

# Keysight 34420A Nano Volt/Micro Ohm Meter



Service  
Guide



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Earth ground symbol.



Chassis ground symbol.

### WARNING

Only qualified, service-trained personnel who are aware of the hazards involved should remove the cover from the instrument.

### WARNING

For continued protection against fire, replace the line fuse only with a fuse of the specified type and rating.

---

The Agilent 34420A is a 7<sup>1/2</sup> digit, high performance nanovolt, micro-ohm meter. Its combination of bench-top and system features makes this meter a versatile solution for your testing requirements now and in the future.

**Convenient bench-top features**

- Built-in math operations including thermistor, thermocouple and RTD temperature measurements
- Two channel input allows ratio and difference functions for voltage measurements
- Highly visible vacuum-fluorescent display
- Portable, ruggedized case with non-skid feet

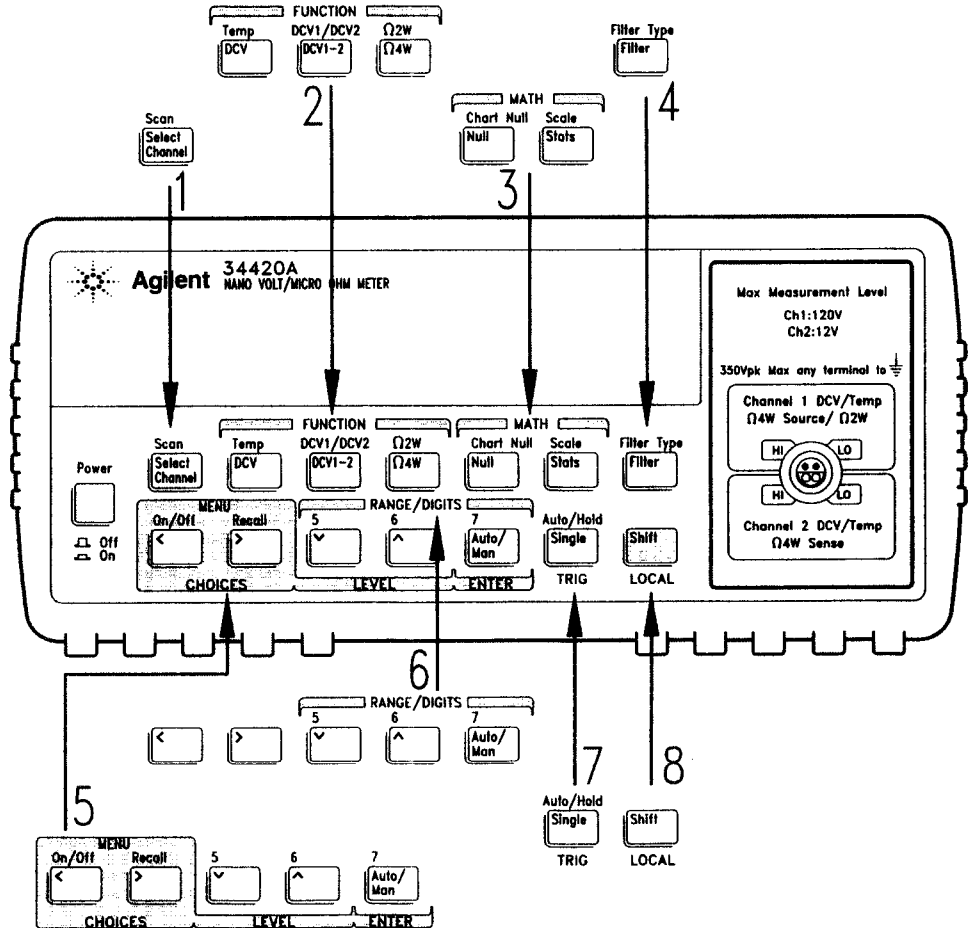
**Flexible system features**

- GPIB (IEEE-488) interface and RS-232 interface are standard
- SCPI (Standard Commands for Programmable Instruments) and Keithley 181 compatibility
- Readings at up to 250 per second

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**Agilent 34420A**  
**Nano Volt/Micro Ohm Meter**

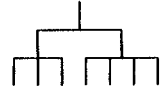
# The Front-Panel at a Glance



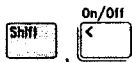
- |                             |  |
|-----------------------------|--|
| 1 Input channel select      | 5 Menu operation keys                      |
| 2 Measurement function keys | 6 Range/number of digits displayed keys    |
| 3 Math operation keys       | 7 Single trigger/autotrigger/auto hold key |
| 4 Filter select key         | 8 Shift / local key                        |

# The Front-Panel Menu at a Glance

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



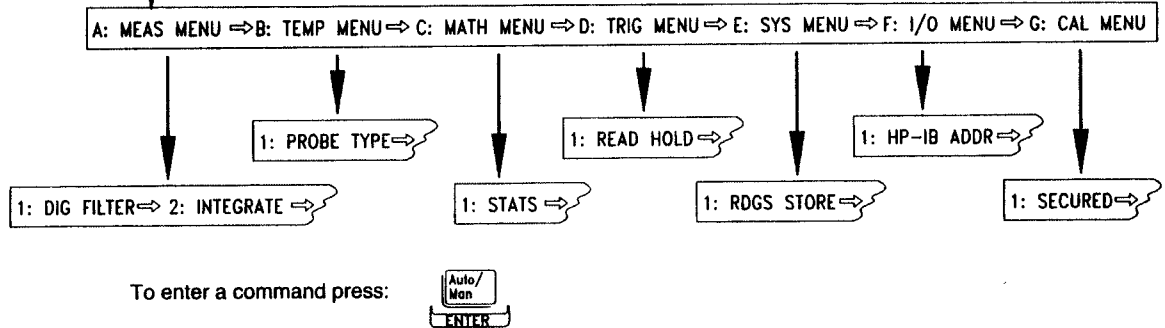
To turn on menu press:



To move left/right



To move up/down



## A: MEASUREMENT MENU

1: DIG FILTER ⇌ 2: INTEGRATE ⇌ 3: OCOMP  $\Omega$  ⇌ 4: LOW POWER  $\Omega$  ⇌ 5: LOW VOLT  $\Omega$  ⇌ 6: LoV LIMIT  $\Omega$

## B: TEMPERATURE MENU

1: PROBE TYPE ⇌ 2: UNITS ⇌ 3: RTD TYPE ⇌ 4: RTD  $R_{\theta}$  ⇌ 5: T/C TYPE ⇌ 6: COLD JUNCT ⇌ 7: JUNCT TEMP

## C: MATH MENU

1: STATS ⇌ 2: NULL VALUE ⇌ 3: SCALE GAIN ⇌ 4: SCALE OFST

## D: TRIGGER MENU

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

## E: SYSTEM MENU

1: RDGS STORE ⇌ 2: SAVED RDGS ⇌ 3: ERROR ⇌ 4: TEST ⇌ 5: CHART OUT ⇌ 6: CHART SPAN ⇌  
7: CHART NULL ⇌ 8: DISPLAY ⇌ 9: COMMA ⇌ 10: PRESET ⇌ 11: REVISION

## F: Input/Output MENU

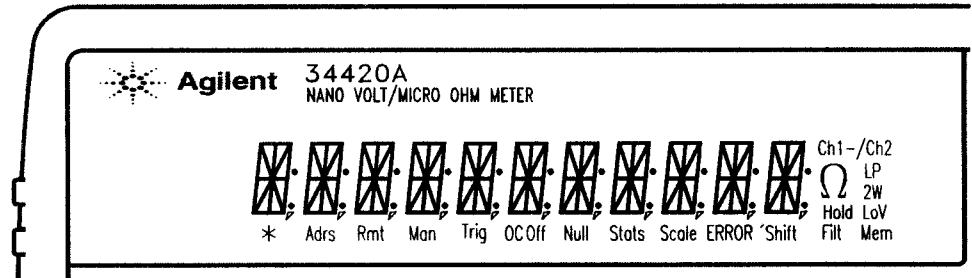
1: HP-IB ADDR ⇌ 2: INTERFACE ⇌ 3: BAUD RATE ⇌ 4: PARITY ⇌ 5: LANGUAGE

## G: CALIBRATION MENU

1: UNSECURED ⇌ [1: SECURED] ⇌ [2: CALIBRATE] ⇌ [3: CHART ZERO] ⇌ [4: CHART GAIN] ⇌  
[5: INJECTED I] ⇌ 6: CAL COUNT ⇌ 7: MESSAGE

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

## Display Annunciators

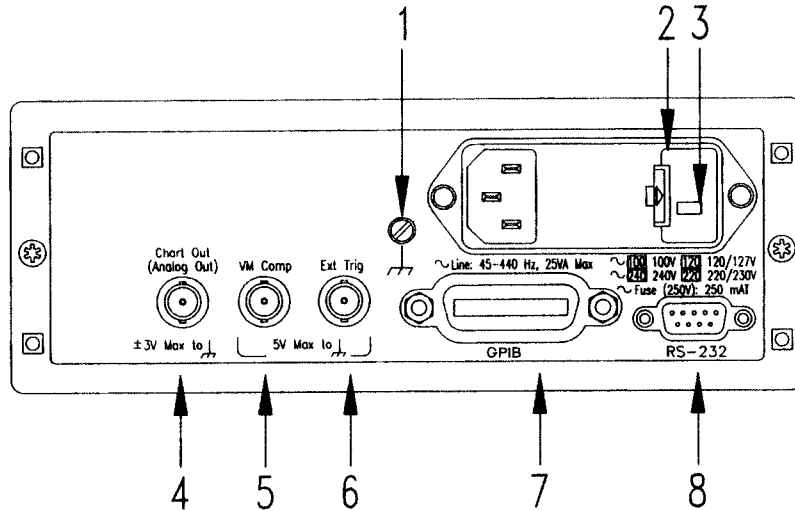


<b>*</b>	Turns on during a measurement.
<b>Adrs</b>	Meter is addressed to listen or talk over the GPIB interface.
<b>Rmt</b>	Meter is in remote mode (using remote interface).
<b>Man</b>	Meter is using manual ranging (autorange is disabled).
<b>Trig</b>	Meter is waiting for a single trigger or external trigger.
<b>OC Off</b>	Offset compensation is turned off.
<b>Null</b>	A null value is being used.
<b>Stats</b>	Math statistics operations are being used.
<b>Scale</b>	Math scaling operations are being used.
<b>ERROR</b>	Hardware or remote interface command error(s) detected.
<b>Shift</b>	"Shift" key has been pressed.
<b>Ch1</b>	Meter input is on Channel 1.
<b>Ch2</b>	Meter input is on Channel 2.
<b>Ch1 - Ch2</b>	Meter is indicating the difference between inputs on channel 1 and channel 2.
<b>Ch1 / Ch2</b>	Meter is indicating the ratio of the inputs on channel 1 and channel 2.
<b>Ω</b>	Meter is measuring resistance (Ohms).
<b>LP</b>	Meter is using low power Ohms.
<b>2W</b>	Meter is using 2-wire Ohms (annunciator off indicates a 4-wire measurement).
<b>LoV</b>	Meter is using voltage limited Ohms.
<b>Hold</b>	Automatic reading hold is enabled.
<b>Filt</b>	The analog and/or the digital filter is enabled.
<b>Mem</b>	Turns on when reading memory is enabled.

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



## The Rear Panel at a Glance



- |  |  |
|--|--|
| <b>1</b> Chassis ground                              | <b>5</b> Voltmeter complete output terminal  |
| <b>2</b> Power-line fuse-holder assembly             | <b>6</b> External trigger input terminal     |
| <b>3</b> Power-line voltage setting                  | <b>7</b> GPIB (IEEE-488) interface connector |
| <b>4</b> Chart recorder output terminal (Analog out) | <b>8</b> RS-232 interface connector          |

### Use the front-panel Input / Output Menu to:

- Select the GPIB or RS-232 interface
- Set the GPIB bus address
- Set the RS-232 baud rate and parity

---

## In This Book

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

**Quick Start** Chapter 2 prepares the meter 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 describes some of the meter's menu features.

**Calibration Procedures** Chapter 4 provides calibration, verification, and adjustment procedures for the meter.

**Theory of Operation** Chapter 5 describes block and circuit level theory related to the operation the meter.

**Service** Chapter 6 provides guidelines for returning your meter to Agilent Technologies for servicing, or for servicing it yourself.

**Replaceable Parts** Chapter 7 contains a detailed parts lists of the meter.

**Backdating** Chapter 8 describes the differences between this manual and older issues of this manual.

**Schematics** Chapter 9 contains the meter's block diagram, schematics, disassembly drawings, and component locator drawings.

*If you have questions relating to the operation of the meter, call 1-800-452-4844 in the United States, or contact your nearest Agilent Technologies Sales Office.*

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# Table of Contents

## **Chapter 1 Specifications**

- Accuracy Specifications 12
- Measurement Characteristics 13
- Operating Characteristics 14
- Dimensions 16
- To Calculate Total Measurement Error 17
- Interpreting Meter Specifications 21
  - Number of Digits and Overrange 21
  - Sensitivity 21
  - Resolution 22
  - Accuracy 22
  - 24-Hour Accuracy 23
  - 90-Day and 1-Year Accuracy 23
  - Temperature Coefficients 23
- Configuring for Highest Accuracy Measurements 23

## **Chapter 2 Quick Start**

- To Prepare the Meter For Use 27
- If the Meter Does Not Turn On 28
- To Adjust the Carrying Handle 30
- To Make Input Connections 31
- To Measure Voltage 33
- To Measure Resistance 34
- To Measure Temperature With Thermistors 35
- To Measure Temperature With RTDs 35
- To Measure Temperature With Thermocouples 36
- To Select a Range 37
- To Set the Number of Digits 38
- To Set the Integration Time 39
- Front-Panel Display Formats 40
- To Rack Mount the Meter 41

## **Chapter 3 Front-Panel Operation**

- Front-Panel Menu Reference 45
- A Front-Panel Menu Tutorial 47
- To Select an Input Channel 55
- To Select a Range 56
- To Set or Change the Number of Digits 57
- To Set the Integration Time 58
- To Trigger the Meter 59
- Null (Relative) Measurements Operation 60
- To Use Math (Stats) 61
- To Set the Number of Samples 62
- Chart Output (Analog Output) 63
- To Unsecure the Meter for Calibration 64

**Chapter 4 Calibration Procedures**

Agilent Technologies Calibration Services 69  
Calibration Interval 69  
Time Required for Calibration 69  
Automating Calibration Procedures 70  
Recommended Test Equipment 70  
Test Considerations 71  
Performance Verification Tests 72  
    Self-Test 72  
    Quick Performance Check 73  
    Performance Verification Tests 73  
Zero Offset Verification 74  
    Zero Offset Verification Procedure 74  
Gain Verification 76  
    Gain Verification Procedure 76  
1 mV and 10 mV Gain Verification (Optional) 78  
    1 mV and 10 mV Gain Verification Procedure 78  
Injected Current Verification (Optional) 80  
    Injected Current Verification Procedure 80  
Chart Output Verification (Optional) 81  
    Chart Output Verification Procedure 81  
Calibration Security Code 83  
    To Unsecure the Meter Without the Security Code 84  
Calibration Count 85  
Calibration Message 85  
Calibration Procedure 86  
Aborting a Calibration in Progress 86  
Zero Calibration 87  
    Zero Calibration Procedure 88  
Gain Calibration 89  
    Gain Adjustment Considerations 89  
    Gain Calibration Procedure 90  
Injected Current Calibration (Optional) 92  
Internal Temperature Reference Calibration (Optional) 94  
Chart Output Calibration (Optional) 95  
Error Messages 96

**Chapter 5 Theory of Operation**

Block Diagram 101  
Input and Protection 103  
Function Switching 105  
DC Amplifier 106  
Ohms Current Source 108  
A-to-D Converter 111  
Configuration Data Shift Register 113  
    Injected Current Compensation 113  
    Chart Recorder Output 113  
Floating Logic 114  
Earth-Referenced Logic 117  
Power Supplies 118  
Front Panel 119

**Chapter 6 Service**

Operating Checklist 123  
    Is the meter inoperative? 123  
    Does the meter fail self-test? 123  
Types of Service Available 124  
    Standard Repair Services (worldwide) 124  
    Express Exchange (U.S.A. only) 124  
Repackaging for Shipment 125  
Electrostatic Discharge (ESD) Precautions 126  
Surface Mount Repair 126  
To Replace the Power-Line Fuse 126  
Input Connector 127  
Cleaning the Connector Contacts 128  
Troubleshooting Hints 129  
    Unit is inoperative 129  
    Unit reports error 705 129  
    Unit fails self-test 129  
    Power supply problems 130  
Self-Test Procedures 131  
    Power-On Self-Test 131  
    Complete Self-Test 131  
    Performing Individual Tests 131

**Chapter 7 Replaceable Parts**

Replaceable Parts 136  
    To Order Replace Parts 136  
    Backdating and Part Changes 136  
    Input Connector Replaceable Parts 137  
    34420-66501 Main PC Assembly 138  
    34420-66502 Display and Keyboard PC Assembly 147  
    34420A Mainframe 148  
    Manufacturer's List 149

**Chapter 8 Backdating**

Backdating 151

**Chapter 9 Schematics**

Mechanical Disassembly 155  
34420-66501 Component Locator 156  
34420-66502 Component Locator 157  
Block Diagram 159  
Input and Protection Schematic 160  
Function Switching Schematic 161  
DC Amplifier Schematic 162  
Ohms Current Source Schematic 163  
A/D Converter Schematic 164  
Configuration Data Shift Registers Schematic 165  
Floating Logic Schematic 166  
Earth Referenced Logic Schematic 167  
Power Supply Schematic 168  
Display and Keyboard Schematic 169



# Specifications

**Chapter 1 Specifications**  
**Agilent 34420A Nano Volt / Micro Ohm Meter**

**ACCURACY SPECIFICATIONS ± (% of reading + % of range) <sup>[1]</sup>**

Function	Range <sup>[2]</sup>	Test Current	24 Hour 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	Maximum Per Lead Resistance
DC Voltage	1.000000 mV <sup>[3]</sup> 10.000000 mV <sup>[3]</sup> 100.00000 mV 1.000000 V 10.000000 V 100.00000 V <sup>[4]</sup>		0.0025 + .0020 0.0025 + .0002 0.0015 + .0003 0.0010 + .0003 0.0002 + .0001 0.0010 + .0004	0.0040 + .0020 0.0040 + .0002 0.0030 + .0004 0.0025 + .0004 0.0020 + .0004 0.0025 + .0005	0.0050 + .0020 0.0050 + .0003 0.0040 + .0004 0.0035 + .0004 0.0030 + .0004 0.0035 + .0005	0.0004 + .0001 0.0004 + .00002 0.0004 + .00006 0.0004 + .00004 0.0001 + .00002 0.0004 + .00005	
Resistance <sup>[5]</sup>	1.000000 Ω 10.000000 Ω 100.00000 Ω 1.000000 KΩ 10.000000 KΩ 100.00000 KΩ 1.000000 MΩ	10 mA 10 mA 10 mA 1 mA 100 μA 10 μA 5 μA	0.0015 + .0002 0.0015 + .0002 0.0015 + .0002 0.0015 + .0002 0.0015 + .0002 0.0015 + .0003 0.0020 + .0003	0.0050 + .0002 0.0040 + .0002 0.0040 + .0002 0.0040 + .0002 0.0040 + .0002 0.0040 + .0004 0.0050 + .0004	0.0070 + .0002 0.0060 + .0002 0.0060 + .0002 0.0060 + .0002 0.0060 + .0002 0.0060 + .0004 0.0070 + .0004	0.0005 + .00002 0.0005 + .00001 0.0005 + .00001 0.0005 + .00001 0.0005 + .00001 0.0005 + .00002 0.0006 + .00003	1 Ω 1 Ω 10 Ω 100 Ω 1 KΩ 1 KΩ 1 KΩ
Low Power Resistance <sup>[5]</sup>	1.000000 Ω 10.000000 Ω 100.00000 Ω 1.000000 KΩ 10.000000 KΩ 100.00000 KΩ 1.000000 MΩ	10 mA 10 mA 1 mA 100 μA 10 μA 5 μA 5 μA	0.0015 + .0002 0.0015 + .0002 0.0015 + .0002 0.0015 + .0002 0.0015 + .0004 0.0015 + .0012 0.0020 + .0003	0.0050 + .0002 0.0040 + .0002 0.0040 + .0002 0.0040 + .0002 0.0040 + .0004 0.0040 + .0015 0.0050 + .0004	0.0070 + .0002 0.0060 + .0002 0.0060 + .0002 0.0060 + .0002 0.0060 + .0004 0.0060 + .0015 0.0070 + .0004	0.0005 + .00002 0.0005 + .00001 0.0005 + .00001 0.0005 + .00001 0.0005 + .00003 0.0005 + .00003 0.0006 + .00003	1 Ω 1 Ω 10 Ω 100 Ω 1 KΩ 1 KΩ 1 KΩ
Voltage Limited Resistance <sup>[5][6]</sup>	10.000000 Ω 100.00000 Ω	1 mA 100 μA	0.0020 + .0002 0.0025 + .0002	0.0050 + .0002 0.0050 + .0002	0.0070 + .0002 0.0070 + .0002	0.0005 + .00002 0.0005 + .00002	1 Ω 5 Ω
Channel 1 / Channel 2 (DCV Ratio)			Ratio Error % = Channel 1 accuracy in % + Channel 2 accuracy in %				
Channel 1 - Channel 2 (DCV Difference)			Difference Error = Channel 1 (% of reading + % of range) + Channel 2 (% of reading + % of range)				
Temperature (resolution = 0.001° C)							
Thermocouple <sup>[7]</sup>		Thermocouple probe accuracy + 0.2° C					
Thermistor		Thermistor probe accuracy + 0.1° C					
RTD		RTD probe accuracy + 0.05° C					

[1] Specifications are for Channel 1 or Channel 2, after 2-hour warm-up, resolution at 7.5 digits (100 NPLC), with FILTERS off.  
RESISTANCE specifications are for 4-wire ohms or 2-wire ohms using Null. Without Null, add 0.2 Ω additional error in 2-wire ohms function.  
With Analog Filter ON, add 0.002% of reading to listed specifications.

[2] 20% overrange on all ranges except 5% on Voltage Limited Resistance.

[3] After using Null. If Null is not used add 100 nanovolts.

[4] Channel 1 only.

[5] Channel 1 only. Resistance measurements, for NPLC <1, add 160 μΩ RMS noise.

[6] Voltage limit can be set to 20 mV (default), 100 mV, or 500 mV. Measured resistance plus Channel 1 HI and LO lead resistance is limited to 10.5 Ω on the 10 Ω range and 105 Ω on the 100 Ω range.

[7] For fixed reference junction. Add 0.3° C for external reference junction, add 2° C for internal reference junction.



## Chapter 1 Specifications Agilent 34420A Nano Volt / Micro Ohm Meter

### DC Voltage Noise Specifications \*

Range	Observation Period		
	2-Minute RMS Noise	2-Minute Peak-Peak Noise	24-Hour Peak-Peak Noise
1 mV	1.3 nVRMS	8 nVpp	12 nVpp
10 mV	1.5 nVRMS	10 nVpp	14 nVpp
100 mV	10 nVRMS	65 nVpp	80 nVpp
1 V	100 nVRMS	650 nVpp	800 nVpp
10 V	450 nVRMS	3 $\mu$ Vpp	3.7 $\mu$ Vpp
100 V	11 $\mu$ VRMS	75 $\mu$ Vpp	90 $\mu$ Vpp

\* After a 2-hour warm-up,  $\pm 1^\circ\text{C}$ , 6.5 digits (10 PLC) with Analog Filter Off and Digital Filter Medium (50 reading average). 2-Minute RMS and 24-hour noise typical. For measurements using 0.02 or 0.2 NPLC, add 800 nV RMS noise.

### DC Voltage Noise vs Source Resistance \*

Source Resistance	Noise	Analog Filter	Digital Filter
0	1.3 nVRMS	Off	Med
100	1.7 nVRMS	Off	Med
1k	4 nVRMS	Off	Med
10k	13 nVRMS	Off	Med
100k	41 nVRMS	On	Med
1M	90 nVRMS	On	Slow

\* Typical noise behavior for Ch 1 or Ch 2, after 2 hour warm-up, 6.5 digits (10 PLC), 2 minute observation period on 1 mV range. For peak-to-peak noise, multiply RMS noise by 6.

### MEASUREMENT CHARACTERISTICS

#### DC Voltage

Measurement Method	Continuously Integrating Multi-slope III A-D Converter
A-D Linearity	0.00008% of reading + 0.00005% of range
Input Resistance	100V (Ch1 only) 10 M $\Omega$ $\pm$ 1% 1mV through 10V >10 G $\Omega$ , in parallel with <3.6 nF
Input Bias Current	<50 pA at 25 $^\circ\text{C}$
Injected Current*	<50 nA pp at 50 or 60 Hz
Input Protection	150 V peak any input terminal to Channel 1 LO, continuous
Channel Isolation	Isolation between input channels >10 <sup>10</sup> $\Omega$
Earth Isolation	350 V peak any input terminal to earth. Impedance from any input terminal to earth is >10 G $\Omega$ and < 400 pF
Maximum Voltage	Channel 1 LO to Channel 2 LO, 150V peak

#### Resistance

Measurement Method	Selectable 4-wire or 2-wire ohms. Current Source referenced to Channel 1 LO input
Offset Compensation	Used on all ranges except 100 k $\Omega$ and 1 M $\Omega$ . Can be turned off if desired
Protection	150V peak
Open Circuit Voltage	For Resistance and Low Power Resistance <14 V. 20 mV, 100 mV, 500 mV selectable clamp

\* Injected current is calibrated at the factory. Different line power configurations will require recalibration.

Chapter 1 Specifications  
**Agilent 34420A Nano Volt / Micro Ohm Meter**

**Temperature**

Thermocouple	Type B, E, J, K, N, R, S, T Range: -210° C to 1820° C
Thermistor	5 kΩ Range: -80° C to 150° C
RTD	4-wire, 4.9 Ω to 2.1 kΩ types: α = .00385 (DIN/IEC 751) and α = .00391 Range: -200° C to 850° C

**Measurement Noise Rejection 60 (50) Hz <sup>[1]</sup>**

dc CMRR	140 dB
ac CMRR	70 dB

**Integration Time Normal Mode Rejection <sup>[2]</sup>**

200 plc/3.335 ms (4s)	110 dB <sup>[3]</sup>
100 plc/1.675 ms (2s)	105 dB <sup>[3]</sup>
20 plc/334 ms (400ms)	100 dB <sup>[3]</sup>
10 plc/167ms (200ms)	95 dB <sup>[3]</sup>
2 plc/33.3 ms (40 ms)	90 dB <sup>[3]</sup>
1plc/16.7ms (20ms)	60 dB
<1plc	0

**OPERATING CHARACTERISTICS <sup>[4]</sup>**

Function	Digits	Integration Time	Readings/s <sup>[5]</sup>
DCV,	7½	200 plc	.15 (.125)
Thermocouple	7½	100 plc	.3 (.25)
	6½	20 plc	1.5 (1.25)
	6½	10 plc	3 (2.5)
	5½	1 plc	25 (20.8)
	5½	0.2 plc <sup>[1]</sup>	100 (100)
	4½	0.02 plc	250 (250)
Resistance,	7½	200 plc	.075 (.062)
DCV1/DCV2,	7½	100 plc	.15 (.125)
DCV 1-2,	6½	20 plc	.75 (.625)
RTD,	6½	10 plc	1.5 (1.25)
Thermistor	5½	1 plc	12.5 (10.4)
	5½	0.2 plc	50 (50)
	4½	0.02 plc	125 (125)

**System Speeds <sup>[6]</sup>**

Configuration Rates	26/s to 50/s
Autorange Rate (DC Volts)	>30/s
ASCII reading to RS-232	55/s
ASCII reading to GPIB	250/s
Max. Internal Trigger Rate	250/s
Max. Ext. Trig. Rate to Memory	250/s

[1] For 1 kΩ unbalanced in LO lead.

[2] For power line frequency ± 0.1%, Filters OFF.  
 For Digital Filter slow add 20 db, for medium or fast add 10 db for NPLC ≥ 1.

[3] For power line frequency ± 1%, use 80 db or ± 3% use 60 db.

[4] Speeds are for delay 0, Display OFF, Filters OFF, OCOMP OFF.

[5] Reading speeds for 60 Hz or (50 Hz), 100 mV through 100 V ranges.  
 1 mV range 30/s MAX, 10 mV range 170/s MAX, thermocouple 120/s MAX.

[6] Speeds are for NPLC 0.02, Delay 0, Display OFF, Chart Out OFF.

# Chapter 1 Specifications

## Agilent 34420A Nano Volt / Micro Ohm Meter

### Triggering and Memory

Reading HOLD Sensitivity	10%, 1%, 0.1%, or 0.01% of range
Samples/Trigger	1 to 50,000
Trigger Delay	0 to 3600s; 10 $\mu$ s step size
External Trigger Delay	<1ms
External Trigger Jitter	<500 $\mu$ s
Memory	1024 readings

### Math Functions

- NULL (Channel 1 DCV, Channel 2 DCV, Difference, Resistance, Temperature)
- STATS (Min, Max, Average, Peak-Peak, Standard Deviation, Number of readings)
- SCALE (Allows linear scaling as  $y=mx+b$ )
- CHART NULL (Establishes zero for rear panel output)

### Filter (Analog or Digital or Both)

Analog	Low pass 2 pole @ 11Hz, available for 1, 10, 100mV range
Digital	Moving average filter, 10 (fast), 50 (medium) or, 100 (slow) reading averages.

### Chart Out (Analog Out)

- Maximum output:  $\pm 3V$
- Accuracy:  $\pm 0.1\%$  of output + 1 mV
- Output Resistance: 1 k $\Omega$   $\pm$  5%
- Update rate: once per reading
- Span and Offset: Adjustable

### Standard Programming Languages

SCPI (IEEE 488.2), Keithley 181

### Accessories Included

4 ft low thermal cable with copper spade lugs, 4-wire shorting plug, user's manual, service manual, contact cleaner, test report and power cord

### General Specifications

Front Panel Connection	shielded, low thermal, 99% copper contacts
Power Supply	100V/120V/220V(230V)/240V $\pm$ 10%
Power Line Frequency	45Hz to 66Hz and 360Hz to 440Hz Automatically sensed at power-on.
Power Consumption	25VA peak (10W average)
Operating Environment	Full accuracy for 0° C to 55° C Full accuracy to 80% R.H. up to 40° C
Storage Environment	-40° C to 75° C
Weight	3 kg (6.5 lbs)
Safety	Designed to CSA, UL-1244, IEC-1010
RFI and ESD	CISPR 11
Vibration and Shock	MIL-T-28800E, Type III, Class 5
Warranty	3 year

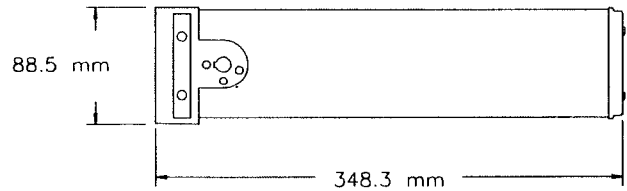
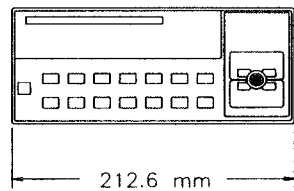
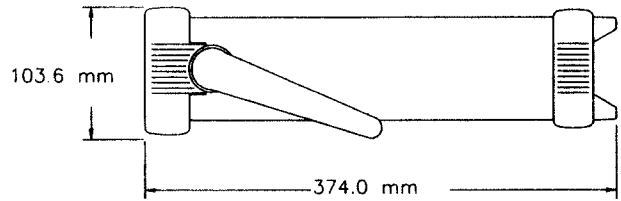
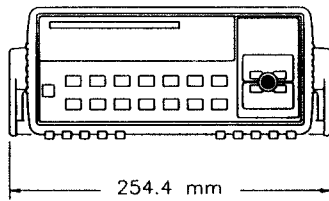
*This ISM device complies with Canadian ICES-001.*

*Cet appareil ISM est conforme à la norme NMB-001 du Canada.*



Chapter 1 Specifications  
Agilent 34420A Nano Volt / Micro Ohm Meter

Dimensions



---

## To Calculate Total Measurement Error

Each specification includes correction factors which account for errors present due to operational limitations of the meter. This section explains these errors and shows how to apply them to your measurements. Refer to "Interpreting Meter Specifications," starting on page 21, to get a better understanding of the terminology used and to help you interpret the meter's specifications.

The meter's accuracy specifications are expressed in the form:

**(% of reading + % of range)**

In addition to the reading error and range conditions, make sure you apply the conditions as described in the footnotes on the specification pages.

- If you are operating the meter outside the  $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$  temperature range specified, apply an additional temperature coefficient 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 illustrates the reading error applied to the meter's 24-hour dc voltage specification.

Range	Input Level	Reading Error (% of reading)	Reading Error Voltage
10 V	10 V	0.0002	$\leq 20\ \mu\text{V}$
10 V	1 V	0.0002	$\leq 2\ \mu\text{V}$
10 V	0.1 V	0.0002	$\leq 200\ \text{nV}$

Chapter 1  
**To Calculate Total Measurement Error**

**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 illustrates the range error applied to the meter's 24-hour dc voltage specification.

Range	Input Level	Range Error (%of range)	Range Error Voltage
10 V	10 V	0.0001	≤ 10 μV
10 V	1 V	0.0001	≤ 10 μV
10 V	0.1 V	0.0001	≤ 10 μV

**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.

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

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

---

**Total Measurement Error Example** Assume that a 5 Vdc signal is input to the meter on the 10 Vdc range. To compute the total measurement error using the 90-day accuracy specifications: ±(0.0020% of reading + 0.0004% of range).

$$\text{Reading Error} = 0.0020\% * 5 V = 100 \mu V$$

$$\text{Range Error} = 0.0004\% * 10 V = 40 \mu V$$

$$\text{Total Error} = 100 \mu V + 40 \mu V = \pm 140 \mu V$$

$$\% \text{ of input error} = \frac{\pm 140 \mu V}{5 V} * 100 = \pm 0.0028\% \text{ of } 5 V$$

$$\text{ppm of input error} = \frac{\pm 140 \mu V}{5 V} * 1,000,000 = \pm 28 \text{ ppm of } 5 V$$


---

---

**Difference Error Example**

This example demonstrates how to compute the total measurement error when using the Difference Function. Assume a difference measurement is made with the following conditions:

- **Channel 1**, 1 V input on the 1 Volt range
- **Channel 2**, 1.2 V input on the 10 Volt range

To compute the total measurement error using the 90-day accuracy specifications for the error:

**Channel 1 (% of reading + % of range) + Channel 2 (% of reading + % of range).**

$$\text{Channel 1 Reading Error} = 0.0025\% * 1 V = 25 \mu V$$

$$\text{Channel 1 Range Error} = 0.0004\% * 1 V = 4 \mu V$$

$$\text{Channel 2 Reading Error} = 0.0020\% * 1.2 V = 24 \mu V$$

$$\text{Channel 2 Range Error} = 0.0004\% * 10 V = 40 \mu V$$

$$\text{Total Error} = 25 \mu V + 4 \mu V + 24 \mu V + 40 \mu V = 93 \mu V$$

$$\text{Difference} = 1 V - 1.2 V = -0.2 V \pm 93 \mu V$$

For difference measurements, if both channel 1 and channel 2 are using the same range, the % of reading error can be applied directly to the voltage difference. In the example, if both channels are using the 1 V range, the total reading error can be computed as:

$$\text{Reading Error} = 0.0025\% * (1.2 V - 1 V) = 5 \mu V$$

$$\text{Channel 1 Range Error} = 0.0004\% * 1 V = 4 \mu V$$

$$\text{Channel 2 Range Error} = 0.0004\% * 1 V = 4 \mu V$$

$$\text{Total Error} = 5 \mu V + 4 \mu V + 4 \mu V = 13 \mu V$$

$$\text{Difference} = 1 V - 1.2 V = -0.2 V \pm 13 \mu V$$

*Using NULL on each input channel will reduce the % of range error in the measurement to the noise level of the meter.*

Chapter 1  
To Calculate Total Measurement Error

---

**Ratio Error  
Example**

This example demonstrates how to compute the total measurement error when using the Ratio Function. Assume a ratio measurement is made with the following conditions:

- **Channel 1**, 5 V input on the 10 Volt range
- **Channel 2**, 10 mV input on the 10 mV range

To compute the total measurement error using the 90-day accuracy specifications:

**Ratio Error % = Channel 1 accuracy in % + Channel 2 accuracy in %**

$$\text{Channel 1 Reading Error \%} = 0.0020\%$$

$$\text{Channel 1 Range Error \%} = 0.0004\% * \frac{\text{Range}}{\text{Reading}} = .0004\% * \frac{10}{5} = .0008\%$$

$$\text{Total Channel 1 Error \%} = 0.0020\% + 0.0008\% = .0028\%$$

$$\text{Channel 2 Reading Error \%} = 0.0040\%$$

$$\text{Channel 2 Range Error \%} = 0.0002\% * \frac{\text{Range}}{\text{Reading}} = .0002\% * \frac{10 \text{ mV}}{10 \text{ mV}} = .0002\%$$

$$\text{Total Channel 2 Error \%} = 0.0040\% + 0.0002\% = .0042\%$$

$$\text{Ratio Error \%} = 0.0028\% + 0.0042\% = .0070\%$$

$$\text{Ratio} = \frac{5 \text{ V}}{10 \text{ mV}} = 500 \pm 0.0070\% = 500 \pm 0.035$$

*For Ratio Measurements, if both input channels use the same range, use 0 for the % of reading error.*



---

## Interpreting Meter Specifications

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

### Number of Digits and Overrange

The *number of digits* specification is the most fundamental, and sometimes, the most confusing characteristic of a meter. The number of digits is equal to the maximum number of "9's" the meter can measure or display. This indicates the number of full digits. Most meters have the ability to overrange and add a partial or "1/2" digit.

For example, the Agilent 34420A can measure 9.999999 Vdc on the 10 V range. This represents seven full digits of resolution. The meter can also overrange on the 10 V range and measure up to a maximum of 12.000000 V. This corresponds to a 7 1/2-digit measurement with 20% overrange capability.

### Sensitivity

Sensitivity is the minimum level that the meter can detect for a given measurement. Sensitivity defines the ability of the meter to respond to small changes in the input level. For example, suppose you are monitoring a 1 mV signal and you want to adjust the level to within  $\pm 1 \mu\text{V}$ . To be able to respond to an adjustment this small, this measurement would require a meter with a sensitivity of at least  $1 \mu\text{V}$ . You could use a 6 1/2-digit meter if it has a 1 Vdc or smaller range. You could also use a 4 1/2-digit meter with a 10 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, part-per-million (ppm), counts, or bits. For example, a 6 1/2-digit meter 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 meter's measurement uncertainty can be determined relative to the calibration reference used. Absolute accuracy includes the meter'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 meter 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 $\pm$ 2 sigma	4.5%
Mean $\pm$ 3 sigma	0.3%
Mean $\pm$ 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 Agilent 34420A is designed and tested to meet performance better than mean  $\pm$  3 sigma of the published accuracy specifications.

## 24-Hour Accuracy

The 24-hour accuracy specification indicates the meter'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  $\pm 1^\circ \text{C}$  temperature range.

## 90-Day and 1-Year Accuracy

These long-term accuracy specifications are valid for a  $23^\circ \text{C} \pm 5^\circ \text{C}$  temperature range. These specifications include the initial calibration errors plus the meter's long-term drift errors.

## Temperature Coefficients

Accuracy is usually specified for a  $23^\circ \text{C} \pm 5^\circ \text{C}$  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 meter outside a  $23^\circ \text{C} \pm 5^\circ \text{C}$  temperature range.

---

## Configuring for Highest Accuracy Measurements

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

- **Front Panel:** Configure the meter for 10 NPLC and use Digital Filter type set to MEDIUM (50 readings). Do not use the Analog Filter type.
- **Remote Operation:** Configure the meter for 200 NPLC and turn the input filters OFF. Use the statistics functions to reduce noise in the measurements. See "Reducing Measurement Noise" in chapter 4 of the *Agilent 34420A User's Guide*.
- Use 4-wire Ohms and Offset Compensation for greater resistance measurement accuracy.
- Use NULL to remove test lead resistance for 2-wire  $\Omega$  measurements.
- Use NULL to remove to remove interconnection offset voltages for voltage and temperature measurements.



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Quick Start

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## Quick Start

This chapter helps you prepare the meter for use and contains exercises designed to get you started with the meter, its menus, and the front panel.

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** display annunciator will turn on). Then, press the key that has the desired label above it. For example, to select the Temperature measurement function, press **Shift** **DCV** .

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 meter features. Inside the rear cover is a diagram of the front panel menu options.*

---

## To Prepare the Meter For Use

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

### 1 Check the list of supplied items.

Verify that you have received the following items with your meter. If any item is missing, contact your nearest Agilent Technologies Sales Office.

- One low thermal input cable.
- One low thermal four-wire shorting plug.
- One power cord.
- This *User's Guide*.
- One *Service Guide*.
- One folded *Quick Reference* card.
- Certificate of Calibration with removable calibration label.
- One bottle of DeoxIT™ contact cleaner.

### 2 Connect the power cord and turn the meter on.

The front panel display will light up while the meter performs its power-on self-test. The GPIB bus address is displayed. The meter is left in 6<sup>1</sup>/<sub>2</sub> digit resolution, channel 1 input, and digital filter on.

*To view the display with all annunciators turned on, hold down **Shift** as you turn on the meter.*

### 3 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 meter; *continue to hold **Shift** for more than 5 seconds*. The self-test will begin when you release the key.

If the self-test is successful, "PASS" is displayed on the front panel. If the test is not successful, "FAIL" is displayed and the **ERROR** annunciator turns on. See Chapter 6 for additional information about the self-test.

## If the Meter Does Not Turn On

Use the following steps to help solve problems you might experience when turning on the meter. If you need more help, see chapter 6.

- 1 Verify there is ac power to the meter.

First verify that the meter's power switch is in the "On" position. Make sure the power cord is firmly plugged into the power module on the meter's rear panel. Verify that the power source is energized.

- 2 Verify the power-line voltage setting.

The line voltage is set to the proper value for your country when the meter is shipped from the factory. Change the voltage setting if it is not correct. The settings are: 100, 120, 220, or 240 Vac (for 230 Vac operation, use the 220 Vac setting).

*See the diagram on the next page to verify or change the setting.*

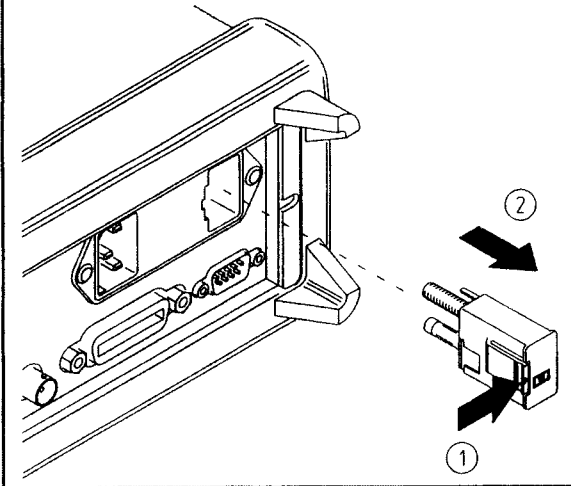
*To replace the 250 mA 250 V fuse, order Agilent part number 2110-0817.*

*This fuse is used for all power line voltage settings.*

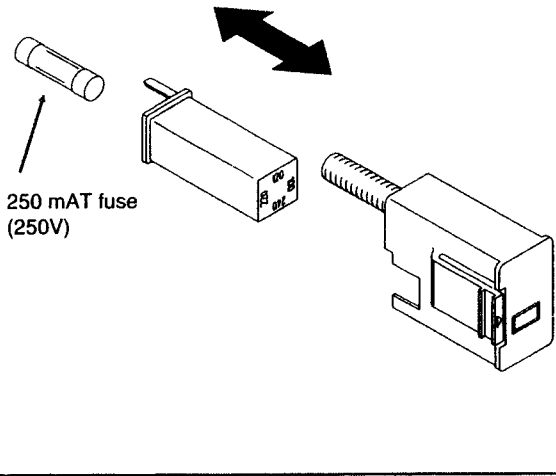


Chapter 2 Quick Start  
If the Meter Does Not Turn On

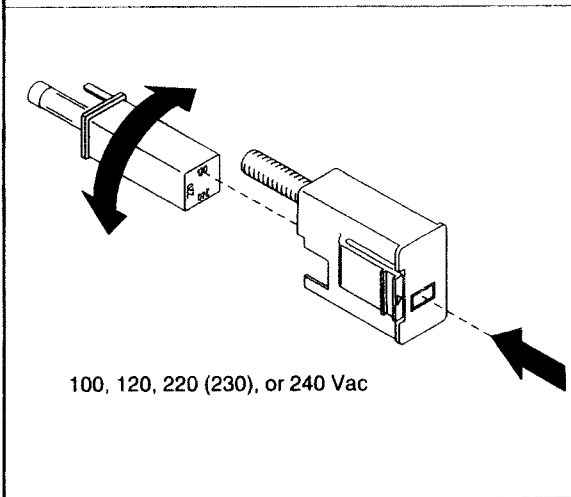
**1 Remove the power cord. Remove the fuse holder assembly from the rear**



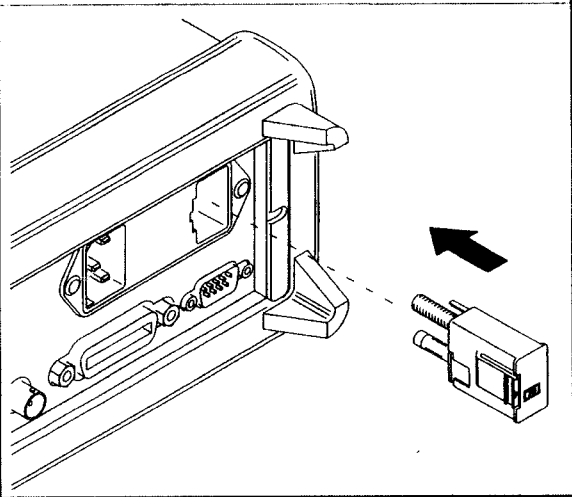
**2 Install the correct fuse. Remove the line-voltage selector from the assembly.**



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



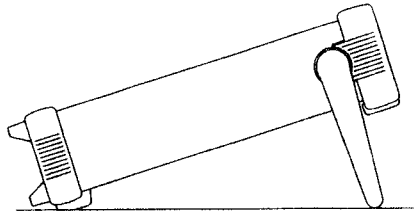
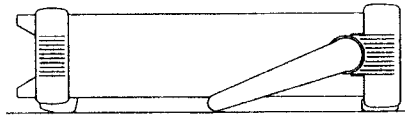
**4 Replace the fuse-holder assembly in the rear panel.**



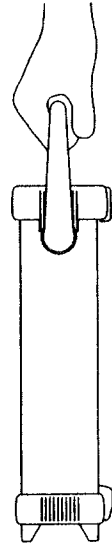
**Install the correct fuse and verify that the correct line voltage appears in the window.**

## To Adjust the Carrying Handle

To adjust the position, grasp the handle by the sides and *pull outward*. Then, rotate the handle to the desired position.



**Bench-top viewing positions**

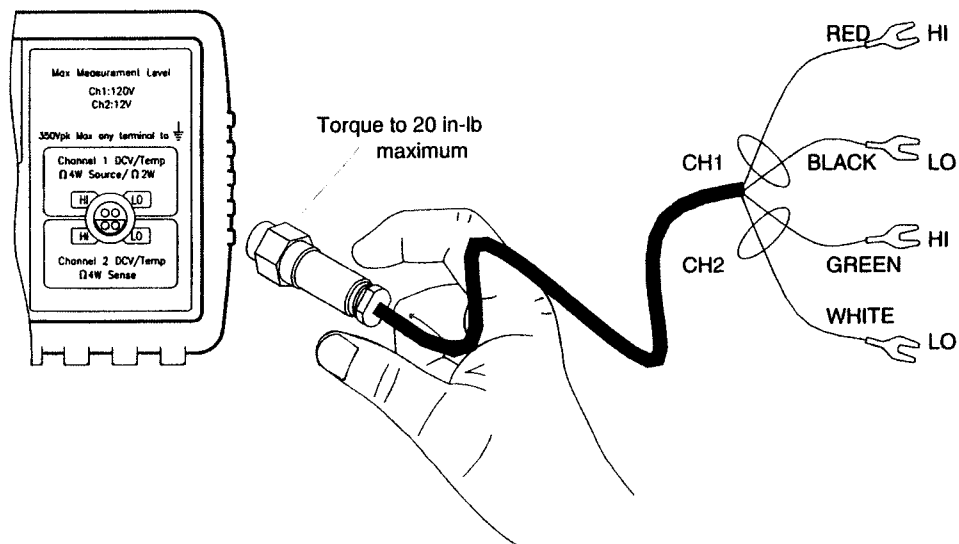


**Carrying Position**

## To Make Input Connections

### Using the Cable Provided

Align the front panel connector and cable conductors, press in.  
Tighten coupling nut.



*The connector and cable are an integral part of the measurement system. For the highest accuracy, use the copper cable and connectors supplied by Agilent Technologies.*

*The conductors may require occasional cleaning to remove oxides. Cleaning the conductors is described on page 128.*

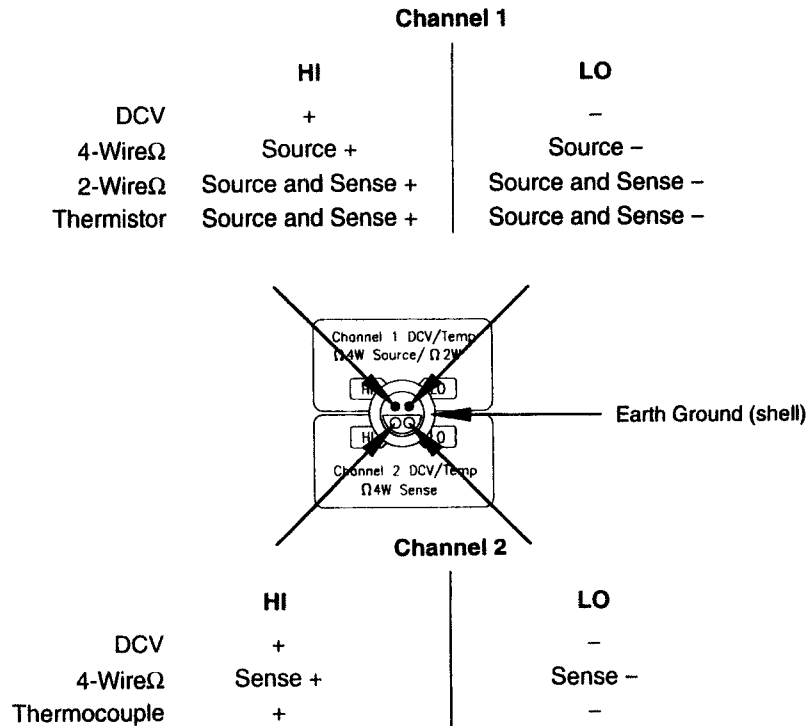
### **Warning**

*The connector body and cable shield are connected to earth ground.*

## Chapter 2 Quick Start To Make Input Connections

### Using a Custom Cable

*Refer to page 127 for additional information about building custom input cables.*



## To Measure Voltage

Channel 1 Ranges: 1 mV, 10 mV, 100 mV, 1 V, 10 V, 100 V

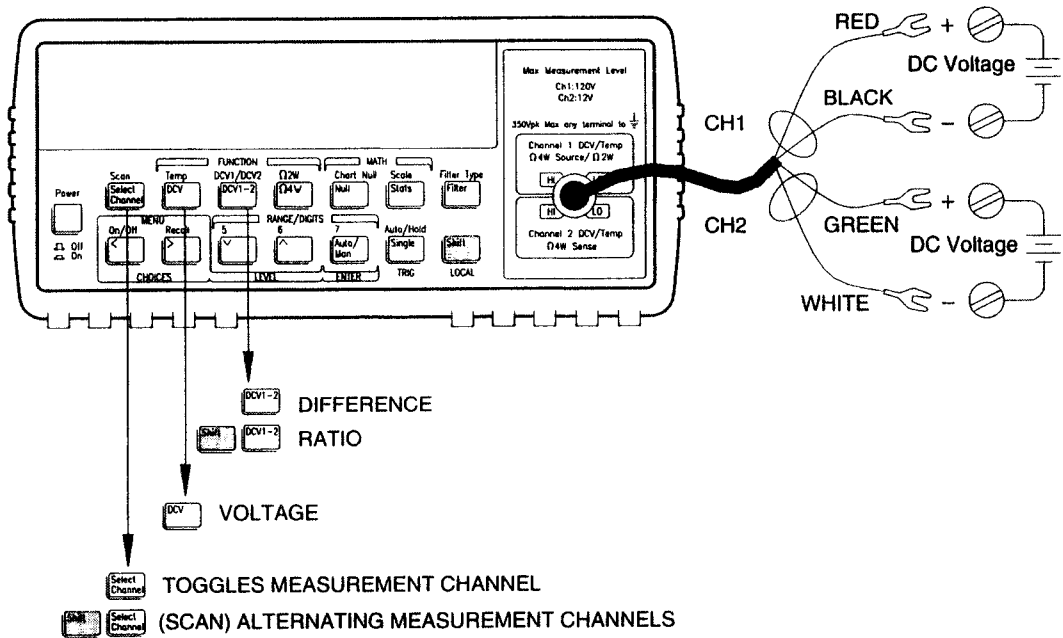
Maximum resolution: 0.1 nV (on 1 mV range)

Channel 2 Ranges: 1 mV, 10 mV, 100 mV, 1 V, 10 V

Maximum resolution: 0.1 nV (on 1 mV range)

Independent NULL for each channel

Channel 1 LO to Channel 2 LO isolated to 150 Vpeak.

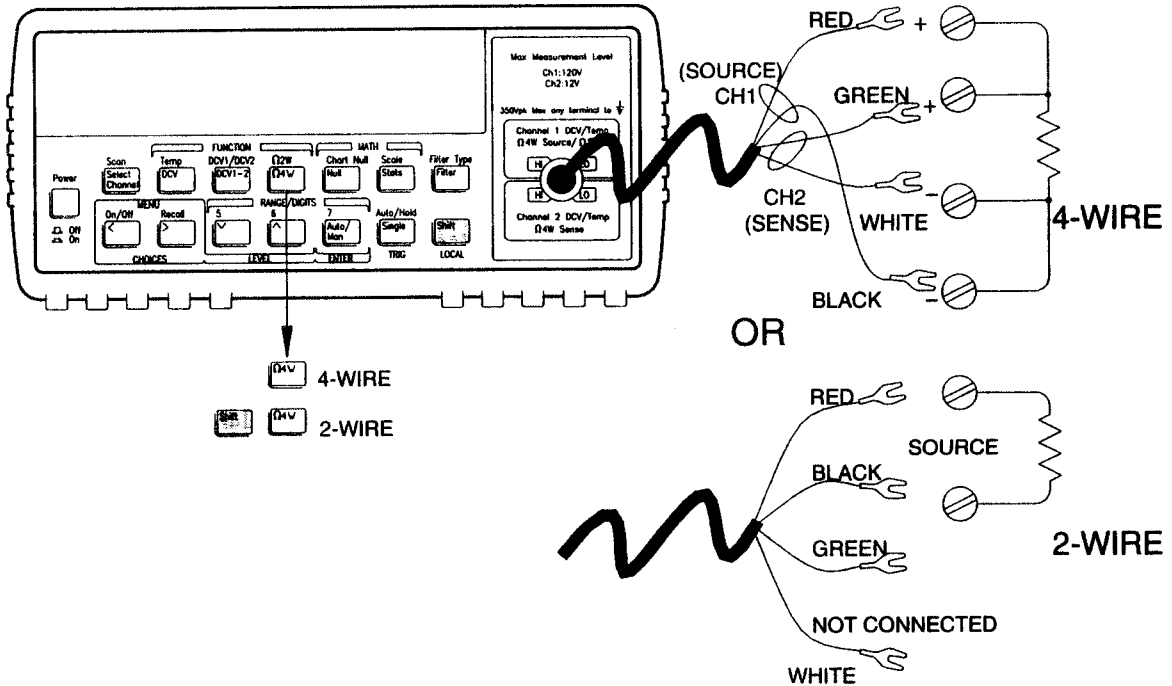


*Scan mode alternates between input channels every 3 seconds or every measurement, whichever is longer.*

## To Measure Resistance

Ranges: 1  $\Omega$  , 10  $\Omega$  , 100  $\Omega$  , 1 k $\Omega$  , 10 k $\Omega$  , 100 k $\Omega$  , 1 M $\Omega$

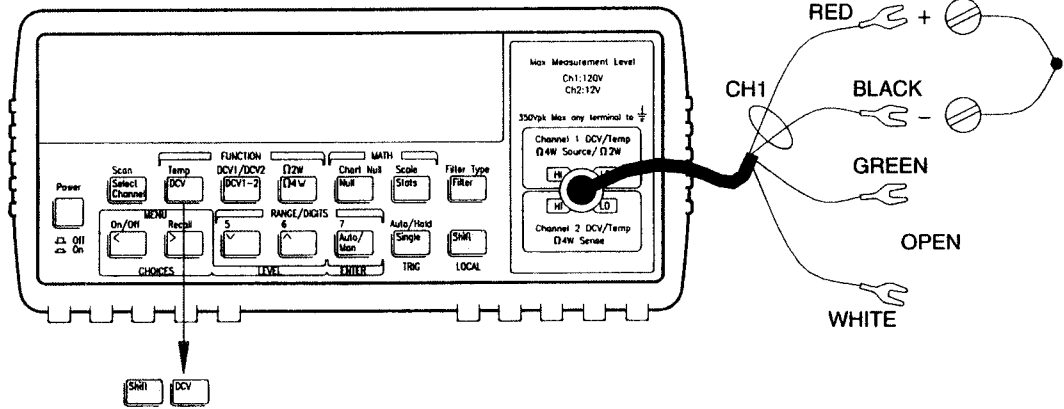
Maximum resolution: 0.1  $\mu\Omega$  (on 1 ohm range).



*Resistance measurements use offset compensation. Offset compensation can be disabled if desired.*

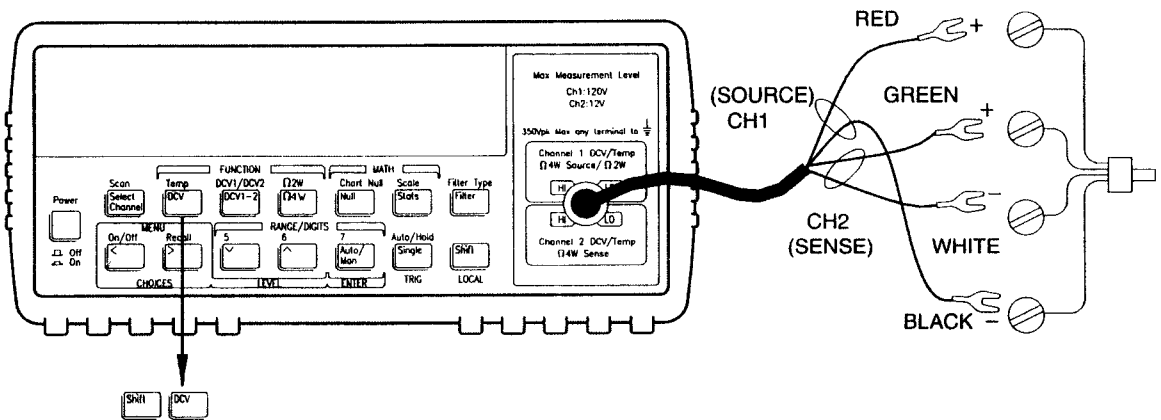
## To Measure Temperature With Thermistors

Thermistor type: 5 k $\Omega$



## To Measure Temperature With RTDs

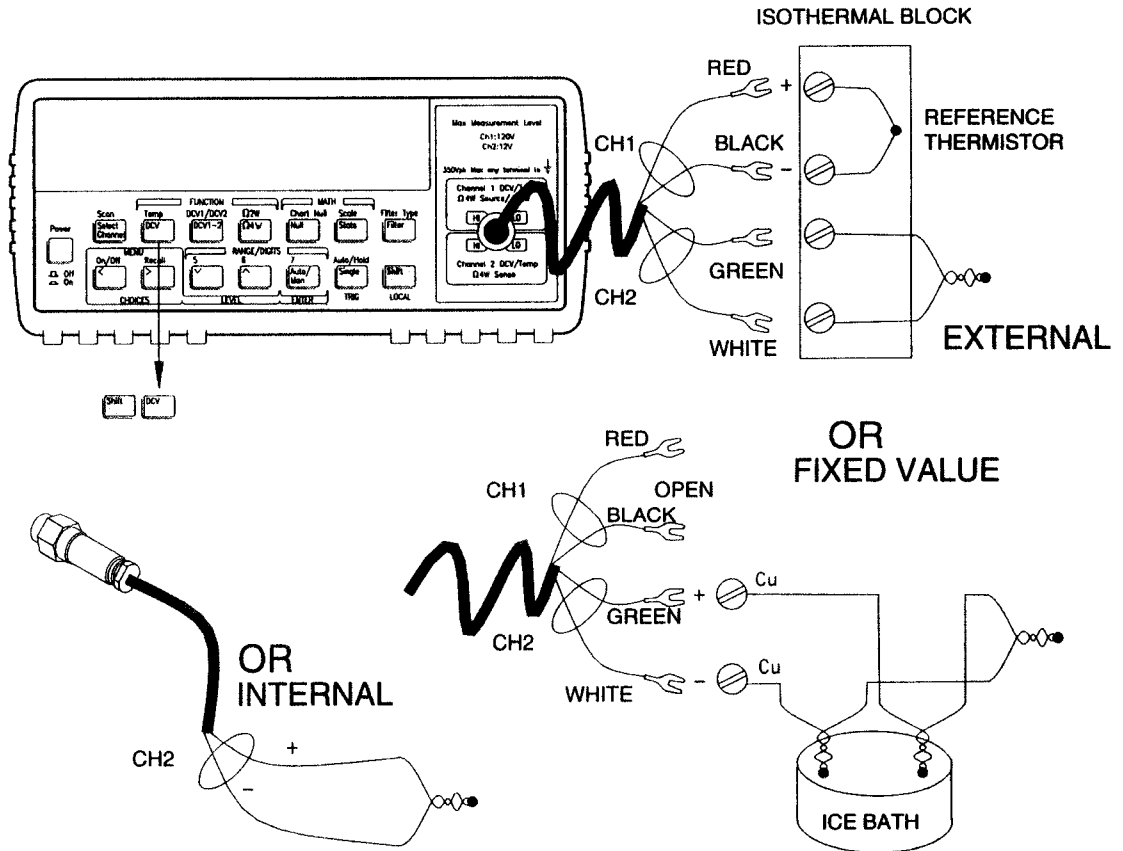
4-wire, type:  $\alpha = .00385$  (DIN/IEC 751) or  $\alpha = .00391$   
 $R_0 = 4.9 \Omega$  to 2.1 k $\Omega$



## To Measure Temperature With Thermocouples

Thermocouple types: B, E, J, K, N, R, S, T

Reference: external thermistor, external fixed value, or internal thermistor.  
 Channel 2 only.

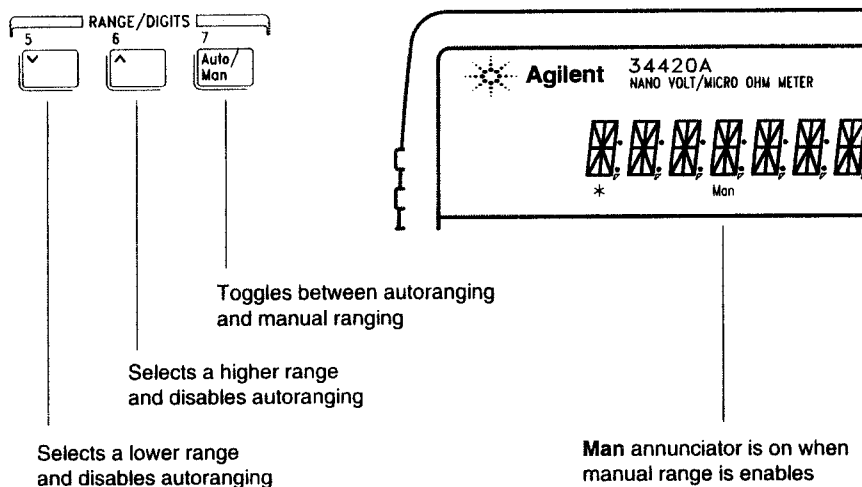


*When using the internal thermistor as the temperature reference, you should make a custom cable to connect the thermocouple wire directly to the input terminals (see page 127).*



## To Select a Range

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



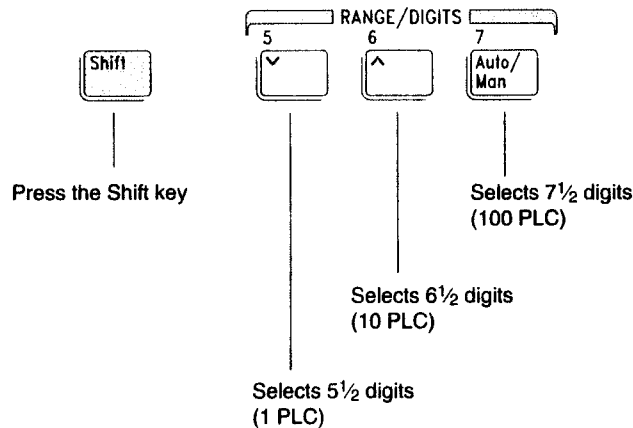
- Autoranging is selected at power-on and after a remote interface reset.
- Autorange thresholds:
  - Down range at <10% of range
  - Up range at >120% of range
- If the input signal is greater than the present range can measure, the meter will give an *overload* indication ("OVLD").
- When making difference or ratio measurements, an overload on either channel will give an overload indication ("OVLD").

*For voltage measurements, ranging is local to the selected channel. This means that you can select the ranging method (auto or manual) for each channel independently. When manually ranging, the selected range is local to the active channel; the meter remembers the range when you switch between channels.*

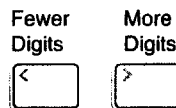
---

## To Set the Number of Digits

You can set the display to show  $4\frac{1}{2}$ ,  $5\frac{1}{2}$ ,  $6\frac{1}{2}$ , or  $7\frac{1}{2}$  digits. In this book, the most significant digit (leftmost on the display) is referred to as the “ $\frac{1}{2}$ ” digit, since it can only be a “0” or “1”. *The number of digits displayed also depends upon the integration time set, see page 39.*



- The number of digits is set to  $6\frac{1}{2}$  digits at power-on and after a remote interface reset.
- The number of digits shown is dependent upon integration time and filter settings. The meter will not allow you to show more digits than the practical measurement capability of the meter. You can, however, reduce the number of digits shown.



## To Set the Integration Time

Integration time is specified in Number of Power Line Cycles (NPLC). You can set the NPLC to 0.02, 0.2, 1, 2, 10, 20, 100, or 200.

- You can set the integration time to one of three fixed values by choosing the number of digits displayed, *see page 38*.
- You can set the integration time in the MEASure menu using the INTEGRATE command.
- The Integration Time is directly related to the maximum number of digits the meter will display.

NPLC	Filter Off Max Digits Shown	Filter On Max Digits Shown
0.02	4½	5½
0.2	5½	6½
1	6½	7½
2	6½	7½
10	6½	7½
20	7½	7½
100	7½	7½
200	7½	7½

- You can always show fewer digits than the maximum allowed (the minimum number of digits shown is 4½).

*Integration Time is local to the selected function. This means that you can select the integration time for each function independently. The meter remembers integration time when you switch between functions.*

---

## Front-Panel Display Formats

-H.DDD,DDD,D EFF

Front-panel display format.

- Negative sign or blank (positive)  
H "1/2" digit (0 or 1)  
D Numeric Digits  
E Exponent (m,k,M)  
F Measurement units

6 digits

1.021,651 V

This is the 1 V range,  
6½ digits are displayed.

"1/2" digit

5 digits

-045.230 mV

This is the 100 mV range,  
5½ digits are displayed.

"1/2" digit

7 digits

0.133,256,7 Ω

This is the 1 ohm range,  
7½ digits are displayed.

"1/2" digit

0.VLD mV

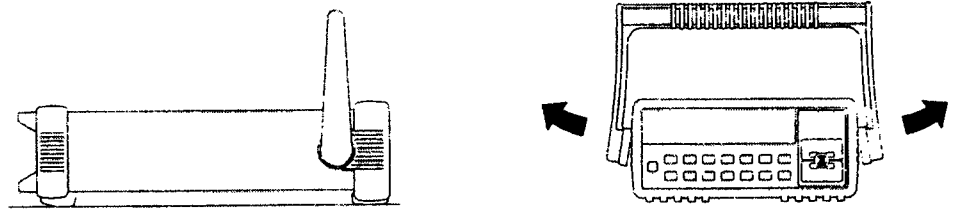
This is an overload indication on the 1 mV range.

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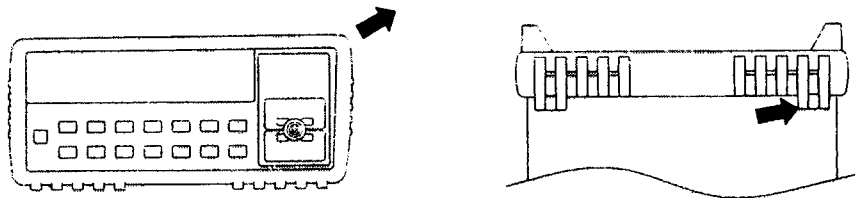
## To Rack Mount the Meter

You can mount the meter 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 *Agilent System II* instrument of the same size can be rack-mounted beside the Agilent 34420A meter.

*Remove the carrying handle, and the front and rear rubber bumpers, before rack-mounting the meter.*

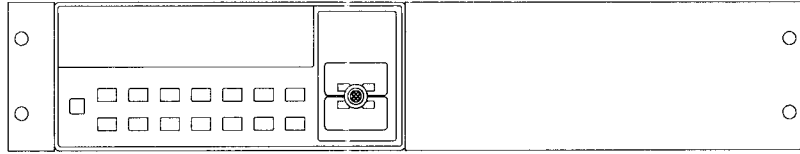


**To remove the handle, rotate it to the vertical position and pull the ends outward.**

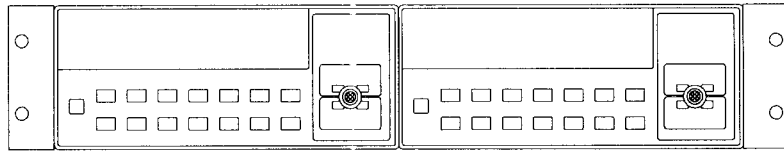


**To remove the rubber bumper, stretch a corner and then slide it off.**

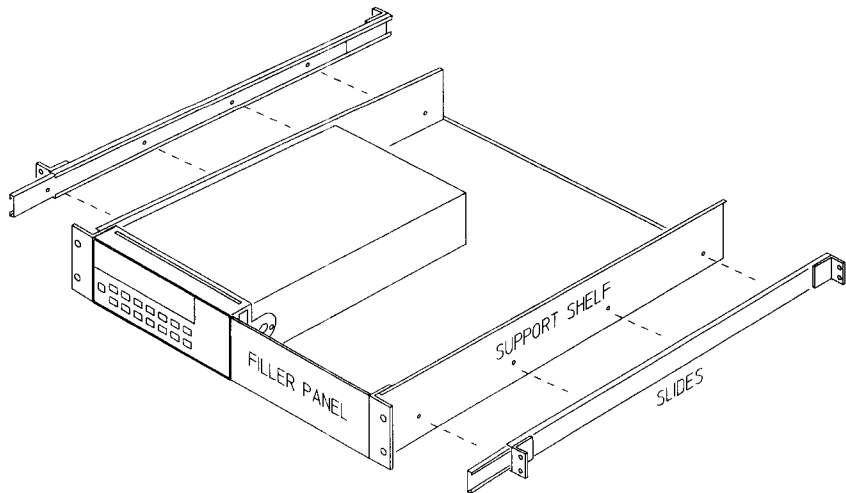
Chapter 2 Quick Start  
**To Rack Mount the Meter**



**To rack mount a single instrument, order adapter kit 5063-9240.**



**To rack mount two instruments side-by-side, order lock-link kit 5061-9694 and flange kit 5063-9212.**



**To install one or two instruments in a sliding support shelf, order shelf 5063-9255, and slide kit 1494-0015 (for a single instrument, also order filler panel 5002-3999).**

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## Front-Panel Operation

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## Front-Panel Operation

This chapter assumes you are familiar with the meter and menu operations. 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,” starting on page 25.

This chapter *does not* give a detailed description of *every* front-panel key or menu operation. It does, however, give you a good overview of the front-panel menu and many front-panel operations. See chapter 3, “Features and Functions”, of the *Agilent 34420A User’s Guide* for a complete discussion of the meter’s capabilities and operation.



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## Front-Panel Menu Reference

### A: MEASurement MENU

1: DIG FILTER ⇨ 2: INTEGRATE ⇨ 3: OCOMP Ω ⇨ 4: LOW POWER Ω ⇨ 5: LOW VOLT Ω ⇨ 6: LoV LIMIT Ω

<b>1: DIG FILTER</b>	Selects the digital filter speed. Can be set to FAST, MEDIUM, or SLOW.
<b>2: INTEGRATE</b>	Sets the measurement integration time.
<b>3: OCOMP Ω</b>	Enables or disables offset compensation for resistance measurements.
<b>4: LOW POWER Ω</b>	Enables or disables low power ohms measurements.
<b>5: LOW VOLT Ω</b>	Enables or disables voltage limited resistance measurements.
<b>6: LoV LIMIT Ω</b>	Sets the voltage limit for voltage limited resistance measurements.

### B: TEMPerature MENU

1: PROBE TYPE ⇨ 2: UNITS ⇨ 3: RTD TYPE ⇨ 4: RTD R<sub>0</sub> ⇨ 5: T/C TYPE ⇨ 6: COLD JUNCT ⇨ 7: JUNCT TEMP

<b>1: PROBE TYPE</b>	Selects thermocouples, thermistors, or RTDs as the temperature probe.
<b>2: UNITS</b>	Sets the measurement units to either °C, °F, or Kelvins.
<b>3: RTD TYPE</b>	Sets the type of RTD in use.
<b>4: RTD R<sub>0</sub></b>	Sets the nominal (0 °C) value for the RTD in use.
<b>5: T/C TYPE</b>	Selects the type of thermocouple in use.
<b>6: COLD JUNCT</b>	Sets the source of the temperature reference junction.
<b>7: JUNCT TEMP</b>	Allows direct entry of reference junction temperature.

### C: MATH MENU

1: STATS ⇨ 2: NULL VALUE ⇨ 3: SCALE GAIN ⇨ 4: SCALE OFST

<b>1: STATS</b>	Recalls the values of minimum, maximum, standard deviation, average, peak-to-peak, and number of readings.
<b>2: NULL VALUE</b>	Selects independent null settings for voltage on channels 1 and 2, resistance, and temperature functions.
<b>3: SCALE GAIN</b>	Sets the gain for linear scaling of the data.
<b>4: SCALE OFST</b>	Sets the offset for linear scaling of data.

### D: TRIGger MENU

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

<b>1: READ HOLD</b>	Selects the reading hold sensitivity band.
<b>2: TRIG DELAY</b>	Specifies a time delay between the trigger and the start of the measurement.
<b>3: N SAMPLES</b>	Sets the number of samples taken per trigger.

## Chapter 3 Front-Panel Operation

### Front-Panel Menu Reference

#### E: SYStem MENU

1: RDGS STORE ⇨ 2: SAVED RDGS ⇨ 3: ERROR ⇨ 4: TEST ⇨ 5: CHART OUT ⇨ 6: CHART SPAN ⇨  
7: CHART NULL ⇨ 8: DISPLAY ⇨ 9: COMMA ⇨ 10: PRESET ⇨ 11: REVISION

<b>1: RDGS STORE</b>	Enables or disables reading memory.
<b>2: SAVED RDGS</b>	Recalls readings stored in memory (up to 1024 readings).
<b>3: ERROR</b>	Retrieves errors from the error queue (up to 20 errors).
<b>4: TEST</b>	Performs a complete self-test or individual self tests.
<b>5: CHART OUT</b>	Enables or disables the chart recorder output (Analog Out).
<b>6: CHART SPAN</b>	Sets the chart recorder output range (Analog Out).
<b>7: CHART NULL</b>	Sets the chart recorder output offset (Analog Out).
<b>8: DISPLAY</b>	Enables or disables the front panel display.
<b>9: COMMA</b>	Enables or disables a comma separator between digits in the display.
<b>10: PRESET</b>	Returns the meter to factory default settings.
<b>11: REVISION</b>	Displays the meter's firmware revision code.

#### F: Input / Output MENU

1: GPIB ADDR ⇨ 2: INTERFACE ⇨ 3: BAUD RATE ⇨ 4: PARITY ⇨ 5: LANGUAGE

<b>1: HP-IB ADDR</b>	Sets the GPIB bus address (0 to 30, default 22).
<b>2: INTERFACE</b>	Selects either the GPIB or RS-232 remote interface.
<b>3: BAUD RATE</b>	Sets the baud rate for RS-232 operation.
<b>4: PARITY</b>	Selects even, odd, or no parity for RS-232 operation.
<b>5: LANGUAGE</b>	Selects interface language, either SCPI or Keithley 181.

#### G: CALibration MENU \*

1: SECURED ⇨ [1: UNSECURED] ⇨ [2: CALIBRATE] ⇨ [3: CHART ZERO] ⇨ [4 : CHART GAIN] ⇨  
[5: INJECTED I] ⇨ 6: CAL COUNT ⇨ 7: MESSAGE

<b>1: SECURED</b>	The meter is secured against calibration; enter code to unsecure.
<b>1: UNSECURED</b>	The meter is unsecured for calibration; enter code to secure.
<b>2: CALIBRATE</b>	Performs a calibration of meter; must be UNSECURED.
<b>3: CHART ZERO</b>	Performs a calibration of the chart recorder output zero level.
<b>4: CHART GAIN</b>	Performs a calibration of the chart recorder output gain.
<b>5: INJECTED I</b>	Performs a calibration to minimize the injected current.
<b>6: CAL COUNT</b>	Reads the total number of times the meter has been calibrated.
<b>7: MESSAGE</b>	Reads the first 11 characters of a calibration string, if any, entered from the remote interface.

\* The commands enclosed in square brackets ( [ ] ) are "hidden" unless the meter is UNSECURED for calibration.



### Messages Displayed During Menu Use

**TOP OF MENU** - You pressed  while on the menu level; this is the top level of the menu and you cannot go any higher.

*To turn off the menu, press   (Menu On/Off). To move across the choices on a level, press  or  . To move down a level, press .*

**MENUS** - You are on the menu level. Press  or  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  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   (Menu On/Off). To move up a level, press .*

**ENTERED** - The change made on the parameter level is saved. This is displayed after you press  (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** - You will see this message if you turn off the menu by pressing  (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   (Menu On/Off) or a front-panel function/math key. You did some editing of parameters but the changes were NOT saved. Press  (Menu Enter) to save changes made on the parameter level.

**VOLTS ONLY** - The requested function is only available for voltage measurements.

**UNAVAILABLE** - The action requested is NOT allowed in the present configuration.

**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 turn off the display comma separator.

The meter can display readings on the front panel with or without a comma separator. The following steps show how to disable the comma.

- 0.824,153 V

**With comma separator  
(factory setting)**

- 0.824153 V

**Without comma separator**

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 SYS 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.).

E: SYS MENU

∨

**3 Move down to the *commands* level within the SYS MENU.**

The RDGS STORE command is your first choice on this level.

1: RDGS STORE

## Chapter 3 Front-Panel Operation

### A Front-Panel Menu Tutorial



#### 4 Move across to the **COMMA** command on the *commands* level.



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

9: COMMA



#### 5 Move down a level to the **COMMA** parameter choices.

The first parameter choice is **ON** for the **COMMA** command (the comma setting is stored in non-volatile memory and **ON** is the factory setting).

ON



#### 6 Move across to the **OFF** choice.

There are two parameter choices for **COMMA**.

OFF

Auto/Man

ENTER

#### 7 Save the change and turn off the menu.

The meter beeps and displays a message to show that the change is now in effect. You are then exited from the menu. The meter will no longer show commas in the display.

ENTERED

---

**Menu Example 2**

The following exercise demonstrates how to use the *menu recall* feature as a shortcut to set the COMMA command back to its original setting. *You must perform the steps in Example 1 before you start this example.*

Recall

**Shift** **>**

- 1 Use menu recall to return to the COMMA command.**

This returns you to the COMMA command, which was the last command used before you exited the menu in the Example 1.

9: COMMA

**v**

- 2 Move down to the COMMA parameter choices.**

The first parameter choice is OFF (the current setting from Example 1).

OFF

**>**

- 3 Move across to the ON choice.**

Set the parameter back to its original value.

ON

**Auto/Man**

ENTER

- 4 Save the change and turn off the menu.**

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

ENTERED

## Chapter 3 Front-Panel Operation

### A Front-Panel Menu Tutorial

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#### Menu Example 3

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 will set the null value for channel 1 to -30 millivolts.

*Make sure the meter has channel 1 selected, is in the dc voltage function, and has 6½ digits displayed. Connect the four-wire short to the meter input.*

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 MATH MENU choice on this level.

There are six menu group choices available on this level.

C: MATH MENU

v

#### 3 Move down to the *commands* level within the MATH MENU.

The STATS command is your first choice on this level.

1: STATS

>

#### 4 Move across to the NULL VALUE command.

2: NULL VALUE



## Chapter 3 Front-Panel Operation

### A Front-Panel Menu Tutorial



#### 5 Move down to edit the NULL VALUE parameter.

The null value should be 0.000000 V when you come to this point in the menu for the first time. For this example, you will first set the null value to -0.300000 volts.

^0.000,000,0 V

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 Make the number negative.

The left most character on the display toggles between +, -, and ^.

- 0.000,000,0 V



#### 7 Move the flashing cursor over to edit the second digit.

Notice that the digit to the right of the decimal point is flashing.

- 0.000,000,0 V



#### 8 Increment the digit until “3” is displayed.

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

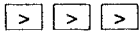
- 0.300,000,0 V

## Chapter 3 Front-Panel Operation

### A Front-Panel Menu Tutorial



#### 9 Move the flashing cursor over to the *units* location.



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

- 0.300,000,0 v



#### 10 Decrease 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 and the **mV** annunciator is on.

- 030.000,00 mV

Auto/Man

ENTER

#### 11 Save the change and turn off the menu.

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

ENTERED

You will be returned to the normal measurement display, and, if you have installed the low thermal four-wire short, the display will show a positive measurement in the approximate amount of the null value just entered. The **Null** annunciator is on in the display.

*Keep in mind that null is turned on and - 0.03 volts is used as the null value for measurements. To clear the null value, press **Null**.*

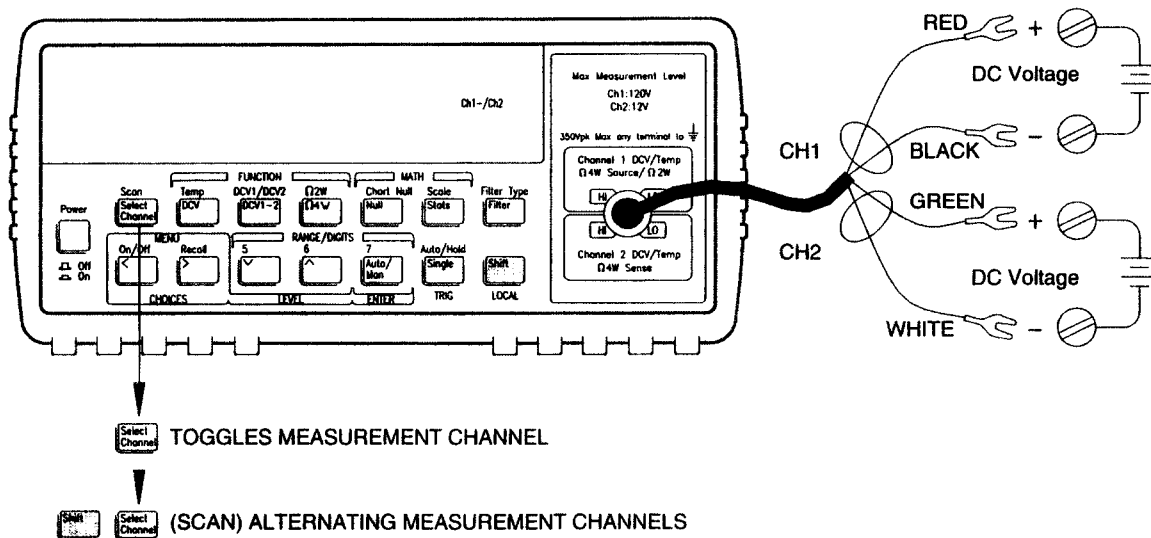
#### Hint

You can use the menu recall feature to save steps when entering the null value. First, press **Null** on the front panel and then press **Shift** **>** (Menu Recall). The meter will jump to the 2:NULL VALUE command. Press **v**. The null value in the display is the first reading taken after you turned NULL on. You can then edit this number as described.

*This is the end of the front-panel menu tutorial. The remainder of the chapter discusses several of the most common front-panel operations.*

## To Select an Input Channel

For *voltage measurements*, you have two independent input channels.

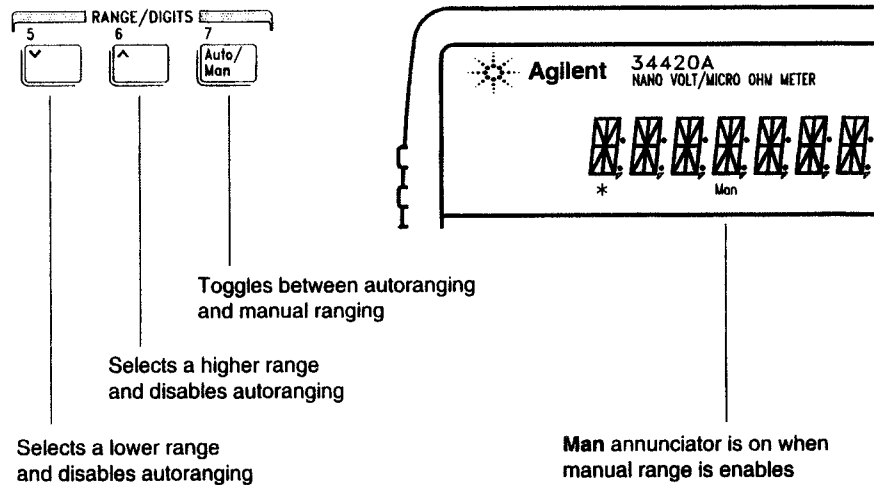


- Pressing **Channel** toggles the display between Channel 1 and Channel 2.
- Pressing **Shift Channel** (Scan) creates an alternating Channel 1 and Channel 2 display. Press **Channel** again to cancel.

*Scan mode alternates between input channels every 3 seconds or every measurement, whichever is longer. If you are using the scan mode, turn off all the input filters (both digital and analog).*

## To Select a Range

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

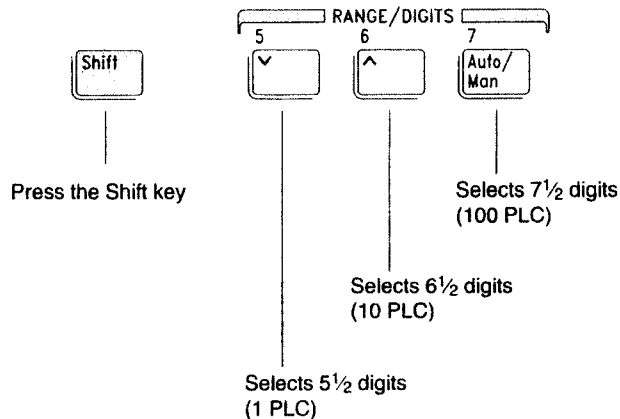


- Autoranging is selected at power-on and after a remote interface reset.
- Autorange thresholds:
  - Down range at <10% of range
  - Up range at >120% of range
- If the input signal is greater than the present range can measure, the meter will give an *overload* indication (“OVLD”).
- When making difference or ratio measurements, an overload on either channel will give an overload indication (“OVLD”).

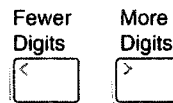
*For voltage measurements, ranging is local to the selected channel. This means that you can select the ranging method (auto or manual) for each channel independently. When manually ranging, the selected range is local to the active channel; the meter remembers the range when you switch between channels.*

## To Set or Change the Number of Digits

You can set the display to show  $4\frac{1}{2}$ ,  $5\frac{1}{2}$ ,  $6\frac{1}{2}$ , or  $7\frac{1}{2}$  digits. In this book, the most significant digit (leftmost on the display) is referred to as the " $\frac{1}{2}$ " digit, since it can only be a "0" or "1". *The number of digits displayed also depends upon the integration time set, see page 58.*



- The number of digits is set to  $6\frac{1}{2}$  digits at power-on and after a remote interface reset.
- The number of digits shown is dependent upon integration time and filter settings. The meter will not allow you to show more digits than the practical measurement capability of the meter. You can, however, reduce the number of digits shown.



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## To Set the Integration Time

Integration time is specified in Number of Power Line Cycles (NPLC). You can set the NPLC to 0.02, 0.2, 1, 2, 10, 20, 100, or 200.

- You can set the integration time to one of three fixed values by choosing the number of digits displayed, *see page 57*.
- You can set the integration time in the MEASure menu using the INTEGRATE command.
- The Integration Time is directly related to the maximum number of digits the meter will display.

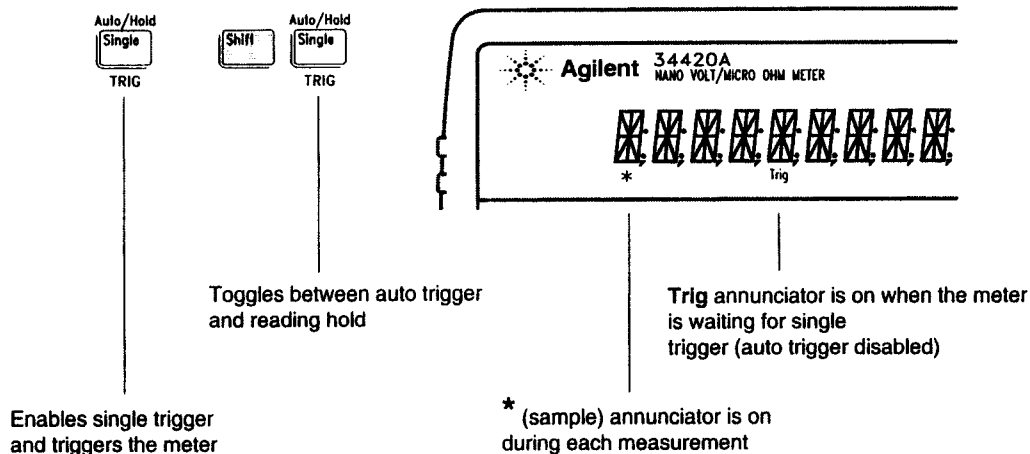
NPLC	Digital Filter Off Max Digits Shown	Digital Filter On Max Digits Shown
0.02	4½	5½
0.2	5½	6½
1	6½	7½
2	6½	7½
10	6½	7½
20	7½	7½
100	7½	7½
200	7½	7½

- You can always select to show fewer digits than the maximum allowed (the minimum number of digits shown is 4½).

*Integration Time is local to the selected function. This means that you can select the integration time for each function independently. The meter remembers integration time when you switch between functions.*

## To Trigger the Meter

You can trigger the meter from the front panel using *single trigger* or *autotrigger*.



- Autotriggering is enabled when you turn on the meter. 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 meter.

### 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 meter is triggered on the negative edge of a TTL pulse.

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

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## Null (Relative) Operation

When making null measurements, also called *relative*, each reading is the difference between the input signal and a stored null value. You could, for example, make a more accurate two-wire ohms measurement by shorting the test leads and pressing **Null** to remove the test lead resistance.

**Reading** = *measurement* – *null value*

- The null value is adjustable and you can set it to any value between 0 and  $\pm 120\%$  of the highest range, for the present function.
- The null value is stored in *volatile* memory; the value is cleared when power has been off or after a remote interface reset.
- Each function and channel has an independent null value. For voltage measurements, each input channel has an independent null. Temperature measurement null is applied to all temperature measurements (if you change the probe type, null is still enabled and applied). The null for resistance measurements applies to both 2-wire and 4-wire measurements.
- The null value is stored in the meter's Null Register. There are two ways you can specify the null value. First, you can enter a specific number into the register from the front-panel menu or from the remote interface. Any previously stored value is replaced with the new value. *If you are operating the meter from the front panel, entering a null value also turns on the null function.*

The second way to enter the null value is to let the meter store the first reading in the register. Press the **Null** key to make the displayed measurement the null value and enable the Null operation. After you enable null, the first reading displayed will be zero. If you entered a number into the register, as described in the paragraph above, the first reading *does not* overwrite the stored value.

- Since an independent null value is stored for each input channel, difference or ratio functions also use these null values. Additionally, when using the difference function, an additional difference null can be applied (the difference null is only available from the front panel).



## To Use Math (Stats)

There are two math operations available, only one of which can be enabled at a time. The meter can either scale the readings as they are taken, or can keep statistics on a group of reading. The selected math operation remains in effect until you disable it, change functions, turn off the power, or perform a remote interface reset.

The scaling math operation is described in the *Agilent 34420A User's Guide*. This discussion applies to stats (statistics) operations only.

- Enable the statistics by pressing the **Stats** key. Read the statistics gathered in the MATH menu under the STATS command.

After viewing the stored statistics, press **Shift** **<** (Menu On/Off) to return to the measurement and continue taking statistics.

- After you enable statistics, the first reading that the meter takes is stored as both the minimum and maximum value. The *minimum* is replaced with any subsequent value that is less. The *maximum* is replaced with any subsequent value that is greater.

- All values are stored in *volatile* memory; the meter clears the values when stats is turned on, when power has been off, or after a remote interface reset or preset.

- When enabled, the following statistics are available:

MIN	minimum reading
MAX	maximum reading
AVER	arithmetic average of all readings
STD DEV	standard deviation of all readings
PEAK – PEAK	peak to peak value of minimum and maximum
COUNT	the total number of readings

### Hint

You can use the menu recall feature to save steps when using the math operations. After pressing **Stats** on the front panel, press **Shift** **>** (Menu Recall). The meter will jump to the 1:STATS command and you can press **v** to view the statistics taken. After viewing the stored statistics, press **Shift** **<** (Menu On/Off) to return to the measurement and continue taking statistics.

## To Set the Number of Samples

Normally, the meter takes one reading (or sample) each time it receives a trigger from the selected trigger source (if the meter is in the wait-for-trigger state). You can, however, instruct the meter to take multiple readings for each trigger received.

- Number of samples: 1 to 50,000. *The default is 1 sample per trigger.*
- The sample count is stored in *volatile* memory; the meter sets the sample count to 1 when power has been off or after a remote interface reset. The CONFigure and MEASure? commands automatically set the sample count to 1.
- **Front Panel operation:** set the number of samples per trigger in the 3: N SAMPLES command under the TRIGger menu.
- **Remote operation:** use the following command:

```
SAMPlE:COUNT {<value>|MIN|MAX}
```

---

## Chart Output (Analog Output)

You can use the Chart Output (Analog Output) connector on the rear panel to run a strip chart recorder or similar instrument. The connector provides an output voltage proportional to the measured voltage.

- Enable the chart output under the 5: CHART OUT command in the SYStem menu.

Set the chart span under the 6: CHART SPAN command in the SYStem menu.

Set the chart offset under the 7: CHART NULL command in the SYStem menu.

You can also press **[Shift] [Null]** (Chart Null) to null the chart output voltage based upon the displayed reading. This action places a null value in the Chart Offset register. Pressing **[Shift] [>]** (Menu Recall) will take you to the 7: CHART NULL command where you can manually edit the null value.

- The output can range from -3.00 V to +3.00 V.
- When chart output is disabled (Off), the output is set to 0 V.
- The output impedance is 1 k $\Omega$ .
- The output voltage is related to the input signal as follows:

$$\frac{(\text{reading} - \text{chart null})}{\text{span}} = \text{chart output voltage}$$

Note that *reading* includes the results of measurement unit conversion, filtering, null, and any math operation performed on the measurement.

- The chart output state (including the *span* and *null* values) is stored in *non-volatile* memory.
- *span* cannot have a negative value.
- The chart output has a voltage "rollover" to prevent the loss of data, see the *Agilent 34420A User's Guide*.

## To Unsecure the Meter for Calibration

The meter can use a calibration security code to prevent unauthorized or accidental calibration. This procedure shows you how to unsecure the meter for calibration.

Shift

<

- 1 Turn on the menu.

A: MEAS MENU

<

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

G: CAL MENU

v

- 3 Move down a level to the SECURED command.

1: SECURED

*If the display shows UNSECURED, you do not need to perform this procedure to perform calibration.*

## Chapter 3 Front-Panel Operation To Unsecure the Meter for Calibration

▼

### 4 Move down to the "parameters" level.

^000000:CODE

0 3 4 4

2 0

### 5 Enter the security code.

^034420:CODE

Auto/Man

ENTER

### 6 Save the change and exit.

The security code is set to "HP34420" when the meter is shipped from the factory. The security code is stored in *non-volatile* memory and *does not* change when the power has been off or after a remote interface reset.

To enter the security code from the front panel, enter only the six digits. To enter the security code from the remote interface, you may use up to 11 characters.

Use the arrow keys to move left or right between digits. Use the up or down arrow keys to change the digits.

*To re-secure the meter (following calibration), perform this procedure again.*

Additional information about the calibration security feature is given on page 83.



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## Calibration Procedures

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# Calibration Procedures

This chapter contains procedures for verification of the meter's performance and adjustment (calibration). The chapter is divided into the following sections:

- Agilent Technologies Calibration Services, page 69
- Calibration Interval, page 69
- Time Required for Calibration, page 69
- Automating Calibration Procedures, page 70
- Recommended Test Equipment, page 70
- Test Considerations, page 71
- Performance Verification Tests, page 72
- Zero Offset Verification, page 74
- Gain Verification, page 76
- 1 mV and 10 mV Gain Verification (Optional), page 78
- Injected Current Verification (Optional), page 80
- Chart Output Verification (Optional), page 81
- Calibration Security Code, page 83
- Calibration Count, page 85
- Calibration Message, page 85
- Calibration Procedure, page 86
- Aborting a Calibration in Progress, page 86
- Zero Calibration, page 87
- Gain Calibration, page 89
- Injected Current Calibration (Optional), page 92
- Internal Temperature Reference Calibration (Optional), page 94
- Chart Output Calibration (Optional), page 95
- Error Messages, page 96

***Closed-Case Electronic Calibration*** The meter features closed-case electronic calibration. No internal mechanical adjustments are required. The meter calculates correction factors based upon the input reference value you set. The new correction factors are stored in non-volatile memory until the next calibration adjustment is performed. (Non-volatile memory does not change when power has been off or after a remote interface reset.)



## Agilent Technologies Calibration Services

When your meter is due for calibration, contact your local Agilent Technologies Service Center for a low-cost recalibration. The Agilent 34420A is supported on automated calibration systems which allow Agilent Technologies to provide this service at competitive prices. Calibrations to MIL-STD-45662 are also available at competitive prices.

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## Calibration Interval

The meter should be calibrated on a regular interval determined by the measurement accuracy requirements of your application. A 1-year or 2-year interval is adequate for most applications. Agilent Technologies does not recommend extending calibration intervals beyond 2 years for any application.

Whatever calibration interval you select, Agilent Technologies recommends that complete re-adjustment should always be performed at the calibration interval. This will increase your confidence that the Agilent 34420A will remain within specification for the next calibration interval. This criteria for re-adjustment provides the best long-term stability. Performance data measured using this method can be used to extend future calibration intervals.

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## Time Required for Calibration

The Agilent 34420A can be automatically calibrated under computer control. With computer control you can perform the complete calibration procedure and performance verification tests in less than 50 minutes. Manual calibrations using the recommended test equipment will take approximately 2 hours.

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## Automating Calibration Procedures

You can automate the complete verification and adjustment procedures outlined in this chapter if you have access to programmable test equipment. You can program the instrument configurations specified for each test over the remote interface. You can then enter readback verification data into a test program and compare the results to the appropriate test limit values.

You can also enter calibration constants from the remote interface. Remote operation is similar to the local front-panel procedure. You can use a computer to perform the adjustment by first selecting the required setup. The calibration value is sent to the meter and then the calibration is initiated over the remote interface. The meter must be unsecured prior to initiating the calibration procedure. For further information on programming the meter, see chapter 4 in the *Agilent 34420A User's Guide*.

## Recommended Test Equipment

The test equipment recommended for the performance verification and adjustment procedures is listed below. If the exact instrument is not available, substitute calibration standards of equivalent accuracy.

Instrument	Requirements	Recommended Model	Use*
Low thermal 4-wire shorting plug	Low EMF four-wire short	Agilent 34103A (provided with meter)	Q,P,O,T
Low thermal input connector and cable	Low EMF, all copper	Agilent 34102A (provided with meter)	Q,P,O,T
Multifunction Calibrator	dc Volts 0 to 100 V resistance 0 to 1 M $\Omega$	Fluke 5700	Q,P
Capacitor	1000 pF	none	O
1000:1 Voltage Divider	Low Thermal Noise	none	O
Temperature Measurement Device (RTD or thermistor)	$\pm 0.2^\circ$ C	none	O
6 1/2 Digit Digital Multimeter (DMM)	10 Vdc $\pm 0.01\%$	Agilent 34401A	O,T

\* Q = Quick Verification  
P = Performance Verification Tests

O = Optional Verification Tests  
T = Troubleshooting

## Test Considerations

To ensure proper instrument operation, verify that you have selected the correct power line voltage prior to attempting any test procedure in this chapter. See page 29 in chapter 2 for more information.

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 3-hour warm-up period with the low thermal shorting plug connected before verification or adjustment.
- Assure that low noise connections are made to the meter and calibrator. Chapter 7 of the *Agilent 34420A User's Guide* describes low noise input connections.
- Allow 5 minutes for thermal offset stabilization after handling the input connector or shorting plug before making measurements or performing calibrations.
- Ensure the input connector or low thermal shorting plug coupling nut is properly tightened (torque to 20 in-lb maximum).

## Performance Verification Tests

The performance verification tests use the meter's specifications listed in chapter 1, "Specifications," starting on page 11.

You can perform four different levels of performance verification tests:

- **Self-Test** A series of internal verification tests that give a high confidence that the meter is operational.
- **Quick Verification** A combination of the internal self-tests and selected verification tests.
- **Performance Verification Tests** An extensive set of tests that are recommended as an acceptance test when you first receive the meter or after performing adjustments.
- **Optional Verification Tests** Tests *not* performed with every calibration. Perform these tests to verify additional specifications or functions of the meter.

### Self-Test

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

To perform a complete self-test hold down the **Shift** key as you press the Power switch to turn on the meter; *hold down the key for more than 5 seconds* (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 10 seconds.

You can perform many tests individually (or all tests at once) using the TEST command in the SYS MENU. You can also perform a self-test from the remote interface (see chapter 4 in the *Agilent 34420A 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 turns on. If repair is required, see chapter 6, "Service," for further details.
- If all tests pass, you have a high confidence (90%) that the meter 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 meter'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. A procedure is given on page 72.
- Perform only the performance verification tests indicated with the letter **Q**.

*If the meter fails the quick performance check, adjustment or repair is required.*

## Performance Verification Tests

The performance verification tests are recommended as acceptance tests when you first receive the meter. The acceptance test results should be compared against the 90 day test limits. You should use the 24-hour test limits only for verification within 24 hours after performing the adjustment procedure. After acceptance, you should repeat the performance verification tests at every calibration interval.

*If the meter fails performance verification, adjustment or repair is required.*

## Zero Offset Verification

This procedure verifies the zero performance of the meter. Verification checks are only performed for those functions and ranges with unique zero calibration constants. A low thermal 4-wire shorting plug is applied to the input of the meter for these checks.

### Zero Offset Verification Procedure

- 1 Set the meter to the following configuration for each function, channel, and range in the table on the next page:  
7 ½ digits (100 PLC)  
Filters OFF
- 2 Read "Test Considerations" on page 71.
- 3 Apply the low thermal 4-wire shorting plug (Agilent PN 34103A) to the meter's input terminal. Ensure the connector coupling nut is properly tightened.
- 4 Allow 5 minutes for the thermal shorting plug and input connector to temperature stabilize.
- 5 Select each function and range in the order shown in the table on the next page. Compare each measurement result to the test limits shown in the table.

---

**Caution**

*Zero offset calibration using a multifunction calibrator is NOT possible. Use only the low thermal 4-wire shorting plug provided.*

Chapter 4 Calibration Procedures  
**Zero Offset Verification**

Step #	Function/Channel	Range	± Error From Zero			
			24 hour	90 day	1 year	
Q	1	Voltage / Channel 1	1 mV	120 nV <sup>1</sup>	120 nV <sup>1</sup>	120 nV <sup>1</sup>
	2	Voltage / Channel 1	10 mV	120 nV <sup>1</sup>	120 nV <sup>1</sup>	130 nV <sup>1</sup>
	3	Voltage / Channel 1	100 mV	300 nV	400 nV	400 nV
	4	Voltage / Channel 1	1 V	3 μV	4 μV	4 μV
	5	Voltage / Channel 1	10 V	10 μV	40 μV	40 μV
Q	6	Voltage / Channel 1	100 V	400 μV	500 μV	500 μV
Q	1	Voltage / Channel 2	1 mV	120 nV <sup>1</sup>	120 nV <sup>1</sup>	120 nV <sup>1</sup>
	2	Voltage / Channel 2	10 mV	120 nV <sup>1</sup>	120 nV <sup>1</sup>	130 nV <sup>1</sup>
	3	Voltage / Channel 2	100 mV	300 nV	400 nV	400 nV
	4	Voltage / Channel 2	1 V	3 μV	4 μV	4 μV
	5	Voltage / Channel 2	10 V	10 μV	40 μV	40 μV
Q	7	4-wire Ohms	1 Ω	2 μΩ	2 μΩ	2 μΩ
	8	4-wire Ohms	10 Ω	20 μΩ	20 μΩ	20 μΩ
	9	4-wire Ohms	100 Ω	200 μΩ	200 μΩ	200 μΩ
	10	4-wire Ohms	1 kΩ	2 mΩ	2 mΩ	2 mΩ
	11	4-wire Ohms	10 kΩ	20 mΩ	20 mΩ	20 mΩ
	12	4-wire Ohms	100 kΩ	300 mΩ	400 mΩ	400 mΩ
	13	4-wire Ohms	1 MΩ	3 Ω	4 Ω	4 Ω
	14	Low Power Ohms	1 Ω	2 μΩ	2 μΩ	2 μΩ
15	Low Power Ohms	10 Ω	20 μΩ	20 μΩ	20 μΩ	
16	Low Power Ohms	100 Ω	200 μΩ	200 μΩ	200 μΩ	
17	Low Power Ohms	1 kΩ	2 mΩ	2 mΩ	2 mΩ	
18	Low Power Ohms	10 kΩ	40 mΩ	40 mΩ	40 mΩ	
19	Low Power Ohms	100 kΩ	1.2 Ω	1.5 Ω	1.5 Ω	
Q	20	Low Power Ohms	1 MΩ	3 Ω	4 Ω	4 Ω
21	Voltage Limited Ohms	10 Ω	20 μΩ	20 μΩ	20 mΩ	
22	Voltage Limited Ohms	100 Ω	200 μΩ	200 μΩ	200 μΩ	
Optional <sup>2</sup>	2-wire Ohms	All	Use 4-wire Ohms specifications <sup>2</sup>			

<sup>1</sup> This value includes 100 nV for NULL off, see the specifications in chapter 1.

<sup>2</sup> For 2-wire Ohms with Null ON (within ± 1°C of NULL), add 2 mΩ to the listed specification. If null is not used, add 0.2 Ω to the listed specification.

## Gain Verification

This procedure is used to check the "full scale" reading calibration of the meter. Verification checks are only performed for those functions, channels, and ranges with unique gain calibration constants.

### Gain Verification Procedure

- 1 Set the meter to the following configuration:  
7 ½ digits (100 PLC)  
Filters OFF
- 2 Read "Test Considerations" on page 71.
- 3 Connect a multifunction calibrator to the meter's input terminals using the low thermal input cable provided (Agilent PN 34102A). Ensure the connector coupling nut is properly tightened.
- 4 Allow 5 minutes for the input connections to temperature stabilize.
- 5 Select each function and range on the meter in the order shown in the table on the next page. At each function and range apply a full scale (input with the multifunction calibrator). Compare each measurement result to the test limits shown in the table.

*The 1 mV and 10 mV gain verification is an optional verification test (see page 78). These range gains are internally derived from the 100mV, 1V, and 10V range calibrations.*



Chapter 4 Calibration Procedures  
Gain Verification

Step #	Calibrator	Meter		± Error From Full Scale			
		Function/Channel	Range	24 hour	90 day	1 year	
Q	1	100 mV	Voltage / Channel 1	100 mV	1.8 μV	3.4 μV	4.4 μV
	2	1 V	Voltage / Channel 1	1 V	13 μV	29 μV	39 μV
	3	10 V	Voltage / Channel 1	10 V	30 μV	240 μV	340 μV
	4	100 V	Voltage / Channel 1	100 V	1.4 mV	3 mV	4 mV
Q	5	100 mV	Voltage / Channel 2 <sup>1</sup>	100 mV	1.8 μV	3.4 μV	4.4 μV
	6	1 V	Voltage / Channel 2 <sup>1</sup>	1 V	13 μV	29 μV	39 μV
	7	10 V	Voltage / Channel 2 <sup>1</sup>	10 V	30 μV	240 μV	340 μV
Q	8	1 Ω	4-wire Ohms	1 Ω	17 μΩ	52 μΩ	72 μΩ
	9	10 Ω	4-wire Ohms	10 Ω	170 μΩ	420 μΩ	620 μΩ
	10	100 Ω	4-wire Ohms	100 Ω	1.7 mΩ	4.2 mΩ	6.2 mΩ
	11	1 kΩ	4-wire Ohms	1 kΩ	17 mΩ	42 mΩ	62 mΩ
	12	10 kΩ	4-wire Ohms	10 kΩ	170 mΩ	420 mΩ	620 mΩ
	13	100 kΩ	4-wire Ohms	100 kΩ	1.8 Ω	4.4 Ω	6.4 Ω
	14	1 MΩ	4-wire Ohms	1 MΩ	23 Ω	54 Ω	74 Ω
Q	15	1 Ω	Low Power Ohms	1 Ω	17 μΩ	52 μΩ	72 μΩ
	16	10 Ω	Low Power Ohms	10 Ω	170 μΩ	420 μΩ	620 μΩ
	17	100 Ω	Low Power Ohms	100 Ω	1.7 mΩ	4.2 mΩ	6.2 mΩ
	18	1 kΩ	Low Power Ohms	1 kΩ	17 mΩ	42 mΩ	62 mΩ
	19	10 kΩ	Low Power Ohms	10 kΩ	190 mΩ	440 mΩ	640 mΩ
	20	100 kΩ	Low Power Ohms	100 kΩ	2.7 Ω	5.5 Ω	7.5 Ω
	21	1 MΩ	Low Power Ohms	1 MΩ	23 Ω	54 Ω	74 Ω
Q	22	10 Ω	Voltage Limited Ohms	10 Ω	220 μΩ	520 μΩ	720 μΩ
	23	100 Ω	Voltage Limited Ohms	100 Ω	2.7 mΩ	5.2 mΩ	7.2 mΩ
Optional <sup>2</sup>			2-wire Ohms	All	Use 4-wire Ohms specifications <sup>2</sup>		

<sup>1</sup> Channel 2 can be verified only, no channel 2 gain calibration exists. Channel 2 gain calibration is derived from channel 1 gain calibration.

<sup>2</sup> For 2-wire Ohms with Null ON (within ± 1°C of NULL), add 2 mΩ to the listed specification. If null is not used, add 0.2 Ω to the listed specification.

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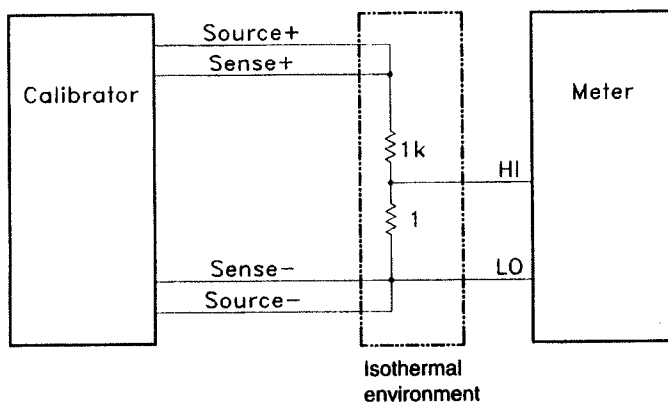
## 1 mV and 10 mV Gain Verification (Optional)

This optional procedure checks the "full scale" gain for the 1 mV and 10 mV ranges. Because of the low voltage levels used to verify these ranges and the inherent inaccuracies of multifunction calibrators at these levels, a voltage divider is used to check these ranges.

*These ranges can only be verified. The gain calibrations for these ranges are derived from the calibrations on the 100mV, 1V, and 10 V ranges.*

### 1 mV and 10 mV Gain Verification Procedure

- 1 Set the meter to the following configuration:  
Channel 1 input  
7 ½ digits (100 PLC)  
Filters OFF
- 2 Connect the calibrator, resistive divider, and meter as shown.



- 3 Measure or calculate the divider ratio.

Chapter 4 Calibration Procedures  
1 mV and 10 mV Gain Verification (Optional)

- 4 Set the calibrator to fixed range (2.2 Volt range on range lock) and 0 Volt output.
- 5 Null the reading on the meter.
- 6 Set the calibrator to 1 Volt output. Adjust the calibrator output from nominal by the divider ratio to produce a 1 mV input to the meter.

*Note: steps 4, 5, and 6 should be performed quickly to minimize thermal offsets.*

- 7 Verify the the meter reading against the table below.
- 8 Repeat steps 4 through 7 using the calibrator 11 Volt range and applying a 10 V output to produce a 10 mV input on the meter.

*Note: you should repeat steps 4 through 8 several times and average the results to reduce the effects of measurement noise.*

Function/Channel	Range	± Error From Full Scale		
		24 hour	90 day	1 year
Voltage / Channel 1	1 mV	45 nV	60 nV	70 nV
Voltage / Channel 1	10 mV	270 nV	420 nV	530 nV

---

## Injected Current Verification (Optional)

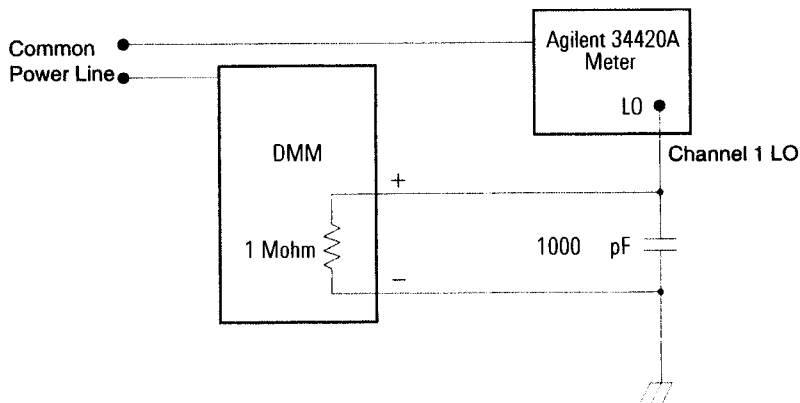
This optional procedure checks the injected current level. Injected current varies with the power line configuration and frequency. You should, therefore, verify injected current using the same power line configuration as the intended use.

### Injected Current Verification Procedure

- 1 Connect the DMM and the meter to the same power line receptacle.
- 2 Set the DMM to measure AC Volts rms on the 100 mV range.

*Note: the DMM input impedance must be 1 M $\Omega$  to perform this procedure.*

- 3 Set the Agilent 34420A to the following configuration:  
Channel 1 input  
7 1/2 digits (100 PLC)  
Filters OFF
- 4 Connect the DMM, capacitor, and meter as shown.



- 5 Measure the rms voltage on the DMM. With the setup shown, 1 mV rms is equivalent to 1 nA rms of injected current. Verify the measured voltage is < 18 mV rms (for peak-to-peak values, multiply the measured rms voltage by 2.8).

---

## Chart Output Verification (Optional)

This optional procedure checks the chart output (analog output) for zero and gain calibration. Before beginning this procedure, you should check and record any settings for the chart span and chart null (see page 63) so that these values can be restored at the end of the procedure.

### Chart Output Verification Procedure

- 1 Set the meter to the following configuration:
  - 6 ½ digits (10 PLC)
  - Channel 1 DCV
  - Math OFF
  - Null OFF
- 2 Read "Test Considerations" on page 71.
- 3 Connect the low thermal 4-wire shorting plug to the meter's input terminals.
- 4 Connect the rear panel chart output terminal to a DMM.
- 5 Turn on the menu.
  - On/Off
  - Shift <
- 6 Select the E:SYS menu.
  - > > > >
- 7 Move down to the commands level and across to the 6:CHART SPAN command.
  - v < < <
  - <
- 8 Move down to the parameters level and set the value to 1.000,000 V.
  - v
- 9 Execute the command.
  - Auto/Man
  - Enter
- 10 Use menu recall to return to the 6: CHART SPAN command.
  - Recall
  - Shift >
- 11 Move to the 7:CHART NULL command.
  - >
- 12 Move down to the parameters level and set the value shown to 0.000,000 V.
  - v

Chapter 4 Calibration Procedures  
**Chart Output Verification (Optional)**

**Auto/Man**

Enter

Recall

**Shift** >

< <

v

**Auto/Man**

Enter

Recall

**Shift** >

> >

v

**Auto/Man**

Enter

**13** Execute the command.

**14** Use menu recall to return to the 7: CHART NULL command.

**15** Move to the 5:CHART OUT command.

**16** Move down to the parameters level and set the value to ON.

**17** Execute the command.

**18** Measure the chart output with the DMM and verify that the output is:  
**0 Volts ±1 mV.**

**19** Use menu recall to return to the 5: CHART OUT command.

**20** Move to the 7:CHART NULL command.

**21** Move down to the parameters level and set the value to -1.000,000 V.

**22** Execute the command.

**23** Measure the chart output with the DMM and verify that the output is:  
**1.000 Volt ±2 mV.**

**24** Restore chart null and chart span to the values set before beginning this procedure.

---

## Calibration Security Code

This feature allows you to enter a security code (electronic key) to prevent accidental or unauthorized calibrations of the meter. When you first receive your meter, it is secured. Before you can adjust calibration constants you *must* unsecure the meter by entering the correct security code. A procedure to unsecure the meter is given on page 64.

- The security code is set to “HP034420” when the meter is shipped from the factory. The security code is stored in *non-volatile* memory, and *does not* change when power has been off or after a remote interface reset.
- To secure the meter from the remote interface, the security code may contain up to 11 alphanumeric characters as shown below. The first character *must* be a letter, but the remaining characters can be letters or numbers. You do not have to use all 11 characters but the first character must always be a letter.

A \_ \_ \_ \_ \_ (11 characters)

- To secure the meter from the remote interface but allow it to be unsecured from the front panel, use the eight-character format shown below. The first two characters must be “HP” and the remaining characters must be numbers. *Only the last six characters are recognized from the front panel, but all eight characters are required.* (To unsecure the meter from the front panel, omit the “HP” and enter the remaining numbers.)

HP \_ \_ \_ \_ \_ (8 characters)

*If you secure the meter from the remote interface and the secure code you use does not have the first two characters “HP” and the next 6 characters as digits, you cannot unsecure the meter from the front panel.*

- *If you forget your security code, you can disable the security feature by adding a jumper inside the meter, and then entering a new code. See the procedure on the following page.*

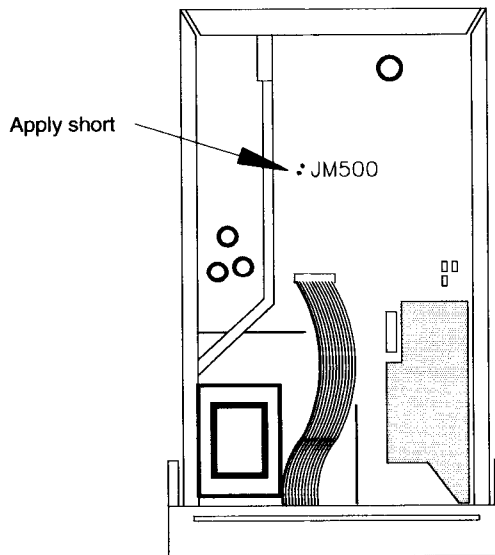
## To Unsecure the Meter Without the Security Code

To unsecure the meter without the correct security code, follow the steps below. A procedure to unsecure the meter is given on page 64. Also see “Electrostatic Discharge (ESD) Precautions” in chapter 6 before beginning this procedure.

- 1 Disconnect the power cord and all input connections (both front and rear terminals).
- 2 Remove the instrument cover. Refer to the disassembly drawing on page 155.
- 3 Connect the power cord and turn on the meter. **Be careful not to touch the power line connections.**
- 4 Apply a short between the two exposed metal pads on JM500 as shown in the figure below.

### Warning

- Exposed Mains
- DO NOT Touch!



34420A FIG 4-1

- 5 While maintaining the short, enter any unsecure code. The meter is now unsecured.
- 6 Remove the short at JM500.
- 7 Turn off the meter and remove the power cord. Reassemble the meter.
- 8 The meter is now unsecured and you can enter a new security code. Be sure you take note of the new security code.



## Calibration Count

The calibration count feature provides an independent “serialization” of your calibrations. You can determine the number of times that your meter 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 increases the value by approximately 24 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. Your meter was calibrated before it left the factory. When you receive your meter read the calibration count to determine its value.
- The calibration count increments up to a maximum of 32,767 after which it wraps around to 0. There is no way provided to program or reset the calibration count. It is an independent electronic calibration “serialization” value.

---

## Calibration Message

You can use the calibration message feature to record calibration information about your meter. For example, you can store such information as the last calibration date, the next calibration due date, the meter’s serial number, or even the name and phone number of the person to contact for a new calibration.

*You can record information in the calibration message only from the remote interface. You can read the message from either the front-panel menu or the remote interface.*

- The calibration message may contain up to 40 characters. The meter can display up to 11 characters of the message on the front panel; any additional characters are truncated.
- The calibration message is stored in *non-volatile* memory, and *does not* change when power has been off or after a remote interface reset.

## Calibration Procedure

The adjustment procedures use the CALibrate menu to initiate internal procedures to generate and set calibration constants. The general menu procedure is the same for all calibration setups.

Before beginning any calibration procedure the meter must be unsecured for calibration (see page 64). The following procedure is the recommended method to complete a meter calibration.

- Read "Test Considerations" (*page 71*).
- Unsecure the meter for calibration (*page 64*).
- Perform the Zero Calibration procedure (*page 87*).
- Perform the Gain Calibration procedure (*page 89*).
- Secure the meter against calibration.
- Note the new security code and calibration count in the meter's maintenance records.

---

## Aborting a Calibration in Progress

Sometimes it may be necessary to abort a calibration after the procedure has already been initiated. You can abort a calibration at any time by pressing any front-panel key (except **Shift**). When performing a calibration from the remote interface, you can abort a calibration by issuing a remote interface device clear message or by pressing the front-panel LOCAL key.

## Zero Calibration

A new set of zero offset correction constants are stored each time a zero calibration is performed. Each channel, function, and range has a unique offset correction. Once the procedure is started, the meter will automatically sequence through all the required input channels, functions, and ranges and store a new zero offset constant for each.

You may not perform a zero calibration for a single input channel, function or range. All zero offset constants are determined when a zero calibration is begun.

As a part of the Zero Calibration, the input amplifier bias current is minimized. This error current is dependent upon temperature. You should perform the Zero Calibration procedures whenever the meter is used in environments with temperatures greater than  $\pm 5^{\circ}\text{C}$  from the calibration temperature.

## **Zero Calibration Procedure**

The automatic zero calibration takes approximately 10 minutes to complete.

The procedure is outlined below. You should review "Test Considerations" on page 71 before beginning this procedure.

- 1** Set the meter to the following configuration:
  - 6 ½ digits (10 PLC)
  - Channel 1 DCV
  - Filters OFF
- 2** Connect the low thermal 4-wire shorting plug to the meter's input terminals. Ensure the connector coupling nut is properly tightened.
- 3** Allow 5 minutes for the thermal shorting plug and input connector to temperature stabilize.
- 4** Turn on the menu and select G:CAL menu.
- 5** Move to the commands level and select 2:CALIBRATE.
- 6** Move down to the parameters level and set the value shown to 0.000,000,0 V.
- 7** Execute the command to begin the automatic zero calibration. The calibration will take approximately 10 minutes to complete. The display will indicate the calibration progress as each channel, range, and function is calibrated.
- 8** Perform the Zero Offset Verification procedure (page 74) to check the results.

On/Off

Shift < <

v >

v

Auto/Man

Enter

## Gain Calibration

The meter stores new gain correction constants each time this procedure is followed. The gain constants are calculated from calibration values entered and from measurements made automatically by the meter.

The 1 mV and 10 mV ranges use an internally derived gain constant and do not have a separate gain calibration. The 1 mV and 10 mV gain constants are based upon measurements performed during the 100 mV, 1 V and 10 V gain calibrations. Channel 1 gain is used for both channel 1 and channel 2. No separate channel 2 gain constants are stored.

*It is recommended that the calibration procedure be followed in the order given here. If you are performing adjustments for an individual function, perform the adjustments ONLY in the order shown.*

## Gain Adjustment Considerations

- The zero calibration procedure *must* have been recently performed before beginning these gain adjustment procedures.
- When performing the 4-wire ohms gain adjustment, new gain constants are also stored for the 2-wire ohms gain constants.
- Gain adjustments can be made with calibrator input values that are within 0.9 to 1.1 of Full Scale.

## Gain Calibration Procedure

Perform the adjustments for each function only in the order shown.

- 1 Read "Test Considerations" on page 71.
- 2 Set the meter to the following configuration for each function, channel, and range in the table on the next page:  
7 ½ digits (100 PLC)  
Null OFF  
Filters OFF
- 3 Connect a multifunction calibrator to the meter's input terminals using the provided cable (Agilent PN 34102A). Ensure the connector coupling nut is properly tightened.
- 4 Allow 5 minutes for the input connector to temperature stabilize.
- 5 Select each function and range in the order shown in the table on the next page. Apply the input signal shown.
- 6 Turn on the menu and select G:CALIBRATE menu.
- 7 Move to the commands level and select 2:CALIBRATE.
- 8 Move down to the parameters level and set the value in the display to the calibrator input value.
- 9 Execute the command to begin the gain calibration.
- 10 Repeat steps 1 through 9 for for each function and gain listed in the table.
- 11 Perform the Gain Verification procedure (page 76) to check the results.

On/OFF

Shift < <

√ >

√

Auto/Man

Enter

Chapter 4 Calibration Procedures  
**Gain Calibration**

Step #	Calibrator Output <sup>1</sup>	Function/Channel	Range
1	100.000,00 mV <sup>2</sup>	DCV / Channel 1	100 mV
2	1.000,000,0 V <sup>2</sup>	DCV / Channel 1	1 V
3	10.000,000 V <sup>2</sup>	DCV / Channel 1	10 V
4	100.000,00 V	DCV / Channel 1	100 V
5	1.000,000,0 Ω	4-wire Ohms	1 Ω
6	10.000,000 Ω	4-wire Ohms	10 Ω
7	100.000,00 Ω	4-wire Ohms	100 Ω
8	1,000.000,0 Ω	4-wire Ohms	1 kΩ
9	10,000.000 Ω	4-wire Ohms	10 kΩ
10	100,000.00 Ω	4-wire Ohms	100 kΩ
11	1,000,000.0 Ω	4-wire Ohms	1 MΩ

<sup>1</sup> Gain calibration can be performed with an input that is within 0.9 to 1.1 of Range.

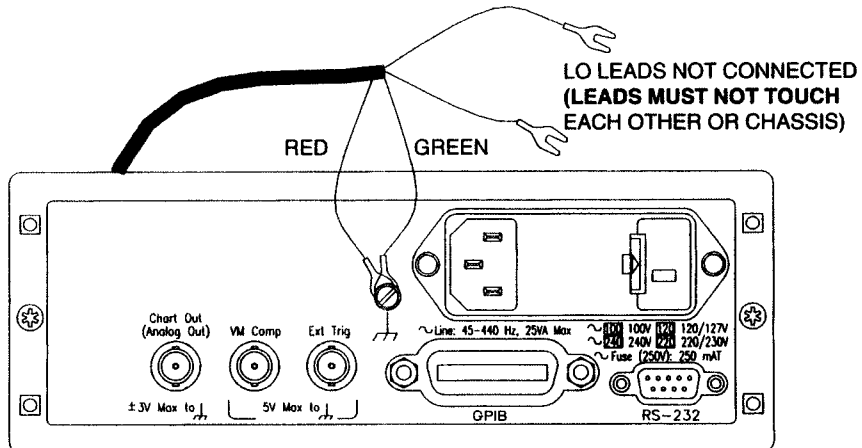
<sup>2</sup> The constants calculated for these ranges are used to derive the gain calibration constants for the 1 mV and 10 mV ranges.

## Injected Current Calibration (Optional)

This calibration minimizes the effects of injected current in the input circuits. Injected current varies with the power line configuration and frequency (these vary by country). You should, therefore, only calibrate injected current using the same power line configuration as the intended use.

*The injected current is calibrated at the factory using 120 Vac line power with a hot lead, neutral lead, and an earth ground lead. You should recalibrate injected current if you are using the meter with different line power configurations. You should only recalibrate injected current using the same power line configuration as the intended use.*

- 1 Set the meter to the following configuration:  
6 ½ digits (10 PLC)  
Channel 1 input
- 2 Connect channel 1 **HI** and channel 2 **HI** leads to the rear panel chassis ground screw.





## Chapter 4 Calibration Procedures

### Injected Current Calibration (Optional)

On/Off

**Shift** <

**3** Turn on the menu.

< v

**4** Select G:CAL menu and go to the command level.

1 : UNSECURED

> > > >

v

**5** Select 5:INJECTED I command and enter the parameter level.

INITIATE

**Auto/Man**

ENTER

**6** Enter the command to begin the calibration. The calibration takes approximately 30 seconds to complete.

**7** The display will show intermediate values of the injected current as the calibration progresses.

**8** When the calibration is finished, the display shows

COMPLETED

**9** The display will then show the final injected current value. You may wish to record this value. After a pause, the meter returns to the measurement mode.

3.8 nA RMS

---

## Internal Temperature Reference Calibration (Optional)

This procedure calibrates the internal reference junction temperature reference used with thermocouple measurements. Perform this calibration if you are using the meter to make thermocouple measurements and are using the internal temperature sensor as a reference. The internal temperature sensor measures the cold junction temperature at the meter's input connector.

- 1 Set the meter to:  
Temperature measurement function  
1:PROBE TYPE to T/C
- 2 Put the temperature measuring device as close to the meter's input connections as possible. Make physical contact with the connector shell.

---

### Warning

*The input connector shell is at earth ground potential.*

- On/Off
- Shift    <    <
- v    >
- v
- Auto/Man
- Enter
- 3 Turn on the menu and select G:CALIBRATE menu.
  - 4 Move to the commands level and select 2:CALIBRATE.
  - 5 Move down to the parameters level and set the value in the display to the measured temperature value.
  - 6 Execute the command to begin the gain calibration.

*The temperature units shown will be the currently set temperature units (°F, °C, or Kelvins).*

---

## Chart Output Calibration (Optional)

The chart output (analog output) uses two calibration constants, a zero and a gain. Chart Output calibrations are performed with an external DMM.

- 1 Set the meter to the power-on state. Connect the low thermal shorting plug to the meter's input.
- 2 Connect the chart output to the input of the DMM. Set the DMM to measure dc volts.
- 3 Turn on the Menu.
- 4 Select the G:CALIBRATE menu.
- 5 Go to the command level and select the 3:CHART ZERO command.
- 6 Go to the parameter level.
- 7 Edit the displayed value to match the value indicated on the DMM. Execute the command. The zero calibration takes approximately 2 seconds to perform.
- 8 Use menu recall to return to the 3:CHART ZERO command.
- 9 Scroll to the 4:CHART GAIN command and go to the parameter level.
- 10 Edit the displayed value to match the value indicated on the DMM. Execute the command. The gain calibration takes approximately 2 seconds to perform.
- 11 Perform the Chart Output verification procedure on page 81.

On/Off

Shift  <

<

>  >

>

Recall

Shift  >

>  >

---

## Error Messages

The following tables are abbreviated lists of meter's 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 chapter 5 in the *Agilent 34420A User's Guide*.

### System Error Messages

<b>Error</b>	<b>Error Message</b>
<b>-330</b>	Self-test Failed
<b>-350</b>	Queue Overflow
<b>501</b>	Isolator UART framing error
<b>502</b>	Isolator UART overrun error
<b>511</b>	RS-232 framing error
<b>512</b>	RS-232 overrun error
<b>513</b>	RS-232 parity error
<b>514</b>	Command allowed only with RS-232
<b>521</b>	Input buffer overflow
<b>522</b>	Output buffer overflow
<b>531</b>	Insufficient Memory
<b>532</b>	Cannot achieve requested resolution
<b>540</b>	Cannot use overload as math reference
<b>550</b>	Command not allowed in Local
<b>552</b>	Command not allowed in current function

Chapter 4 Calibration Procedures  
**Error Messages**

Self-Test Error Messages

<b>Error</b>	<b>Error Message</b>
601	Front panel does not respond
602	RAM read/write fail
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
613	Ohms 5 uA source failed
614	Ohms 10 uA source failed
615	Ohms 100 uA source failed
616	Ohms 1 mA source failed
617	Ohms 10 mA source failed
618	Ohms 20 mV voltage clamp failed
619	Ohms 100 mV voltage clamp failed
620	Ohms 500 mV voltage clamp failed
621	Low impedance DC gain X100 failed
622	High impedance DC gain X100 failed
623	Cannot calibrate precharge
624	Unable to sense line frequency
625	I/O Processor did not respond
626	I/O Processor failed self-test
627	Hardware overload comparator failed
630	Bias Current DAC test failed

Chapter 4 Calibration Procedures  
**Error Messages**

Calibration Error Messages

<b>Error</b>	<b>Error Message</b>
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
709	No cal for this function or range
710	Full scale correction out of range
720	Cal DCV offset out of range
722	Cal RES offset out of range
723	Cal FRES offset out of range
730	Precharge DAC convergence failed
731	A/D turnover correction out of range
737	Bias current selfcal failed
738	Charge compensation selfcal failed
739	Injected current selfcal failed
740	Cal checksum failed, secure state
741	Cal checksum failed, string data
742	Cal checksum failed, DCV correction
743	Cal checksum failed, Low Power FRES
744	Cal checksum failed, RES corrections
745	Cal checksum failed, FRES corrections
746	Cal checksum failed, Low Voltage FRES corrections
747	Cal checksum failed, GPIB address
748	Cal checksum failed, internal data



---

# Theory of Operation

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

- Block Diagram, page 101
- Input and Protection, page 103
- Function Switching, page 105
- DC Amplifier, page 106
- Ohms Current Source, page 108
- A-to-D Converter, page 111
- Configuration Data Shift Register, page 113
- Floating Logic, page 114
- Earth-Referenced Logic, page 117
- Power Supplies, page 118
- Front Panel, page 119

The self-test procedures are described in chapter 6.



## Block Diagram

Referring to the block diagram on page 159, you will notice that the meter's circuitry is divided into two major blocks: the *floating circuitry* and the *earth (ground) referenced circuitry*. All measurement, control, and display functions are contained in the floating section. This section contains the input switching, function selection, and measurement circuitry. It also contains the meter's main CPU.

All measurement circuits, including the a-to-d converter, are controlled by the floating section. Each measuring function converts the input to a dc voltage between  $\pm 12$  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 *A/D Converter* changes the voltage from the DC Amplifier into digital information. The conversion uses a *Multislope III* ADC method based upon patented Agilent Technologies ADC technology. This conversion technique uses a stable Voltage Reference. The A / D Converter digital information is used by the Main Controller to calculate the measurement. Additionally, the A / D converter provides information about the conversion process to the slope decision state machine.

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 GPIB (IEEE-488) and RS-232 interfaces. It also handles external trigger, voltmeter complete handshake signaling, and the chart (analog) output.

## Chapter 5 Theory of Operation

### Block Diagram

The *Shift Register* sets 48 bits used to control functions of the meter. The shift registers clock the serial data stream according to control signals from the Gate Array, U501.

The *Floating Logic* contains the Main Controller, U500, and its associated ASIC. The Main Controller coordinates and controls all functions and measurements of the meter. Meter instructions are stored in ROM. The RAM stores measurement configurations (volatile memory). The Cal Memory stores calibration constants in non-volatile memory. The Main Controller is clocked by a 12 MHz Oscillator. To preserve the isolation of the floating circuitry, measurement and control information is sent serially through opto-isolators to the Earth Referenced Logic.

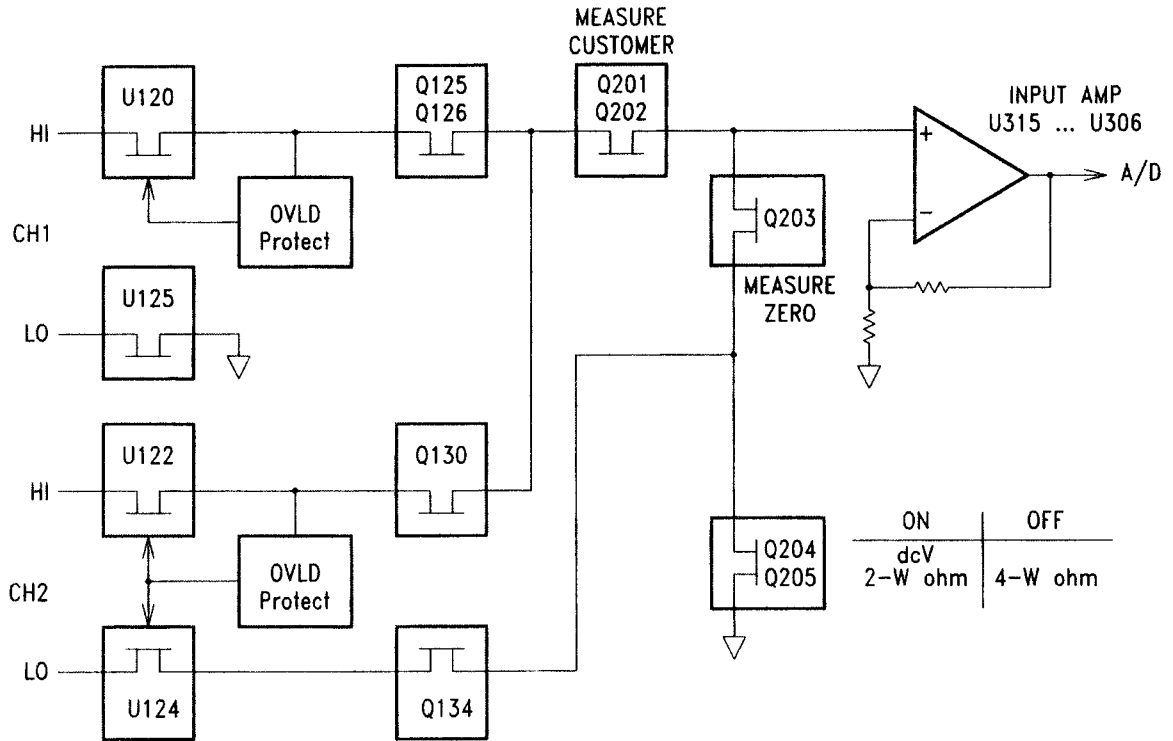
The *Front Panel Controller* recognizes front panel Keyboard presses and controls the Display. A Level Shift is required to interface the Front Panel Controller logic levels with the Main Controller logic levels.

The *Earth Referenced Logic* contains an I/O Controller slaved to the Main Controller. The I/O Controller uses a serial data link to the Main Controller through Opto-isolators. The I/O Controller provides the GPIB and RS-232 Interfaces as well as the Voltmeter Complete, External Trigger, and Chart Recorder functions.

Separate *Power Supplies* are provided for the Floating Circuitry and earth Referenced Circuitry. The Power Transformer provides the bound between floating and earth reference. The power supply also provides the line frequency reference used by the Main Controller and resets the Main Controller after power is applied.

## Input and Protection

This discussion refers to the *Input and Protection* schematic on page 160 and the simplified input diagram below. Each input terminal is protected against high energy transients (e.g., electrostatic discharge) through E101 through E104, L101 through L106 and C101 through C106.



## Chapter 5 Theory of Operation

### Input and Protection

The **Channel 1 HI** input signal is connected from the input terminal through the solid state switch U120 and FETs Q125 and Q126. (Similar switching arrangements exist in the **Channel 2 HI** and **LO** input paths.) U121A/B controls the state of the switches. In normal operation on all ranges except the 100 V range, the switches are turned on by a bit from the *Shift Registers*. The **Channel 1 HI** overload circuit consists of Q121, Q122, Q123, and Q124 along with U121B. This forms an overload clamp circuit that opens the input protection switch U120 if the input exceeds  $\pm 14$  Vdc. A similar circuit exists for the **Channel 2 HI** input.

On the 100 V Range, relay K102 is closed to connect the input signal to the Function Switch through the 100:1 high voltage divider resistor network U102A. Both K101 and K102 are driven by relay driver U150 (on the *Function Switching* schematic). The high voltage divider can only be connected to channel 1 input. The maximum range on **Channel 2** input is 10 V.

Resistance measurements are made by applying a known current through an unknown resistance. The current is supplied from the **Channel 1 HI** input terminal and returns to the **Channel 1 LO** input terminal. The resulting voltage drop across the unknown resistance is then measured by the meter's dc circuitry. In the 2-wire ohms function, the voltage drop is measured across the **Channel 1 HI** and **LO** input terminals. In the 4-wire ohms function, the voltage is measured across the **Channel 2 HI** and **LO** input terminals.

## Function Switching

This discussion refers to the *Function Switching* schematic on page 161. The Function Switching allows one of three sources to be dynamically selected. The three sources are: the "Measure Customer" input (MC), the "Measure Zero" input (MZ), and "Precharge" (PRE). The "Measure Customer" input is the signal applied to the input terminals. The "Measure Zero" input is the ground of the meter and allows measurement of internal offset voltages which are also present in the "Measure Customer" input. The displayed result is computed from MC–MZ. The "Precharge" input is used to precharge internal capacitances to reduce charge injection to the input terminal from dynamic switching of MC and MZ.

Q201 and Q202 form the "Measure Customer" switch. Closing these switches applies the input signal to the DC Amplifier (INPUT AMP+). The state of the "Measure Customer Switch" is controlled by U201A.

The "Measure Zero Switch" uses Q203, Q204, and Q205. During the measure zero portion of the measurement cycle, Q203 is closed. The zero measurement for dc Volts and 2-wire Ohms function is taken with Q204 and Q205 on. For 4-wire Ohms function, Q204 and Q205 are off and U124 and Q134 are on.

U101B switches precharge, the high voltage divider, or ohms current to the DC Amplifier. The high voltage divider is used only on the 100 V range. It is a 10 M $\Omega$ , 100:1 voltage divider that has a 1 Volt output for a 100 Volt input. The signal is coupled by U126 and U101 to the input amplifier and then to the A/D converter. Additionally, the X1 amplifier signal is used by U206A to provide the BOOT signal. This signal ensures the FET switches have the proper bias when turned on.

U203, U204, and U314 form a programmable gain amplifier. This circuit is used to inject a signal via capacitors C201 and C202 that minimizes switching transients at the input terminals when the "Measure Customer" switch is opened and closed.

---

## DC Amplifier

This discussion refers to the *DC Amplifier* schematic on page 162. The DC Amplifier is used by every measuring function.

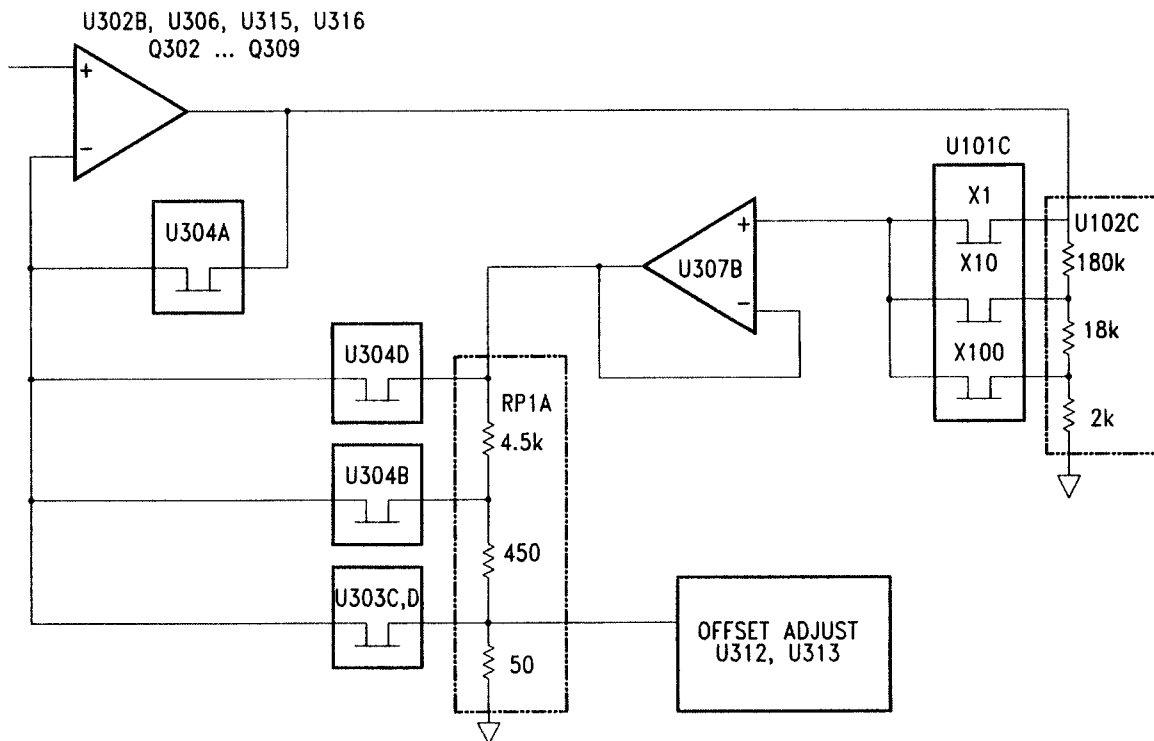
The dc input amplifier is comprised of dual FET U315, a cascade stage for U315 consisting of Q305 through Q308, an active load stage for high gain consisting of Q302 through Q304, and an output stage amplifier U306. Each range, for a full scale input, is designed to produce a 10 Volt output to the A/D Converter. Resistors R311 and R312 prevent oscillation on high ranges and are shorted by switches U303A and U303B at lower ranges.

A simplified schematic of the range selection is shown on the next page. The amplifier gain is determined by two attenuators, U102C and RP1A. The attenuators are isolated from each other by U307. Each attenuator can provide the amplifier with a gain of X1, X10, or X100. The overall gain with both attenuators in the feedback loop of the amplifier is the product of the gain provided by each attenuator and can be X1, X10, X100, X1000, or X10000. As implemented, the feedback for the X1 gain is provided by turning U304A on. Dividers U101C and RP1A are used in series for high gain ranges. The table below shows the relationship between range, amplifier gain, and the switches closed to provide that gain.

DCV Range	Amplifier Gain	Closed Switches	
.001	X 10000	U303C & D X100	U101C X100
.01	X 1000	U303C & D X100	U101C X10
.1	X 100	U304B X10	U101C X10
1	X 10	U304D X1	U101C X10
10	X 1	U304A X1	
100	X 10	U304D X1	U101C X10

The bias current of the dc amplifier is nulled using DAC U301 and amplifier U314B. Together with R302 through 304, and CR301, they allow a few millivolts of programmable voltage to be developed across R305. The resulting current flow is used to null the input bias current of the dc amplifier.

## Chapter 5 Theory of Operation DC Amplifier



Operational amplifiers U312A and U312B and DAC U313 provide programmable offset adjustments to null the input FET U315 offset voltage. The DAC is programmed "on the fly" during measure zero time. The offset voltage is checked after each DAC adjustment and further adjustments are made as necessary to obtain a voltage that is less than 10% of full scale during autozero.

The dc amplifier has a programmable 2-pole analog filter. C306 is switched with Q311. C303 through C305 are switched in with JFET Q310. Both Q310 and Q311 are switched in or out depending upon the state of switch U304C. Both pole frequencies are approximately 11 Hz.

U311A and U311B are overload comparators that sense the output of the DC Amplifier. If the peak level at the output of the dc amplifier exceeds approximately  $\pm 14$  volts, the comparator output U311A or U311B will change state. This information is sent to the CPU and will cause the reading to output as an OVLD.

## Ohms Current Source

This discussion refers to the *Ohms Current Source* schematic on page 163 and the simplified schematic on the next page. The Ohms current is generated by applying a stable voltage across a stable resistance. The exact value of the current becomes part of the range gain constant stored during calibration.

The +7 V reference voltage is applied to the 40 k $\Omega$  resistor in RP1B using U451A and Q451. This current flows through Q451 and either the 28.57 k $\Omega$  resistor in U102D or the 11.43 k $\Omega$  resistor in RP1C. Switch U101D determines which resistor is used.

The current through Q451 produces a 5 V drop across the 28.57 k $\Omega$  resistor or a 2 V drop across the 11.43 k $\Omega$  resistor. Depending upon the range set, the 5 V signal across the 28.57 k $\Omega$  resistor is applied to either the 5 k $\Omega$ , 50 k $\Omega$ , 0.5 M $\Omega$ , or 1 M $\Omega$  resistor in U102D using U451B, Q455, and Q456. The resulting current is the current source output for the 1 k $\Omega$  to 1 M $\Omega$  ranges. The 1 $\Omega$ , 10  $\Omega$ , and 100  $\Omega$  ranges use Q452, Q453, and Q454 to select the 10 mA current source in response to programming from the CPU. When the REG46 bit is set to 0 V, Q454 is turned off which turns on switches Q452 and Q453. The 2 V signal across the 11.43 k $\Omega$  resistor is applied to the 200  $\Omega$  range resistor in RP1C. This results in a 10 mA current flowing through Q452, Q455, and Q456, which then flows through over voltage protection transistors Q459 through Q462 to relay K101 where it is switched to the **Channel 1 HI** input terminal during ohms measurements.

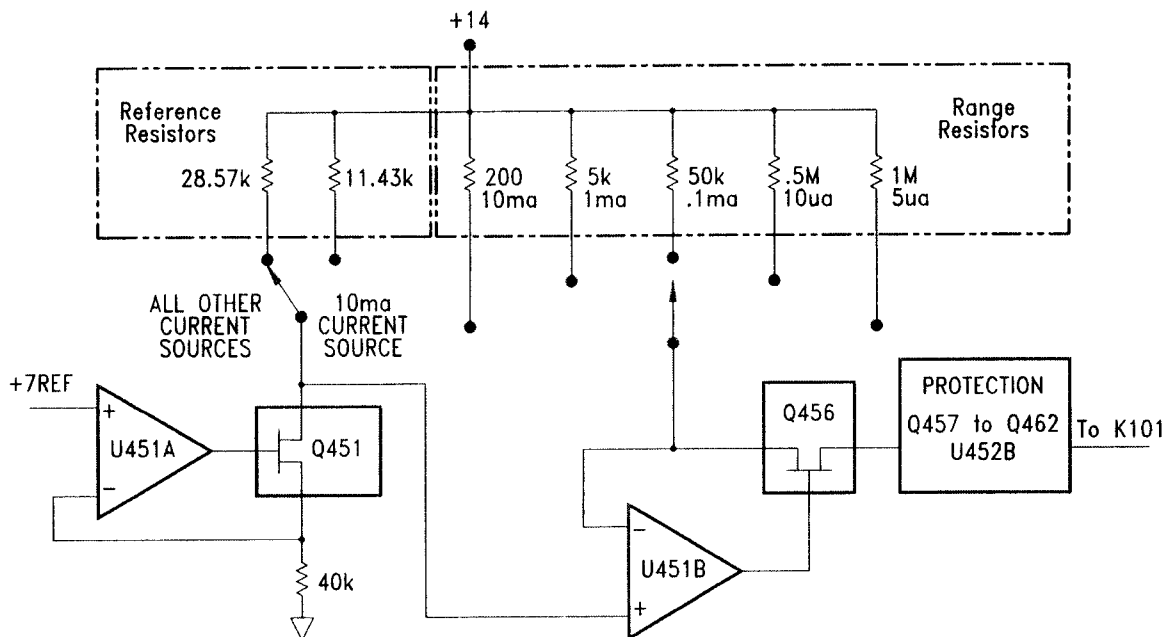
The table below shows the range, current source, and references used for 2-wire or 4-wire resistance measurements.

Ohms Range	Current	Reference Resistor	Range Resistor
1 $\Omega$	10 ma	11.43 k $\Omega$	200 $\Omega$
10 $\Omega$	10 ma	11.43 k $\Omega$	200 $\Omega$
100 $\Omega$	10 ma	11.43 k $\Omega$	200 $\Omega$
1 k $\Omega$	1 ma	28.57 k $\Omega$	5 k $\Omega$
10 k $\Omega$	.1 ma	28.57 k $\Omega$	50 k $\Omega$
100 k $\Omega$	10 $\mu$ a	28.57 k $\Omega$	500 k $\Omega$
1 M $\Omega$	5 $\mu$ a	28.57 k $\Omega$	1 M $\Omega$



## Chapter 5 Theory of Operation Ohms Current Source

The protection circuits protect the ohms current source from inadvertently applied voltages up to  $\pm 150$  V peak. Protection from large positive voltages is provided by CR454. Protection from large negative voltages is provided by the sum of the collector to base breakdown voltages of Q459 and Q461. Bias for these transistors is provided by Q458 and resistors R461, R464 and R465 when negative over voltages are applied. U452B also turns off JFET Q456 to protect Q459 and Q461 from excessive temperature rise when negative overvoltages are applied.



## Chapter 5 Theory of Operation

### Ohms Current Source

When Voltage Limited Resistance measurements are enabled, U310B, U452A and relay K451 form the output voltage clamp circuit. Voltage clamping is only available on the 10  $\Omega$  and 100  $\Omega$  ranges. The ohms output voltage is sensed by U310B which has a voltage gain of approximately X12. The signal from U310B is routed by K451 to comparator U452A. If the signal is larger than the "clamp voltage" set at U452 pin 3, the output of U452 will go negative, turning on Q457 which will turn the current source transistor Q456 off. When a resistor value of less than the range is connected to the input terminals, comparator U452A will reverse state allowing the current source turn on. The meter can be programmed to 3 different levels of voltage clamping when operating in this mode. They are 20 mV, 100 mV, and 500 mV. Resistors R462, R463, and R474 along with programming via register bits 47 and 48 set these levels. Capacitor C454 provides enough time delay to minimize any voltage overshoot while comparator U452A is turning the current source off. If the current source terminals are open circuited, R467 prevents the open circuit voltage from rising above the programmed "clamp voltage".

## A-to-D Converter

This discussion refers to the *A/D Converter* schematic on page 164. The analog-to-digital converter (ADC) changes dc voltages into digital information. The circuitry consists of an integrator amplifier (U402 and U420), current steering switch U411, resistor network U102E, and voltage reference U403. The 0 or 5 Volt signal output is sent to the ASIC U501, and residue ADC U500.

The ADC method used by the Agilent 34420A is called *Multislope III*. It is based on patented Agilent Technologies ADC technology. *Multislope III* is a charge balancing, continuously integrating, analog-to-digital conversion technique. The ADC charge balancing algorithm is always running, even when the meter is not triggered. The input voltage continuously forces charge onto the integrator capacitors C400 and C401 through the 100 k $\Omega$  resistor in U102E at pin 15.

Switches 2 and 3 in U411 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  $\mu$ s 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  $\pm 15$  V, the integrator output (FLASH) will remain within the 0 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 or 5 V by R405 and CR403 to protect U500.

## Chapter 5 Theory of Operation

### A-to-D Converter

The integrator amplifier is formed by U402 and U420. Resistors R420 and R421 affect the amplifier stability and prevent amplifier oscillation. Amplifier U420 improves the offset voltage characteristics of integrator amplifier U402.

Each analog-to-digital conversion begins when the meter 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 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 30 k $\Omega$  resistors in U102E (pins 26 and 28). Amplifier U401B provides a precise +5 V reference for the U500 on-chip ADC.

## Configuration Data Shift Register

This discussion refers to the *Configuration Data Shift Register* schematic on page 165. The Shift Register uses six 8-bit, serial input to parallel output, shift registers. The 0V or 5V outputs control configurations of the meter. The serial data is sent from the main controller and clocked into the registers by the ASIC U501.

## Injected Current Compensation

Also shown on this schematic is the Injected Current Compensation circuit. This circuit uses an inverting amplifier, U607, and programmable gain amplifier using U607B and U608. This circuit produces a small current between the isolated or floating voltmeter measurement circuitry and earth ground. the small current is used to null injected current from the power transformer.

## Chart Recorder Output

The Chart Recorder Output circuit is also shown on the *Configuration Data Shift Register* schematic. The circuit discussion is given in the Earth Referenced Logic on page 117.

## Floating Logic

This discussion refers to the *Floating Logic* schematic on page 166. 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, ASIC 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 ADC 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 high, address data is present on the address/data bus. ASIC 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 <sub>H</sub> – 1FF7 <sub>H</sub>	U503	8k X 8 RAM
1FF8 <sub>H</sub> – 1FFF <sub>H</sub>	U501	ASIC internal registers
2000 <sub>H</sub> – FFFF <sub>H</sub>	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.

## Chapter 5 Theory of Operation

### Floating Logic

ASIC 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 the ADC slope count at the COMP 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 48 bit (6 x 8 bits) measurement configuration register (shown on the schematic on page 166), 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/second for the measurement configuration registers and to 93.75 k bits/second 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)	SERDAT0	FPDI
Data IN (receive)	SERBK	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.

## Chapter 5 Theory of Operation

### Floating Logic

The meter'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. The FLASH input is used to sample the residual charge on the main integrating ADC output of U402.

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 U101B. 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 line 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/second. When the RS-232 interface is selected, data is sent across the isolated link at 93.75 k bits/second. The 11-bit data frame is configured for one start bit, eight data bits, one control bit, and one stop bit.



## Earth-Referenced Logic

The *Earth Referenced Logic Circuits* schematic shown on page 167 provides all rear panel input/output capability. Microprocessor U700 handles GPIB (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  $\pm 9$  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.

Shown on the Configuration Data Shift Register schematic on page 165 is the Chart Recorder Output. U700 programs DAC U610 to output a voltage in the range of  $\pm 3$ Vdc, in direct proportion to the measured input voltage on a given range. A full 3 Vdc output represents a 120% full scale input voltage.

## Power Supplies

Referring to the schematic shown on page 168, the meter uses two types of power supplies: *floating supplies* and *earth referenced supplies*. The floating supply outputs are  $\pm 18$  Vdc, +5 Vdc, and a 6 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, power line filters, on/off switching, and line voltage selection (100/120/220/240). The meter 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. Relay drive circuits are also powered from this supply.

The floating  $\pm 18$  volt supplies are produced by bridge rectifier CR551, filter capacitors C551 and C553, and regulators U551 and U552. In addition, the vacuum fluorescent display is driven from the  $\pm 18$  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 GPIB (IEEE-488) and RS-232 interfaces along with other input/output circuits are powered from this supply. A -5V supply is obtained from U609 and U611 to power the DAC, U610, to provide the chart recorder (analog) output.

## Front Panel

The front panel circuits (schematic shown on page 169) 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 bi-directional serial interface. The main CPU, U500, can cause a hardware reset to processor U602 by signal IGFPRES. The front panel logic operates from -13 volts (logic 1) and -18 volts (logic 0). The front panel logic high supply (-13 volts) is produced by the -18 volt supply and voltage regulator U609. The four serial communication signals are level shifted by comparator U607 from the floating logic 0 V to 5 V levels to the -18 V to -13 V levels present on the front panel assembly. U608 acts as the serial shift register interface for processor U602.

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 (see page 168). Keyboard scanning is accomplished through a conventional scanned row-column key matrix. Keys are scanned by outputting data at microprocessor U602 port pins P0.0 through P0.4 to poll each key column for a key press. Column read-back data are read by the microprocessor at port pins P1.0 through P1.3 for decoding and communication to the floating logic circuits.



—————  
Service

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# Service

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

- Operating Checklist, page 123
- Types of Service Available, page 124
- Repackaging for Shipment, page 125
- Electrostatic Discharge (ESD) Precautions, page 126
- Surface Mount Repair, page 126
- To Replace the Power-Line Fuse, page 126
- Input Connector, page 127
- Cleaning the Connector Contacts, page 128
- Troubleshooting Hints, page 129
- Self-Test Procedures, page 131

## Operating Checklist

Before returning your meter to Agilent Technologies for service or repair check the following items:

### **Is the meter inoperative?**

- Verify that the ac power cord is connected to the meter.
- Verify that the front-panel Power switch is depressed.
- Verify that the power-line fuse is installed and not open  
(see page 29):

**Use a 250 mA, 250V fuse for all power line settings.**

- Verify the power-line voltage setting.  
*See "To Prepare the Meter for Use" on page 27.*

### **Does the meter fail self-test?**

- Verify that the correct power-line voltage is selected.  
*See "To Prepare the Meter for Use" on page 27.*

## Types of Service Available

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

### **Standard Repair Services (worldwide)**

Contact your nearest Agilent Service Center. They will arrange to have your meter repaired or replaced.

### **Express Exchange (U.S.A. only)**

You can receive a replacement Agilent 34420A via overnight shipment for low downtime.

- 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 meter.
  - If you do not return your failed meter within 45 days, your credit card will be billed for a new Agilent 34420A.
  - If you choose not to supply a credit card number, you will be asked to send your failed unit to a designated Agilent Service Center. After the failed unit is received, Agilent will send your replacement unit.
- 2 Agilent will immediately send a replacement Agilent 34420A 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.



## Chapter 6 Service Repackaging for Shipment

### Express Exchange (continued)

- If your failed unit was “in-warranty,” your replacement unit continues the original three year warranty period. You *will not* be billed for the replacement unit as long as the failed unit is received by Agilent.
- If your three year warranty has expired, Agilent will bill you for the Agilent 34420A exchange price — less than a new unit price. Agilent warrants exchange units against defects for 90 days.

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## Repackaging for Shipment

For the *Express Exchange Service* described on the previous page, return your failed Agilent 34420A to the designated Agilent Service Center using the shipping carton of the exchange unit. A shipping label will be supplied. Agilent will notify you when your failed unit has been received.

If the instrument is to be shipped to Agilent for service or repair, be sure to:

- Attach a tag to the meter identifying the owner and indicating the required service or repair. Include the instrument model number and full serial number.
- Place the meter 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 meter. Use static-free packaging materials to avoid additional damage to your unit.

*Agilent 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 the meter or any electronic device.

- Disassemble instruments *only* in a static-free work area.
  - Use a conductive work area to dissipate static charge.
  - Use a conductive wrist strap to dissipate static charge accumulation.
  - Minimize handling.
  - Keep replacement parts in original static-free packaging.
  - Remove all plastic, foam, 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 will void your Agilent Technologies factory warranty.*

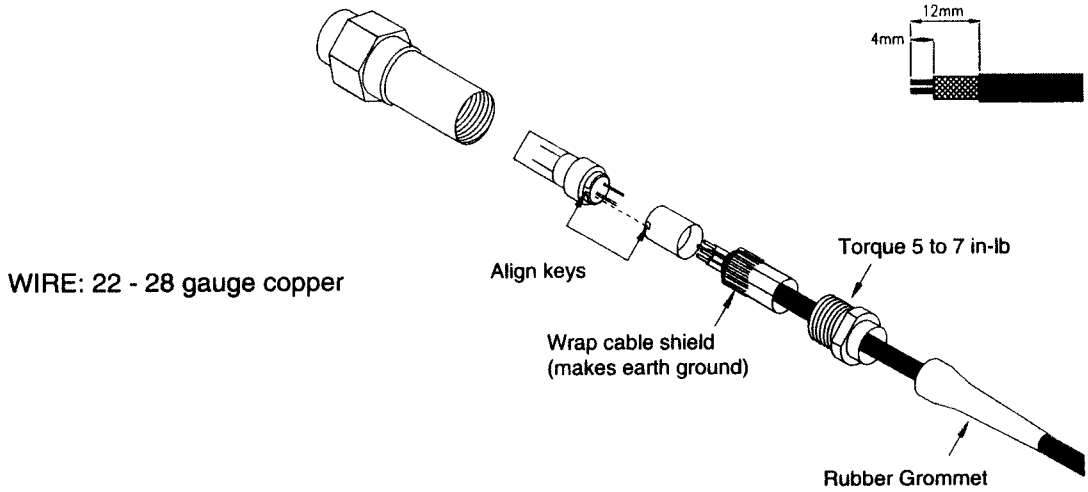
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## To Replace the Power-Line Fuse

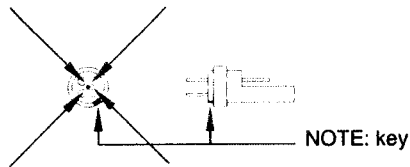
The power-line fuse is located within the meter's fuse-holder assembly on the rear panel (see page 29). Use a 250 mA T slow-blow fuse (Agilent part number 2110-0817). This fuse is used for all power line settings.

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## Input Connector



		Channel 1	
		HI	LO
DCV		+	-
4-Wire $\Omega$		Source +	Source -
2-Wire $\Omega$		Source and Sense +	Source and Sense -
Thermistor		Source and Sense +	Source and Sense -



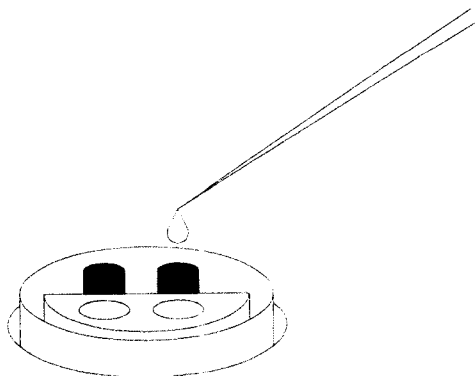
		Channel 2	
		HI	LO
DCV		+	-
4-Wire $\Omega$		Sense +	Sense -
Thermocouple		+	-

## Cleaning the Connector Contacts

Because the meter uses connector contacts that are almost pure copper, they are subject to oxidation. Oxidation can cause measurement errors. *See chapter 7 of the Agilent 34420A User's Guide for a discussion of the causes of measurement error.*

To help prevent the formation of oxides on the connector contacts, keep the connector engaged whenever possible. After extended periods of time, it may be necessary to treat the connector contacts. The recommended treatment uses DeoxIT™ and a small bottle of DeoxIT was included with the Agilent 34420A. Use the following procedure to apply DeoxIT to the connector terminals.

- 1 Remove the power cord from the meter.
- 2 Remove the input connector.
- 3 Stand the meter on a smooth level surface so that the front panel is up.
- 4 Apply one drop of DeoxIT to each connector pin in the input connector. A convenient method to apply a single drop is to use a clean piece of wire to transfer the liquid from the container provided to the connector.



- 5 Remove any excess DeoxIT from the connector by wiping with a clean soft cloth.
- 6 Engage and disengage the input cable several times to distribute the DeoxIT evenly over both halves of the connector.

DeoxIT™ is a trademark of CAIG Laboratories, Inc., San Diego, California.

## Troubleshooting Hints

This section provides a brief check list of common failures. Before troubleshooting or repairing the meter, make sure the failure is in the instrument rather than any external connections. Also make sure that the instrument is accurately calibrated. The meter's circuits allow troubleshooting and repair with basic equipment such as a 6½-digit multimeter.

### Unit is inoperative

- Verify that the ac power cord is connected to the meter.
- Verify that the front-panel Power switch is depressed.
- Verify the power-line fuse is not open (*refer to page 29*):

**Use a 250 mA, 250V fuse for all power line settings.**

- Verify the power-line voltage setting.  
*See "To Prepare the meter for use" on page 27.*

### Unit reports error 705

This error 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 may have occurred.

### Unit fails self-test

Verify that the correct power-line voltage setting is selected. Also, ensure that all terminal connections (both front panel and rear terminals) are removed while the self-test is performed.

### **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.

Check the main supply voltages as tabulated below.

<b>Power Supply</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Check At</b>
+5 Ground Ref.	4.75 V	5.25V	U751 pin 3
-5 Ground Ref.	-5.25 V	-4.75 V	U611 pin 1
+5 Floating	4.75 V	5.25V	U553 pin 2
+18 Floating	17.8 V	20.1V	U551 pin 2
-18 Floating	-20.1 V	-18.2V	U552 pin 3
+7 REF Floating	6.8 V	7.1 V	U400 pin 7
+5VSP Floating	4.75V	5.25V	U401 pin 7

Some circuits produce their own local power supplies derived from the main supplies. Be sure to check that these local supplies are active. Local supplies are included in the display and front panel, the input amplifier, and the input and protection circuits. Always check that the power supplies are free of ac oscillations using an oscilloscope.

## Self-Test Procedures

### Power-On Self-Test

Each time the meter 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-test performs checks 601, 625, and 626.

### Complete Self-Test

Hold the shift key for 5 seconds while turning on the power to perform a complete self-test. The meter beeps when the test starts. The tests are performed in the order shown below.

### Performing Individual Tests

You can perform individual self-tests through the SYStem menu and TEST command. At the parameter level, you can choose to TEST ALL or scroll through a list of test numbers. All numbered tests are looped to give a continuous pass/fail indication when started from the menu (they will repeat the test until interrupted).

- 601**      **Front panel does not respond** The main CPU U500 attempts to establish serial communications with the front panel processor U602. During this test, U602 turns on all display segments. Communication must function in both directions for this test to pass. If this error is detected during power-up self-test, the meter will beep twice. This error is only readable from the remote interface.
- 602**      **RAM read/write failed** This test writes and reads a 55<sub>h</sub> and AA<sub>h</sub> checkerboard pattern to each address of ram U503. Any incorrect readback will cause a test failure.
- 603**      **A / D sync stuck** The main CPU issues an A / D sync pulse to U500 and U501 to latch the value in the ADC slope counters. A failure is detected when a sync interrupt is not recognized and a subsequent time-out occurs.
- 604**      **A / D slope convergence failed** The input amplifier is configured to the measure zero (MZ) state 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.

Chapter 6 Service  
**Self-Test Procedures**

- 605 Cannot calibrate rundown gain** This test checks the nominal gain between the integrating ADC and the U500 on-chip 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 on-chip ADC. The nominal gain is check to  $\pm 10\%$  tolerance.
- 607 Rundown too noisy** This test checks the gain repeatability between the integrating ADC and the U500 on-chip ADC. The gain test (606) is performed eight times. Gain noise must be less than  $\pm 64$  lsb's of the U500 on-chip ADC.
- 608 Serial configuration readback failed** This test re-sends the last 9 byte serial configuration data to all the serial path (SERDAT, SERBCK, SERCLK). The data is then clocked back into U501 and compared against the original 9 bytes sent. A failure occurs if the data do not match. This tests checks the serial data path through U501, U101, U150, and U601 through U606.
- 609 DC gain X1 failed** This test configures for the 10 V range. The dc amplifier gain is set to X1. The measure customer (MC) input is connected to the internal TSENSE source which produces 0.6 volts. A 20 ms ADC measurement is performed and checked against a limit of  $0.6\text{ V} \pm 0.3\text{ V}$ .
- 610 DC gain X10 failed** This test configures for the 1 V range. The dc amplifier gain is set to X10. The measure customer (MC) input is connected to the internal TSENSE source which produces 0.6 volts. A 20 ms ADC measurement is performed and checked against a limit of  $0.6\text{ V} \pm 0.3\text{ V}$ .
- 611 DC gain X100 failed** This test configures for the 100 mV range. The dc amplifier gain is set to X100. The measure customer (MC) input is created from the 1mA current source and 20mV Ohms Clamp circuit with the inputs open. A 20 ms ADC measurement is performed and checked against a limit of  $20\text{ mV} \pm 11\text{ mV}$ .



Chapter 6 Service  
Self-Test Procedures

- 613 Ohms 5  $\mu$ A source failed** This test configures the 10 V range with the internal 499  $\Omega$  test resistor (R109) connected across the input. the 5  $\mu$ A current source is connected. A 40 ms ADC measurement is performed and the result is checked against a limit of 0.0025 V  $\pm$ 0.001 V.
- 614 Ohms 10  $\mu$ A source failed** This test configures the 10 V range with the internal 499  $\Omega$  test resistor (R109) connected across the input. The 10  $\mu$ A current source is connected. A 40 ms ADC measurement is performed and the result is checked against a limit of 0.005 V  $\pm$ 0.0015 V.
- 615 Ohms 100  $\mu$ A source failed** This test configures the 10 V range with the internal 499  $\Omega$  test resistor (R109) connected across the input. The 100  $\mu$ A current source is connected. A 40 ms ADC measurement is performed and the result is checked against a limit of 0.05 V  $\pm$ 0.01 V.
- 616 Ohms 1 mA source failed** This test configures the 10 V range with the internal 499  $\Omega$  test resistor (R109) connected across the input. The 1 mA current source is connected. A 40 ms ADC measurement is performed and the result is checked against a limit of 0.5 V  $\pm$ 0.1 V.
- 617 Ohms 10 mA source failed** This test configures the 10 V range with the internal 499  $\Omega$  test resistor (R109) connected across the input. The 10 mA current source is connected. A 40 ms ADC measurement is performed and the result is checked against a limit of 5 V  $\pm$ 1 V.
- 618 Ohms 20 mV voltage clamp failed** This test configures the 10 V range. The 10 mA current source is connected into an open circuit and the 20 mV ohms clamp voltage is selected and measured. The result is checked for 20 mV  $\pm$ 10 mV.
- 619 Ohms 100 mV voltage clamp failed** This test configures the 10 V range. The 10 mA current source is connected into an open circuit and the 100 mV ohms clamp voltage is selected and measured. The result is checked for 85 mV  $\pm$ 35 mV.
- 620 Ohms 500 mV voltage clamp failed** This test configures the 10 V range. The 10 mA current source is connected into an open circuit and the 500 mV ohms clamp voltage is selected and measured. The result is checked for 425 mV  $\pm$ 175 mV.

Chapter 6 Service  
**Self-Test Procedures**

- 621 Low impedance DC gain X100 failed** This test configures the 100 mV range. The 10 mA current source is connected into an open circuit and the 20 mV ohms clamp voltage is selected and measured. The input gain is set to X100 through U307B, RP1A pin 2, and U303C/D. The result is checked to 20 mV  $\pm$ 11 mV.
- 622 High impedance DC gain X100 failed** This test configures the 100 mV range. The 10 mA current source is connected into an open circuit and the 20 mV ohms clamp voltage is selected and measured. The input gain is set to X100 through U307B, U102C pin 14, U102C pin 31, and U304D. The result is checked to 20 mV  $\pm$ 11 mV.
- 623 Cannot calibrate precharge** This test configures to the 1 V range with the input internally grounded. The ADC is configured for 200 ms measurements. The U500 pulse width modulated (PWM) DAC output (C512) is set to about 4 volts. 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 volts and the precharge offset is measured again. The gain of the offset adjustment is calculated. This test assures a precharge amplifier offset 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 meter will assume a 50 Hz line operation for all future measurements.
- 625 I/O processor did 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. If this condition is detected at power-on self-test, the meter will beep and the error annunciator will be on.
- 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.
- 627 Hardware overload comparator failed** This test configures the 10 V range. The +18 V power supply is internally applied to the input. The overload comparator (U311A/B) bit is checked for an overload condition (bit set to 0). Only the positive comparator is checked.
- 630 Bias current DAC failed** This test configures the 1 V range with the input internally grounded through R227. The bias current DAC, U301, is then programmed to both extremes and a measurement taken at each. A check is made to ensure that 0 V is between the two measurements.

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## Replaceable Parts

## Replaceable Parts

This chapter contains information ordering replacement parts for your meter. The parts lists are divided into the following four groups.

- Input Connector Replaceable Parts
- Main PC Assembly, 34420-66501
- Display and Keyboard PC Assembly, 34420-66502
- Mainframe Parts List

Parts are listed in alphanumeric order according to their schematic reference designators. The parts lists include a brief description of the part with applicable Agilent part numbers and manufacturer part number.

## To Order Replace Parts

You can order replaceable parts from Agilent using the Agilent part number or directly from the manufacturer using the manufacturer's part number. To order replaceable parts from Agilent, do the following:

- 1 Contact your nearest Agilent Sales Office or Agilent Service Center.
- 2 Identify the parts by the Agilent 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.

### **Input Connector Replaceable Parts**

Use the following Agilent Technologies part numbers to obtain replacement input connectors and cables. Contact your nearest Agilent Technologies Sales Office for replaceable parts.

<b>Agilent Part Number</b>	<b>Description</b>
34104A	Low thermal input connector (blank)
34103A	Low thermal 4-wire shorting plug
34102A	Low thermal input connector and 4 foot cable with spade lugs.

You can obtain additional DeoxIT™, part number D100L2, from:  
CAIG Laboratories, Inc.  
16744 West Bernardo Drive  
San Diego, CA 92172-1904

Chapter 7 Replaceable Parts  
34420-66501 Main PC Assembly

34420-66501 Main PC Assembly

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr Code	Mfr Part Number
C101 - C106	0160-7439	6	CAP-FXD 47pF +-5% 500 V CER COG	04222	12067A470JAT A
C107	0160-6497	36	CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C201 - C202	0160-5968	2	CAP-FXD 82pF 50 V	04222	08051A820JAT A
C203	0160-5963	1	CAP-FXD 18pF 50 V	04222	08055A180JAT A
C204	0160-5967	6	CAP-FXD 100pF 5%	04222	08055A101JAT A
C205	0160-5947	5	CAP-FXD 1000pF 50 V	04222	08055C102KAT A
C206	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C207	0160-6670	2	CAP 3300pF 50V 5% COG 1210	04222	12105A332JATRA
C208	0160-5967		CAP-FXD 100pF 5%	04222	08055A101JAT A
C209	0160-5947		CAP-FXD 1000pF 50 V	04222	08055C102KAT A
C211 - C212	0160-5950	3	CAP-FXD 470pF 50 V	04222	08055A471JAT A
C220	0160-6736	5	CAP-FXD 0.01uF 50 V	04222	12065C103KAT A
C221	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C301	0160-5945	2	CAP-FXD 0.01uF 50 V	04222	08055C103KAT A
C302	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C303	0160-3839	1	CAPACITOR-FXD 2.2 UF	04222	TAJB225M020
C306	0160-5344	1	CAP .082uF 100V 5% POLYCARB METALLIZED	84411	HEW-249
C307	0180-3975	3	CAP-FXD 2.2uF 20 V TA	04222	TAJB225M020
C308	0160-5945		CAP-FXD 0.01uF 50 V	04222	08055C103KAT A
C309 - C310	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C311	0160-6670		CAP 3300pF 50V 5% COG 1210	04222	12105A332JATRA
C400 - C402	0160-5954	4	CAP 220PF 5% 50V	04222	08055A221JAT A
C403 - C404	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C407 - C410	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C411	0180-3744	1	TANT SMD 4.7 20%	04222	TAJB475M010
C441 - C442	0160-6736		CAP-FXD 0.01uF 50 V	04222	12065C103KAT A
C449	0160-6736		CAP-FXD 0.01uF 50 V	04222	12065C103KAT A
C451	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C452	0160-5954		CAP 220PF 5% 50V	04222	08055A221JAT A
C453	0160-7260	1	CAP-FXD 22pF 500 V	04222	12107C222KAT A
C454	0160-8051	1	CAP-FXD 1.5uF +-10% 160 V POLYE-MET	54217	MKS4 1.5uF 160V 10%
C500 - C503	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C504	0160-6736		CAP-FXD 0.01uF 50 V	04222	12065C103KAT A
C506	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C512	0180-4228	2	CAP-FXD 47uF 10 V TA	04222	TAJD476M010
C551	0180-4433	2	CAP-FXD 1000uF +-20% 50 V AL-ELCTLT	54217	KME50VB102M16X25MCV
C552	0180-3751	5	CAP-FXD 1uF 35 V TA	04222	TAJB105M035

Chapter 7 Replaceable Parts  
34420-66501 Main PC Assembly

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr Code	Mfr Part Number
C553	0180-4433		CAP-FXD 1000uF +-20% 50 V AL-ELCTLT	54217	KME50VB102M16X25MCV
C554	0180-3751		CAP-FXD 1uF 35 V TA	04222	TAJB105M035
C555	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C556	0180-4435	1	CAP-FXD 2200uF +-20% 25 V AL-ELCTLT	54217	KME25VB222M16X25MCV
C557	0180-4116	2	CAP-FXD 22uF 20 V TA	04222	TAJD226M020
C558	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C559	0180-4116		CAP-FXD 22uF 20 V TA	04222	TAJD226M020
C560 - C561	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C601	0160-5947		CAP-FXD 1000pF 50 V	04222	08055C102KAT A
C602	0160-5967		CAP-FXD 100pF 5%	04222	08055A101JAT A
C603	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C604	0160-5947		CAP-FXD 1000pF 50 V	04222	08055C102KAT A
C605 - C606	0160-5967		CAP-FXD 100pF 5%	04222	08055A101JAT A
C607	0160-5947		CAP-FXD 1000pF 50 V	04222	08055C102KAT A
C608	0160-5967		CAP-FXD 100pF 5%	04222	08055A101JAT A
C609 - C611	0160-5944	3	CAP-FXD 0.047uF 50 V	04222	08055C473KAT A
C613 - C614	0160-7437	2	CAP 220pF 500V 5% COG 1206	04222	CC1206C0G221J500LR
C615	0180-3975		CAP-FXD 2.2uF 20 V TA	04222	TAJB225M020
C616 - C617	0180-4287	2	CAP-FXD 10uF 35 V TA	04222	TAJD106M035
C618	0180-3751		CAP-FXD 1uF 35 V TA	04222	TAJB105M035
C619 - C621	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C622	0180-3975		CAP-FXD 2.2uF 20 V TA	04222	TAJB225M020
C700 - C703	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C704	0160-6729	1	CAP. FIXED. CER./CHIP	04222	12065C332KAT A
C705	0160-5950		CAP-FXD 470pF 50 V	04222	08055A471JAT A
C706	0180-4228		CAP-FXD 47uF 10 V TA	04222	TAJD476M010
C707 - C711	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C751	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C752	0180-4434	1	CAP-FXD 4700uF +-20% 25 V AL-ELCTLT	54217	KME25VB472M18X35LL
C753	0180-3751		CAP-FXD 1uF 35 V TA	04222	TAJB105M035
CR101 - CR102	1902-1572	5	DIODE-ZNR 15V 5% TO-236 (SOT-23) PD=.35W	25403	BZX84C15L
CR120 - CR121	1906-0337	3	DIODE-DUAL 60V 200MA TO-253	25403	BAS56
CR201	1906-0334	4	DIODE- 200V 200MA	07263	MMBF4393
CR301	1902-1512	3	DIODE-ZNR 7.5V 5% PD=.155W TC=+5.3MV IR=	25403	BZX84C7V5
CR302 - CR303	1902-1572		DIODE-ZNR 15V 5% TO-236 (SOT-23) PD=.35W	25403	BZX84C15L
CR304	1906-0334		DIODE- 200V 200MA	07263	MMBF4393
CR305	1902-1565	1	DIODE-ZNR 4.7V 5% TO-236 (SOT-23)	25403	BZX84-C4V7
CR306	1906-0337		DIODE-DUAL 60V 200MA TO-253	25403	BAS56
CR307	1902-1572		DIODE-ZNR 15V 5% TO-236 (SOT-23) PD=.35W	25403	BZX84C15L

Chapter 7 Replaceable Parts  
34420-66501 Main PC Assembly

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr Code	Mfr Part Number
CR308	1902-1512		DIODE-ZNR 7.5V 5% PD=.155W TC=+5.3MV IR=	25403	BZX84C7V5
CR401 - CR402	1902-1541	2	DIODE-ZNR 3.3V 5% TO-236 (SOT-23)	25403	BZX84C3V3
CR403 - CR404	1906-0291	11	DIODE- 70V 100MA	04713	MBAV99
CR451	1906-0334		DIODE- 200V 200MA	07263	MMBF4393
CR452	1902-1512		DIODE-ZNR 7.5V 5% PD=.155W TC=+5.3MV IR=	25403	BZX84C7V5
CR453	1902-1562	1	DIO ZNR SOT23 4.3V 2% 200MW BZX84B4V3	25403	BZX84-B4V3
CR454	1906-0334		DIODE- 200V 200MA	07263	MMBF4793
CR551 - CR552	1906-0407	3	DIODE-FW BRDG 400V 1A	71744	DF04S
CR553	1906-0291		DIODE- 70V 100MA	04713	MBAV99
CR554	1902-1542	1	DIODE-ZNR 6.2V 5% TO-236 (SOT-23)	05403	BZX84C6V2
CR555 - CR556	1902-1609	2	DIODE-ZNR 6.2V 5% PD=1.5W IR=5UA	04713	1SMB5920B
CR602 - CR603	1902-1592	2	DIODE-ZNR 5.1V 5% TO-236 (SOT-23)	05403	BZX84C5V1
CR604 - CR606	1906-0291		DIODE- 70V 100MA	04713	MBAV99
CR701 - CR705	1906-0291		DIODE- 70V 100MA	04713	MBAV99
CR751	1906-0407		DIODE-FW BRDG 400V 1A	71744	DF04S
E101	1970-0214	3	TUBE TVS AX 230V 15% 20A CG2-230L	71744	CG2-230L
E102	1970-0100	2	TUBE-ELECTRON SURGE V PTCTR	23663	11484
E103 - E104	1970-0214		TUBE TVS AX 230V 15% 20A CG2-230L	71744	CG2-230L
E105	1970-0100		TUBE-ELECTRON SURGE V PTCTR	23663	11484
E700	9164-0173	1	BEEPER	51406	PKM24-4AO-1
J101	34420-81601	1	CONN/CBL ASSY F	28480	34420-81601
J601	1250-1884	3	CONNECTOR-RF BNC RCPT PC-W-STDFS 50-OHM	00779	227161-6
J701	1252-2320	1	CONN-RECT MICRORBN 24-CKT 24-CONT	22526	79432-001
J702 - J703	1250-1884		CONNECTOR-RF BNC RCPT PC-W-STDFS 50-OHM	00779	227161-6
J704	1252-2266	1	CONN-RECT D-SUBMIN 9-CKT 9-CONT	00779	748959-1
JM401	0699-1503	5	RESISTOR .05 +-100% TKF	09021	RM73Z2BT
JM551 - JM553	0699-1503		RESISTOR .05 +-100% TKF	09021	RM73Z2BT
JM751	0699-1503		RESISTOR .05 +-100% TKF	09021	RM73Z2BT
K101 - K102	0490-1789	3	RELAY 2C 5VDC-COIL 3A 220VC	01850	DS2E-SL3-5V-C-H305
K451	0490-1789		RELAY 2C 5VDC-COIL 3A 220VC	01850	DS2E-SL3-5V-C-H305
L101 - L102	9140-1278	2	L TH 68uH 10% 790MASRF 9MHZ TSL0707	06352	TSL0707-680KR73
L103	9100-1788	6	CORE-FERRITE CHOKE-WIDEBAND;IMP:680	02114	VK200 20/4B
L104	9140-1505	3	INDUCTOR 68UH +-5% 2.8W-MMX3.4LG-MM Q=30	09021	KL32TE68J
L105	9100-1788		CORE-FERRITE CHOKE-WIDEBAND;IMP:680	02114	VK200 20/4B
L106	9140-1505		INDUCTOR 68UH +-5% 2.8W-MMX3.4LG-MM Q=30	09021	KL32TE68S
L107 - L109	9100-1788		CORE-FERRITE CHOKE-WIDEBAND;IMP:680	02114	VK200 20/4B
L401 - L403	9170-1431	4	CORE-SHIELDING BEAD	06352	HF50ACB-453215
L404	9170-1506	1	CORE-SHIELDING BEAD	06352	HF50ACB201209



Chapter 7 Replaceable Parts  
34420-66501 Main PC Assembly

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr Code	Mfr Part Number
L451	9140-1505		INDUCTOR 68UH +-5% 2.8W-MMX3.4LG-MM Q=30	09021	KL32TE68J
L501	9170-1431		CORE-SHIELDING BEAD	06352	HF50ACB-453215
L601	9100-1788		CORE-FERRITE CHOKE-WIDEBAND;IMP:680	02114	VK200 20/4B
MP1 - MP2	0380-0643	2	STANDOFF-HEX .255-IN-LG 6-32-THD	2L446	02685
MP3	2190-0577	1	WASHER- NO. 10 .194-IN-ID .294-IN-OD	20859	03118
P500	1252-4484	1	CONN-POST TYPE 2.0-PIN-SPCG 12-CONT	27264	52007-1210
P551	1252-4488	1	CONN-POST TYPE .156-PIN-SPCG 8-CONT	27264	26-64-4080
P751	1252-4487	1	CONN-POST TYPE .156-PIN-SPCG 3-CONT	27264	26-64-4030
Q120	1855-0715	3	TRANSISTOR	04713	MMBF4393
Q121 - Q122	1855-0863	8	TRANSISTOR J-FET P-CHAN D-MODE TO-236AA	27014	MMBF5461SEL
Q123	1854-1053	1	TRANSISTOR PD=350MW	04713	MMBT2222A
Q124	1853-0525	2	TRANSISTOR PD=200MW FT=200MHZ	04713	MMBT2907A
Q125 - Q126	1855-0954	9	XSTR JFET N SEL T092 CULEADS 35V SNJ7229	13349	SNJ7229
Q127	1855-0715		TRANSISTOR	04713	MMBF4393
Q128 - Q129	1855-0863		TRANSISTOR J-FET P-CHAN D-MODE TO-236AA	27014	MMBF5461SEL
Q130	1855-0954		XSTR JFET N SEL T092 CULEADS 35V SNJ7229	13349	SNJ7229
Q132 - Q133	1855-0863		TRANSISTOR J-FET P-CHAN D-MODE TO-236AA	27014	MMBF5461SEL
Q134	1855-0954		XSTR JFET N SEL T092 CULEADS 35V SNJ7229	13349	SNJ7229
Q201 - Q205	1855-0954		XSTR JFET N SEL T092 CULEADS 35V SNJ7229	13349	SNJ7229
Q206	1855-0865	2	TRANSISTOR J-FET N-CHAN D-MODE TO-236AA	27014	MMBF4117A
Q301	1854-1014	7	TRANSISTOR PD=350MW FT=100MHZ	04713	MMBT6429
Q302 - Q304	1853-0568	3	TRANSISTOR PD=350MW FT=40MHZ	56289	TMPT5087
Q305 - Q309	1854-1014		TRANSISTOR PD=350MW FT=100MHZ	04713	MMBT6429
Q310	1855-0752	3	TRANSISTOR J-FET N-CHAN D-MODE TO-236AA	27014	MMBF4392
Q311	1855-0715		TRANSISTOR	04713	MMBF4393
Q451 - Q452	1855-0752		TRANSISTOR J-FET N-CHAN D-MODE TO-236AA	27014	MMBF4392
Q453	1855-0865		TRANSISTOR J-FET N-CHAN D-MODE TO-236AA	27014	MMBF4117A
Q454	1854-1014		TRANSISTOR PD=350MW FT=100MHZ	04713	MMBT6429
Q455	1853-0700	1	TRANSISTOR PNP SI TO-92 PD=625MW	27014	6292/62547A
Q456	1855-0863		TRANSISTOR J-FET P-CHAN D-MODE TO-236AA	27014	MMBF5461SEL
Q457	1853-0525		TRANSISTOR PD=200MW FT=200MHZ	04713	MMBT2907A
Q458	1855-0863		TRANSISTOR J-FET P-CHAN D-MODE TO-236AA	27014	MMBF5461SEL
Q459 - Q462	1853-0727	4	TRANSISTOR PNP SI SOT-23 (TO-236AB)	04713	MMBT6520L
R101	0699-1327	5	RESISTOR 1M +-1% .125W TKF TC=0+-100	09021	RK73H2BT1004F
R103 - R104	0699-1327		RESISTOR 1M +-1% .125W TKF TC=0+-100	09021	RK73H2BT1004F
R105	0699-1330	17	RESISTOR 100K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1003F
R106	0699-2433	12	RESISTOR 25.5K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2552F
R107	0699-1330		RESISTOR 100K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1003F

Chapter 7 Replaceable Parts  
34420-66501 Main PC Assembly

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr Code	Mfr Part Number
R108	0699-2433		RESISTOR 25.5K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2552F
R109	0699-1939	4	RESISTOR 499 +-1% .125W TKF TC=0+-100	91637	CRCW1206F
R121	0699-1386	6	RESISTOR 5.62K +-1% .125W TKF TC=0+-100	09021	RK73H2BT5621F
R122	0699-1330		RESISTOR 100K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1003F
R123	0699-1327		RESISTOR 1M +-1% .125W TKF TC=0+-100	09021	RK73H2BT1004F
R124 - R125	0699-1330		RESISTOR 100K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1003F
R126 - R127	0699-1391	14	RESISTOR 10K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1002F
R128	0699-2433		RESISTOR 25.5K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2552F
R129	0699-1334	11	RESISTOR 301K 1% 1206 .125W TC=100 200V	09021	RK73H2BT3013F
R130	0699-1380	3	RESISTOR 3.16K +-1% .125W TKF TC=0+-100	09021	RK73H2BT3161F
R131 - R132	0699-1330		RESISTOR 100K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1003F
R133	0699-2433		RESISTOR 25.5K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2552F
R134	0699-1334		RESISTOR 301K 1% 1206 .125W TC=100 200V	09021	RK73H2BT3013F
R135	0699-2433		RESISTOR 25.5K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2552F
R136	0699-1334		RESISTOR 301K 1% 1206 .125W TC=100 200V	09021	RK73H2BT3013F
R137	0699-1386		RESISTOR 5.62K +-1% .125W TKF TC=0+-100	09021	RK73H2BT5621F
R138	0699-2631	8	RESISTOR 2K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2001F
R201	0699-1391		RESISTOR 10K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1002F
R202	0699-2433		RESISTOR 25.5K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2552F
R203	0699-1330		RESISTOR 100K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1003F
R204	0699-2433		RESISTOR 25.5K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2552F
R205	0699-1329	4	RESISTOR 6.19K +-1% .125W TKF TC=0+-100	09021	RK73H2BT6191F
R206	0699-1402		RESISTOR 25.5K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2552F
R207	0699-2156	6	RESISTOR 20K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2002F
R208	0699-1329		RESISTOR 6.19K +-1% .125W TKF TC=0+-100	09021	RK73H2BT6191F
R209	0699-3001	2	RESISTOR 215K +-1% .1W TKF TC=0+-100	09021	RK73H2A2153F
R210	0699-2631		RESISTOR 2K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2001F
R211	0699-3004	2	RESISTOR 316K +-1% .1W TKF TC=0+-100	09021	RK73H2A3163F
R212	0699-2433		RESISTOR 25.5K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2552F
R213	0699-3004		RESISTOR 316K +-1% .1W TKF TC=0+-100	09021	RK73H2A3163F
R214	0699-2433		RESISTOR 25.5K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2552F
R215 - R216	0699-1423	17	RESISTOR 215 +-1% .125W TKF TC=0+-100	09021	RK73H2BT2150F
R217	0699-1318	14	RESISTOR 1K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1001F
R218 - R220	0699-1423		RESISTOR 215 +-1% .125W TKF TC=0+-100	09021	RK73H2BT2150F
R221	0699-1334		RESISTOR 301K 1% 1206 .125W TC=100 200V	09021	RK73H2BT3013F
R222 - R223	0699-1391		RESISTOR 10K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1002F
R224	0699-1466	3	RESISTOR 10M 10% 1206 .125W 200V TC=200	19701	RM73B2BT106J
R226	0699-1466		RESISTOR 10M 10% 1206 .125W 200V TC=200	19701	RM73B2BT106J
R227	0699-2902	2	RESISTOR 100M 10% SMT 1206 .25W TC=250	11502	CR1206-F-100M-10%

Chapter 7 Replaceable Parts  
34420-66501 Main PC Assembly

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr Code	Mfr Part Number
R301	0699-1408	4	RESISTOR 51.1K +-1% .125W TKF TC=0+-100	09021	RK73H2BT5112F
R302	0699-2156		RESISTOR 20K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2002F
R303	0699-1412	1	RESISTOR 75K +-1% .125W TKF TC=0+-100	09021	RK73H2BT7502F
R304	0699-1422	1	RESISTOR 196 +-1% .125W TKF TC=0+-100	09021	RK73H2BT1960F
R305	0699-1466		RESISTOR 10M 10% 1206 .125W 200V TC=200	19701	RM73B2BT106J
R306	0699-2490	2	RESISTOR 1K +0.1% .125W TF TC=0+-25	11502	W1206R031001BT
R307	0699-1785	2	RESISTOR 13.3K +-1% .125W TKF TC=0+-100	91637	CRCW1206F
R308	0699-2490		RESISTOR 1K +0.1% .125W TF TC=0+-25	11502	W1206R031001BT
R309 - R310	0699-2631		RESISTOR 2K +-1% .125W TKF TC=0+-100	09201	RK73H2BT2001F
R311 - R312	0699-2835	2	RESISTOR 500 +-0.1% .125W TF TC=0+-25	11502	W1206R035000BT
R313	0699-1434	1	RESISTOR 619 +-1% .125W TKF TC=0+-100	09201	RK73H2BT6190F
R314	0699-2127	2	RESISTOR 36.5K +-1% .125W TKF TC=0+-100	09201	RK73H2BT3652F
R315	0699-1402	1	RESISTOR 30.1K 1% 1206 .125W 200V TC=100	09201	RK73H2BT3012F
R316	0699-1939		RESISTOR 499 +-1% .125W TKF TC=0+-100	91637	CRCW1206F
R317	0699-2844	1	RESISTOR 13.7K 0.1% 1206 SMT .125W TC=25	11502	W1206R031372BT
R318	0699-2846	1	RESISTOR 5K +0.1% .125W TF TC=0+-25	11502	W1206R035001BT
R319	0699-1334		RESISTOR 301K 1% 1206 .125W TC=100 200V	09201	RK73H2BT3013F
R320	0699-2035	1	RESISTOR 715 +-1% .125W TKF TC=0+-100	91637	CRCW1206F
R321	0699-1939		RESISTOR 499 +-1% .125W TKF TC=0+-100	91637	CRCW1206F
R322	0699-2631		RESISTOR 2K +-1% .125W TKF TC=0+-100	09201	RK73H2BT2001F
R323	0699-2156		RESISTOR 20K +-1% .125W TKF TC=0+-100	09201	RK73H2BT2002F
R324	0699-1409	1	RESISTOR 56.2K +-1% .125W TKF TC=0+-100	09201	RK73H2BT5622F
R325	0699-2156		RESISTOR 20K +-1% .125W TKF TC=0+-100	09201	RK73H2BT2002F
R327	0699-1408		RESISTOR 51.1K +-1% .125W TKF TC=0+-100	19701	9C12063AFKR
R328	0699-1415	7	RESISTOR 100 +-1% .125W TKF TC=0+-100	09201	RK73H2BT1000F
R329	0699-1440	1	RESISTOR 121K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1213F
R330	0699-1334		RESISTOR 301K 1% 1206 .125W TC=100 200V	09201	RK73H2BT3013F
R331	0699-2156		RESISTOR 20K +-1% .125W TKF TC=0+-100	09201	RK73H2BT2002F
R332	0699-3045	11	RESISTOR 5.11K +-1% .1W TKF TC=0+-100	09201	RK73H2A5111F
R333	0699-1334		RESISTOR 301K 1% 1206 .125W TC=100 200V	09201	RK73H2BT3013F
R334	0699-1402		RESISTOR 30.1K 1% 1206 .125W 200V TC=100	09201	RK73H2BT3012F
R335	0699-1329		RESISTOR 6.19K +-1% .125W TKF TC=0+-100	09201	RK73H2BT6191F
R336	0699-1939		RESISTOR 499 +-1% .125W TKF TC=0+-100	91637	CRCW1206F
R337	0699-1386		RESISTOR 5.62K +-1% .125W TKF TC=0+-100	09201	RK73H2BT5621F
R338	0699-3001		RESISTOR 215K +-1% .1W TKF TC=0+-100	09201	RK73H2A2153F
R339	0699-2902		RESISTOR 100M 10% SMT 1206 .25W TC=250	11502	CR1206-F-100M-10%
R340	0699-3045		RESISTOR 5.11K +-1% .1W TKF TC=0+-100	09201	RK73H2A5111F
R403	0699-1389	3	RESISTOR 8.25K +-1% .125W TKF TC=0+-100	09201	RK73H2BT8251F
R405	0699-1380		RESISTOR 3.16K +-1% .125W TKF TC=0+-100	09201	RK73H2BT3161F

Chapter 7 Replaceable Parts  
34420-66501 Main PC Assembly

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr Code	Mfr Part Number	
R406	0699-1330	1	RESISTOR 100K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1003F	
R407 - R408	0699-1318		RESISTOR 1K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1001F	
R409	0699-1372		RESISTOR 1.47K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1471F	
R420	0699-1389		RESISTOR 8.25K +-1% .125W TKF TC=0+-100	09201	RK73H2BT8251F	
R421	0699-1318		RESISTOR 1K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1001F	
R422	0699-1360		RESISTOR 46.4 +-1% .125W TKF TC=0+-100	09201	RK73H2BT46R4F	
R440	0699-1406		2	RESISTOR 42.2K +-1% .125W TKF TC=0+-100	09201	RK73H2BT04222F
R441	0699-1785			RESISTOR 13.3K +-1% .125W TKF TC=0+-100	91637	CRCW1206F
R442	0699-2127		RESISTOR 36.5K +-1% .125W TKF TC=0+-100	09201	RK73H2BT3652F	
R449	0699-1415		RESISTOR 100 +-1% .125W TKF TC=0+-100	09201	RK73H2BT1000F	
R451	0699-1386		RESISTOR 5.62K +-1% .125W TKF TC=0+-100	09201	RK73H2BT5621F	
R452 - R453	0699-1408		RESISTOR 51.1K +-1% .125W TKF TC=0+-100	19701	9C12063AFKR	
R454	0699-1318		RESISTOR 1K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1001F	
R455	0699-2433		RESISTOR 25.5K +-1% .125W TKF TC=0+-100	09201	RK73H2BT2552F	
R456	0699-2631	RESISTOR 2K +-1% .125W TKF TC=0+-100	09201	RK73H2BT2001F		
R457	0699-1319	1	RESISTOR 12.1K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1212F	
R458	0699-2433		RESISTOR 25.5K +-1% .125W TKF TC=0+-100	09201	RK73H2BT2552F	
R459	0699-2631		RESISTOR 2K +-1% .125W TKF TC=0+-100	09201	RK73H2BT2001F	
R460	0699-1330		RESISTOR 100K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1003F	
R461	0699-2431	2	RESISTOR 3.32K +-1% .125W TKF TC=0+-100	09201	RK73H2BT3321F	
R462	0699-2433		RESISTOR 25.5K +-1% .125W TKF TC=0+-100	09201	RK73H2BT2552F	
R463 - R465	0699-1330	RESISTOR 100K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1003F		
R466	0699-2631	RESISTOR 2K +-1% .125W TKF TC=0+-100	09201	RK73H2BT2001F		
R467	0699-1327	RESISTOR 1M +-1% .125W TKF TC=0+-100	09201	RK73H2BT1004F		
R468	0699-1391	RESISTOR 10K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1002F		
R469	0699-1329	RESISTOR 6.19K +-1% .125W TKF TC=0+-100	09201	RK73H2BT6191F		
R470 - R471	0699-1330	RESISTOR 100K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1003F		
R472	0699-1374	2	RESISTOR 1.78K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1781F	
R473	0699-2156		RESISTOR 20K +-1% .125W TKF TC=0+-100	09201	RK73H2BT2002F	
R474	0699-3045		RESISTOR 5.11K +-1% .1W TKF TC=0+-100	09201	RK73H2A5111F	
R501	0699-1318		RESISTOR 1K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1001F	
R502	0699-1330	RESISTOR 100K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1003F		
R503	0699-1423	RESISTOR 215 +-1% .125W TKF TC=0+-100	09201	RK73H2BT2150F		
R504	0699-3045	RESISTOR 5.11K +-1% .1W TKF TC=0+-100	09201	RK73H2A5111F		
R505 - R506	0699-1386	RESISTOR 5.62K +-1% .125W TKF TC=0+-100	09201	RK73H2BT5621F		
R507	0699-1391	RESISTOR 10K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1002F		
R508 - R509	0699-1318	RESISTOR 1K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1001F		
R510 - R511	0699-1391	RESISTOR 10K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1002F		
R512	0699-1318	RESISTOR 1K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1001F		

Chapter 7 Replaceable Parts  
34420-66501 Main PC Assembly

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr Code	Mfr Part Number
R513 - R517	0699-1423		RESISTOR 215 +-1% .125W TKF TC=0+-100	09201	RK73H2BT2150F
R518	0699-1391		RESISTOR 10K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1002F
R519	0699-3045		RESISTOR 5.11K +-1% .1W TKF TC=0+-100	09201	RK73H2A5111F
R551	0699-1424	1	RESISTOR 237 +-1% .125W TKF TC=0+-100	09201	RK73H2BT2370F
R552	0699-2431		RESISTOR 3.32K +-1% .125W TKF TC=0+-100	09201	RK73H2BT3321F
R553	0699-2834	1	RESISTOR 400 +-0.1% .125W TF TC=0+-25	11502	W1206R034000BT
R554	0699-3803	1	RESISTOR 5.62K +-0.1% .125W TKF TC=0+-25	11502	W1206R035621BT
R555	0699-1406		RESISTOR 42.2K +-1% .125W TKF TC=0+-100	09201	RK73H2BT04222F
R556	0699-1391		RESISTOR 10K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1002F
R559	0699-1348	1	RESISTOR 14.7 +-1% .125W TKF TC=0+-100	09201	RK73H2BT14R7F
R601 - R602	0699-1423		RESISTOR 215 +-1% .125W TKF TC=0+-100	09201	RK73H2BT2150F
R603	0699-1415		RESISTOR 100 +-1% .125W TKF TC=0+-100	09201	RK73H2BT1000F
R604 - R607	0699-1423		RESISTOR 215 +-1% .125W TKF TC=0+-100	09201	RK73H2BT2150F
R608 - R610	0699-1334		RESISTOR 301K 1% 1206 .125W TC=100 200V	09201	RK73H2BT3013F
R611	0699-2986	2	RESISTOR 21.5K +-1% .1W TKF TC=0+-100	19701	9C08052A2152FKR
R612	0699-1391		RESISTOR 10K +-1% .125W TKF TC=0+-100	09201	RK73H2BT1002F
R613	0699-1334		RESISTOR 301K 1% 1206 .125W TC=100 200V	09201	RK73H2BT3013F
R616 - R619	0699-1415		RESISTOR 100 +-1% .125W TKF TC=0+-100	09201	RK73H2BT1000F
R620	0699-1427	1	RESISTOR 316 +-1% .125W TKF TC=0+-100	09201	RK73H2BT3160F
R621	0699-3408	2	RESISTOR 1K +-5% 1W TKF TC=0+-200	2M627	MCR1001KJ
R622	0699-2156	1	RESISTOR 20K +-1% .125W TKF TC=0+-100	09201	RK73H2BT2002F
R623	0699-1389		RESISTOR 8.25K +-1% .125W TKF TC=0+-100	09201	RK73H2BT8251F
R625 - R630	0699-3045		RESISTOR 5.11K +-1% .1W TKF TC=0+-100	19701	9C08052A5111FKR
R631	0699-1391		RESISTOR 10K +-1% .125W TKF TC=0+-100	80031	9C12063AFKR
R701	0699-3408		RESISTOR 1K +-5% 1W TKF TC=0+-200	91637	CRCW2512-102J
R702	0699-2986		RESISTOR 21.5K +-1% .1W TKF TC=0+-100	19701	9C08052A2152FKR
R703	0699-1391		RESISTOR 10K +-1% .125W TKF TC=0+-100	80031	9C12063AFKR
R704	0699-1330		RESISTOR 100K +-1% .125W TKF TC=0+-100	80031	9C12063AFKR
R705	0699-1318		RESISTOR 1K +-1% .125W TKF TC=0+-100	80031	9C12063AFKR
R706	0699-3407	1	RESISTOR 100 +-5% 1W TKF TC=0+-200	91637	CRCW2512-101J
R707 - R708	0699-1318		RESISTOR 1K +-1% .125W TKF TC=0+-100	80031	9C12063AFKR
R709	0699-1380		RESISTOR 3.16K +-1% .125W TKF TC=0+-100	80031	9C12063AFKR
R720	0699-1374	1	RESISTOR 1.78K +-1% .125W TKF TC=0+-100	80031	9C12063AFKR
R750 - R751	0699-1318		RESISTOR 1K +-1% .125W TKF TC=0+-100	80031	9C12063AFKR
RP1	1810-1749	1	RESISTOR NETWORK .5%.05MW-20MW TC=5	28480	1810-1749
RV101	1901-1603	3	DIO,TVS,BIDIR,SMD,600WP,150V,SMBJ150C	71744	SMBJ150C
RV102	0837-0227	2	VARISTOR, 250V	34371	V250LAX1169
RV103 - RV104	1901-1603		DIO,TVS,BIDIR,SMD,600WP,150V,SMBJ150C	71744	SMBJ150C
RV105	0837-0227		VARISTOR, 250V	34371	V250LAX1169

7

Chapter 7 Replaceable Parts  
34420-66501 Main PC Assembly

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr Code	Mfr Part Number
SHD701	33120-00613	1	SHIELD-D CONN	28480	33120-00613
U101	1SK6-0001	1	INTEGRATED CIRCUIT; ASCI	28480	1SK6-0001
U102	1NB4-5035	1	CUST R NET PKG, REPLACES 34401-67901	28480	1NB4-5035
U110	1826-2261	1	IC TEMP XDCR PRCN SINGLE 8-PLSTC-SOIC	27014	LM35DM
U111	1826-2116	4	IC, OA, ZX, JFET, 8SO, 3MHZ, 4MV, MC34182D	04713	MC34182D
U120	1990-1753	4	SOLID STATE RELAY LED-PXSTR IF=20MA-MAX	28480	1990-1753
U121	1826-1572	1	IC COMPARATOR PRCN DUAL 8 PIN PLSTC-SOIC	18324	LM393D
U122	1990-1753	1	SOLID STATE RELAY LED-PXSTR IF=20MA-MAX	28480	1990-1753
U123	1826-1572	1	IC COMPARATOR PRCN DUAL 8 PIN PLSTC-SOIC	18324	LM393D
U124 - U125	1990-1753	1	SOLID STATE RELAY LED-PXSTR IF=20MA-MAX	28480	1990-1753
U126	1826-2979	1	IC OP AMP PRCN 8 PIN PLSTC-SOIC	27014	LTC1050CS8
U150	1820-8937	1	IC GATE-ARY CMOS	27014	SCX6B04AKP
U201 - U202	1826-1572	1	IC COMPARATOR PRCN DUAL 8 PIN PLSTC-SOIC	18324	LM393D
U203	1826-1776	1	IC OP AMP H-SLEW-RATE SINGLE 8 PIN	04713	MC34071D
U204	1826-2339	3	IC; 8-BIT 16-P-SOIC CMOS	24355	AD7524JR
U206	1826-2116	1	IC, OA, ZX, JFET, 8SO, 3MHZ, 4MV, MC34182D	04713	MC34182D
U301	1826-1458	1	D/A 8-DGT 16-P-SOIC	04713	DAC08ED
U302	1826-1813	1	IC OP AMP GP DUAL 8 PIN PLSTC-SOIC	04713	LM358D
U303	1826-1985	1	ANALOG SWITCH 4 SPST 16 -P-SOIC	17856	DG411DY
U304	1826-1609	1	ANALOG SWITCH 4 SPST 16 -P-SOIC	24355	ADG211AKR
U306	1826-2558	1	IC OP AMP WB SINGLE 8 PIN PLSTC-SOIC	04713	MC34081BD
U307	1826-2981	1	IC OP AMP PRCN DUAL 8 PIN PLSTC-SOIC	07014	LT1124CS8
U310	1826-2116	1	IC, OA, ZX, JFET, 8SO, 3MHZ, 4MV, MC34182D	04713	MC34182D
U311	1826-1572	1	IC COMPARATOR PRCN DUAL 8 PIN PLSTC-SOIC	18324	LM393D
U312	1826-2420	4	IC OP AMP LP DUAL 8 PIN PLSTC-SOIC	24355	AD706JR
U313	1826-2339	1	IC; 8-BIT 16-P-SOIC CMOS	24355	AD7524JR
U314	1826-2176	1	IC OP AMP PRCN DUAL 8 PIN PLSTC-SOIC	24355	AD712JR
U315	1855-0953	1	XSTR JFET N MTCHDPR TO78 15V SNJ3600X05	13349	SNJ3600X05
U316	1826-1848	1	IC V RGLTR-V-REF-FXD 2.475/2.525V	04713	MC1403D
U400 - U401	1826-2420	1	IC OP AMP LP DUAL 8 PIN PLSTC-SOIC	24355	AD706JR
U402	1826-1991	1	IC OP AMP HS SINGLE 8 PIN PLSTC-SOIC	24355	AD711JR
U403	1826-1249	1	IC V RGLTR-V-REF-FXD 6.8/7.1V TO-46 PKG	18324	LM399AH(SEL)
U404	1820-5937	1	IC FF CMOS/74AC D-TYPE POS-EDGE-TRIG	28480	1820-5937
U405	1813-0827	1	CLK-OSC-XTAL STD 12.000-MHZ 0.01%	28480	1813-0827
U411	1820-4346	1	IC MUXR/DATA-SEL CMOS/74HC 2-TO-1-LINE	18324	74HC4053D
U420	1826-1925	1	IC OP AMP LOW-NOISE SINGLE 8 PIN	24355	OP-27GS
U451	1826-2420	1	IC OP AMP LP DUAL 8 PIN PLSTC-SOIC	24355	AD706JR
U452	1826-1572	1	IC COMPARATOR PRCN DUAL 8 PIN PLSTC-SOIC	18324	LM393D
U500	1821-1479	1	IC MCU EMBEDDED 80C196 PLCC68S	34649	N80C196KB

Chapter 7 Replaceable Parts  
34420-66501 Main PC Assembly

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr Code	Mfr Part Number
U501	1820-8907	1	IC GATE-ARY CMOS	27014	SCX6206AK0
U502	34420-88801	1	IC-PROG OTP (BLANK=1818-5187 2 M	28480	34420-88801
U503	1818-4777	1	IC 256K-BIT SRAM 70-NS CMOS	04713	M5M5256CFP-70LL
U505	1818-5236	1	IC 4K EEPROM 500-NS CMOS	27014	NM93C66M8
U506	1990-1552	2	OPTO-ISOLATOR LED-IC GATE IF=10MA-MAX	28480	HCPL-2211-300
U551	1826-2465	1	IC V RGLTR-ADJ-POS 1.2/37V 3-TO-220 PKG	27014	LM317T-LB01
U552	1826-2463	1	IC V RGLTR-ADJ-NEG 1.2/37V 3-TO-220 PKG	27014	LM337T-LB01
U553	1826-2461	1	IC V RGLTR-FXD-POS 4.75/5.25V 5-TO-220	27014	LM2925T-LB01
U601 - U606	1820-5790	6	IC SHF-RGTR CMOS/74HC SYNCHRO SERIAL-IN	18324	74HC4094D
U607	1826-2116		IC,OA,ZX,JFET,8SO,3MHZ,4MV,MC34182D	04713	MC34182D
U608	1826-2339		IC; 8-BIT 16-P-SOIC CMOS	24355	AD7524JR
U609	1826-2400	1	IC,VCONV,SWCAP,8SO,LTC1044CS8	27014	LTC1044CS8
U610	1826-2793	1	IC DA VOUT SER 16SOL 16BIT AD1851R	24355	AD1851R
U611	1826-1783	1	IC V RGLTR-FXD-NEG -4.8/-5.2V 8-P-SOIC	27014	MC79L05ACD
U612	1826-1601	1	IC V RGLTR-V-REF-ADJ 2.5/36V 8-P-SOIC	27014	LM431ACM
U700	34401-88805	1	PROG PAL	28480	34401-88805
U701	1820-6974	1	IC-GPIB CONTROLLER IEEE-488 1975/78	01295	TMS9914AFNL
U702	1820-6176	1	IC-INTERFACE XCVR BIPOLAR BUS OCTL	01295	SN75ALS160DW
U703	1820-6175	1	IC-INTERFACE XCVR BIPOLAR BUS OCTL	01295	SN75ALS162DW
U704	1990-1552		OPTO-ISOLATOR LED-IC GATE IF=10MA-MAX	28480	1990-1552
U705	1820-6470	1	IC SCHMITT-TRIG CMOS/74HCT INV HEX	27014	MC74HCT14AD
U706	1820-7662	1	IC-INTERFACE DRVR/RCVR BIPOLAR DUAL	27014	LT1180CS
U751	1826-2464	1	IC V RGLTR-FXD-POS 4.8/5.2V 3-TO-220 PKG	27014	LM340T-5-LB01
XU403	1200-1672	1	SOCKET-IC-DIP 4-CONT DIP-SLDR	06776	SBL-041-SP122-TG30
Y701	0410-4009	1	CERO-RES 12MHZ +1-0.8%	28480	0410-4009

7

Chapter 7 Replaceable Parts  
34420-66502 Display and Keyboard PC Assembly

34420-66502 Display and Keyboard PC Assembly

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr Code	Mfr Part Number
C601	0160-5945	3	CAP-FXD 0.01uF 50 V	04222	08055C103KAT A
C602	0160-5947	3	CAP-FXD 1000pF 50 V	04222	08055C102KAT A
C603 - C605	0160-6497	10	CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C606 - C607	0160-5947		CAP-FXD 1000pF 50 V	04222	08055C102KAT A
C608 - C609	0160-5945		CAP-FXD 0.01uF 50 V	04222	08055C103KAT A
C610 - C615	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
C616 - C617	0180-3751	2	CAP-FXD 1uF 35 V TA	04222	TAJB105M035
C618	0160-6497		CAP-FXD 0.1uF 25 V	04222	12065C104KAT A
CR601	1906-0291	1	DIODE- 70V 100MA	27014	MBAV99
CR603	1902-1542	1	DIODE-ZNR 6.2V 5% TO-236 (SOT-23)	25403	BZX84C6V2
L601	9170-1431	1	CORE-SHIELDING BEAD	06352	HF50ACB-453215
M601	34401-00611	1	SHIELD-ESD	28480	34401-00611
Q601	1854-1037	1	TRANSISTOR PD=350MW FT=300MHZ	04713	TMPT3904
R602	0699-1399	2	RESISTOR 23.7K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2372F
R603	0699-1435	1	RESISTOR 681 +-1% .125W TKF TC=0+-100	09021	RK73H2BT6810F
R604	0699-1391	4	RESISTOR 10K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1002F
R605 - R608	0699-1423	4	RESISTOR 215 +-1% .125W TKF TC=0+-100	09021	RK73H2BT2150F
R609 - R610	0699-1391		RESISTOR 10K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1002F
R611 - R612	0699-1330	2	RESISTOR 100K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1003F
R613	0699-1399		RESISTOR 23.7K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2372F
R614 - R617	0699-1344	4	RESISTOR 10 +-1% .125W TKF TC=0+-100	09021	RK73H2BT10R0F
R618	0699-1378	1	RESISTOR 2.61K +-1% .125W TKF TC=0+-100	09021	RK73H2BT2611F
R619	0699-1391		RESISTOR 10K +-1% .125W TKF TC=0+-100	09021	RK73H2BT1002F
U601	1826-2264	1	IC PWR MGT-UND-V-SEN 8 PINS P-SOIC PKG	04713	MC34064D-5
U602	34401-88804	1	PGM'D 1820-8905 8BIT MCU W/4K EPROM	28480	34401-88804
U603	1820-5330	1	IC-INTERFACE DRVR BIPOLAR DISPLAY	01295	SN75518FN
U604	1820-5562	1	IC GATE CMOS/74HC NOR QUAD 2-INP	04713	MC74HC02AD
U605	1820-4966	1	IC FF CMOS/74HC D-TYPE POS-EDGE-TRIG	04713	MC74HC74AD
U606	34420-89301	1	VFD-11DIG-14SEG-BLU/GRN-CC1253G	28480	34420-89301
U607	1826-1528	1	IC COMPARATOR LP QUAD 14 PIN PLSTC-SOIC	27014	LM339M
U608	1820-6756	1	IC SHF-RGTR CMOS/74HC BIDIR	04713	MC74HC299D
U609	1826-1402	1	IC V RGLTR-FXD-POS 4.8/5.2V 8-P-SOIC PKG	04713	MC78L05ACD
W601	34401-61602	1	CABLE ASSY, 8.8L	28480	34401-61602
Y601	0410-4009	1	CERO-RES 12MHZ +1-0.8%	28480	0410-4009



Chapter 7 Replaceable Parts  
**34420A Mainframe**

**34420A Mainframe**

Reference Designator	Agilent Part Number	Qty	Part Description	Mfr Code	Mfr Part Number
A1	34420-66501	1	PCA-MAIN	28480	34420-66501
A2	34420-66502	1	PCA FRONT PANEL	28480	34420-66502
CBL1	8120-1378	1	CBL-U.S.	80126	07913-008GY
CVR1	34401-84101	1	COVER	28480	34401-84101
F1	2110-0817	1	FUSE .25A 250V	75915	239.250
FRM1	34420-80101	1	CHASSIS	28480	34420-80101
MNL1	34420-90000	1	MANUAL - STANDARD ENGLISH	28480	34420-90000
MP1	03478-88304	1	BEZEL-REAR, MLD	28480	03478-88304
MP10	9135-0484	1	POWER MODULE 2 AMP LINE FILTER	28480	9135-0484
MP11	34420-81602	1	CABLE ASSEMBLY PLUG	28480	34420-81602
MP13	9135-0485	1	FUSE DRAWER FOR POWER MODULE	28480	9135-0485
MP2	34420-40201	1	FRONT PANEL/BEZEL	28480	34420-40201
MP3	34401-43701	1	PUSH-ROD/POWER ON	28480	34401-43701
MP4	34401-86000	1	BUMPER/COVER KIT	28480	34401-86000
MP5	34401-45001	1	FRONT HANDLE	28480	34401-45001
MP6	0380-1820	1	SPACER SNAP-IN	28480	0380-1820
MP7	34420-81603	1	CONNECTING SHORTING BLK ASSY (OPT)	28480	34420-81603
MP8	34420-49301	1	WINDOW/FRONT	28480	34420-49301
MP9	34420-81902	1	KEYPAD, FLUBBER-SWITCH	28480	34420-81902
SCW1-7	0515-0433	7	SCRPHM4.0x08 TXSC	28480	0515-0433
SHD1	34420-80601	1	SHEILD FRONT	28480	34420-80601
SHD2	34420-80602	1	SHEILD-AIR	28480	34420-80602
SHD3	34420-80603	1	SHIELD FOR TRANSFORMER	28480	34420-80603
T901	9100-5174	1	POWER TRANSFORMER	28480	9100-5174

Chapter 7 Replaceable Parts  
**Manufacturer's List**

**Manufacturer's List**

<b>Mfr Code</b>	<b>Manufacturer's Name</b>	<b>Manufacturer's Address</b>	<b>Zip Code</b>
00779	AMP INC	HARRISBURG, PA, USA	17111
01295	TEXAS INSTRUMENTS INC	DALLAS, TX, USA	75265
01850	AROMAT CORP	MOUNTAINSIDE, NJ, US	07092
02114	FERROXCUBE CORP.	SAUGERTIES, NY, US	12477
04222	AVX CORP	GREAT NECK, NY, USA	11021
04713	MOTOROLA INC	ROSELLE, IL, USA	60195
06352	TDK CORP OF AMERICA	SKOKIE, IL, US	60076
06776	ROBINSON NUGENT INC	NEW ALBANY, IN, US	47150
07263	FAIRCHILD SEMICONDUCTOR CORP	CUPERTINO, CA, USA	95014
09021	KOA SPEER ELECTRONICS INC	BRADFORD, PA	16701
11502	IRC INC	CORPUS CHRISTI, TX, USA	78411
13349	INTERFET CORP	GARLAND, TX, US	75042
17856	SILICONIX INC	SANTA CLARA, CA, US	95054
18324	SIGNETICS CORP	SUNNYVALE, CA, USA	94086
19701	NORTH AMERICAN PHILLIPS CORP	NEW YORK, NY, US	10017
20859	MELLOWES CO THE	MILWAUKEE, WI	53212
22526	BERG ELECTRONICS INC	ETTERSILL, PA, US	17319
23663	JOSLYN ELECTRONIC SYSTEMS DIV.	GOLETA, CA, US	93017
24226	GOWANDA ELECTRONICS CORP	GOWANDA, NY, US	14070
24355	ANALOG DEVICES INC	NORWOOD, MA, USA	2062
25403	NV PHILIPS ELCOMA	EINDHOVEN, NE	
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA, CA, USA	95052
27264	MOLEX INC	LISLE, IL, USA	
28480	AGILENT DIV 01 SAN JOSE COMPONENTS	SAN JOSE, CA, USA	95131
34371	HARRIS CORP	MELBOURNE, FL, US	32901
34649	INTEL CORP	SANTA CLARA, CA, USA	95054
51406	MURATA CORPORATION OF AMERICA	MARIETTA, GA, USA	30067
56289	SPRAGUE ELECTRIC COMPANY	LEXINGTON, MA, US	02173
71744	GENERAL INSTRUMENT CORP	CLIFTON, NJ, USA	7012
72799	GENERAL ELECTRIC CO	FAIRFIELD, CT, US	06430
75915	LITTELFUSE INC	DES PLAINES, IL, USA	60016
76381	3M CO	ST PAUL, MN, US	55144
80031	MEPCO ELECTRA CORP	MOSSISTOWN, NJ, US	07960
84411	AMERICAN SHIZUKI CORP	CANOGA PARK, CA, US	91304
85480	BRADY WH CO	MILWAUKEE, WI, US	53209
91637	VISHAY ELECTRONIC COMPONENTS	COLUMBUS, NE, US	68601
2L446	ADAC SCREW MACHINE PRODUCTS	REDWOOD CITY, CA	94063
2M627	ROHM CORP	KYOTO 615, JP	
S4217	NIPPON CHEMI-CON CORP	OHME-SHI TOKYO, JP	

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Backdating

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## Backdating

**This chapter normally contains information necessary to adapt this manual to instruments not directly covered by the current content. At his printing, however, the manual applies to all instruments. Therefore, no information is included in this chapter.**



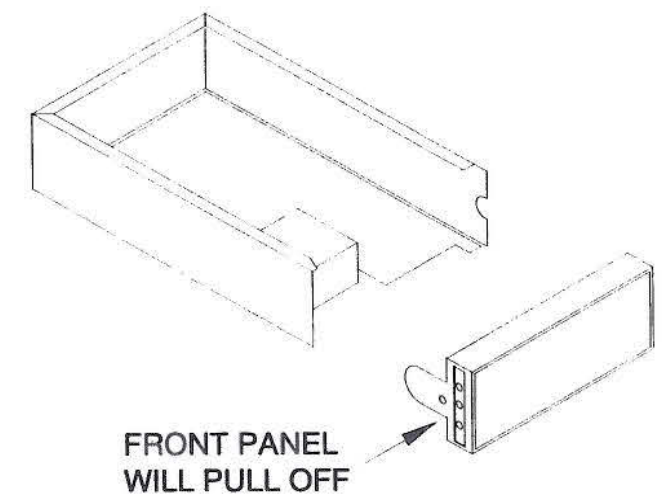
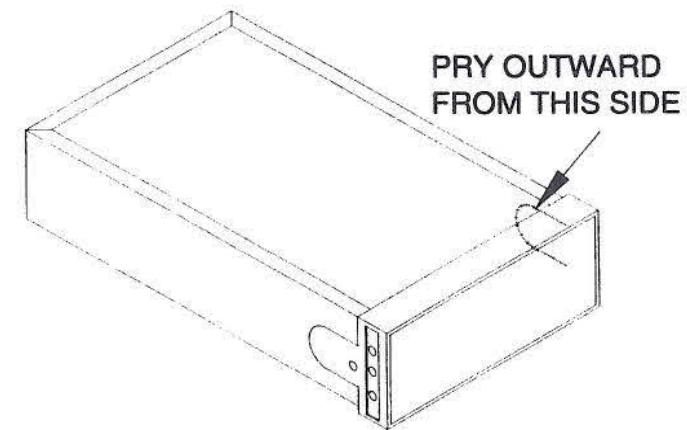
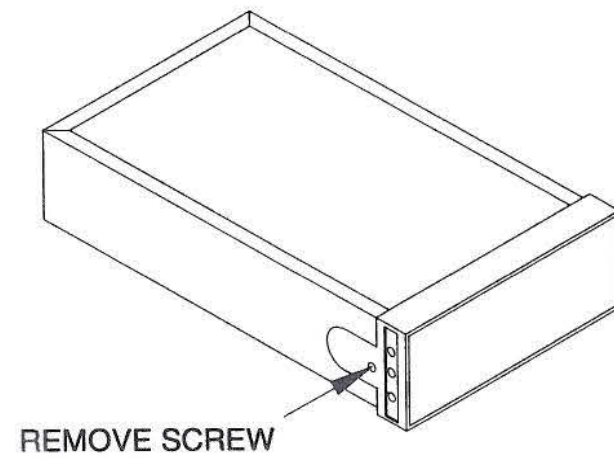
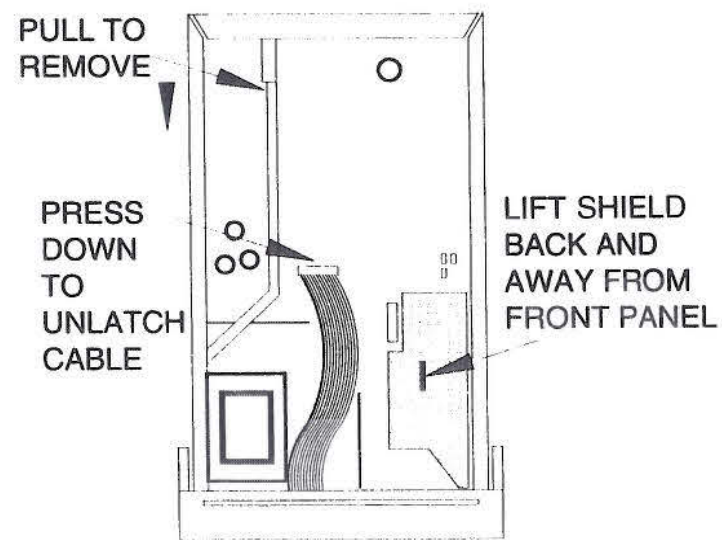
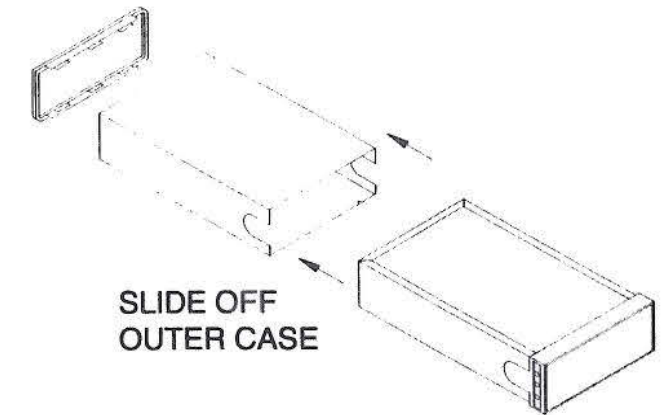
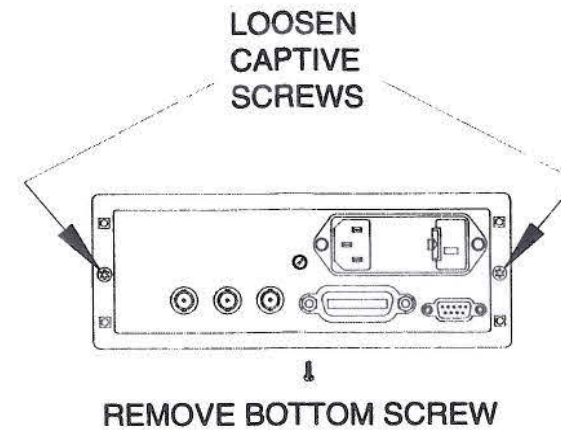
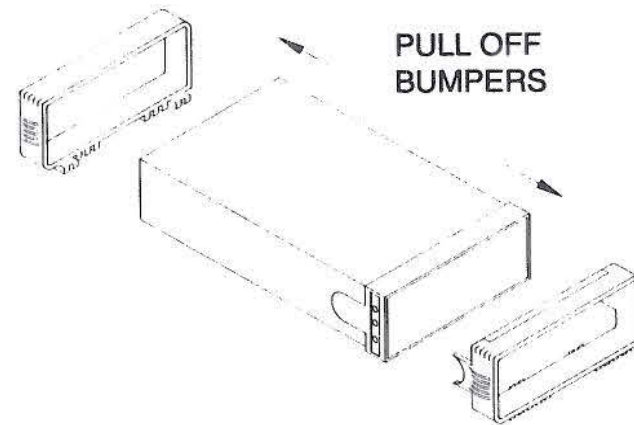
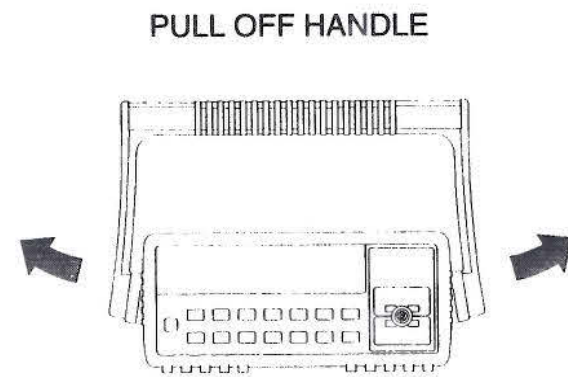
## Schematics

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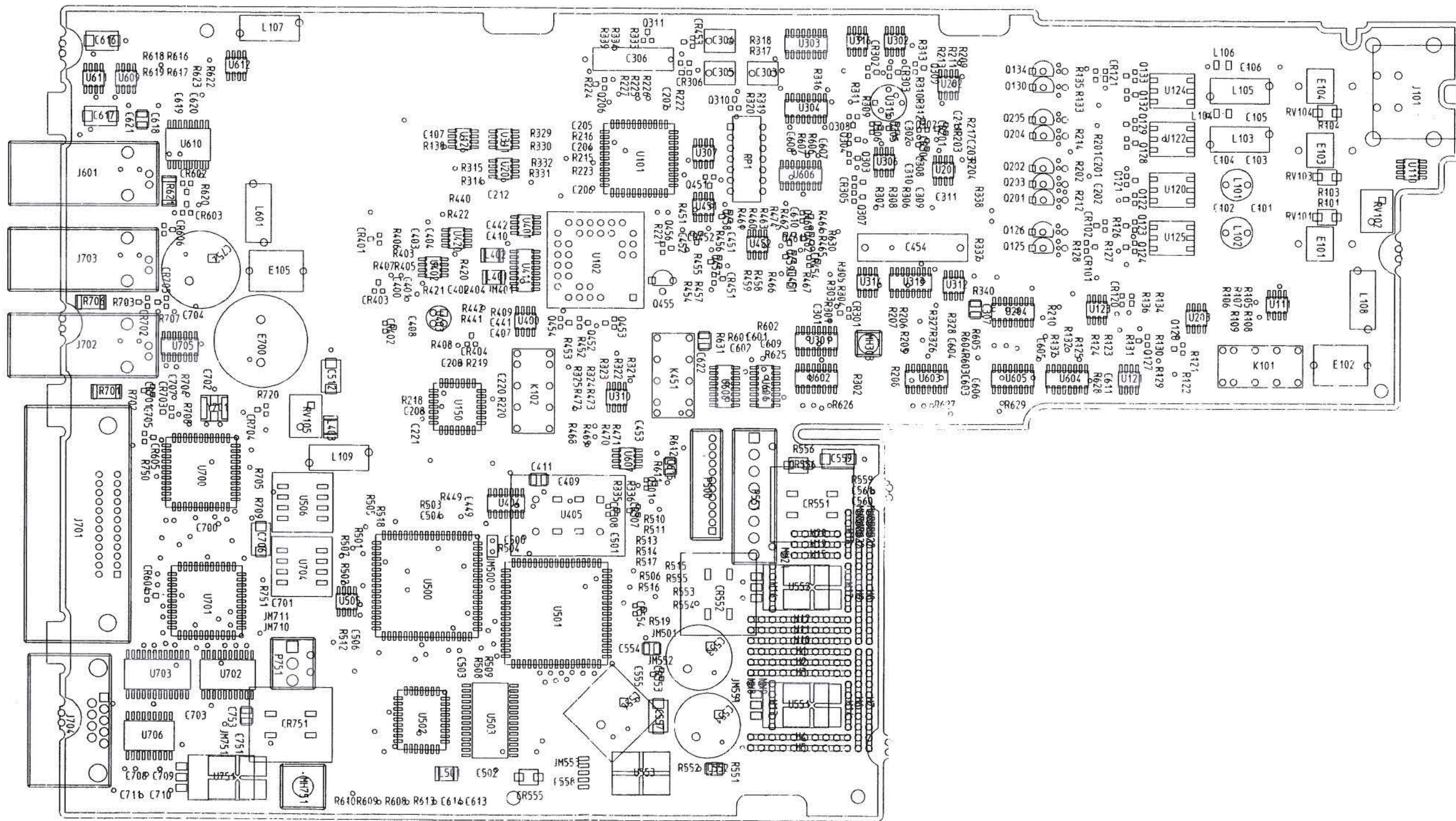
## Schematics

This chapter contains a block diagram, disassembly drawings, schematics, and component locator drawings for the meter. The block diagram and schematics support the Theory of Operations in Chapter 5.

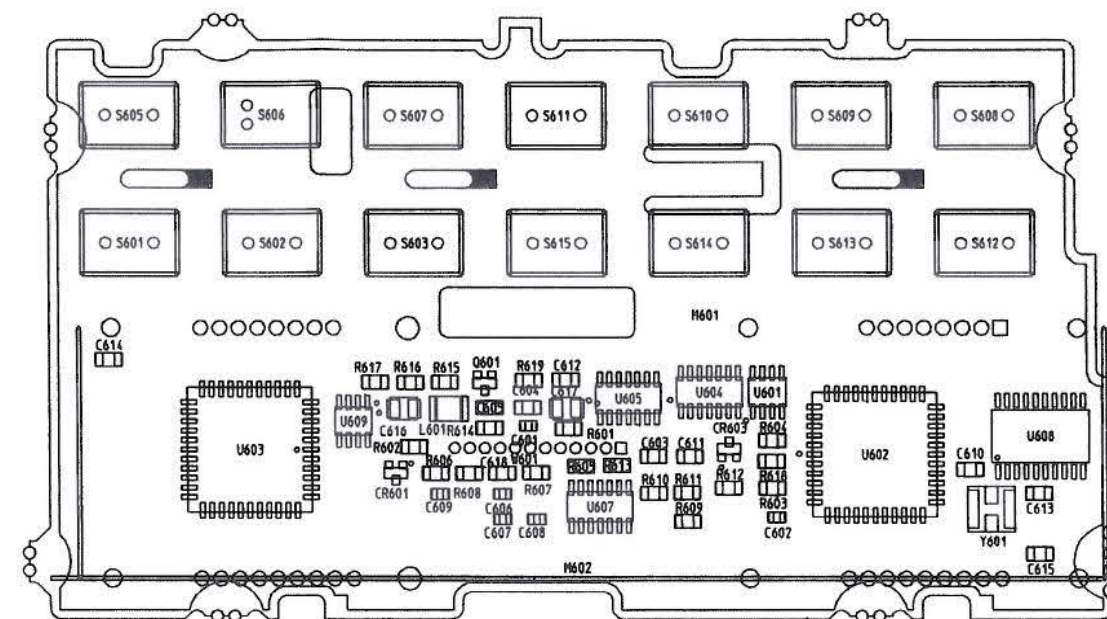
- Mechanical Disassembly, 155
- 34420-66501 Component Locator, 156
- 34420-66502 Component Locator, 157
- Agilent 34420A Block Diagram, 159
- Input and Protection Schematic, 160
- Function Switching Schematic, 161
- DC Amplifier Schematic, 162
- Ohms Current Source Schematic, 163
- A/D Converter Schematic, 164
- Configuration Data Shift Registers Schematic, 165
- Floating Logic Schematic, 166
- Earth Referenced Logic Schematic, 167
- Power Supplies Schematic, 168
- Display and Keyboard Schematic, 169



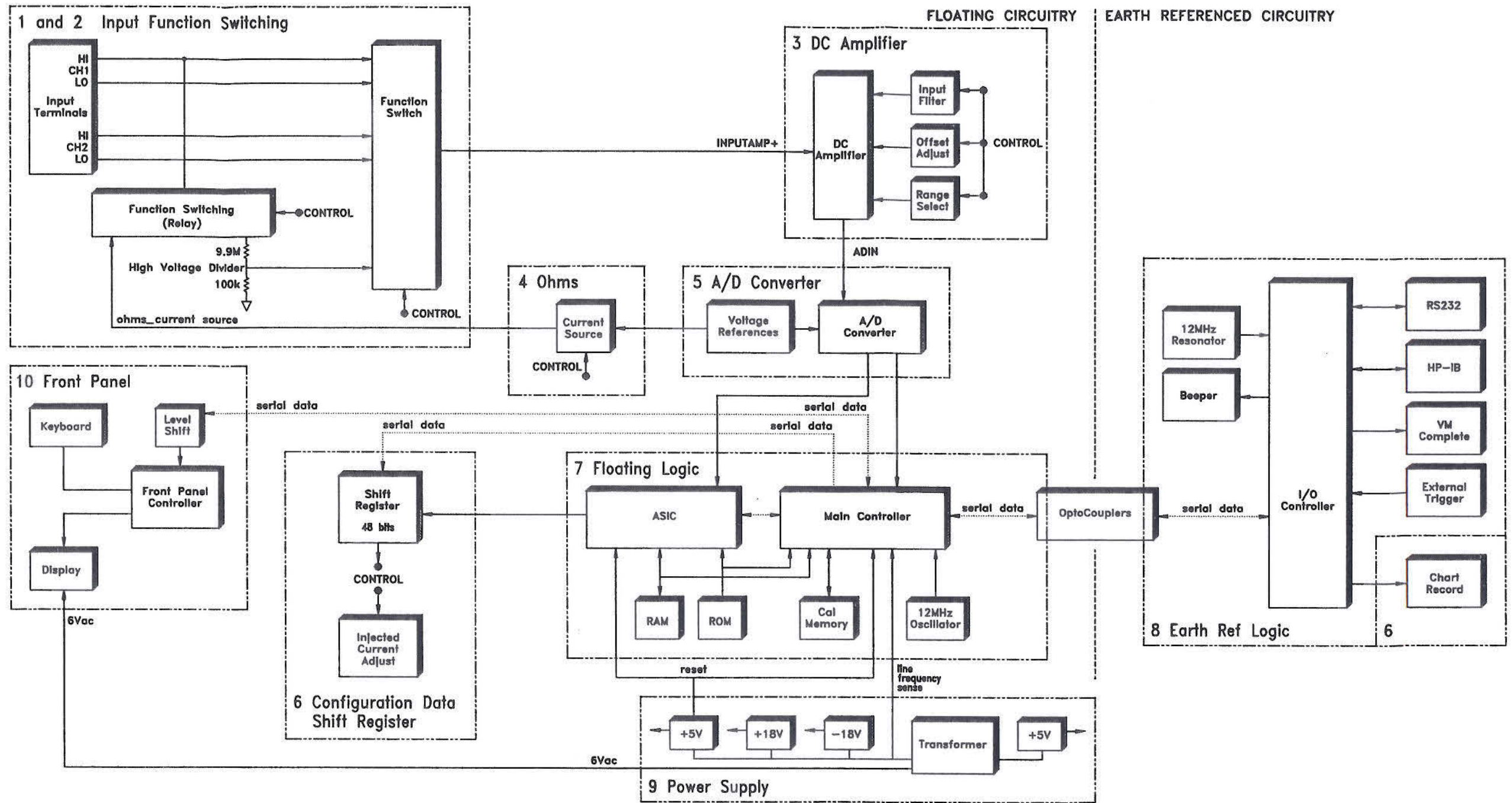


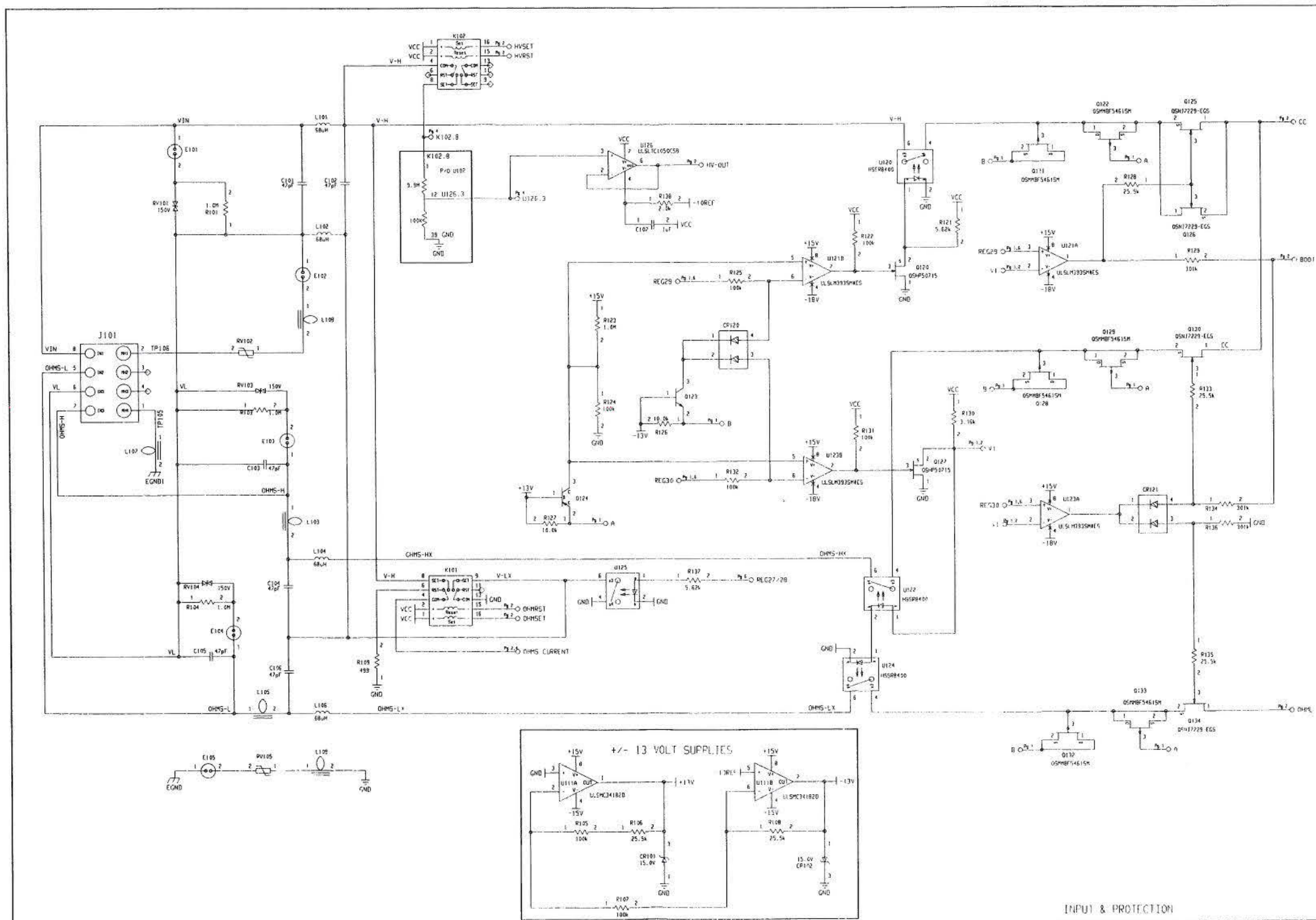




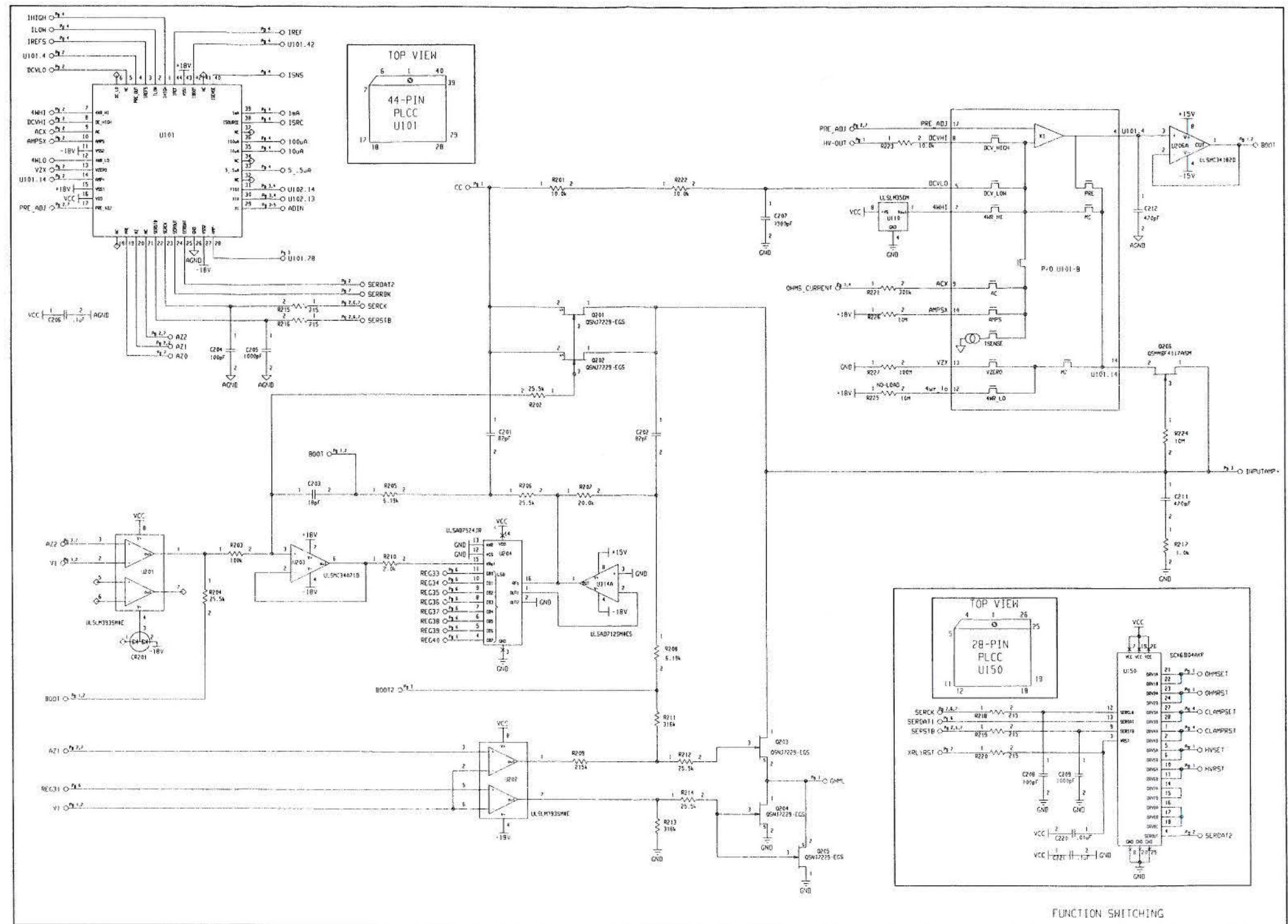


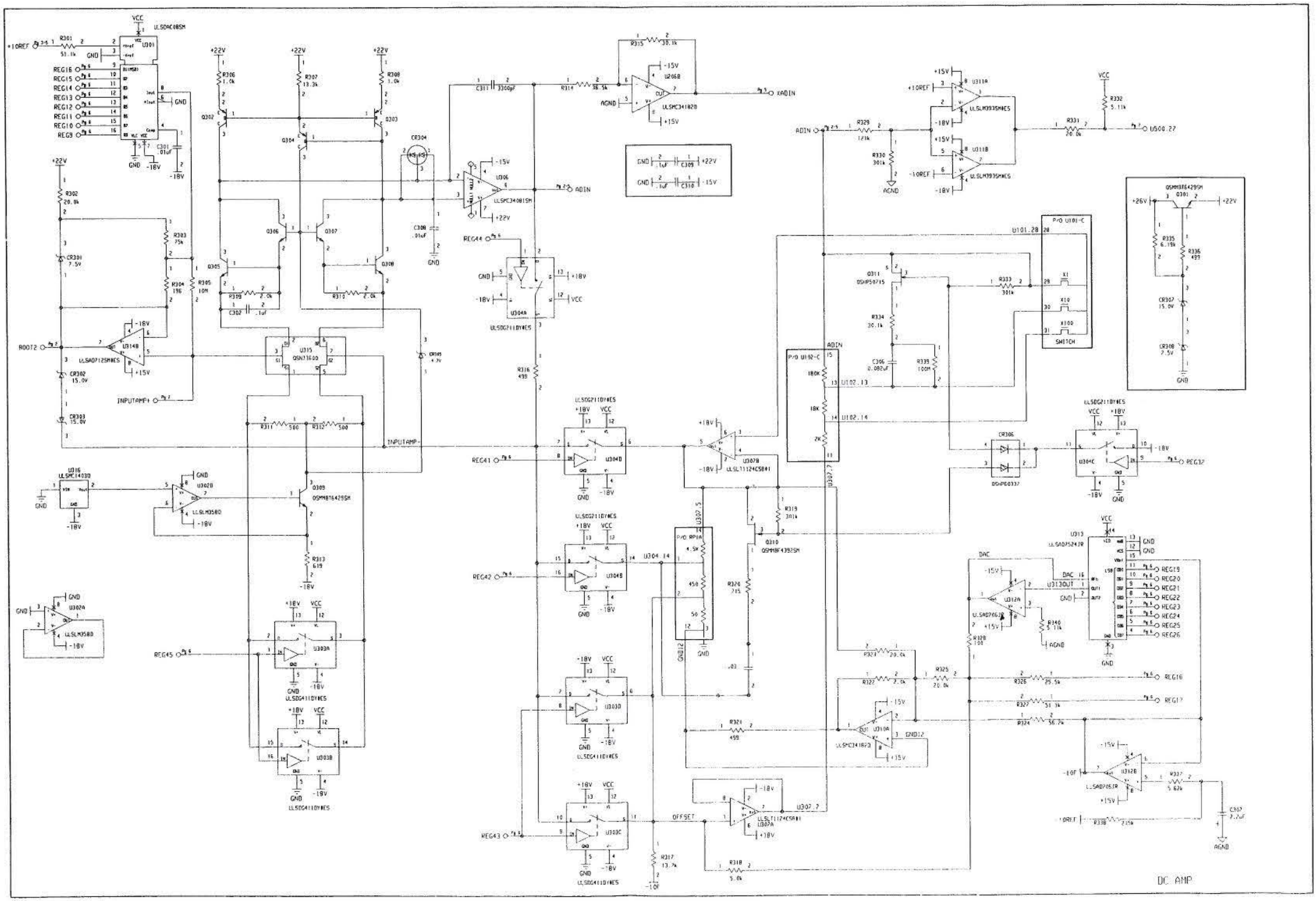


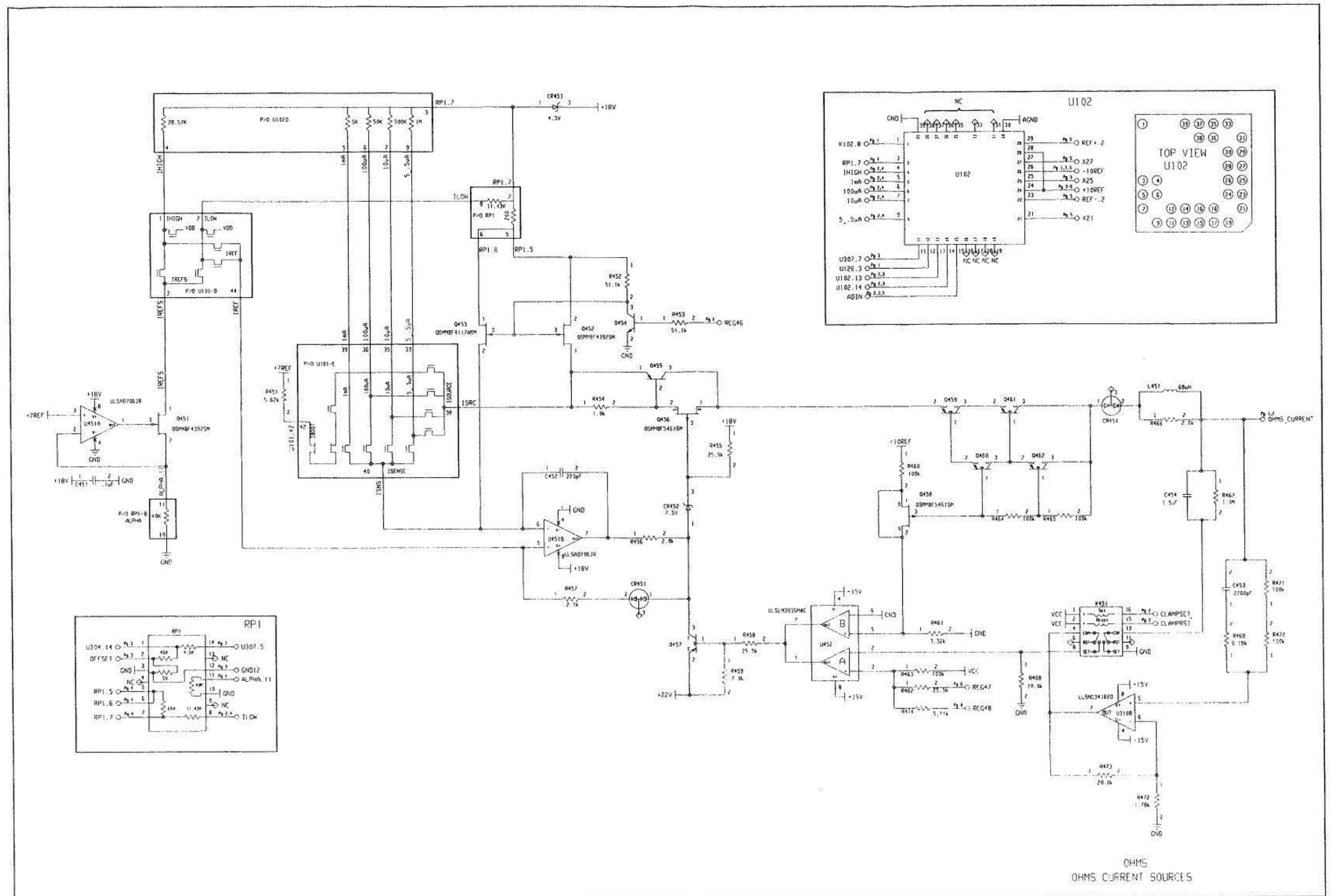






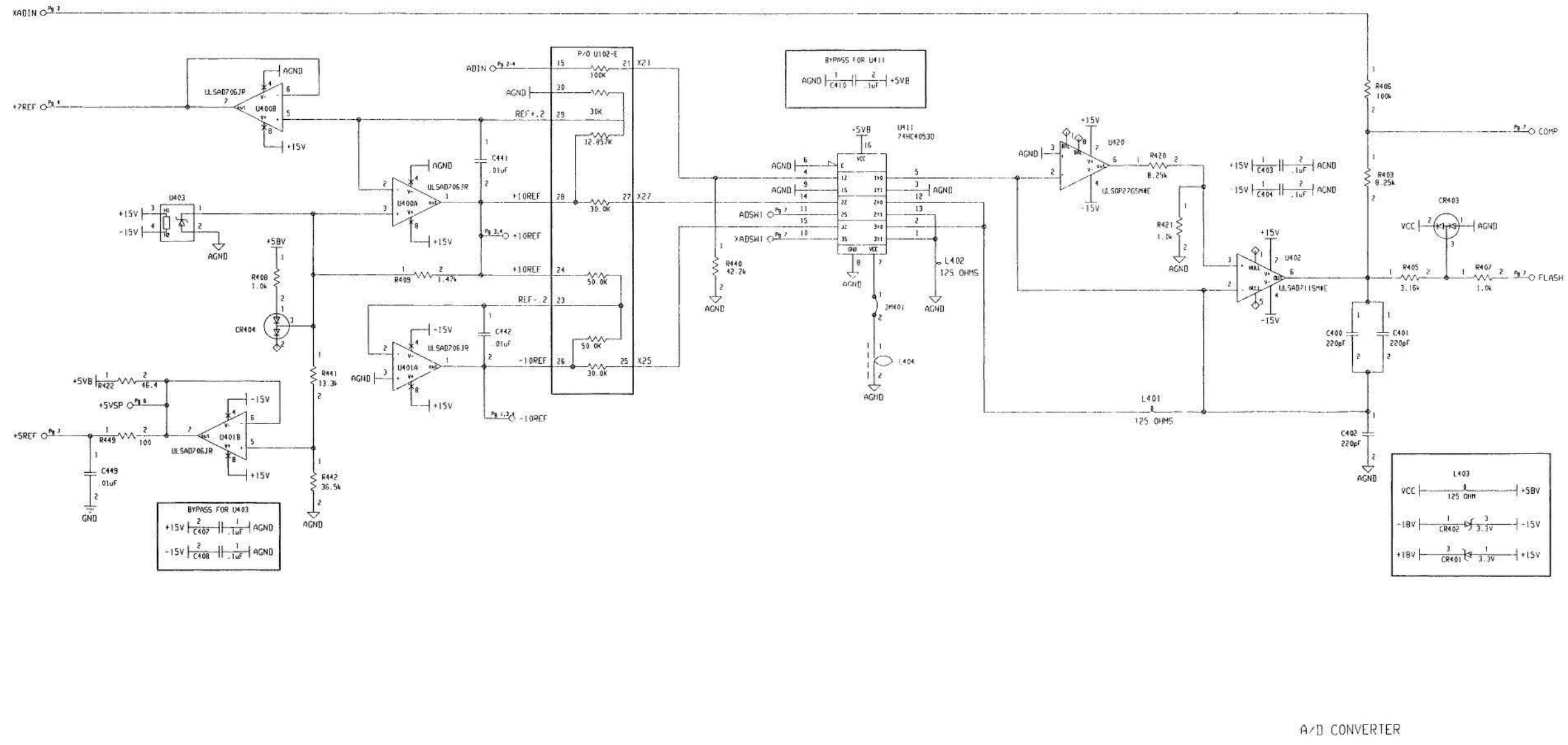






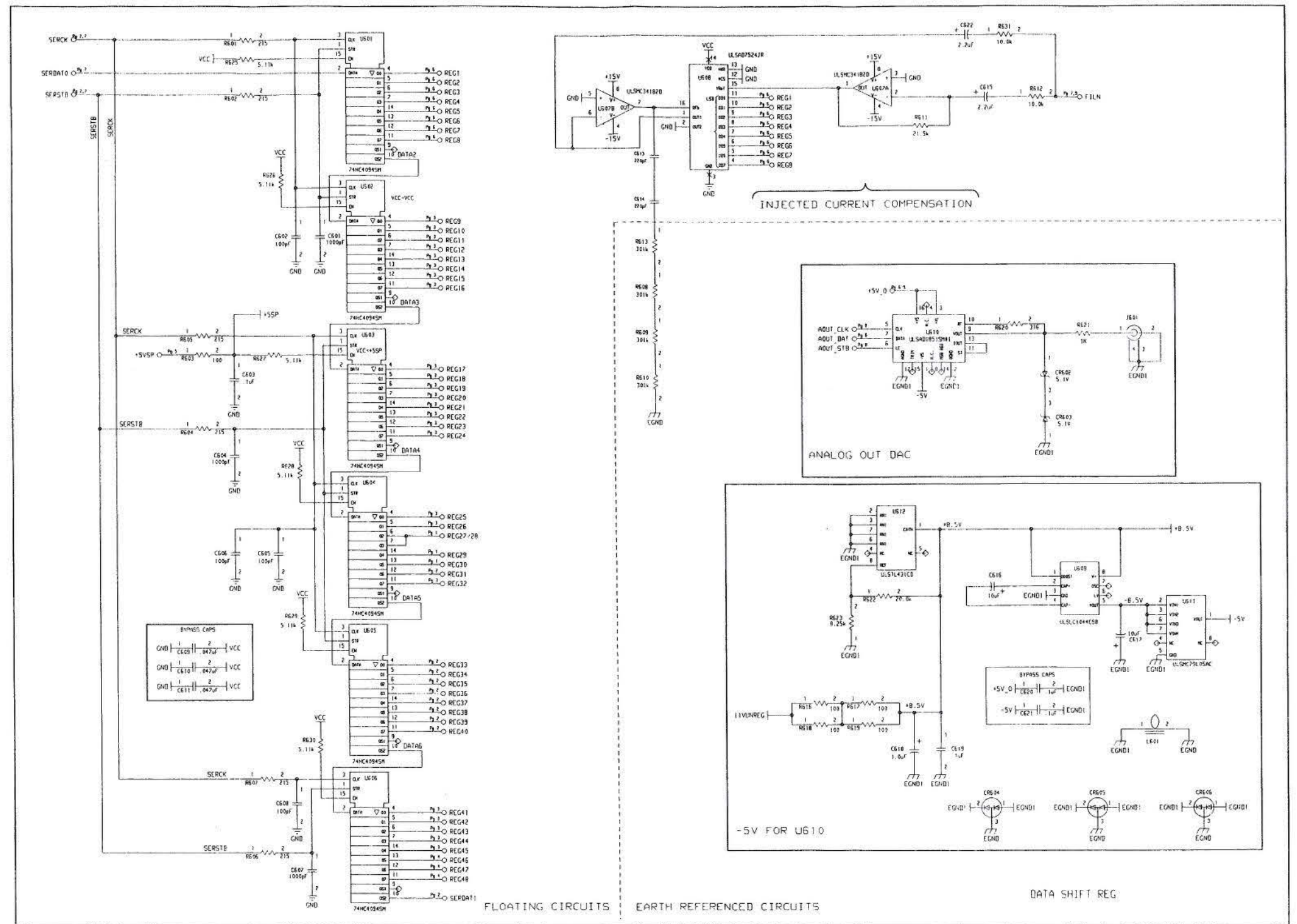


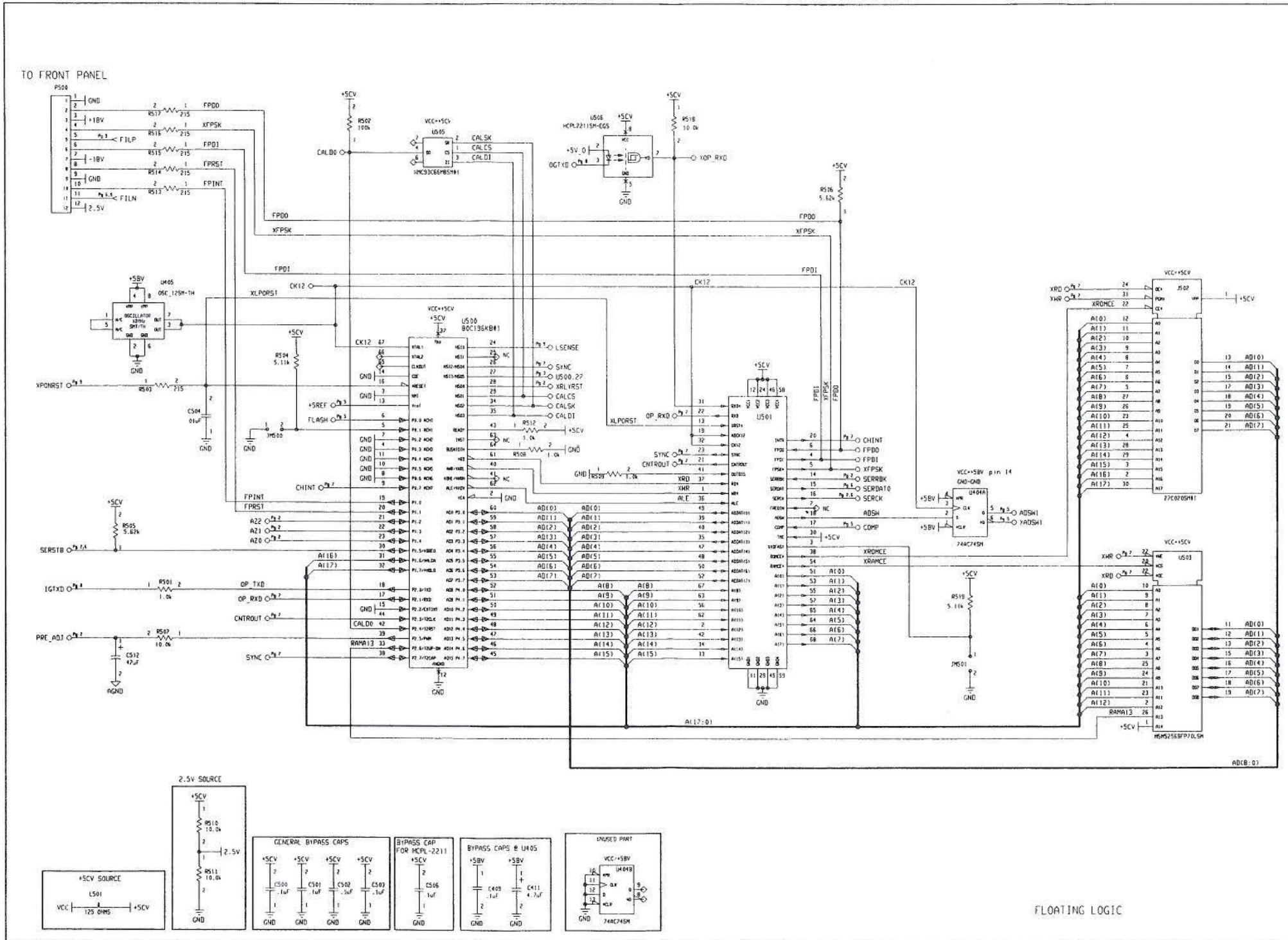
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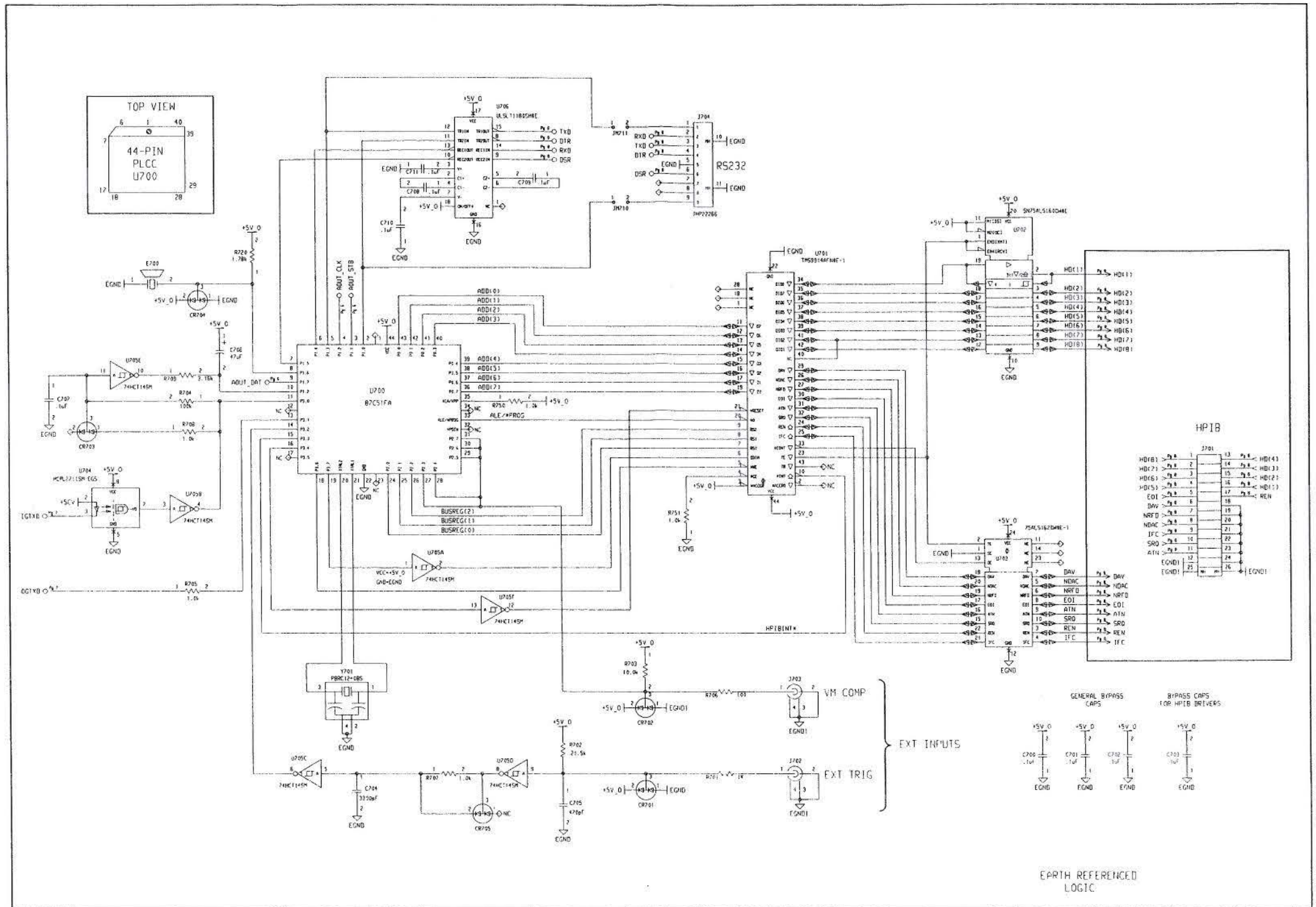
A/D CONVERTER

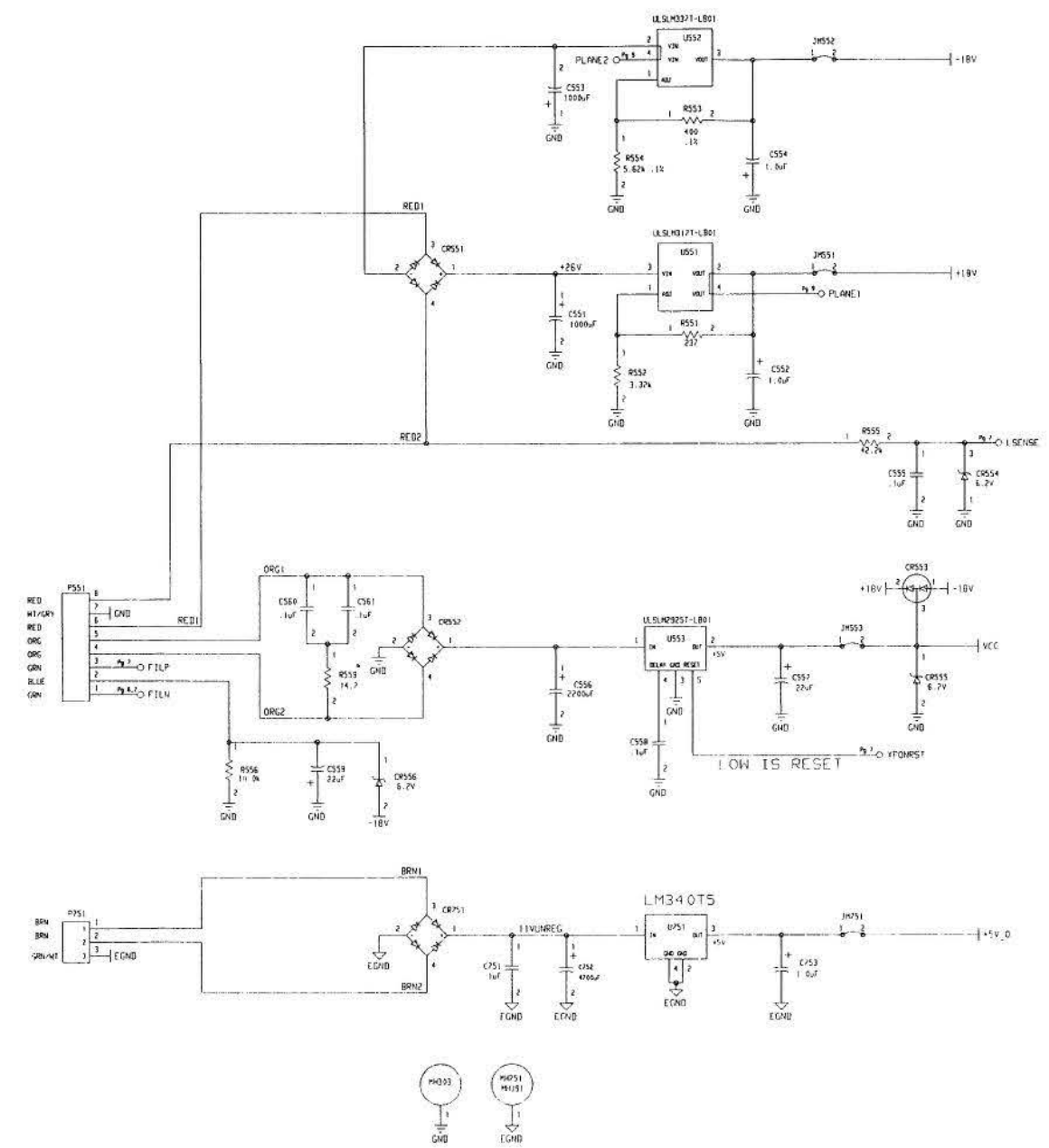
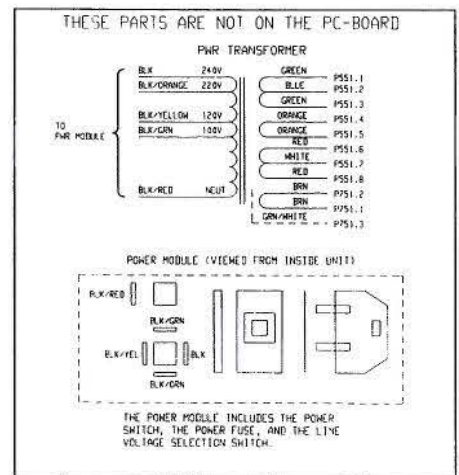




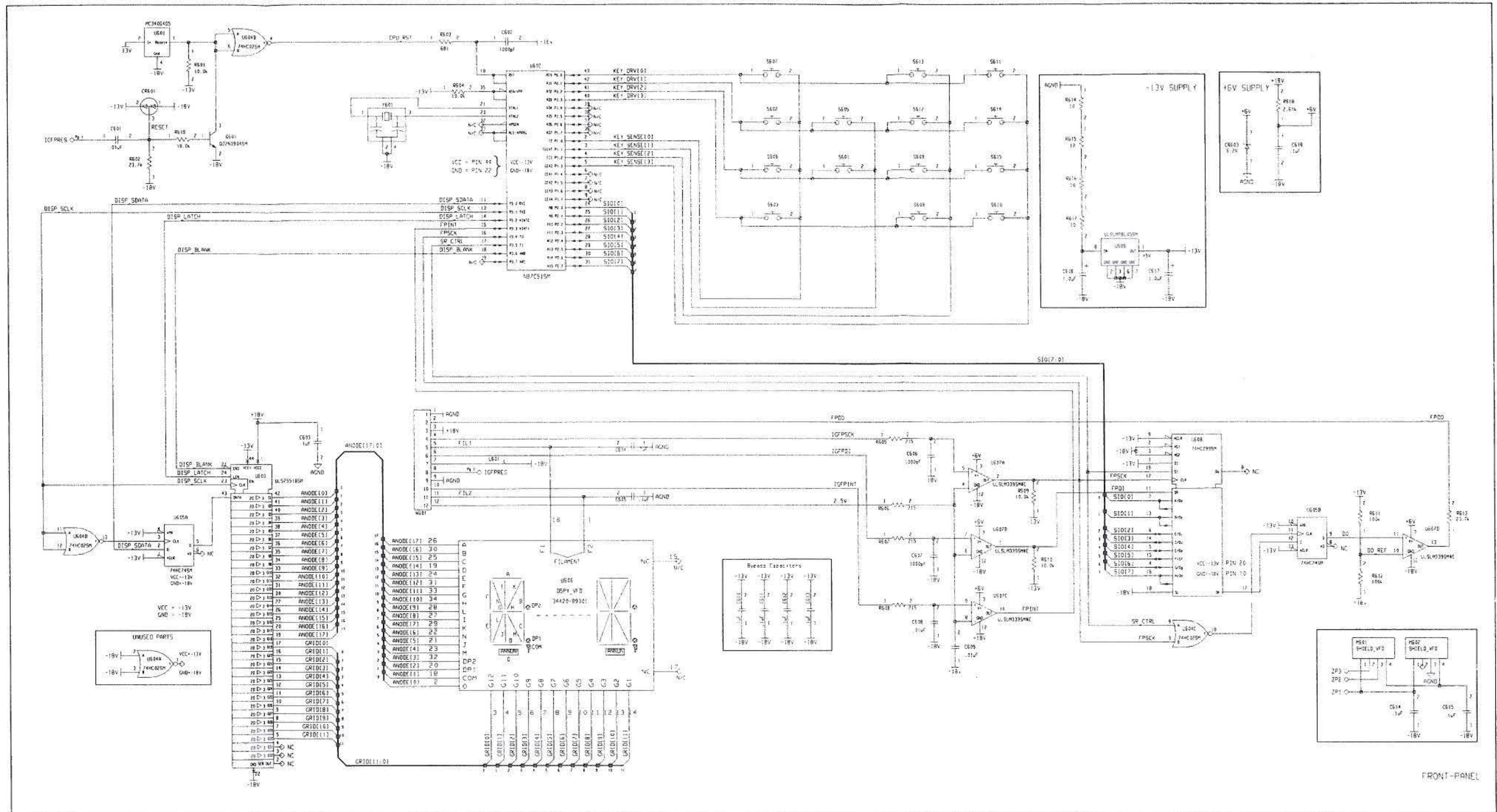








POWER SUPPLIES





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