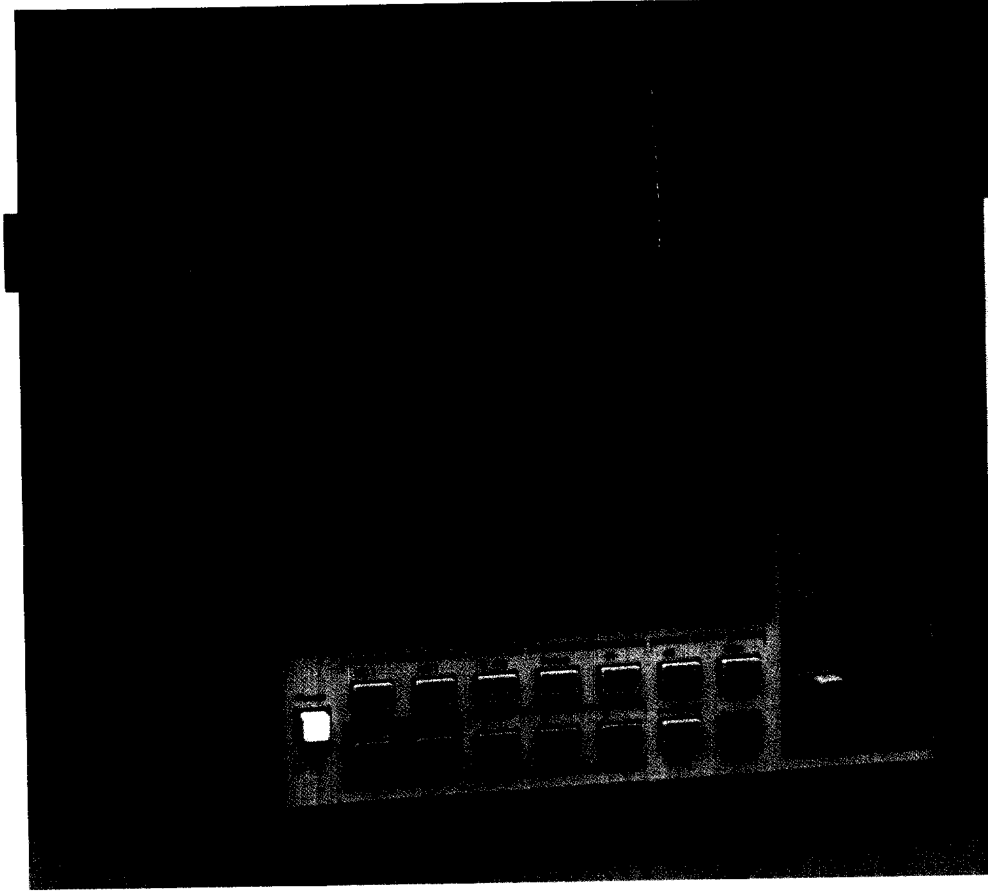
HEWLETT PACKARD



Service Guide

HP 34401A Multimeter

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Safety

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

Warning

The Warning symbol 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 symbol until the indicated conditions are fully understood and met.

Caution

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

Safety Symbols

Instruction manual symbol. Refer to the manual to protect against damage to the product.

Hazardous voltage symbol.

Earth ground symbol.

Chassis ground symbol.

Hewlett-Packard Company
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Loveland, Colorado 80539 U.S.A.

The HP 34401A is a 6½-digit, high-performance digital multimeter. Its combination of bench-top and system features makes this multimeter a versatile solution for your measurement needs now and in the future.

Convenient bench-top features

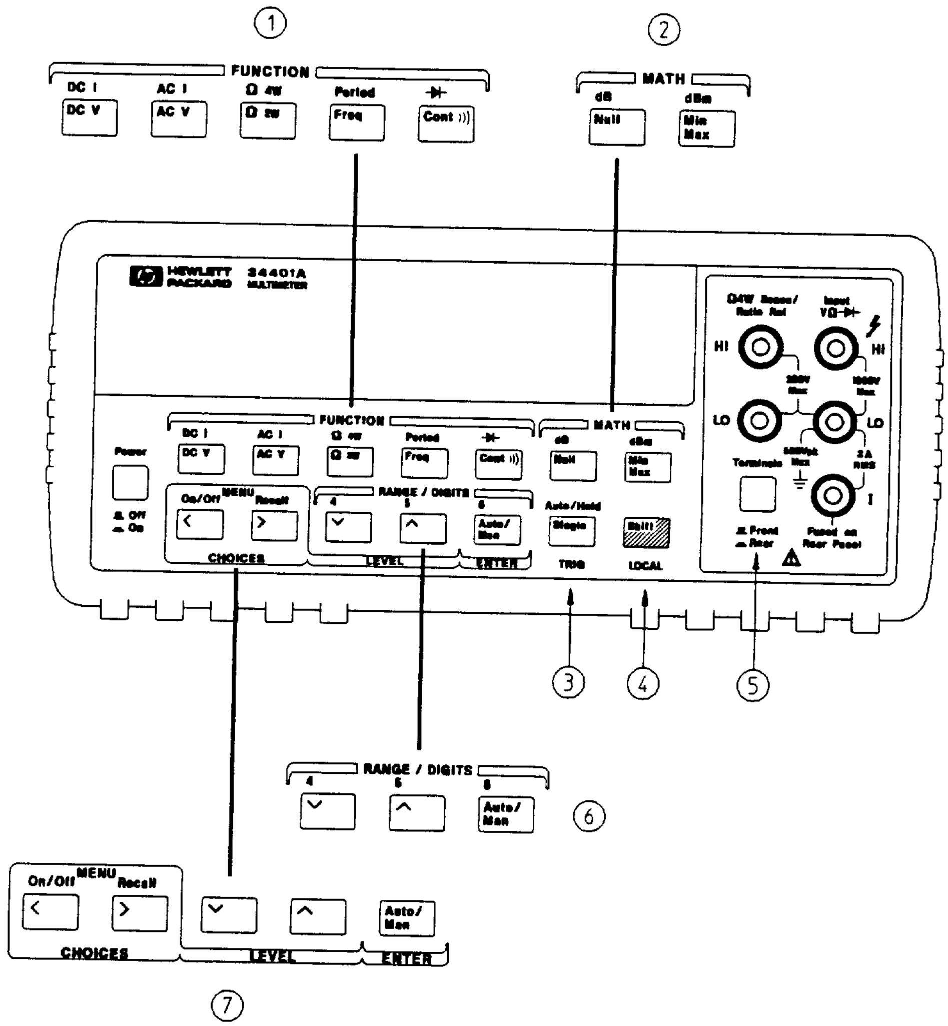
- Highly visible vacuum-fluorescent display
- Built-in math operations
- Continuity and diode test functions
- Hands-free, Reading Hold feature
- Portable, ruggedized case with non-skid feet

Flexible system features

- HP-IB (IEEE-488) interface is standard
- RS-232 interface is standard
- Standard programming languages: SCPI, HP 3478A, and Fluke 8840
- Reading rates up to 1000 readings per second
- Storage for up to 512 readings
- Limit testing with pass/fail signals

HP 34401A Multimeter

The Front Panel at a Glance



1 Measurement function keys	**5** Front / rear input terminal switch
2 Math operation keys	**6** Range / number of digits displayed keys
3 Single trigger / autotrigger / reading hold key	**7** Menu operation keys
4 Shift / local key	

The Front-Panel Menu at a Glance

The menu is organized in a top-down tree structure with 3 levels.

To turn on menu press: Shift On/Off <

< > To move left or right

∨ ∧ To move up or down

A: MEAS MENU ➡ B: MATH MENU ➡ C: TRIG MENU ➡ D: SYS MENU ➡ E: I/O MENU ➡ F: CAL MENU

1: AC FILTER ➡ 2: CONTINUITY ➡ | 1: MIN-MAX ➡ | 1: READ HOLD ➡ | 1: RDGS STORE ➡ | 1: HP-IB ADDR ➡ | 1: SECURED ➡

To enter command press: Auto/Man ENTER

A: MEASurement MENU

1: AC FILTER ➡ 2: CONTINUITY ➡ 3: INPUT R ➡ 4: RATIO FUNC ➡ 5: RESOLUTION

B: MATH MENU

1: MIN–MAX ➡ 2: NULL VALUE ➡ 3: dB REL ➡ 4: dBm REF R ➡ 5: LIMIT TEST ➡ 6: HIGH LIMIT ➡ 7: LOW LIMIT

C: TRIGger MENU

1: READ HOLD ➡ 2: TRIG DELAY ➡ 3: N SAMPLES

D: SYStem MENU

1: RDGS STORE ➡ 2: SAVED RDGS ➡ 3: ERROR ➡ 4: TEST ➡ 5: DISPLAY ➡ 6: BEEP ➡ 7: COMMA ➡ 8: REVISION

E: Input / Output MENU

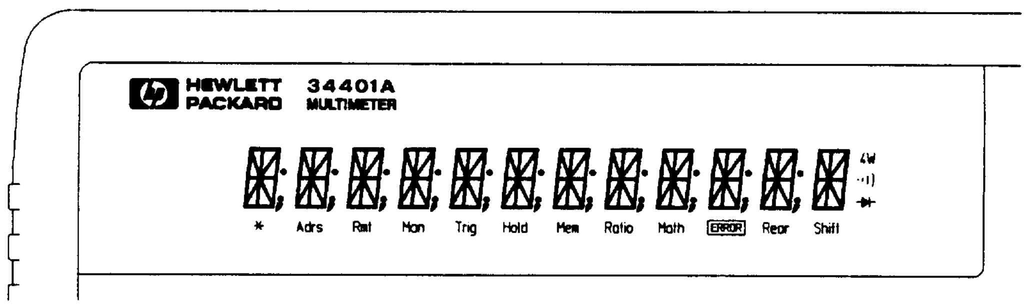
1: HP–IB ADDR ➡ 2: INTERFACE ➡ 3: BAUD RATE ➡ 4: PARITY ➡ 5: LANGUAGE

F: CALibration MENU

1: SECURED ➡ [1: UNSECURED] ➡ [2: CALIBRATE] ➡ 3: CAL COUNT ➡ 4: MESSAGE

NOTE: The two commands enclosed in square brackets ([ ]) in the CAL MENU are "hidden" unless the multimeter is UNSECURED for calibration.

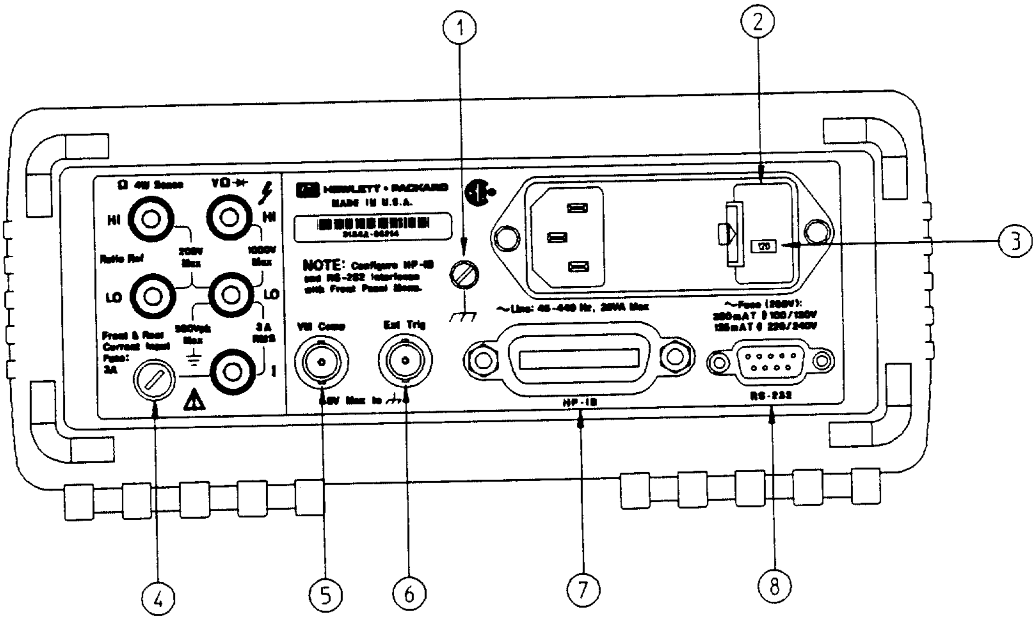
Display Annunciators



*****	Turns on during a measurement.
Adrs	Multimeter is addressed to listen or talk over the HP-IB interface.
Rmt	Multimeter is in remote mode (remote interface).
Man	Multimeter is using manual ranging (autorange is disabled).
Trig	Multimeter is waiting for a single trigger or external trigger.
Hold	Reading Hold is enabled.
Mem	Turns on when reading memory is enabled.
Ratio	Multimeter is in dcv:dcv ratio function.
Math	A math operation is enabled (null, min-max, dB, dBm, or limit test).
ERROR	Hardware or remote interface command errors are detected.
Rear	Rear input terminals are selected.
Shift	"Shift" key has been pressed.
4W	Multimeter is in 4-wire ohms function.
·ı))	Multimeter is in continuity test function.
→+	Multimeter is in diode test function.

To review the display annunciators, hold down the `Shift` **key as you turn on the multimeter.**

The Rear Panel at a Glance



1 Chassis ground	**5** Voltmeter Complete output terminal
2 Power-line fuse-holder assembly	**6** External Trigger input terminal
3 Power-line voltage setting	**7** HP-IB (IEEE-488) interface connector
4 Front and rear current input fuse	**8** RS-232 interface connector

Use the front-panel Input/Output Menu to:

- Select the HP-IB or RS-232 interface (see chapter 4 in the User's Guide).
- Set the HP-IB bus address (see chapter 4 in the User's Guide).
- Set the RS-232 baud rate and parity (see chapter 4 in the User's Guide).

In This Book

Specifications Chapter 1 lists the multimeter's specifications and describes how to interpret these specifications.

Quick Start Chapter 2 describes how to prepare the multimeter for use and helps you get familiar with a few of its front-panel features.

Menu Tutorial Chapter 3 introduces you to the front-panel menu and steps you through some simple examples.

Calibration Procedures Chapter 4 provides a detailed description of the multimeter's calibrations and adjustments.

Theory of Operation Chapter 5 gives descriptions of each functional block in the multimeter.

Service Chapter 6 provides guidelines for returning your multimeter to HP for servicing, or for servicing it yourself.

Replaceable Parts Chapter 7 contains a detailed parts list of the multimeter.

Backdating Chapter 8 describes the procedures involved with back issues.

Schematics Chapter 9 provides the multimeter's schematics.

If you have questions relating to the operation of the multimeter, call 303-679-EASY (3279) *in the United States, or contact your nearest HP Sales Office.*

Contents

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1

Specifications

DC Characteristics

Accuracy Specifications ± (% of reading + % of range) [1]

Function	Range [3]	Test Current or Burden Voltage	24 Hour [2] 23°C ± 1°C	90 Day 23°C ± 5°C	1 Year 23°C ± 5°C	Temperature Coefficient 0°C – 18°C 28°C – 55°C
DC Voltage	100.0000 mV		0.0030 + 0.0030	0.0040 + 0.0035	0.0050 + 0.0035	0.0005 + 0.0005
	1.000000 V		0.0020 + 0.0006	0.0030 + 0.0007	0.0040 + 0.0007	0.0005 + 0.0001
	10.00000 V		0.0015 + 0.0004	0.0020 + 0.0005	0.0035 + 0.0005	0.0005 + 0.0001
	100.0000 V		0.0020 + 0.0006	0.0035 + 0.0006	0.0045 + 0.0006	0.0005 + 0.0001
	1000.000 V		0.0020 + 0.0006	0.0035 + 0.0010	0.0045 + 0.0010	0.0005 + 0.0001
Resistance [4]	100.0000 Ω	1 mA	0.0030 + 0.0030	0.008 + 0.004	0.010 + 0.004	0.0006 + 0.0005
	1.000000 kΩ	1 mA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	10.00000 kΩ	100 μA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	100.0000 kΩ	10 μA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	1.000000 MΩ	5 μA	0.002 + 0.001	0.008 + 0.001	0.010 + 0.001	0.0010 + 0.0002
	10.00000 MΩ	500 nA	0.015 + 0.001	0.020 + 0.001	0.040 + 0.001	0.0030 + 0.0004
	100.0000 MΩ	500 nA // 10 MΩ	0.300 + 0.010	0.800 + 0.010	0.800 + 0.010	0.1500 + 0.0002
DC Current	10.00000 mA	< 0.1 V	0.005 + 0.010	0.030 + 0.020	0.050 + 0.020	0.002 + 0.0020
	100.0000 mA	< 0.6 V	0.01 + 0.004	0.030 + 0.005	0.050 + 0.005	0.002 + 0.0005
	1.000000 A	< 1 V	0.05 + 0.006	0.080 + 0.010	0.100 + 0.010	0.005 + 0.0010
	3.000000 A	< 2 V	0.10 + 0.020	0.120 + 0.020	0.120 + 0.020	0.005 + 0.0020
Continuity	1000.0 Ω	1 mA	0.002 + 0.010	0.008 + 0.020	0.010 + 0.020	0.001 + 0.002
Diode Test	1.0000 V	1 mA	0.002 + 0.010	0.008 + 0.020	0.010 + 0.020	0.001 + 0.002
DC:DC Ratio	100 mV to 1000 V		(Input Accuracy) + (Reference Accuracy) Input Accuracy = accuracy specification for the HI-LO input signal. Reference Accuracy = accuracy specification for the HI-LO reference input signal.			

Transfer Accuracy (typical)

$$\frac{\text{(24 hour \% of range error)}}{2}$$

Conditions:
Within 10 minutes and ± 0.5°C.
Within ±10% of initial value.
Following a 2-hour warm-up.
Fixed range between 10% and 100% of full scale.
Using 6½ digit slow resolution (100 PLC).
Measurements are made using accepted metrology practices.

Measuring Characteristics

DC Voltage	
Measurement Method:	Continuously integrating, multi-slope III A/D converter.
A/D Linearity:	0.0002% of reading + 0.0001% of range
Input Resistance:	
0.1 V, 1 V, 10 V ranges	Selectable 10 MΩ or >10 GΩ
100 V, 1000 V ranges	10 MΩ ±1%
Input Bias Current:	< 30 pA at 25°C
Input Terminals:	Copper alloy
Input Protection:	1000 V on all ranges
Resistance	
Measurement Method:	Selectable 4-wire or 2-wire ohms. Current source referenced to LO input.
Max. Lead Resistance: (4-wire ohms)	10% of range per lead for 100 Ω, 1 kΩ ranges. 1 kΩ per lead on all other ranges.
Input Protection:	1000 V on all ranges
DC Current	
Shunt Resistor:	0.1 Ω for 1A, 3A. 5 Ω for 10 mA, 100 mA
Input Protection:	Externally accessible 3A, 250 V fuse Internal 7A, 250 V fuse
Continuity / Diode Test	
Response Time:	300 samples/sec with audible tone
Continuity Threshold:	Adjustable from 1 Ω to 1000 Ω
DC:DC Ratio	
Measurement Method:	Input HI-LO / Reference HI-LO
Input HI-LO	100 mV to 1000 V ranges
Reference HI-Input LO	100 mV to 10 V ranges (autoranged)
Input to Reference	Reference LO to Input LO voltage < 2 V Reference HI to Input LO voltage < 12 V

Measurement Noise Rejection
60 Hz (50 Hz) [5]
DC CMRR 140 dB

Integration Time	**Normal Mode Rejection** [6]
100 PLC / 1.67s (2s)	70 dB [7]
10 PLC / 167 ms (200 ms)	60 dB [7]
1 PLC / 16.7 ms (20 ms)	60 dB
<1 PLC / 3 ms (800 μs)	0 dB

Teflon is a registered trademark of E.I. duPont deNemours and Co.

Operating Characteristics [8]

Function	**Digits**	**Readings/s**	**Additional Noise Error**
DCV, DCI, and Resistance	6½	0.6 (0.5)	0% of range
	6½	6 (5)	0% of range
	5½	60 (50)	0.001% of range
	5½	300	0.001% of range [10]
	4½	1000	0.01% of range [10]

System Speeds [9]	
Function Change	26/sec
Range Change	50/sec
Autorange Time	<30 ms
ASCII readings to RS-232	55/sec
ASCII readings to HP-IB	1000/sec
Max. Internal Trigger Rate	1000/sec
Max. External Trigger Rate to Memory	1000/sec
Max. External Trigger Rate to HP-IB	900/sec

Autozero OFF Operation
Following instrument warm-up at calibration temperature ±1°C and <10 minutes, add 0.0002% range additional error + 5 μV.

Settling Considerations
Reading settling times are affected by source impedance, cable dielectric characteristics, and input signal changes.

Measurement Considerations
HP recommends the use of Teflon® or other high-impedance, low-dielectric absorption wire insulation for these measurements.

[1] Specifications are for 1-hour warm-up at 6½ digits.
[2] Relative to calibration standards.
[3] 20% overrange on all ranges, except 1000 Vdc, 3 A range.
[4] Specifications are for 4-wire ohms function, or 2-wire ohms using Math Null. Without Math Null, add 0.2 Ω additional error in 2-wire ohms function.
[5] For 1 kΩ unbalance in LO lead.
[6] For power-line frequency ± 0.1%.
[7] For power-line frequency ± 1%, use 40 dB. For ± 3%, use 30 dB.
[8] Readings speeds for 60 Hz and (50 Hz) operation, Autozero Off.
[9] Speeds are for 4½ digits, Delay 0, Autozero OFF, and Display OFF. Includes measurement and data transfer over HP-IB.
[10] Add 20 μV for dc volts, 4 μA for dc current, or 20 mΩ for resistance.

AC Characteristics

Accuracy Specifications ± (% of reading + % of range) [1]

Function	Range [3]	Frequency	24 Hour [2] 23°C ± 1°C	90 Day 23°C ± 5°C	1 Year 23°C ± 5°C	Temperature Coefficient 0°C – 18°C 28°C – 55°C
True RMS AC Voltage [4]	100.0000 mV	3 Hz – 5 Hz	1.00 + 0.03	1.00 + 0.04	1.00 + 0.04	0.100 + 0.004
		5 Hz – 10 Hz	0.35 + 0.03	0.35 + 0.04	0.35 + 0.04	0.035 + 0.004
		10 Hz – 20 kHz	0.04 + 0.03	0.05 + 0.04	0.06 + 0.04	0.005 + 0.004
		20 kHz – 50 kHz	0.10 + 0.05	0.11 + 0.05	0.12 + 0.05	0.011 + 0.005
		50 kHz – 100 kHz	0.55 + 0.08	0.60 + 0.08	0.60 + 0.08	0.060 + 0.008
		100 kHz – 300 kHz [6]	4.00 + 0.50	4.00 + 0.50	4.00 + 0.50	0.20 + 0.02
	1.000000 V to 750.000 V	3 Hz – 5 Hz	1.00 + 0.02	1.00 + 0.03	1.00 + 0.03	0.100 + 0.003
		5 Hz – 10 Hz	0.35 + 0.02	0.35 + 0.03	0.35 + 0.03	0.035 + 0.003
		10 Hz – 20 kHz	0.04 + 0.02	0.05 + 0.03	0.06 + 0.03	0.005 + 0.003
		20 kHz – 50 kHz	0.10 + 0.04	0.11 + 0.05	0.12 + 0.05	0.011 + 0.005
		50 kHz – 100 kHz [5]	0.55 + 0.08	0.60 + 0.08	0.60 + 0.08	0.060 + 0.008
		100 kHz – 300 kHz [6]	4.00 + 0.50	4.00 + 0.50	4.00 + 0.50	0.20 + 0.02
True RMS AC Current [4]	1.000000 A	3 Hz – 5 Hz	1.00 + 0.04	1.00 + 0.04	1.00 + 0.04	0.100 + 0.006
		5 Hz – 10 Hz	0.30 + 0.04	0.30 + 0.04	0.30 + 0.04	0.035 + 0.006
		10 Hz – 5 kHz	0.10 + 0.04	0.10 + 0.04	0.10 + 0.04	0.015 + 0.006
	3.00000 A	3 Hz – 5 Hz	1.10 + 0.06	1.10 + 0.06	1.10 + 0.06	0.100 + 0.006
		5 Hz – 10 Hz	0.35 + 0.06	0.35 + 0.06	0.35 + 0.06	0.035 + 0.006
		10 Hz – 5 kHz	0.15 + 0.06	0.15 + 0.06	0.15 + 0.06	0.015 + 0.006

Additional Low Frequency Errors (% of reading)

Frequency	AC Filter Slow	Medium	Fast
10 Hz – 20 Hz	0	0.74	—
20 Hz – 40 Hz	0	0.22	—
40 Hz – 100 Hz	0	0.06	0.73
100 Hz – 200 Hz	0	0.01	0.22
200 Hz – 1 kHz	0	0	0.18
> 1 kHz	0	0	0

Additional Crest Factor Errors (non-sinewave) [7]

Crest Factor	Error (% of reading)
1 – 2	0.05%
2 – 3	0.15%
3 – 4	0.30%
4 – 5	0.40%

Sinewave Transfer Accuracy (typical)

Frequency	Error (% of range)
10 Hz – 50 kHz	0.002%
50 kHz – 300 kHz	0.005%

Conditions:
Sinewave input.
Within 10 minutes and ± 0.5°C.
Within ±10% of initial voltage and ±1% of initial frequency.
Following a 2-hour warm-up.
Fixed range between 10% and 100% of full scale (and <120 V).
Using 6½ digit resolution.
Measurements are made using accepted metrology practices.

Measuring Characteristics

Measurement Noise Rejection [8]

AC CMRR	70 dB

True RMS AC Voltage

Measurement Method:	AC-coupled True RMS – measures the ac component of the input with up to 400 Vdc of bias on any range.
Crest Factor:	Maximum 5:1 at full scale
AC Filter Bandwidth:	
Slow	3 Hz – 300 kHz
Medium	20 Hz – 300 kHz
Fast	200 Hz – 300 kHz
Input Impedance:	1 MΩ ± 2%, in parallel with 100 pF
Input Protection:	750 V rms all ranges

True RMS AC Current

Measurement Method:	Direct coupled to the fuse and shunt. AC-coupled True RMS measurement (measures the ac component only).
Shunt Resistor:	0.1 Ω for 1 A and 3 A ranges
Burden Voltage:	1 A range: < 1 V rms 3 A range: < 2 V rms
Input Protection:	Externally accessible 3A, 250 V fuse Internal 7A, 250 V fuse

Settling Considerations

Applying >300 V rms (or >1 A rms) will cause self-heating in signal-conditioning components. These errors are included in the instrument specifications. Internal temperature changes due to self-heating may cause additional error on lower ac voltage ranges. The additional error will be less than 0.02% of reading and will generally dissipate within a few minutes.

Operating Characteristics [9]

Function	Digits	Reading/s	AC Filter
ACV, ACI	6½	7 sec/reading	Slow
	6½	1	Medium
	6½	1.6 [10]	Fast
	6½	10	Fast
	6½	50 [11]	Fast

System Speeds [11], [12]

Function or Range Change	5/sec
Autorange Time	<0.8 sec
ASCII readings to RS-232	50/sec
ASCII readings to HP-IB	50/sec
Max. Internal Trigger Rate	50/sec
Max. External Trigger Rate to Memory	50/sec
Max. External Trigger Rate to HP-IB or RS-232	50/sec

[1] Specifications are for 1-hour warm-up at 6½ digits, Slow ac filter, sinewave input.
[2] Relative to calibration standards.
[3] 20% overrange on all ranges, except 750 Vac, 3 A range.
[4] Specifications are for sinewave input >5% of range. For inputs from 1% to 5% of range and <50 kHz, add 0.1% of range additional error. For 50 kHz to 100 kHz, add 0.13% of range.
[5] 750 Vac range limited to 100 kHz or $8x10^7$ Volt-Hz.
[6] Typically 30% of reading error at 1 MHz.
[7] For frequencies below 100 Hz, slow AC filter specified for sinewave input only.
[8] For 1 kΩ unbalance in LO lead.
[9] Maximum reading rates for 0.01% of ac step additional error. Additional settling delay required when input dc level varies.
[10] For External Trigger or remote operation using default settling delay (Delay Auto).
[11] Maximum useful limit with default settling delays defeated.
[12] Speeds are for 4½ digits, Delay 0, Display OFF, and Fast AC filter.

Frequency and Period Characteristics

Accuracy Specifications ± (% of reading) [1]

Function	**Range** [3]	**Frequency**	**24 Hour** [2] **23°C ± 1°C**	**90 Day 23°C ± 5°C**	**1 Year 23°C ± 5°C**	**Temperature Coefficient 0°C – 18°C 28°C – 55°C**
Frequency, Period [4]	100 mV to 750 V	3 Hz – 5 Hz	0.10	0.10	0.10	0.005
		5 Hz – 10 Hz	0.05	0.05	0.05	0.005
		10 Hz – 40 Hz	0.03	0.03	0.03	0.001
		40 Hz – 300 kHz	0.006	0.01	0.01	0.001

Additional Low-Frequency Errors (% of reading) [4]

	Resolution		
Frequency	**6½**	**5½**	**4½**
3 Hz – 5 Hz	0	0.12	0.12
5 Hz – 10 Hz	0	0.17	0.17
10 Hz – 40 Hz	0	0.2	0.2
40 Hz – 100 Hz	0	0.06	0.21
100 Hz – 300 Hz	0	0.03	0.21
300 Hz – 1 kHz	0	0.01	0.07
> 1 kHz	0	0	0.02

Transfer Accuracy (typical)

0.0005% of reading

Conditions:

Within 10 minutes and ± 0.5°C.
Within ±10% of initial value.
Following a 2-hour warm-up.
For inputs > 1 kHz and > 100 mV.
Using 6½ digit slow resolution (1 second gate time).
Measurements are made using accepted metrology practices.

Measuring Characteristics

Frequency and Period

Measurement Method:	Reciprocal-counting technique. AC-coupled input using the ac voltage measurement function.
Voltage Ranges:	100 mV rms full scale to 750 V rms. Auto or manual ranging.
Gate Time:	10 ms, 100 ms, or 1 sec

Settling Considerations
Errors will occur when attempting to measure the frequency or period of an input following a dc offset voltage change. The input blocking RC time constant must be allowed to fully settle (up to 1 sec) before the most accurate measurements are possible.

Measurement Considerations
All frequency counters are susceptible to error when measuring low-voltage, low-frequency signals. Shielding inputs from external noise pickup is critical for minimizing measurement errors.

Operating Characteristics [5]

Function	Digits	Reading/s
Frequency, Period	6½	1
	5½	9.8
	4½	80

System Speeds [5]

Configuration Rates	14/sec
Autorange Time	<0.6 sec
ASCII readings to RS-232	55/sec
ASCII readings to HP-IB	80/sec
Max. Internal Trigger Rate	80/sec
Max. External Trigger Rate to Memory	80/sec
Max. External Trigger Rate to HP-IB or RS-232	80/sec

[1] Specifications are for 1-hour warm-up at 6½ digits.
[2] Relative to calibration standards.
[3] 20% overrange on all ranges, except 750 Vac range.
[4] Input > 100 mV.
For 10 mV input, multiply % of reading error x10.
[5] Speeds are for 4½ digits, Delay 0, Display OFF, and Fast AC filter.

General Information

General Specifications

Power Supply:	100 V / 120 V / 220 V / 240 V ±10%.
Power Line Frequency:	45 Hz to 66 Hz and 360 Hz to 400 Hz. Automatically sensed at power-on.
Power Consumption:	25 VA peak (10 W average)
Operating Environment:	Full accuracy for 0°C to 55°C Full accuracy to 80% R.H. at 30°C
Storage Environment:	– 40°C to 70°C
Rack Dimensions (HxWxD):	88.5 mm x 212.6 mm x 348.3 mm
Weight:	3.6 kg (8 lbs)
Safety:	Designed to CSA, UL-1244, IEC-1010
EMI:	MIL-461C, FTZ 1046, FCC
Vibration and Shock:	MIL-T-28800E Type III, Class 5
Warranty:	3 years standard

Accessories Included

Test Lead Kit with probes, alligator, and grabber attachments.
User's Guide, Service Guide, test report, and power cord.

Triggering and Memory

Reading HOLD Sensitivity:	0.01%, 0.1%, 1%, or 10% of reading
Samples per Trigger:	1 to 50,000
Trigger Delay:	0 to 3600 sec (10 μs step size)
External Trigger Delay:	< 1 ms
External Trigger Jitter:	< 500 μs
Memory:	512 readings

Math Functions

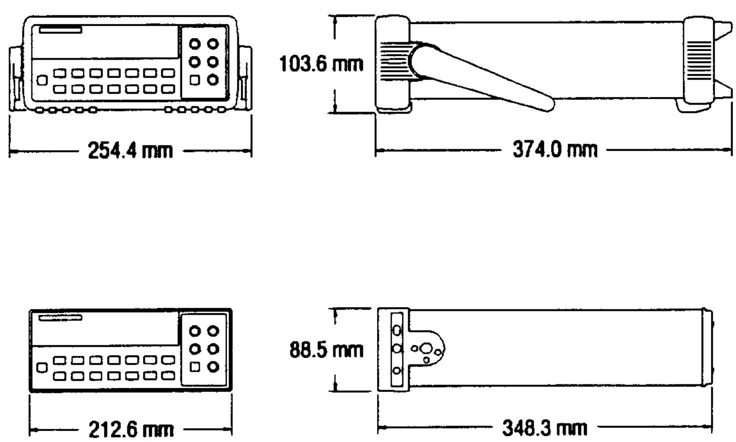
Null, Min/Max/Average, dB, dBm, Limit Test (with TTL output).
dBm reference resistances: 50, 75, 93, 110, 124, 125, 135, 150, 250, 300, 500, **600**, 800, 900, 1000, 1200, or 8000 ohms.

Standard Programming Languages

SCPI (Standard Commands for Programmable Instruments)
HP 3478A Language Emulation
Fluke 8840A, Fluke 8842A Language Emulation

Remote Interface

HP-IB (IEEE-488.1, IEEE-488.2) and RS-232C



To Calculate Total Measurement Error

Each specification includes correction factors which account for errors present due to operational limitations of the multimeter. This section explains these errors and shows how to apply them to your measurements. Refer to "Interpreting Multimeter Specifications," later in this chapter to get a better understanding of the terminology used and to help you interpret the multimeter's specifications.

The multimeter's accuracy specifications are expressed in the form: (*% of reading + % of range*). In addition to the reading error and range error, you may need to add additional errors for certain operating conditions. Check the list below to make sure you include *all* measurement errors for a given function. Also, make sure you apply the conditions as described in the footnotes on the specification pages.

- If you are operating the multimeter outside the 23°C±5°C temperature range specified, apply an additional *temperature coefficient error*.
- For dc voltage, dc current, and resistance measurements, you may need to apply an additional *reading speed error* or *autozero OFF error*.
- For ac voltage and ac current measurements, you may need to apply an additional *low frequency error* or *crest factor error*.

Understanding the "% of reading" Error The *reading error* compensates for inaccuracies that result from the function and range you select, as well as the input signal level. The reading error varies according to the input level on the selected range. This error is expressed in percent of reading. The following table shows the reading error applied to the multimeter's 24-hour dc voltage specification.

Range	Input Level	Reading Error (% of reading)	Reading Error Voltage
10 Vdc	10 Vdc	0.0015	≤150 μV
10 Vdc	1 Vdc	0.0015	≤15 μV
10 Vdc	0.1 Vdc	0.0015	≤1.5 μV

Understanding the "% of range" Error The *range error* compensates for inaccuracies that result from the function and range you select. The range error contributes a constant error, expressed as a percent of range, *independent* of the input signal level. The following table shows the range error applied to the multimeter's 24-hour dc voltage specification.

Range	Input Level	Range Error (% of range)	Range Error Voltage
10 Vdc	10 Vdc	0.0004	$\leq 40\,\mu V$
10 Vdc	1 Vdc	0.0004	$\leq 40\,\mu V$
10 Vdc	0.1 Vdc	0.0004	$\leq 40\,\mu V$

Total Measurement Error To compute the total measurement error, add the reading error and range error. You can then convert the total measurement error to a "percent of input" error or a "ppm (part-per-million) of input" error as shown below.

$$\textit{\% of input error} = \frac{\text{Total Measurement Error}}{\text{Input Signal Level}} \times 100$$

$$\textit{ppm of input error} = \frac{\text{Total Measurement Error}}{\text{Input Signal Level}} \times 1{,}000{,}000$$

Error Example

Assume that a 5 Vdc signal is input to the multimeter on the 10 Vdc range. Compute the total measurement error using the 90-day accuracy specifications: ±(0.0020% of reading + 0.0005% of range).

Reading error	$= 0.0020\% \times 5\,\text{Vdc}$	$= 100\,\mu V$
Range error	$= 0.0005\% \times 10\,\text{Vdc}$	$= 50\,\mu V$
Total error	$= 100\,\mu V + 50\,\mu V$	$= \pm 150\,\mu V$
		$= \pm$ 0.0030% of 5 Vdc
		$= \pm$ 30 ppm of 5 Vdc

Interpreting Multimeter Specifications

This section is provided to give you a better understanding of the terminology used and will help you interpret the multimeter's specifications.

Number of Digits and Overrange

The "number of digits" specification is the most fundamental, and sometimes, the most confusing characteristic of a multimeter. The number of digits is equal to the maximum number of "9's" the multimeter can measure or display. This indicates the number of *full digits*. Most multimeters have the ability to overrange and add a partial or "½" digit.

For example, the HP 34401A can measure 9.99999 Vdc on the 10 V range. This represents six full digits of resolution. The multimeter can also overrange on the 10 V range and measure up to a maximum of 12.00000 Vdc. This corresponds to a 6½-digit measurement with 20% overrange capability.

Sensitivity

Sensitivity is the minimum level that the multimeter can detect for a given measurement. Sensitivity defines the ability of the multimeter to respond to small changes in the input level. For example, suppose you are monitoring a 1 mVdc signal and you want to adjust the level to within $\pm 1\,\mu V$. To be able to respond to an adjustment this small, this measurement would require a multimeter with a sensitivity of at least 1 μV. You could use a 6½-digit multimeter *if* it has a 1 Vdc or smaller range. You could also use a 4½-digit multimeter with a 10 mVdc range.

For ac voltage and ac current measurements, note that the smallest value that can be measured is different from the sensitivity. For the HP 34401A, these functions are specified to measure down to 1% of the selected range. For example, the multimeter can measure down to 1 mV on the 100 mV range.

Resolution

Resolution is the numeric ratio of the maximum displayed value divided by the minimum displayed value on a selected range. Resolution is often expressed in percent, parts-per-million (ppm), counts, or bits. For example, a 6½-digit multimeter with 20% overrange capability can display a measurement with up to 1,200,000 counts of resolution. This corresponds to about 0.0001% (1 ppm) of full scale, or 21 bits including the sign bit. All four specifications are equivalent.

Accuracy

Accuracy is a measure of the "exactness" to which the multimeter's measurement uncertainty can be determined *relative to* the calibration reference used. Absolute accuracy includes the multimeter's relative accuracy specification plus the known error of the calibration reference relative to national standards (such as the U.S. National Institute of Standards and Technology). To be meaningful, the accuracy specifications must be accompanied with the conditions under which they are valid. These conditions should include temperature, humidity, and time.

There is no standard convention among multimeter manufacturers for the confidence limits at which specifications are set. The table below shows the probability of non-conformance for *each specification* with the given assumptions.

Specification Criteria	Probability of Failure
Mean ± 2 sigma	4.5%
Mean ± 3 sigma	0.3%
Mean ± 4 sigma	0.006%

Variations in performance from reading to reading, and instrument to instrument, decrease for increasing number of sigma for a given specification. This means that you can achieve greater actual measurement precision for a specific accuracy specification number. The HP 34401A is designed and tested to meet performance better than mean ± 4 sigma of the published accuracy specifications.

Transfer Accuracy

Transfer accuracy refers to the error introduced by the multimeter due to noise and short-term drift. This error becomes apparent when comparing two nearly-equal signals for the purpose of "transferring" the known accuracy of one device to the other.

24-Hour Accuracy

The 24-hour accuracy specification indicates the multimeter's relative accuracy over its full measurement range for short time intervals and within a stable environment. Short-term accuracy is usually specified for a 24-hour period and for a ±1°C temperature range.

90-Day and 1-Year Accuracy

These long-term accuracy specifications are valid for a 23°C ± 5°C temperature range. These specifications include the initial calibration errors plus the multimeter's long-term drift errors.

Temperature Coefficients

Accuracy is usually specified for a 23°C ± 5°C temperature range. This is a common temperature range for many operating environments. You must add additional temperature coefficient errors to the accuracy specification if you are operating the multimeter outside a 23°C ± 5°C temperature range.

Configuring for Highest Accuracy Measurements

The measurement configurations shown below assume that the multimeter is in its power-on or reset state. It is also assumed that manual ranging is enabled to ensure proper full scale range selection.

DC Voltage, DC Current, and Resistance Measurements:

- Set the resolution to 6 digits (you can use the 6 digit slow mode for further noise reduction).
- Set the input resistance to greater than 10 GΩ, for the 100 mV, 1 V, and 10 V ranges, for the best dc voltage accuracy.
- Use 4-wire ohms for the best resistance accuracy.
- Use Math Null to null the test lead resistance for 2-wire ohms, and to remove interconnection offset for dc voltage measurements.

AC Voltage, AC Current Measurements:

- Set the resolution to 6 digits.
- Select the slow ac filter (3 Hz to 300 kHz).

Frequency and Period Measurements:

- Set the resolution to 6 digits.

Quick Start

Quick Start

One of the first things you will want to do with your multimeter is to become acquainted with its front panel. We have written the exercises in this chapter to prepare the multimeter for use and help you get familiar with some of its front-panel operations.

The front panel has two rows of keys to select various functions and operations. Most keys have a *shifted* function printed in *blue* above the key. To perform a shifted function, press `Shift` (the **Shift** annunciator will turn on). Then, press the key that has the desired label above it. For example, to select the dc current function, press `Shift` `DC V` .

If you accidentally press `Shift` , just press it again to turn off the **Shift** annunciator.

> *The rear cover of this book is a fold-out Quick Reference Guide. On this cover you will find a quick summary of various multimeter features.*

To prepare the multimeter for use

The following steps help you verify that the multimeter is ready for use.

1 **Check the list of supplied items.**

Verify that you have received the following items with your multimeter. If anything is missing, contact your nearest Hewlett-Packard Sales Office.

- ☐ One test lead kit.
- ☐ One power cord.
- ☐ One power-line fuse is installed: *250 mA for 100, 120 Vac.*
- ☐ One power-line fuse is shipped separately: *125 mA for 220, 240 Vac.*
- ☐ One *User's Guide.*
- ☑ This *Service Guide.*

2 **Verify that the correct power-line fuse is installed.**

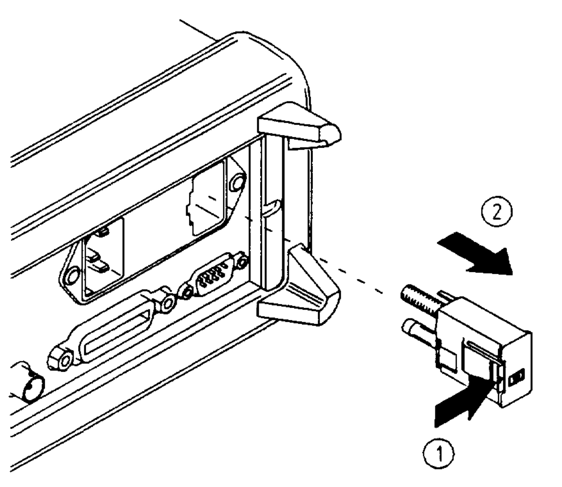
For 100 or 120 Vac operation, the correct fuse (250 mAT) is *already installed* when the multimeter is shipped from the factory.

For 220 or 240 Vac operation, *remove the 250 mAT fuse* and replace it with the 125 mAT fuse also included with the multimeter.

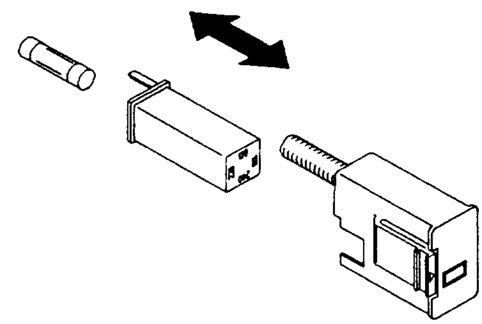
3 **Verify the power-line voltage setting.**

The line voltage is set to *120 Vac* when the multimeter is shipped from the factory. Change the voltage setting if it is not correct for your location. The settings are: *100, 120, 220,* or *240 Vac.*

1 Remove the fuse-holder assembly from the rear panel.

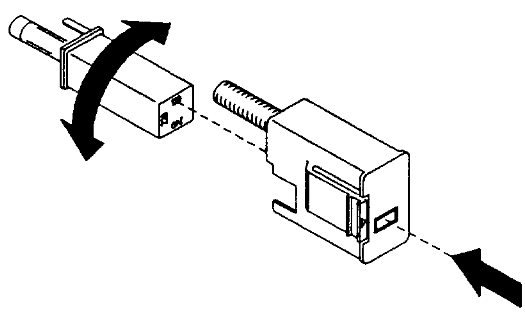


2 *Install the correct fuse.* Remove the line-voltage selector from the assembly.



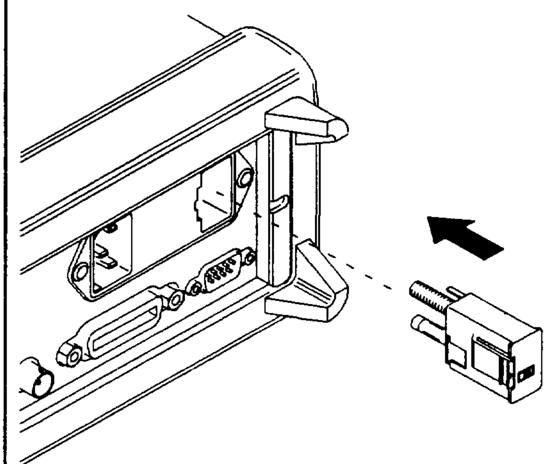
100 or 120 Vac: 250 mAT fuse
220 or 240 Vac: 125 mAT fuse

3 Rotate the line-voltage selector until the correct voltage appears in the window.



100, 120, 220 or 240 Vac

4 Replace the fuse-holder assembly in the rear panel.



Install the correct fuse and verify that the correct line voltage appears in the window.

To turn on the multimeter

The following steps show you how to turn on the multimeter and verify that it is operating properly.

1 **Connect the power cord and turn on the multimeter.**

The front-panel display will light up while the multimeter performs its power-on self-test. The HP-IB bus address is displayed. Notice that the multimeter powers up in the *dc voltage* function with autoranging enabled.

To review the power-on display with all annunciators turned on, hold down `Shift` *as you turn on the multimeter.*

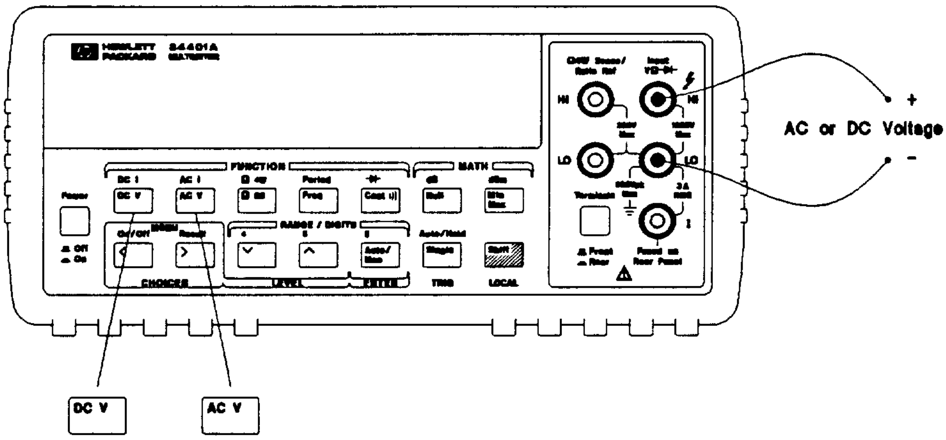
2 **Perform a *complete* self test.**

The *complete* self-test performs a more extensive series of tests than those performed at power-on. Hold down `Shift` as you press the Power switch to turn on the multimeter; *hold down the key for more than 5 seconds*. The self-test will begin when you release the key.

If the self-test is successful, "PASS" is displayed. If the self-test is not successful, "FAIL" is displayed and the **ERROR** annunciator turns on. See chapter 6, "Service," for instructions on returning the multimeter to Hewlett-Packard for service.

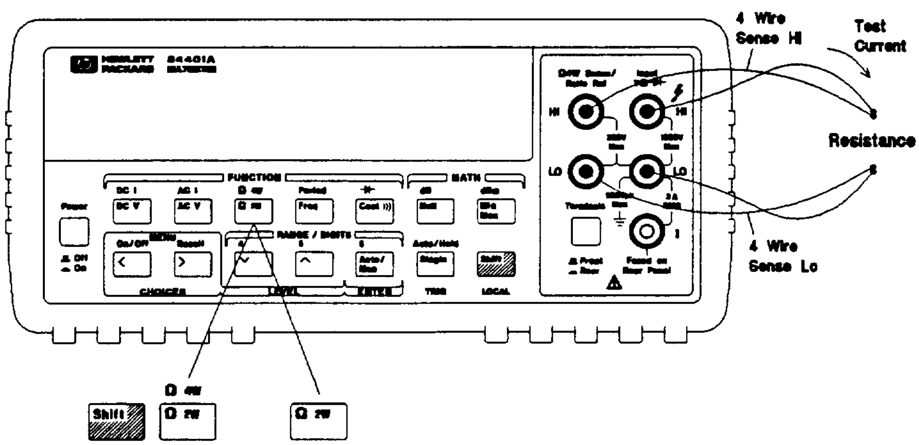
To measure voltage

Ranges: 100 mV, 1 V, 10 V, 100 V, 1000 V (750 Vac)
Maximum resolution: 100 nV *(on 100 mV range)*
AC technique: true RMS, ac-coupled



To measure resistance

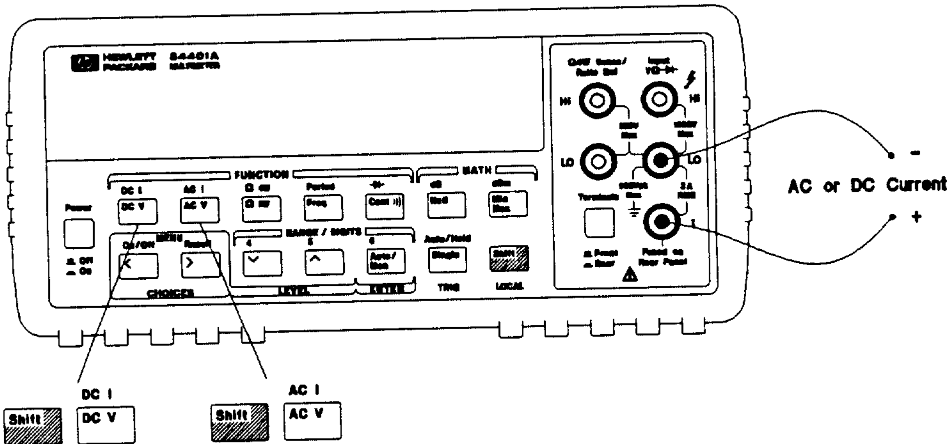
Ranges: 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ, 10 MΩ, 100 MΩ
Maximum resolution: 100 $\mu\Omega$ *(on 100 ohm range)*



2

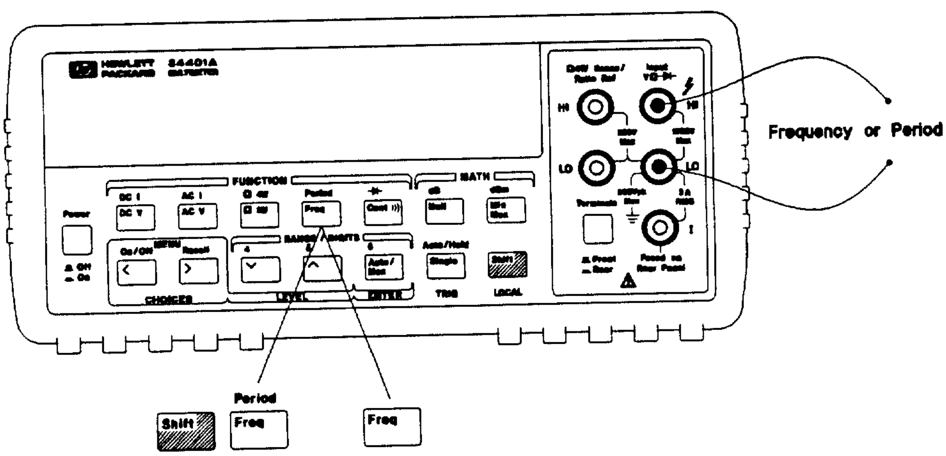
To measure current

Ranges: 10 mA (dc only), 100 mA (dc only), 1 A, 3 A
Maximum resolution: 10 nA *(on 10 mA range)*
AC technique: true RMS, ac-coupled



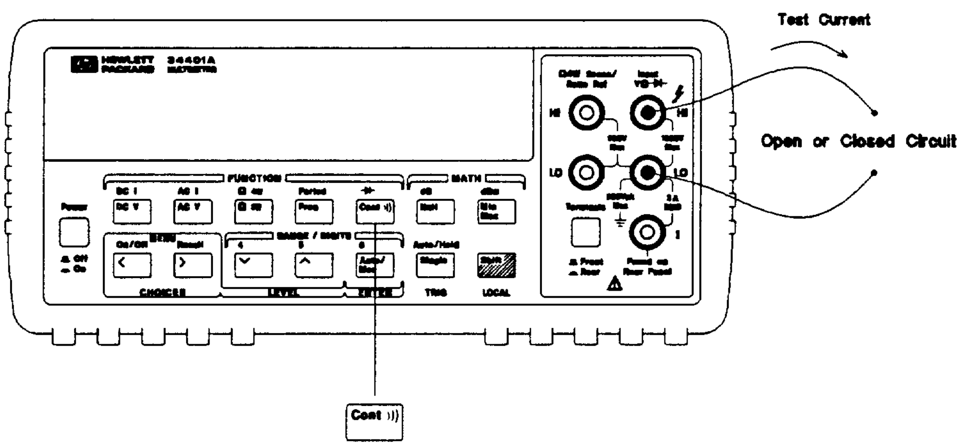
To measure frequency (or period)

Measurement band: 3 Hz to 300 kHz (0.33 sec to 3.3 μsec)
Input signal range: 100 mVac to 750 Vac
Technique: reciprocal counting



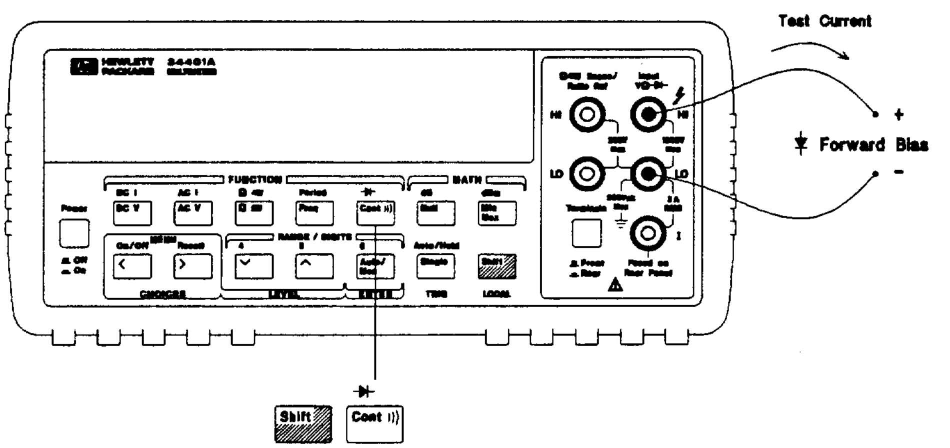
To test continuity

Test current source: 1 mA
Maximum resolution: 0.1 Ω *(range is fixed at 1 kohm)*
Beeper threshold: 1 Ω to 1000 Ω *(beeps below adjustable threshold)*



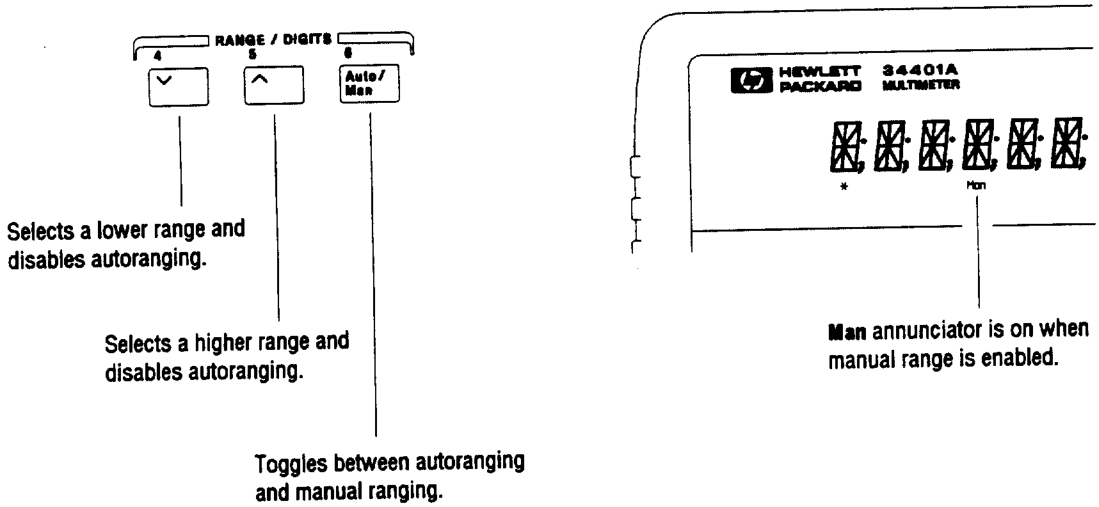
To check diodes

Test current source: 1 mA
Maximum resolution: 100 μV *(range is fixed at 1 Vdc)*
Beeper threshold: 0.3 volts $\leq V_{measured} \leq$ 0.8 volts *(not adjustable)*



To select a range

You can let the multimeter automatically select the range using *autoranging* or you can select a fixed range using *manual ranging*.

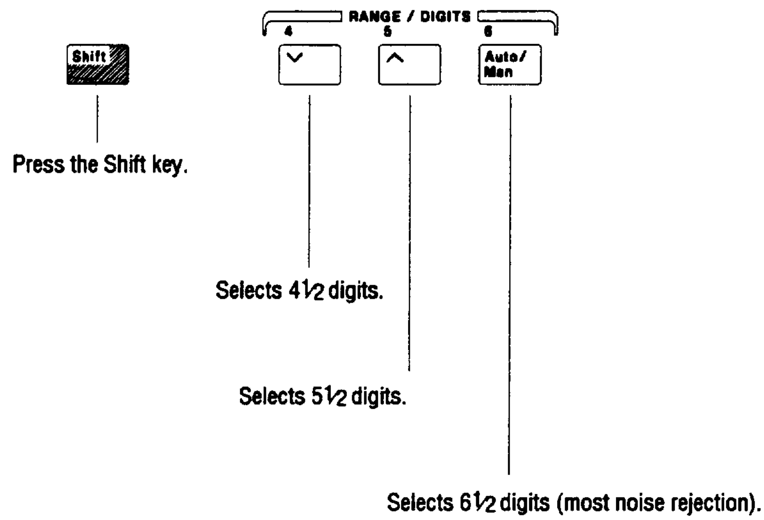


- Autoranging is selected at power-on and after a remote interface reset.
- Autorange thresholds:
  Down range at <10% of range
  Up range at >120% of range
- If the input signal is greater than the present range can measure, the multimeter will give an *overload* indication ("OVLD").
- For frequency and period measurements from the front panel, ranging applies to the signal's input *voltage*, not its frequency.
- The range is fixed for continuity (1 kΩ range) and diode (1 Vdc range).

Ranging is local to the selected function from the front panel. This means that you can select the ranging method (auto or manual) for each function independently. When manually ranging, the selected range is local to the function; the multimeter remembers the range when you switch between functions.

To set the resolution

You can set the display resolution to 4½, 5½, or 6½ digits either to optimize measurement speed or noise rejection. In this book, the most significant digit (leftmost on the display) is referred to as the "½" digit, since it can only be a "0" or "1."



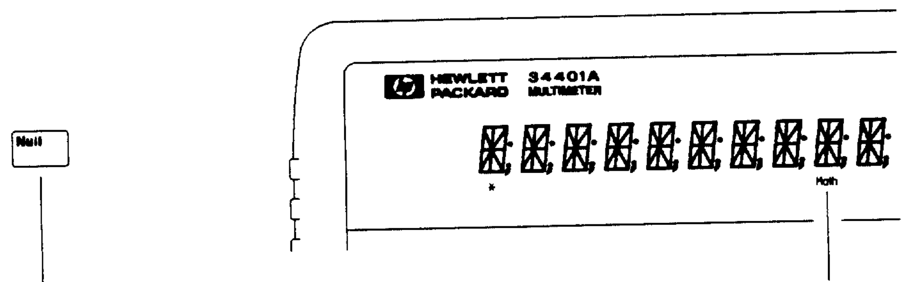
- The resolution is set to 5½ digits at power-on and after a remote interface reset.
- The resolution is fixed at 4½ digits for continuity and diode tests.

Resolution is local to the selected function from the front panel. This means that you can select the resolution for each function independently. The multimeter remembers the resolution when you switch between functions.

To make null (relative) measurements

Each null measurement, also called *relative,* is the difference between a stored null value and the input signal.

***Result** = reading – null value*

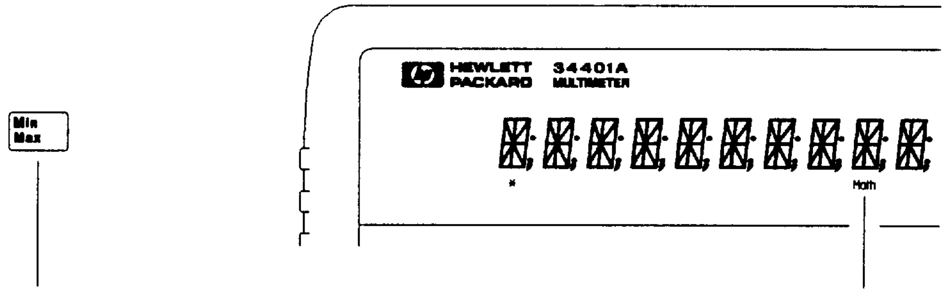


- You can make null measurements with any function except continuity or diode test. The null operation is local to the selected function; when you change functions, null is disabled.
- To null the test lead resistance for more accurate two-wire ohms measurements, short the ends of the test leads together and then press `Null`.
- The first reading taken after you press `Null` is stored as the null value in the Null Register. Any previously stored value is replaced with the new value.
- After enabling null, you can edit the stored null value by pressing `Shift` `>` (Menu Recall). This takes you to the "NULL VALUE" command in the MATH MENU (*only if null is enabled*). Go down to the "parameter" level, and then edit the displayed value.
- The null register is cleared when you change functions, turn null off, turn off the power, or perform a remote interface reset.

To store minimum and maximum readings

You can store the minimum and maximum readings during a series of measurements. The following discussion shows how to read the minimum, maximum, average, and reading count.

To read the minimum, maximum, average, and count, use the MATH menu.



Enables min-max operation;
Press again to disable.

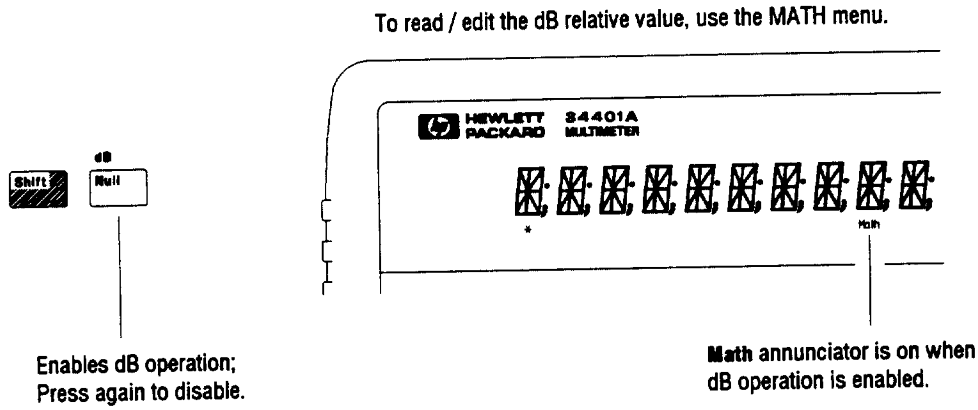
Math annunciator is on when min-max operation is enabled.

- You can use min-max with any function except continuity or diode test. The min-max operation is local to the selected function; when you change functions, min-max is disabled.
- After enabling min-max, you can read the stored minimum, maximum, average, and count by pressing `Shift` `>` (Menu Recall). This takes you to the "MIN–MAX" command in the MATH MENU (*only if min-max is enabled*). Go down to the "parameter" level, and then read the values by pressing `<` or `>`.
- The stored values are cleared when you turn min-max off, turn off the power, or perform a remote interface reset.
- The average is of all readings taken since min-max was enabled (not just the average of the stored minimum and maximum). The count is the total number of readings taken since min-max was enabled.

To make dB measurements

Each dB measurement is the difference between the input signal and a stored relative value, with both values converted to dBm.

dB = reading in dBm – dB relative value

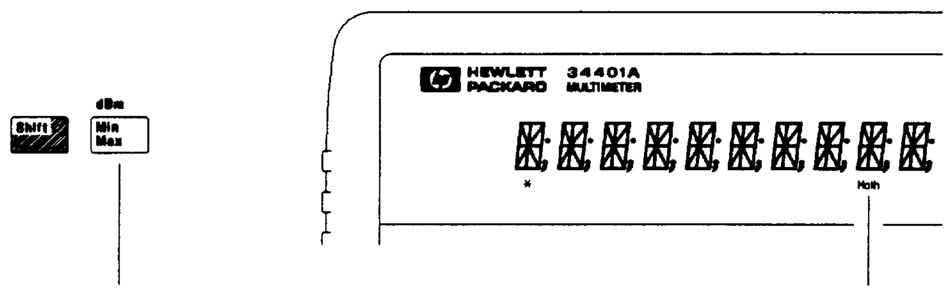


- Select `DC V` or `AC V` .
- The first reading taken after you enable dB measurements is converted to dBm and is stored as the relative value in the dB Relative Register. Any previously stored value is replaced with the new value.
- After enabling dB operations, you can edit the relative value by pressing `Shift` `>` (Menu Recall). This takes you to the "dB REL" command in the MATH MENU (*only if dB is enabled*). Go down to the "parameter" level, and then edit the value displayed.
- The register is cleared when you change functions, turn dB off, turn off the power, or perform a remote interface reset.

To make dBm measurements

The dBm operation calculates the power delivered to a resistance referenced to 1 milliwatt.

$$dBm = 10 \times \text{Log}_{10}\,(\,reading^2\ /\,reference\ resistance\ /\,1\ \text{mW}\,)$$

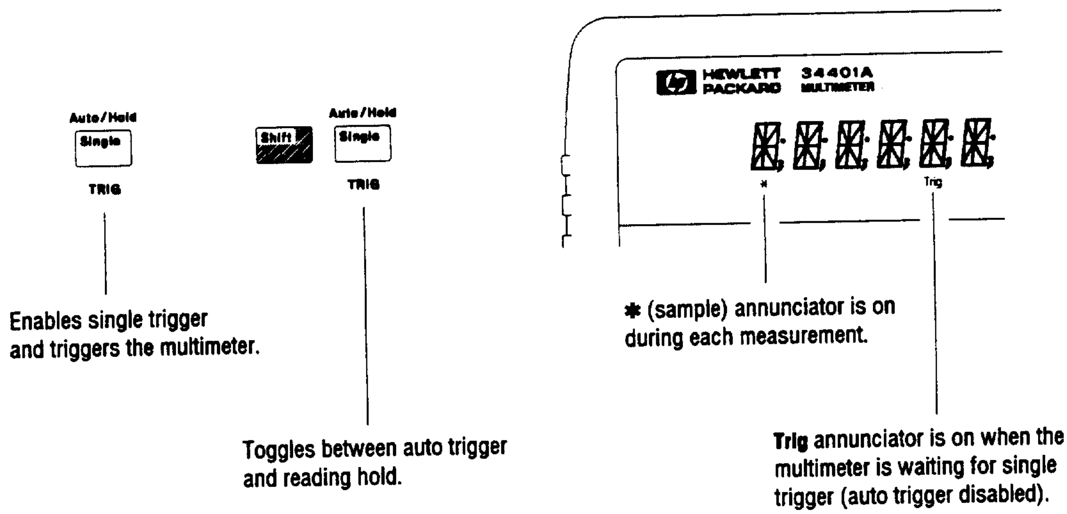


- Select [DC V] or [AC V].
- The factory setting for the reference resistance is 600 Ω. To select a different value, press [Shift] [>] (Menu Recall) after enabling dBm operations. This takes you to the "dBm REF R" command in the MATH MENU *(only if dBm is enabled)*.

  Go down to the "parameter" level, and then select a value: *50, 75, 93, 110, 124, 125, 135, 150, 250, 300, 500,* ***600****, 800, 900, 1000, 1200, or 8000 ohms.*
- The reference resistance is stored in *non-volatile* memory and *does not* change when power has been off or after a remote interface reset.

To trigger the multimeter

You can trigger the multimeter from the front panel using *single trigger* or *auto trigger*.



- Auto triggering is enabled when you turn on the multimeter. Notice that the ✱ (sample) annunciator turns on during each measurement.
- Single triggering takes one reading each time you press `Single` and then waits for the next trigger. Continue pressing this key to trigger the multimeter.

Using an External Trigger

The external trigger mode is also enabled by pressing `Single`. It is like the single trigger mode except that you apply a trigger pulse to the rear-panel *Ext Trig* terminal. The multimeter is triggered on the negative edge of a TTL pulse.

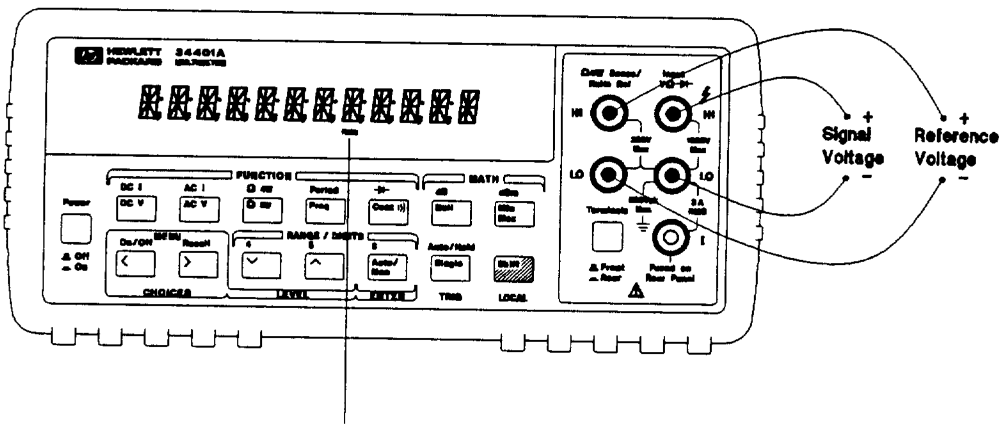
The front-panel `Single` key is disabled when in remote.

To make dcv:dcv ratio measurements

To calculate a ratio, the multimeter measures a dc reference voltage applied to the **Sense** terminals and the voltage applied to the **Input** terminals.

$$Ratio = \frac{dc\ signal\ voltage}{dc\ reference\ voltage}$$

To enable ratio measurements, use the MEAS menu.



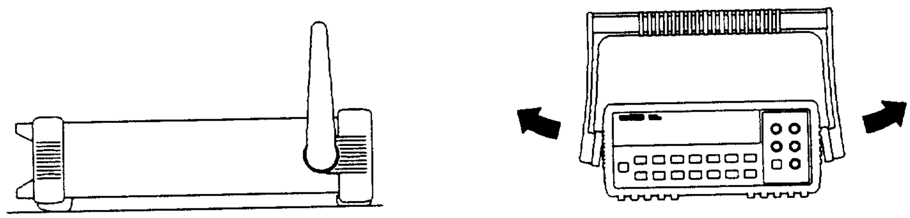
Ratio annunciator is on when ratio measurements are enabled.

- At the **Sense** terminals, the reference voltage measurement function is always *dc voltage* and has a maximum measurable input of ±12 Vdc. Autoranging is automatically selected for reference voltage measurements on the **Sense** terminals.
- The **Input LO** and **Sense LO** terminal must have a common reference and cannot have a voltage difference greater than ±2 volts.
- The specified measurement range applies *only* to the signal connected to the **Input** terminals. The signal on the **Input** terminals can be any dc voltage up to 1000 volts.

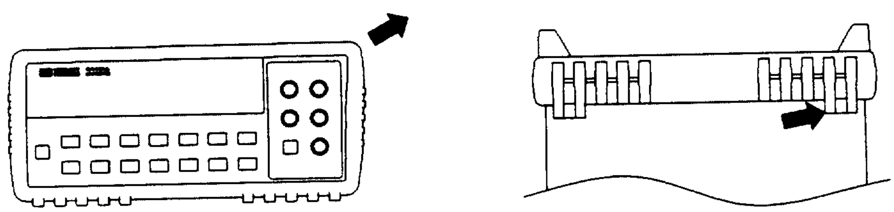
To rack mount the multimeter

You can mount the multimeter in a standard 19-inch rack cabinet using one of three optional kits available. Instructions and mounting hardware are included with each rack-mounting kit. Any *HP System II* instrument can be rack-mounted beside the HP 34401A Multimeter.

Remove the carrying handle and the front and rear rubber bumpers before rack-mounting the multimeter.



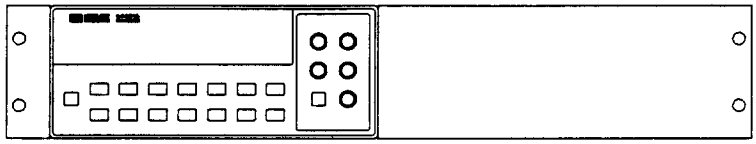
To remove the handle, rotate it to the vertical position and pull the ends outward.



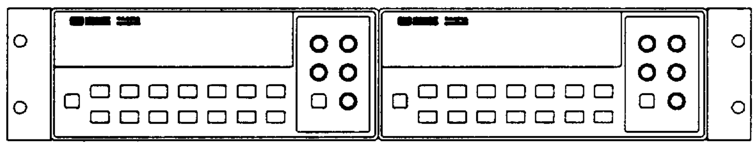
Front

Rear (bottom view)

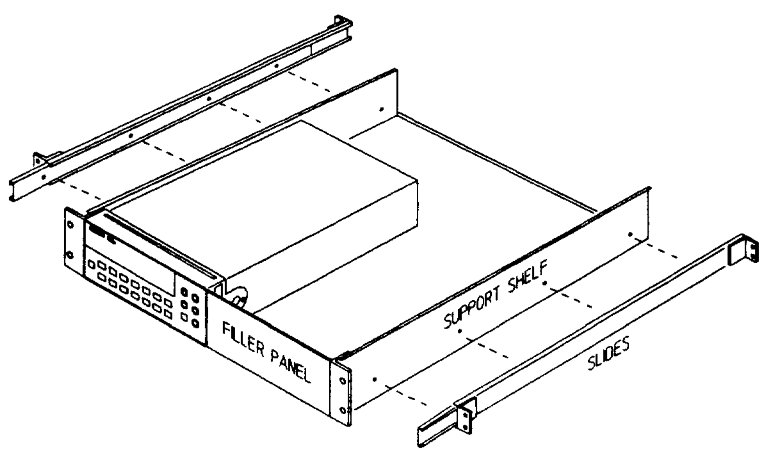
To remove the rubber bumper, stretch a corner and then slide it off.



To rack mount a single instrument, order adapter kit 5062-3972.



To rack mount two instruments side-by-side, order lock-link kit 5062-3994 and flange kit 5062-3974.



To install one or two instruments in a sliding support shelf, order shelf 5062-3996, and slide kit 1494-0015 (for a single instrument, also order filler panel 5062-4022).

3

Menu Tutorial

Menu Tutorial

By now you should be familiar with the FUNCTION and RANGE / DIGITS groups of front-panel keys. You should also understand how to make front-panel connections for the various types of measurements. If you are not familiar with this information, we recommend that you read chapter 2, "Quick Start."

This chapter introduces you to the front panel menu. It describes each menu and takes you step-by-step through calibration examples.

Front-panel menu reference

A: MEASurement MENU

1: AC FILTER ➡ 2: CONTINUITY ➡ 3: INPUT R ➡ 4: RATIO FUNC ➡ 5: RESOLUTION

1: AC FILTER	Selects the slow, medium, or fast ac filter.
2: CONTINUITY	Sets the continuity beeper threshold (1Ω to 1000Ω).
3: INPUT R	Sets the input resistance for dc voltage measurements.
4: RATIO FUNC	Enables the dcv:dcv ratio function.
5: RESOLUTION	Selects the measurement resolution.

B: MATH MENU

1: MIN–MAX ➡ 2: NULL VALUE ➡ 3: dB REL ➡ 4: dBm REF R ➡ 5: LIMIT TEST ➡ 6: HIGH LIMIT ➡ 7: LOW LIMIT

1: MIN-MAX	Recalls the stored minimum, maximum, average, and reading count.
2: NULL VALUE	Recalls or sets the null value stored in the null register.
3: dB REL	Recalls or sets the dBm value stored in the dB relative register.
4: dBm REF R	Selects the dBm reference resistance value.
5: LIMIT TEST	Enables or disables limit testing.
6: HIGH LIMIT	Sets the upper limit for limit testing.
7: LOW LIMIT	Sets the lower limit for limit testing.

C: TRIGger MENU

1: READ HOLD ➡ 2: TRIG DELAY ➡ 3: N SAMPLES

1: READ HOLD	Sets the reading hold sensitivity band.
2: TRIG DELAY	Specifies a time interval which is inserted before a measurement.
3: N SAMPLES	Sets the number of samples per trigger.

Continued on next page ➡

D: SYStem MENU

1: RDGS STORE ➡ 2: SAVED RDGS ➡ 3: ERROR ➡ 4: TEST ➡ 5: DISPLAY ➡ 6: BEEP ➡ 7: COMMA ➡ 8: REVISION

1: RDGS STORE	Enables or disables reading memory.
2: SAVED RDGS	Recalls readings stored in memory (up to 512 readings).
3: ERROR	Retrieves errors from the error queue (up to 10 errors).
4: TEST	Performs a complete self-test.
5: DISPLAY	Enables or disables the front-panel display.
6: BEEP	Enables or disables the beeper function.
7: COMMA	Enables or disables a comma separator between digits on the display.
8: REVISION	Displays the multimeter's firmware revision codes.

E: Input / Output MENU

1: HP-IB ADDR ➡ 2: INTERFACE ➡ 3: BAUD RATE ➡ 4: PARITY ➡ 5: LANGUAGE

1: HP-IB ADDR	Sets the HP-IB bus address (0 to 31).
2: INTERFACE	Selects the HP-IB or RS-232 interface.
3: BAUD RATE	Selects the baud rate for RS-232 operation.
4: PARITY	Selects even, odd, or no parity for RS-232 operation.
5: LANGUAGE	Selects the interface language: SCPI, HP 3478, or Fluke 8840/42.

F: CALibration MENU

1: SECURED ➡ [1: UNSECURED] ➡ [2: CALIBRATE] ➡ 3: CAL COUNT ➡ 4: MESSAGE

1: SECURED	The multimeter is secured against calibration; enter code to unsecure.
1: UNSECURED	The multimeter is unsecured for calibration; enter code to secure.
2: CALIBRATE	Performs complete calibration of present function; must be UNSECURED.
3: CAL COUNT	Reads the total number of times the multimeter has been calibrated.
4: MESSAGE	Reads the calibration string (up to 12 characters) entered from remote.

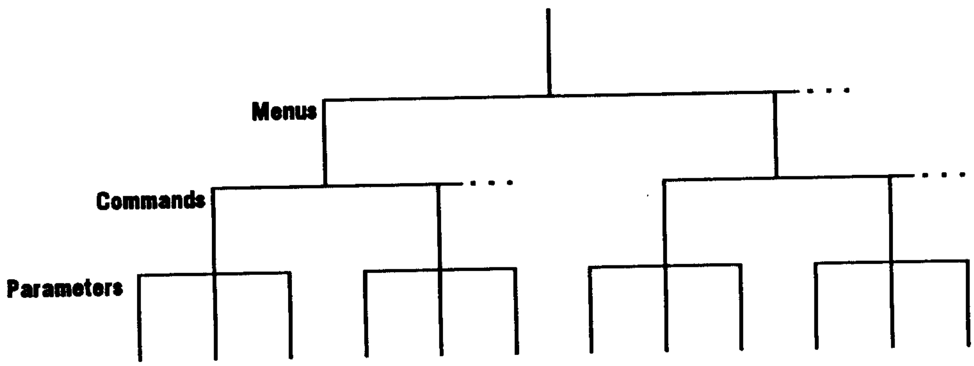
NOTE: The two commands enclosed in square brackets ([ ]) are "hidden" unless the multimeter is UNSECURED for calibration.

3

A front-panel menu tutorial

This section is a step-by-step tutorial which shows how to use the front-panel menu. We recommend that you spend a few minutes with this tutorial to get comfortable with the structure and operation of the menu.

The menu is organized in a top-down tree structure with three levels (menus, commands, and parameters). You move down [v] or up [∧] the menu tree to get from one *level* to the next. Each of the three levels has several horizontal *choices* which you can view by moving left [<] or right [>].



- To *turn on* the menu, press [Shift] [<] (On/Off).
- To *turn off* the menu, press [Shift] [<] (On/Off), or press any of the function or math keys on the top row of front-panel keys.
- To *execute* a menu command, press [Auto/Man] (ENTER).

> *If you become confused or get lost at any point during the tutorial, simply turn off the menu and start over again with step 1 for that example.*

Messages Displayed During Menu Use

TOP OF MENU You pressed [^] while on the "menus" level; this is the top level of the menu and you cannot go any higher.

To turn off the menu, press [Shift] [<] (Menu On/Off). To move across the choices on a level, press [<] or [>]. To move down a level, press [v].

MENUS You are on the "menus" level. Press [<] or [>] to view the choices.

COMMANDS You are on the "commands" level. Press [<] or [>] to view the command choices within the selected menu group.

PARAMETER You are on the "parameter" level. Press [<] or [>] to view and edit the parameter for the selected command.

MENU BOTTOM You pressed [v] while on the "parameter" level; this is the bottom level of the menu and you cannot go any lower.

To turn off the menu, press [Shift] [<] (Menu On/Off). To move up a level, press [^].

CHANGE SAVED The change made on the "parameter" level is saved. This is displayed after you press [Auto/Man] (Menu Enter) to execute the command.

MIN VALUE The value you specified on the "parameter" level is too small for the selected command. The minimum value allowed is displayed for you to edit.

MAX VALUE The value you specified on the "parameter" level is too large for the selected command. The maximum value allowed is displayed for you to edit.

EXITING MENU You will see this message if you turn off the menu by pressing [Shift] [<] (Menu On/Off) or a front-panel function/math key. You did not edit any values on the "parameter" level and changes were NOT saved.

NOT ENTERED You will see this message if you turn off the menu by pressing [Shift] [<] (Menu On/Off) or a front-panel function/math key. You did some editing of parameters but the changes were NOT saved. Press [Auto/Man] (Menu Enter) to save changes made on the "parameter" level.

NOT RELEVANT The selected math operation is NOT valid for the function in use.

Menu Example 1

The following steps show you how to turn on the menu, move up or down between levels, move across the choices on each level, and turn off the menu. In this example you will unsecure the multimeter for calibration.

On/Off
[Shift] [<]

1 **Turn on the menu.**

You enter the menu on the "menus" level. The MEAS MENU is your first choice on this level.

```
A: MEAS MENU
```

[>] [>] [>]
[>] [>]

2 **Move across to the CAL MENU choice on this level.**

There are six menu group choices available on the "menus" level. Each choice has a letter prefix for easy identification (A: , B: , etc.).

```
F: CAL MENU
```

[v]

3 **Move down to the "commands" level within the CAL MENU.**

Either SECURED or UNSECURED is the first command on this level. If SECURED is displayed you must unsecure the multimeter so that calibrations can be performed.

```
1: SECURED
```

Continued on next page ➡

[v]

4 Move down to the "parameters" level.

The multimeter will wait for the security code to be entered.

```
^ 000000    CODE
```

[0] [3] [4]
[4] [0] [1]

[Auto/Man]
ENTER

5 Unsecure the multimeter by entering the security code.

The multimeter is shipped from the factory with a security code of "HP034401". Use the left/right arrows (< >) to advance digits and the up/down arrows (∧ ∨) to increment numbers.

If you have not changed the security code, you can enter the numeric numbers (034401) from the front panel to unsecure the multimeter for calibration. (Only the numeric numbers are used when entering from the front panel.)

```
^ 034401  CODE
```

> *HP recommends that you use a unique SECURE code for each multimeter to obtain the maximum benefit from the electronic calibration security features of the HP 34401A.*
>
> *To secure the multimeter again, return to the parameter level of the UNSECURED command and enter a new security code.*

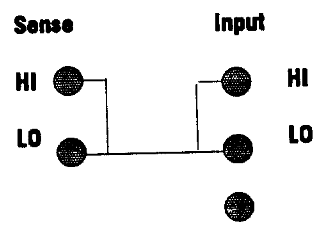
For further information on the electronic security features of the HP 34401A Multimeter, see "Calibration security code" in chapter 4.

Menu Example 2

Some commands in the menu require that you enter a numeric parameter value. The following steps show you how to enter a number in the menu. For this example you need to apply a short between HI-LO Sense and HI-LO Input. This example will set the calibration value to 0.0 volts.

Caution: Completing this example will perform a zero calibration. Refer to chapter 4, "Calibration procedures," before attempting this example.

3



On/Off
[Shift] [<]

1 **Turn on the menu.**

You enter the menu on the "menus" level. The MEAS MENU is your first choice on this level.

```
A: MEAS MENU
```

[>] [>] [>]
[>] [>]

2 **Move across to the CAL MENU choice on this level.**

There are six menu group choices available on the "menus" level. Each choice has a letter prefix for easy identification (A: , B: , etc.).

```
F: CAL MENU
```

Continued on next page ➡

[v]

3 Move down to the "commands" level within the CAL MENU.

Either SECURED or UNSECURED is the first command on this level. To perform a calibration, UNSECURED must be displayed. If SECURED is displayed, see example 1 in this chapter to unsecure for calibration.

```
1: UNSECURED
```

[>]

4 Move across to the CALIBRATE command on the "commands" level.

There are four command choices available in the CAL MENU. Each choice on this level has a number prefix for easy identification (**1:** , **2:** , etc.).

```
2: CALIBRATE
```

[v]

5 Move down to edit the CALIBRATE VALUE parameter.

The calibration value should read 100.000,0 mVDC when you come to this point in the menu for the first time (when set to 100 mV dc V range). For this example, you will set the calibration value to 0.0 volts.

```
∧ 100.000,0  mVDC
```

When you see the flashing "∧" on the left side of the display, you can abort the edit and return to the "commands" level by pressing [∧] .

[>]

6 Move the flashing cursor over to edit the first digit.

Notice that the leftmost digit is flashing.

```
100.000,0  mVDC
```

Continued on next page ➡

[v]

7 Decrement the first digit until "0" is displayed.

You decrement or increment each digit independently. Neighboring digits are not affected.

000.000,0 mVDC

[<] [<]

8 Move the flashing cursor over to the "units" location.

Notice that the units are flashing on the right side of the display.

000.000,0 **mVDC**

[^]

9 Increase the displayed number by a factor of 10.

Notice that the position of the decimal point changes and the displayed number increases by a factor of 10.

0.000,000 **VDC**

[Auto/Man]
ENTER

10 Save the change and turn off the menu.

The multimeter beeps and displays a message to show that the change is now in effect. You are automatically exited from the menu.

The zero offset calibration procedure determines new calibration constants for each function and range. Separate calibration is required for the front and rear terminals.

4

Calibration Procedures

Calibration Procedures

This chapter contains procedures for performing HP 34401A verification and calibration procedures. The chapter contains the following sections:

The performance verification tests use the HP 34401A specifications listed in chapter 1, "Specifications."

Closed-case electronic calibration

The HP 34401A Multimeter features closed-case electronic calibration. There are no internal mechanical adjustments. The multimeter will automatically prompt you for the required full scale input when performing a range calibration. It will then measure the applied input and calculate correction factors based upon the known (user entered) input reference value. The new correction factors will be stored in non-volatile memory for use until the next time a calibration adjustment is performed. (The non-volatile memory does not change when power is turned off or after a remote interface reset.)

Hewlett-Packard calibration services

When your HP 34401A Multimeter is due for calibration, contact your local HP Service Center for a low cost recalibration. The HP 34401A Multimeter is supported on automated calibration systems which allow us to provide this service at competitive prices. Calibrations to MIL-STD-45662 are also available at competitive prices.

Calibration interval

The HP 34401A Multimeter should be calibrated on a regular interval determined by the measurement accuracy requirements of your application. A 90 day interval is recommended for the most demanding applications, while a 1 year or 2 year interval may be adequate for less demanding applications. HP does not recommend extending calibration intervals beyond 2 years in any application.

Whatever calibration interval you select, HP recommends that complete re-adjustment should always be performed at the calibration interval. This will increase your confidence that the HP 34401A will remain in specification for the next calibration interval. This criteria for readjustment provides the best measure of the multimeter's long-term stability. Performance data measured this way can easily be used to extend future calibration intervals.

Calibration time

The HP 34401A Multimeter can be automatically calibrated under computer control. With computer control you can perform the complete calibration procedure and performance verification tests in less than 20 minutes. Manual calibrations using a multifunction calibrator will take approximately 40 minutes.

Automating calibration procedures

The complete verification and adjustment procedures outlined in this chapter may be automated if programmable standards like a multifunction calibrator are available. The configurations specified for each test may be programmed over the remote interface. Readback verification data may be automatically entered into a test program and checked against the appropriate test limit values.

The HP 34401A Multimeter can also be adjusted by the remote interface. Remote adjustment is similar to the local front panel procedure. Adjustments are accomplished by using a computer to setup the multimeter to the required function and range. The calibration value is sent to the multimeter and then the calibration procedure is initiated over the remote interface. The multimeter must be unsecured prior to initiating the calibration procedure.

For further details on how to program the multimeter, see chapters 3 and 4 in the *HP 34401A User's Guide.*

Recommended test equipment

The test equipment recommended for the performance verification and adjustment procedures is listed below. If the exact item is not available, use the accuracy requirements shown to select substitute calibration standards.

Application	Recommended	Accuracy Requirements
Zero Calibration		4-terminal short using ONLY copper interconnections.
DC Voltage	Fluke 5700A	< 1/5 dmm 24 hr. spec +/- 1ppm linearity
DC Current	Fluke 5700A / 5725A	< 1/5 dmm 24 hr spec
Resistance	Fluke 5700A	< 1/5 dmm 24 hr spec
AC Voltage	Fluke 5700A / 5725A	< 1/5 dmm 24 hr spec
AC Current	Fluke 5700A / 5725A	< 1/5 dmm 24 hr spec
Frequency	HP 3325A	< 1/5 dmm 24 hr spec

A suggested alternate method would be to use an HP 3458A 8-1/2 digit Digital Multimeter to measure less accurate yet stable sources. The output value measured from the source can be entered into the HP 34401A Multimeter as the target calibration value.

Test considerations

To ensure proper instrument operation, verify that the correct power line voltage is selected prior to attempting any test procedure in this chapter. See chapter 2, "Quick Start," for more information.

Ensure that all measurement terminal connections (both front panel and rear panel) are removed while the HP 34401A internal self-test is being performed. Errors may be induced by ac signals present on the multimeter's input terminals during a self-test. Long leads can also act as an antenna causing pick-up of ac signals.

For optimum performance, all test procedures should comply with the following recommendations:

- Assure that the calibration ambient temperature is stable and between 18°C and 28°C.
- Assure ambient relative humidity is less than 80%.
- Allow a 2 hour warm-up period before verification or adjustment.
- Use only copper connections to minimize thermal offset voltages.
- Use shielded twisted TEFLON® insulated cable to reduce high resistance errors.
- Keep cables as short as possible.
- Allow 5 minutes after handling input connections for thermal offset voltage settling.

Because the HP 34401A Multimeter is able to make highly accurate measurements, special care *must* be taken to ensure that the calibration standards and test procedures used do not introduce additional errors. Ideally, the standards used to test and calibrate the multimeter should be an order of magnitude more accurate than each multimeter range full scale error specification.

For dc voltage, dc current, and resistance measurements, care should be taken to assure that the calibrator 0 output is correct. If necessary, the multimeter measurements can be referenced to the calibrator's 0 output using the front panel NULL function. This will need to be repeated for each range of the measuring function being verified.

Performance verification tests

You can perform three different levels of performance verification tests:

- **Self-test** - A series of internal verification tests that give a high confidence that the multimeter is operational.
- **Quick verification** - A combination of the internal self-tests and selected verification tests (specified by **Q**).
- **Performance verification tests** - An extensive set of tests that are recommended as an acceptance test when the instrument is first received or after performing adjustments.

Self-test

A brief power-on self-test occurs automatically whenever you turn on the multimeter. This limited test assures that the multimeter is capable of operation.

To perform a complete self-test including over 25 tests, hold down the SHIFT key for about 5 seconds as you press the **Power** switch to turn on the multimeter (a complete description of these tests can be found in chapter 6). The meter will automatically perform the complete self-test procedure when you release the key. The self-test will complete in approximately 20 seconds.

Many tests can be performed individually (or all tests at once) using the front panel menu:

D: SYS
4: TEST

Self-test can also be performed from the remote interface. For further information, refer to chapter 3 in the *HP 34401A User's Guide*.

- If the self-test is successful, "PASS" is displayed on the front panel.
- If the self-test fails, "FAIL" is displayed and the ERROR annunciator will turn on. If repair is needed, see chapter 6, "Service," for further details.
- If all tests pass, you have a high confidence (90%) that the multimeter is operational.

Quick performance check

The quick performance check is a combination of internal self-test and an abbreviated performance test (specified by the letter **Q** in the performance verification tests) . This test provides a simple method to achieve high confidence in the meter's ability to functionally operate and meet specifications. These tests represent the absolute minimum set of performance checks recommended following any service activity. Auditing the multimeter's performance for the quick check points (designated by a **Q**) verifies performance for "normal" accuracy drift mechanisms. This test does not check for abnormal component failures.

To perform the quick performance check, do the following:

- Perform a complete self-test.
- Perform only the performance verification tests indicated with the letter **Q**.

If the HP 34401A Multimeter fails the quick performance check, adjustment or repair is needed.

Performance verification tests

The performance verification tests are recommended as acceptance tests when the instrument is first received. The acceptance test results should be compared against 90 day test limits. The 24 hour test limits should only be used for verification within 24 hours after performing the adjustment procedure.

After acceptance, the performance verification tests should be repeated with the next calibration interval.

If the HP 34401A Multimeter fails performance verification, adjustment or repair is needed.

ALL Configurations shown assume starting from a power-on or remote reset condition.

Zero offset verification

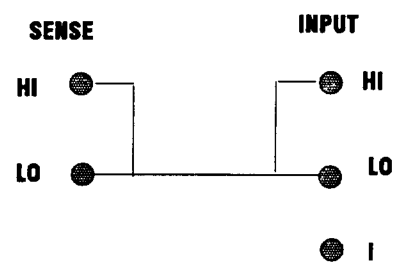
This procedure is used to check the zero offset performance of the HP 34401A Multimeter. Verification checks are only performed for those functions and ranges with unique offset calibration constants. A low thermal EMF four-terminal short is applied to the input of the meter. Measurements are checked for each function and range as described in the procedure below.

Zero offset verification procedure

Configuration: 6-1/2 digit (slow or fast)

1 Check the "Test considerations" section earlier in this chapter.

2 Apply a 4-wire short (copper) across the Input HI-LO and Sense HI-LO terminals as shown below (front or rear terminal).



3 Select the shorted terminal set (front or rear) with the front rear switch.

Separate zero offset calibration constants are stored for the front and rear input terminals.

4 Select each function and range in the order shown in the table on the next page. Compare measurement results to the appropriate test limits shown in the table.

Zero offset verification tests cont'd

Input (Front/Rear)	Function	Quick check	HP 34401A Range	Error from nominal 24 hour	90 day	1 year
open	DC Current		10 mA	± 1 µA	± 2 µA	± 2 µA
open		Q	100 mA	± 4 µA	± 5 µA	± 5 µA
open			1 A	±60 µA	±100 µA	±100 µA
open			3 A	± 600 µA	± 600 µA	± 600 µA
short	DC Volt	Q	100 mV	± 3 µV	± 3.5 µV	± 3.5 µV
short			1 V	± 6 µV	± 7 µV	± 7 µV
short			10 V	±40 µV	±50 µV	±50 µV
short			100 V	± 600 µV	± 600 µV	± 600 µV
short			1000 V	± 6 mV	± 10 mV	± 10 mV
short	2-wire Ohms[1] and 4-wire Ohms		100 Ω	± 3 mΩ	± 4 mΩ	± 4 mΩ
short			1 kΩ	± 5 mΩ	± 10 mΩ	± 10 mΩ
short		Q	10 kΩ	± 50 mΩ	± 100 mΩ	± 100 mΩ
short			100 kΩ	± 500 mΩ	± 1 Ω	± 1 Ω
short			1 MΩ	± 10 Ω	± 10 Ω	± 10 Ω
short			10 MΩ	± 100 Ω	± 100 Ω	± 100 Ω
short			100 MΩ	± 10 kΩ	± 10 kΩ	± 10 kΩ

[1] For 2-wire ohms these errors assume you are using Math Null. Without Math Null, an additional 200 mΩ of error must be added.

Caution - Zero offset calibration using a multifunction calibrator is NOT recommended. The calibrator and cabling offset can be large and unstable causing poor offset calibration of the HP 34401A or any multimeter.

Note - These offset tests should be verified for both the front and the rear input terminals.

Q = Quick performance verification test points.

Gain verification

This procedure is used to check the "full scale" reading calibration of the HP 34401A Multimeter. Verification checks are only performed for those functions and ranges with unique gain calibration constants. Begin verification by selecting a measuring function and range. Follow the verification procedure below for the selected function.

DC Volt, Resistance, and DC Current gain verification test

Configuration: 6-1/2 digit (slow or fast)

1 Check the "Test considerations" section earlier in this chapter.

2 Select each function and range in the order shown below. Compare measurement results to the appropriate test limits shown in the table. (Be certain to allow for appropriate source settling.)

Input (Front)	Function	Quick check	HP 34401A Range	Error from nominal 24 hour	90 day	1 year
100 mV	DC Volts		100 mV	± 6 μV	± 7.5 μV	± 8.5 μV
1 V			1 V	± 26 μV	± 37 μV	± 47 μV
10 V		Q	10 V	±190 μV	± 250 μV	± 400 μV
-10 V			10 V	±190 μV	±250 μV	±400 μV
100 V		Q	100 V	± 2.6 mV	± 4.1 mV	± 5.1 mV
1000 V			1000 V	± 26 mV	± 45 mV	± 55 mV
100 Ω	2-wire Ohms[1] and 4-wire Ohms		100 Ω	± 6 mΩ	± 12 mΩ	± 14 mΩ
1 kΩ		Q	1 kΩ	± 25 mΩ	± 90 mΩ	± 110 mΩ
10 kΩ			10 kΩ	± 250 mΩ	± 900 mΩ	± 1.1 Ω
100 kΩ [2]			100 kΩ	± 2.5 Ω	± 9 Ω	± 11 Ω
1 MΩ [2]			1 MΩ	± 30 Ω	± 90 Ω	± 110 Ω
10 MΩ [2]		Q	10 MΩ	± 1.6 kΩ	± 2.1 kΩ	± 4.1 kΩ
100 MΩ [2]			100 MΩ	± 310 kΩ	± 810 kΩ	± 810 kΩ
10 mA	DC Current		10 mA	± 1.5 μA	± 5 μA	± 7 μA
100 mA		Q	100 mA	± 14 μA	± 35 μA	± 55 μA
1 A			1 A	±560 μA	±900 μA	±1.1 mA
2 A			3 A	± 3.6 mA	± 4.2 mA	± 4.2 mA

[1] For 2-wire ohms these errors assume you are using Math Null. Without Math Null, an additional 200 mΩ of error must be added.
[2] Use shielded twisted pair TEFLON® insulated cables to reduce settling and noise errors.
Q = Quick performance verification test points.

AC Volt gain verification test

Configuration: AC volt
6-1/2 digit
SLOW AC Filter

1 Check the "Test considerations" section earlier in this chapter.

2 Select each function and range in the order shown below. Compare measurement results to the appropriate test limits shown in the table. (Be certain to allow for appropriate source settling.)

Input (Front)	Input Frequency	HP 34401A Range	Quick check	Error from nominal 24 hour	90 day	1 year
100 mV	1 kHz	100 mV		± 70 µV	± 90 µV	± 100 µV
100 mV	50 kHz		Q	± 150 µV	± 160 µV	± 170 µV
1 V	1 kHz	1 V		±600 µV	±800 µV	± 900 µV
1 V	50 kHz			± 1.4 mV	± 1.6 mV	± 1.7 mV
10 V	1 kHz	10 V		± 6 mV	± 8 mV	± 9 mV
10 V	50 kHz		Q	± 14 mV	± 16 mV	± 17 mV
10 V	10 Hz			± 6 mV	± 8 mV	± 9 mV
10 mV	1 kHz	100 mV		± 34 µV	± 45 µV	± 46 µV
100 V	1 kHz	100 V	Q	± 60 mV	± 80 mV	± 90 mV
100 V	50 kHz			±140 mV	±160 mV	±170 mV
750 V	1 kHz	750 V		± 450 mV	± 600 mV	± 675 mV
750 V [1]	50 kHz			± 1.05 V	± 1.2 V	± 1.275 V

[1] Some calibrators may have difficulty driving the multimeter and cable load at this V-Hz output. Use short, low capacitance cable to reduce calibration loading. Verification can be performed at >195 Vrms. New test limits can be computed from the accuracy specification shown in chapter 1 for the actual test conditions used.

Caution - The 50 kHz ac voltage test points may fail performance verification if the internal shields have been removed and reinstalled. Consult the "Gain adjustment procedure" for further information on how to recalibrate the ac voltage function.

Q = Quick performance verification test points.

AC Current gain verification test

Configuration: AC current
6-1/2 digit
SLOW AC Filter

1 Check the "Test considerations" section earlier in this chapter.

2 Select each function and range in the order shown below. Compare measurement results to the appropriate test limits shown in the table. (Be certain to allow for appropriate source settling.)

Input (Front)	Input Frequency	HP 34401A Range	Error from nominal		
			24 hour	90 day	1 year
1 A	1 kHz	1 A	± 1.4 mA	± 1.4 mA	± 1.4 mA
2 A	1 kHz	3 A	± 4.8 mA	± 4.8 mA	± 4.8 mA

Frequency gain verification test

Configuration: Frequency
6-1/2 digit

1. Check the "Test considerations" earlier in this chapter.

2. Select each function and range in the order shown below. Compare measurement results to the appropriate test limits shown in the table. (Be certain to allow for appropriate source settling.)

Input (Front)	Input Frequency	Quick check	HP 34401A Range	Error from nominal		
				24 hour	90 day	1 year
10 mV [1]	100 Hz		100 mV	± .06 Hz	± .1 Hz	± .1 Hz
1 V	100 kHz	Q	1 V	± 6 Hz	± 10 Hz	± 10 Hz

[1] Using a coaxial input cable.

Q = Quick performance verification test points.

4

Optional AC performance verification tests

These tests are **NOT** intended to be performed with every calibration. They are provided as an aid for verifying additional instrument specifications.

Configuration: AC volt
6-1/2 digit
SLOW AC Filter

1 Check the "Test considerations" section earlier in this chapter.

2 Select each function and range in the order shown below. Compare measurement results to the appropriate test limits shown in the table. (Be certain to allow for appropriate source settling.)

Input (Front)	Input Frequency	HP 34401A Range	Error from nominal		
			24 hour	90 day	1 Year
1 V	20 Hz	1 V	± 600 µV	± 800 µV	± 900 µV
1 V	1 kHz	1 V	± 600 µV	± 800 µV	± 900 µV
1 V	20 kHz	1 V	± 600 µV	± 800 µV	± 900 µV
1 V	50 kHz	1 V	± 1.4 mV	± 1.6 mV	± 1.7 mV
1 V	100 kHz	1 V	± 6.3 mV	± 6.8 mV	± 6.8 mV
1 V	300 kHz	1 V	± 45 mV	± 45 mV	± 45 mV
10 V	1 kHz	10 V	± 6 mV	± 8 mV	± 9 mV
1 V	1 kHz	10 V	± 2.4 mV	±3.5 mV	± 3.6 mV
100 mV	1 kHz	10 V	± 12 mV	± 13 mV	± 13 mV

Calibration security code

This feature allows you to enter a security code (electronic key) to prevent accidental or unauthorized calibrations of the multimeter. When you first receive your multimeter it is secured. Before you can adjust calibration constants you MUST unsecure the meter by entering the correct security code. See example 1 in chapter 3, "Menu Tutorial."

- The security code is set to "HP034401" when the multimeter is shipped from the factory. Only the last six characters ("034401") are entered from the front panel. For remote interface operation, refer to the *HP 34401A User's Guide* for more information.
- The security code is stored in non-volatile memory and does not change when power is turned off or after a remote interface reset.
- The security code may contain up to 12 characters. However, only six characters must be used if you will be unsecuring or securing the instrument from the front panel.
- **IF YOU FORGET** your security code, you can disable the security feature momentarily by following the procedure.

To unsecure the multimeter without the security code

To unsecure the meter without the correct security code, follow the steps below. Chapter 9, "Schematics," contains the schematics associated with this procedure. See example 1 in chapter 3, "Menu Tutorial," for an example of entering the security code. Also see "ESD precautions" in chapter 6 before beginning this procedure.

1 Disconnect the power line input.

2 Disconnect ALL input connections (both front and rear terminals).

3 Remove the instrument cover. There are 2 rear panel screws and 1 screw on the bottom cover. (See the Chassis Assembly Drawing on page 9-3.)

4 Remove the internal metal shields, push the top shield to the side, and lift out. (See the Chassis Assembly Drawing on page 9-3.)

Continued on the next page ➡

5 Apply power to the instrument and turn it on. Be careful not to touch power line connections.

6 Apply a short between the two exposed metal pads on JM500. JM500 is located between U500 and U506. It is outlined with a small rectangular silkscreen. (See the 34401-66501 Main Board Component Locator Drawing on page 9-5.)

7 While maintaining the short, enter any unsecure code. The meter is now unsecured.

8 Remove the short at JM500.

9 Reassemble the instrument.

Now you can enter a new security code. Be sure you note the new security code.

Calibration count

The calibration count feature provides an independent "serialization" of your HP 34401A calibrations. You can determine the number of times that your multimeter has been calibrated. By monitoring the calibration count, you can determine whether an unauthorized calibration has been performed. Since the value increments by one for each calibration, a complete calibration of the multimeter increases the value by several counts.

- The calibration count is stored in non-volatile memory and does not change when power has been off or after a remote interface reset.
- The calibration count increments up to a maximum of 32,767 after which it wraps around to 0.
- There is no way provided for the user to program or reset the calibration count value. It is an independent electronic calibration "serialization" value.
- Your multimeter was calibrated before it left the factory. When you receive your multimeter, read the calibration count to determine its initial value.

Calibration message

You can store a message of up to 12 characters from the remote interface. The message is readable through the front panel menu or from the remote interface. The calibration message is stored in secured calibration memory (the multimeter must be unsecured to change the calibration message).

The calibration message can be used to store such messages as the last calibration date, the next calibration due date, an encoded version of the instrument's calibration secure code, or even the name or phone number of who to contact to obtain a new calibration.

Calibration procedures

Before beginning any adjustment procedures, the multimeter MUST be in an "UNSECURED" state. For assistance on how to accomplish this, see "Calibration security code" earlier in this chapter. Each adjustment should be followed by a performance verification check for added confidence. We recommend the following general procedure always be followed.

- Follow the guidelines discussed in the "Test considerations" section.
- UNSECURE the meter as outlined in the "Calibration security code" section.
- Perform the Zero adjustment procedure.
- Perform the Gain adjustment procedure.
- Perform the verification tests.
- SECURE the meter.
- Note the new secure code and calibration count in your maintenance records.

Aborting a calibration in progress

Sometimes it becomes necessary to abort a calibration once the procedure has been initiated. A calibration may be aborted at any time by pressing any front panel key (except SHIFT). When performing a calibration from the remote interface, calibrations may be aborted by issuing a remote interface device clear message or by pressing the front panel LOCAL key. Changing the front/rear switch position during a calibration will also abort the calibration in progress..

Zero adjustment

The HP 34401A multimeter stores a new set of offset correction constants for every measurement function and range each time this procedure is executed. Separate offset correction constants are stored for the front and rear input terminals. The multimeter will sequence through all required functions and ranges automatically and store new zero offset calibration constants. ALL offset corrections are determined automatically. *You may not correct a single range or function without re-entering ALL zero offset correction constants automatically.* This feature is intended to save calibration time and improve zero calibration consistency.

> *Never turn off the meter during Zero Adjustment. This may cause ALL calibration memory to be lost.*

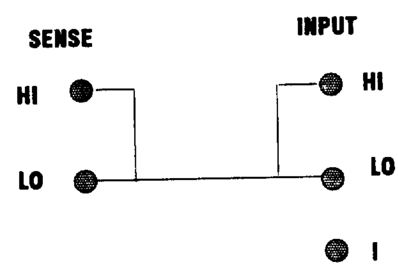
4

Zero adjustment procedure

The automatic zero adjustment procedure takes about 5 minutes to complete for each terminal set calibrated (front or rear terminal).

Follow the steps outlined below. Review the "Test considerations" section earlier in this chapter before beginning this test. Also see example 2 in chapter 3, "Menu Tutorial," for an example of how to initiate a zero calibration.

1 Select the DCV function and apply a 4-wire short (copper) across the Input HI-LO and Sense HI-LO terminals as shown below (front or rear terminal).



Zero adjustment procedure cont'd

2 Select the shorted terminal set (front or rear terminal) with the front rear switch.

NOTE- separate calibration constants are stored for the front and rear input terminals.

3 Enter the menu (`shift` `<`) and use the left/right arrow keys (< >) to select **F: CAL MENU**.

4 Use the arrow keys to move down to the commands level and select **2. CALIBRATE**.

5 Use the arrow keys to move down and set the input value to 000.0000 mV.

6 Execute by pressing `Auto/Man`
Enter.

7 Perform Zero offset verification tests to check zero calibration results .

8 Repeat steps 1 through 7 for the other input terminal set (front or rear).

Gain adjustment

The HP 34401A Multimeter stores a *single* new gain correction constant each time this procedure is followed. The gain constant is computed from the calibration value entered for the calibration command and from measurements made automatically during the adjustment procedure. Most measuring functions and ranges have gain adjustment procedures. Only the 100 MΩ range and the ac current, continuity, and diode test functions do not have gain calibration procedures. The gain calibration value may be entered through the front panel menu or over the bus. See example 2 in chapter 3 for assistance on how to enter calibration values.

Adjustments for each function should be performed ONLY in the order shown in the performance verification table. See "Performance verification tests" earlier in this chapter for the tables used for gain adjustments.

Gain adjustment considerations:

- The zero adjustment procedure MUST have been recently performed prior to beginning any gain adjustment procedures.
- The -10 V dc calibration electronically corrects the multimeter's a-to-d converter linearity characteristic. This calibration should be performed ONLY after servicing the a-to-d converter or replacement of the calibration RAM, U505. Consult the "-10 V dc Adjustment procedure" later in this section.
- When performing a 4-wire ohms gain adjustment, a new gain correction constant is ALSO stored for the corresponding 2-wire ohms measurement range. If desired, the 2-wire gain can be adjusted separately AFTER the 4-wire ohms gain calibration is completed.
- AC voltage gain calibration relies upon prior calibration of the dc voltage function. Failure to do so can cause significant calibration errors.

Never turn off the meter during a Gain Adjustment. This may cause calibration memory for the present function to be lost.

Valid gain adjustment input values

Gain adjustment can be accomplished using the following input values:

Function	Range	Valid Calibration Input Values
DC V	100 mV to 100 V	0.9 - 1.1 x Full Scale
	1000 V	900 V - 1050 V
RES, FRES (2-wire,4-wire)	100 Ω to 10 M Ω	0.9 - 1.1 x Full Scale
DCI	10 mA to 1 A	0.9 - 1.1 x Full Scale
	3 A	1 A - 3.03 A
AC V [1]	100 mV to 100 V	0.9 - 1.1 x Full Scale
	750 V	195 V - 770 V
Frequency	ANY	ANY INPUT > 100 mV rms, 1 kHz - 100 kHz

[1] Valid frequencies are as follows: 1 kHz ± 10% for the 1 kHz calibration, 45 kHz - 100 kHZ for the 50 kHz calibration, and 10 Hz ± 10% for the 10 Hz calibration .

Gain adjustment procedure

Adjustment for each function should be performed ONLY in the order shown in the performance verification table. See "Performance verification tests" earlier in this chapter for the performance verification taoles used for gain adjustments.

Review the "Test considerations" and "Gain adjustment considerations" sections before beginning this test.

1 Select a function to be adjusted. Refer to the appropriate gain verification table (pages 64 - 66).

2 Apply the input signal shown in the **Input** column of the appropriate verification table.

Always complete tests in the same order as shown in the appropriate verification table.

3 Enter the menu ([shift][<]) and use the left/right arrows (< >) to select **F: CAL MENU.**

4 Use the arrow keys to move down to the commands level and select **2. CALIBRATE.**

Gain adjustment procedure cont'd

5 Use the arrow keys to set the calibration value for the present input value.

6 Execute by pressing Auto/Man
Enter.

7 Perform Gain verification test to check calibration results.

8 Repeat steps 1 through 7 for each gain verification test point shown in the tables.

Each range in the gain adjustment procedure takes less than 20 seconds to complete.

-10 V dc Adjustment procedure

The -10 V dc calibration electronically corrects the multimeter's a-to-d converter linearity characteristic. *This adjustment should ONLY be performed after servicing the a-to-d converter or replacement of the calibration RAM, U505.*

Configuration: DC Volts
6-1/2 digit SLOW (NPLC 100)

1 Perform the +10 V dc gain adjustment procedure. Note the multimeter's reading immediately following the +10 V calibration.

2 Manually reverse the multimeter's input connections and allow time for thermal offset voltages to settle (usually about 1 minute).

3 Enter the + 10 V reading noted in step 1 above with the "-" sign for the -10 V calibration value.

4 Check that the -10 V reversed input reads within the following limits: 0 ± 30 μV of the +10 V input reading.

Error messages

The following tables are abbreviated lists of HP 34401A error messages. They are intended to include errors which are likely to be encountered during the procedures described in this chapter. For a more complete list of error messages and descriptions, see the *HP 34401A User's Guide*.

System error messages

Error	Error Message
-330	Self-test failed
-350	Too many errors
501	Isolator UART framing error
502	Isolator UART overrun error
511	RS-232 framing error
512	RS-232 overrun error
513	RS-232 parity error
514	Command allowed only with RS-232
521	Input buffer overflow
522	Output buffer overflow
531	Insufficient memory
532	Cannot achieve requested resolution

Self-test error messages

Error	Error Message
601	Front panel does not respond
602	RAM read/write failed
603	A/D sync stuck
604	A/D slope convergence failed
605	Cannot calibrate rundown gain
606	Rundown gain out of range
607	Rundown too noisy
608	Serial configuration readback failed
609	DC gain x1 failed
610	DC gain x10 failed
611	DC gain x100 failed
612	Ohms 500 nA source failed
613	Ohms 5 uA source failed
614	DC 1000 V zero failed
615	Ohms 10 uA source failed
616	DC current sense failed
617	Ohms 100 uA source failed
618	DC high voltage attenuator failed
619	Ohms 1 mA source failed
620	AC rms zero failed
621	AC rms full scale failed
622	Frequency counter failed
623	Cannot calibrate precharge
624	Unable to sense line frequency
625	I/O processor does not respond
626	I/O processor failed self-test

For further descriptions of the self-test procedures, refer to "Self-test procedures" in chapter 6.

Calibration error messages

Error	Error Message
605	Cannot calibrate rundown gain
606	Rundown gain out of range
701	Cal security disabled by jumper
702	Cal secured
703	Invalid secure code
704	Secure code too long
705	Cal aborted
706	Cal value out of range
707	Cal signal measurement out of range
708	Cal signal frequency out of range
709	No cal for this function or range
720	Cal DCV offset out of range
721	Cal DCI offset out of range
722	Cal RES offset out of range [1]
723	Cal FRES offset out of range [1]
730	Precharge DAC convergence failed
731	A/D turnover correction out of range
732	AC flatness DAC convergence failed
733	AC low frequency convergence failed
734	AC low frequency correction out of range
735	AC rms converter noise correction out of range
740 [2]	Cal checksum failed, secure state
741 [2]	Cal checksum failed, string data
742 [2]	Cal checksum failed, DCV corrections
743 [2]	Cal checksum failed, DCI corrections
744 [2]	Cal checksum failed, RES corrections
745 [2]	Cal checksum failed, FRES corrections
746 [2]	Cal checksum failed, AC corrections
747 [2]	Cal checksum failed, HP-IB address
748 [2]	Cal checksum failed, internal data

[1] RES is the 2-wire ohms function. FRES is the 4-wire ohms function.

[2] This error may be generated if you turn off the power during a calibration. Recalibration is required to clear the error. If the error persists, a hardware failure of U505 may have occured.

5

Theory of Operation

Theory of Operation

This chapter is organized to provide descriptions of the circuitry contained on each schematic shown in chapter 9. A block diagram level overview is provided followed by more detailed descriptions of the circuitry contained in the schematics chapter:

Self-test procedures are described in chapter 6.

Block diagram

Referring to the instrument block diagram on page 9-7, it can be seen that the HP 34401A Multimeter circuitry is separated into two major blocks: the floating circuitry and the earth referenced circuitry. All measurement, control, and display functions are contained in the floating section. It contains the input switching, function selection, and measurement circuitry. It also contains the instrument's main CPU.

All measurement setup and a-to-d conversion is performed in the floating section. Each measuring function converts the input to a dc voltage between ±12 volts. The ADC (a-to-d conversion) changes the dc voltage into a digital representation. This digital information is used by the main CPU to calculate the reading. Data stored at the time of calibration is recalled and used to correct the measurement data. The corrected reading is then formatted and sent to the front panel processor for display. The corrected reading can also be sent to the earth referenced I/O processor for output to the remote interface.

The earth referenced circuitry consists of a processor configured as a slave to the main CPU. This processor establishes external I/O communications with the main CPU through an optically isolated serial communication link. The earth referenced processor provides the HP-IB (IEEE-488) and RS-232 interfaces. It also handles external trigger and voltmeter complete handshake signaling.

Separate power supplies are provided for the floating and earth referenced sections. The front panel operates from the floating section with its logic common different from the floating CPU logic common.

Front/rear selection

Referring to the schematic on page 9-8, the purpose of this circuitry is to allow selection of either the front terminals or the rear terminals (via switch S1). The output of S1 is connected to the Function Switching schematic (page 9-9). Input protection circuitry designed to protect the measuring circuits from high energy transients such as electrostatic discharge or power line transients is also shown.

The double fused (F101, F102) current input is designed to protect against potential catastrophic damage caused by accidental input connection across high VA sources beyond the 250 V rating of the rear panel current input fuse. U110 bootstraps out the offset current errors caused by the leakage current of CR100. CR100 clamps the current input to protect R120 and R121 from excessive overloads.

Note - Only the front panel or rear panel current input is fused with F101 and F102 as selected by the front/rear switch, S1. The unselected input is not fused through F101 and F102.

Function switching

The purpose of the function switching section, schematic on page 9-9, is to connect the Input HI terminal to the various measuring functions. This is accomplished through K101, K102, K103, and K104. In addition, the connections of the 4-wire ohms HI Sense and LO Sense inputs are shown. Shunt selection (ranging) and voltage sensing are also shown for the current function. The table below shows the state of each relay for each measuring function. Relay K101 opens momentarily during each range or function change. All relay coils are driven from U150.

Function	K101	K102	K103	K104	Sense at
0.1 V - 10 V DC	Closed	Set	Set	Set [1]	U101-5
100 V - 1000 V DC	Closed	Set	Reset	Set	U102-12
2-Wire OHMS	Closed	Reset	Set	Reset [2]	U101-5
4-Wire OHMS	Closed	Reset	Set	Reset [2]	[3]
AC Voltage	Closed	Set	Reset	Reset	AC_IN
Frequency/ Period	Closed	Set	Reset	Reset	AC_IN
3 A, 1 A DCI	Closed	Reset	Set	Reset	U101-10
100 mA, 10 mA DCI	Closed	Set	Set	Reset	U101-10
3 A, 1 A ACI	Closed	Reset	Set	Set	AC_IN

[1] K104 will be reset when input resistance is selected to > 10,000 MΩ through the menu.
[2] K104 will be set for the 100 MΩ range.
[3] Configurations shown are for the current source output (HI) terminal. The measurement sense is accomplished through the Sense HI / Sense LO terminals.

DC Amplifier

The DC Amplifier circuit (schematic on page 9-10) is used by every measuring function except frequency and period. Analog switch U101B selects various input signals for measurement by the ADC. Switch U101B has three sources which can be dynamically selected: measure customer input (MC), measure zero input (MZ), and precharge (PRE). The MC state is the actual input measurement. The MZ state measures internal offset voltages which are also present in the MC measurement. The final measurement result is computed from MC-MZ. The PRE state is used to "precharge" internal capacitances to reduce charge injection to the input terminal from the dynamic switching of MC and MZ. Autozero off disables the dynamic switching of the amplifier input. However, a new MZ value is automatically taken whenever a new function or range is selected, even if autozero is turned off. [1]

In the DC Volts function, ranging is accomplished through both input relay switching (K101-K104) and solid state switching (U101). As a result the input to the ADC has the same nominal 10 V value for a full scale input on each range. The dc input op amp is comprised of source follower dual FET U104, amplifier U106, and associated bias circuitry. The feedback resistors U102C and switches U101C select non-inverting amplifier gains of x1, x10, and x100 for the dc input amplifier circuit. Amplifier output ADIN drives the dc input to the a-to-d converter for all measuring functions.

DCV Range	U102A Divider	U101 Input	Amplifier Gain	ADC Input
100 mV		Pin 5	x100	10 V
1 V		Pin 5	x10	10 V
10 V		Pin 5	x1	10 V
100 V	1/100	Pin 8	x10	10 V
1000 V	1/100	Pin 8	x1	10 V

[1] The output of the input amplifier will continue to cycle from a 0 V (MZ) level to the MC amplified input level during autozero operation. Autozero can be disabled from the remote interface or suspended using the TRIGGER SINGLE configuration from the front panel.

In the DC current function, a current is applied between the Input I and LO terminals. Ranging is accomplished by relay K102 and amplifier gain switching in U101. Since a known resistor (the shunt resister) is connected between these terminals, a voltage proportional to the unknown current is generated. The voltage sensed at R121 is measured by the multimeter's dc circuitry. The table below illustrates the dc current measuring function configurations.

DCI Range	Shunt Resistor	U101-10 Input	Amplifier Gain	ADC Input
3 A	0.1Ω	300 mV	x10	3 V
1 A	0.1Ω	100 mV	x100	10 V
100 mA	5.1Ω	510 mV	x10	5.1 V
10 mA	5.1Ω	51 mV	x100	5.1 V

Resistance measurements are made by applying a known current through an unknown resistance. The resulting voltage drop across the unknown resistance is then measured by the multimeter's dc circuitry. The 100 MΩ range is measured using the known internal 10 MΩ resistance (U102A) in parallel with the unknown input resistance while applying the 500 nA current source. The result is computed from the measured data. The internal 10 MΩ resistance is determined whenever a zero calibration is performed.

In the 2-wire ohms function, the voltage drop is measured across the Input HI and Input LO terminals. In the 4-wire ohms function, the voltage is measured across the HI Sense and LO Sense terminals. Lead resistances in series with the current source (Input HI-LO) are not part of the final measurement. However, they do reduce the available current source compliance voltage for the resistor under test. The ohms current source will become non-linear when the compliance voltage limit is exceeded. The full scale voltage developed across the unknown resistor and the dc amplifier gain for each resistance range are tabulated below.

Ohms Range	Voltage across R	Amplifier Gain	ADC Input
100 Ω	100 mV	x100	10 V
1 k to 100 kΩ	1 V	x10	10 V
1 MΩ	5 V	x1	5 V
10 MΩ	5 V	x1	5 V
100 MΩ	4.5 V	x1	4.5 V

Ohms current source (page 9-10)

The ohms current source (schematic on page 9-10) flows from the Input HI terminal to the Input LO terminal for both the 2-wire and 4-wire ohms functions. Each current value is generated by forcing a stable, precise voltage across a stable resistance. The value of the current becomes part of the range gain constant stored during calibration.

The + 7 V reference voltage is used to generate a stable reference current with U201A. R201 and R202 are the resistance references for the current sources as shown in the table below. The IREF current is used to produce a precise voltage drop across the 28.57 kΩ resistor in U102D-4. The IREF generated using R202 produces an approximate 5 V drop across the 28.57 kΩ resistor. The IREF generated using R201 produces an approximate 0.5 V drop. This voltage is used to force a reference voltage across the selected current source range resistor (5 kΩ, 50 kΩ, 500 kΩ, 1 MΩ) by U201B. The resulting precision current flows through JFET Q202 and protection circuit Q203 to Q211, and CR202 to relay K102 where it is switched to the Input HI terminal for ohms measurements. The protection circuits are designed to protect the ohms current source from inadvertently applied voltages in excess of ±1000 V. Protection from large positive voltages is provided by the reverse breakdown voltage of CR202. Protection from large negative voltages is provided by the sum of the collector to base breakdown voltages of Q203, Q205, Q207, and Q209. Bias for these transistors is provided by Q211 and R203 to R206 while negative overvoltages are applied.

Range	Current	Open Circuit Voltage	Compliance Limit	Reference	Isource R U102D
100 Ω	1 mA	9 V	2.5 V	R202	5 kΩ
1 kΩ	1 mA	9 V	2.5 V	R202	5 kΩ
10 kΩ	100 uA	9 V	4 V	R202	50 kΩ
100 kΩ	10 uA	9 V	4 V	R202	500 kΩ
1 MΩ	5 uA	9 V	8 V	R202	1 MΩ
10 MΩ	500 nA	14 V	10 V	R201	1 MΩ
100 MΩ [1]	500 nA [1]	5 V		R201	1 MΩ

[1] Measured in parallel with the internal 10 MΩ resistor.

AC Circuit

Referring to the schematic on page 9-11, the HP 34401A Multimeter uses a True RMS ac-to-dc converter to measure ac voltages and currents. The ac-to-dc converter changes the input ac voltage to a dc voltage. All voltage ranging is performed in the ac circuit so that the input to the multimeter's dc circuitry (AC_OUT) is nominally 2 volts dc for a full scale ac input. The dc amplifier is always configured for x1 gain in ac functions (voltage, current, frequency, and period). Relay K104 connects the ac circuit to either the Input HI terminal or to R121, the current function voltage sense point. Note that the input to the ac circuit may contain a dc bias from the applied ac signal.

Input coupling capacitor C301 blocks the dc portion of the input signal. Only the ac component of the input signal is measured by the multimeter. The ac circuit voltage ranging comprises two gain stages U301 and U305/U312. The voltage gains for each stage are tabulated below.

Function	Range	1st Stage	2nd Stage	ADC Input
ACV,Freq, or Peroid	100 mV	x0.2	x100	2 V dc
	1 V	x0.2	x10	2 V dc
	10 V	x0.2	x1	2 V dc
	100 V	x0.002	x10	2 V dc
	700 V	x0.002	x1	1.4 V dc
ACI	3 A	x0.2	x10	0.6 V dc
	1 A	x0.2	x100	2 V dc

The 1st stage is a compensated attenuator implementing a gain of x0.2 or x0.002 as selected by U304A and U304B. Each voltage range has a unique 50 kHz frequency response correction produced by a programmable variable capacitor connected across R304.

The programmable capacitance is implemented by varying the signal level across a compensating capacitor. In the x0.2 configuration, low frequency gain is set by R301, R302, and R304. The variable gain element U302/U303 essentially varies the value of C306 from 0 to 1 times its value in 256 steps. The exact gain constant is determined during the 50 kHz ac voltage range calibration procedure. In the x0.002 configuration, low frequency gain is set by R301, R302, and R303. The variable gain element U302/U303 essentially varies the value of C305 plus C306 from 0 to 1 times their value in 256 steps. The exact gain constant is determined during the 50 kHz ac voltage range calibration procedure.

The second stage is made up of two amplifiers (U305 and U312) each configured for a fixed gain of x10. Overall 2nd stage gains of x1, x10, and x100 are produced by routing the 1st stage output either around, or through one or both amplifiers as shown in the table below.

2nd Stand Gain	U306A	U306B	U306C	U306D	U304C
x1	ON	OFF	OFF	OFF	OFF
x10	OFF	ON	OFF	ON	OFF
x100	OFF	OFF	ON	ON	ON

The output of the 2nd stage is connected to the rms-to-dc converter stage. Any residual dc offset from the amplifier stages is blocked by capacitor C316. Buffer U307 drives the input to the rms-to-dc converter as well as the frequency comparator (U310A) input. The rms-to-dc converter has two selectable averaging filters (C318 and C318 plus C321) for the analog computer circuit of U308. The two analog averaging filters together with digital filters running in the main CPU implement the three selectable AC Filters: SLOW, MEDIUM, and FAST. The faster analog filter (using C318) is used for all ACV, ACI, and Frequency or Period autoranging. The slower analog filter is used only with the SLOW and MEDIUM AC Filter choices.

In frequency or period measurements, U310A generates a logic signal (FREQIN) for every input zero crossing. The ac sections FREQRNG dc output is measured directly by the main CPU's 10 bit ADC during frequency or period measurements. This lower resolution measurement is sufficient to perform voltage ranging decisions for these functions. The frequency comparator output is disabled during ac voltage and current measurements by U310B forcing U310A's input to - 15 V.

A-to-D Converter

The analog-to-digital converter (ADC, schematic on page 9-12) is used to change dc voltages into digital information. The circuitry consists of an integrator amplifier (U402 and U420), current steering switch U411, resistor network U102E, voltage reference U403, ADC controller U501, and residue ADC U500.

The ADC method used by the HP 34401A is called multislope III. It is based on patented Hewlett-Packard ADC technology. Multislope III is a charge balancing continuously integrating analog-to-digital converter. The ADC charge balancing algorithm is always running, even when the multimeter is not triggered. The input voltage continuously forces charge onto the integrator capacitors C400 and C401 through U102E-R16. Switches U411A and U411B steer fixed positive or negative reference currents onto the integrator capacitor to cancel, or balance, the accumulated input charge. The level shifted (R403 and R406) output of the integrator is checked every 2.66 μs by the U501 COMP input. Logic state machines in U501 control the U411 current steering to continuously seek an approximate 2.5 V level on the integrator amplifier output, FLASH. If the ADC input voltage ADIN is between ± 15 V, the integrator output (FLASH) will remain within the 0 V to 5 V range of the U500 on chip ADC. An input greater than +15 V may cause the integrator output (U402-6) to saturate at about -18 V. An input less than -15 V may cause U402 to saturate with an output of about +18 V. The U500 ADC input (FLASH) is clamped to 0 V or 5 V by R405 and CR403 to protect U500.

The integrator amplifier is formed by U402 and U420. Resistors R420 and R421 affect the amplifier stability. Amplifier oscillation may occur if their values are incorrect. Amplifier U420 improves the offset voltage characteristics of integrator amplifier U402.

Each analog-to-digital conversion begins when the HP 34401A is triggered. The ADC starts by clearing the integrator slope count in U501. At the end of the integration period, the slope count is latched. The slope count provides the most significant bits of the input voltage conversion. The least significant bits are converted by the on chip ADC of CPU U500.

The instrument precision voltage reference is U403. Resistor R409 provides a stable bias current for the reference zener diode. R408 and CR404 provide a bias to assure that the reference zener biases to +7 V during power up. IC U400A amplifies the voltage reference to +10 V while amplifier U401A inverts the +10 V reference to -10 V. The reference voltages force precision slope currents for the integrating ADC through U102E-R17, R18. Amplifier U401B provides a precise +5 V reference for the U500 on chip ADC.

Floating logic

Referring to the schematic on page 9-13, the floating common logic controls operation of the entire instrument. All measurement control and bus command interpretation is performed in the main CPU, U500. The front panel and earth referenced processors operate as slaves to U500. The floating common logic is comprised of the main CPU U500, custom gate array U501, the program ROM U502, RAM U503, calibration EERAM U505, and the 12 MHz clock oscillator U405. Power on reset is provided to the main CPU by voltage regulator U553.

The main CPU, U500, is a 16 bit micro controller incorporating such features as receive and transmit serial ports, timer/counter ports, an 8 bit pulse width modulated DAC port, and selectable input 10 bit successive approximation a-to-d converter ports. A conventional address/data bus is used to transfer data between the CPU and external ROM and RAM. When the address latch enable (ALE) signal goes hi, address data is present on the address/data bus. Custom gate array U501 latches the address data and decodes the correct chip enable (low true) for external ROM and RAM accesses and for read/write accesses to the internal registers of U501. The system memory map is shown below.

0000 hex - 1FF7 hex	U503 8k x 8 RAM
1FF8 hex - 1FFF hex	U501 Gate Array
2000 hex - FFFF hex	U502 Program ROM

Program ROM U502 contains four 64k x 8 banks of data. Banks are selected by controlling the A16 and A17 ROM address bits directly from CPU port bits.

Custom gate array U501 performs address latching and memory map decoding functions as discussed above. In addition, U501 contains a variety of internal read/write registers. The read (XRD) and write (XWR) signals transfer data out of and in to U501 when it is addressed. There are four internal registers in U501: an internal configuration register, an 8 bit counter register, a serial transmit/receive register, and an internal status register.

The counter register is used to capture either ADC slope count at the COMP input or frequency count at the FREQIN input. The COMP input functions as both a clocked comparator and the slope counter input for the ADC. In both cases the counter register captures the lower 8 bits of a 24 bit counter. The upper 16 bits of the count are captured by the SYNC input to U500. The serial register is used to send and receive serial data bytes from the main CPU to the 40 bit (5 x 8 bits) measurement configuration register comprised of U309, U311, U150, and U101 or to communicate with the front panel processor. The serial register is multiplexed to these two circuits. The transmission rate is selected to 1.5 M bits/sec for the measurement configuration registers and to 93.75 k bits/sec for communication with the front panel processor. The general serial interface is a 3 bit interface as shown below.

U501 Internal Signal	Measurement Configuration Signals	Front Panel Signals
Serial Clock	SERCK	XFPSK
Data OUT (send)	SERDATO	FPDI
Data IN (receive)	SERRBK	FPDO

Serial data is received simultaneously as serial data is clocked out. The measurement configuration readback data (SERRBK) is only checked during self-test operation. Front panel data is exchanged in both directions whenever a byte is sent from U501. The measurement configuration register data is strobed to outputs by U500 signal SERSTB. Interrupts from the front panel are detected by U501 and signaled to the processor by CHINT. The processor line FPINT signals the front panel processor that U501 has data to send.

The gate array (U501) internal status register reports a serial port busy bit and 4 bits of time interpolation data. The time interpolation data is used to extend the time counting resolution of processor U500 during ADC conversions and frequency measurements.

The multimeter's calibration correction data are stored in a 128 x 16 bit non-volatile electrically erasable RAM, EERAM U505. The EERAM read/write data is accessed by a 4 bit serial protocol controlled by U500.

The main processor has an on chip 10 bit successive approximation ADC with two selectable inputs: FLASH and FREQRNG. The FLASH input is used to sample the residual charge on the main integrating ADC output of U402. The FREQRNG input is used to make voltage ranging decisions concurrent with frequency or period measurements.

The main CPU's pulse width modulated DAC outputs a 0 V to 5 V dc level after filtering the 23 kHz output with R507 and C512. This level is used to adjust the precharge amplifier offset voltage in U101. Port bits are also configured to detect the front/rear input switch position (FXR0) and to measure the input power line frequency (LSENSE). Frequencies from 55 Hz to 66 Hz are measured as 60 Hz. All other input frequencies are assumed to be 50 Hz.

The main CPU communicates with the earth referenced processor U700 through an optically isolated (U506 and U704) asynchronous serial link. Data is sent in an 11 bit frame at a rate of 187.5 k bits/sec. When the RS-232 interface is selected, data is sent across the isolated link at 93.75 k bits/sec. The 11 bit data frame is configured for 1 start bit, 8 data bits, 1 control bit, and 1 stop bit.

Earth referenced logic

The earth referenced logic circuits (schematic on page 9-14) provide all rear panel input/output capability. Microprocessor U700 handles HP-IB (IEEE-488) control through bus interface chip U701 and bus receiver/driver chips U702 and U703. The RS-232 interface is also controlled through U700. RS-232 transceiver chip U706 provides the required level shifting to approximate ±9 volt logic levels through on-chip charge-pump power supplies using capacitors C708 and C709. Communication between the earth referenced logic interface circuits and the floating measurement logic is accomplished through an optically isolated bi-directional serial interface. Isolator U506 couples data from U700 to microprocessor U501. Isolator U704 couples data from U501 to microprocessor U700.

Power supplies

Referring to the schematic on page 9-15, the multimeter uses two types of power supplies: floating supplies and earth referenced supplies. The floating supply outputs are ±18 Vdc, +5 Vdc, and a 5 Vrms center tapped filament supply for the vacuum fluorescent display. The earth referenced circuits are powered from a single +5 Vdc supply.

The ac mains are connected by module P1. This module includes the functions of mains connection, on/off switching, and line voltage selection (100 / 120 / 220 / 240). The multimeter automatically configures for the applied line frequency by counting the frequency of the output of clamp circuit CR554, R555, C555 (LSENSE).

The 5 volt floating supply is produced by bridge rectifier CR552, filter capacitor C556, and regulator U553. The reset output of U553 will change to logic LO when the unregulated dc input to the regulator falls below 5.5 volts. XPONRST is the instrument master hardware reset signal. This supply powers all floating logic. Relay drive circuits are also powered from this supply.

The floating ±18 volt supplies are produced by bridge rectifier CR551, filter capacitors C551 and C553, and regulators U551 and U552. These supplies are used to power all measuring circuits. In addition, the vacuum fluorescent display is driven from the ±18 volt supplies. A separate winding of T1 provides a center tapped 5 Vrms filament supply for the display. Bias circuit CR556, R556, and C559 generates the required cathode dc bias for the display filament supply.

The 5 volt earth referenced supply is produced by rectifier CR751, C752, and regulator U751. This supply is earth referenced by the screw which mounts the PC board to the instrument chassis. The HP-IB (IEEE-488) and RS-232 interfaces along with other input/output circuits are powered from this supply.

Front panel

The front panel circuits (schematic on page 9-16) consist of vacuum fluorescent display control, display high voltage drivers, and keyboard scanning. Communication between the front panel and floating logic circuits is accomplished through a 4-wire bidirectional serial interface. The main CPU, U500, can cause a hardware reset to processor U600 by signal IGFPRES. The front panel logic operates from +13 volts (logic 0) and +18 volts (logic 1). The 4 serial communication signals are level shifted by comparator U602 from the floating logic 0 V to 5 V levels to the 13 V to 18 V levels present on the front panel assembly. The front panel logic low supply (+13 volts) is produced by the +18 volt supply and 4.7 V zener CR606. Level shift outputs for the front panel receive data are clamped to the 13 volt supply VLB.

Display anode and grid voltages are +18 volts for an "on" segment and -18 volts for an "off" segment. The -12 V cathode bias for the display is provided by filament winding center tap bias circuit CR556, R556, and C559 on the power supply schematic (page 9-15). Keyboard scanning is accomplished through a conventional scanned row-column key matrix. Keys are scanned by outputting data to shift register U601 to poll each key column for a key press. Row read-back data are parallel loaded into shift register U601 and shifted back into processor U600 for decoding and communication to the floating logic circuits.

6

Service

Service

This chapter discusses the procedures involved for returning a failed multimeter to HP for service or repair. Subjects covered include the following:

Operating Checklist

Before returning your multimeter to HP for service or repair check the following items:

- **Is your multimeter inoperative?**

  Verify that the ac power line the unit is connected to is live.

  Verify that the HP 34401A front panel **Power** switch is depressed.

  Verify that the correct power line fuse is installed:
  Use a 250 mAT / 250 V fuse for 100 V or 120 V.
  Use a 125 mAT / 250 V fuse for 220 V or 240 V.

  Verify that the correct power line voltage range is selected.

  See "To prepare the multimeter for use" in chapter 2 of this guide.

- **Does the multimeter fail Self-test?**

  Verify that the correct power line voltage range is selected.

  Ensure that all measurement terminal connections (both front panel and rear panel) are removed while the self-test is performed. Errors may be induced by ac signals present on the multimeter input terminals during self-test. Long test leads can act as an antenna causing pick-up of ac signals.

  See "To prepare the multimeter for use" in chapter 2 of this guide.

- **Is the multimeter's current input inoperative?**

  Verify that the rear panel 3 A / 250 V current input fuse is functional.

  Verify that the internal 7 A / 250 V sand-filled fuse is functional.

  See "To replace the current input fuses" later in this chapter.

Types of service available

If your HP 34401A Multimeter fails within three years of original purchase, HP will repair or replace it free of charge. If your unit fails after your 3 year warranty expires, HP will repair or replace it at a very competitive price. HP will make the decision locally whether to repair or replace your unit.

Standard repair services (worldwide)

Contact your nearest HP Service Center. They will arrange to have your HP 34401A Multimeter repaired or replaced.

Express exchange (USA Only)

Receive a replacement HP 34401A via overnight shipment for low downtime.

Express exchange process

1 Call 1-800-258-5165 and ask for EXPRESS EXCHANGE.

- You will be asked for your shipping address and a credit card number to guarantee return of your failed HP 34401A.
- If you do not return the failed HP 34401A within 45 days, your credit card will be billed for a new HP 34401A.
- If you choose not to supply a credit card number, you will be asked to send your failed unit to a designated HP Service Center before HP will send a replacement unit.

2 HP will immediately send a replacement HP 34401A to you via overnight shipment.

- The replacement unit will have a different serial number than your failed unit.
- If you can not accept a new serial number for the replacement unit, use the Standard Repair Service option described above.

- If your unit was "in-warranty", your replacement unit will continue the warranty time clock to the end of your 3 year standard warranty. You will NOT be billed for the replacement unit as long as the failed unit is received by HP.
- If your 3 year warranty has expired, HP will bill you for the HP 34401A exchange price --- less than a new unit price. HP warrants exchange units against defects for 90 days.

Repackaging for shipment

For the EXPRESS EXCHANGE Service described above, return your failed HP 34401A to the designated HP Service Center using the shipping carton of the exchange unit. A shipping label will be supplied. HP will notify you when your failed unit has been received.

If the instrument is to be shipped to HP for service or repair, be sure you do the following:

- Attach a tag to the instrument identifying the owner and indicating the required service or repair. Include the instrument model number and full serial number.
- Place the instrument in its original container with appropriate packaging material.
- Secure the container with strong tape or metal bands.

If the original shipping container is not available, place your unit in a container which will ensure at least 4 inches of compressible packaging material around all sides for the unit. Use static free packaging materials to avoid additional damage to your unit.

HP suggests that you always insure shipments.

Electrostatic discharge (ESD) precautions

Almost all electrical components can be damaged by electrostatic discharge (ESD) during handling. Component damage can occur at electrostatic discharge voltages as low as 50 volts.

The following guidelines will help prevent ESD damage when servicing this or any electronic device.

- Disassemble instruments ONLY in a static-free work area.
- Utilize a conductive work area to dissipate static charge.
- Personnel should use a conductive wrist strap to dissipate static charge accumulation.
- Minimize handling.
- Keep replacement parts in original static-free packaging.
- Remove all plastic, styrofoam, vinyl, paper, and other static generating materials from the immediate work area.
- Use ONLY anti-static solder suckers.

Surface mount repair

Surface mount components should ONLY be removed using soldering irons or desoldering stations *expressly* designed for surface mount components.

> *Use of conventional solder removal equipment will almost always result in permanent damage to the printed circuit board and subsequent voiding of your Hewlett-Packard factory warranty.*

To replace the power-line fuse

The power-line fuse is located within the multimeter's fuse-holder assembly on the rear panel (see "Rear Panel at a Glance" in the front of this manual). For 100 or 120 Vac operation, you must use a 250 mAT slow-blow fuse (HP part number 2110-0817). For 220 or 240 Vac operation, you must use a 120 mAT slow-blow fuse (HP part number 2110-0894).

To replace the current input fuses

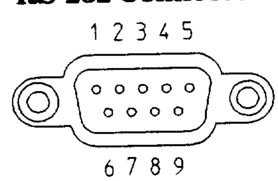
The front and rear current input terminals are protected by two series fuses. The first fuse is a 3 A, 250 Vac, fast-blow fuse and is located on the rear panel (see "Rear Panel at a Glance" in the front of this manual). To replace this fuse, order HP part number 2110-0780.

A second fuse is located inside the multimeter to provide an additional level of current protection. This fuse is a 7 A, 250 Vac, high-interrupt rated fuse (HP part number 2110-0614). To replace this fuse, you must remove the multimeter's case by loosening three screws (See Chassis Assembly Drawing on page 9-3).

To connect the pass/fail output signals

The RS-232 connector on the multimeter's rear panel is a 9-pin connector (DB-9, male connector). When the RS-232 interface is NOT selected (IEEE-488 interface is selected), the internal pass and fail TTL output signals (limit testing) may be connected to the RS-232 connector. The pass and fail signals are low true and indicate the Math Pass/Fail Limit Test result for the NEXT reading to be output to the HP-IB bus. The signals are active low for approximately 2 ms for each reading taken.

RS-232 Connector



Pin Number	Input/Output	Description
1	Output	*Limit Test Pass
2	Input	Receive Data (RxD)
3	Output	Transmit Data (TxD)
4	Output	Data Terminal Ready (DTR)
5	-	Signal Ground (SG)
6	Input	Data Set Ready (DSR)
9	Output	*Limit Test Fail

*TTL output is available only after installing the two jumpers described on the next page.

Installation Procedure:

The assembly drawings and schematics are located in chapter 9, "Schematics."

1 Unscrew the 2 rear bezel captive screws. (See the Chassis Assembly Drawing on page 9-3.)

2 Remove 1 screw from bottom cover. (See the Chassis Assembly Drawing on page 9-3.)

3 Slide the metal cover off of the chassis. (See the Chassis Assembly Drawing on page 9-3.)

4 Install JM710 and JM711 located adjacent to the power supply connector, P751. A bare wire may be used if a 0 ohm surface mount resistor is not available. (See the 34401-66501 Main Board Component Locator Drawing on page 9-5.)

5 Reassemble the instrument. Make sure to reinstall the bottom cover screw.

> *Do not use the RS-232 interface if you have configured the multimeter to output pass/fail signals on pins 1 and 9. Internal components on the interface circuitry may be damaged*

Troubleshooting hints

This section provides a brief check list of common failures. Before troubleshooting or repairing the Multimeter, make sure the failure is in the instrument rather than any external connections. Also make sure that the instrument is accurately calibrated. The multimeter's circuits allow troubleshooting and repair with basic equipment such as a 6-1/2 digit multimeter and a 100 MHz oscilloscope.

> *Caution: This instrument contains CMOS integrated circuits which are susceptible to failure due to electrostatic discharge. Refer to the "Electrostatic discharge (ESD) precautions" section earlier in this chapter for further handling precautions.*

- **Unit is inoperative**

  Verify that the connected power line is live.

  Verify that the HP 34401A front panel **Power** switch is depressed.

  Verify that the correct power line fuse is installed:
  for 100 V or 120 V use a 250 mAT / 250 V fuse,
  for 220 V or 240 V use a 125 mAT / 250 V fuse.

  Verify that the correct power line voltage range is selected. See the "To prepare the multimeter for use" section in chapter 2.

- **Unit indicates an error between 740 and 748**

  These errors may be produced if you accidentally turn off power the unit during a calibration or while changing a non-volatile state of the instrument. Recalibration or resetting the state should clear the error. If the error persists, a hardware failure of U505 may have occurred.

- **Unit fails self-test**

  Verify that the correct power line voltage range is selected. See the "To prepare the multimeter for use" section in chapter 2.

  Ensure that all measurement terminal connections (both front panel and rear panel) are removed while the self-test is being performed. Errors may be induced by ac signals present on the multimeter input terminals during self-test. Long test leads can act as an antenna causing pick-up of ac signals.

- **Current input is inoperative**

  Verify that the rear panel 3 A / 250 V current input fuse is functional.

  Verify that the internal 7 A / 250 V sand-filled fuse is functional.

- **Power supply problems**

  Check that the input to the supply voltage regulator is at least 1 V greater than its output.

  Circuit failures can cause heavy supply loads which may pull down the regulator output voltage.

  Some circuits produce their own local power supplies from the main supplies. Be sure to check that these local supplies are active. In particular, the ADC (analog-to-digital converter), ac, and front panel sections have local supplies.

  Failure of the analog voltage reference U403 will cause many self-test failures. Be certain that U403 is seated properly in its socket.

  Always check that the supplies are free of ac oscillations using an oscilloscope.

  Check the main supply voltages tabulated below.

Power Supply	Minimum	Maximum
+5 Ground Ref.	4.75 V	5.25 V
+5 Floating	4.75 V	5.25 V
+18 Floating	18.0 V	20.0 V
-18 Floating	-17.0 V	-19.1 V
+7REF Floating	6.45 V	7.35 V
+5REF Floating	4.75 V	5.25 V

- **Readings indicate OVERLOAD**

  An overload is caused when the gain and offset corrected reading result is greater than the full scale value (or less than the full scale value) for the present measuring function and range. This can be caused by incorrect calibration, saturated (railed) dc input amplifier, or by failure of the a-to-d converter. Overload can also be caused if the current source value is too large in the ohms function. In ac functions, overload will also be generated if the output of the rms-to-dc converter U308 is greater than 2 V dc for sinewave inputs > 20 Hz.

- **Readings are Inaccurate**

Inaccurate readings are normally caused by either invalid calibration or by non-linear measuring circuits. If recalibration does not correct the inaccuracies, the amplifier or solid state switches may be causing measurement non-linearities. Non-linear operation of the ohms current source due to failure of Q202 to Q211 may cause reading inaccuracies in the ohms function. If the input to the ADC is shown to be linear, check the ±10 V reference voltages. Check switch U411, U420, and U402 for proper operation.

- **Readings show excessive noise**

Reading noise is usually caused by the dc input amplifier or the a-to-d converter circuitry. Remember that it is normal for the most sensitive measuring ranges to show more noise than the least sensitive ranges. Verify that the multimeter fails to meet its zero input specifications. Low frequency ac measurements will experience more noise than higher frequency inputs. Verify that the multimeter fails to meet ac specifications. Ensure that the correct AC Filter is selected for the applied input signal frequency.

If calibration constants become corrupted, it is possible for the multimeter to generate noisy results without a hardware failure. Perform a new zero offset calibration and gain calibration before attempting to service the instrument.

- **Readings indicate zero with any input applied**

A constant zero reading is normally caused when either the output of the dc input amplifier is stuck at a fixed level (like 0 volts) or when the a-to-d converter integrator amplifier U402 is stuck at a fixed level.

Self-test procedures

Power on self-test

Each time the HP 34401A Multimeter is powered on, a small set of self-tests are performed. These tests check that the minimum set of logic and measurement hardware are functioning properly. The power-on self-tests are listed below in the order they are executed. For a more complete description of each test, see the description in the following section, "Self-test procedures."

- Test 701, checks that the calibration security disable jumper is removed.
- Self-test 624, determines the correct power line frequency for the measurement section.
- Copy secured calibration constants from calibration ram U505 to working ram U503. *Errors 740 - 748 may be reported during this operation.*
- Self-test 625, establishs communication with the I/O processor U700.
- Self-test 601, establishs communication with the front panel U600.
- Self-test 603, checks that the ADC logic is functioning U501.
- Self-test 604, checks that the ADC analog hardware is functioning.
- Self-test 626, checks that U700 passed its self-test.

Self-test procedures

This section provides a brief description for each internal self-test procedure including purpose, test setup, and failure criteria. Erroneous self-test failures may occur when the power line voltage is improperly set. Errors may also be produced by ac signals present on the multimeter input terminals (front or rear) during self-test. Long test leads can act as an antenna causing pick-up of ac signals.

Failing a self-test procedure indicates that parts of the multimeter are not functioning properly and need to be serviced. Passing self-test gives a better than 90% confidence that the HP 34401A hardware is operational. However, passing self-test does not guarantee that the instrument will produce accurate results. Only performance verification can assess the accuracy of measurement results.

Self-test procedures are numbered in the order in which they are executed. The order is designed to build confidence from a small kernel towards progressively more complex internal configurations.

Many individual self-test procedures may be executed from the front panel by selecting the desired test number from the parameter list of the SELF-TEST command.

> *NOTE: K101 is always open during self-test so that signals present on the input terminals are disconnected. However, ac signals may still feed through K101 causing self-test failures as mentioned earlier in this section.*

- **601, "Front panel does not respond"**. The main CPU U500 attempts to establish serial communications with the front panel processor U600. During this test, U600 turns on all display segments. Communication must function in both directions for this test to pass.
- **602, "RAM read/write failed"**. This test writes and reads a 55 hex and AA hex checker board pattern to each address of ram U503. Any incorrect readback will cause a test failure. This error is only readable from the remote interface.
- **603, "A/D sync stuck"**. The main CPU issues an a/d sync pulse to U500-38 and to U501 where ADC slope counters are latched. A failure is detected when a sync interrupt is not recognized and a subsequent time-out occurs.
- **604, "A/D slope convergence failed"**. The dc section is configured to the measure zero state (MZ) in the 10 V range. This test checks whether the ADC integrator produces nominally the same number of positive and negative slope decisions ($\pm$10%) during a 20 mS interval.
- **605, "Cannot calibrate rundown gain"**. This test checks the nominal gain between the integrating ADC and the U500 onchip ADC. This error is reported if the procedure can not run to completion due to a hardware failure.
- **606, "Rundown gain out of range"**. This test checks the nominal gain between the integrating ADC and the U500 onchip ADC. The nominal gain is checked to $\pm$10% tolerance.

- **607, "Rundown too noisy"**. This test checks the gain repeatability between the integrating ADC and the U500 onchip ADC. The gain test (606), is performed eight times. Gain noise must be less than ±64 lsb's of the U500 on chip ADC.
- **608, "Serial configuration readback failed"**. This test re-sends the last 5 byte serial configuration data for the measurement sections. The data is then clocked back into U501 and compared against the original 5 bytes sent. A failure occurs if the data do not match.
- **609, "DC gain x1 failed"**. This test configures for the 10 V dc range. The dc amplifier gain is set to x1. The measure customer (MC) input is selected to the internal TSENSE source which produces 0.6 V. A 20 mS ADC measurement is performed and checked against a limit of 0.6 V ±0.3 V.
- **610, "DC gain x10 failed"**. This test configures for the 1 V dc range. The dc amplifier gain is set to x10. The measure customer (MC) input is selected to the internal TSENSE source which produces 0.6 V. A 20 mS ADC measurement is performed and checked against a limit of 0.6 V ±0.3 V.
- **611, "DC gain x100 failed"**. This test configures for the 100 mV dc range. The dc amplifier gain is set to x100. The measure customer (MC) input is selected to the internal TSENSE source which produces 0.6 V. A 20 mS ADC measurement is performed and checked for a +overload response.
- **612, "Ohms 500 nA source failed"**. This test configures to the 10 V dc range with the internal 10 M 100:1 divider U102A connected across the input. The 500 nA ohms current source is connected to produce a nominal 5 V signal. A 20 ms ADC measurement is performed and the result is checked against a limit of 5 V ±1 V.
- **613, "Ohms 5 μA source failed"**. This test configures to the 10 V dc range with the internal 10 M 100:1 divider U102A connected across the input. The 5 μA ohms current source is connected. The compliance limit of the current source is measured. A 20 ms ADC measurement is performed and the result is checked against a limit of 7.5 V ±3 V.
- **614, "DC 1000 V zero failed"**. This test configures to the 1000 V dc range with no input applied. A 20 ms ADC measurement is performed and the result is checked against a limit of 0 V ±5 mV.

- **615, "Ohms 10 μA source failed"**. This test configures to the 10 V dc range with the internal 10 M 100:1 divider U102A connected across the input. The 10 μA ohms current source is connected. The compliance limit of the current source is measured. A 20 ms ADC measurement is performed and the result is checked against a limit of 7.5 V ±3 V.
- **616, "DC current sense failed"**. This test configures to the 3 A dc range. A 20 ms ADC measurement is performed and the result is checked against a limit of 0 A ±5 A. This test confirms that the dc current sense path is functional. The test limit is set wide because K101 does not open the current input during self-test. This test should catch a dc current sense failure without causing false failures when current inputs are applied during self-test.
- **617, "Ohms 100 μA source failed"**. This test configures to the 10 V dc range with the internal 10 M 100:1 divider U102A connected across the input. The 100 μA ohms current source is connected. The compliance limit of the current source is measured. A 20 ms ADC measurement is performed and the result is checked against a limit of 7.5 V ±3 V.
- **618, "DC high voltage attenuator failed"**. This test configures to the 1000 V dc range. The 500 nA ohms current source is connected to produce a nominal 5 V signal. A 20 ms ADC measurement is performed and the result is checked against a limit of 5 V ±1 V.
- **619, "Ohms 1 mA source failed"**. This test configures to the 10 V dc range with the internal 10 M 100:1 divider U102A connected across the input. The 1 mA ohms current source is connected. The compliance limit of the current source is measured. A 20 ms ADC measurement is performed and the result is checked against a limit of 7 V ±3.5 V.
- **620, "AC rms zero failed"**. This test configures for the 100 mV ac range with the ac input grounded through K103. The internal residual noise of the ac section is measured and checked against a limit of -10 mV to 70 mV at the output of the rms-to-dc converter.
- **621, "AC rms full scale failed"**. This test configures for the 100 mV ac range. The 1 mA ohms current source is switched on to charge the ac input capacitor C301. This produces a pulse on the output of the rms-to-dc converter which is sampled 100 ms after the current is applied. A 20 ms a/d measurement is performed and checked against a limit of 10 V ±8 V into the ADC.

- **622, "Frequency counter failed"**. This test configures for the 100 mV ac range. This test immediately follows test 621. With C301 holding a charge from test 621 the ac input is now switched to ground with K103. This produces a positive pulse on the input to the frequency comparator U310A. While C301 discharges, the ENAB FREQ bit is toggled 4 times to produce a frequency input to the counter logic in U501. A failure occurs if the counter can not measure the frequency input.
- **623, "Cannot calibrate precharge"**. This test configures to the 100 V dc range with no input applied. The ADC is configured for 200 ms measurements. The U500 pulse width modulated (PWM) DAC output (C512) is set to about 4 V. A reading is taken in with U101 in the MC state. A second reading is taken in the PRE state. The precharge amplifier voltage offset is calculated. The U500 DAC output is set to about 1.5 V and the precharge offset is measured again. The gain of the offset adjustment is calculated. This test assures a precharge amplifier offset adjustment is achievable.
- **624, "Unable to sense line frequency"**. This test checks that the LSENSE logic input to U500 is toggling. If no logic input is detected, the instrument will assume 50 Hz line operation for all future measurements.
- **625, "I/O processor does not respond".** This test checks that communications can be established between U500 and U700 through the optically isolated (U506 and U704) serial data link. Failure to establish communication in either direction will generate an error.
- **626, "I/O processor failed self-test"**. This test causes the earth referenced processor U700 to execute an internal, ram test. Failure will generate an error.

7

Replaceable Parts

Replaceable Parts

This section contains information for ordering replacement parts for your HP 34401A Multimeter. The parts lists are grouped by printed circuit assembly:

Main PC Assembly A1 (34401-66501)
Display PC Assembly A2 (34401-66502)
Mainframe Parts List (HP 34401A)

Parts are listed in the alphanumeric order of their schematic reference designators. A brief part description is provided along with the applicable HP part number and manufacturer part number.

To order replacement parts

Parts may be obtained from HP or directly from the manufacturer using the manufacturers part number shown in the replaceable parts list. To order replacement parts from HP, do the following:

1 Contact your nearest HP Sales Office or HP Service Center.

2 Identify parts by their HP part number shown in the replaceable parts list.

3 Provide the instrument model number and serial number.

Backdating and part changes

Always refer to chapter 8, "Backdating," before attempting repair or before ordering replacement parts. Parts changes are documented in the backdating chapter.

34401-66501 Replacement parts

Reference Designation	HP Part Number	Qty	Part Description	Mfr. Code	Mfr Part Number
A1C100	0160-6839	1	CAPACITOR-FXD 470pF +-2% 630 V	28480	0160-6839
A1C101-C103	0160-6842	3	CAPACITOR-FXD 220pF +-2% 630 V	28480	0160-6842
A1C104	0160-6497	36	CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C105	0160-6731	3	CAPACITOR-FXD 1000pF +-10% 50 V	04222	12061C102KAT A
A1C106-C107	0160-5967	3	CAPACITOR-FXD 100pF +-5% 50 V	04222	08051A101JAT A
A1C108	0160-6736	7	CAPACITOR-FXD 0.01uF +-10% 50 V	04222	12061C103KAT A
A1C109	0150-0012	1	CAPACITOR-FXD 0.01uF +-20% 1 kV	56289	C023A102J103M S38-CDH
A1C110	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C113	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C120	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C150	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C151	0160-6736		CAPACITOR-FXD 0.01uF +-10% 50 V	04222	12061C103KAT A
A1C152	0160-6731		CAPACITOR-FXD 1000pF +-10% 50 V	04222	12061C102KAT A
A1C210	0160-5954	4	CAPACITOR-FXD 220pF +-5% 50 V	04222	08051A221JAT A
A1C212	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C301	0160-3986	1	CAPACITOR-FXD 0.22uF +-10% 400 V	14752	210BE224K
A1C302	0160-7605	1	CAPACITOR-FXD 1.8pF +-13.89% 1.5 kV	04222	MA30SA1R8CAA
A1C303	0160-6098	1	CAPACITOR-FXD 680pF +-5% 50 V	04222	12061A681JAT A
A1C304	0160-5973	1	CAPACITOR-FXD 6.8pF +-7.35% 50 V	04222	08051A6R8DAT A
A1C305	0160-6096	1	CAPACITOR-FXD 470pF +-5% 50 V	04222	12061A471JAT A
A1C306	0160-5972	1	CAPACITOR-FXD 5.6pF +-8.93% 50 V	04222	08051A5R6DAT A
A1C307	0160-5967		CAPACITOR-FXD 100pF +-5% 50 V	04222	08051A101JAT A
A1C308-C310	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C311-C312	0180-4116	6	CAPACITOR-FXD 22uF +-20% 20 V	28480	0180-4116
A1C313	0160-5955	1	CAPACITOR-FXD 68pF +-5% 50 V	04222	08051A680JAT A
A1C314-C315	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C316	0160-5847	2	CAPACITOR-FXD .22uF +-10% 100 V	28480	0160-5847
A1C317	0160-6729	2	CAPACITOR-FXD 3300pF +-10% 50 V	04222	12061C332KAT A
A1C318	0160-5847		CAPACITOR-FXD .22uF +-10% 100 V	28480	0160-5847
A1C319-C320	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C321	0160-5469	1	CAPACITOR-FXD 1uF +-10% 50 V	50088	BF064D0105KDB
A1C322-C323	0180-4116		CAPACITOR-FXD 22uF +-20% 20 V	28480	0180-4116
A1C324	0160-5959	2	CAPACITOR-FXD 33pF +-5% 50 V	04222	08051A330JAT A
A1C326	0160-6731		CAPACITOR-FXD 1000pF +-10% 50 V	04222	12061C102KAT A
A1C327	0160-5959		CAPACITOR-FXD 33pF +-5% 50 V	04222	08051A330JAT A
A1C400-C401	0160-5954		CAPACITOR-FXD 220pF +-5% 50 V	04222	08051A221JAT A
A1C403-C404	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C407-C410	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C411	0180-3744	1	CAPACITOR-FXD 4.7uF +-20% 10 V	28480	0180-3744
A1C441-C442	0160-6736		CAPACITOR-FXD 0.01uF +-10% 50 V	04222	12061C103KAT A
A1C449	0160-6736		CAPACITOR-FXD 0.01uF +-10% 50 V	04222	12061C103KAT A
A1C500-C503	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C504-C505	0160-6736		CAPACITOR-FXD 0.01uF +-10% 50 V	04222	12061C103KAT A
A1C506	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A

34401-66501 Replacement parts cont'd

Reference Designation	HP Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
A1C512	0180-4228	2	CAPACITOR-FXD 47uF +-20% 10 V	28480	0180-4228
A1C551	0180-4433	2	CAPACITOR-FXD 1000uF +-20% 50 V	28480	0180-4433
A1C552	0180-3751	3	CAPACITOR-FXD 1uF +-20% 35 V	28480	0180-3751
A1C553	0180-4433		CAPACITOR-FXD 1000uF +-20% 50 V	28480	0180-4433
A1C554	0180-3751		CAPACITOR-FXD 1uF +-20% 35 V	28480	0180-3751
A1C555	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C556	0180-4435	1	CAPACITOR-FXD 2200uF +-20% 25 V	28480	0180-4435
A1C557	0180-4116		CAPACITOR-FXD 22uF +-20% 20 V	28480	0180-4116
A1C558	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C559	0180-4116		CAPACITOR-FXD 22uF +-20% 20 V	28480	0180-4116
A1C700-C703	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C704	0160-6729		CAPACITOR-FXD 3300pF +-10% 50 V	04222	12061C332KAT A
A1C705	0160-5954		CAPACITOR-FXD 220pF +-5% 50 V	04222	08051A221JAT A
A1C706	0180-4228		CAPACITOR-FXD 47uF +-20% 10 V	28480	0180-4228
A1C707-C711	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C751	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A1C752	0180-4434	1	CAPACITOR-FXD 4700uF +-20% 25 V	28480	0180-4434
A1C753	0180-3751		CAPACITOR-FXD 1uF +-20% 35 V	28480	0180-3751
A1CR100	1901-0638	1	DIODE-FULL-WAVE BRIDGE 100V4A	71744	KBU4B
A1CR103	1902-1565	3	DIODE-ZENER 4.7V 5% TO-236	28480	1902-1565
A1CR201	1902-1565		DIODE-ZENER 4.7V 5% TO-236	28480	1902-1565
A1CR202	1901-1378	1	DIODE-HV RECTIFIER 1.6KV 500MA	71744	GP10Y
A1CR203	1902-1565		DIODE-ZENER 4.7V 5% TO-236	28480	1902-1565
A1CR301-CR303	1906-0291	11	DIODE-DUAL 70V 100MA TO-236AA	04713	MBAV99
A1CR304-CR307	1902-1541	6	DIODE-ZENER 3.3V 5% TO-236	04713	BZX84C3V3
A1CR401-CR402	1902-1541		DIODE-ZENER 3.3V 5% TO-236	04713	BZX84C3V3
A1CR403-CR404	1906-0291		DIODE-DUAL 70V 100MA TO-236AA	04713	MBAV99
A1CR551-CR552	1906-0407	3	DIODE-FULL-WAVE BRIDGE 400V 1A	71744	DF04S
A1CR553	1906-0291		DIODE-DUAL 70V 100MA TO-236AA	04713	MBAV99
A1CR554	1902-1542	1	DIODE-ZENER 6.2V 5% TO-236	04713	BZX84C6V2
A1CR555-CR556	1902-1609	2	DIODE-ZENER 6.2V 5% PD=1.5W	04713	1SMB5920B
A1CR701-CR705	1906-0291		DIODE-DUAL 70V 100MA TO-236AA	04713	MBAV99
A1CR751	1906-0407		DIODE-FULL-WAVE BRIDGE 400V 1A	71744	DF04S
A1E100-E101	1970-0212	2	TUBE ELECTRON SURGE ARRESTOR 1500V/10A	28480	1970-0212
A1E700	9164-0173	1	ALARM-AUDIBLE 25 V	28480	9164-0173
A1F101	2110-0780	1	FUSE (METRIC) 3A 250V FE UL	75915	235003
A1F102	2110-0614	1	FUSE (INCH) 7A 250V NTD FE UL	75915	314007
A1FC101	2110-0869	1	FUSEHOLDER-HRZNTL PC MNT 6.3A 250V	28480	2110-0869
A1FC102	2110-0565	1	FUSEHOLDER CAP 12A MAX FOR UL	28480	2110-0565
A1J701	1252-2047	1	CONNECTOR-RECT 24-CKT 24-CONTACT	09922	488-1R4-24DM30K9
A1J702-J703	1250-1884	2	CONNECTOR-RF BNC FEM 50-OHM	00779	227161-6

34401-66501 Replacement parts cont'd

Reference Designation	HP Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
A1J704	1252-2266	1	CONNECTOR-RECT D-SUBMIN 9-CKT 9-CONTACT	00779	748959-1
A1JM551-JM553	0699-1503	4	RESISTOR-FXD 0 CWM	91637	CRCW1206000J
A1JM751	0699-1503		RESISTOR-FXD 0 CWM	91637	CRCW1206000J
A1K101	0490-1748	1	RELAY-REED 2A 500VDC 5VDC-COIL	71707	3200-0103
A1K102-K104	0490-1789	3	RELAY 2C 5VDC-COIL 3A 220VC	28480	0490-1789
A1L101	9140-1244	2	INDUCTOR-FIXED 1MH +-5% 3.4W	28480	9140-1244
A1L102-L104	9140-1238	5	INDUCTOR-FIXED 10UH +-5% 2.8W	24226	SM3-102J
A1L106	9140-1244		INDUCTOR-FIXED 1MH +-5% 3.4W	28480	9140-1244
A1L110-L111	9140-1238		INDUCTOR-FIXED 10UH +-5% 2.8W	24226	SM3-102J
A1L401-L403	9170-1431	4	CORE-SHIELDING BEAD	28480	9170-1431
A1L404	9170-1506	1	CORE-SHIELDING BEAD	28480	9170-1506
A1L501	9170-1431		CORE-SHIELDING BEAD	28480	9170-1431
A1P101-P102	34401-62101	2	INPUT JACK ASSY	28480	34401-62101
A1P500	1252-4484	1	CONNECTOR-POST TYPE 12-CONTACT	27264	52007-1210
A1P551	1252-4488	1	CONNECTOR POST TYPE 8 CONTACT	27264	26-64-4080
A1P751	1252-4487	1	CONNECTOR POST TYPE 3 CONTACT	27264	26-64-4030
A1PCB1	34401-26501	1	PRINTED CIRCUIT BOARD - BLANK	28480	34401-26501
A1Q104	1855-0752	2	TRANSISTOR J-FET N-CHAN D-MODE	27014	MMBF4392
A1Q150-Q153	1854-1014	4	TRANSISTOR NPN SI PD=350MW FT=100MHZ	04713	MMBT6429
A1Q201	1855-0752		TRANSISTOR J-FET N-CHAN D-MODE	27014	MMBF4392
A1Q202	1855-0863	1	TRANSISTOR J-FET P-CHAN D-MODE	27014	MMBF5461SEL
A1Q203-Q210	1853-0727	8	TRANSISTOR PNP SI SOT-23	04713	MMBT6520L
A1Q211	1855-0865	1	TRANSISTOR J-FET N-CHAN D-MODE	27014	MMBF4117A
A1Q301	1855-0800	1	TRANSISTOR MOSFET N-CHAN E-MODE	04713	MTD3055EL
A1R101-R102	0699-1327	3	RESISTOR 1M +-1% .125W	28480	0699-1327
A1R103	0699-1380	5	RESISTOR 3.16K +-1% .125W	28480	0699-1380
A1R104-R111	0699-3409	8	RESISTOR 13K +-5% 1W	91637	CRCW2512-133J
A1R112-R113	0699-1330	5	RESISTOR 100K +-1% .125W	28480	0699-1330
A1R114-R117	0699-1423	17	RESISTOR 215 +-1% .125W	28480	0699-1423
A1R118	0699-1380		RESISTOR 3.16K +-1% .125W	28480	0699-1380
A1R119	0699-1423		RESISTOR 215 +-1% .125W	28480	0699-1423
A1R120	0699-1514	1	RESISTOR .1 +-1% 5W MFS	01686	LO-5-.1-1-RP
A1R121	0699-3413	1	RESISTOR 5 +-0.1% .125W	11502	CM60T13 50HMS0.1
A1R122	0699-1329	4	RESISTOR 6.19K +-1% .125W	28480	0699-1329
A1R124	0699-1329		RESISTOR 6.19K +-1% .125W	28480	0699-1329
A1R126-R127	0699-1398	8	RESISTOR 21.5K +-1% .125W	28480	0699-1398
A1R130	0699-1394	2	RESISTOR 14.7K +-1% .125W	28480	0699-1394
A1R131	0699-1398		RESISTOR 21.5K +-1% .125W	28480	0699-1398
A1R150	0699-1391	9	RESISTOR 10K +-1% .125W	28480	0699-1391

34401-66501 Replacement parts cont'd

Reference Designation	HP Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
A1R151	0699-1427	2	RESISTOR 316 +-1% .125W	28480	0699-1427
A1R160-R161	0686-4715	2	RESISTOR 470 +-5% .5W CC	01121	EB4715
A1R170-R176	0699-3406	14	RESISTOR 24K +-5% 1W	91637	CRCW2512-243J
A1R180-R186	0699-3406		RESISTOR 24K +-5% 1W	91637	CRCW2512-243J
A1R196	0699-1391		RESISTOR 10K +-1% .125W	28480	0699-1391
A1R197	0699-1389	2	RESISTOR 8.25K +-1% .125W	28480	0699-1389
A1R201	0699-3404	1	RESISTOR 400K +-1% .125W	28480	0699-3404
A1R202	0699-3405	1	RESISTOR 40K +-1% .1W	28480	0699-3405
A1R203-R206	0699-1332	4	RESISTOR 196K +-1% .125W	28480	0699-1332
A1R207	0699-1318	13	RESISTOR 1K +-1% .125W	28480	0699-1318
A1R290	0699-1374	4	RESISTOR 1.78K +-1% .125W	28480	0699-1374
A1R301-R302	0699-2469	2	RESISTOR 500K +-0.25% .25W	28480	0699-2469
A1R303	0699-1307	1	RESISTOR 1.96K +-0.1% .1W	28480	0699-1307
A1R304	0699-0481	1	RESISTOR 200K +-1% .1W	28480	0699-0481
A1R305	0699-1374		RESISTOR 1.78K +-1% .125W	28480	0699-1374
A1R306	0699-1423		RESISTOR 215 +-1% .125W	28480	0699-1423
A1R307	0699-1374		RESISTOR 1.78K +-1% .125W	28480	0699-1374
A1R308	0699-1423		RESISTOR 215 +-1% .125W	28480	0699-1423
A1R309	0699-1329		RESISTOR 6.19K +-1% .125W	28480	0699-1329
A1R310	0699-1360	1	RESISTOR 46.4 +-1% .125W	28480	0699-1360
A1R311-R312	0699-1412	3	RESISTOR 75K +-1% .125W	28480	0699-1412
A1R313	0699-1329		RESISTOR 6.19K +-1% .125W	28480	0699-1329
A1R314	0699-1398		RESISTOR 21.5K +-1% .125W	28480	0699-1398
A1R315	0699-1327		RESISTOR 1M +-1% .125W	28480	0699-1327
A1R316	0699-1423		RESISTOR 215 +-1% .125W	28480	0699-1423
A1R317	0699-1406	2	RESISTOR 42.2K +-1% .125W	28480	0699-1406
A1R318	0699-1318		RESISTOR 1K +-1% .125W	28480	0699-1318
A1R319	0699-1398		RESISTOR 21.5K +-1% .125W	28480	0699-1398
A1R320	0699-1427		RESISTOR 316 +-1% .125W	28480	0699-1427
A1R321	0699-1382	1	RESISTOR 3.83K +-1% .125W	28480	0699-1382
A1R322	0699-1412		RESISTOR 75K +-1% .125W	28480	0699-1412
A1R323-R324	0699-1398		RESISTOR 21.5K +-1% .125W	28480	0699-1398
A1R325-R326	0699-1423		RESISTOR 215 +-1% .125W	28480	0699-1423
A1R403	0699-1319	1	RESISTOR 12.1K +-1% .125W	28480	0699-1319
A1R405	0699-1380		RESISTOR 3.16K +-1% .125W	28480	0699-1380
A1R406	0699-1330	6	RESISTOR 100 +-1% .125W	28480	0699-1415
A1R407-R408	0699-1318		RESISTOR 1K +-1% .125W	28480	0699-1318
A1R409	0699-1372	1	RESISTOR 1.47K +-1% .125W	28480	0699-1372
A1R420	0699-1389		RESISTOR 8.25K +-1% .125W	28480	0699-1389
A1R421	0699-1318		RESISTOR 1K +-1% .125W	28480	0699-1318
A1R430	0699-1348	1	RESISTOR 14.7 +-1% .125W	28480	0699-1348
A1R440	0699-1406		RESISTOR 42.2K +-1% .125W	28480	0699-1406
A1R441	0699-1394		RESISTOR 14.7K +-1% .125W	28480	0699-1394
A1R442	0699-2127	1	RESISTOR 36.5K +-1% .125W	28480	0699-2127
A1R449	0699-1415	1	RESISTOR 100 +-1% .125W	28480	0699-1415
A1R501	0699-1318		RESISTOR 1K +-1% .125W	28480	0699-1318
A1R502	0699-1330		RESISTOR 100K +-1% .125W	28480	0699-1330

34401-66501 Replacement parts cont'd

Reference Designation	HP Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
A1R503	0699-1423		RESISTOR 215 +-1% .125W	28480	0699-1423
A1R504	0699-1391		RESISTOR 10K +-1% .125W	28480	0699-1391
A1R505-R506	0699-1386	2	RESISTOR 5.62K +-1% .125W	28480	0699-1386
A1R507	0699-1391		RESISTOR 10K +-1% .125W	28480	0699-1391
A1R508-R509	0699-1318		RESISTOR 1K +-1% .125W	28480	0699-1318
A1R510-R511	0699-1391		RESISTOR 10K +-1% .125W	28480	0699-1391
A1R512-R517	0699-1423		RESISTOR 215 +-1% .125W	28480	0699-1423
A1R518	0699-1391		RESISTOR 10K +-1% .125W	28480	0699-1391
A1R551	0699-1424	2	RESISTOR 237 +-1% .125W	28480	0699-1424
A1R552	0699-2431	1	RESISTOR 3.32K +-1% .125W	28480	0699-2431
A1R553	0699-1424		RESISTOR 237 +-1% .125W	28480	0699-1424
A1R554	0699-1380		RESISTOR 3.16K +-1% .125W	28480	0699-1380
A1R555	0699-1453	1	RESISTOR 464K +-1% .125W	28480	0699-1453
A1R556	0699-1391		RESISTOR 10K +-1% .125W	28480	0699-1391
A1R701	0699-3408	1	RESISTOR 1K +-5% 1W	91637	CRCW2512-102J
A1R702	0699-1398		RESISTOR 21.5K +-1% .125W	28480	0699-1398
A1R703	0699-1391		RESISTOR 10K +-1% .125W	28480	0699-1391
A1R704	0699-1330		RESISTOR 100K +-1% .125W	28480	0699-1330
A1R705	0699-1318		RESISTOR 1K +-1% .125W	28480	0699-1318
A1R706	0699-3407	1	RESISTOR 100 +-5% 1W	91637	CRCW2512-101J
A1R707-R708	0699-1318		RESISTOR 1K +-1% .125W	28480	0699-1318
A1R709	0699-1380		RESISTOR 3.16K +-1% .125W	28480	0699-1380
A1R720	0699-1374		RESISTOR 1.78K +-1% .125W	28480	0699-1374
A1R750-R751	0699-1318		RESISTOR 1K +-1% .125W	28480	0699-1318
A1RV100-RV102	0837-0382	3	DIODE-VARISTOR 1.1KV	28480	0837-0382
A1S1	3101-3162	1	SWITCH-PUSHBUTTON .4A 25 VAC/VDC	71468	603296
A1U101	1SK6-0001	1	SWITCH CHIP	28480	1SK6-0001
	34401-67901	1	RES NETWORK	28480	34401-67901
A1U103	1826-2420	5	IC-OP AMP LP DUAL 8-PIN	24355	AD706JR
A1U104	1855-0864	1	TRANSISTOR-JFET DUAL	27014	NPDSU406
A1U105	1826-2083	3	IC-OP AMP H-SLEW-RATE SGL 8-PIN	04713	MC34081AD
A1U106	1826-1925	2	IC-OP AMP LOW-NOISE SGL 8-PIN	06665	OP-27GS
A1U110	1826-2083		IC-OP AMP H-SLEW-RATE SGL 8-PIN	04713	MC34081AD
A1U150	1820-8937	1	IC GATE-ARRAY CMOS	27014	SCX6B04AKP
A1U153	1826-2420		IC-OP AMP LP DUAL 8-PIN	24355	AD706JR
A1U201	1826-2420		IC-OP AMP LP DUAL 8-PIN	24355	AD706JR
A1U301	1826-2436	1	IC-OP AMP WIDEBAND 8-PIN	27014	LF356M
A1U302	1826-2339	1	IC-CONVERTER D/A 8-BIT CMOS	24355	AD7524JR
A1U303	1826-2437	3	IC-OP AMP WIDEBAND 8-PIN	27014	LF357M
A1U304	1826-1985	1	IC ANALOG SWITCH 4 SPST 16-P-SOIC	17856	DG411DY
A1U305	1826-2437		IC-OP AMP WIDEBAND 8-PIN	27014	LF357M
A1U306	1826-1609	1	IC ANALOG SWITCH 4 SPST 16-P-SOIC	17856	DG211DY
A1U307	1826-2083		IC-OP AMP H-SLEW-RATE SGL 8-PIN	04713	MC34081AD
A1U308	1826-2445	1	IC-CONVERTER RMS/DC 16-P-SOIC MISC	24355	AD637JR

7

34401-66501 Replacement parts cont'd

Reference Designation	HP Part Number	Qty	Part Description	Mfr. Code	Mfr. Part Number
A1U309	1820-5790	2	IC SHF-RGTR CMOS/74HC SYNCHR	01832	474HC4094D
A1U310	1826-1572	1	IC COMPARATOR PRCN DUAL 8-PIN	18324	LM393D
A1U311	1820-5790		IC SHF-RGTR CMOS/74HC SYNCHR	01832	474HC4094D
A1U312	1826-2437		IC-OP AMP WIDEBAND 8-PIN	27014	LF357M
A1U400-U401	1826-2420		IC-OP AMP LP DUAL 8-PIN	24355	AD706JR
A1U402	1826-1991	1	IC-OP AMP HS SINGLE 8-PIN	24355	AD711JR
A1U403	1826-1249	1	IC V RGLTR-V-REF-FXD 6.8/7.1V	28480	1826-1249
A1U404	1820-5937	1	IC FF CMOS/74AC D-TYPE POS-EDGE-TRIG	27014	74AC74SC
A1U405	1813-0827	1	CLOCK-OSCILLATOR-XTAL 12.0MHZ 0.01%	28480	1813-0827
A1U411	1820-4346	1	IC MUXR/DATA-SEL CMOS/74HC 2-TO-1-LINE	18324	74HC4053D
A1U420	1826-1925		IC-OP AMP LOW-NOISE SGL 8-PIN	06665	OP-27GS
A1U500	1820-6721	1	IC-16-BIT MCU,I/O,TIMER,TIMER,A/D	34649	N80C196KB12
A1U501	1820-8907	1	IC GATE-ARRAY CMOS	27014	SCX6206AK0
A1U502	34401-88801	1	PROG EPROM (1818-5187)	2848	034401-88801
	1818-5187	1	IC 2M OTP ROM 150-NS CMOS	34335	AM27C020-155JC
A1U503	1818-4777	1	IC CMOS 262144 (256K) STAT RAM 70-NS	28480	1818-4777
A1U505	1818-5236	1	IC 4K EEPROM 500-NS CMOS	27014	NM93C66M8
A1U506	1990-1552	2	OPTO-ISOLATOR LED-IC GATE IF=10MA-MAX	28480	HCPL-2211-300
A1U551	1826-2465	1	IC V RGLTR-ADJ-POS 1.2/37V	27014	LM317T-LB01
A1U552	1826-2463	1	IC V RGLTR-ADJ-NEG 1.2/37V	27014	LM337T-LB01
A1U553	1826-2461	1	IC V RGLTR-FXD-POS 4.75/5.25V	27014	LM2925T-LB01
A1U700	34401-88802	1	MICRO PROC (1821-0015)	28480	34401-88802
	1821-0015	1	IC-8-BIT MCU W/8K EPROM & PRGMBL CNTR	34649	N87C51FA
A1U701	1820-6974	1	IC-GPIB CONTROLLER IEEE-488 1975/78	01295	TMS9914AFNL
A1U702	1820-6176	1	IC-INTERFACE HPIB OCTAL DATA XCVR	01295	SN75ALS160DW
A1U703	1820-6175	1	IC-INTERFACE XCVR BIPOLAR BUS OCTL	01295	SN75ALS162DW
A1U704	1990-1552		OPTO-ISOLATOR LED-IC GATE	28480	HCPL-2211-300
A1U705	1820-6470	1	IC SCHMITT-TRIGGER CMOS/74HCT	18324	74HCT14D
A1U706	1820-7662	1	IC-INTERFACE DRVR/RCVR BIPOLAR DUAL	28480	1820-7662
A1U751	1826-2464	1	IC V RGLTR-FXD-POS 4.8/5.2V	27014	LM340T-5-LB01
A1US403	1200-1672	1	SOCKET-IC-DIP 4 CONTACT DIP-SLDR	06776	SBL-041-SP122-TG30
A1XF102	2110-0690	1	FUSEHOLDER-BIPIN-SOCKET 16A 250V UL	28480	2110-0690
A1Y701	0410-2356	1	CRYSTAL-QUARTZ 12.0 MHZ	28480	0410-2356

Code list of manufacturers - 34401-66501

Mfr. Code	Manufacturer's Name	Manufacturer's Address			Zip Code
00779	AMP INC	HARRISBURG	PA	US	17111
01121	ALLEN-BRADLEY CO INC	EL PASO	TX	US	79935
01295	TEXAS INSTRUMENTS INC	DALLAS	TX	US	75265
01686	RCL ELECTRONICS INC	NORTHBROOK	IL	US	60062
04222	AVX CORP	GREAT NECK	NY	US	11021
04713	MOTOROLA INC	ROSELLE	IL	US	60195
06665	PRECISION MONOLITHICS INC	SANTA CLARA	CA	US	95054
06776	ROBINSON NUGENT INC	NEW ALBANY	IN	US	47150
09922	BURNDY CORP	NORWALK	CT	US	06856
11502	IRC INC	BOONE	NC	US	28607
14752	ELECTRO CUBE INC	SAN GABRIEL	CA	US	91776
17856	SILICONIX INC	SANTA CLARA	CA	US	95054
18324	SIGNETICS CORP	SUNNYVALE	CA	US	94086
24226	GOWANDA ELECTRONICS CORP	GOWANDA	NY	US	14070
24355	ANALOG DEVICES INC	NORWOOD	MA	US	02062
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA	US	95052
27264	MOLEX INC	LISLE	IL	US	60532
28480	HEWLETT PACKARD COMPANY - CORPORATE	PALO ALTO	CA	US	94304
34335	ADVANCED MICRO DEVICES INC	SUNNYVALE	CA	US	94086
34649	INTEL CORP	SANTA CLARA	CA	US	95054
50088	SGS-THOMSON MICROELECTRONICS INC	PHOENIX	AZ	US	85022
56289	SPRAGUE ELECTRIC CO	LEXINGTON	MA	US	02173
71468	ITT CORP	NEW YORK	NY	US	10022
71707	COTO WABASH	PROVIDENCE	RI	US	02907
71744	GENERAL INSTRUMENT CORP	CLIFTON	NJ	US	07012
75915	LITTELFUSE INC	DES PLAINES	IL	US	60016
76381	3M CO	ST PAUL	MN	US	55144
85480	BRADY W H CO	MILWAUKEE	WI	US	53209
91637	DALE ELECTRONICS INC	COLUMBUS	NE	US	68601

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34401-66502 Replacement parts

Reference Designation	HP Part Number	Qty	Part Description	Mfr. Code	Mfr.Part Number
A2C600-C601	0160-6497	4	CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A2C602-C604	0180-3751	3	CAPACITOR-FXD 1uF +-20% 35 V	28480	0180-3751
A2C605	0160-6736	3	CAPACITOR-FXD 0.01uF +-10% 50 V	04222	12061C103KAT A
A2C606	0160-5959	1	CAPACITOR-FXD 33pF +-5% 50 V	04222	08051A330JAT A
A2C608-C609	0160-6497		CAPACITOR-FXD 0.1uF +-10% 50 V	04222	12065C104KAT A
A2C620-C621	0160-6731	2	CAPACITOR-FXD 1000pF +-10% 50 V	04222	12061C102KAT A
A2C622-C623	0160-6736		CAPACITOR-FXD 0.01uF +-10% 50 V	04222	12061C103KAT A
A2CR600	1902-1544	1	DIODE-ZENER 10V 5% TO-236 PD=.35W	04713	BZX84C10
A2CR601	1906-0291	2	DIODE-DUAL 70V 100MA	04713	MBAV99
A2CR603	1906-0291		DIODE-DUAL 70V 100MA	04713	MBAV99
A2CR604-CR605	1906-0337	4	DIODE-DUAL 60V 200MA	28480	1906-0337
A2CR606	1902-1565	1	DIODE-ZENER 4.7V 5%	28480	1902-1565
A2CR608-CR609	1906-0337		DIODE-DUAL 60V 200MA	28480	1906-0337
A2M600-M601	34401-00601	2	SHIELD-ESD	28480	34401-00601
A2PCB1	34401-26502	1	PRINTED CIRCUIT BOARD - BLANK	28480	34401-26502
A2R600	0699-1322	1	RESISTOR 68.1K +-1% .125W	28480	0699-1322
A2R602	0699-1378	1	RESISTOR 2.61K +-1% .125W	28480	0699-1378
A2R603	0699-1399	1	RESISTOR 23.7K +-1% .125W	28480	0699-1399
A2R604	0699-1398	1	RESISTOR 21.5K +-1% .125W	28480	0699-1398
A2R605-R606	0699-1330	6	RESISTOR 100K +-1% .125W	28480	0699-1330
A2R609-R611	0699-1396	3	RESISTOR 17.8K +-1% .125W	28480	0699-1396
A2R620-R623	0699-1423	4	RESISTOR 215 +-1% .125W	28480	0699-1423
A2R640-R641	0699-1330		RESISTOR 100K +-1% .125W	28480	0699-1330
A2R643-R644	0699-1330		RESISTOR 100K +-1% .125W	28480	0699-1330
A2RP601	1810-1360	1	NETWORK-RES 16-SMD 10.0K OHM X 8	91637	SOMC-1603-103G
A2U600	1820-8985	1	IC-MCU W/FIP DRIVER	28480	1820-8985
A2U601	1820-5805	1	IC SHF-RGTR CMOS/74HC BIDIR	01295	SN74HC194DW
A2U602	1826-1528	1	IC COMPARATOR LP QUAD	27014	LM339M
A2U603	2090-0296	1	DISPLAY VACUUM FLOURESCENT	28480	2090-0296
A2W601	34401-61602	1	CABLE ASSY 8.8"L 0.236/0.157" STRIP	28480	34401-61602

Code list of manufacturers - 34401-66502

Mfr. Code	Manufacturer's Name	Manufacturer's Address			Zip Code
01295	TEXAS INSTRUMENTS INC	DALLAS	TX	US	75265
04222	AVX CORP	GREAT NECK	NY	US	11021
04713	MOTOROLA INC	ROSELLE	IL	US	60195
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA	US	95052
28480	HEWLETT PACKARD COMPANY - CORPORATE	PALO ALTO	CA	US	94304
85480	BRADY W H CO	MILWAUKEE	WI	US	53209
91637	DALE ELECTRONICS INC	COLUMBUS	NE	US	68601

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HP 34401A Mainframe replacement parts

Reference Designation	HP Part Number	Qty	Part Description	Mfr. Code	Mfr Part Number
	34401-80010	1	FUSE KIT	28480	34401-80010
	34401-87101	1	PKG CARTON/INCLUDES INSERTS	28480	34401-87101
	34401-90000	1	MANUAL KIT-ENGLISH	28480	34401-90000
	5180-6661	1	STANDARD TEST LEAD KIT	28480	5180-6661
	7121-5497	1	LABEL-BLANK 1.5-IN-WD .25-IN-LG	85480	LAT-9-619-10
	8120-1378	1	CABLE ASSEMBLY 18-AWG 3-COND	16428	CH7081
A1	34401-66501	1	PC ASSY - MAIN MOTHER BOARD	28480	34401-66501
A2	34401-66502	1	PC ASSY - FRONT PANEL BOARD	28480	34401-66502
CVR1	34401-84101	1	INSTRUMENT COVER	28480	34401-84101
FRM1	34401-80101	1	CHASSIS	28480	34401-80101
MP1	03478-88304	1	REAR PANEL	28480	03478-88304
MP2	34401-40201	1	FRONT PANEL/BEZEL	28480	34401-40201
MP3	34401-43701	1	POWER ON PUSH ROD	28480	34401-43701
MP4	34401-43702	1	FRONT TO REAR PUSH ROD	28480	34401-43702
MP5	34401-45001	1	FRONT HANDLE	28480	34401-45001
MP6-MP7	34401-45002	2	TERMINAL LATCH	28480	34401-45002
MP8	34401-49301	1	WINDOW-FRONT	28480	34401-49301
MP9	34401-81902	1	FLUBBER SWITCHES ON FRNT PNL	28480	34401-81902
MP10	34401-86201	1	PWR-MOD/FUSE DRWR	28480	34401-86201
MP11/MP12	34401-86000	1	BUMPER KIT	28480	34401-86000
SCW1-SCW8	0515-0433	8	SCREW-M4 X 0.7 8MM-LG PAN-HD	28480	0515-0433
SHD1	34401-00603	1	TOP SHIELD	28480	34401-00603
SHD2	34401-00602	1	SHIELD-BOTTOM	28480	34401-00602
T901	9100-4972	1	TRANSFORMER-POWER	28480	9100-4972

Code list of manufacturers - HP 34401A Mainframe

Mfr. Code	Manufacturer's Name	Manufacturer's Address			Zip Code
00779	AMP INC	HARRISBURG	PA	US	17111
16428	COOPER INDUSTRIES INC	HOUSTON	TX	US	77210
28480	HEWLETT PACKARD COMPANY - CORPORATE	PALO ALTO	CA	US	94304
46384	PENN ENGINEERING & MFG CORP	DOYLESTOWN	PA	US	18901
71983	DOW CHEMICAL CO	MIDLAND	MI	US	48674
85480	BRADY W H CO	MILWAUKEE	WI	US	53209

Backdating

Backdating

This chapter normally contains information necessary to adapt this manual to instruments not directly covered by the current content. At this printing, however, the manual (and perhaps change sheets) does apply to all instruments. Therefore, no information is included in this chapter.

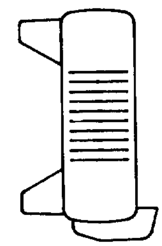
Schematics

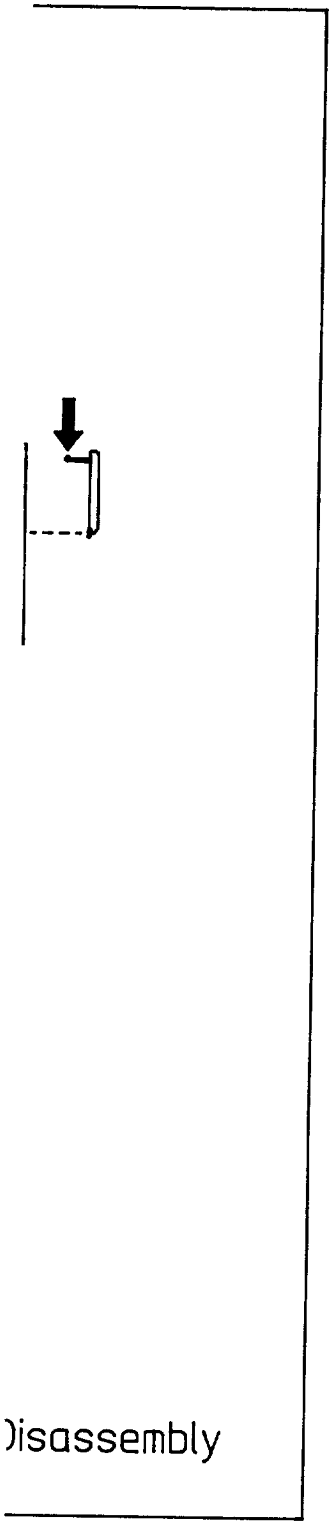
Schematics

Measurement Configuration	Power-On/Reset State
AC filter	20 Hz (medium filter)
Autozero	On
* Continuity threshold	* 10 Ω
Function	DC volts
Input resistance	10 MΩ (fixed for all dc voltage ranges)
Integration time	10 PLCs
Range	Autorange
Resolution	5½ digits, slow mode
Math Operations	**Power-On/Reset State**
Math state, function	Off, Null
Math registers	All registers are cleared
* dBm reference resistance	* 600 Ω
Triggering Operations	**Power-On/Reset State**
Reading hold threshold	0.10% of full scale
Samples per trigger	1 sample
Trigger delay	Automatic delay
Trigger source	Auto trigger
System-Related Operations	**Power-On/Reset State**
* Beeper mode	* On
* Comma separators	* On
Display mode	On
Reading memory	Off (cleared)
Input/Output Configuration	**Power-On/Reset State**
* Baud rate	* 9600 baud
* HP-IB address	* 22
* Interface	* HP-IB
* Language	* SCPI
* Parity	* Even (7 data bits)
Calibration	**Power-On/Reset State**
* Calibration state	* Secured

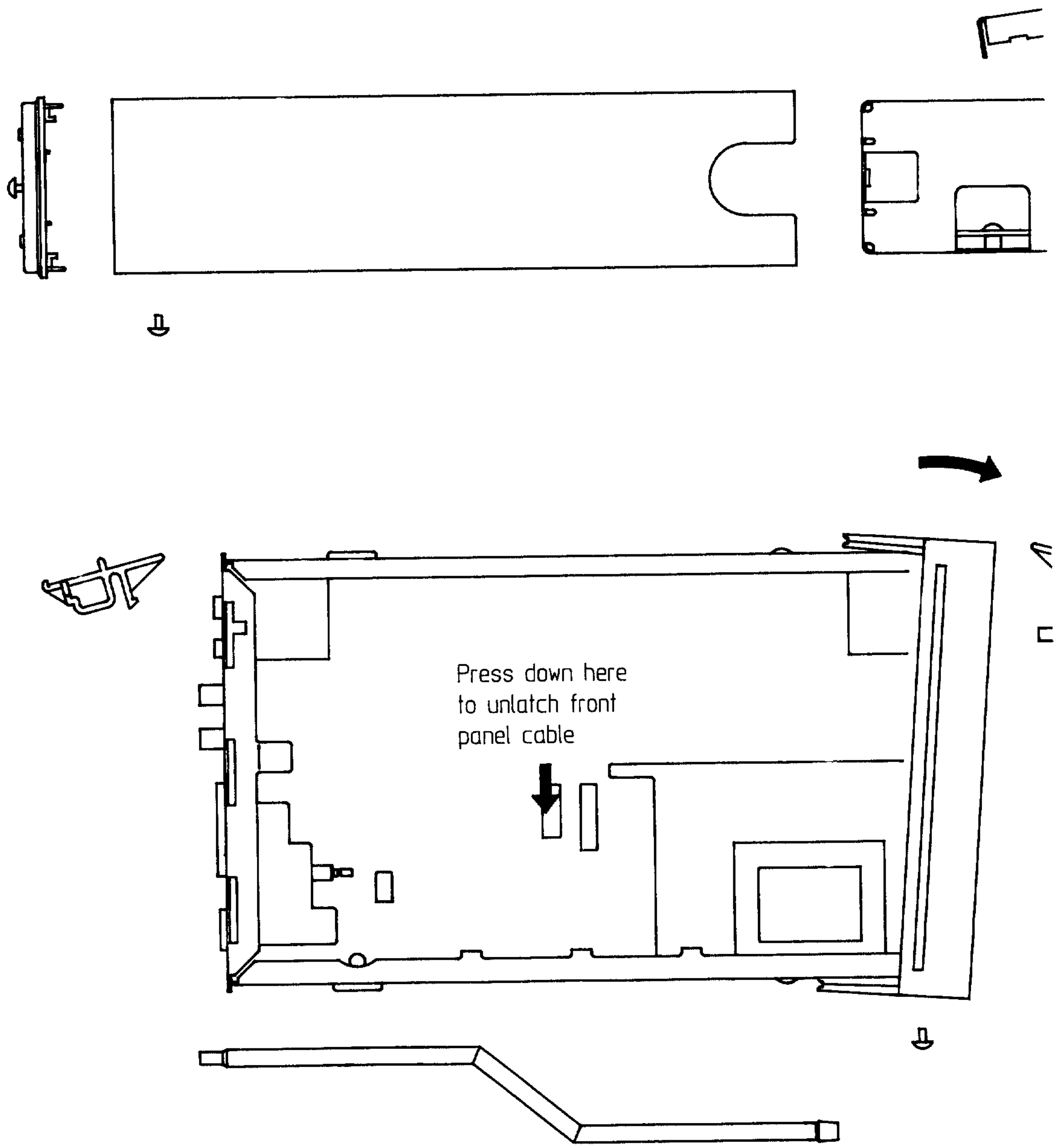
Those items marked with " * " above are stored in non-volatile memory.
The factory settings are shown.

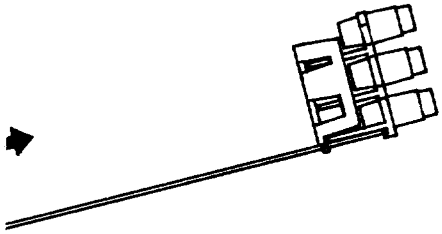
Quick Start
Menu Tutorial
Calibration Procedures
Theory of Operation
Service
Replaceable Parts
Backdating
Schematics

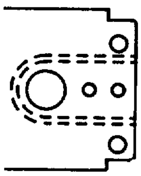


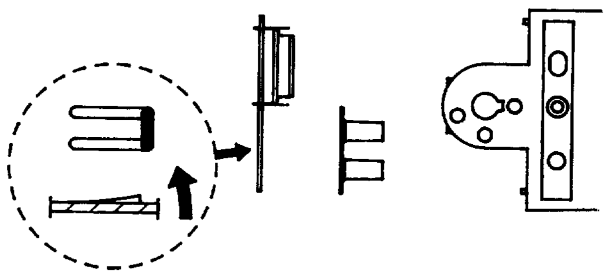


Front Panel Assembly Drawing
9-4

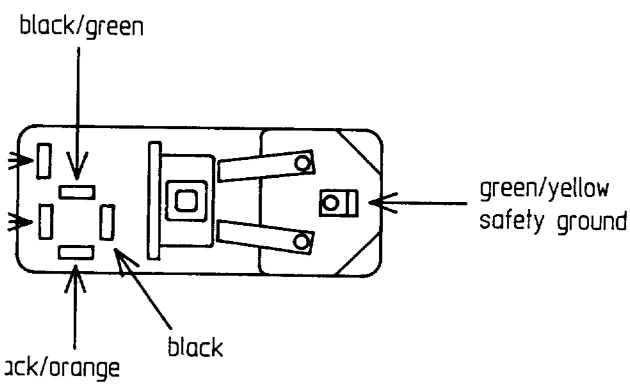

Press down here
to unlatch front
panel cable



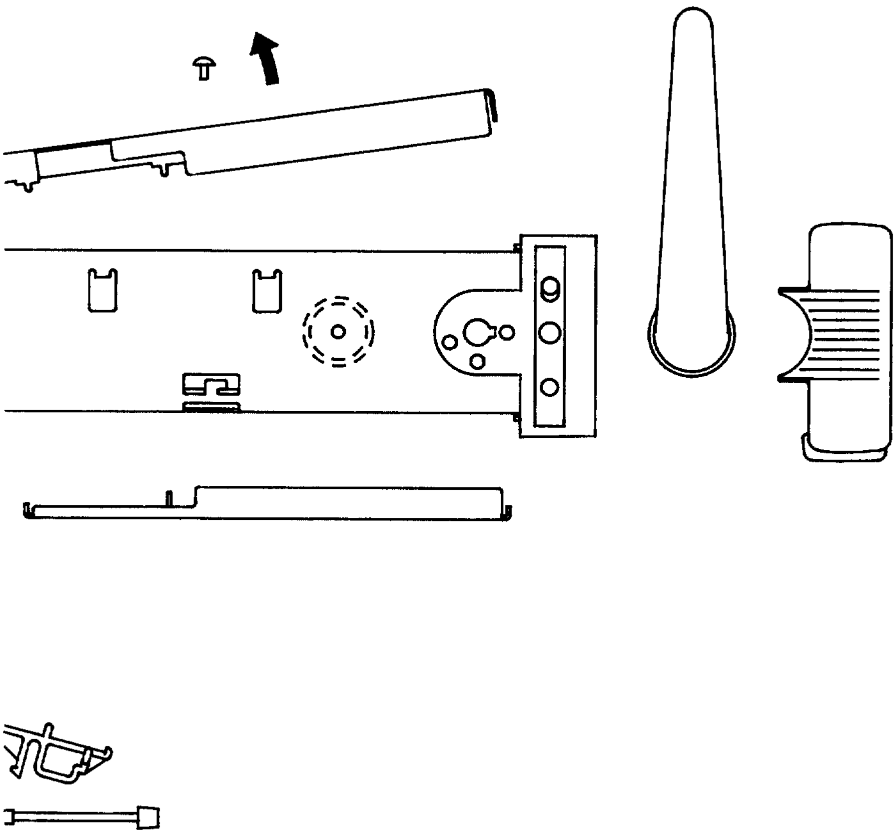




Disassembly of front panel

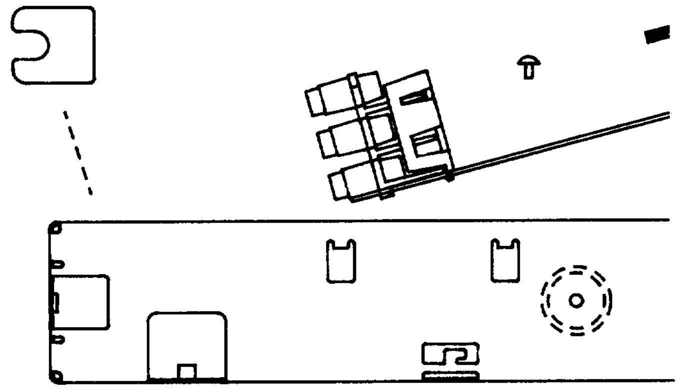


ormer wire to power module connections

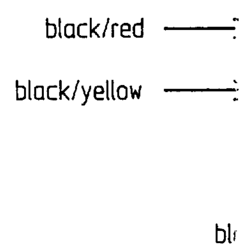


Removal of front
panel frame

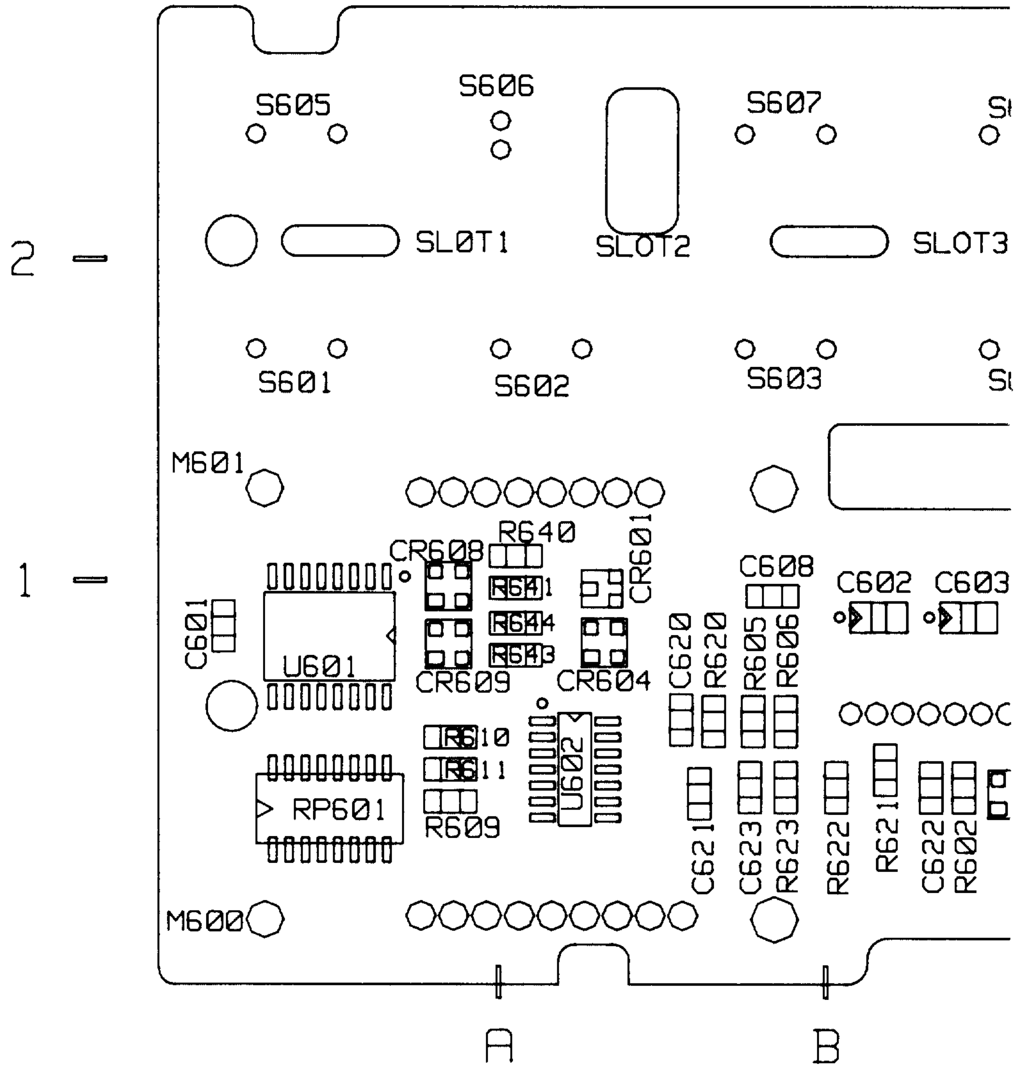
Mechanical Disassembly

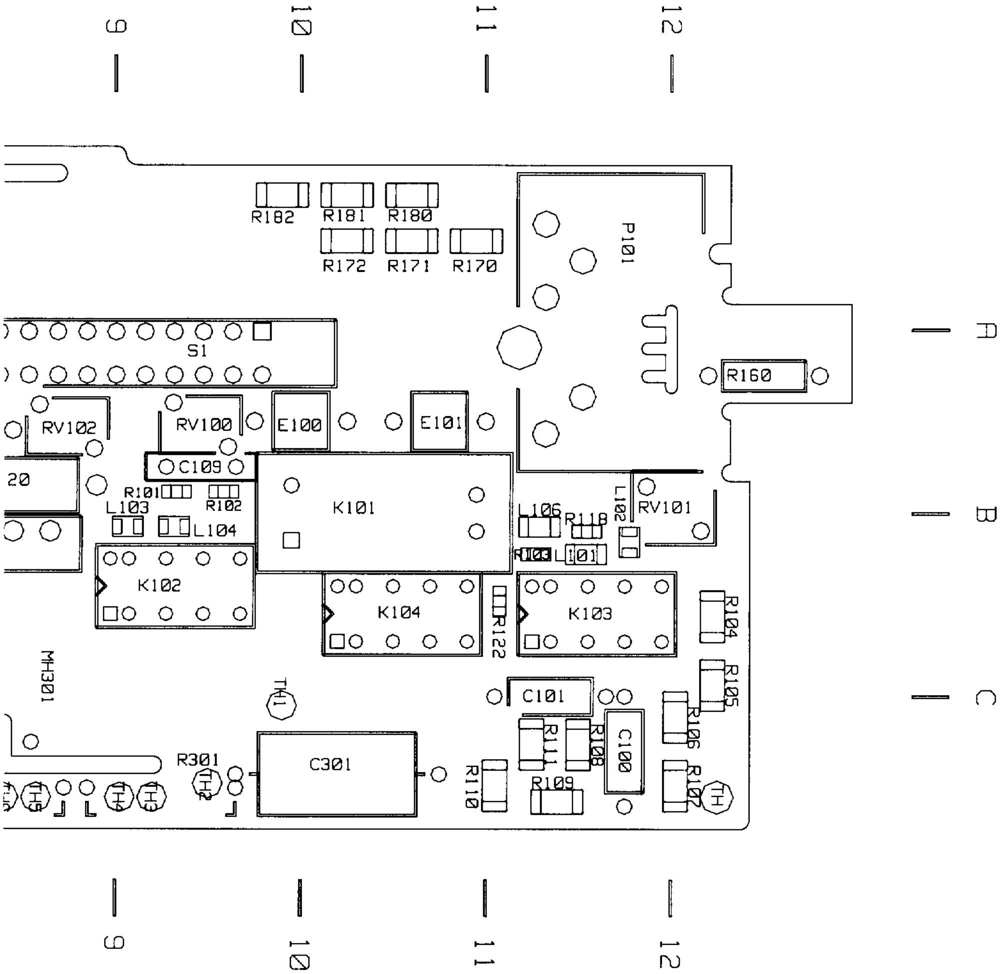


Removal of PCB

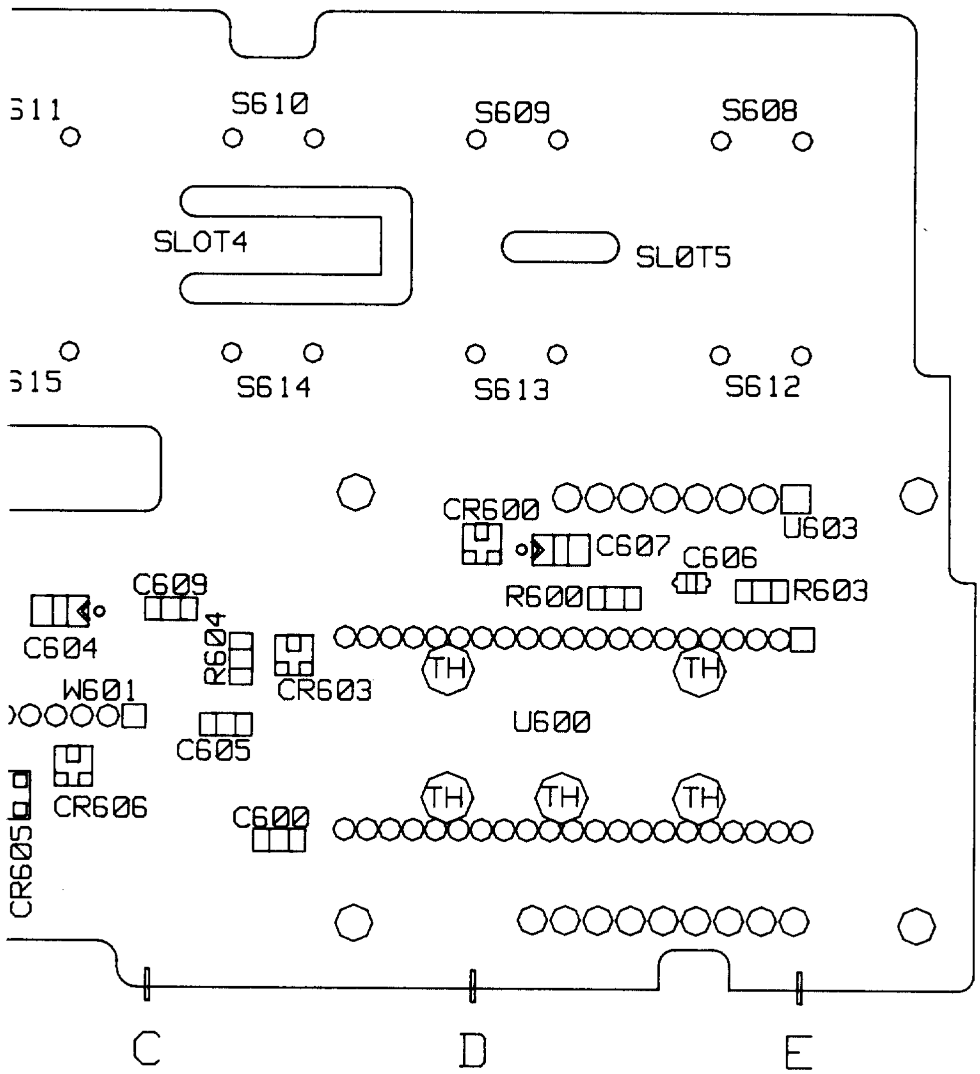


Transf

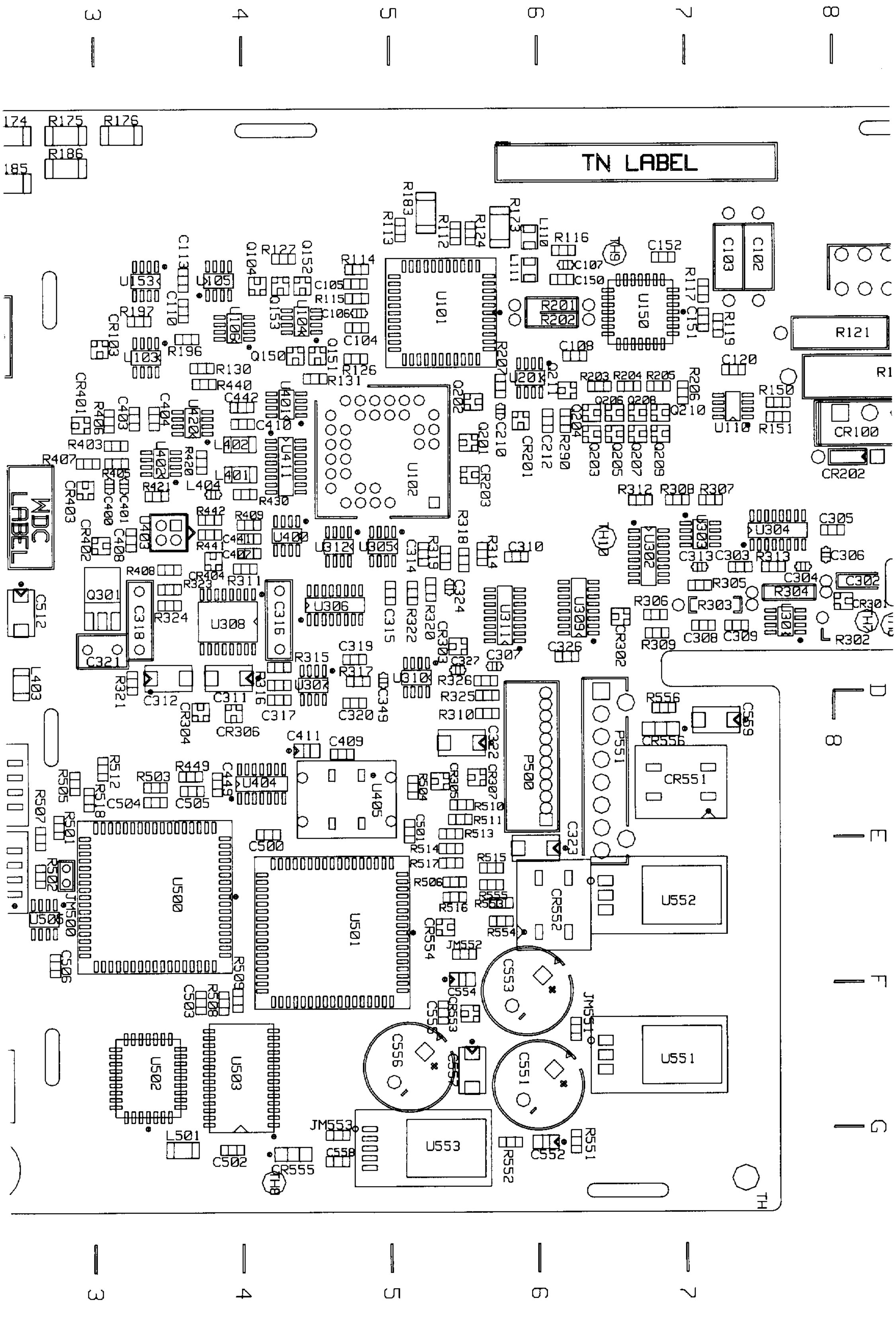

S605
S606
S607
SLOT1
SLOT2
SLOT3
S601
S602
S603
M601
R640
CR608
CR601
C608
C602
C603
R641
R644
R643
C601
U601
CR609
CR604
C620
R620
R605
R606
R610
R611
U602
RP601
R609
C621
C623
R623
R622
R621
C622
R602
M600
1
2
A
B



34401A-66501 Main Board
Component Locator Drawing

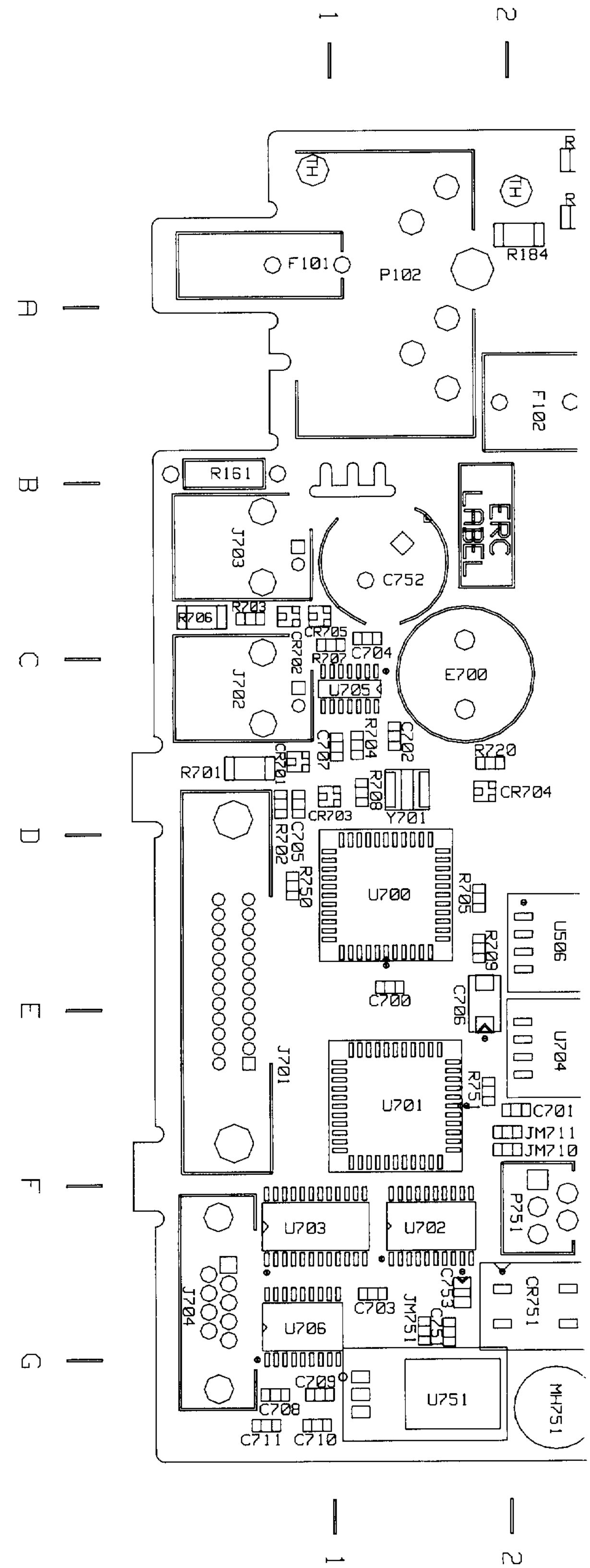


S610
S609
S608
SLOT4
SLØT5
S614
S613
S612
CR600
U603
C607
C606
R600
R603
C609
C604
R604
CR603
W601
U600
C605
CR606
C600
CR605
TH
C
D
E



TN LABEL
WDC LABEL
U101
U102
U150
U308
U500
U501
U502
U503
U551
U552
U553
P500
P551
CR551
CR552
C553
C556
C551
R121
CR100

34401A-66502 Front Panel
Component Locator Drawing
9-6



F101
P102
R184
F102
R161
ERC LABEL
J703
C752
R706
R703
CR705
CR702
R707
C704
E700
J702
U705
R704
C707
C702
R720
R701
CR701
R708
Y701
CR704
CR703
C705
R702
R750
U700
R705
U506
R209
C700
C706
U704
J701
R751
U701
C701
JM711
JM710
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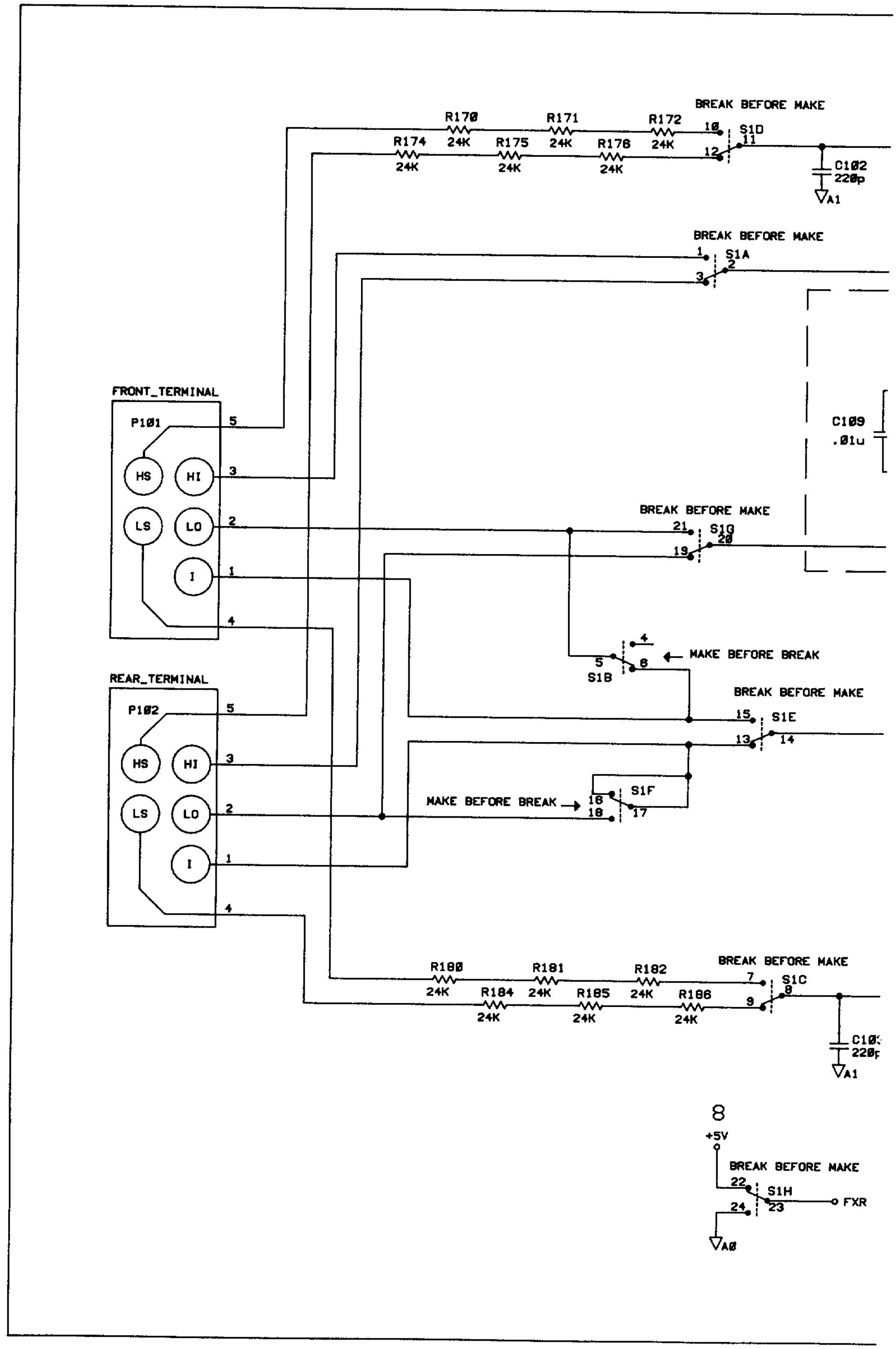
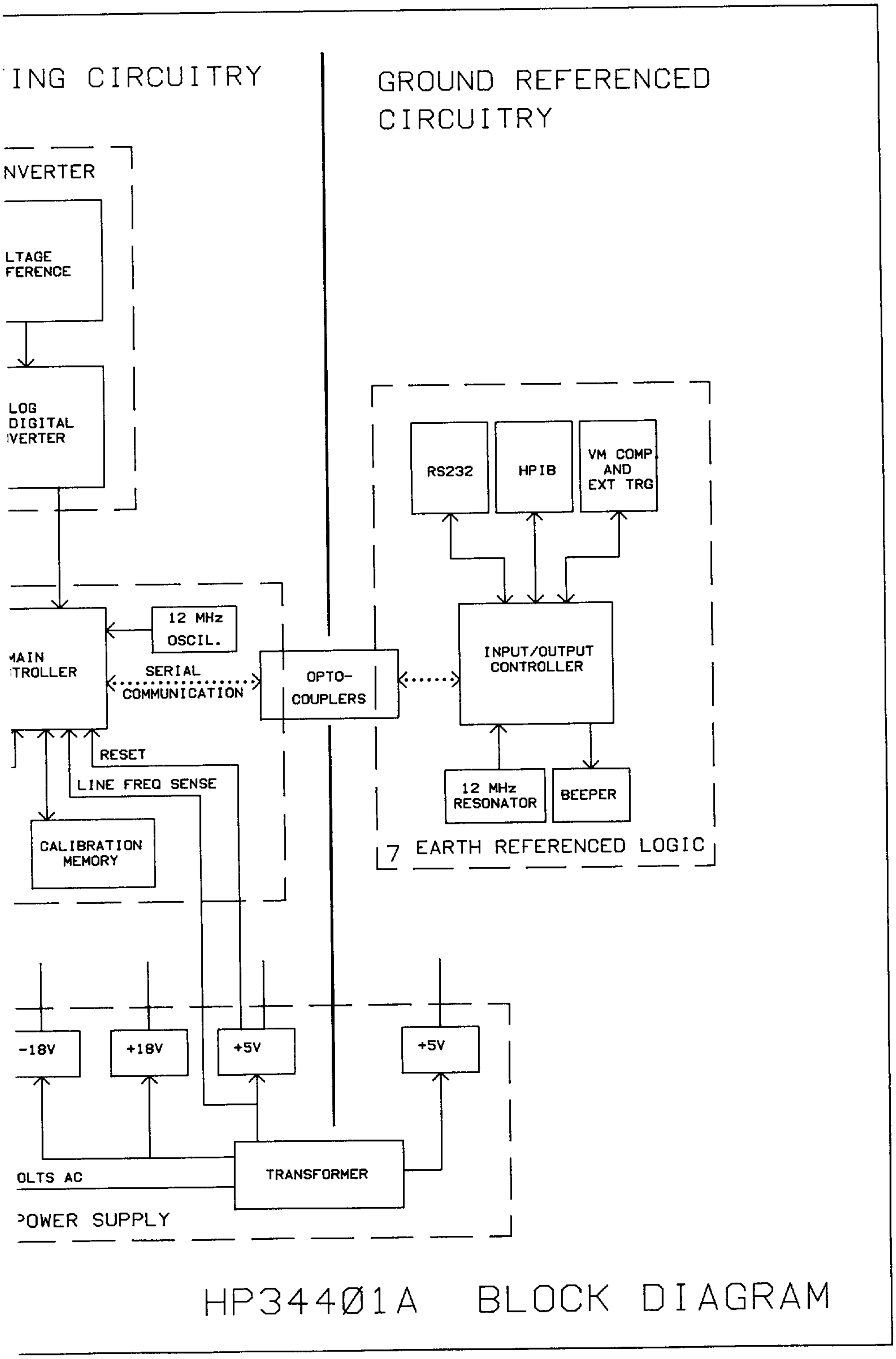
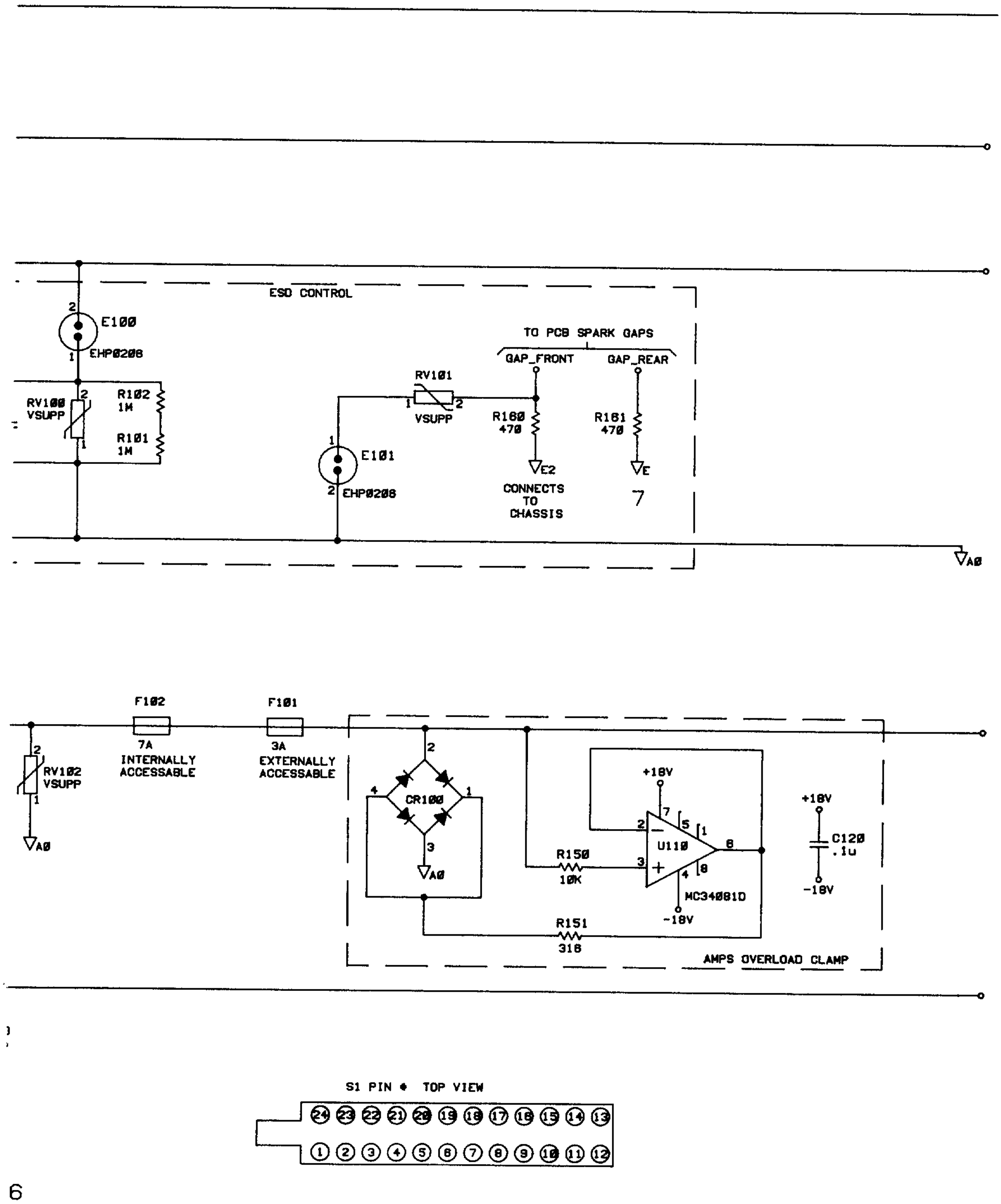
MH751
C708
C711
C710



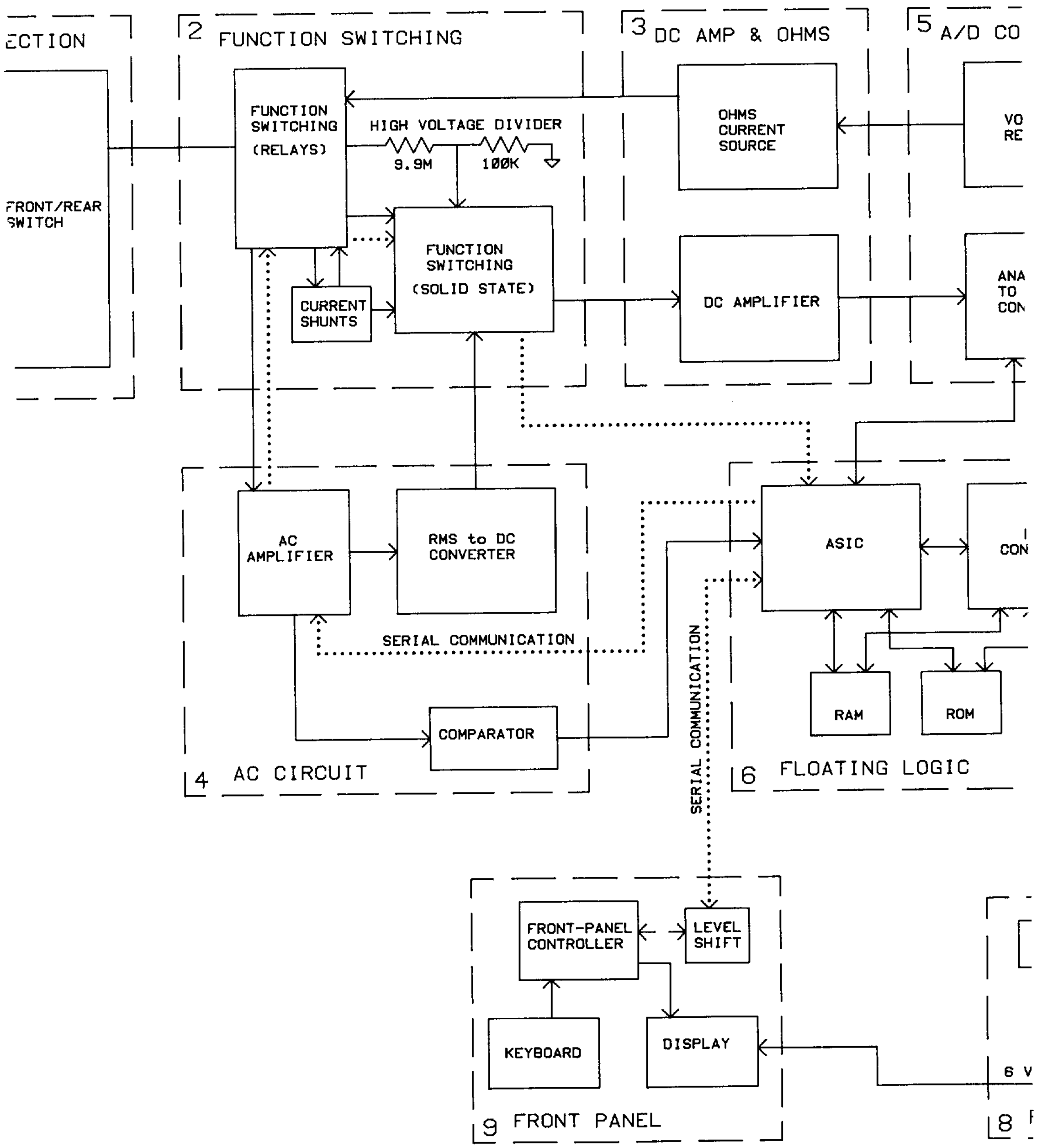
BREAK BEFORE MAKE
R170
R171
R172
R174
24K
R175
R176
S1D
C102
220p
A1
S1A
FRONT_TERMINAL
P101
HS
HI
LS
LO
I
C109
.01u
S1G
MAKE BEFORE BREAK
S1B
REAR_TERMINAL
P102
S1E
S1F
R180
R181
R182
R184
R185
R186
S1C
+5V
S1H
FXR
A0



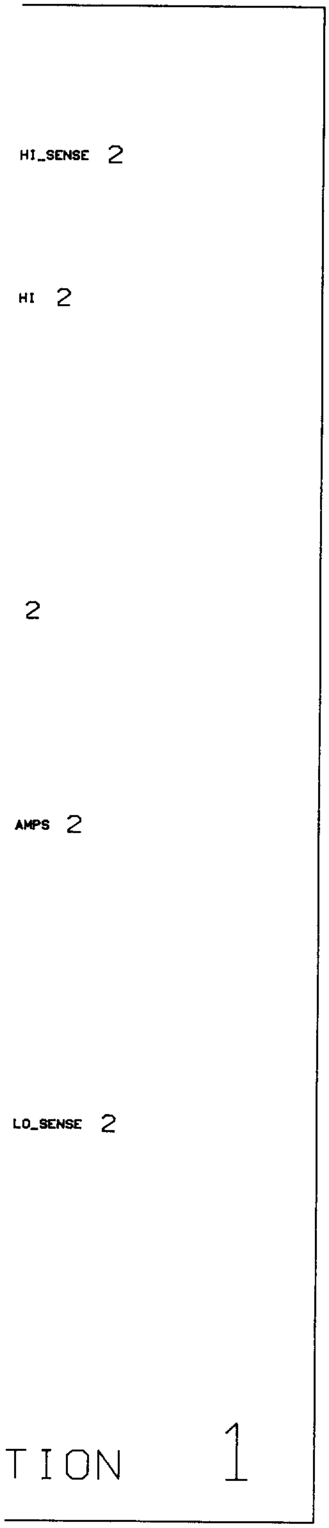
ING CIRCUITRY
GROUND REFERENCED CIRCUITRY
NVERTER
LTAGE FERENCE
LOG DIGITAL IVERTER
RS232
HPIB
VM COMP AND EXT TRG
12 MHz OSCIL.
MAIN TROLLER
SERIAL COMMUNICATION
OPTO-COUPLERS
INPUT/OUTPUT CONTROLLER
RESET
LINE FREQ SENSE
CALIBRATION MEMORY
12 MHz RESONATOR
BEEPER
EARTH REFERENCED LOGIC
-18V
+18V
+5V
+5V
TRANSFORMER
OLTS AC
POWER SUPPLY
HP34401A BLOCK DIAGRAM



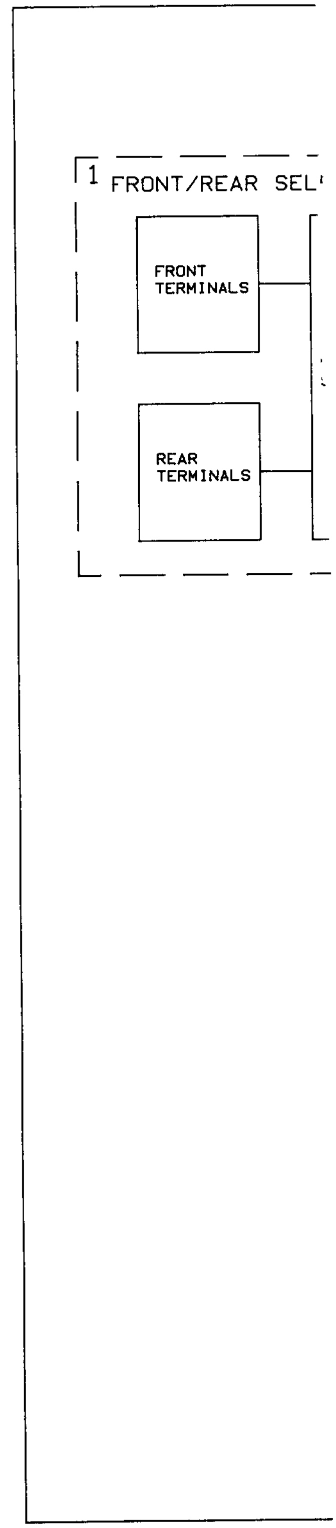
30-SEP-91 34401-66501 FRONT/REAR SELEC

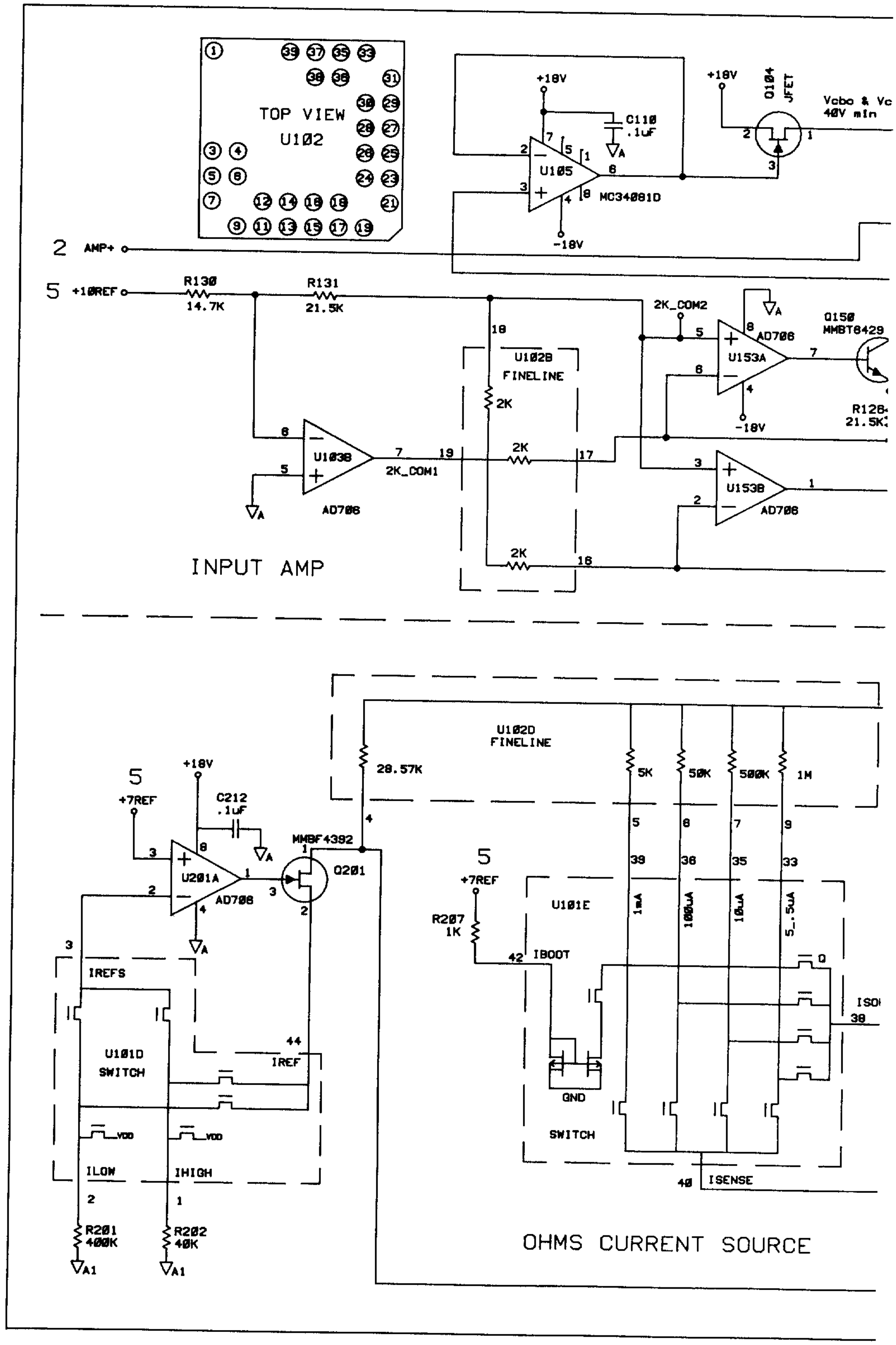


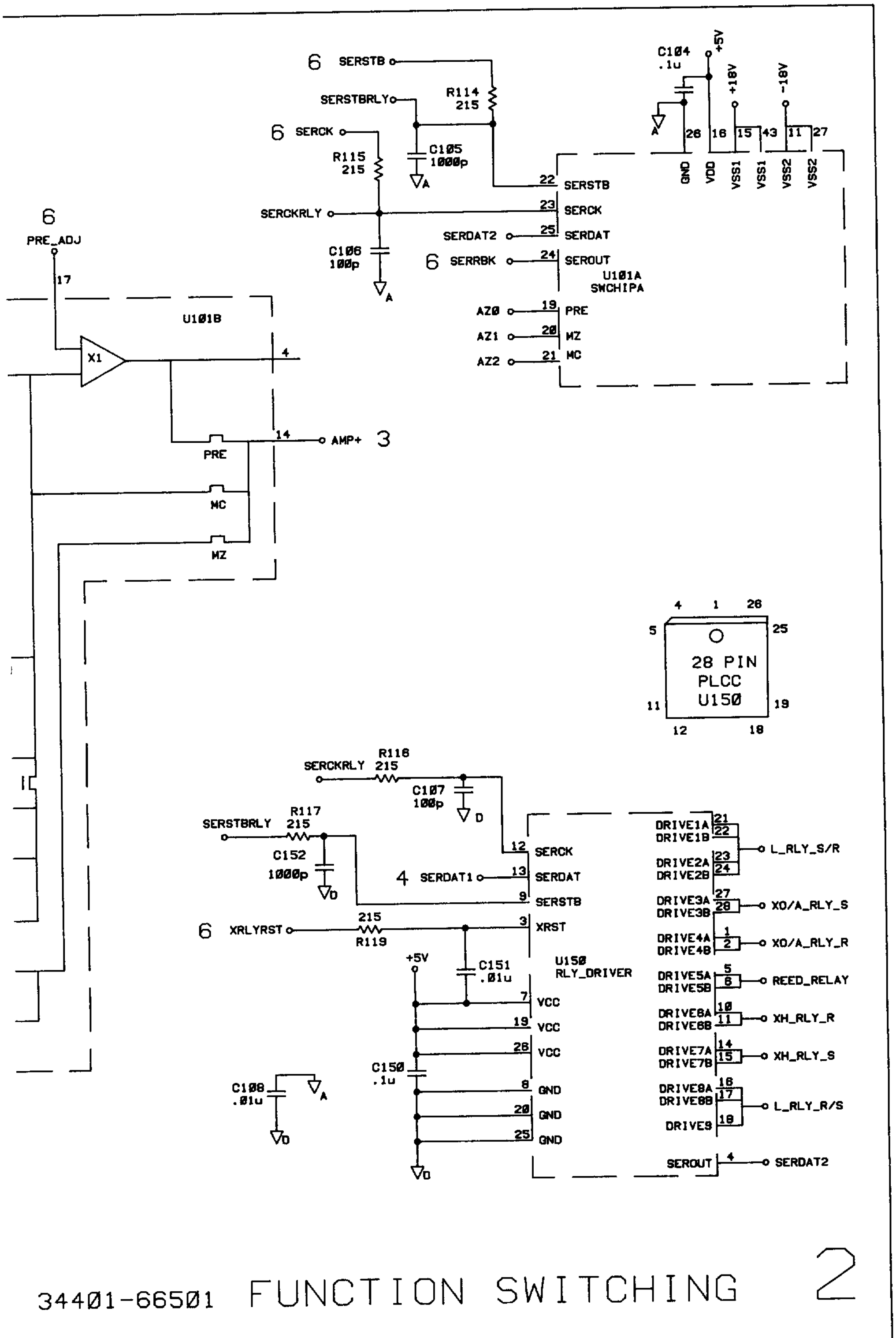
ECTION
FRONT/REAR SWITCH
2 FUNCTION SWITCHING
FUNCTION SWITCHING (RELAYS)
HIGH VOLTAGE DIVIDER
9.9M
100K
CURRENT SHUNTS
FUNCTION SWITCHING (SOLID STATE)
3 DC AMP & OHMS
OHMS CURRENT SOURCE
DC AMPLIFIER
5 A/D CO
VO RE
ANA TO CON
AC AMPLIFIER
RMS to DC CONVERTER
SERIAL COMMUNICATION
COMPARATOR
4 AC CIRCUIT
ASIC
CON
RAM
ROM
6 FLOATING LOGIC
SERIAL COMMUNICATION
FRONT-PANEL CONTROLLER
LEVEL SHIFT
KEYBOARD
DISPLAY
9 FRONT PANEL
6 V
8



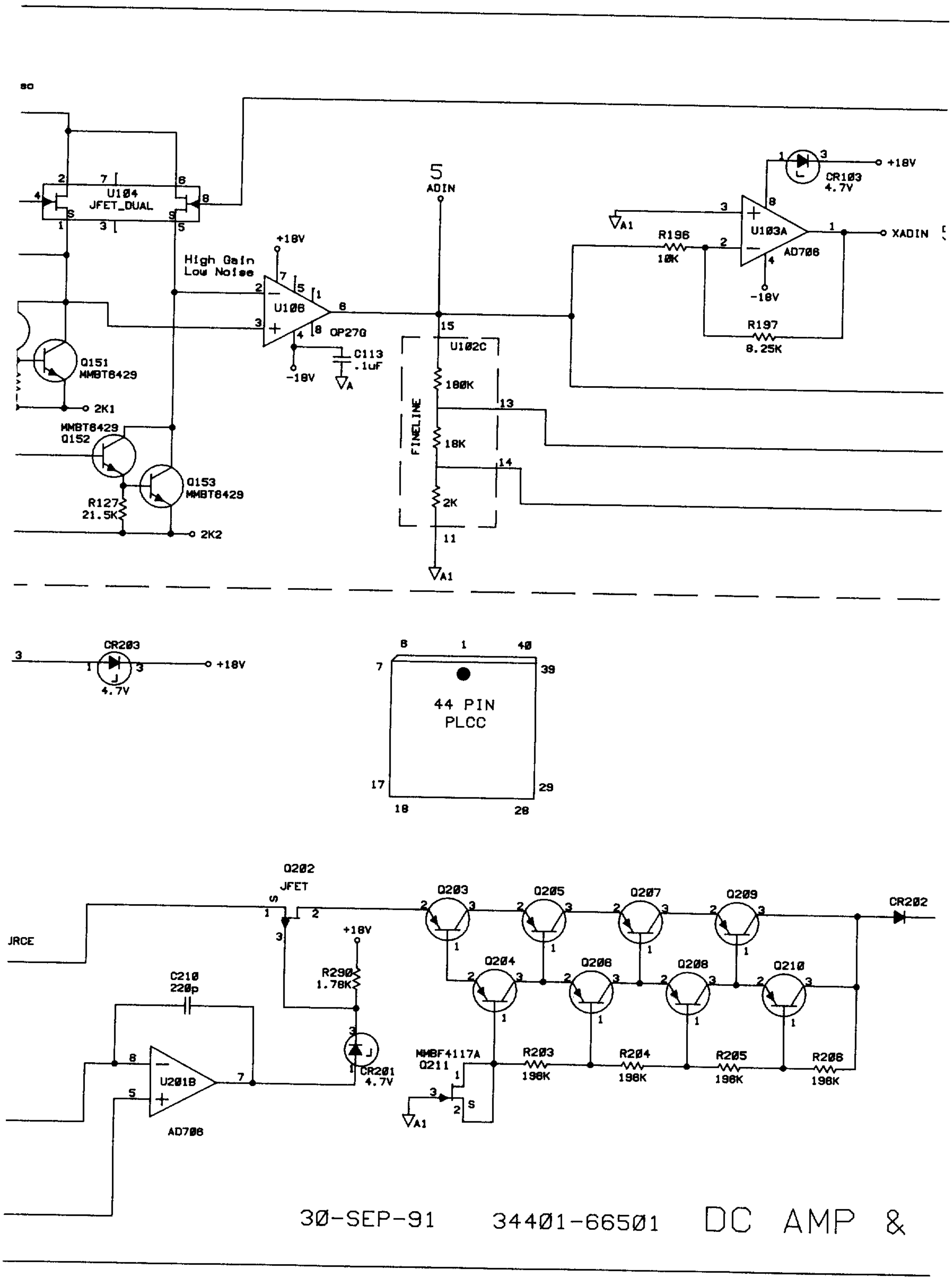
Front/Rear Selection Schematic


1 FRONT/REAR SEL
FRONT
TERMINALS
REAR
TERMINALS

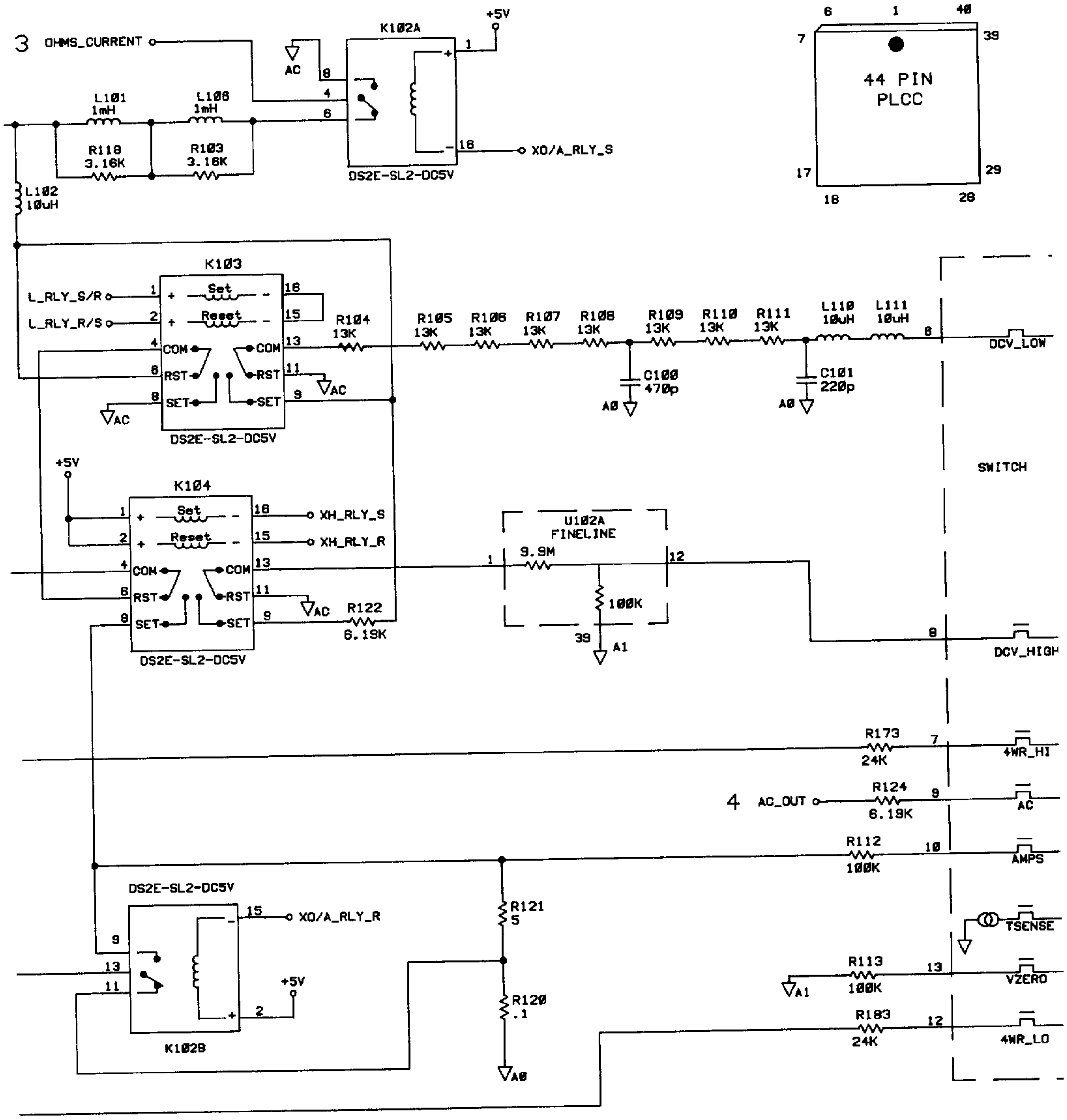

TOP VIEW
U102
+18V
C110
.1uF
U105
MC34081D
-18V
Q104
JFET
Vcbo & Vc
40V min
AMP+
+10REF
R130
14.7K
R131
21.5K
2K_COM2
U153A
AD706
Q150
MMBT8429
R128
21.5K
U102B
FINELINE
2K
U103B
AD706
2K_COM1
U153B
INPUT AMP
U102D
FINELINE
28.57K
5K
50K
500K
1M
+7REF
C212
.1uF
MMBF4392
Q201
U201A
AD706
IREFS
U101D
SWITCH
IREF
ILOW
IHIGH
R201
400K
R202
40K
R207
1K
IBOOT
U101E
1mA
100uA
10uA
5_.5uA
GND
SWITCH
ISENSE
OHMS CURRENT SOURCE



Function Switching Schematic

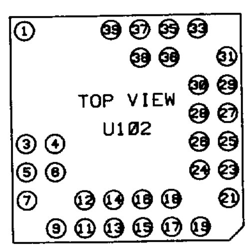


U104
JFET_DUAL
High Gain
Low Noise
+18V
-18V
U106
OP27G
C113
.1uF
5
ADIN
U102C
FINELINE
100K
10K
2K
CR103
4.7V
U103A
AD706
R196
10K
R197
8.25K
XADIN
Q151
MMBT6429
2K1
MMBT6429
Q152
Q153
MMBT6429
R127
21.5K
2K2
CR203
4.7V
44 PIN
PLCC
Q202
JFET
JRCE
C210
220p
U201B
AD706
R290
1.78K
CR201
4.7V
MMBF4117A
Q211
Q203
Q205
Q207
Q209
Q204
Q206
Q208
Q210
CR202
R203
196K
R204
196K
R205
196K
R206
196K
30-SEP-91
34401-66501
DC AMP &

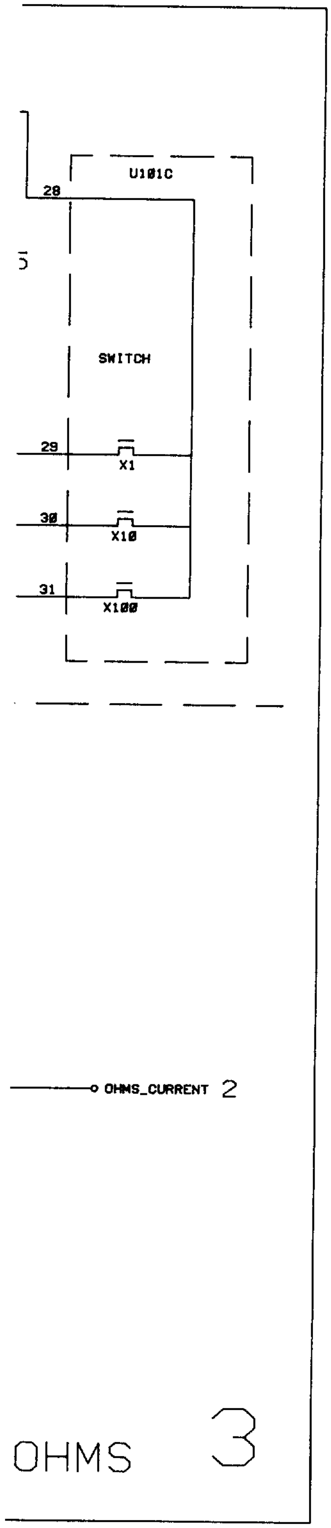


BOARD INTERCONNECTION OF GROUNDS

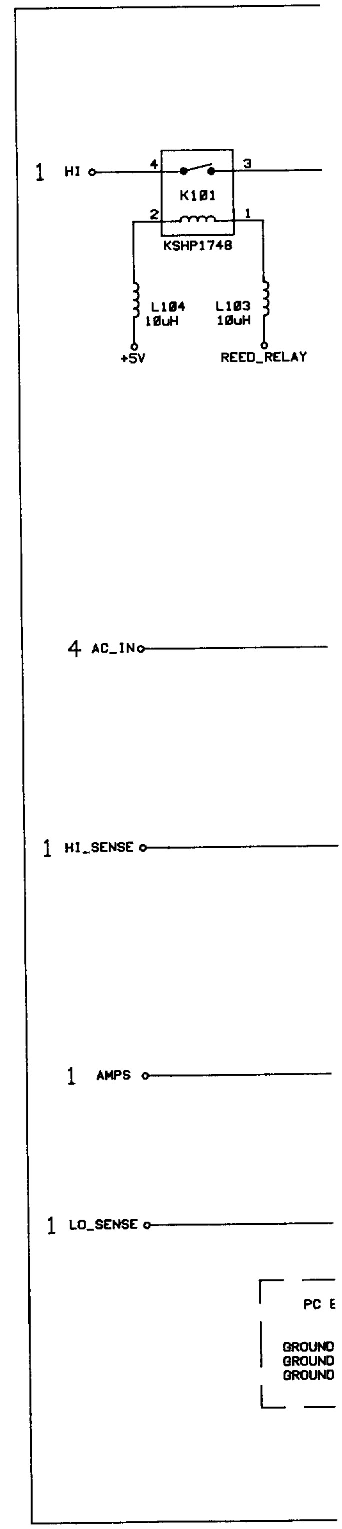
"A0" IS CONNECTED TO GROUND "A1"
"A1" IS CONNECTED TO GROUNDS "AC" AND "A"
"A" IS CONNECTED TO GROUND "D"



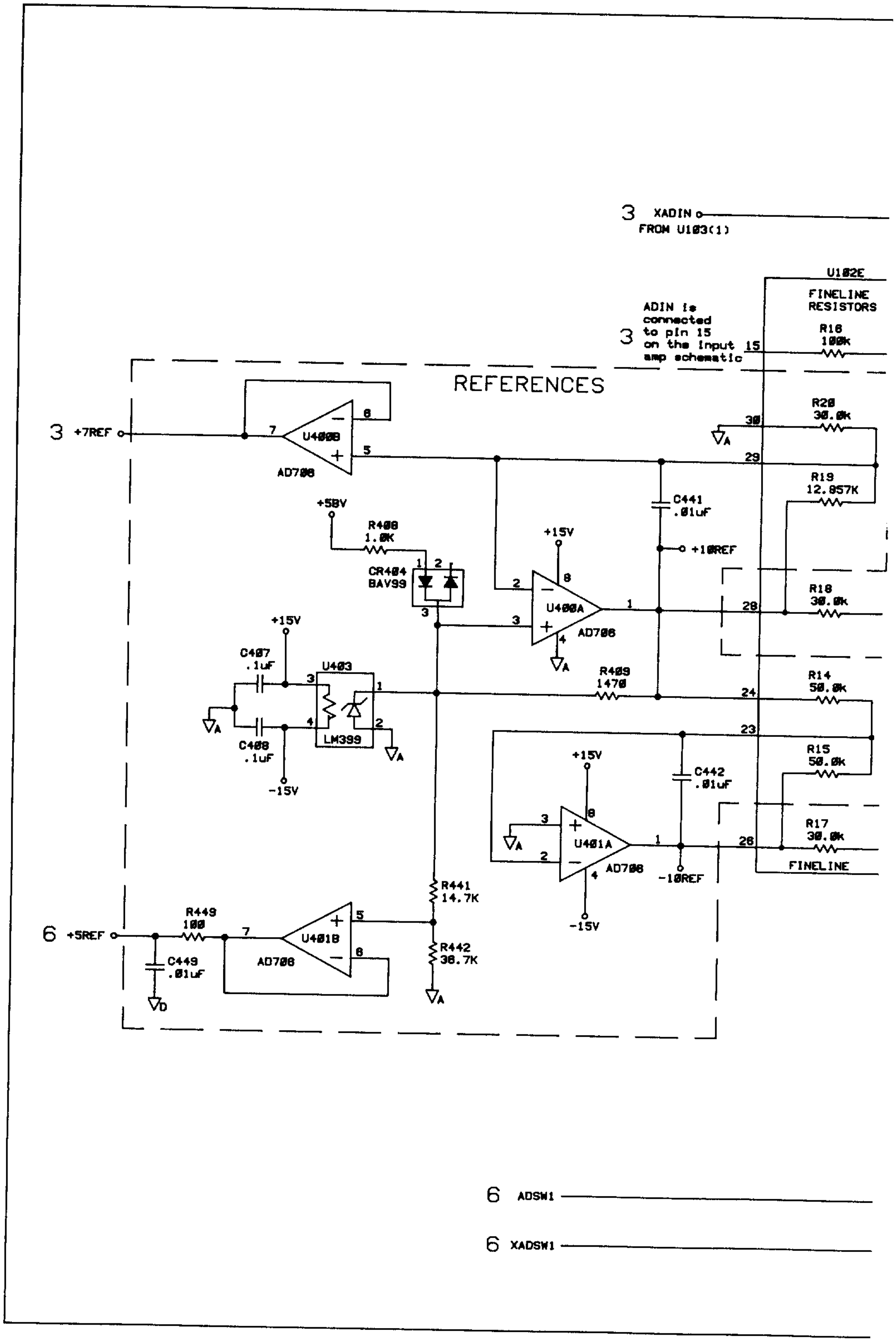
30-SEP-91

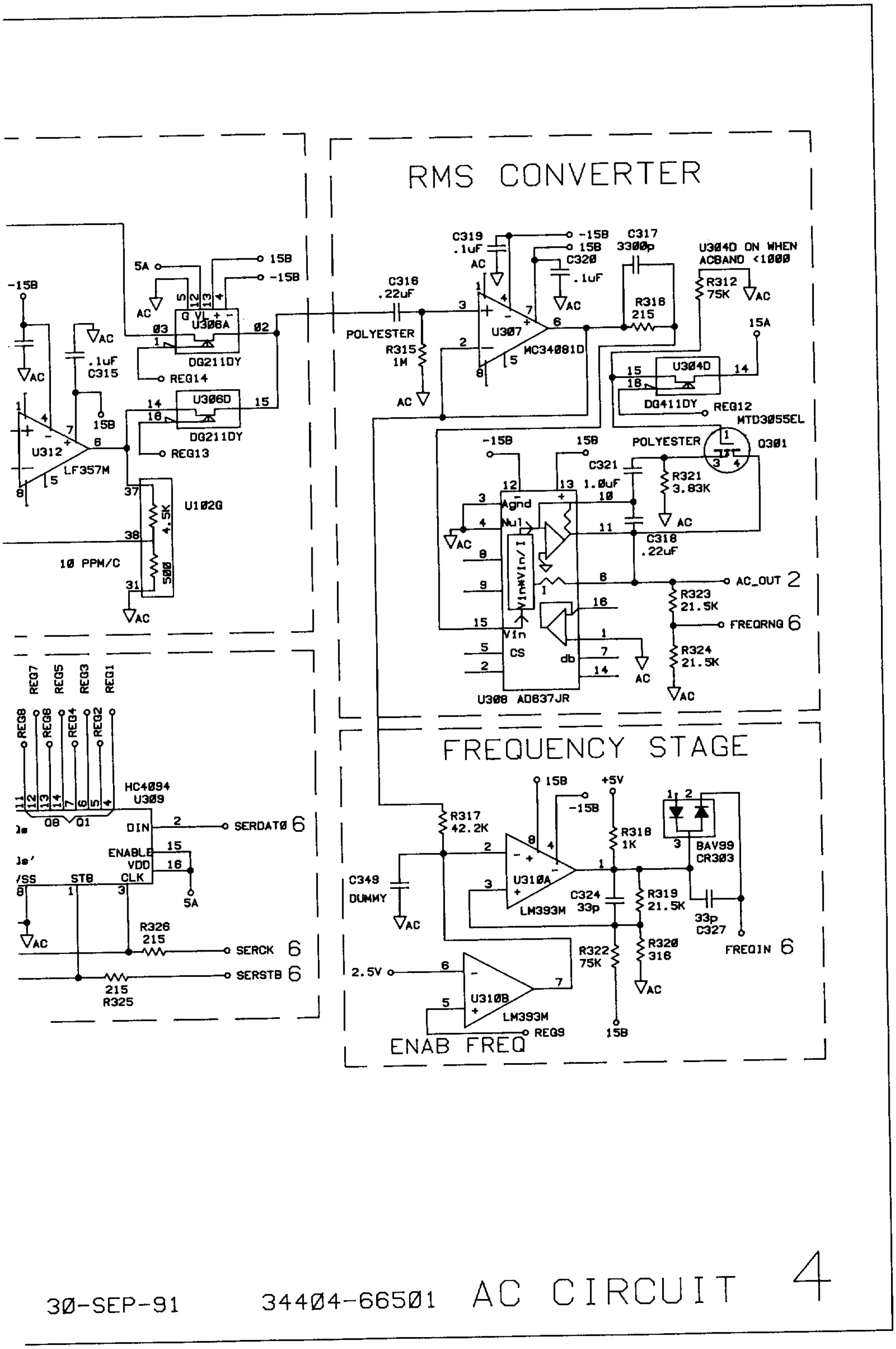


DC Amp and Ohm Schematic

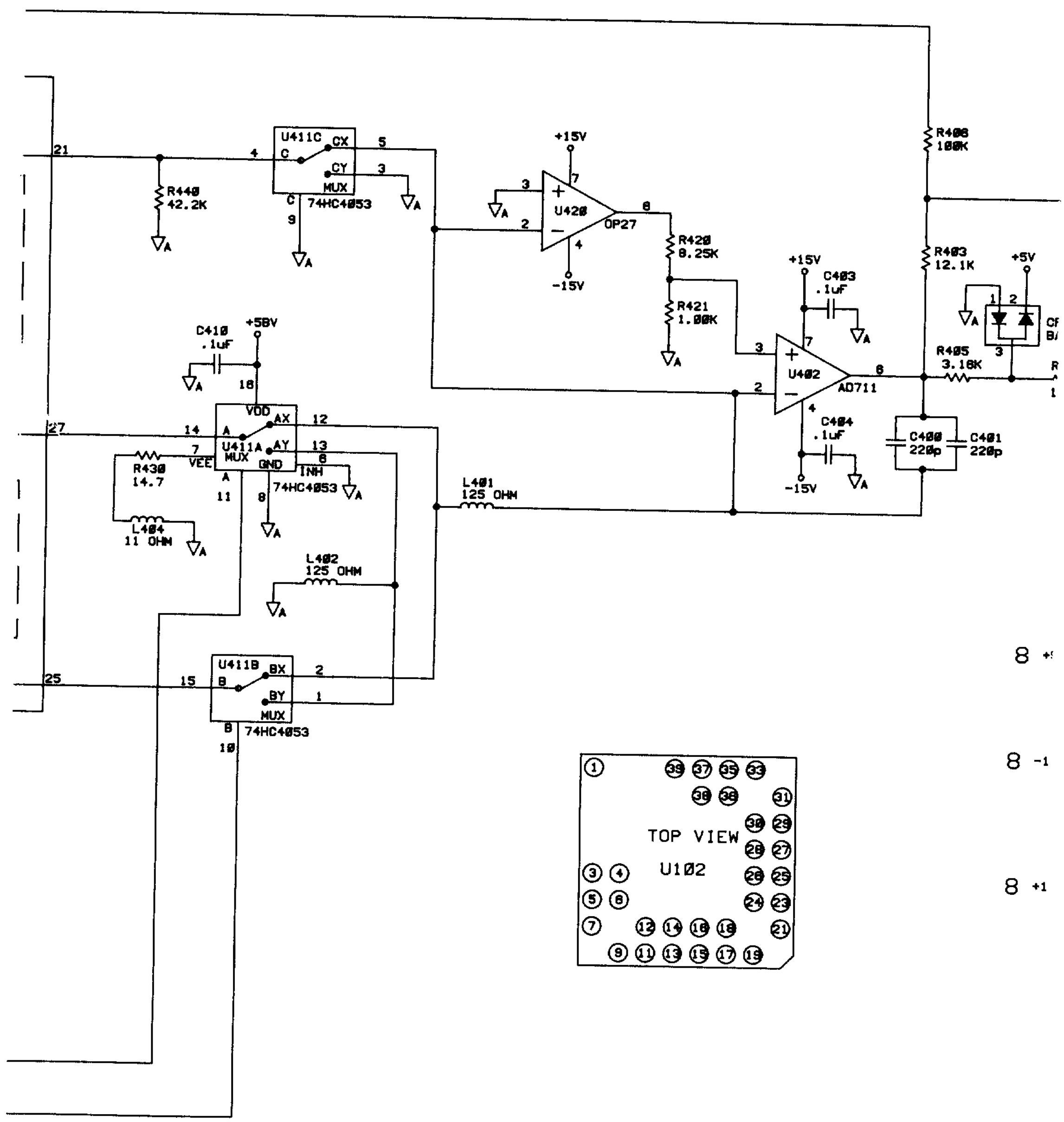


1 HI
4
3
K1Ø1
2
1
KSHP1748
L1Ø4
1ØuH
L1Ø3
1ØuH
+5V
REED_RELAY
4 AC_IN
1 HI_SENSE
1 AMPS
1 LO_SENSE
PC E
GROUND
GROUND
GROUND

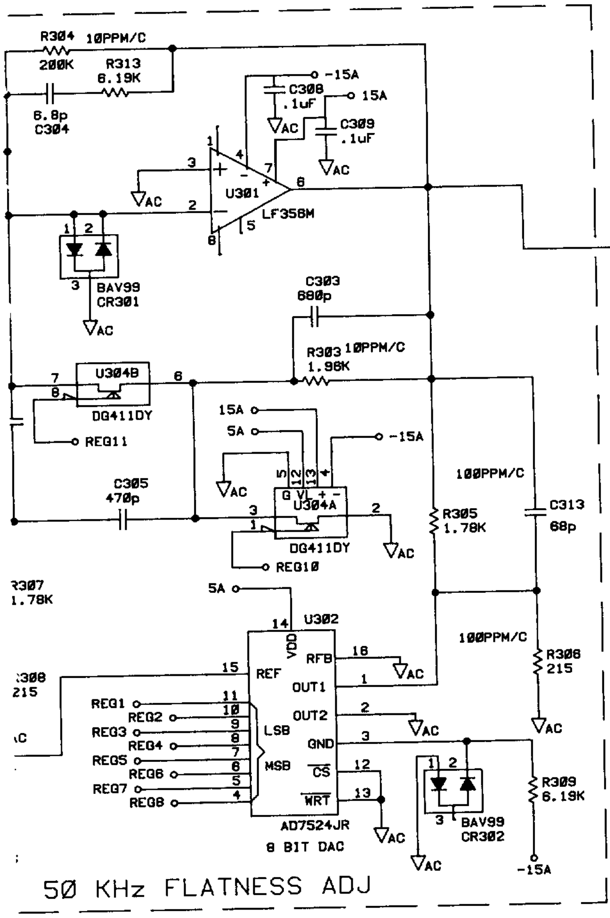

3 XADIN
FROM U103(1)
U102E
FINELINE RESISTORS
ADIN is connected to pin 15 on the input amp schematic
REFERENCES
3 +7REF
U400B
AD706
+5BV
R408 1.0K
CR404 BAV99
U400A
AD706
C441 .01uF
+10REF
+15V
C407 .1uF
C408 .1uF
U403
LM399
-15V
R409 1470
U401A
AD706
C442 .01uF
-10REF
R441 14.7K
R442 30.7K
6 +5REF
R449 100
C449 .01uF
U401B
AD706
R16 100k
R20 30.0k
R19 12.857K
R18 30.0k
R14 50.0k
R15 50.0k
R17 30.0k
FINELINE
6 ADSW1
6 XADSW1

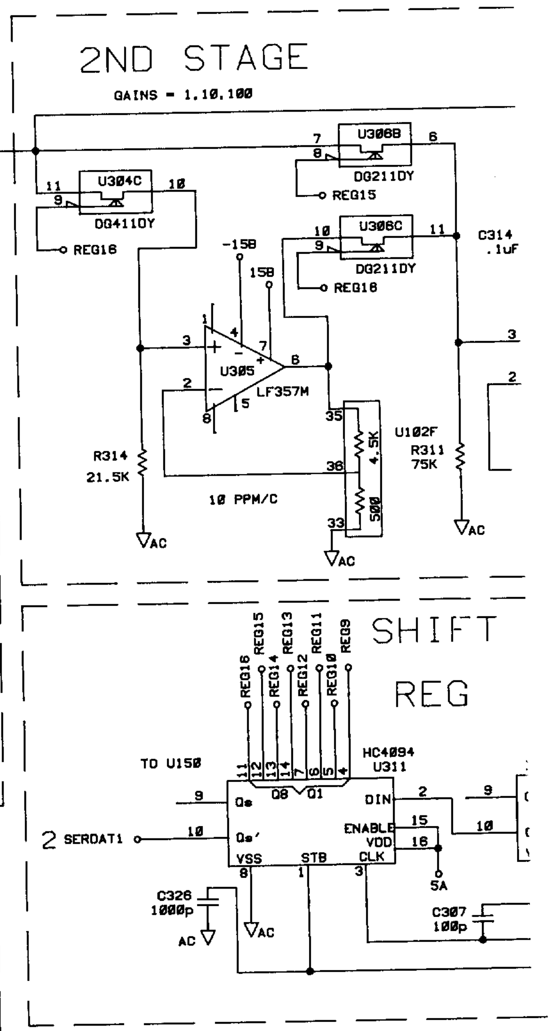


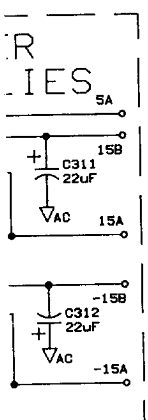
AC Circuit Schematic



30-SEP-91 34401-66501 A/D CONVER

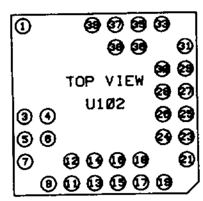


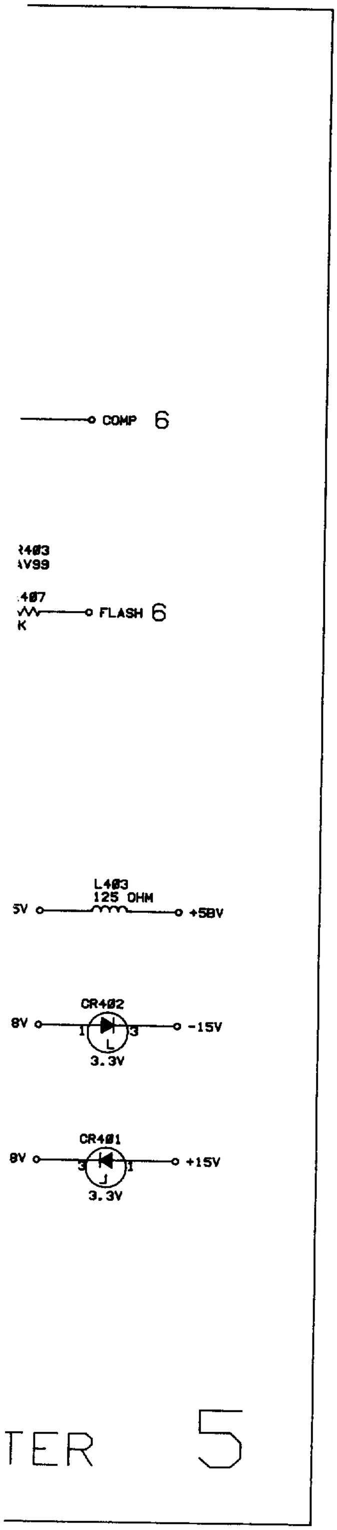




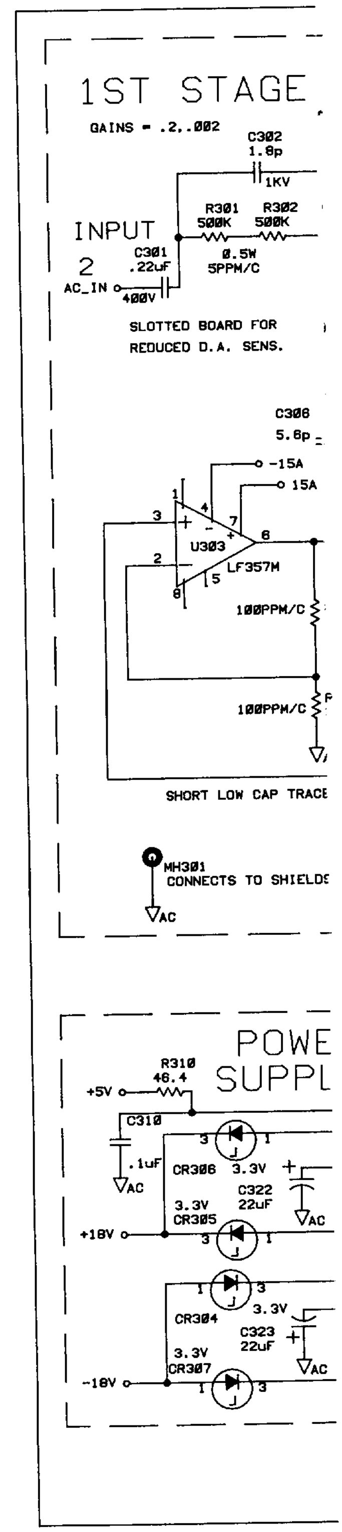
CONFIGURATION INFO

	REG16	REG15	REG14	REG13	REG12	REG11	REG10	REG9
FREQ ENABLE								1
FREQ DISABLE								0
RMS SLOW FILTER					0			
RMS FAST FILTER					1			
100mV RANGE	0	1	1	0		1	0	
1 V RANGE	1	0	1	0		1	0	
10 V RANGE	1	1	0	1		1	0	
PSEUDO 10V RANGE	0	1	1	0		0	1	
100 V RANGE	1	0	1	0		0	1	
1000 V RANGE	1	1	0	1		0	1	

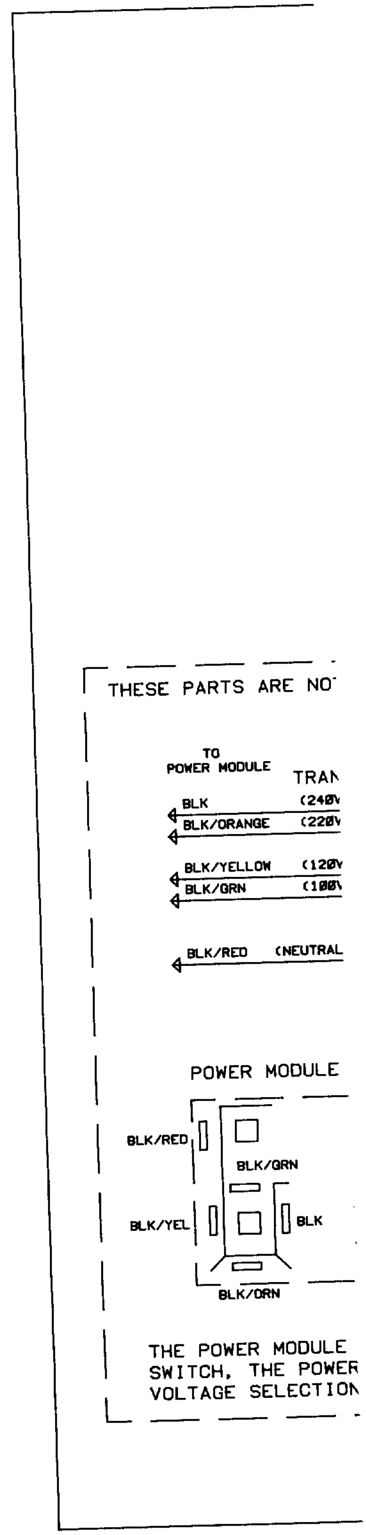


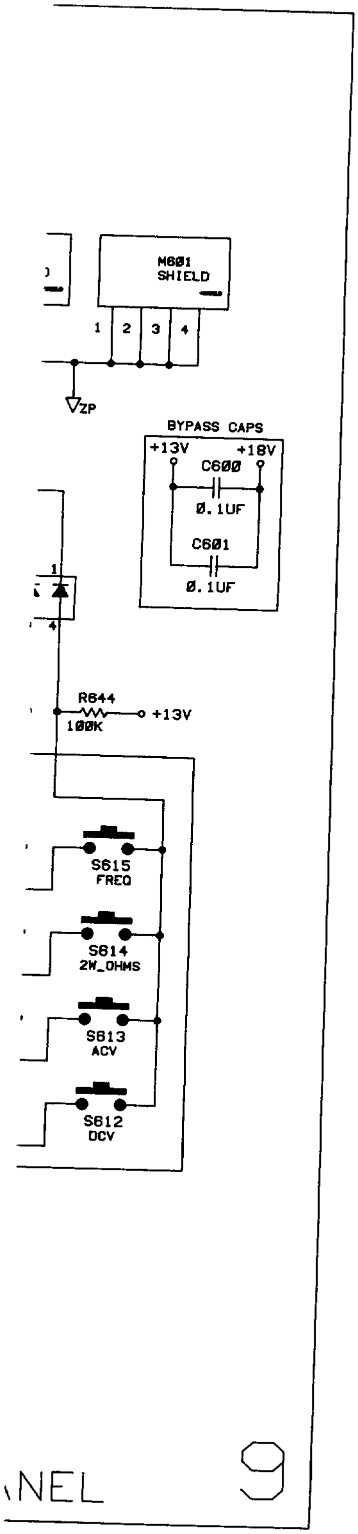


A/D Converter Schematic

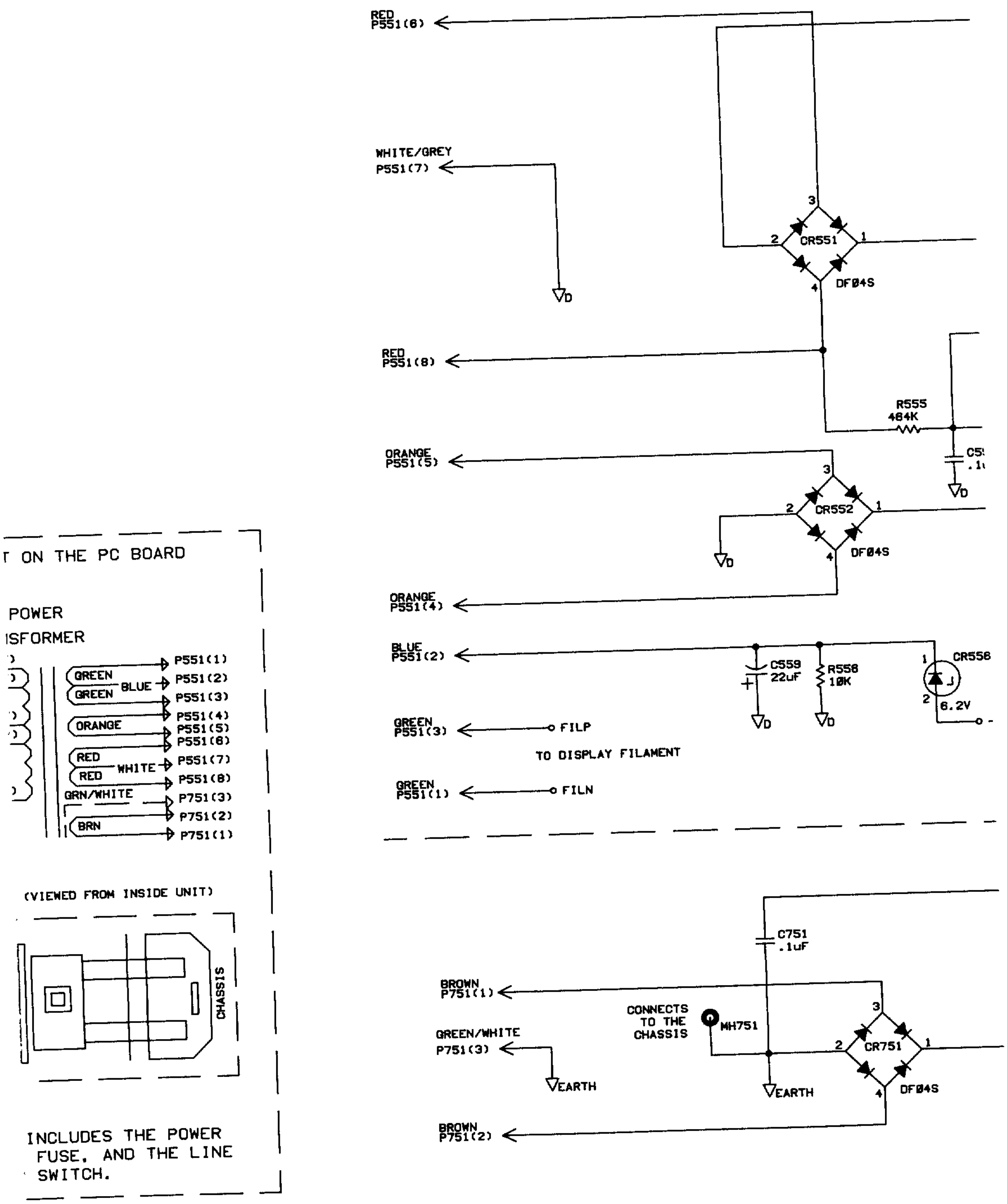


1ST STAGE
GAINS = .2,.002
C302
1.8p
1KV
R301
500K
R302
500K
INPUT
2
C301
.22uF
0.5W
5PPM/C
AC_IN
400V
SLOTTED BOARD FOR
REDUCED D.A. SENS.
C306
5.6p
-15A
15A
U303
LF357M
100PPM/C
100PPM/C
SHORT LOW CAP TRACE
MH301
CONNECTS TO SHIELDS
AC
POWE
SUPPL
R310
46.4
+5V
C310
.1uF
AC
CR306
3.3V
C322
22uF
3.3V
CR305
+18V
CR304
3.3V
C323
22uF
3.3V
CR307
-18V

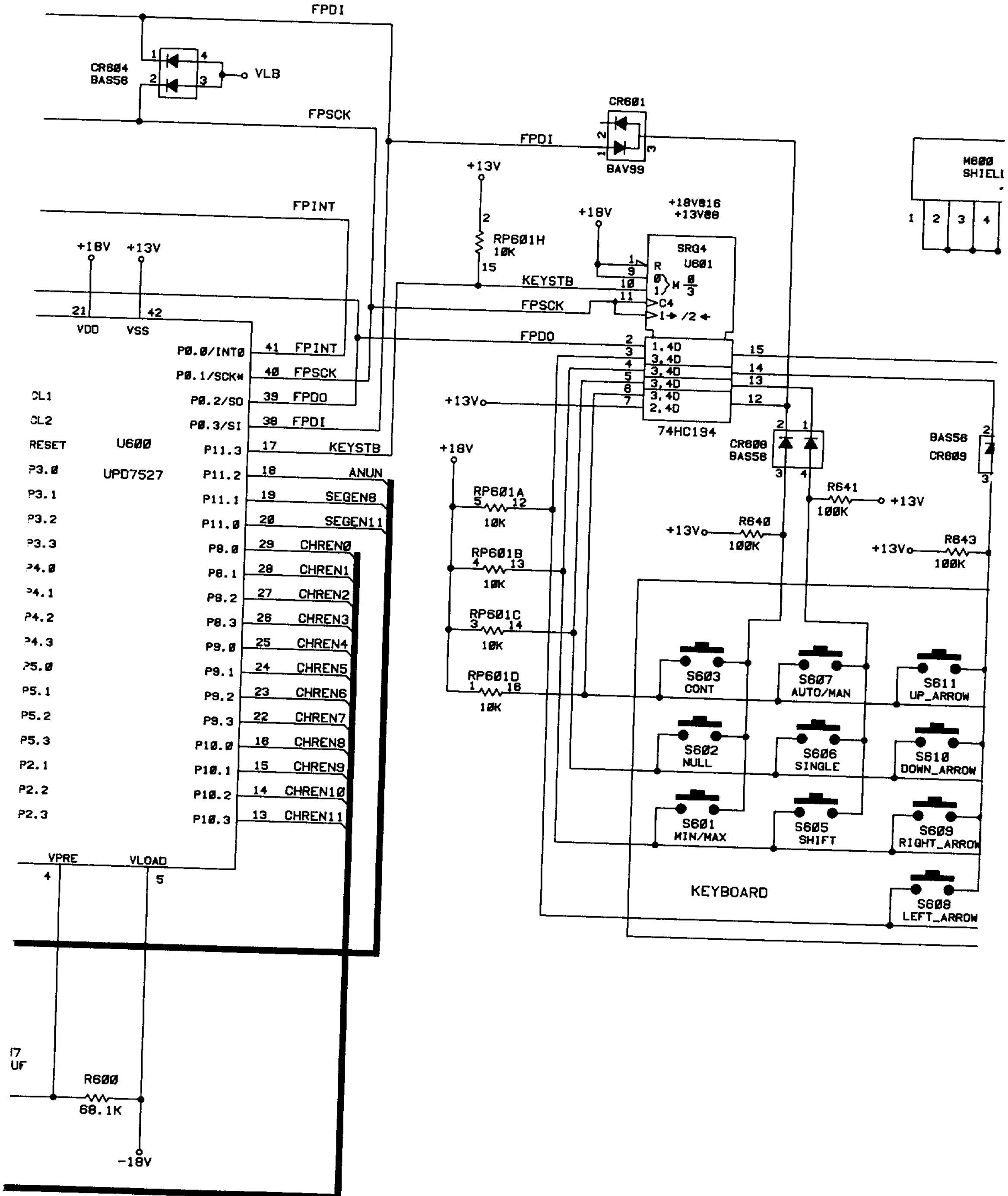

THESE PARTS ARE NO
TO
POWER MODULE
TRAN
BLK
(240V
BLK/ORANGE
(220V
BLK/YELLOW
(120V
BLK/GRN
(100V
BLK/RED
(NEUTRAL
POWER MODULE
BLK/RED
BLK/GRN
BLK/YEL
BLK
BLK/ORN
THE POWER MODULE
SWITCH, THE POWER
VOLTAGE SELECTION



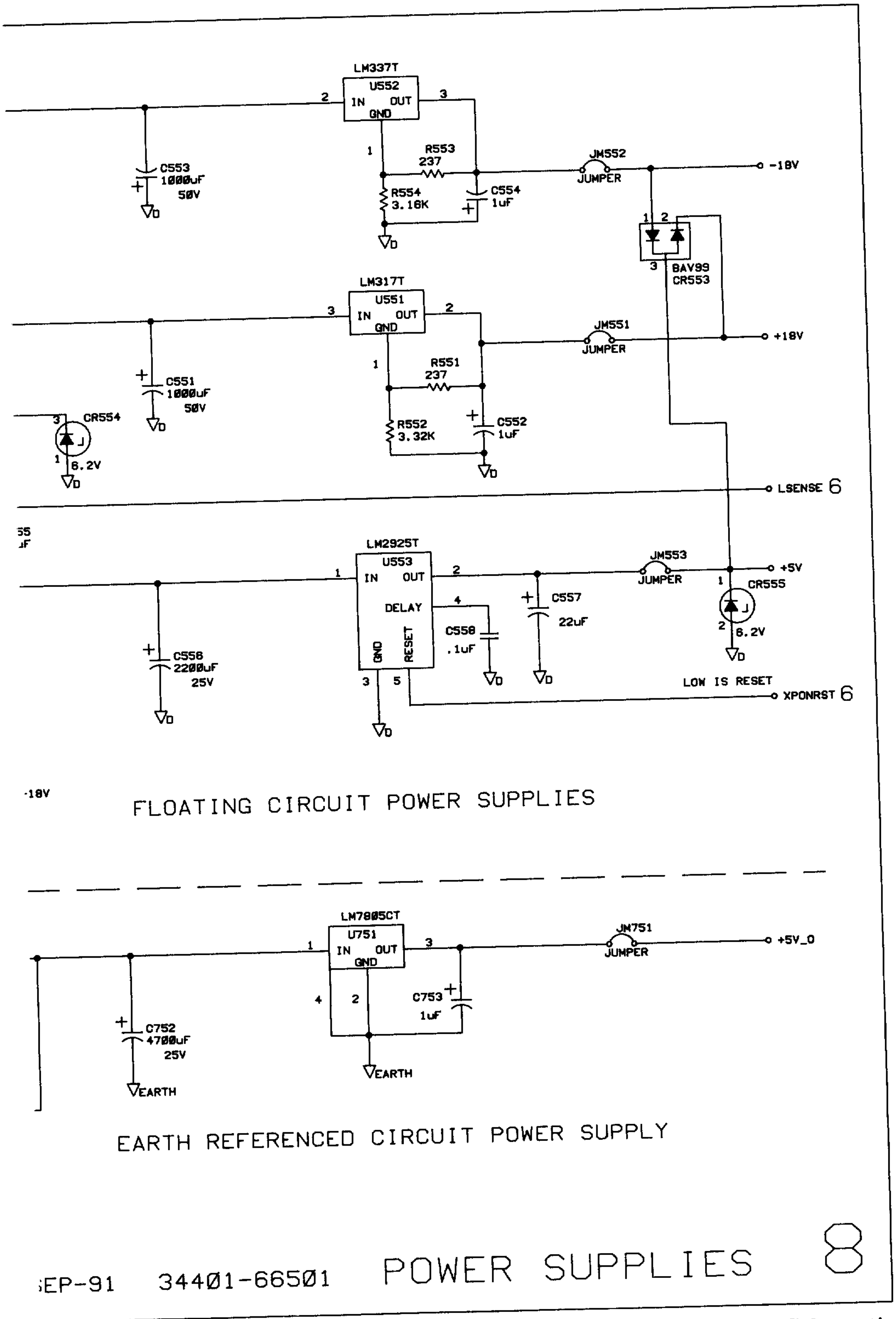
Front Panel Schematic

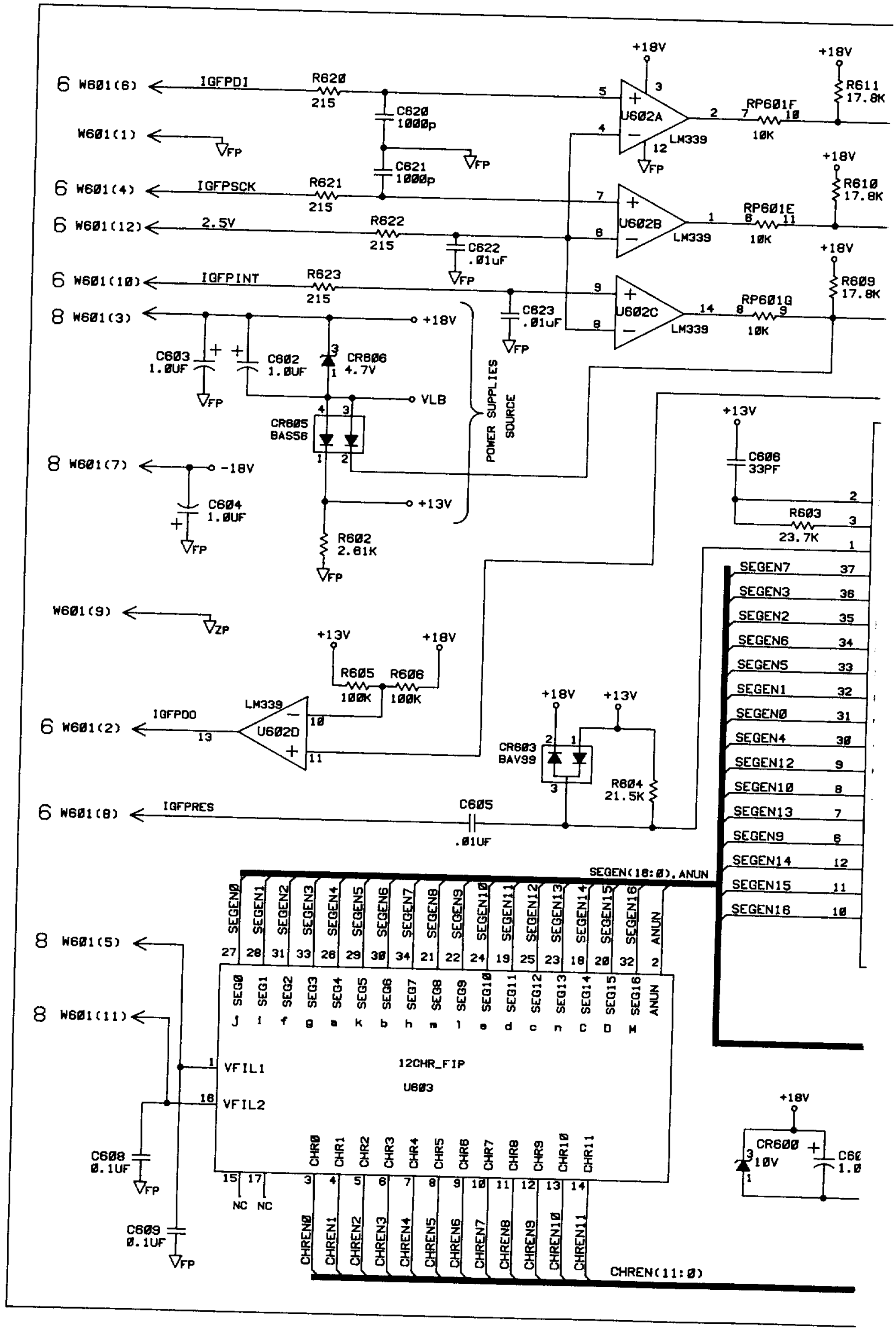

RED P551(6)
WHITE/GREY P551(7)
CR551
DF04S
RED P551(8)
R555 464K
C5: .1
ORANGE P551(5)
CR552
DF04S
ORANGE P551(4)
BLUE P551(2)
C559 22uF
R558 10K
CR556
6.2V
GREEN P551(3)
FILP
TO DISPLAY FILAMENT
GREEN P551(1)
FILN
T ON THE PC BOARD
POWER
ISFORMER
GREEN
BLUE
GREEN
ORANGE
RED
WHITE
RED
GRN/WHITE
BRN
P551(1)
P551(2)
P551(3)
P551(4)
P551(5)
P551(6)
P551(7)
P551(8)
P751(3)
P751(2)
P751(1)
(VIEWED FROM INSIDE UNIT)
CHASSIS
INCLUDES THE POWER FUSE, AND THE LINE SWITCH.
C751 .1uF
BROWN P751(1)
CONNECTS TO THE CHASSIS
MH751
GREEN/WHITE P751(3)
EARTH
EARTH
CR751
DF04S
BROWN P751(2)

9



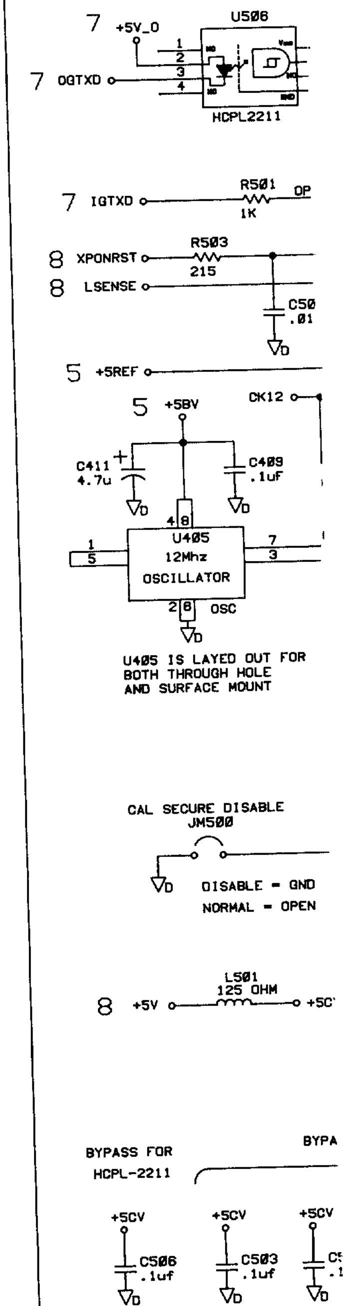
30-SEP-91 34401-66502 FRONT PA

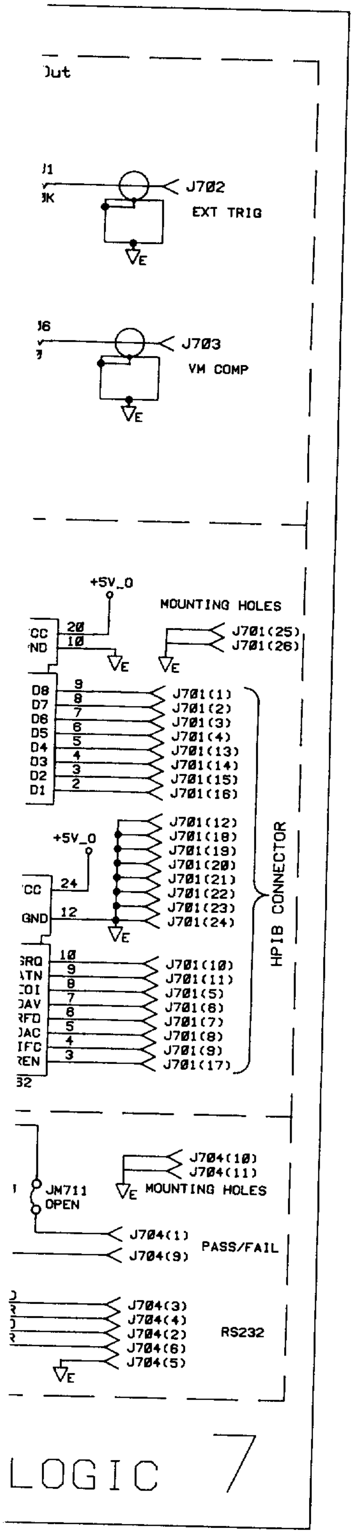

LM337T
U552
IN OUT
GND
C553
1000uF
50V
R553
237
R554
3.16K
C554
1uF
JM552
JUMPER
-18V
BAV99
CR553
LM317T
U551
IN OUT
GND
C551
1000uF
50V
R551
237
R552
3.32K
C552
1uF
JM551
JUMPER
+18V
CR554
6.2V
LSENSE 6
LM2925T
U553
IN OUT
DELAY
GND
RESET
C556
2200uF
25V
C558
.1uF
C557
22uF
JM553
JUMPER
+5V
CR555
6.2V
LOW IS RESET
XPONRST 6
-18V
FLOATING CIRCUIT POWER SUPPLIES
LM7805CT
U751
IN OUT
GND
C752
4700uF
25V
C753
1uF
JM751
JUMPER
+5V_0
EARTH
EARTH
EARTH REFERENCED CIRCUIT POWER SUPPLY
EP-91 34401-66501 POWER SUPPLIES 8



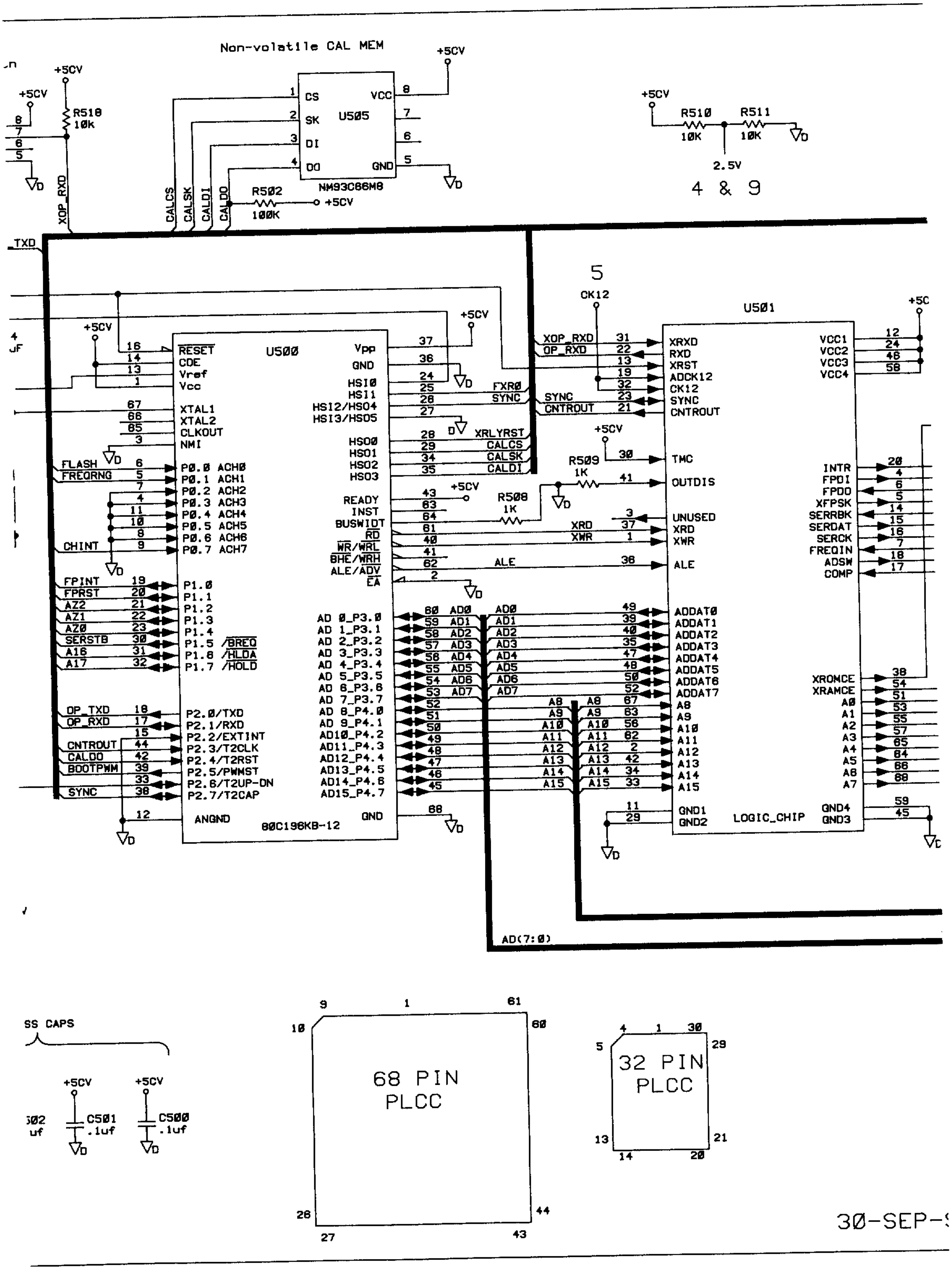
W601(6)
IGFPDI
R620 215
C620 1000p
C621 1000p
W601(1)
W601(4)
IGFPSCK
R621 215
W601(12)
2.5V
R622 215
C622 .01uF
W601(10)
IGFPINT
R623 215
C623 .01uF
W601(3)
+18V
U602A LM339
U602B LM339
U602C LM339
RP601F 10K
RP601E 10K
RP601G 10K
R611 17.8K
R610 17.8K
R609 17.8K
C603 1.0UF
C602 1.0UF
CR606 4.7V
VLB
CR605 BAS56
POWER SUPPLIES SOURCE
W601(7)
-18V
C604 1.0UF
+13V
R602 2.61K
C606 33PF
R603 23.7K
W601(9)
R605 100K
R606 100K
LM339 U602D
IGFPDO
W601(2)
CR603 BAV99
R604 21.5K
W601(8)
IGFPRES
C605 .01UF
SEGEN(16:0),ANUN
W601(5)
W601(11)
VFIL1
VFIL2
12CHR_FIP
U603
C608 0.1UF
C609 0.1UF
NC
CHREN(11:0)
CR600 10V

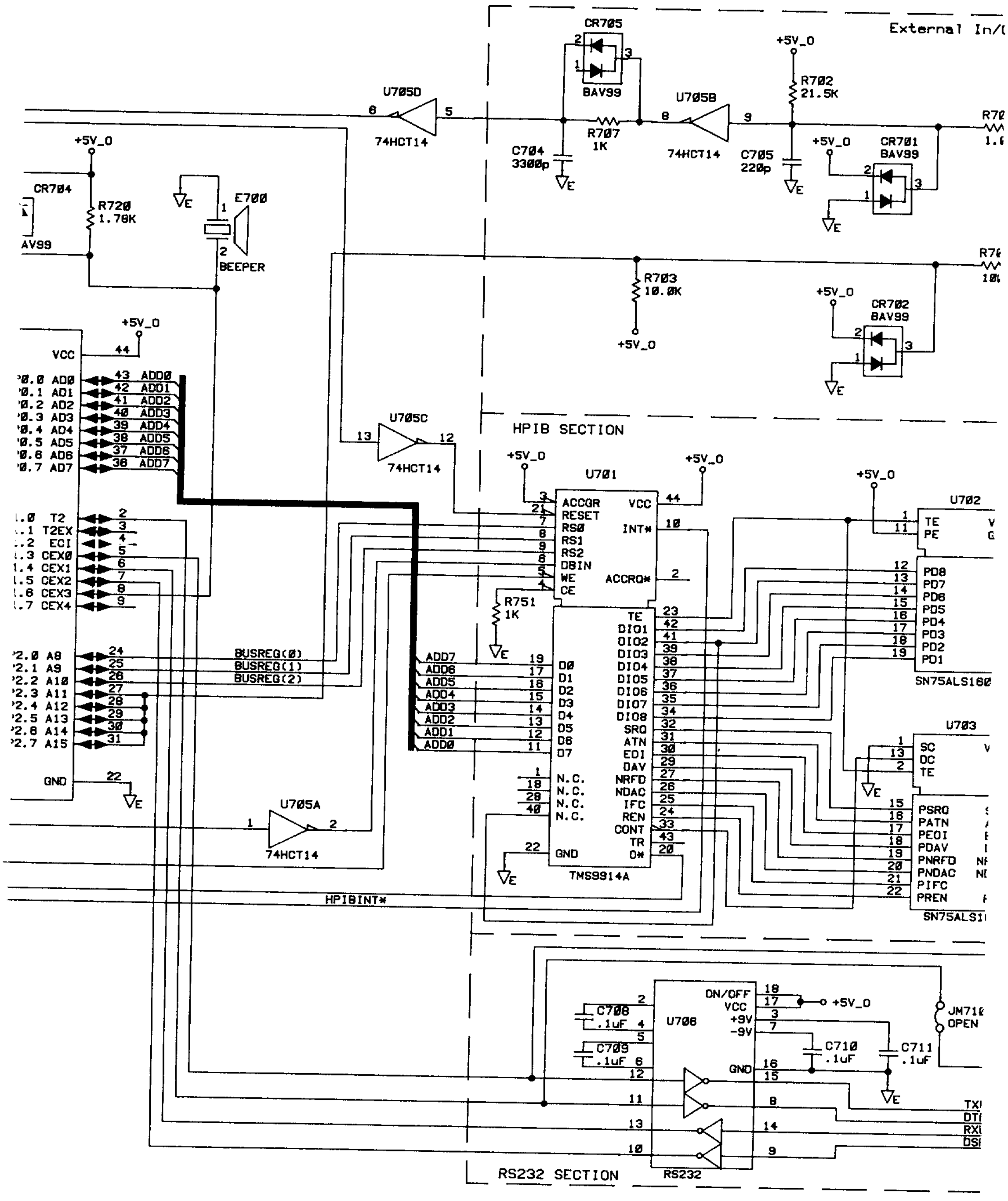
Crossguard Communicatio



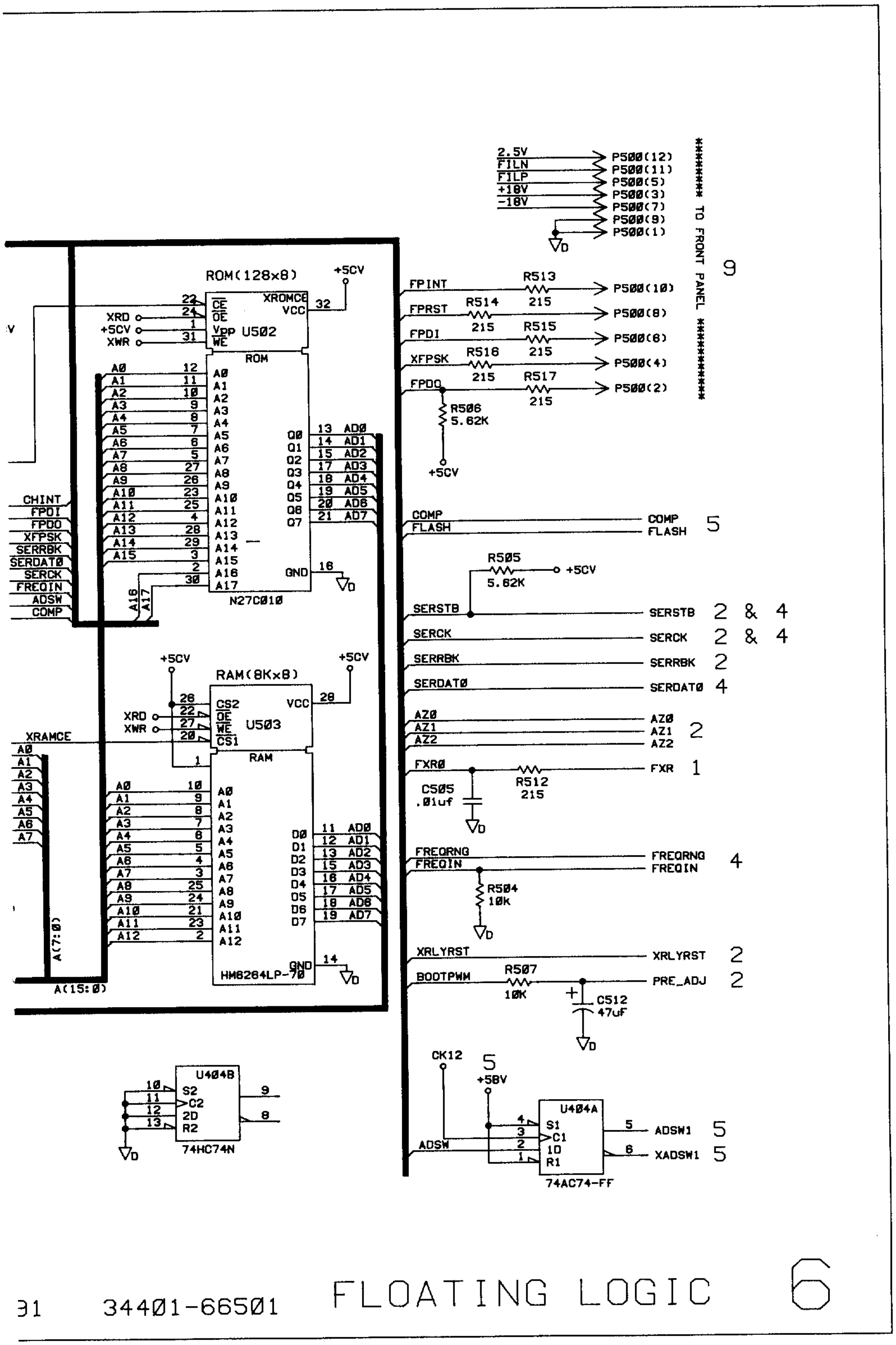


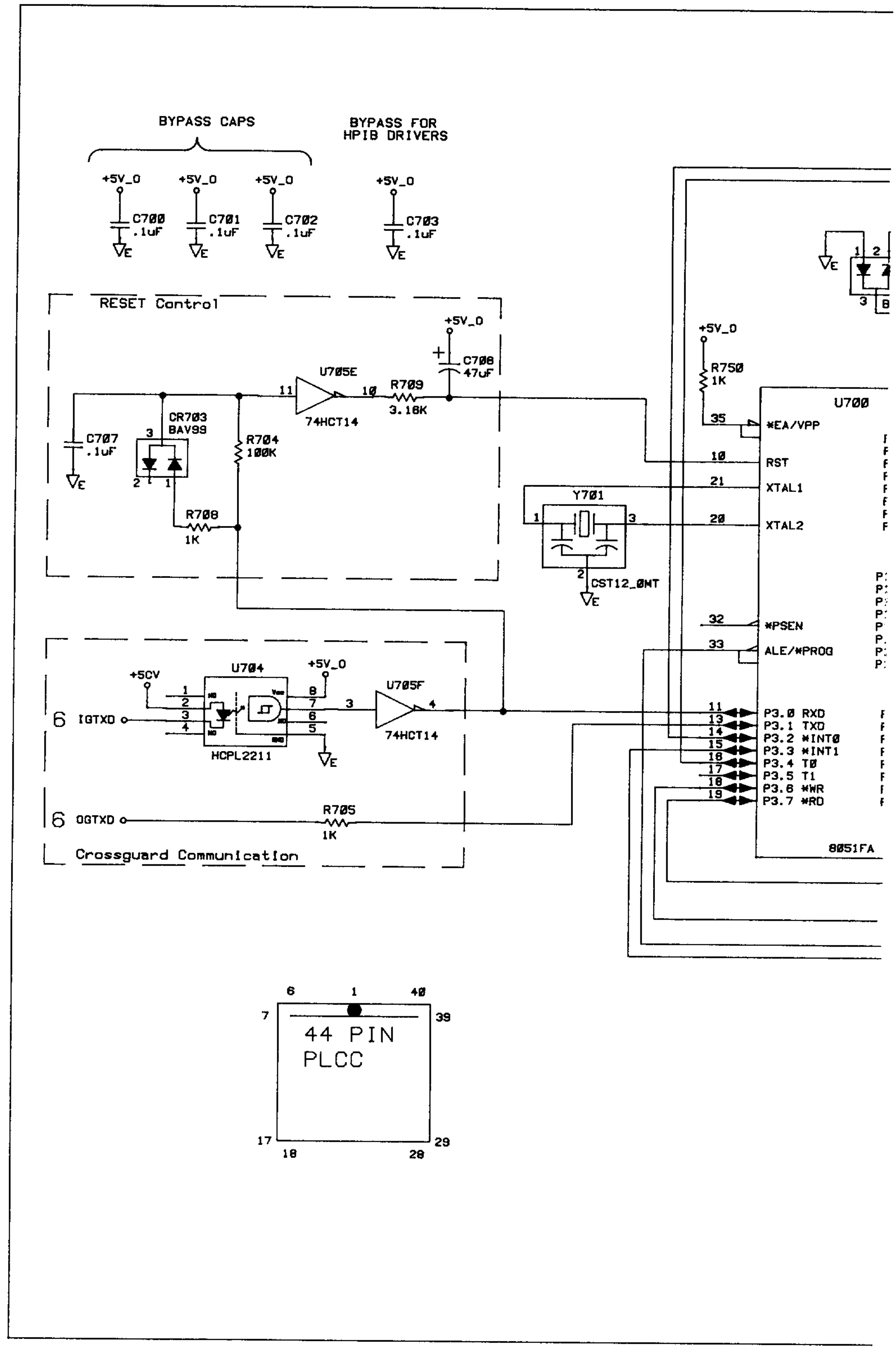
Earth Referenced Logic Schematic


Non-volatile CAL MEM
+5CV
R518
10K
XOP_RXD
CS
SK
DI
DO
VCC
GND
U505
NM93C66M8
CALCS
CALSK
CALDI
CALDO
R502
100K
+5CV
R510
10K
R511
10K
2.5V
4 & 9
5
CK12
U501
TXD
RESET
CDE
Vref
Vcc
XTAL1
XTAL2
CLKOUT
NMI
U500
Vpp
GND
HSI0
HSI1
HSI2/HSO4
HSI3/HSO5
HSO0
HSO1
HSO2
HSO3
READY
INST
BUSWIDT
RD
WR/WRL
BHE/WRH
ALE/ADV
EA
FXR0
SYNC
XRLYRST
CALCS
CALSK
CALDI
FLASH
FREQRNG
CHINT
P0.0 ACH0
P0.1 ACH1
P0.2 ACH2
P0.3 ACH3
P0.4 ACH4
P0.5 ACH5
P0.6 ACH6
P0.7 ACH7
FPINT
FPRST
AZ2
AZ1
AZ0
SERSTB
A16
A17
P1.0
P1.1
P1.2
P1.3
P1.4
P1.5 /BREQ
P1.6 /HLDA
P1.7 /HOLD
OP_TXD
OP_RXD
CNTROUT
CALDO
BOOTPWM
SYNC
P2.0/TXD
P2.1/RXD
P2.2/EXTINT
P2.3/T2CLK
P2.4/T2RST
P2.5/PWMST
P2.6/T2UP-DN
P2.7/T2CAP
ANGND
80C196KB-12
GND
AD 0_P3.0
AD 1_P3.1
AD 2_P3.2
AD 3_P3.3
AD 4_P3.4
AD 5_P3.5
AD 6_P3.6
AD 7_P3.7
AD 8_P4.0
AD 9_P4.1
AD10_P4.2
AD11_P4.3
AD12_P4.4
AD13_P4.5
AD14_P4.6
AD15_P4.7
R509
1K
R508
1K
XOP_RXD
OP_RXD
SYNC
CNTROUT
XRD
XWR
ALE
XRXD
RXD
XRST
ADCK12
CK12
SYNC
CNTROUT
TMC
OUTDIS
UNUSED
XRD
XWR
ALE
ADDAT0
ADDAT1
ADDAT2
ADDAT3
ADDAT4
ADDAT5
ADDAT6
ADDAT7
A8
A9
A10
A11
A12
A13
A14
A15
GND1
GND2
LOGIC_CHIP
GND4
GND3
VCC1
VCC2
VCC3
VCC4
INTR
FPDI
FPDO
XFPSK
SERRBK
SERDAT
SERCK
FREQIN
ADSW
COMP
XROMCE
XRAMCE
A0
A1
A2
A3
A4
A5
A6
A7
AD(7:0)
SS CAPS
+5CV
C501
.1uf
C500
.1uf
68 PIN
PLCC
32 PIN
PLCC
30-SEP-

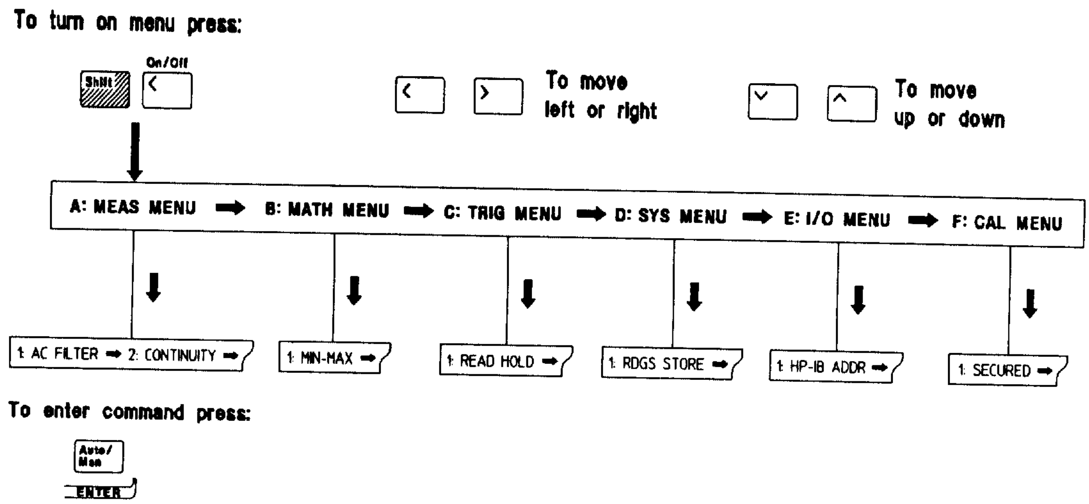


14-OCT-91 34401-66501 EARTH REFERENCED


ROM(128x8)
U502
N27C010
RAM(8Kx8)
U503
HM6264LP-70
U404B
74HC74N
U404A
74AC74-FF
TO FRONT PANEL
31
34401-66501
FLOATING LOGIC
6



BYPASS CAPS
BYPASS FOR HPIB DRIVERS
+5V_O
C700 .1uF
C701 .1uF
C702 .1uF
C703 .1uF
RESET Control
U705E
74HCT14
R709 3.16K
C706 47uF
CR703 BAV99
C707 .1uF
R704 100K
R708 1K
R750 1K
U700
*EA/VPP
RST
XTAL1
XTAL2
*PSEN
ALE/*PROG
P3.0 RXD
P3.1 TXD
P3.2 *INT0
P3.3 *INT1
P3.4 T0
P3.5 T1
P3.6 *WR
P3.7 *RD
8051FA
Y701
CST12_0MT
U704
+5CV
HCPL2211
U705F
74HCT14
IGTXD
OGTXD
R705 1K
Crossguard Communication
44 PIN PLCC



A: MEASurement MENU

1: AC FILTER ➡ 2: CONTINUITY ➡ 3: INPUT R ➡ 4: RATIO FUNC ➡ 5: RESOLUTION

B: MATH MENU

1: MIN–MAX ➡ 2: NULL VALUE ➡ 3: dB REL ➡ 4: dBm REF R ➡ 5: LIMIT TEST ➡ 6: HIGH LIMIT ➡ 7: LOW LIMIT

C: TRIGger MENU

1: READ HOLD ➡ 2: TRIG DELAY ➡ 3: N SAMPLES

D: SYStem MENU

1: RDGS STORE ➡ 2: SAVED RDGS ➡ 3: ERROR ➡ 4: TEST ➡ 5: DISPLAY ➡ 6: BEEP ➡ 7: COMMA ➡ 8: REVISION

E: Input / Output MENU

1: HP–IB ADDR ➡ 2: INTERFACE ➡ 3: BAUD RATE ➡ 4: PARITY ➡ 5: LANGUAGE

F: CALibration MENU

1: SECURED ➡ [1: UNSECURED] ➡ [2: CALIBRATE] ➡ 3: CAL COUNT ➡ 4: MESSAGE

NOTE: The two commands enclosed in square brackets ([ ]) in the CAL MENU are "hidden" unless the multimeter is UNSECURED for calibration.

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