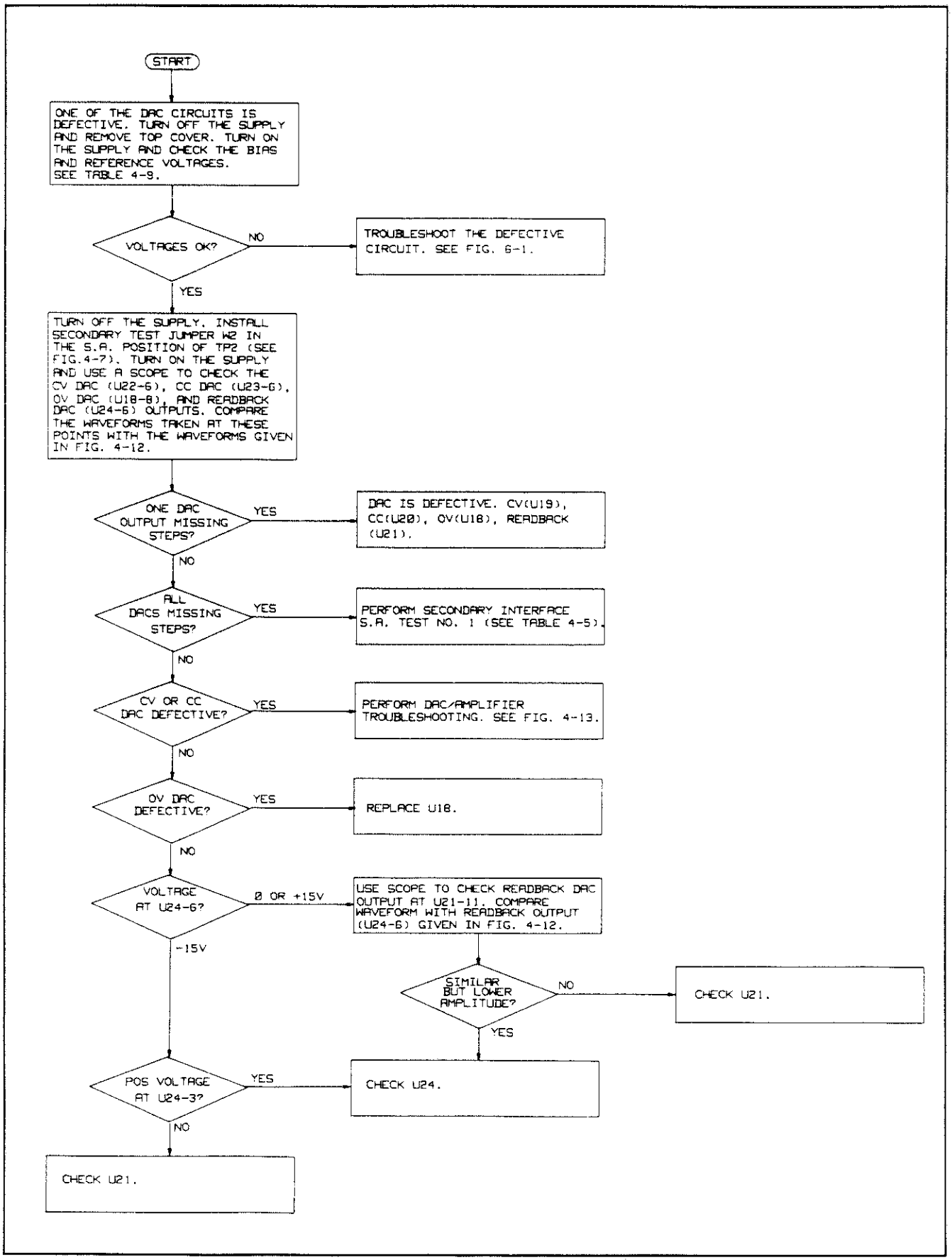
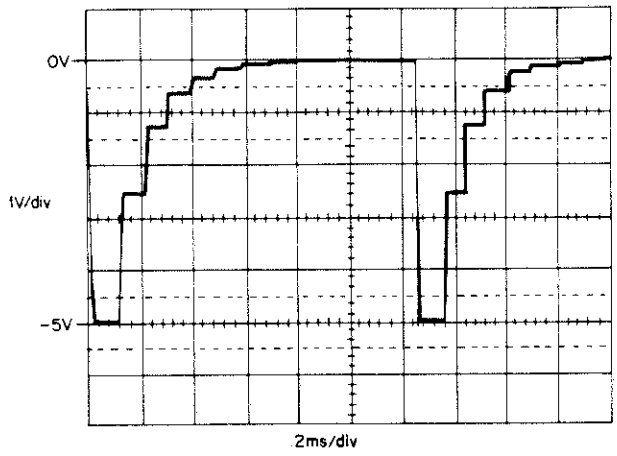
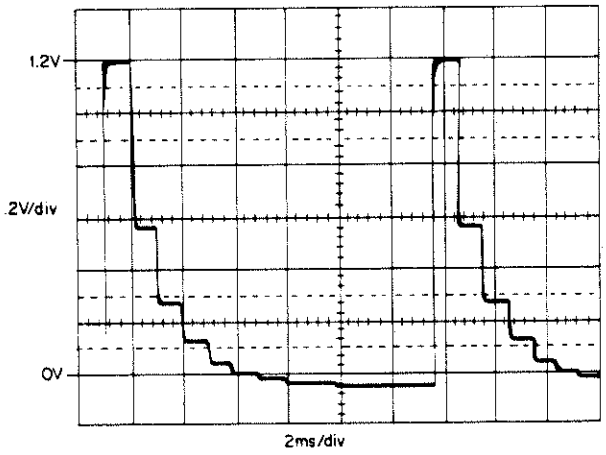


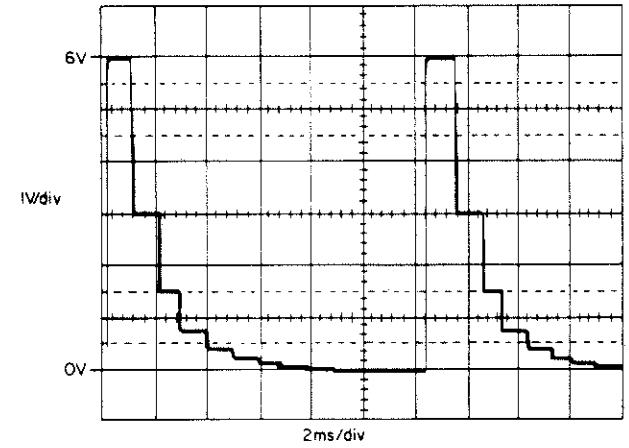
Figure 4-11. DAC Circuits Troubleshooting



A. CV DAC (U22-6) and CC DAC (U23-6) Outputs



B. Overvoltage (OV) DAC (U18-8) Output



C. Readback DAC (U24-6) Output

Figure 4-12. DAC Waveforms

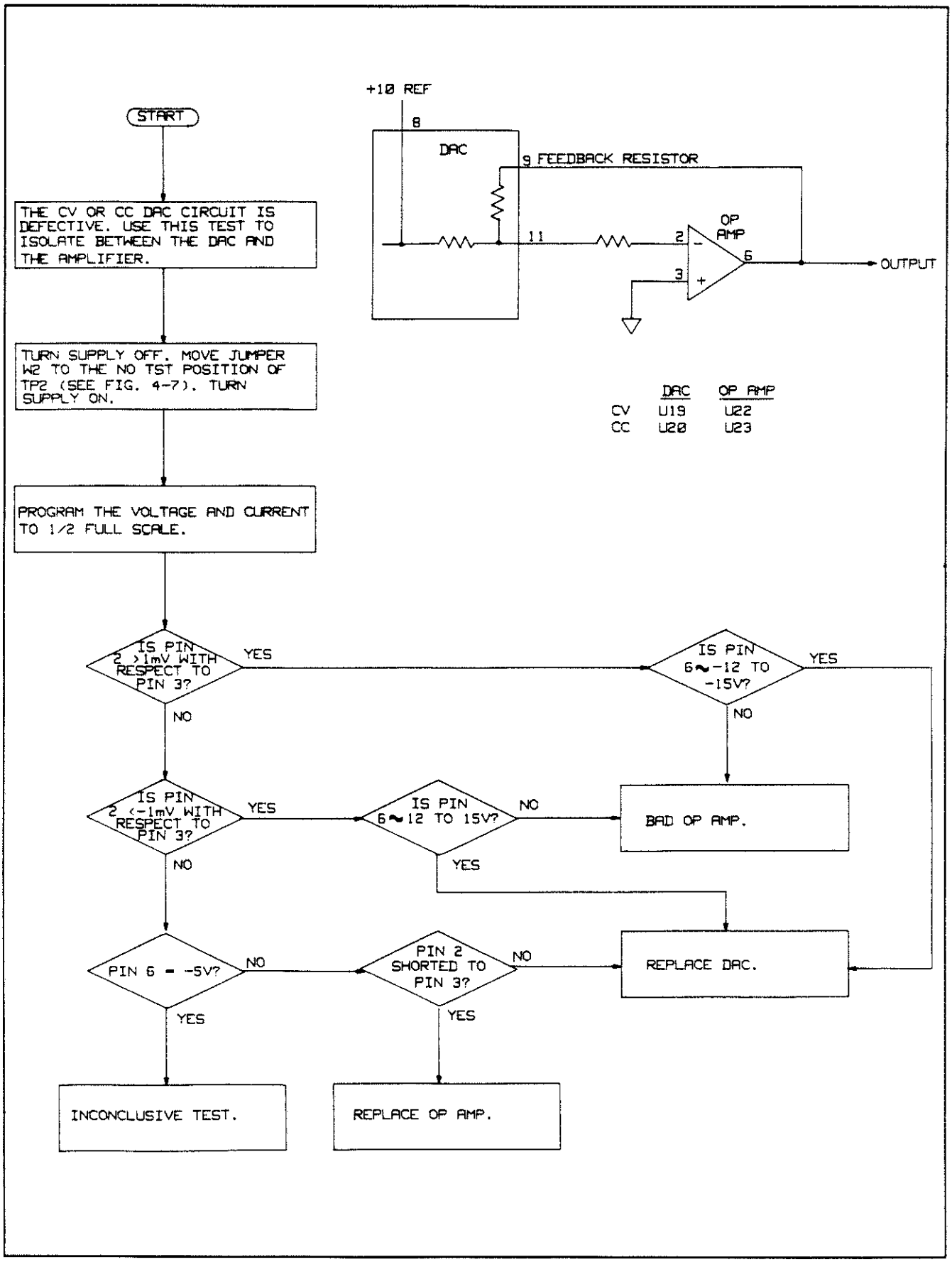


Figure 4-13. CV/CC DAC and Amplifier Circuit Troubleshooting

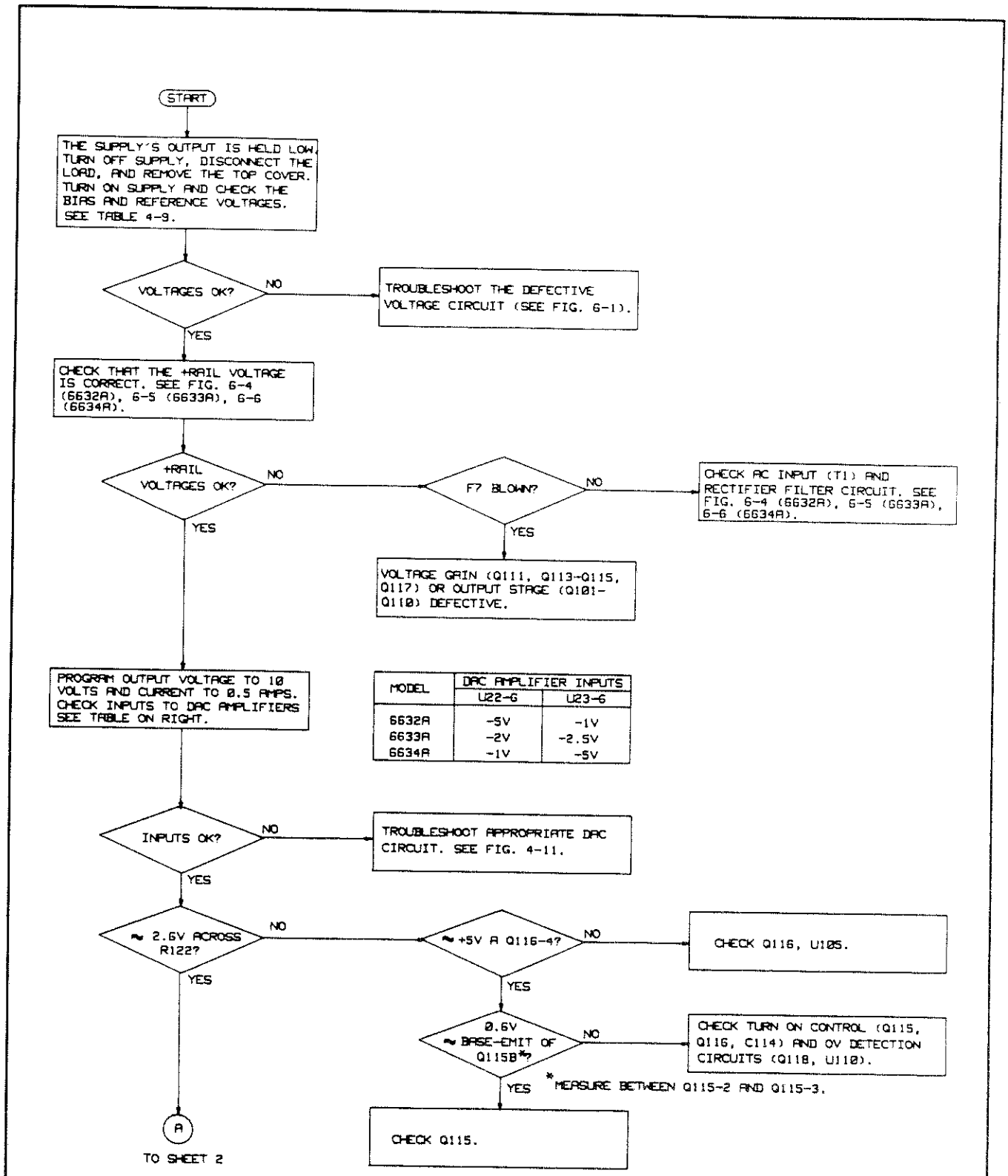


Figure 4-14 (Sheet 1). Output Low Troubleshooting

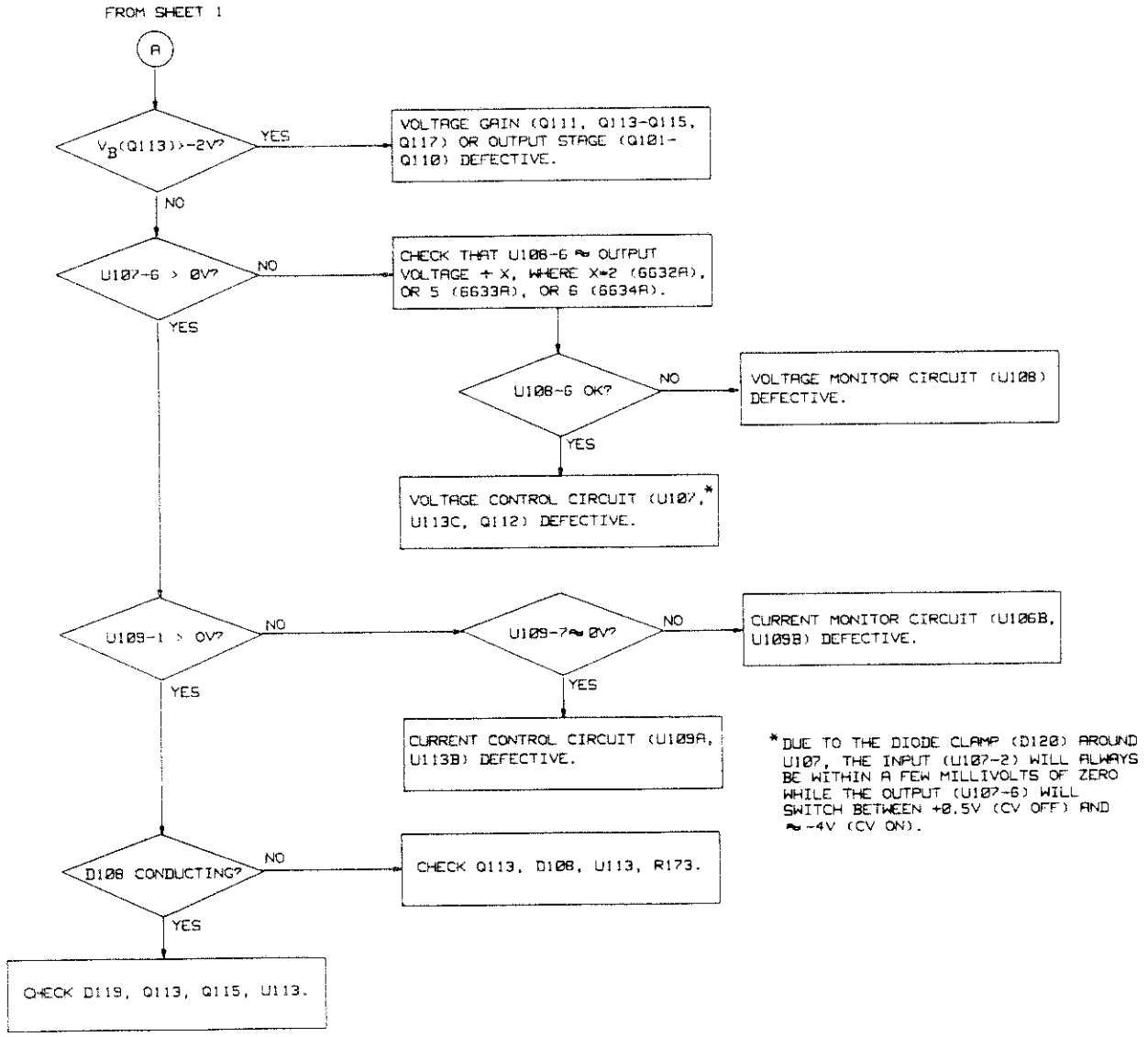


Figure 4-14 (Sheet 2). Output Low Troubleshooting

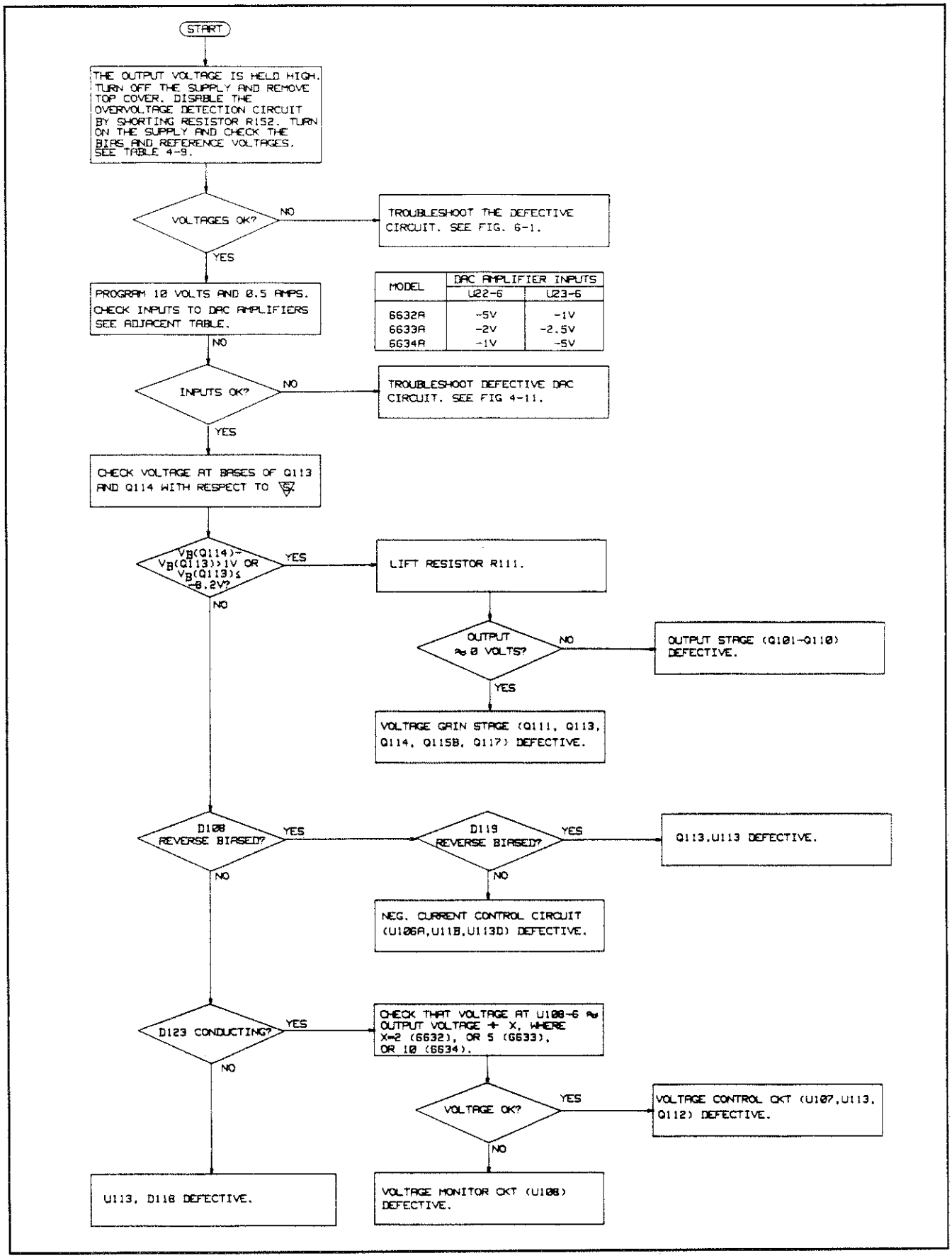


Figure 4-15. Output High Troubleshooting

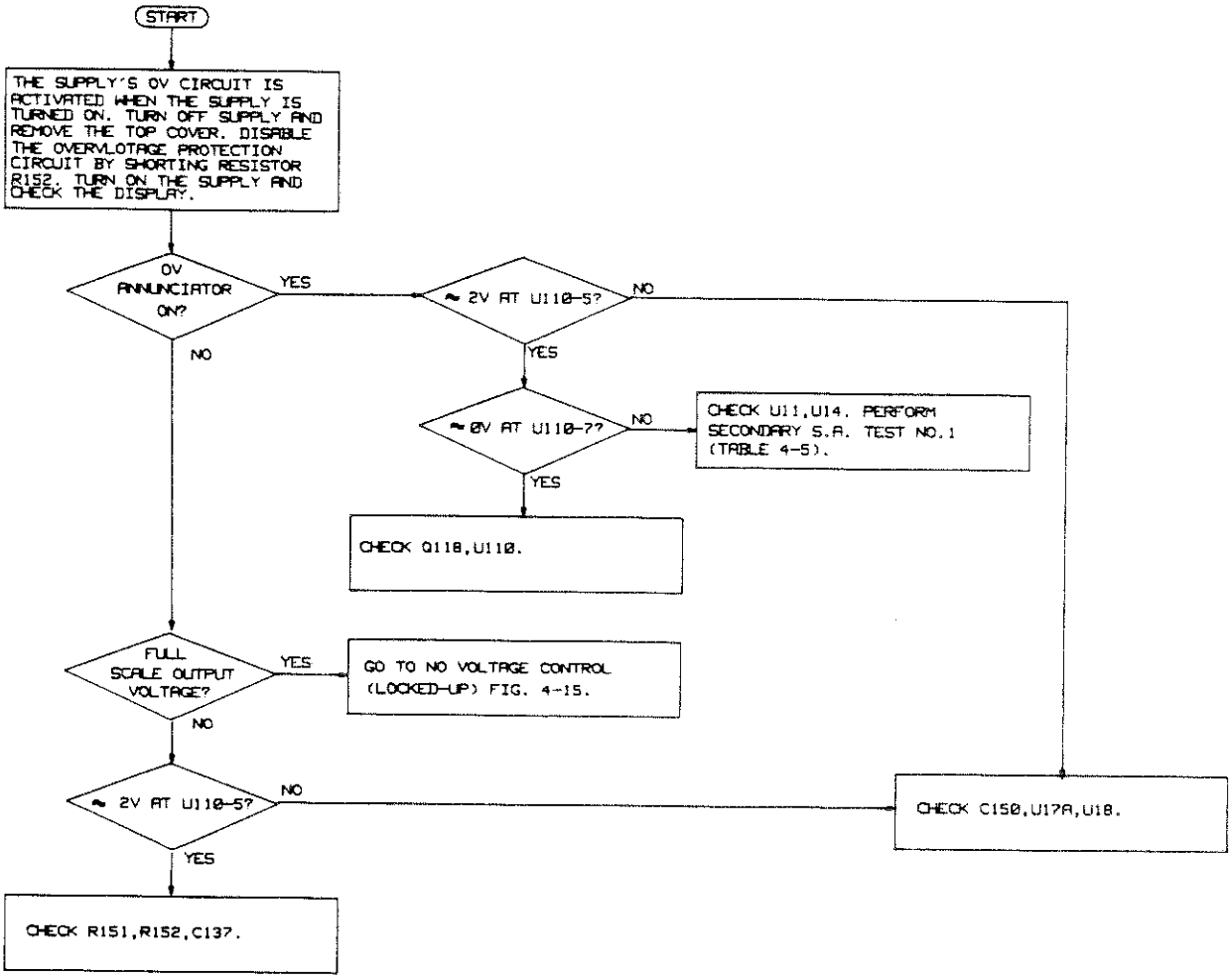


Figure 4-16. Overvoltage at Turn-On Troubleshooting

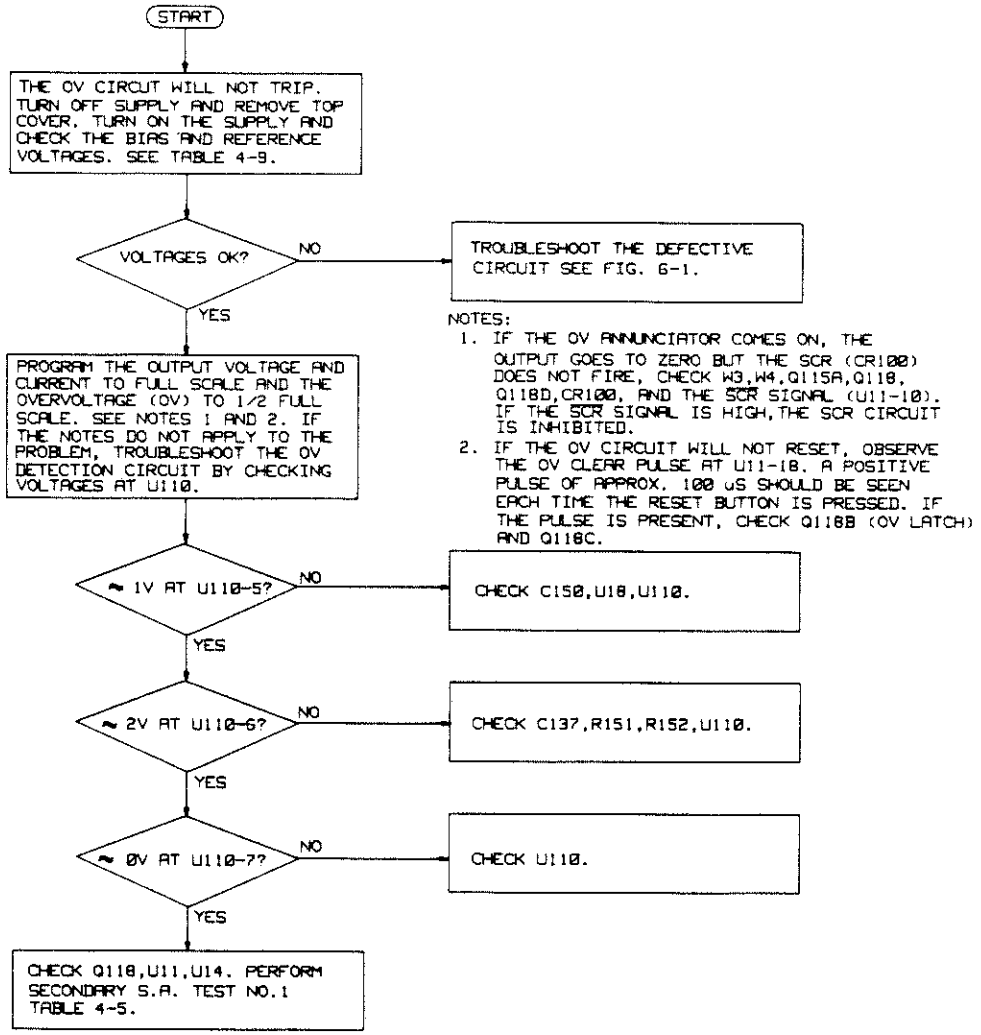


Figure 4-17. Overvoltage will not Trip Troubleshooting

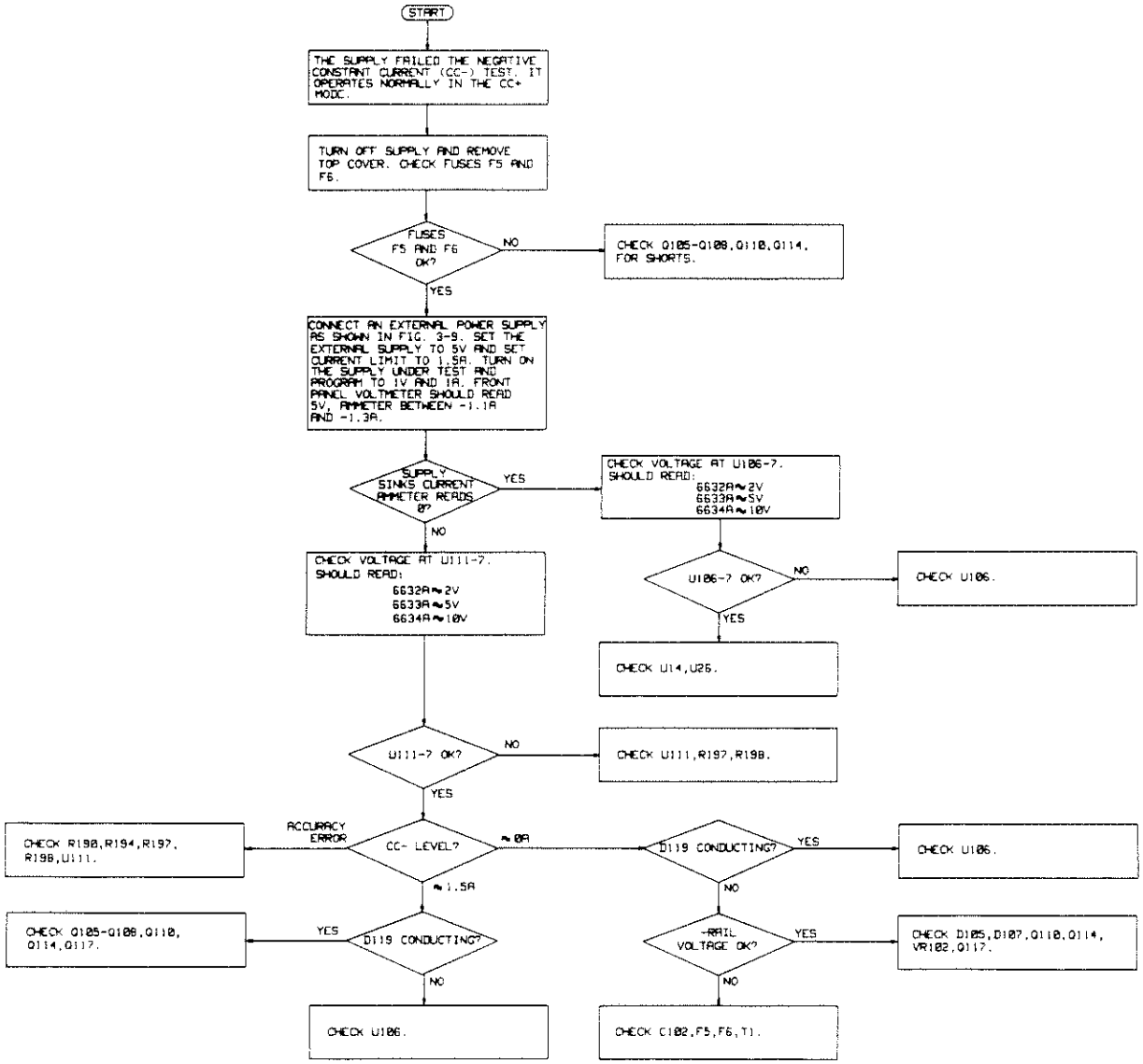


Figure 4-18. CC– Will Not Regulate Troubleshooting

Section V
REPLACEABLE PARTS

5-1 INTRODUCTION

This section contains information on ordering replacement parts. Table 5-4 lists all of the electrical and mechanical components for the HP 6632A through HP 6634A series Power Supplies.

Where replaceable parts differ for the same reference designator, the differences are tabulated by model number below the reference designator. Each entry in these tables includes the following information:

a. Reference designator (Refer to Table 5-1).
b. Hewlett-Packard part number.
c. Description of Part (Refer to Table 5-2 for abbreviations).
d. Manufacturer's Federal Supply Code number (refer to Table 5-3 for manufacturer's name and address).
e. Manufacturer's Part Number.

5-2 HOW TO ORDER PARTS

You can order parts from your local Hewlett-Packard sales office. Refer to the list of sales offices at the back of the manual for the office nearest you. When ordering parts include the following information:

a. The Hewlett-Packard part number.
b. A description of the part.
c. The quantity desired.
d. The model number in which the part is used (i.e. HP 6632A, 6633A, or 6634A).

If you wish to order a part directly from the manufacturer, locate the manufacturer's Federal Supply Code and corresponding address in Table 5-3.

Table 5-1. Reference Designators

B	Blower
C	Capacitor
D	Diode
F	Fuse
J	Jack
L	Inductor
P	Plug
Q	Transistor
R	Resistor
RT	Thermal Resistor
T	Transformer
S	Switch
TB	Barrier Block
TP	Test Pins
U	Integrated Circuit
VR	Voltage Regulator (Zener Diode)
W	Wire
XT	Connector
Y	Crystal Oscillator

Table 5-2. Description of Abbreviation

ANLG	Analog
ASSY	Assembly
AWG	American Wire Gauge
BAR-BLK	Barrier Block
BNDPOST	Binding Post
CER	Ceramic
CHAS	Chassis
COMP	Carbon Film Composition
CONN	Connector
CVR	Cover
DAC	Digital to Analog Converter
DBLCHAM	Double Chamber
DIO	Diode
EEPROM	Electrically Erasable Programmable Read Only Memory
ELECT	Electrolytic
EPROM	Erasable Programmable Read Only Memory
FET	Field Effect Transistor

Table 5-2. Description of Abbreviation (continued)

FXD	Fixed
GND	Ground
HS	Heat Sink
IC	Integrated Circuit
INDTR	Inductor
INSUL	Insulator
JFET	Junction Field Effect Transistor
LCD	Liquid Crystal Display
LKWR	Lock Washer
MACH	Machine
MET	Metal Oxide
METPA	Metalized Paper
METPOL	Metalized Polycarbonate
MOS	Metal Oxide Semi-Conductor
MPU	Microprocessor Unit
MTG	Mounting
MUXR	Multiplexer
NMOS	Negative Channel Metal Oxide Semi-Conductor
OSC	Oscillator
PNL	Panel
PWR	Power
RAM	Random Access Memory
RECT	Rectifier
REG	Regulator
REGIS	Register
RES	Resistor
ROM	Read Only Memory
SCR	Screw
SHLD	Shoulder
SI	Silicon
VTL	Voltage
WW	Wire Wound
XFMR	Transformer
XSTR	Transistor

Table 5-3. Federal Manufacturer Codes

Code	Manufacturer	Address
01121	Allen Bradley Company	Milwaukee, WI.
01281	TRW Inc.	Philidelphia, PA.
01295	Texas Instruments Inc.	Dallas, TX.
04713	Motorola Semiconductor Products	Phoenix, AZ.
07115	Corning Glass Works	Bradford, PA.
07263	Fairchild Semi-Conductor Corp.	Hicksville, N.Y.
13141	Unitrode Transistor Products Inc.	Calabasa, CA.
16299	Corning Glass Works	Raleigh, N.C.
17896	Siliconxs	Santa Clara, CA.
19701	Mepco/Electro Corp.	Mineral Wells, TX.
26480	Hewlett-Packard Company	Palo Alto, Calif.
27014	National Semiconductor Corp.	Santa Clara, CA.
56289	Sprague Electric Company	North Adams, Mass.
80795	ITT	New York, N.Y.
81483	International Rectifier	Los Angeles, Ca.

ble 5-4. HP 6632-6634A Parts List

Ref Desig	HP Part No.	Description	Mfr Code	Mfr Part No.
		Main Board Assembly Electrical		
6632A	06632-60020	20V Output Board Assembly	28480	
6633A	06633-60020	50V Output Board Assembly	28480	
6634A	06634-60020	100V Output Board Assembly	28480	
B1		See Chassis Electrical		
C1,2	0160-4787	fxd cer 22pF 5% 100V	28480	
C3-5	0160-5422	fxd cer .047uF 20% 50V	28480	
C6	0160-5166	fxd cer .015uF 20% 100V	28480	
C7	0160-5422	fxd cer .047uF 20% 50V	28480	
C8	0160-4808	fxd cer 470pF 5% 100V	28480	
C9,10		Not Used		
C11	0160-5422	fxd cer .047uF 20% 50V	28480	
C12,13	0160-4787	fxd cer 22pF 5% 100V	28480	
C14		Not Used		
C15,16	0160-5410	fxd cer 3300pF 5% 50V	28480	
C17	0160-4820	fxd cer 1800pF 5% 100V	28480	
C18-20	0160-4807	fxd cer 33pF 5% 100V	28480	
C21,22	0180-0405	fxd elect 1.8uF 10% 20V	56289	150D185X9020A2
C23	0160-4835	fxd cer .1uF 10% 50V	28480	
C24	0180-0374	fxd elect 10uF 10% 20V	56289	150D106X9020B2
C25	0160-4835	fxd cer .1uF 10% 50V	28480	
C26	0180-3497	fxd elect 6800uF 10% 16V	28480	
C27,28	0160-5422	fxd cer .047uF 20% 50V	28480	
C29,30		Not Used		
C31-34	0160-5422	fxd cer .047uF 20% 50V	28480	
C35-36	0160-5469	fxd cer 1uF 10% 50V	28480	
C37-39	0160-5422	fxd cer .047uF 20% 50V	28480	
C100		Not Used		
C101				
6632	0180-3840	fxd elect 7400uF 20% 63V	28480	
6633	0180-3964	fxd elect 2200uF 125V	28480	
6634	0180-3966	fxd elect 820uF 250V	28480	
C102				
6632	0180-3962	fxd elect 33,000uF 16V	28480	
6633	0180-3963	fxd elect 17,000uF 16V	28480	
6634	0180-3965	fxd elect 8200uF 16V	28480	
C103				
6632	0180-3840	fxd elect 7400uF 20% 63V	28480	
6633,34		Not Used		
C104	0180-0291	fxd elect 1uF 10% 35V	56289	150D105X9035A
C105	0180-2980	fxd elect 1000uF 20% 35V	28480	
C106				
6632	0160-5422	fxd cer .047uF 20% 50V	28480	
6633	0160-5644	fxd cer .033uF 10% 50V	28480	
6634	0160-5166	fxd cer .015uF 20% 100V	28480	
C107				
6632	0160-5422	fxd cer .047uF 20% 50V	28480	
6633	0160-4832	fxd cer .01uF 10% 100V	28480	
6634	0160-0157	fxd cer 4700pF 10% 200V	28480	

Table 5-4. HP 6632-6634A Parts List (continued)

Ref Desig	HP Part No.	Description	Mfr Code	Mfr Part No.
C108,109	0160-4439	fxd cer 4700pF 20% 250V	28480	
C110				
6632	0180-3699	fxd elect 470uF 20%	28480	
6633	0180-3967	fxd elect 100uF 100V	28480	
6634	0180-3696	fxd elect 22uF 250V	28480	
C111				
6632	0160-4835	fxd cer .1uF 10% 50V	28480	
6633	0160-6804	fxd cer .047uF 250V	28480	
6634	0160-6805	fxd cer .01uF 400V	28480	
C112	0160-4832	fxd cer .01uF 10% 100V	28480	
C113				
6632,33		Not Used		
6634	0160-6836	fxd cer .01uF 250V	28480	
C114	0160-5098	fxd cer .22uF 10% 50V	28480	
C115				
6632	0160-5422	fxd cer .047uF 20% 50V	28480	
6633	0160-5644	fxd cer .033uF 10% 50V	28480	
6634	0160-5166	fxd cer .015uF 20% 100V	28480	
C116		Not Used		
C117				
6632	0160-4811	fxd cer 270pF 5% 100V	28480	
6633	0160-4812	fxd cer 220pF 5% 100V	28480	
6634	0160-4813	fxd cer 180pF 5% 100V	28480	
C118	0160-5422	fxd cer .047uF 20% 50V	28480	
C119	0160-4787	fxd cer 22pF 5% 100V	28480	
C120				
6632	0160-5422	fxd cer .047uF 20% 50V	28480	
6633,34	0160-6803	fxd cer .047uF 250V	28480	
C121	0160-4835	fxd cer .1uF 10% 50V	28480	
C122	0160-6827	fxd cer .022uF 400V	28480	
C123				
6632	0160-5422	fxd cer .047uF 20% 50V	28480	
6633,34	0160-6803	fxd cer .047uF 250V	28480	
C124	0160-5422	fxd cer .047uF 20% 50V	28480	
C125,126				
6632	0160-5422	fxd cer .047uF 20% 50V	28480	
6633,34	0160-6800	fxd cer .022uV 400V	28480	
C127	0160-5422	fxd cer .047uF 20% 50V	28480	
C128	0160-4835	fxd cer .1uF 10% 50V	28480	
C129	0160-5422	fxd cer .047uF 20% 50V	28480	
C130				
6632	0160-5469	fxd cer 1uF 10% 50V	28480	
6633	0160-5847	fxd cer .22uF 100V	28480	
6634	0160-6806	fxd cer .1uF 400V	28480	
C131	0160-4259	fxd metpa .22uF 10% 250V	28480	
C132,133	0160-4281	fxd metpa 2200pF 20% 250V	28480	
C134	0180-3496	fxd elect 2200uF 10% 35V	28480	
C135	0160-4835	fxd cer .1uF 10% 50V	28480	
C136	0180-0374	fxd elect 10uF 10% 20V	56289	150DX06X9020B2
C137	0160-4812	fxd cer 220pF 5% 100V	28480	
C138	0160-4789	fxd cer 15pF 5% 100V	28480	
C139	0160-4810	fxd cer 330pF 5% 100V	28480	

Table 5-4. HP 6632-6634A Parts List (continued)

Ref Desig	HP Part No.	Description	Mfr Code	Mfr Part No.
C140	0160-6827	fxd cer .022uF 400V	28480	
C141	0160-5469	fxd cer 1uF 10% 50V	28480	
C142		Not Used		
C143				
6632	0160-4831	fxd cer 4700pF 10% 100V	28480	
6633	0160-0153	fxd cer 1000pF 10% 200V	28480	
6634	0160-6832	fxd cer 220pF 250V	28480	
C144				
6632	0160-5422	fxd cer .047uF 20% 50V	28480	
6633,34	0160-6804	fxd cer .047uF 250V	28480	
C145	0160-5422	fxd cer .047uF 20% 50V	28480	
C146				
6632	0160-4831	fxd cer 4700pF 10% 100V	28480	
6633	0160-0153	fxd cer 1000pF 10% 200V	28480	
6634	0160-6832	fxd cer 220pF 250V	28480	
C147		Not Used		
C148				
6632	0160-5422	fxd cer .047uF 20% 50V	28480	
6633,34	0160-6803	fxd cer .047uF 250V	28480	
C149	0160-5422	fxd cer .047uF 20% 50V	28480	
C150	0160-5410	fxd cer 3300pF 5% 50V	28480	
C151-153		Not Used		
C154	0180-0374	fxd elect 10uF 10% 20V		
C155,156	0160-5422	fxd cer .047uF 20% 50V	28480	
C157				
6632	0160-5422	fxd cer .047uF 20% 50V	28480	
6633	0160-6800	fxd cer .022uF 400V	28480	
6634	0160-6805	fxd cer .01uF 400V	28480	
C158	0160-5422	fxd cer .047uF 20% 50V	28480	
C159	0180-0291	fxd elect 1uF 35V 35V	56289	150D105X9035A2
C160	0160-5410	fxd cer 3300pF 5% 50V	28480	
C161	0160-4812	fxd cer 220pF 5% 100V	28480	
C400*	0160-4441	fxd cer .47uF 10% 50V	28480	
C401*	0160-4441	fxd cer .47uF 10% 50V	28480	
CR100				
6632,33**	5060-3234	Assy (HS & HP P/N 1884-3234)	28480	
6634	5060-3251	Assy (HS & HP P/N 1884-0316)	04713	2N6402
D1	1901-0050	Diode, switching	13141	1N4150
D2,3	1901-0731	Diode, pwr rect	80795	1N4004G
D4	1901-0050	Diode, switching	28480	
D5,6	1901-0731	Diode, pwr rect	80795	1N4004G
D101				
6632,33**	5060-3234	Assy (HS & HP P/N 1884-3234)	28480	
6634	1901-0719	Diode, Pwr Rect	28480	
D102	1901-0719	Diode, Pwr Rect	28480	
D103	1901-0050	Diode, switching	28480	
D104,105	1901-1098	Diode, switching	28480	

* These are user installed parts. See paragraph 4-13 (Inductive Loading) in the Operating Manual (HP P/N 5957-6360) for details.

** HP Part No. 5060-3234 includes CR100 and D101 mounted back-to-back on the heat sink.

Table 5-4. HP 6632-6634A Parts List (continued)

Ref Desig	HP Part No.	Description	Mfr Code	Mfr Part No.
D106,107				
6632		Not Used		
6633,34	1901-1098	Diode, switching	28480	
D108	1901-0050	Diode, switching	28480	
D109-110				
6632	5060-3233	Assy (HS & HP P/N 1901-0891)	28480	
6633	1901-0719	Diode, Pwr Rect	28480	
6634	1901-1248	Diode, Rect	04713	1N4937
D111-112				
6632	5060-3228	Assy (HS & HP P/N 1901-0987)	3L585	RUR810
6633	1901-0719	Diode, Pwr Rect	28480	
6634	1901-1248	Diode, Rect	04713	1N4937
D113-115		Not Used		
D116				
6632		Not Used (R155 is used)		
6633,34	1901-1098	Diode, switching	28480	
D117	1901-0033	Diode, switching	13141	1N645
D118,119	1901-0050	Diode, switching	28480	
D120	1901-0033	Diode, switching	13141	1N645
D121		Not Used		
D122	1901-0033	Diode, switching	13141	1N645
D123	1901-0050	Diode, switching	28480	
D124	1901-0033	Diode, switching	13141	1N645
D125-128	1901-1065	Diode, pwr rect	13141	1N4930
F1				
110/120VAC	2110-0055	Fuse, 4A 250V	28480	
220/240VAC	2110-0002	Fuse, 2A 250V	28480	
F2				
6632	2110-0777	Fuse, 8A 32V	28480	
6633,34		Not Used (R219 is used)		
F3	2110-0712	Fuse, 4A	28480	
F4	2110-0699	Fuse, 5A	28480	
F5,6				
6632,33	2110-0697	Fuse, 15A	28480	
6634	2110-0685	Fuse, 7A	28480	
F7				
6632	2110-0685	Fuse, 7A	28480	
6633	2110-0712	Fuse, 4A	28480	
6634	2110-0684	Fuse, 2A	28480	
F8	2110-0712	Fuse, 4A	28480	
J1	1252-0268	Connector female (HP-IB)	28480	
J2	1251-4927	Connector (Keyboard)	28480	
J3	1251-4927	Connector (display)	28480	
J4	1251-4743	Connector male (ac pwr)	28480	
L101,102				
6632	9140-0115	Inductor 22uH 10%	28480	
6633,34		Not Used		
Q1	1858-0054	Transistor array	28480	
Q101-104				
6632,33	1854-0989	Transistor, NPN	04713	MJ15003
6634	1854-1162	Transistor, NPN	28480	
Q105-108				
6632,33	1853-0651	Transistor, PNP	28480	
6634	1853-0653	Transistor, PNP	28480	

Table 5-4. HP 6632-6634A Parts List (continued)

Ref Desig	HP Part No.	Description	Mfr Code	Mfr Part No.
Q109				
6632	5060-3230	Assy (HS & HP P/N 1854-0872)	03508	D44H11
6633	5060-3249	Assy (HS & HP P/N 1854-1161)	28480	
6634	5060-3252	Assy (HS & HP P/N 1854-0838)	04713	TIP47
Q110				
6632	5060-3231	Assy (HS & HP P/N 1853-0497)	03508	D45H11
6633,34	5060-3250	Assy (HS & HP P/N 1853-0652)	28480	
Q111	1853-0221	Transistor, PNP	3L585	2N5416
Q112	1855-0386	JFET 2N4392	27014	2N4392
Q113,114				
6632	1854-0263	Transistor, NPN	04713	2N3019
6633	1854-0523	Transistor, NPN	28480	
6634	1854-0232	Transistor, NPN	28480	
Q115	1858-0074	Transistor array	04713	MPQ6100
Q116	1858-0054	Transistor array	28480	
Q117	1853-0451	Transistor, PNP	01295	2N3799
Q118	1821-0001	Transistor array	3L585	CA3046
Q119	5060-3245	Assy (HS & HP P/N 1854-1128)	28480	
R1	1810-0560	Resistor network (8 X 5.6K)	28480	
R2	0698-3359	fxd film 12.7K 1% 1/8W	28480	
R3	0757-0280	fxd film 1K 1% 1/8W	28480	
R4	1810-0424	Resistor network (15 X 4.7K)	28480	
R5	0757-0455	fxd film 36.5K 1% 1/8W	07115	CT4-1/8-TO-3652-F
R6	0757-0469	fxd film 150K 1% 1/8W	07115	CT4-1/8-TO-1503-F
R7	1810-0305	Resistor network (8 X 4.7K)	28480	
R8,9	0757-0280	fxd film 1K 1% 1/8W	28480	
R10-12		Not Used		
R13	1810-0603	Resistor network (7 X 10K)	28480	
R14		Not Used		
R15	0757-0280	fxd film 1K 1% 1/8W	28480	
R16	0757-0465	fxd film 100K 1% 1/8W	07115	CT4-1/8-TO-1003-F
R17	0757-0436	fxd film 4.32K 1% 1/8W	28480	
R18	0757-0465	fxd film 100K 1% 1/8W	07115	CT4-1/8-TO-1003-F
R19,20		Not Used		
R21	0757-0457	fxd film 47.5K 1% 1/8W	07115	CT4-1/8-TO-4752-F
R22	0757-0442	fxd film 10K 1% 1/8W	07115	CT4-1/8-TO-1002-F
R23	0757-0465	fxd film 100K 1% 1/8W	07115	CT4-1/8-TO-1003-F
R24	0757-0280	fxd film 1K 1% 1/8W	28480	
R25	0698-6619	fxd film 15K .1% 1/8W	28480	
R26	0698-6320	fxd film 5K .1% 1/8W	28480	
R27	0698-3153	fxd film 3.83K 1% 1/8W	28480	
R28	0698-3274	fxd film 10K 1% 1/8W	28480	
R29	0698-8234	fxd film 12.1K 1% 1/8W	28480	
R30	0757-0438	fxd film 5.11K 1% 1/8W	07115	CT4-1/8-TO-5111-F
R31-33	0757-0401	fxd film 100 1% 1/8W	28480	
R34	0698-3456	fxd film 287K 1% 1/8W	28480	
R35	0698-3557	fxd film 806 1% 1/8W	28480	
R36	0757-0458	fxd film 51.1K 1% 1/8W	07115	CT4-1/8-TO-5112-F
R37	0757-0280	fxd film 1k 1% 1/8W	28480	
R38-39				
6632,33	0757-0442	fxd film 10K 1% 1/8W	28480	
6634	0757-0199	fxd film 21.5K 1% 1/8W	28480	

Table 5-4. HP 6632-6634A Parts List (continued)

Ref Desig	HP Part No.	Description	Mfr Code	Mfr Part No.
R101-108				
6632	0811-3522	fxd ww .66 1% 3W	28480	
6633	0811-1832	fxd ww 5 1% 3W	28480	
6634	0811-3143	fxd ww 10 1% 3W	28480	
R109	0757-0401	fxd film 100 1% 1/8W	28480	
R110				
6632,33	0698-3444	fxd film 316 1% 1/8W	28480	
6634	0757-0420	fxd film 750 1% 1/8W	07115	CT4-1/8-TO-751-F
R111				
6632	0757-0407	fxd film 200 1% 1/8W	28480	
6633	0757-0414	fxd film 432 1% 1/8W	28480	
6634	0757-0280	fxd film 1K 1% 1/8W	07115	CT4-1/8-TO-1001-F
R112				
6632	0698-3444	fxd film 316 1% 1/8W	28480	
6633	0698-4187	fxd film 632 .5%	28480	
6634	0757-0427	fxd film 1.5K 1% 1/8W	07115	CT4-1/8-TO-1501-F
R113				
6632	0757-0442	fxd film 10K 1% 1/8W	07115	CT4-1/8-TO-1002-F
6633	0757-0458	fxd film 51.1K 1% 1/8W	07115	CT4-1/8-TO-5112-F
6634	0698-3454	fxd film 215K 1% 1/8W	28480	
R114				
6632	0698-3441	fxd film 215 1% 1/8W	28480	
6633	0698-0085	fxd film 2.61K 1% 1/8W	28480	
6634	0698-4443	fxd film 4.53K 1%	28480	
R115				
6632	0757-0273	fxd film 3.01K 1% 1/8W	28480	
6633	0698-3159	fxd film 26.1K 1% 1/8W	28480	
6634	0698-3159	fxd film 26.1K 1% 1/8W	28480	
R116				
6632	0757-0280	fxd film 1K 1% 1/8W	07115	CT4-1/8-TO-1001-F
6633,34	0757-0438	fxd film 5.11K 1% 1/8W	07115	CT4-1/8-TO-5111-F
R117				
6632	0757-0280	fxd film 1K 1% 1/8W	07115	CT4-1/8-TO-1001-F
6633	0757-0438	fxd film 5.11K 1% 1/8W	07115	CT4-1/8-TO-5111-F
6634	0698-3156	fxd film 14.7K 1% 1/8W	28480	
R118,119				
6632	0698-3441	fxd film 215 1% 1/8W	28480	
6633	0757-0414	fxd film 432 1% 1/8W	28480	
6634	0757-0280	fxd film 1K 1% 1/8W	07115	CT4-1/8-TO-1001-F
R120				
6632	0757-0438	fxd film 5.11K 1% 1/8W	07115	CT4-1/8-TO-5111-F
6633,34	0757-0441	fxd film 8.25K 1% 1/8W	07115	CT4-1/8-TO-8251-F
R121	0698-3456	fxd film 287K 1% 1/8W	28480	
R122				
6632	0698-3444	fxd film 316 1% 1/8W	28480	
6633	0757-0416	fxd film 511 1% 1/8W	07115	CT4-1/8-TO-511R-F
6634	0757-0420	fxd film 750 1% 1/8W	07115	CT4-1/8-TO-751-F
R123	0757-0436	fxd film 4.32K 1% 1/8W	28480	
R124	0757-0455	fxd film 36.5K 1% 1/8W	07115	CT4-1/8-TO-1003-F
R125	0698-0084	fxd film 2.15K 1% 1/8W	28480	
R126				
6632	0698-6631	fxd film 2.5K .1% 1/8W	28480	
6633	0698-6322	fxd film 4K .1% 1/8W	28480	
6634	0698-6671	fxd film 7k .25% 1/8W	28480	

Table 5-4. HP 6632-6634A Parts List (continued)

Ref Desig	HP Part No.	Description	Mfr Code	Mfr Part No.
R127	0698-3156	fxd film 14.7K 1% 1/8W	28480	
R128	0698-3454	fxd film 215K 1% 1/8W	28480	
R129				
6632	0698-6631	fxd film 2.5K .1% 1/8W	28480	
6633	0698-6322	fxd film 4K .1% 1/8W	28480	
6634	0698-6671	fxd film 7K .25% 1/8W	28480	
R130	1810-0162	Resistor network (13 X 4.7K)	28480	
R131	1810-0424	Resistor network (15 X 4.7K)	28480	
R132	1810-0316	Resistor network (8 X 10K)	28480	
R133	0698-3156	fxd film 14.7K 1% 1/8W	28480	
R134	0698-6630	fxd film 20K .1% 1/8W	28480	
R135				
6632,33	0757-0458	fxd film 51.1K 1% 1/8W	07115	CT4-1/8-TO-5112
6634	0757-0467	fxd film 20K .1% 1/8W	07115	CT4-1/8-TO-1213
R136	0698-8827	fxd film 1M 1% 1/8W	28480	
R137				
6632	0698-4509	fxd film 80.6K 1%	28480	
6633	0698-3456	fxd film 287K 1% 1/8W	28480	
6634	0698-3260	fxd film 464K 1% 1/8W	28480	
R138				
6632	0698-4509	fxd film 80.6K 1%	28480	
6633	0698-3454	fxd film 215K 1% 1/8W	28480	
6634	0698-4536	fxd film 340K 1%	28480	
R139,140	0757-0442	fxd film 10K 1% 1/8W	07115	CT4-1/8-TO-1002-F
R141,142				
6632	0683-0475	fxd film 4.7 5% 1/4W	28480	
6633,34	0757-0346	fxd film 10 1% 1/8W		
R143,144	0757-0442	fxd film 10K 1% 1/8W	07115	CT4-1/8-TO-1212-F
R145,146		Not Used		
R147	0757-0199	fxd film 21.5K 1% 1/8W	28480	
R148	0757-0442	fxd film 10K 1% 1/8W	07115	CT4-1/8-TO-100
R149	0757-0338	fxd film 1K 1% 1/4W	07115	NA5-1/4-TO-1001-
R150				
6632	8159-0005	fxd 0 ohms	28480	
6633,34		Not Used		
R151				
6632	0698-8695	fxd film 36K .1% 1/8W	28480	
6633	0698-6358	fxd film 100K .1% 1/8W	28480	
6634	0698-6376	fxd film 200K .1% 1/8W	28480	
R152	0698-6322	fxd film 4K .1% 1/8W	28480	
R153	0757-0442	fxd film 10K 1% 1/8W	07115	CT4-1/8-TO-1002-F
R154,155				
6632	8159-0005	fxd 0 ohms	28480	
6633,34		Not Used (D116 is used)		
R156,157		Not Used		
R158,159				
6632	0757-0403	fxd film 121 1% 1/8W	07115	CTF-1/8-TO-121R-F
6633	0757-0416	fxd film 511 1% 1/8W	07115	CT4-1/8-TO-511R-F
6634	0757-0283	fxd film 2K 1% 1/8W	28480	
R160	0757-0458	fxd film 51.1K 1% 1/8W	07115	CT4-1/8-TO-5112-F
R161,162				
6632	0757-0280	fxd film 1K 1% 1/8W	07115	CT4-1/8-TO-1001-F
6633	0698-0084	fxd film 2.15K 1% 1/8W	28480	
6634	0757-0438	fxd film 5.11K 1% 1/8W	07115	CT4-1/8-TO-5111-F

Table 5-4. HP 6632-6634A Parts List (continued)

Ref Desig	HP Part No.	Description	Mfr Code	Mfr Part No.
R163,164				
6632	0699-2248	fxd film 47.5K .05% 1/8W	28480	
6633	0699-2247	fxd film 121K .05% 1/8W	28480	
6634	0699-2198	fxd film 243K .05% 1/8W	28480	
R165,166	0699-2246	fxd film 25K .05% 1/8W	28480	
R167	0757-0442	fxd film 10K 1% 1/8W	07115	CT4-1/8-TO-1002-F
R168				
6632	0698-6351	fxd film 133K .1% 1/8W	28480	
6633	0698-4536	fxd film 340K 1%	28480	
6634	0757-0472	fxd film 200K 1% 1/8W	07115	CT4-1/8-TO-2003-F
R169	0698-8827	fxd film 1M 1% 1/8W	28480	
R170	0698-8076	fxd film 8.66K 1% 1/8W	28480	
R171	0698-3274	fxd film 10K 1% 1/8W	28480	
R172		Not Used		
R173	0757-0438	fxd film 5.11K 1% 1/8W	07115	CT4-1/8-TO-5111-F
R174	0698-6362	fxd film 1K .1% 1/8W	28480	
R175				
6632	0698-8807	fxd film 39K .1% 1/8W	28480	
6633,34	0699-1212	fxd film 19K .1% 1/8W	28480	
R176	0757-0280	fxd film 1K 1% 1/8W	07115	CT4-1/8-TO-1001-F
R177	0698-6358	fxd film 100K .1% 1/8W	28480	
R178	0698-8959	fxd film 619K 1% 1/8W	28480	
R179	0698-6363	fxd film 40K .1% 1/8W	28480	
R180	0698-6353	fxd film 50K .1% 1/8W	28480	
R181	0757-0436	fxd film 4.32K 1% 1/8W	28480	
R182				
6632	0698-3642	fxd met 3K 5% 2W	28480	
6633	0698-3646	fxd met 12K 5% 2W	28480	
6634	0764-0046	fxd met 33K 5% 2W	28480	
R183	0757-0280	fxd film 1K 1% 1/8W	07115	CT4-1/8-TO-1001-F
R184,185	0698-6630	fxd film 20K .1% 1/8W	28480	
R186				
6632	0757-0438	fxd film 5.11K 1% 1/8W	07115	CT4-1/8-TO-5111-F
6633	0757-0458	fxd film 51.1K 1% 1/8W	07115	CT4-1/8-TO-5112-F
6634	0698-3454	fxd film 215K 1% 1/8W	28480	
R187	0683-1065	fxd comp 10M 5% 1/4W	28480	
R188				
6632	0811-3770	Fuseable res .05 1% 9W	28480	
6633	0811-3771	Fuseable res .25 1% 9W	28480	
6634	0811-3772	Fuseable res .50 1% 9W	28480	
R189	0698-6358	fxd film 100K .1% 1/8W	28480	
R190	0698-6363	fxd film 40K .1% 1/8W	28480	
R191		Not Used		
R192	0698-8826	fxd film 825k 1% 1/8W	28480	
R193				
6632	0698-8812	fxd film 1 1% 1/8W	28480	
6633	0683-0475	fxd film 4.7 5% 1/4W	28480	
6634	0757-0379	fxd film 12.1 1% 1/8W	28480	
R194	0698-6353	fxd film 50K 1% 1/8W	28480	
R195	0757-0436	fxd film 4.32K 1% 1/8W	28480	
R196				
6632		Not Used		
6633	0757-0461	fxd film 68.1K 1% 1/8W	07115	CT4-1/8-TO-6812-F
6634	0757-0458	fxd film 51.1K 1% 1/8W	07115	CT4-1/8-TO-5112-F
R197,198	0698-6630	fxd film 20K .1% 1/8W	28480	

Table 5-4. HP 6632-6634A Parts List (continued)

Ref Desig	HP Part No.	Description	Mfr Code	Mfr Part No.
R199				
6632	0757-0280	fxd film 1K 1% 1/8W	07115	CT4-1/8-TO-1001-F
6633	0698-3156	fxd film 14.7K 1% 1/8W	28480	
6634	0757-0438	fxd film 5.11K 1% 1/8W	07115	CT4-1/8-TO-5111-F
R200				
6632	0757-0280	fxd film 1K 1% 1/8W	07115	CT4-1/8-TO-1001-F
6633,34	0698-3156	fxd film 14.7K 1% 1/8W	28480	
R201	0698-0084	fxd film 2.15K 1% 1/8W	28480	
R202-206	0757-0280	fxd film 1K 1% 1/8W	07115	CT4-1/8-TO-1001-F
R207,208	0757-0438	fxd film 5.11K 1% 1/8W	07115	CT4-1/8-TO-5111-F
R209	0757-0441	fxd film 8.25K 1% 1/8W	07115	CT4-1/8-TO-8251-F
R210,211	0698-0084	fxd film 2.15K 1% 1/8W	28480	
R212	0757-0395	fxd film 56.2 1% 1/8W	07115	CT4-1/4-TO-56R2-F
R213	0757-0416	fxd film 511 1% 1/8W	07115	CT4-1/8-TO-511R-F
R214	0757-0465	fxd film 68.1K 1% 1/8W	07115	CT4-1/8-TO-6812-F
R215	0698-3156	fxd film 14.7K 1% 1/8W	28480	
R216				
6632,33		Not Used		
6634	0764-0046	fxd met 33K 5% 1/4W	28480	
R217				
6632	0683-6845	fxd film 680K 5% 1/4W	28480	
6633	0683-1555	fxd film 1.5M 5% 1/4W	28480	
6634	0683-3355	fxd film 3.3M 5% 1/4W	28480	
R218		Not Used		
R219				
6632		Not Used		
6633	0811-3777	Fuseable res (.15,5W)	28480	
6634	0811-3776	Fuseable res (.5,5W)	28480	
R220	0698-3156	fxd film 14.7K 1% 1/8W	28480	
R221				
6632,33		Not Used		
6634	0698-3642	fxd met 3K 5% 2W	28480	
R222				
6632,33	8159-0005	fxd 0 ohms	28480	
6634	0698-3642	fxd met 3K 5% 2W	28480	
R223				
6632,33		Not Used		
6634	0698-3642	fxd met 3K 5% 2W	28480	
R224				
6632	0698-3634	fxd met 470 5% 2W	28480	
6633,34	0698-3642	fxd met 3K 5% 2W	28480	
R400***	0757-0199	fxd film 21.5K 1% 1/8W	28480	
R401***	0757-0199	fxd film 21.5K 1% 1/8W	28480	
RT1	0837-0220	Thermistor 10K	28480	
S1		See Chassis Electrical		
S2,3	3101-2828	Switch (line volt select)	28480	
S4	3101-2927	Switch (norm/fast)	28480	
T1		See Chassis Electrical		
TB1	0360-2338	Barrier block	28480	
TP1	1251-8736	Test Pins (primary)	28480	
TP2	1251-4926	Test Pins (secondary)	28480	
TS1	3103-0140	Thermal switch	28480	

*** These are user installed parts. See paragraph 4-13 (Inductive Loading) in the Operation Manual (HP P/N 5957-6360).

Table 5-4. HP 6632-6634A Parts List (continued)

Ref Desig	HP Part No.	Description	Mfr Code	Mfr Part No.
U1	5080-2115	IC MPU	28480	
U2	1820-2549	IC 8291A talker/listener	28480	
U3	1LH4-0001	IC HP-IB transceiver	28480	
U4	1826-1245	IC Volt Reg	01295	TL7702A
U5	5060-2948	IC Assy-Volt Reg (MC7805LT)	28480	
U6	1820-2998	IC Latch CMOS	04713	MC74HC373N
U7,8		Not Used		
U9,10	1990-0996	IC Optical isolator	28480	
U11	5080-2116	IC Microprocessor Unit	28480	
U12	1820-2923	IC Gate CMOS	04713	MC74HC10N
U13	1820-2228	IC Quad Latch CMOS NAND	04713	MC14044BCP
U14	1820-2257	IC Buffer CMOS	04713	MC14503BCP
U15	1818-3619	IC Memory (256 bit) (NMC93E)	28480	
U16	1826-1369	IC Volt Reg (LT1021DCN8-1)	28480	
U17	1826-0346	IC Op amp	27014	LM358N
U18	1826-1068	IC DAC 8-bit	28480	
U19-21	1826-1488	IC DAC (1230LCD)	28480	
U22-24	1826-0493	IC Op amp LO-BIAS HI-IMP	27014	LM308AN
U25		Not Used		
U26	1826-1370	IC QUAD COMP LP365N	28480	
U100		Not Used		
U101	5060-3232	IC ASSY-VTL REG UA7815UC	28480	
U102		Not Used		
U103	1826-0144	IC VTL REG	04713	MC7805CT
U104	5060-3229	IC VTL REG MC7915CT	28480	
U105	1826-1245	IC VTL REG	01295	TL7702A
U106	1826-0962	IC Dual op amp LF412CN	28480	
U107,108	1826-0961	IC LF411	28480	
U109	1826-0962	IC Dual op amp LF412CN	28480	
U110	1826-0412	IC COMP PRCN DUAL 8 PIN DIP	27014	LM393N
U111	1826-0346	IC Op amp	27014	LM358N
U112		Not Used		
U113	1826-1370	IC QUAD COMP LP365N	28480	
VR100	1902-3149	Diode zener 9.09V 5%	28480	
VR101	1902-0040	Diode zener 14V 5%	28480	
VR102				
6632,33		Not Used		
6634	1902-3092	Diode zener 4.99V 2%	28480	
W1,2	1258-0209	Jumper (Test) (REF TP1, TP2)	28480	
W3,4	7175-0057	Wire AWG 22	28480	
XT1P1	1251-8512	Connector (XFMR primary)	28480	
XT1P2	1251-6832	Connector (secondary pwr)	28480	
XT1P3	1252-0063	Connector (HP-IB bias)	28480	
XT1P4	1252-0063	Connector (secondary bias)	28480	
XT1P5	1252-0063	Connector (fan)	28480	
XT1P6	1252-0056	Connector (line switch)	28480	
XT1P7	1251-8676	Connector (DFI/RI)	28480	
XT1P8	1251-8621	Connector (option board)	28480	
Y1, 2	0410-1627	Resonator 4MHz	28480	

Table 5-4. HP 6632-6634A Parts List (continued)

Ref Desig	HP Part No.	Description
		Mechanical
	0340-0174	TRANSISTOR INSULATOR (REF Q105-Q108)
	0340-0795	TRANSISTOR INSULATOR (REF Q101-Q108)
	1200-0181	TRANSISTOR INSULATOR (REF Q111, Q113, Q11
	0380-0181	SPACER-ROUND .75-IN (REF FAN)
	0380-0643	STANDOFF-HEX .255 IN (REF HPIB)
	0515-0885	SCREW-MACHINE M4X0.7 (REF REAR COVER)
	0515-1114	SCREW-MACHINE M4X0.7 (REF MAIN BD, T1 BRKT, GND WIRE)
	0515-1117	SCREW-MACHINE M5X0.8 (REF CVR LFT SIDE)
	0515-1132	SCREW-MACHINE M5X0.8 10MM LG. (REF STRAP HANDLE)
	0515-1244	SCREW-MACHINE M3.5X.6 35MM LG. (REF BARRIER BLK COV)
	0515-1285	SCREW-MACHINE (REF FAN)
	0515-1831	SCREW-MACHINE M4X0.7 12LG (REF FRONT FRAME, T1 BRKT)
	0535-0031	NUT-HEX M3 W/LKWR (REF Q101-Q108, TB1, J1, J4)
	0535-0082	NUT HEX M4 W/LKWR (REF GRD LUG FRONT FRAME, TS1)
	0590-0534	NUT SELF THREADING (REF KEYPAD BD, LCD)
	2190-0585	WASHER-LOCK HLCL (REF FAN)
	2190-0586	WASHER-LOCK M4 HLCL (REF J1, HPIB NUTS)
	2190-0646	WASHER-LOCK (REF GND WIRE)
	3050-0891	WASHER FLAT M3 MTLC (REF J4)
	3050-0892	WASHER-FLAT MTLC (REF FAN)
	3050-0893	WASHER-FLAT M4 MTLC (REF FRONT FRAME, T1 BRACKET)
	3050-1192	WASHER-FLAT MTLC (REF BARRIER BLOCK COVER)
	1251-5389	CONNECTOR-POST-TP-BDY (REF FAN)
	1251-5613	CONNECTOR SGL CONN (REF BIND POST !!!OPTION!!!)
	1251-7401	CONNECTOR-SGL-CONT (REF FAN)
	1400-1281	CLIP-CABLE (REF BRACKET, FRONT)
	2110-0565	FUSEHOLDER-CAP (REF F1)
	2110-0642	FUSEHOLDER-EXTR POST (REF F1)
	2110-0269	FUSEHOLDER-CLIP TYPE (REF F2)
	5041-6819	CAP STRAP HANDLE, FRONT
	5041-6820	CAP STRAP HANDLE, REAR
	5060-9802	HANDLE, STRAP 14"
	5040-7201	FOOT, FULL & 1/2
	5001-0438	TRIM, SIDE 3.5
	06632-40005	FRONT FRAME
	06632-00007	SCREENED FRONT PANEL MODEL 6632A
	06033-00002	SCREENED FRONT PANEL MODEL 6633A
	06634-00002	SCREENED FRONT PANEL MODEL 6634A
	06632-00001	CHASSIS
	06632-00002	COVER
	06632-00003	BRACKET
	06632-20001	H/S OUTPUT (REF Q101,2,3,4,5,6,7,8)
	06632-80011	LABEL - INFO (REF OUTPUT H/S)
	7121-5010	LABEL - WARNING (REF OUTPUT H/S)
	06632-20002	BARRIER BLOCK COVER (REF TB1)
	06632-60003	ASSY, FRONT PANEL-MODEL 6632
	06633-60003	ASSY, FRONT PANEL-MODEL 6633
	06634-60003	ASSY, FRONT PANEL-MODEL 6634
	06632-40006	SILICON RUBBER KEY PAD 6632
	5020-2678	PCB KEY PAD (REF FRONT PANEL)
	06632-60004	ASSY-LCD (REF FRONT PANEL)
	5957-6360	OPERATING MANUAL

Table 5-4. HP 6632-6634A Parts List (continued)

Ref Desig	HP Part No.	Description
		Chassis Electrical
B1	3160-0497	FAN (REF HS 06632-20001)
S1	3101-2862	ROCKER SWITCH (LINE)
T1	9100-4574	POWER TRANSFORMER MODEL 6632
	9100-4573	POWER TRANSFORMER MODEL 6633
	9100-4572	POWER TRANSFORMER MODEL 6634
	1258-0209	JUMPER (REF TP1,TP2)
		Cabling
	06632-80001	CABLE ASSY - PRIMARY
	06632-80002	CABLE ASSY - PRIMARY TO SWITCH (REF S1)
	06632-80003	CABLE ASSY - SECONDARY
	06632-80004	CABLE ASSY - BIAS
	8120-4944	CABLE ASSY - 1@ - LCD DISPLAY & KEYPAD
	8120-1348	CABLE ASSY - LINE CORD 120V 18AWG
	5060-3169	CABLE ASSY - REF TS1

Section VI
CIRCUIT DIAGRAMS

6-1 INTRODUCTION

This section contains functional schematic and component location diagrams for the HP 6632A- 6634A series of HP-IB System DC Power Supplies.

6-2 FUNCTIONAL SCHEMATIC DIAGRAMS

The circuits contained in HP Models 6632A-6634A are shown functionally on the foldout schematics (Figures 6-1 through 6-6). Notes that apply to all of the schematics are given in Table 6-1. Notes that apply only to a particular schematic are given on the apron of the appropriate foldout schematic. Logic symbols used on the schematics are described in Appendix B. The block diagram below shows the functional relationship between the blocks of circuits and gives the corresponding schematic figure numbers.

Figure 6-1 shows the ac power input and dc bias supply circuits for all three HP Models (6632A-6634A).

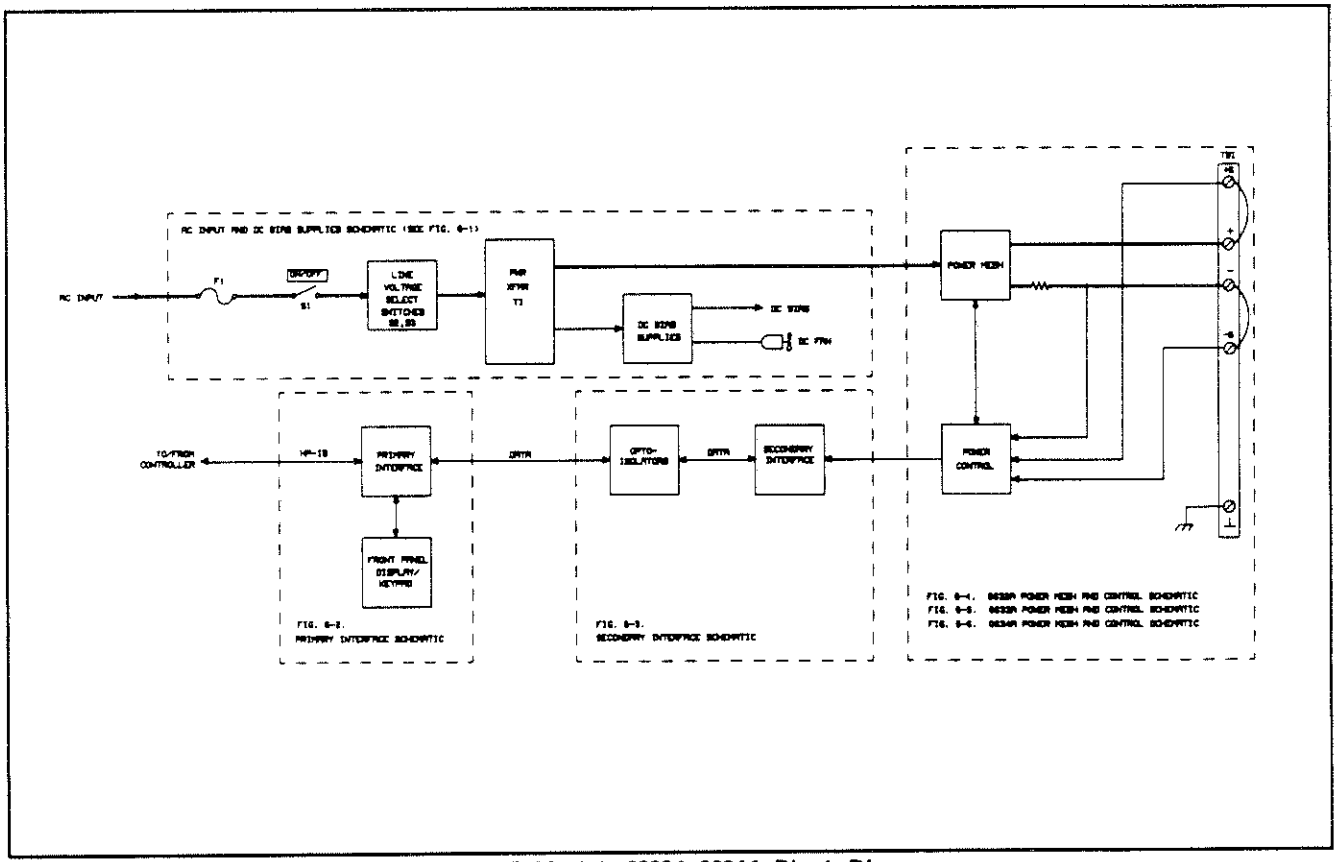
Figure 6-2 illustrates the primary interface circuits and Figure 6-3 illustrates the secondary interface circuits for all three HP Models (6632A-6634A).

Figures 6-4 through 6-6 show the power mesh and control circuits for HP Models 6632A-6634A as follows: HP Model 6632A (Figure 6-4), HP Model 6633A (Figure 6-5), and HP Model 6634A (Fig. 6-6).

The power mesh and control circuits include typical node voltage measurements that are provided for troubleshooting purposes. The measurements were taken with the applicable supply's output set as indicated in the notes on the apron of the schematic.

6-3 COMPONENT LOCATION ILLUSTRATION

Most of the components in the supply are contained on the main circuit board. A component location diagram that covers all three HP Models is shown on the rear of the first foldout schematic Figure 6-1. The location diagram includes a location grid and a table to help you locate parts on the main board.



HP Models 6632A-6634A Block Diagram

Table 6-1. Schematic Diagram Notes

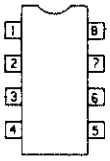
1. All resistors are in ohms, 1/8 W, 1%, unless otherwise specified.

2. All capacitors are in microfarads unless otherwise specified.

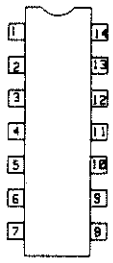
3. All components are mounted on the main circuit board except those marked with an asterisk (*).

4. The square pads on the PC board indicate one of the following:
   a. Pin 1 of an IC, transistor array, or resistor network.
   b. The positive end of a polarized capacitor.
   c. The cathode of a diode or the emitter of a transistor.

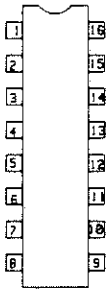
5. Pin locations for the IC's, transistor arrays, and resistor networks are as follows:



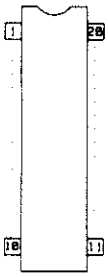
U4, U9-10, U15-U17, U22-24, U105-111



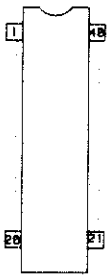
R13, R130, Q115, Q118, U12



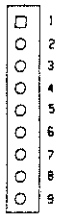
Q1, Q116, R1, R4, R131, R132, U13-17, U26, U113



U6, U18, U19-21



U1-3, U11



R7

6. Pin locations for other semi-conductors are marked on circuit board as follows:

CR100

U104

U5,U101

U103

Q109, Q110

Q112

Schematic Notes For Figure 6-1

1. Fan B1 is bolted to the output stage heatsink assemblies.

2. ▭ denotes front panel marking.

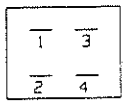
3. Fuse F1 is 4A for 100/120 Vac input or 2A for 220/240 Vac input.

4. Before connecting the supply to the power source, check that the positions of voltage select switches S2 and S3 match the nominal line voltage source (100,120,220, or 240 Vac). See Section II in the Operating Manual (HP P/N 5957-6360) for details.

5. Transformer T1 terminal locations are shown in Section IV of this manual.

6. The schematic lists typical ac and dc voltages measured at nominal line voltage. The dc voltages for the +5Vp Bias Supply and Start-Up circuit are measured with respect to the primary interface common ⏚P ; all other dc voltages were measured with respect to the secondary interface common ⏚S The ac measurements were taken across the secondary windings as shown on this schematic. The ac measurement values for the power mesh circuits are shown on the applicable schematic: Figure 6-4 (HP Model 6632A), Figure 6-5 (HP Model 6633A), or Figure 6-5 (HP Model 6634A), Figure 6-5 (HP Model 6633A), or Figure 6-5 (HP Model 6634A).

7 The pin arrangements for line switch S1 are shown below.



Switch S1 Rear View

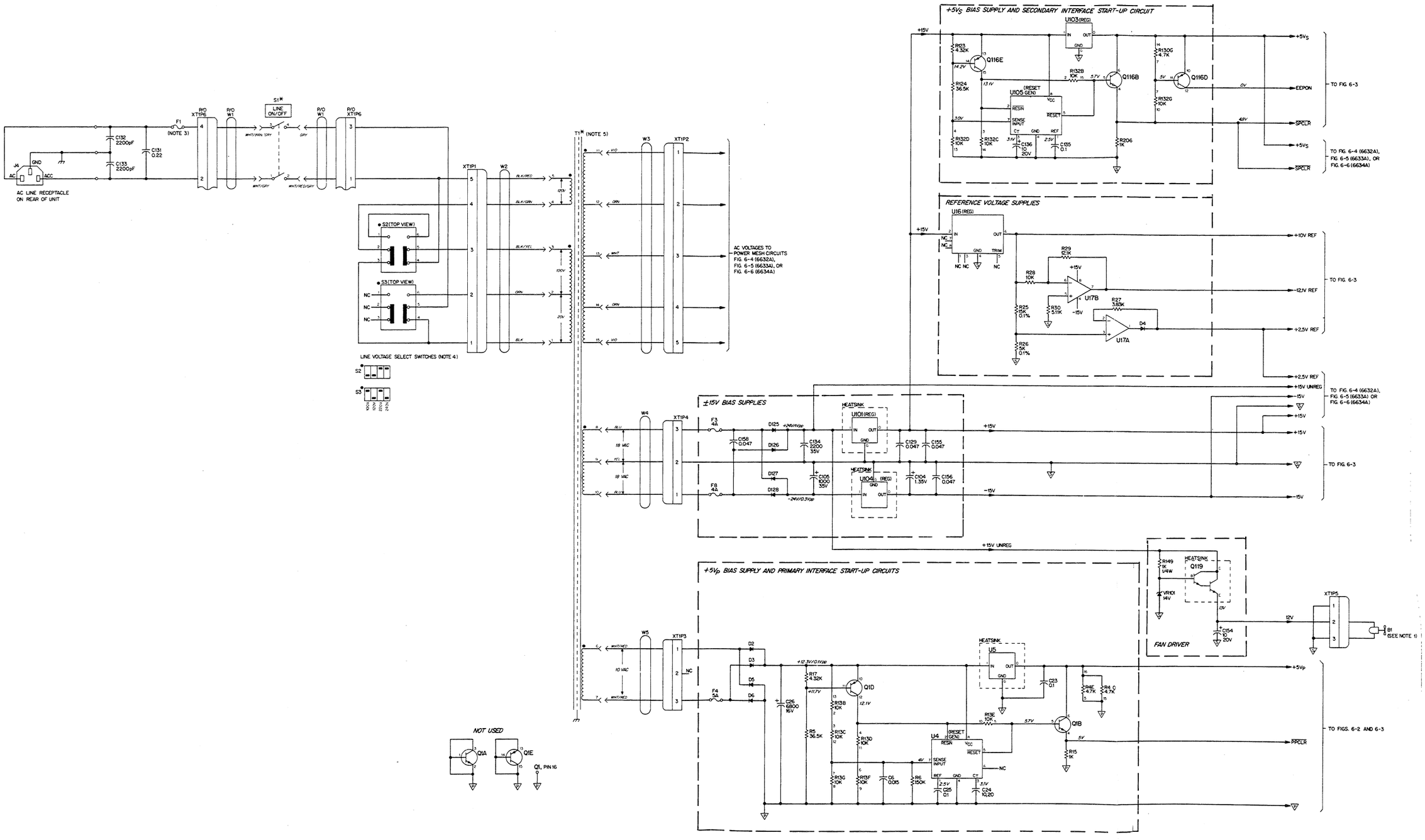
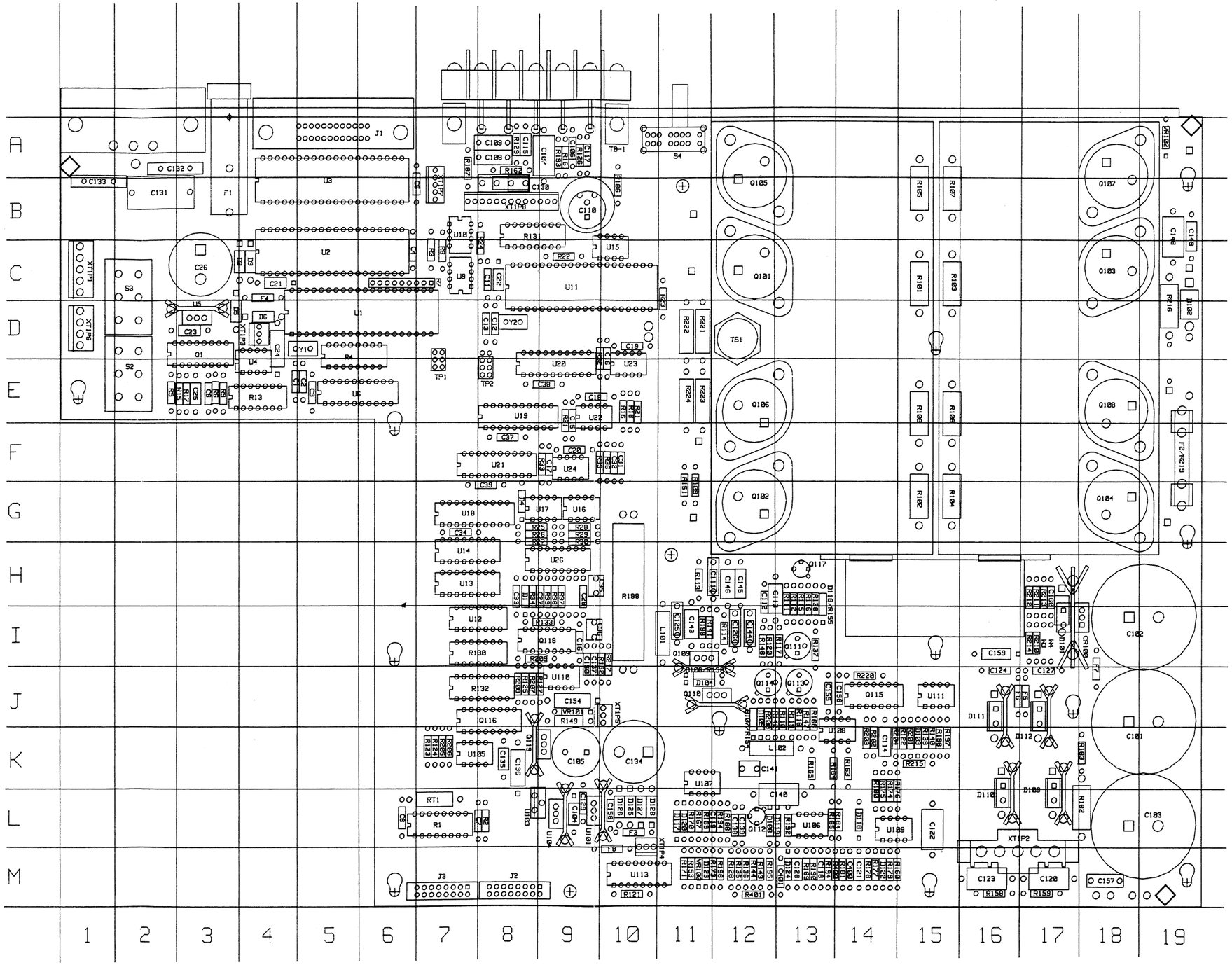


Figure 6-1. HP Models 6632A-6634A AC Input and DC Bias Supplies, Schematic Diagram


A
B
C
D
E
F
G
H
I
J
K
L
M
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
J1
U3
U2
U1
F1
C131
C132
C133
C26
S3
S2
XT1P1
XT1P6
XT1P8
XT1P3
XT1P4
XT1P5
XT1P2
TB-1
S4
TS1
Q105
Q101
Q106
Q102
Q107
Q103
Q108
Q104
Q117
Q118
Q119
Q120
Q121
Q122
Q123
Q124
Q125
Q126
Q127
Q128
Q129
Q130
Q131
Q132
Q133
Q134
Q135
Q136
Q137
Q138
Q139
Q140
Q141
Q142
Q143
Q144
Q145
Q146
Q147
Q148
Q149
Q150
Q151
Q152
Q153
Q154
Q155
Q156

C001 ------ E4
C002 ------ E5
C003 ------ E5
C004 ------ C6
C005 ------ B6
C006 ------ E3
C007 ------ L7
C008 ------ L6
C009,010 -- NU
C011 ------ C8
C012 ------ D8
C013 ------ D8
C014 ------ NU
C015 ------ E9
C016 ------ I9
C017 ------ F9
C018 ------ E9
C019 ------ D10
C020 ------ F9
C021 ------ C4
C022 ------ C8
C023 ------ D3
C024 ------ D4
C025 ------ E3
C026 ------ C3
C027 ------ H9
C028 ------ H9
C029 ------ NU
C030 ------ NU
C031 ------ F10
C032 ------ F10
C033 ------ H8
C034 ------ G7
C035 ------ H9
C036 ------ I9
C037 ------ F8
C038 ------ E9
C039 ------ G8
C100 ------ NU
C101 ------ K18
C102 ------ I18
C103 ------ L19
C104 ------ L9
C105 ------ K9
C106 ------ A9
C107 ------ A9
C108 ------ A8
C109 ------ A8
C110 ------ B9
C111 ------ H12
C112 ------ H12
C113 ------ H12
C114 ------ K14
C115 ------ A8
C116 ------ NU
C117 ------ A9
C118 ------ M13
C119 ------ L12
C120 ------ M17
C121 ------ M14
C122 ------ L15
C123 ------ M16
C124 ------ J16
C125 ------ I11
C126 ------ I12
C127 ------ J17
C128 ------ M13
C129 ------ L9
C130 ------ B8
C131 ------ B2
C132 ------ A2
C133 ------ B1
C134 ------ K10
C135 ------ K8
C136 ------ K8
C137 ------ J9
C138 ------ L12
C139 ------ L12
C140 ------ L12
C141 ------ K12
C142 ------ NU
C143 ------ I11
C144 ------ I12
C145 ------ H12
C146 ------ H12
C147 ------ NU
C148 ------ B19
C149 ------ B19
C150 ------ J9
C151-153 -- NU
C154 ------ J9
C155 ------ J13
C156 ------ J13
C157 ------ M18
C158 ------ L10
C159 ------ I16
C160 ------ H17
C161 ------ I9
C400* ----- M14
C401* ----- M13
CR100 ----- I18
D001 ------ H8
D002 ------ C4
D003 ------ C4
D004 ------ G8
D005 ------ D3
D006 ------ D4
D100 ------ NU
D101 ------ I17
D102 ------ D19
D103 ------ K15
D104 ------ J11
D105 ------ J12
D106 ------ J11
D107 ------ J12
D108 ------ L12
D109 ------ L17
D110 ------ L16
D111 ------ J16
D112 ------ K17
D113-115 -- NU
D116 ------ H13
D117 ------ L11
D118 ------ L14
D119 ------ L13
D120 ------ L11
D121 ------ NU
D122 ------ M14
D123 ------ M11
D124 ------ M13
D125 ------ L10
D126 ------ L10
D127 ------ L10
D128 ------ L10
F001 ------ B3
F002 ------ F19
F003 ------ L10
F004 ------ C4
F005 ------ J17
F006 ------ J16
F007 ------ J18
F008 ------ M10
J001 ------ A6
J002 ------ M8
J003 ------ M7
L101 ------ I11
L102 ------ K12
Q001 ------ D3
Q101 ------ C12
Q102 ------ G12
Q103 ------ C18
Q104 ------ G18
Q105 ------ B12
Q106 ------ E12
Q107 ------ B18
Q108 ------ E18
Q109 ------ I11
Q110 ------ J11
Q111 ------ I13
Q112 ------ L12
Q113 ------ J13
Q114 ------ J12
Q115 ------ J14
Q116 ------ J8
Q117 ------ H13
Q118 ------ I9
Q119 ------ K8
R001 ------ L7
R002 ------ L8
R003 ------ C7
R004 ------ D5
R005 ------ E2
R006 ------ E3
R007 ------ C7
R008 ------ C7
R009 ------ E3
R010-12 --- NU
R013 ------ E4
R014 ------ NU
R015 ------ E3
R016 ------ E10
R017 ------ E3
R018 ------ E10
R019-020 -- NU
R021 ------ E10
R022 ------ C9
R023 ------ C11
R024 ------ C8
R025 ------ G8
R026 ------ G8
R027 ------ G8
R028 ------ G9
R029 ------ G9
R030 ------ G9
R031 ------ E9
R032 ------ D10
R033 ------ F9
R034 ------ H8
R035 ------ F10
R036 ------ F10
R037 ------ H9
R038 ------ H9
R039 ------ H9
R100 ------ NU
R101 ------ C15
R102 ------ G15
R103 ------ K18
R104 ------ G15
R105 ------ B15
R106 ------ E15
R107 ------ B15
R108 ------ E15
R109 ------ G11
R110 ------ J13
R111 ------ H13
R112 ------ H13
R113 ------ H11
R114 ------ I12
R115 ------ H13
R116 ------ H13
R117 ------ I13
R118 ------ J13
R119 ------ J13
R120 ------ I12
R121 ------ M10
R122 ------ K15
R123 ------ K7
R124 ------ K7
R125 ------ J8
R126 ------ A9
R127 ------ J9
R128 ------ M12
R129 ------ A8
R130 ------ I7
R131 ------ B8
R132 ------ J8
R133 ------ I9
R134 ------ L12
R135 ------ M12
R136 ------ M12
R137 ------ I13
R138 ------ H13
R139 ------ K15
R140 ------ K15
R141 ------ I11
R142 ------ J12
R143 ------ M12
R144 ------ M12
R145,146 -- NU
R147 ------ J13
R148 ------ I12
R149 ------ J9
R150 ------ J11
R151 ------ G11
R152 ------ J10
R153 ------ M11
R154 ------ J12
R155 ------ H13
R155 ------ H13
R156,157 -- NU
R158 ------ M16
R159 ------ M17
R160 ------ M14
R161 ------ A9
R162 ------ A8
R163 ------ K14
R164 ------ K13
R165 ------ K13
R166 ------ J13
R167 ------ L11
R168 ------ L12
R169 ------ L11
R170 ------ L11
R171 ------ M11
R172 ------ NU
R173 ------ M11
R174 ------ L14
R175 ------ L14
R176 ------ L14
R177 ------ M14
R178 ------ M14
R179 ------ M14
R180 ------ L14
R181 ------ M14
R182 ------ L18
R183 ------ K18
R184 ------ L14
R185 ------ L13
R188 ------ H10
R189 ------ M13
R190 ------ M13
R191 ------ NU
R192 ------ L13
R193 ------ A9
R194 ------ M13
R195 ------ M12
R196 ------ M12
R197 ------ K15
R198 ------ K15
R199 ------ I11
R200 ------ J12
R201 ------ K15
R202 ------ K14
R203 ------ K14
R204 ------ K14
R205 ------ K7
R206 ------ K7
R207 ------ J8
R208 ------ J8
R209 ------ I9
R210 ------ I17
R211 ------ H17
R212 ------ H17
R213 ------ H17
R214 ------ I17
R215 ------ K15
R216 ------ D19
R217 ------ J10
R218 ------ NU
R219 ------ F19
R220 ------ J14
R221 ------ D11
R222 ------ D11
R223 ------ E11
R224 ------ E11
R400* ----- M13
R401* ----- M12
RT01 ------ L7
S002 ------ E2
S003 ------ C2
S004 ------ A11
TB01 ------ A10
TP01 ------ E7
TP02 ------ E8
TS01 ------ D12
U001 ------ D5
U002 ------ C5
U003 ------ B5
U004 ------ E4
U005 ------ D3
U006 ------ E5
U007,008 -- NU
U009 ------ C7
U010 ------ B7
U011 ------ C9
U012 ------ I7
U013 ------ H7
U014 ------ H7
U015 ------ C10
U016 ------ G9
U017 ------ G9
U018 ------ G7
U019 ------ E8
U020 ------ E9
U021 ------ F8
U022 ------ E9
U023 ------ E10
U024 ------ F9
U025 ------ NU
U026 ------ H9
U100 ------ NU
U101 ------ L9
U102 ------ NU
U103 ------ L8
U104 ------ L9
U105 ------ K7
U106 ------ L13
U107 ------ K11
U108 ------ K13
U109 ------ L14
U110 ------ J9
U111 ------ J15
U112 ------ NU
U113 ------ M10
VR100 ----- M11
VR101 ----- J9
VR102 ----- A19
W001 ------ D8
W002 ------ E8
W003 ------ I17
W004 ------ I17
XT1P1------ C1
XT1P2 ----- M16
XT1P3 ----- D4
XT1P4 ----- M10
XT1P5 ----- J10
XT1P6 ----- D1
XT1P7 ----- B7
XT1P8 ----- B8
Y001 ------ D5
Y002 ------ D8

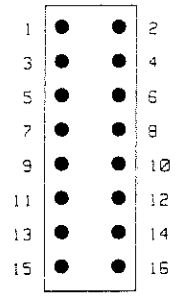
* = These parts are user installed. See paragraph 4-13 (Inductive Loading) in the Operation Manual (5957-6360).

Schematic Notes for Figure 6-2

1. Jumper W1 is shown installed in the NORM position (across pins 5 and 6) of primary test header TP1. The SA (TP1 pins 1 and 2) and NO TST (TP1 pins 3 and 4) jumper positions are described in Section IV.

2 XT1P7 is provided for the connection of optional remote inhibit/discreet fault indicator circuitry.

3. The pin arrangements for J2 (front panel keyboard connector) and J3 (front panel display connector) are as follows:



J2, J3 (Top View)

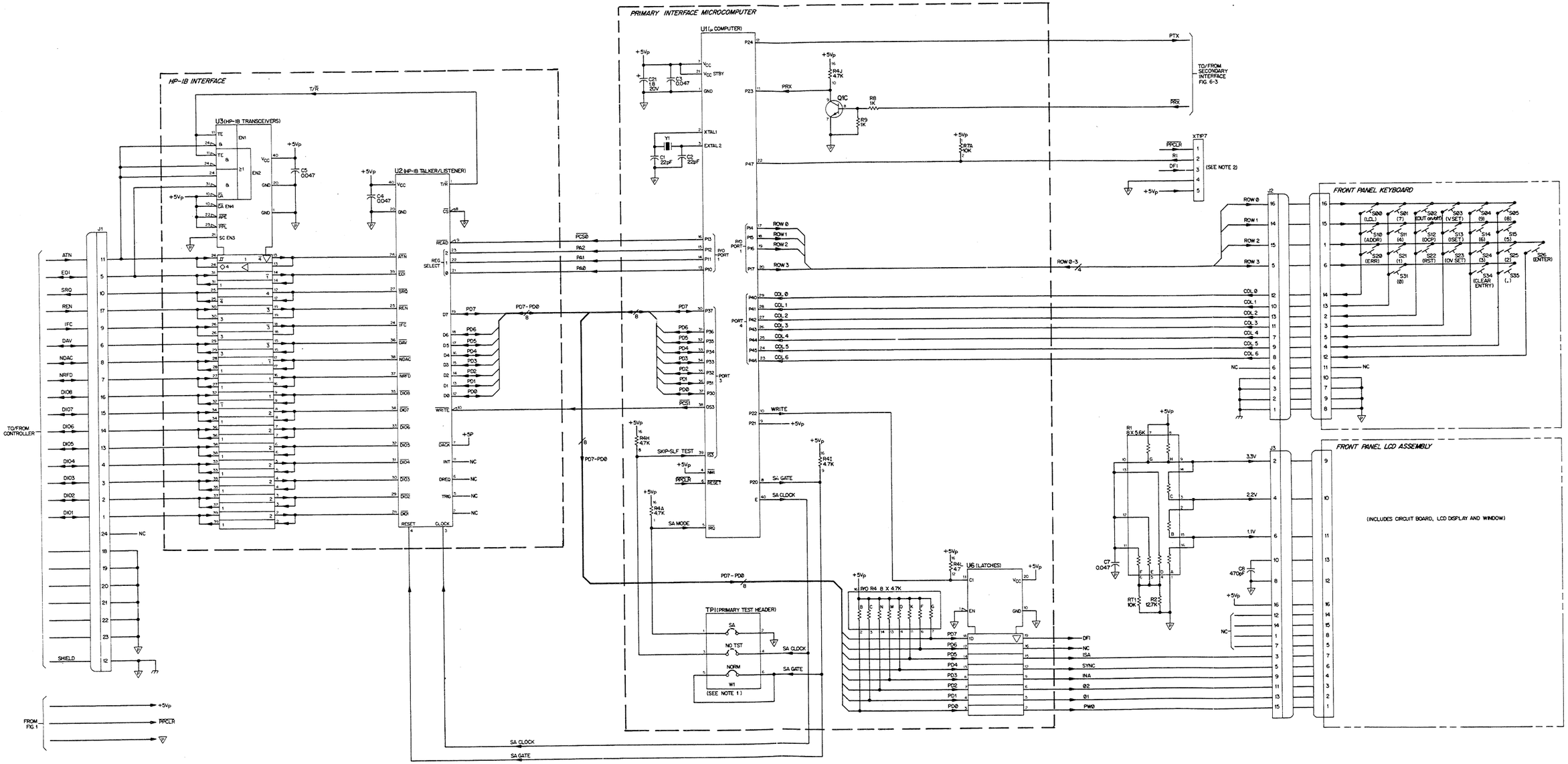


Figure 6-2. HP Models 6632A-6634A Primary Interface Circuits, Schematic Diagram

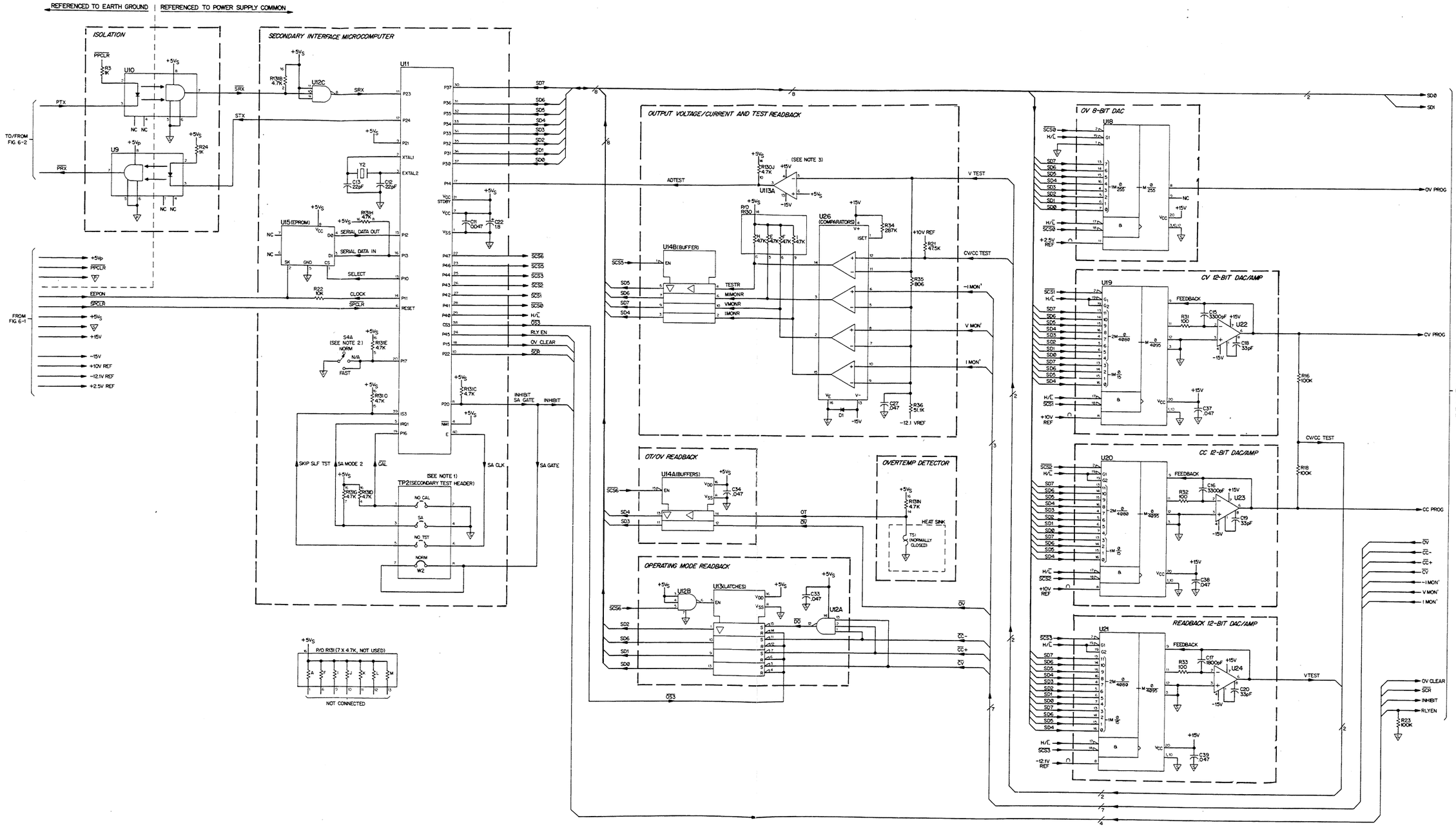


Figure 6-3. HP Models 6632A-6634A Secondary Interface Circuits, Schematic Diagram

Schematic Notes for Figure 6-3

1. Jumper W2 is shown installed in the NORM position (across pins 7 and 8) of secondary test header TP2. The NO CAL (TP2 pins 1 and 2), SA (TP2 pins 3 and 4), and NO TST (TP2 pins 5 and 6) jumper positions are described in Section IV.

2. OPERATING MODE switch S4 selects either the NORMAL or FAST mode (see paragraph 4-4 in the Operating Manual). Switch S4 is actually a three position switch: NORMAL, N/A, and FAST. The FAST and N/A positions are connected together and select the same operating mode (FAST). For functional clarity, section S4A, shown in the secondary interface microcomputer circuit on this schematic, is also shown in the voltage gain stage on the power mesh schematics (Figures 6-4 through 6-6).

3. Sections B through D of quad comparator IC (U113) are shown in the voltage and current control circuits on the power mesh schematics (Figures 6-4 through 6-6).

Schematic Notes for Figure 6-4

1. OPERATING MODE switch S4 selects either the NORMAL or FAST mode (see paragraph 4-4 in the Operating Manual). Switch S4 is actually a three position switch: NORMAL, N/A, and FAST. The FAST and N/A positions are connected together and select the same operating mode (FAST). For functional clarity, section S4A, shown in the voltage gain stage on this schematic, is also shown in the secondary interface microcomputer circuit of Figure 6-3.

2. XT1P8 is provided for the connection of optional output relays and control circuitry.

3. The schematic lists typical node voltages measured with respect to power supply common ⏚ for a properly calibrated unit at nominal line voltage. Most of the measurements were taken in the CV mode with no load connected and with 1/2 full scale voltage, 1/2 full scale current, and OV settings as follows: VSET = 10V, ISET = 2.5A, OVSET = 22V.

   Voltages in parenthesis indicate that the measurement was taken with the same 1/2 full scale voltage and 1/2 full scale current settings as above but in the CC mode with a 4 Ω load connected. If the CC annunciator is not on, program the current to a slightly lower value until it comes on.

4. Pin 16 of transistor array Q116 is connected to ⏚.

5. Pins 4 and 11 of transistor array Q115 are not used.

6. R400, C400 in the current control circuit and R401, C401 in the negative current control circuit are used for inductive loading compensation and are user installed. Refer to paragraph 4-13 in the Operating Manual (HP P/N 5957-6360).

7. Jumpers W3 and W4 connect SCR crowbar CR100 across the output of the supply. You can remove the SCR from the circuit by removing these jumpers (see paragraph 4-15 in the Operating Manual).

8. Front panel + and − output binding posts are available (Option 020).

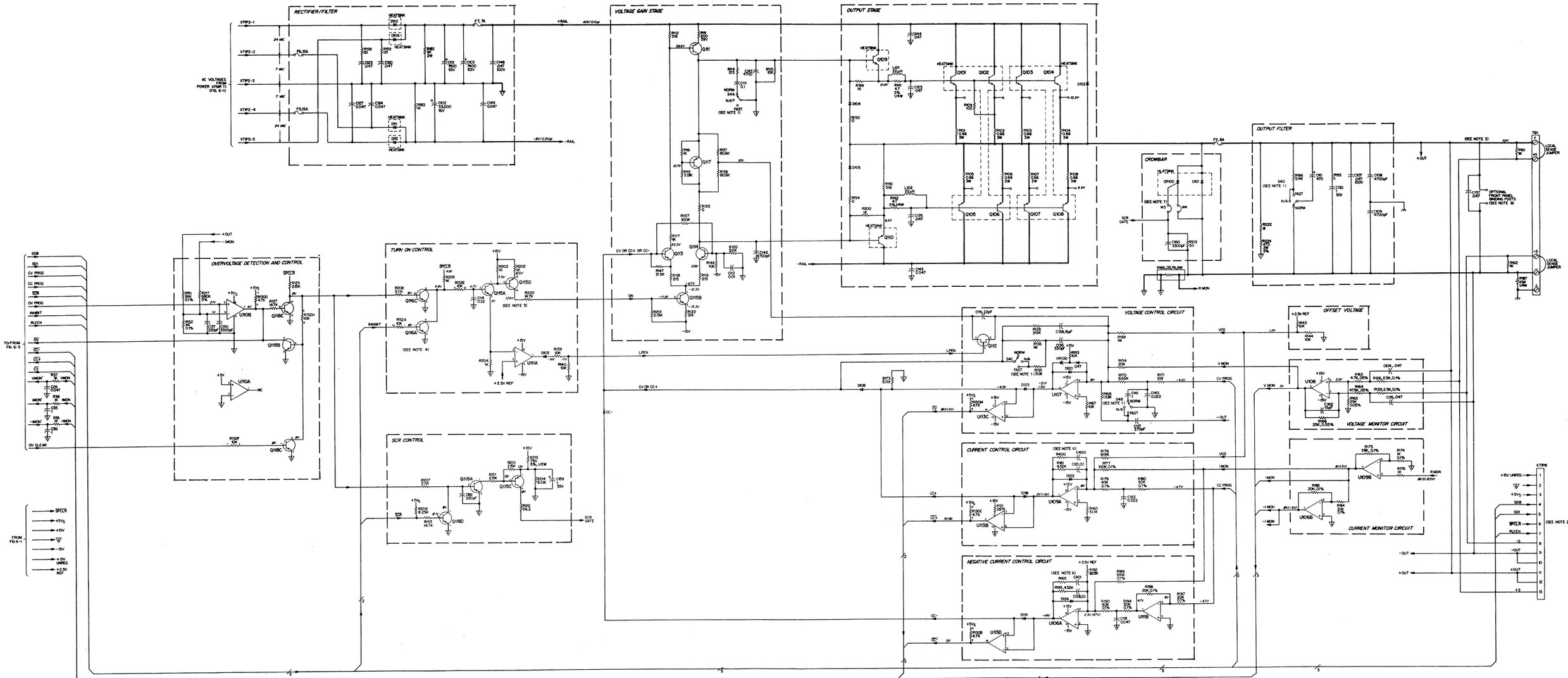


Figure 6-4. Model HP 6632A Power Mesh and Control Circuits, Schematic Diagram

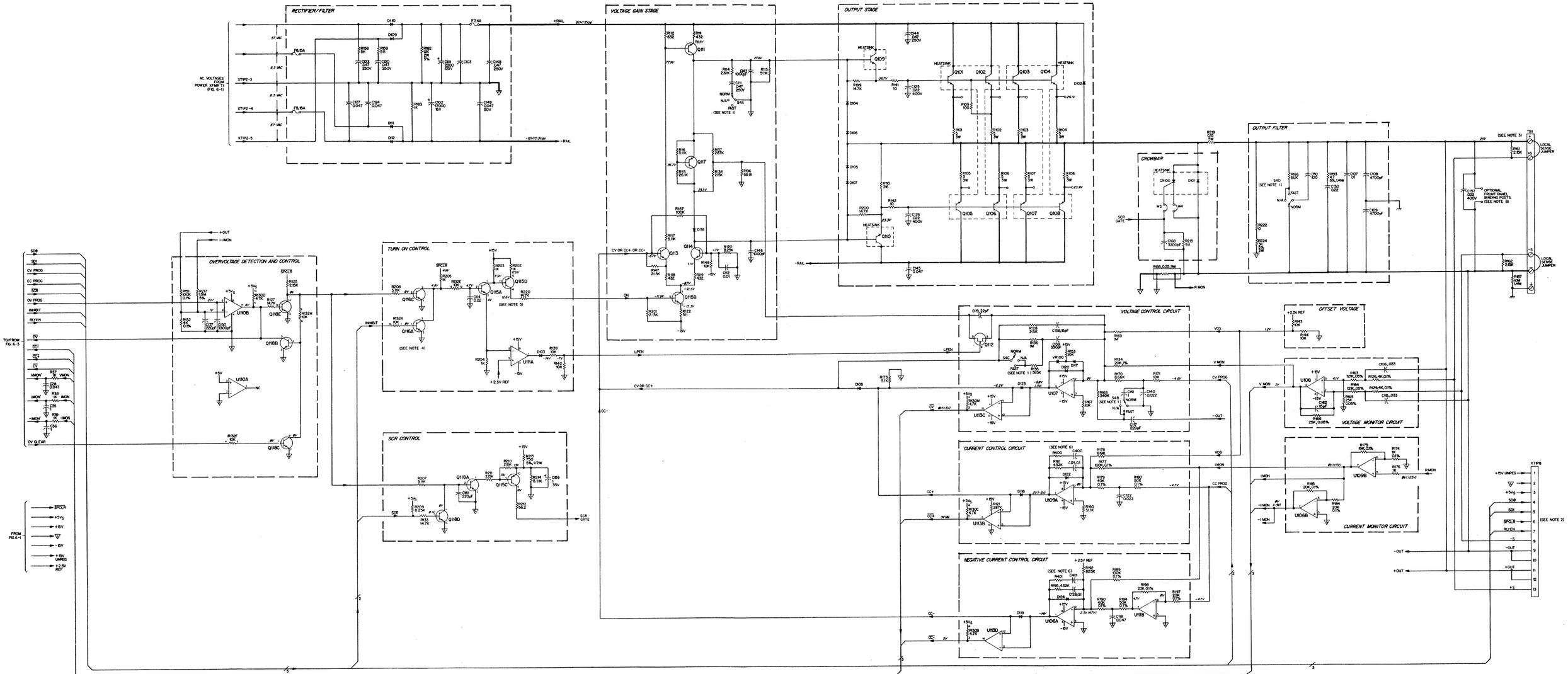


Figure 6-5. Model HP 6633A Power Mesh and Control Circuits, Schematic Diagram

Schematic Notes for Figure 6-5

1. OPERATING MODE switch S4 selects either the NORMAL or FAST mode (see paragraph 4-4 in the Operating Manual). Switch S4 is actually a three position switch: NORMAL, N/A, and FAST. The FAST and N/A positions are connected together and select the same operating mode (FAST). For functional clarity, section S4A, shown in the voltage gain stage on this schematic, is also shown in the secondary interface microcomputer circuit of Figure 6-3.

2. XT1P8 is provided for the connection of optional output relays and control circuitry.

3. The schematic lists typical node voltages measured with respect to power supply common ⏚ for a properly calibrated unit at nominal line voltage. Most of the measurements were taken in the CV mode with no load connected and with 1/2 full scale voltage, 1/2 full scale current, and OV settings as follows: VSET = 25V, ISET = 1A, OVSET = 55V.

   Voltages in parenthesis indicate that the measurement was taken with the same 1/2 full scale voltage and 1/2 full scale current settings as above but in the CC mode with a 25 Ω load connected. If the CC annunciator is not on, program the current to a slightly lower value until it comes on.

4. Pin 16 of transistor array Q116 is connected to ⏚.

5. Pins 4 and 11 of transistor array Q115 are not used.

6. R400, C400 in the current control circuit and R401, C401 in the negative current control circuit are used for inductive loading compensation and are user installed. Refer to paragraph 4-13 in the Operating Manual (HP P/N 5957-6360).

7. Jumpers W3 and W4 connect SCR crowbar CR100 across the output of the supply. You can remove the SCR from the circuit by removing these jumpers (see paragraph 4-15 in the Operating Manual).

8. Front panel + and − output binding posts are available (Option 020).

Schematic Notes for Figure 6-6

1. OPERATING mode switch S4 selects either the NORMAL or FAST mode (see paragraph 4-4 in the Operating Manual). Switch S4 is actually a three position switch: NORMAL, N/A, and FAST. The FAST and N/A positions are connected together and select the same operating mode (FAST). For functional clarity, section S4A, shown in the voltage gain stage on this schematic, is also shown in the secondary interface microcomputer circuit of Figure 6-3.

2. XT1P8 is provided for the connection of optional output relays and control circuitry.

3. The schematic lists typical node voltages measured with respect to power supply common ⏚ for a properly calibrated unit at nominal line voltage. Most of the measurements were taken in the CV mode with no load connected and with 1/2 full scale voltage, 1/2 full scale current, and OV settings as follows: VSET = 50V, ISET = .5A, OVSET = 110V.

   Voltages in parenthesis indicate that the measurement was taken with the same 1/2 full scale voltage and 1/2 full scale current settings as above but in the CC mode with a 100 Ω load connected. If the CC annunciator is not on, program the current to a slightly lower value until it comes on.

4. Pin 16 of transistor array Q116 is connected to ⏚.

5. Pins 4 and 11 of transistor array Q115 are not used.

6. R400, C400 in the current control circuit and R401, C401 in the negative current control circuit are used for inductive loading compensation and are user installed. Refer to paragraph 4-13 in the Operating Manual (HP P/N 5957-6360).

7. Jumpers W3 and W4 connect SCR crowbar CR100 across the output of the supply. You can remove the SCR from the circuit by removing these jumpers (see paragraph 4-15 in the Operating Manual).

8. Front panel + and − output binding posts are available (Option 020).

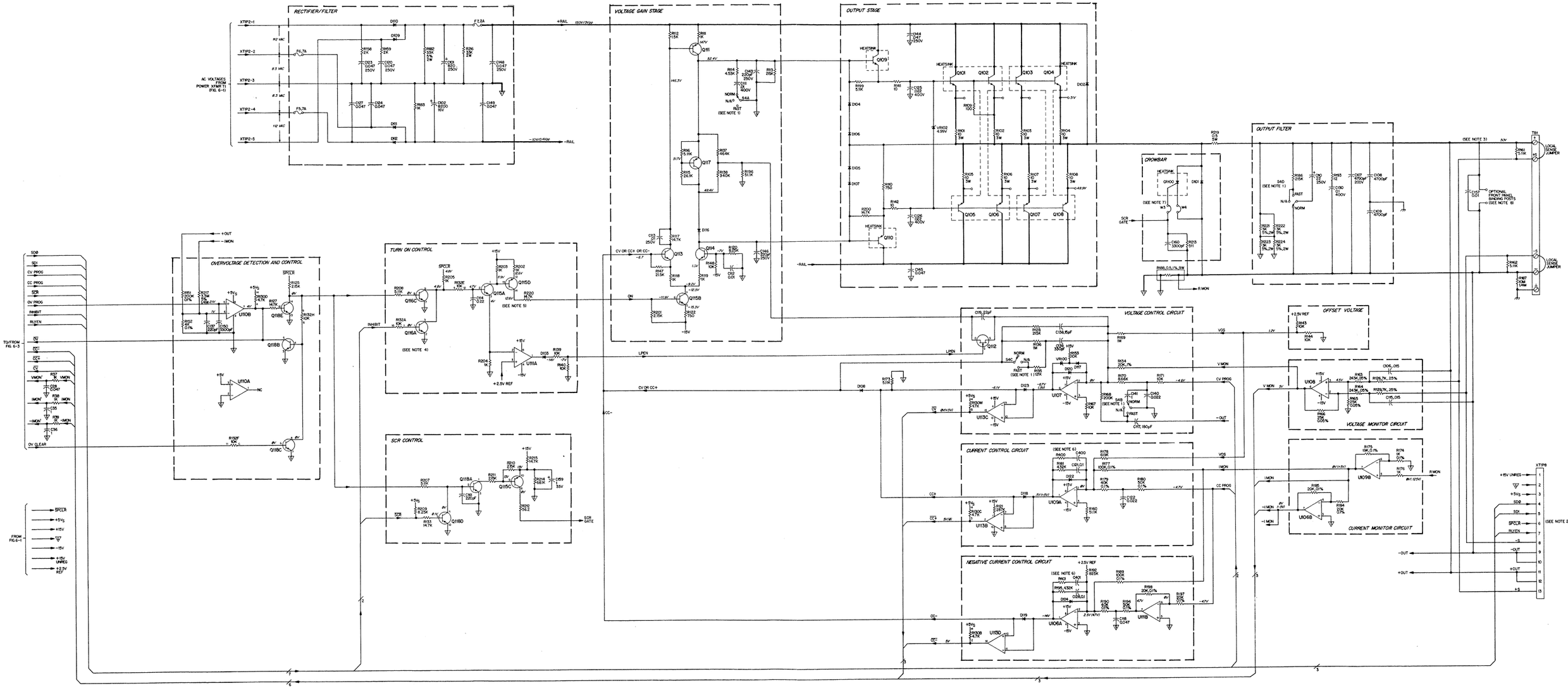


Figure 6-6. Model HP 6634A Power Mesh and Control Circuits, Schematic Diagram

Appendix A
MANUAL BACKDATING CHANGES

Manual backdating changes describe changes necessary to adapt the manual to instruments with serial numbers lower than those listed on the title page. Look up the serial number for your instrument in the following table and make only the manual changes listed for your instrument.

Model	Prefix Number	Serial Number	Make Changes
6632A	2715A	00223-00134	1
	2709A	00133-00101	1,2
6633A	2709A	00128-00101	2
6634A	2710A	00128-00101	2

CHANGE 1:

In Table 5-4 for HP Model 6632A, change transistor Q111 to HP Part No. 1853-0320, 2N4032. If this component must be replaced, replace with HP Part No. 1853-0221 as listed in Table 5-4.

CHANGE 2:

In Table 5-4 make the following changes:

R178: Change to 499K HP Part No. 0698-3215

R192: Change to 1 Meg HP Part No. 0698-8827.

If either of these components must be replaced, use the component value currently listed in Table 5-4.

Appendix B
LOGIC SYMBOLOGY

The logic symbols used in this manual are based on ANSI/IEEE Std 91-1984 (or later), which is a revision of ANSI Y32.14. The following paragraphs and illustrations provide a brief description of the symbology to aid in interpreting the symbols. When referring to the symbols, it should be remembered that:

1. Power supply and ground connections usually are not shown on the symbols, but are listed separately on the schematic.

2. Items in brackets [ ] are not part of the symbol, but are included to help the user interpret the symbol.

3. Unless arrows indicate otherwise, inputs are on left, outputs are on right, and signal flow is from left to right.

4. In an array of two or more identical elements, only the first (top) element is shown in full detail.

5. When shown individually on a schematic rather than as part of an array, basic logic gates (AND, OR, buffer) are shown by distinctive-shape outlines (see Figure B-1).

Qualifier and Functional Labels. Figure B-2 shows qualifiers and functional labels. Qualifiers denote basic logic function. For example, "&" denotes the AND function. Functional labels, such as DEMUX for a demultiplexer, identify complex devices.

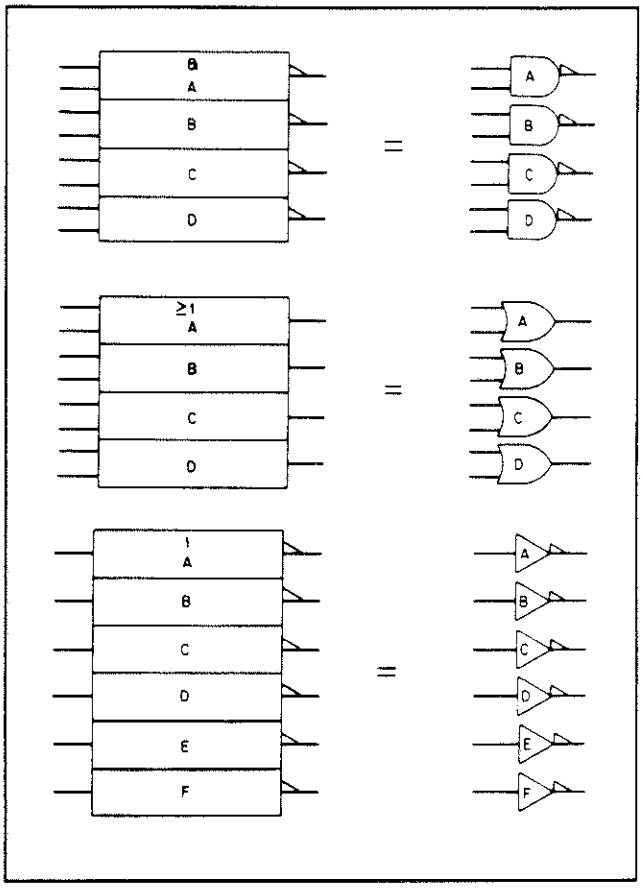
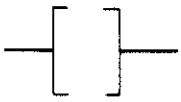


Figure B-1. Distinctive-Shape Outlines

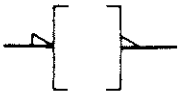
FF	**Flip-Flop** - Binary element with two states, set and reset. When the flip-flop is set, its outputs will be in their active states. When the flip-flop is reset, its outputs will be in their inactive states.
&	**AND** - All inputs must be active for the output to be active.
≥1	**OR** - One or more inputs being active will cause the output to be active.
=1	**EXCLUSIVE OR** - Output will be active when one (and only one) input is active.
1	**Buffer or Inverter** - Without special amplification.
=m	**m and only m** - Output will be active when m (and only m) inputs are active (m is replaced with a number).
=	**Logic Identity** - Output will be active only when all or none of the inputs are active (i.e., when all inputs are identical, output will be active).
	Amplifier - The output will be active only when the input is active (can be used with polarity or logic indicator at input or output to signify inversion).
X/Y	**Signal Level Converter or Code Converter** Input level(s) are different than output level(s), or input code (X) is converted to output code (Y) per weighted values or table.
CTR	**Counter** - Produces one output pulse each time it receives a specific number of input pulses.
MUX	**Multiplexer** - The output is dependent only on the selected input.
DEMUX	**Demultiplexer** - Only the selected output is a function of the input.
REG	**Register** - Array of unconnected flip-flops that form a simple register or latch.
SRG*	**Shift Register** - Register in which data can be shifted from one stage to the next, the asterisk indicates the number of stages.
COMP	**Comparator** - The active output indicates which of two or more sets of inputs is of greatest magnitude.
1⎍	**Monstable (One-Shot) Multivibrator** - Output becomes active when the input becomes active. Output remains active (even if the input becomes inactive) for a period of time that is characteristic of the device and/or circuit.
BIN/OCT	**Binary-to-Octal Decoder**- Converts a three-line binary code to eight-line octal code.
HPRI/BIN	**High-Priority-to-Binary Encoder** - Encodes the address of the highest active of eight inputs to three-line binary code.
#/⎍	**Digital-to-Analog Converter** - Output current is a linear product of a digital word.
RAM	**Random Access Memory** - Addressable memory with read-in and read-out capability.
ROM	**Read Only Memory** - Addressable memory with read-out capability only.
EPROM	**Erasable Programmable Read Only Memory** - Similar to a ROM in normal use, but can be erased and programmed with special equipment.

Figure B-2. Qualifiers and Functional Labels

Indicator Symbols. Inidicator symbols identify the active state of a devices input or output, shown in Figure B-3.

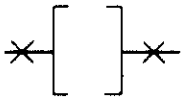


Implied Indicator - Absence of polarity indicator (see below) implies that the active state is a relative high voltage level.



Polarity Indicator - The active state is a relatively low voltage level.

Dynamic Indicator - The active state is a transition from a relative low to a relative high voltage level, or from a high to a low voltage level if a polarity indicator is shown outside symbol.

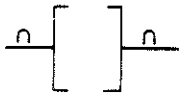


Non-Logic Indicator - Input or output does not carry logic information (e.g. RC inputs to a one-shot multivibrator).

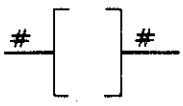
Open-Circuit Output, general symbol.

Open-Circuit Output, H Level - NPN open emitter, PNP open collector, P-channel FET open drain, N-channel FET open source.

Open-Circuit Output, L Level - NPN open collector, PNP open emitter, P-channel FET open source, N-channel FET open drain.



Analog Input or Output - Used only when necessary to distinquish analog signals.



Digital Input or Output - Used only when necessary to distinguish digital signals.

D

Data Input - Always enabled by another input (generally a C input-see Dependency Notation). Any D input is associated with storage.

Shift Right (Down) Input - When active, causes the contents of a shift register to shift to the right or down "m" places (m is replaced with a number).

NOTE

If m = 1, it is omitted.

Postponed Output - Output delayed until input returns to its initial state.

Three-State Output- Indicates outputs that can have a high-impedance (disconnect) state in addition to the normal binary logic states.

Bithreshold Input - Input characterized by hysteresis; one threshold for positive-going signals and a different threshold for negative-going signals.

Greater-Than - Input or Output of a magnitude comparator.

Less-Than - Input or Output of a magnitude comparator.

Equal Input or Output - Of a magnitude comparator.

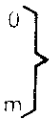
E

Extension Input or Extender Output - Connected between devices to extend the number of inputs.

Multiplier Input - Analog input used to control a variable characteristic of a function (e.g. range).

CT

Content - Indicates the value of an input or output when active.



Binary Grouping - m is highest power of 2.

Input Line Grouping - Two or more terminals implement a single logic input.

Figure B-3. Input and Output Indicators

Contiguous Blocks. Two symbols may share a common boundary parallel or perpendicular to the direction of signal flow. Note that in the example shown in Figure B-4 there is generally no logic connection across a horizontal line, but there is always an implied logic connection cross a vertical line. Notable exceptions to this rule are the horizontal lines beneath control blocks and between sections of shift registers and counters.

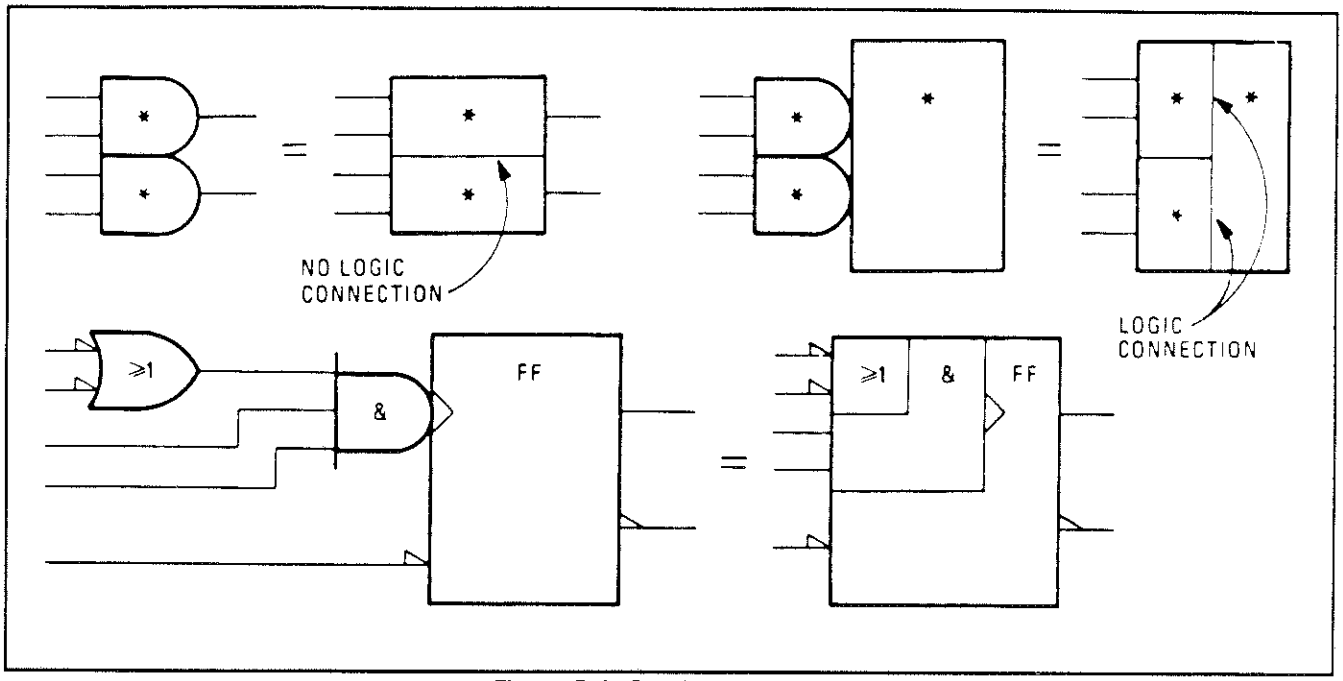


Figure B-4. Contiguous Blocks

Common Control Block. The Control block is used in conjunction with an array of related symbols in order to group common logic lines. Figure B-5 shows how the Control block is usually represented. Figure B-6 shows a quad D-type flip-flop with reset. This can be redrawn as shown in Figure B-7. Note that the more complex representation shown in Figure B-6 can be used when the flip-flops are functionally scattered around the schematic (i.e., not used as a quad unit).

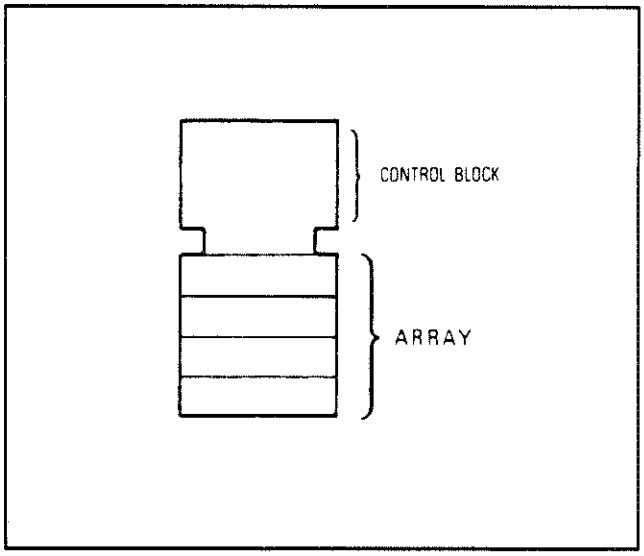


Figure B-5 Common Control Block

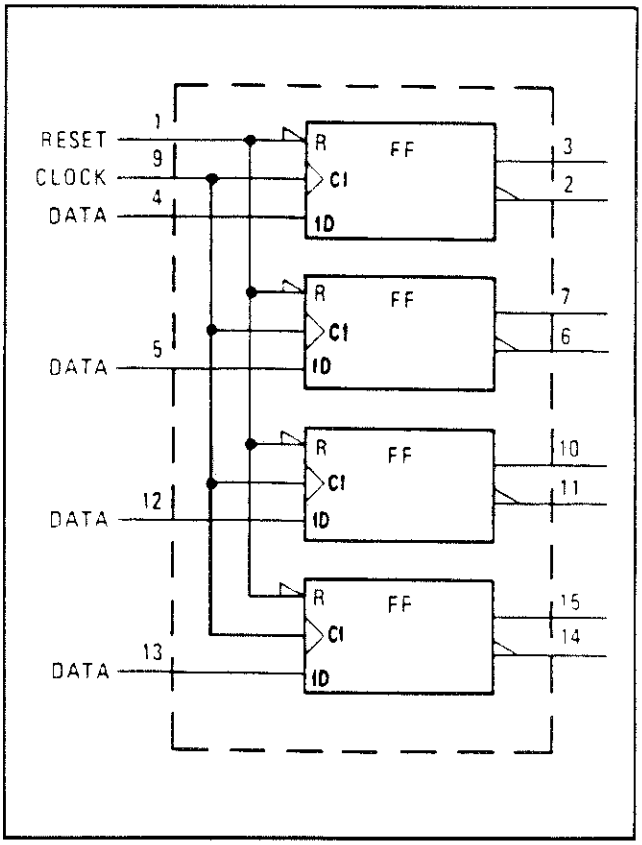


Figure B-6. Quad D-Type Latch (Individual)

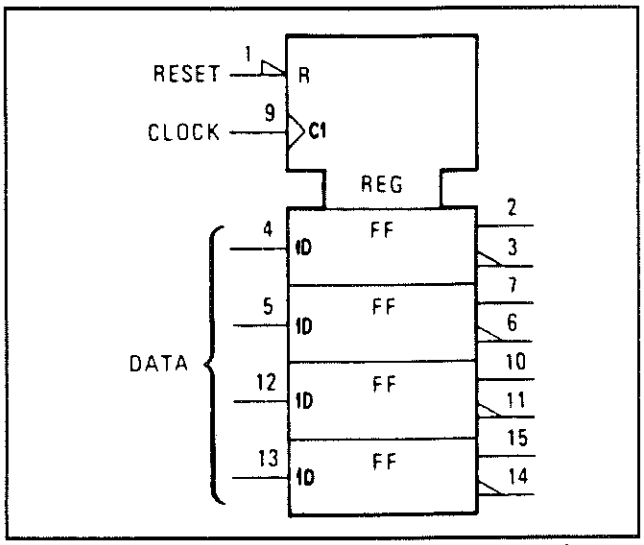
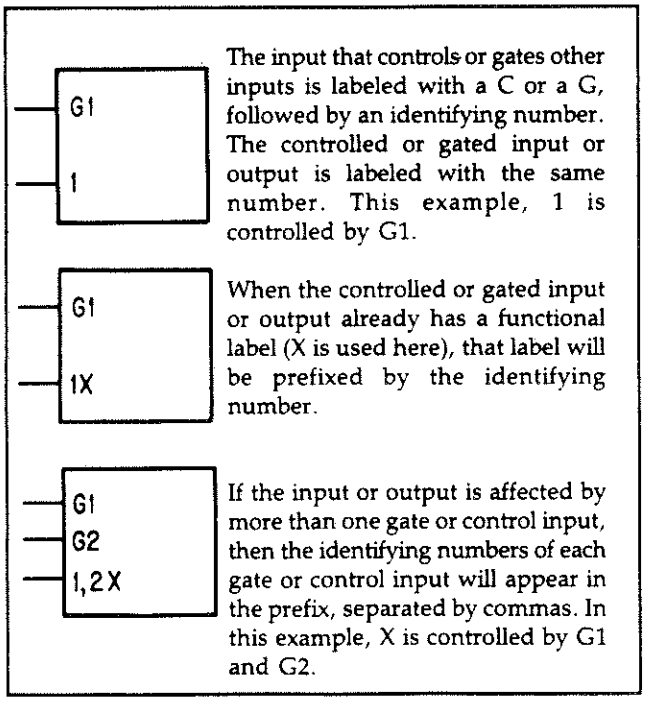


Figure B-7. Quad D-Type Latch (Combined)

Dependency Notation. Dependency notation simplifies symbols for complex integrated circuit elements by defining the interdependencies of inputs or outputs without actually showing all the elements and interconnections involved. (See Figure B-8 and B-9 for examples of AND dependency and enable dependency.)

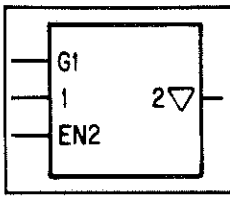


The input that controls or gates other inputs is labeled with a C or a G, followed by an identifying number. The controlled or gated input or output is labeled with the same number. This example, 1 is controlled by G1.

When the controlled or gated input or output already has a functional label (X is used here), that label will be prefixed by the identifying number.

If the input or output is affected by more than one gate or control input, then the identifying numbers of each gate or control input will appear in the prefix, separated by commas. In this example, X is controlled by G1 and G2.

Figure B-8. AND Dependency Notation



When an EN input is active, the output is enabled to function normally. When an EN input is inactive, the output becomes a high impedance, effectively removing that device from the circuit.

Figure B-9. Enable Dependency Notation

Application of dependency notation is accomplished by:

1. labelling the input affecting other inputs or outputs with the letter symbol denoting the relationship involved followed by an appropriately chosen identifying number, and
2. labelling each input or output affected by the affecting input with that same number.

If it is the complement of the internal logic state of the affecting input or output that does the affecting, a bar is placed over the identifying number at the affected input or output.

If the affected input or output requires a label to denote its function, this label shall be prefixed by the identifying number of the affecting input.

If an input or output is affected by more than one affecting input, the identifying numbers of each of the affecting inputs shall appear in the label of the affected one separated by commas. The left-to-right reading order of these identifying numbers is the same as the sequence of the affecting relationships.

Two affecting inputs labelled with different letters shall not have the same identifying number, unless one of the letters is A.

If two affecting inputs have the same letter and the same identifying number they stand in an OR relationship to each other.

If the labels denoting the functions of affecting inputs or outputs must be numbers (e.g., outputs of a coder), the identifying numbers to be associated with both affecting inputs and affected input or outputs shall be replaced by another character selected to avoid ambiguity (e.g., Greek letters).

An affecting input affects only the corresponding affected inputs and outputs of the symbol.

Note that dependency notation is usually indicated by numbers. The numbers themselves have no value; they simply relate two or more points having the same number. However, sometimes an input or output has a weighted value (e.g., 1,2,4,8); in these cases a non-numeric symbol (e.g., α) may be used to avoid confusion between a weighted value and the dependency notation.

Eleven types of dependencies are listed below:

A **Address** - Identifies the address inputs of a memory.

C **Control** - Identifies an input, such as a timing or clock input, that produces action, and indicates which other inputs are controlled by it. Used for sequential elements (flip-flops, registers), and may imply more than a simple AND relationship.

EN **Enable** - Identifies an input that enables outputs, and indicates which outputs are affected by it. Acts as a connect switch when active, and a disconnect switch when inactive.

G **Gate (AND)** - Identifies an input having an AND relationship with other inputs or outputs having the same identifier number (or symbol).

M **Mode** - Identifies an input that selects the mode of operation, and indicates which inputs and outputs depend on that mode.

N **Negate** - Identifies an input that when active, complements other inputs or outputs, and identifies which inputs and outputs are affected.

R **Reset** - When active, causes a flip-flop to reset.

S **Set** - When active, causes a flip-flop to reset.

V **OR** - Identifies an input having an OR relationship with other inputs or outputs having the same identifier number (or symbol).

X **Transmission** - Identifies an input that makes or breaks bidirectional connections between affected input/output ports.

Z **Interconnection** - Identifies a point that is internally connected to another input, output, internal input, or internal output having the same identifier number (or symbol).

Miscellaneous Terms and Symbols. Figure B-10 shows miscellaneous terms and symbols that are used in conjunction with the logic symbols, function tables, and truth tables used in this section.

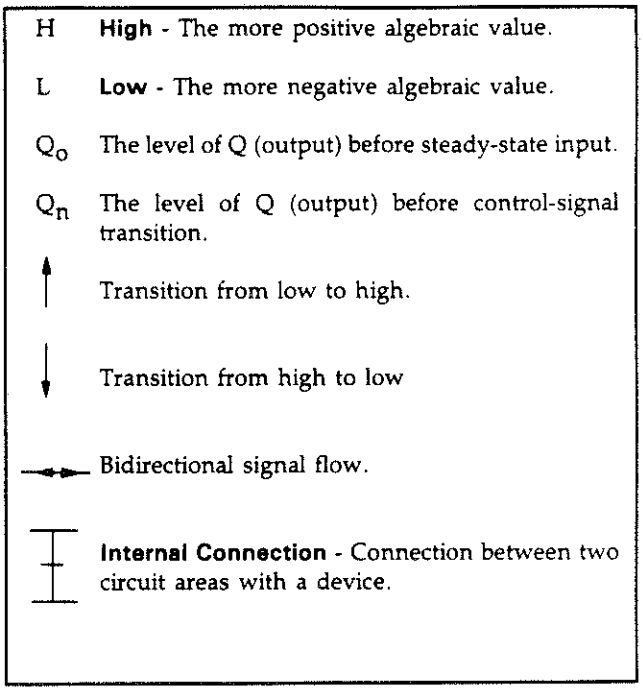


Figure B-10. Miscellaneous Terms and Symbols