California Instruments

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INSTRUCTION MANUAL
751L-M/ 1501L-M/ 2001L-M

Invertron®

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1. INTRODUCTION

1.1. INTRODUCTION

This instruction manual contains information on the installation, operation, calibration, and maintenance of the California Instruments Model 2001L-M/1501L-M and 751L-PT. The 2001L-M/1501L-M and 751L-M will hereafter be referred to as the AC Power Source. The difference between the 2001L-M/ 1501L-M and 751L-M will be detailed throughout the manual.

1.2. GENERAL DESCRIPTION

This instrument is a high efficiency power source that provides a low distortion sine wave output. The AC Power Source can supply up to 2000VA for the 2001L-M, 1667 VA for the 1501L-M and 835 VA for the 751L-M. See the following table for the full output VA rating.

MODEL	OUTPUT VA	
	35°C	50°C
2001L	2000	1800
1501L	1667	1500
751L	835	750

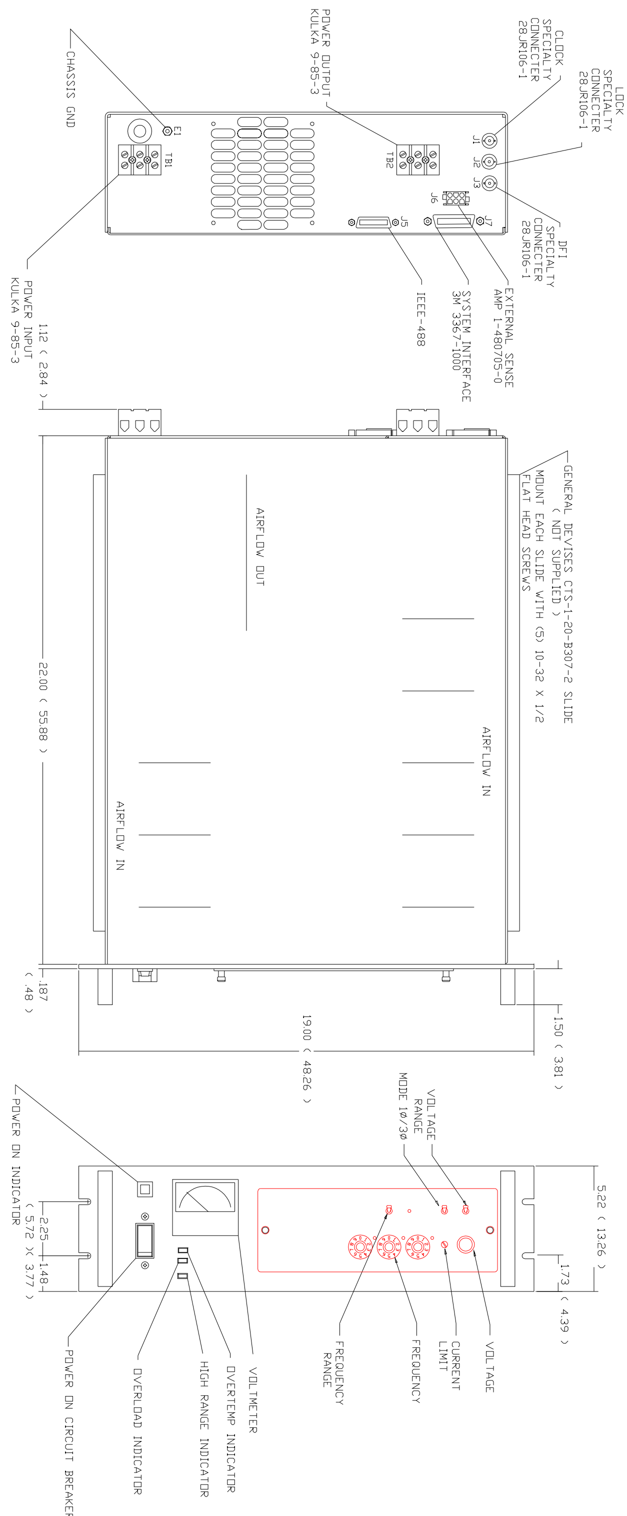
Full power is available at the maximum output voltage on either of two voltage ranges. The standard voltage ranges are 135 and 270. Three optional voltage range pairs are available: 67.5/135, 156/312 and 200/400.

Full power is available from 45 Hz to 5 KHz except for the 200/400 volt range (EHV option). The upper limit for the EHV range is 1000 Hz. The AC Power Source is illustrated in Figure 1-1.

1.3. ACCESSORY EQUIPMENT/RACK SLIDES

General Devices Model CTS-1-20-B307-2 rack slides may be attached to the sides of the power source using 10-32 X 1/2 flat head screws.

Figure 0-1:California Instruments 2001L/1501l/751L



1.4. SPECIFICATIONS

Table 1-1 contains the operation specifications of the AC Power Source. All specifications are tested in accordance with standard California Instruments test procedures. The following specifications apply for operation at 100% of full scale voltage, constant line voltages and no-load conditions unless specified otherwise.

2001L/1501L /751L-M SPECIFICATIONS

ELECTRICAL SPECIFICATIONS

All specifications apply using external sense, 23 ±1°C, constant line and load conditions, after 15 minute warmup, unless otherwise specified.

OUTPUT

Model	POWER, VA		CURRENT, 135V		CURRENT, 270V	
T ambient	35°C	50°C	35°C	50°C	35°C	50°C
2001L	2000	1800	14.8A	13.33A	7.4A	6.66A
1501L	1667	1500	12.34A	11.12A	6.18A	5.56A
751L	835	750	6.18A	5.56A	3.09A	2.78A

For other Voltage Ranges: Output current = (Maximum Power)/Voltage Range

Power factor: 0 to 1.0

Peak Repetitive Current:
2001L = 4.0 times maximum current at 50°C
1501L = 5.0 times maximum current at 50°C
751L = 6.0 times maximum current at 50°C

Peak Non-repetitive (20 ms) Current:
2001L = 4.0 times maximum current at 50°C
1501L = 5.0 times maximum current at 50°C
751L = 6.0 times maximum current at 50°C

Voltage Range:
135/270 volts STD
67.5/135 LV option
156/312 HV option
200/400 EHV option

Total Distortion (maximum for all harmonics and noise to 300 KHz at full output power with a linear load.):

	1% up to 2 KHz 2% up to 5 KHz
Line Regulation:	0.02% of full scale for ±10 line change
Load Regulation:	0.05% of full scale from no load to full load
Frequency Range:	45* Hz to 5 KHz at 50°C max current 45* Hz to 2 KHz at 35°C max current 45* Hz to 1 KHz for EHV option
Frequency Accuracy:	±0.001% of programmed valu

NOTE (*): Operation down to 17 Hz at reduced output voltage.

PROTECTION

Output overload:	Will operate at constant current.
Output short circuit:	Immediate shutdown with automatic recovery.
Invalid frequency:	Immediate shutdown.
Sense line fault:	Output voltage limited to 115% of program value
Overtemperature:	Default to 0 volts with automatic recovery.
Measurements:	Voltmeter, analog panel meter. Accuracy 5% of full scale.

2001L/1501L /751L-M SPECIFICATIONS(CONTINUED)

SUPPLEMENTAL SPECIFICATIONS

ELECTRICAL

Input

Line voltage: 103 - 127 VAC.
187 - 253 VAC.

Current worst case (pf=0.6, eff=75%, volt=103, full load): 36Amps (2001L)

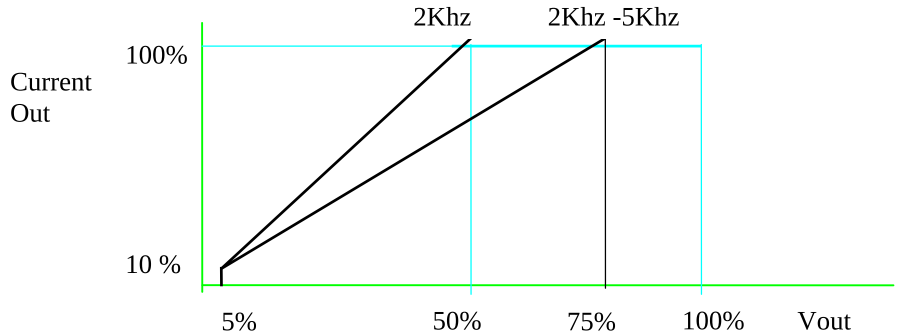
Line frequency: 47 - 440 Hz.

Efficiency: 75% typical.

Surge current (turn-on): 185 amps peak at 253V input voltage.

Output

Output Current/ Output Voltage (see graph below)



Output noise : (20 KHz to 1 MHz at full load)
160 mV rms (typical)

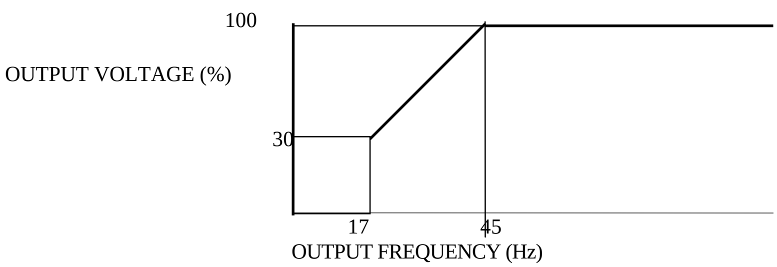
Voltage temperature coefficient:
±0.02of full scale/°C.

Voltage stability (24 hours):
±0.015% of full scale under constant load, line and temp.

Steady state output impedance:
= (voltage range * 0.0005) / (Maximum Current)

Frequency Range:

At less than Full-scale Voltage: (Refer to graph below)



Frequency temperature coefficient:
±5 ppm per degree C.

Frequency Stability:
±15 ppm per year.

Isolation: 500 Volts rms input to output.

CONTROL

Front panel controls:

- Voltage Range
- Circuit Breaker
- 10-turn voltage amplitude potentiometer
- 3 position frequency range switch
- 3 frequency setting rotary switches
- 1-turn current limit potentiometer
- 300 volt analog meter

Functions

Voltage: Amplitude varied by 10-turn potentiometer.
Voltage range: Set by toggle switch

CONTROL

Frequency:

Range:	17 to 5000 Hz (1000 Hz EHV)
Resolution:	0.1 Hz from 45 to 99.9 Hz, 1 Hz from 100 to 999 Hz, 10 Hz from 1000 to 5000 Hz

Current limit:

varied from 0 to 100% of range by single turn potentiometer.

FEATURES

Remote shut down:

A logic low input program, the output to initial volt and open the output relay.

Output Relay

Normally closed at power up. Output Relay can be controlled remotely.

External Modulation:

External 0 to 10 v rms, DC to output frequency signal gives 0 to 10% amplitude modulation.

Indicators:

Power on, high voltage range, overtemperature, output overload.

MECHANICAL

Dimensions:	5.25 inches (13.3 cm)high, 23 inches (58.4 cm) deep, 19 inches (48.3 cm) wide
Weight:	2001L - 75 lbs (34 kg) 1501L - 75 lbs (34 kg) 751L - 75 lbs (34 kg)
Material:	Aluminum front panel, steel chassis.
Finish:	Gray 26440 per Fed Std 595.
Air intake/exhaust:	Sides/rear.
Modularity:	Modules interconnected with motherboard.

Connectors: Input - Kulka 9-85-3.
Output - Kulka 9-85-3.
Sense - Amp 1-480705-1.
Interface - 3M 3367-1000.

Chassis slides: Zero Manufacturing CTN-1-20-E94.

ENVIRONMENTAL AND QUALITY

Operating temperature:	0 to 50°C.
Storage temperature:	-40 to 85°C.
Operating altitude:	0 to 6000 feet.(0 to 1800 meters).

OPTIONS:

Output Voltage Ranges:

High Voltage:	156/312
Low Voltage:	67.5/135
Extra High voltage:	200/400 (1000 Hz max frequency)

LK: Allows unit to operate as a master or slave in synchronization with other controllers.

RPV: Remote program voltage; 0 to 10 vdc sets output to 0 to 100% of range. External modulation cannot be used if RPV option is installed. Refer to page 25 for connections for this option.

CAUTION

Voltages up to 400 VAC are available in certain sections of this power source. This equipment generates potentially lethal voltages.

DEATH

On contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied.

1.

2. INSTALLATION AND ACCEPTANCE

2.1. UNPACKING

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. DO NOT return an instrument to the factory without prior approval. Do not destroy the packing container until the unit has been inspected for damage in shipment.

2.2. POWER REQUIREMENTS

2.2.1. AC LINE VOLTAGE

The AC Power Source has been designed to operate from either of the following AC line voltages ranges:

1) 103 to 127 volts
2) 187 to 253 volts.

CAUTION: ***The AC Power Source will be damaged if it is operated at an input voltage that is outside its configured input range.***

The input voltage range is set at the factory. Section 2.3 gives the procedure to change the input voltage range.

2.2.2. LINE FREQUENCY OPERATING RANGE

The AC Power Source has been designed to operate over the line frequency range from 47 Hz to 440 Hz.

2.2.3. INPUT POWER

The input power to the AC Power Source depends upon line and load conditions and may be as high as 2650 watts. (2001L)

2.3. INPUT VOLTAGE RANGE SELECTION

<u>WARNING:</u> ***Voltages up to 360 VDC and 400 VAC are present in certain sections of this power source. This equipment generates potentially lethal voltages.***

<u>DEATH:</u> ***On contact may result if personnel fail to observe safety precautions. Do not touch electric circuits when power is applied. Servicing should only be performed by trained personnel.***

The input voltage range is configured by two wires and eight jumpers. See Figure 2-2 or Figure 2-3 for the location of the A6 board (DC Supply) where the jumpers are located.

2.3.1. LOW INPUT VOLTAGE RANGE CONFIGURATION (103-127V) Figure 2-2

In order to change the voltage range configuration:

1. Turn off the input circuit breaker.

2. Disconnect AC input power at TB1.

3. Remove the AC Power Source top cover by removing (13) #6-32 x 5/16" FLH screws.

4. Remove the (2) #6-32 x 1" PHN screws and lock washers that hold the amplifier module from the far end opposite the connector.

5. Remove the (2) #6-32 x 3/8" PHN screws and lock washers located near the connector, attaching the red insulator to the center bracket.

6. Remove the amplifier by lifting its end up and disconnecting from the connector.

7. Locate and remove the (2) #8-32 x 1/2" FLH screws on the outside of the chassis which attaches the perforated support bracket to the chassis, and lift perforated support bracket up and out of unit.

The low input voltage range is set by making the following connections inside the power source:

Wire W5	4005-050-005	From CB1B-LN to A6-E2.
Wire W11	4005-050-011	From DS1 to A6-E7.

Jumper A6-J1	From 2 to 5.
Jumper A6-J1	From 3 to 4.
Jumper A6-J2	From 2 to 5.
Jumper A6-J2	From 3 to 4.
Jumper A6-J3	From 2 to 5.
Jumper A6-J3	From 3 to 4.
Jumper A6-J4	From 2 to 5.
Jumper A6-J4	From 3 to 4.

2.3.2. HIGH INPUT VOLTAGE RANGE CONFIGURATION (187-253V) Figure 2-3

In order to change the voltage range configuration:

1. Turn off the input circuit breaker.

2. Disconnect AC input power at TB1.

3. Remove the AC Power Source top cover by removing (13) #6-32 x 5/16” FLH screws.

4. Remove the (2) #6-32 x 1” PHN screws and lock washers that hold the amplifier module from the far end opposite the connector.

5. Remove the (2) #6-32 x 3/8” PHN screws and lock washers located near the connector, attaching the red insulator to the center bracket.

6. Remove the amplifier by lifting its end up and disconnecting from the connector.

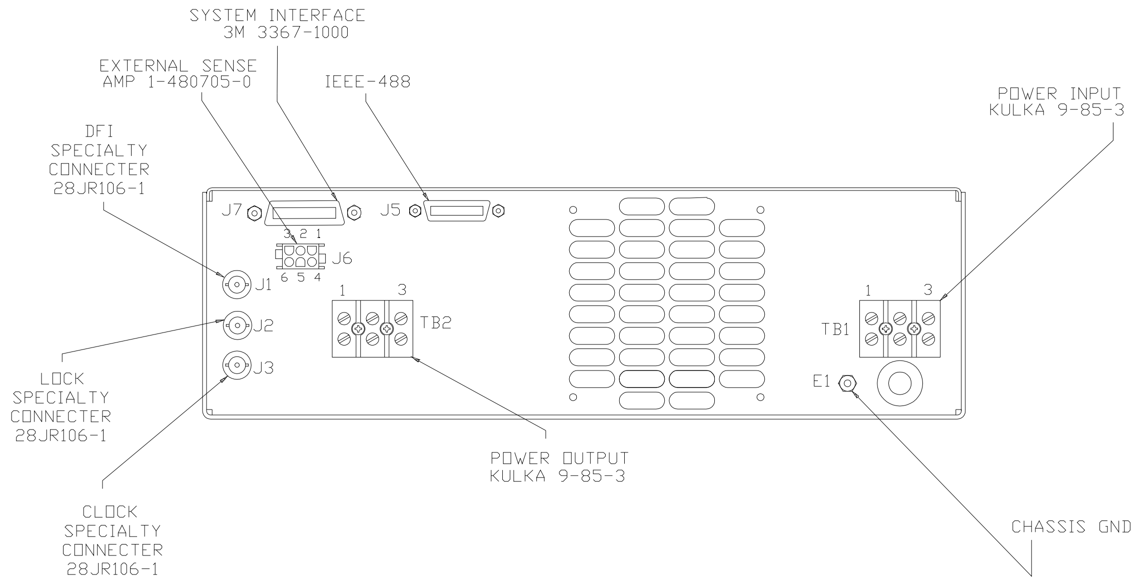
7. Locate and remove the (2) #8-32 x 1/2” FLH screws on the outside of the chassis which attaches the perforated support bracket to the chassis, and lift perforated support bracket up and out of unit.

The high input voltage range is set by making the following connections inside the power source:

Wire W5 4005-050-005 From CB1B-LN to CR1-AC.
Wire W11 4005-050-011 From DS1 to A6-E4.

Jumper A6-J1	From 1 to 6.
Jumper A6-J1	From 2 to 3.
Jumper A6-J2	From 1 to 6.
Jumper A6-J2	From 2 to 3.
Jumper A6-J3	From 1 to 6.
Jumper A6-J3	From 2 to 3.
Jumper A6-J4	From 1 to 6.
Jumper A6-J4	From 2 to 3.

Figure 0-1: Rear Panel Connections



TB1

PIN	FUNCTION
1	HI INPUT
2	LO INPUT
3	GND

J6

PIN	FUNCTION
1	Ø C SENSE
2	Ø B SENSE
3	Ø NEUT SENSE
4	Ø A SENSE

TB2

PIN	FUNCTION
1	HI OUTPUT
2	LO OUTPUT
3	GND

Figure 0-2: Internal Adjustments and Jumper Locations for Input Line Voltage 103 to 127

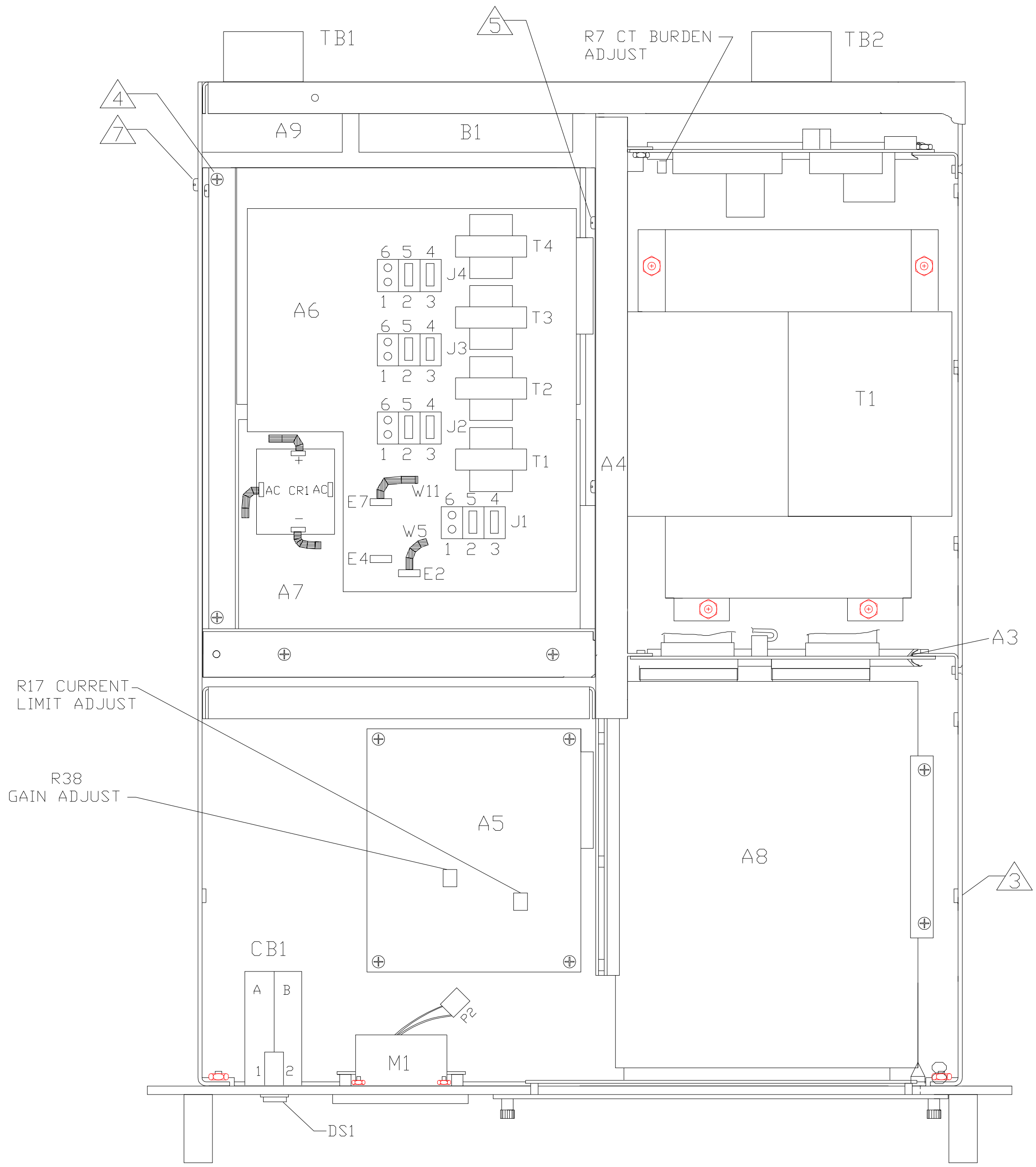
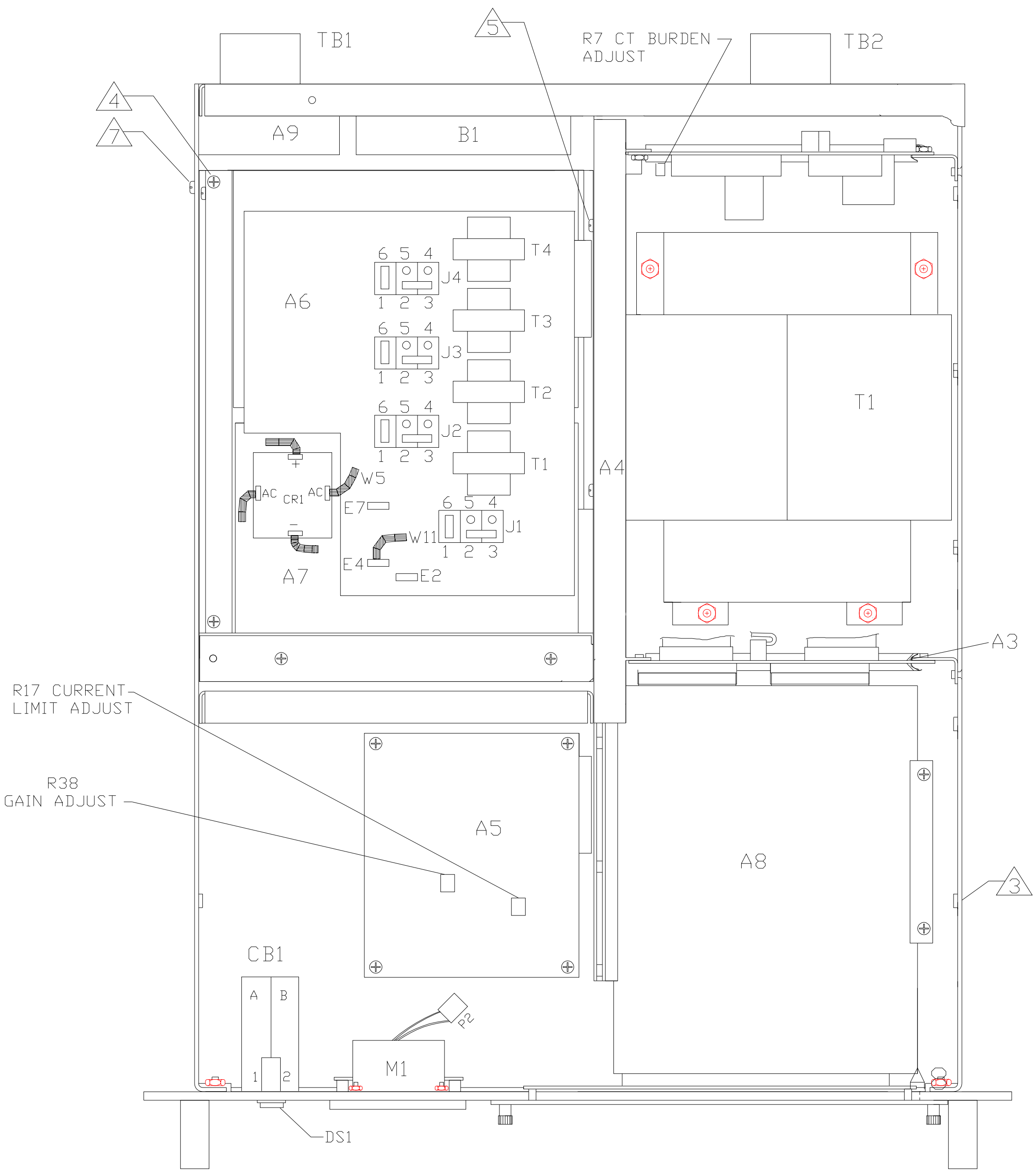


Figure 0-3: Internal Adjustments and Jumper Locations for Input Line Voltage 187 to 253 Volts



2.4.

MECHANICAL INSTALLATION

The power source has been designed for rack mounting in a standard 19 inch rack. The unit should be supported from the sides with optional rack slides. See Accessory Equipment/Rack Slides in paragraph 1.3. The cooling fan at the rear of the unit must be free of any obstructions which would interfere with the flow of air. A 2.5 inch clearance should be maintained between the rear of the unit and the rear panel of the mounting cabinet. Also, the air intake holes on the sides of the power source must not be obstructed. See Figure 1-1. Special consideration of overall air flow characteristics and the resultant internal heat rise must be allowed for with systems installed inside encosed cabinets to avoid self heating and over temperature problems.

2.5. INPUT WIRING

The AC Power Source must be operated from a three-wire single phase service. The mains source must have a current rating greater than or equal to 35 amps for the 2001L and 1501L ,or 20 Amps for the 751L if used on the low input range. Connect AC mains to TB1. Refer to Figure 2-1 for the input power connections.

2.6. OUTPUT CONNECTIONS

The output terminal block, TB2, is located at the rear of the power source. All load connections must be made at TB2. The remote sense inputs allow the power source output voltages to be monitored directly at the load and must be connected. The remote sense wires are connected at J3 on the rear panel.

The output power cables must be large enough to prevent a voltage difference greater than 3.5V rms between TB1 and the voltage between Remote Sense HI and LO input. Table 2-1 shows the maximum length of the output wires. The table assumes the Remote Sense input is connected at the load.

Table 0-1: Minimum Wire Size

OUTPUT CURRENT IN AMPS	WIRE GAGE AWG	MAXIMUM LENGTH (in feet) WIRE BETWEEN OUTPUT AND LOAD
14.8	14	46
14.8	12	73
14.8	10	117

The Remote Sense inputs must be connected. Failure to connect the Remote sense input will result in poor Load Regulation and Line Regulation.

2.7. OUTPUT VOLTAGE RANGES

The standard voltage ranges for this AC Power Source are 135 and 270. Selecting of the 270 volt range causes the front panel "HIGH RANGE" lamp to illuminate. The range may be changed from the front panel toggle switch. Each time the output voltage range is changed the output voltage is momentarily set to zero to reduce relay contact wear.

2.8. FUNCTION TEST

Refer to Figure 2-3 for the test setup.

Perform the following test sequence:

1) Apply the AC line power and turn on the front panel circuit breaker. No loads should be connected to the output terminal block.

2) Verify that the POWER ON lamp is lit.

3) With the front panel control, select the high voltage range by setting the Voltage Range switch to the HI position. This will select the 270 volt range for the standard voltage range.

4) Verify the HIGH RANGE lamp is lit.

5) Adjust the output to 270 volts by adjusting the front panel Amplitude control knob.

6) Verify that the front panel voltmeter indicates approximately 270 volts.

7) Set the AC Power Source to the 135 volt range by toggling the Voltage Range switch to the Low position.

8) Adjust the output to 135 volts by adjusting the front panel Amplitude control knob.

9) Observe the output with the oscilloscope or distortion analyzer. The output should be a clean sine wave having less than 1.0% distortion.

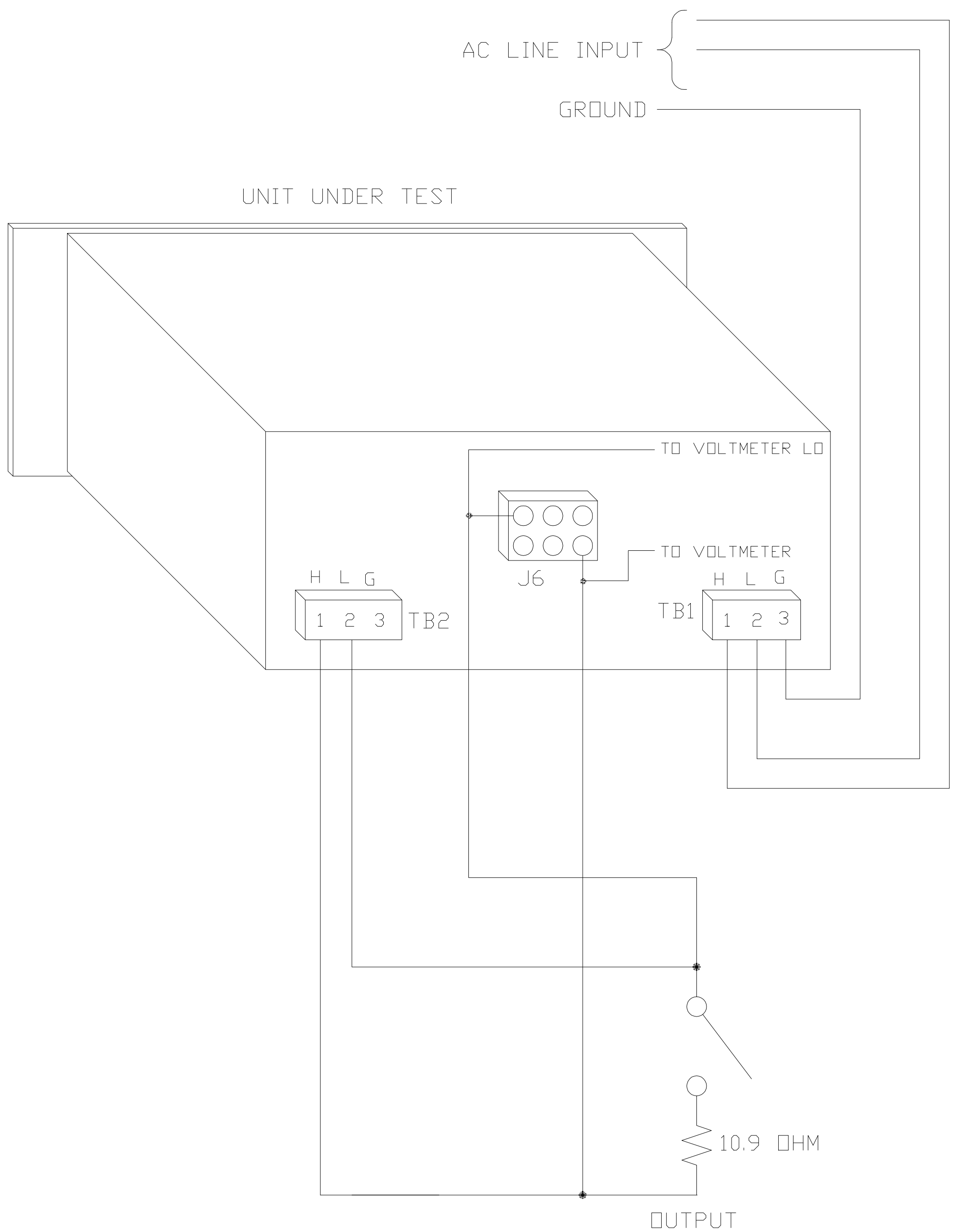
10) Apply a full load to the output. Refer to Table 4-2 for the resistance of the load. Verify that the output voltage remains within (0.0005 x Voltage Range) volts of the no-load voltage. The waveforms shall still appear clean on the oscilloscope and have less than 1% distortion.

11) Locate the Current Limit pot at the front panel. Adjust the Current Limit pot to 50% Current Limit.

12) Observe the OVERLOAD light in the power source. It should be on.

13) Program the output voltage to zero voltage.

Figure 0-4: Test Setup



3.

OPERATION

3.1. GENERAL

The AC Power Source may be programmed from the front panel. The rear panel of the AC Power Source holds the power input and output terminals, remote sense connector, system interface connector and the chassis ground stud.

3.2. FRONT PANEL CONTROLS

Refer to Figure 3-1 for an illustration of the AC Power Source front panel.

CIRCUIT BREAKER

The circuit breaker switches power to the AC power source. The circuit breaker will trip in the event that a fault within the power source causes excessive current to flow.

POWER ON LAMP

The power on lamp illuminates when the circuit breaker is switched on and the power source begins to draw input power.

VOLTMETER

The average responding AC voltmeter is connected directly to the power source output. Full scale deflection is 300 volts. The voltmeter will indicate no voltage if the output relay is open.

INDICATOR LAMPS

OVERTEMP: This lamp illuminates when the temperature of the power amplifier heatsink has surpassed a maximum set level. The overheated amplifier will shut down until its heatsink has cooled to a safe operating temperature. The amplifier will recover automatically.

OVERLOAD: This lamp illuminates when the power source has limited the output current to the preset program level. The output waveform will clip and remain clipped until the load is reduced to the program value.

HIGH RANGE: This lamp illuminates when the power source has switched to the high voltage setting.

FREQUENCY SELECT DIALS: Three dial switches are used to set the output frequency. The output frequency is set within the frequency range selected by the Frequency Range select switch.

An LED is set between the second and third LED for Range 45.0 to 99.9 Hz.

An LED is set after the third digit for range 100 to 199 Hz.

An LED is set between the first and second digit for range 1.00 KHz to 5.00 KHz.

FREQUENCY RANGE SELECT: This three-position switch selects the desired Frequency Range as specified by the previous paragraph.

VOLTAGE AMPLITUDE Knob: This knob controls the output amplitude from 0 to full scale.

VOLTAGE RANGE Switch: The Voltage Range switch select the low voltage range or the high voltage range.

CURRENT LIMIT Knob: This knob controls the desired current limit. The current setting varies between 0 and maximum current setting for the power source.

LIMIT LAMP: This lamp is lit when the programming frequency value is above the maximum frequency limit of the oscillator. This maximum frequency limit is set at the factory.

This lamp is also lit momentarily when a range change is selected or during the power turn on. The output is disabled when this lamp is lit.

3.3. REAR PANEL CONNECTIONS

TB1 is the terminal block for the three input wire. Terminals 1 and 2 connect to the High and Low input. Terminal 3 is the chassis connection which should be connected to the input main ground.

TB2 is the power output terminal block. Refer to Table 3-1 for identification of the TB1 and TB2 terminals.

Table 0-1: Terminal Identification

TB 1	DESCRIPTION	TB2	DESCRIPTION
1	Input HI	1	Output HI
2	Input LO	2	Output LO
3	Chassis Ground	3	Chassis Ground

J6 is the remote sense input connector. The remote sense input must be connected to the respective AC Power Source output. If the inputs are not connected, an AMP FAULT error message will be generated. Table 3-2 identifies the pins of connector J6.

Figure 0-1: Front Panel Controls and Indicators

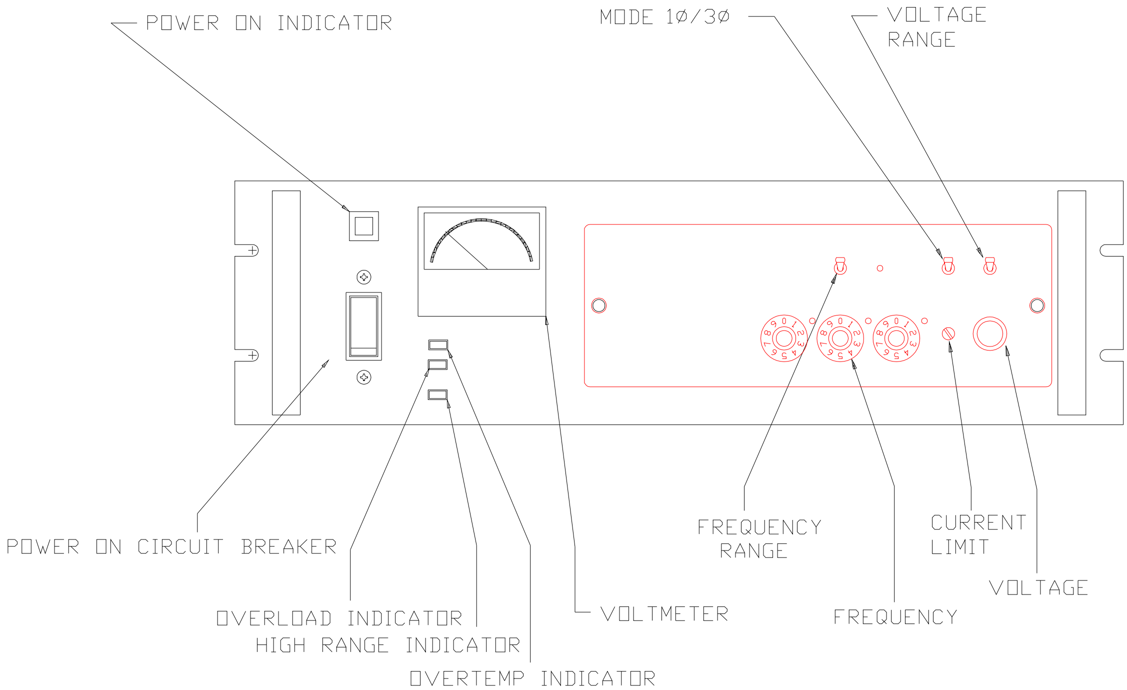


Table 0-2: Connector Identification

J6	DESCRIPTION	CONNECT TO:
1	Do not connect	
2	Do not connect	
3	Sense LO	Output LO
4	Sense HI	Output HI
5	No Connection	- - - - -
6	No Connection	- - - - -

J7 is the System Interface connector. Table 3-3 identifies the pins of the System Interface connector.

RPV Option: Apply the +10 volt DC input signal to the rear panel system interface connector J7. Use pin 9 as the high input and pin 1as the reference return pin.

Table 0-3: System Interface Connector J7

J7	Description
1	Analog Common
3	Analog Common
5	CT Common, Current Transformer Common
7	Analog Common
9	RPV, Allows amplitude to be programmed with an external 0-10V DC input
10	OVP TMP , Overtemperature indication
11	CNF, Output relay
13	FLT A, Phase A current limit fault
14	F STB LO, Function Sync output LO
15	EX SYNC LO, External Sync input LO
16	No connection
17	No connection
18	No connection
20	MR A, Phase A amplifier input signal
22	CS A, Phase A current sum
24	OS A, Oscillator Phase A output
26	CL A, Phase A DC current limit
27	D COM, Digital Common
28	RNG HI, High Voltage range
31	F STB HI. Function Sync output HI
32	EX SYNC HI, External Sync input HI
36	REMOTE SHUTDOWN

J7-1 ANALOG COMMON: This is the common for all analog signals on the connector.

J7-3 ANALOG COMMON: See J7-1.

J7-5 CT COMMON:

J7-7 ANALOG COMMON: See J7-1.

J7-9 RPV: 0 to +10V DC input for RPV option. Use pin 1 for return.

J7-10 $\overline{\text{OVR TMP}}$: A logic low output to indicate an overtemperature condition.

J7-11 $\overline{\text{CNF}}$: Output relay control indication. This is an output logic line that indicates the state of the output relay. A logic low indicates the output relay is open.

J7-13 FLT A: Make no connections.

J7-14 F STB LO: a Function Sync signal. This is the emitter lead of an optically isolated NPN transistor. The internal power controller turns this transistor on to indicate a change of programmed values.

J5-15 EX SYNC LO: External Sync Low signal. This is the ground return for the TTL external sync input. It connects to the cathode of an LED at the input of an optocoupler. Refer to J7-31.

J7-16 No connection.

J7-17 No connection.

J7-18 No connection.

J7-20 MR A: This is the input signal to the phase A amplifier from the internal oscillator drive signal. Do not make any connection to this pin except for troubleshooting.

J7-22 CS A: Current sum for the phase A output. Make no connection to this pin.

J7-24 OS A: This is the output from the internal phase A oscillator. Use this pin as an input if an oscillator is not installed. 5.0 V rms on this pin will generate a full-scale output voltage.

J7-26 CL A: A DC level from the oscillator used to set the current limit for phase A.

J7-27 D COM: Digital common.

J7-28 $\overline{\text{RNG HI}}$: A logic output from the internal oscillator to control the Range relays. A logic low on this pin indicates the high voltage range. If the power system is used without an oscillator, this pin is a logic input.

J7-31 F STB HI: Function Sync High signal. This is the collector lead of an optically isolated NPN transistor. The internal power controller turns this transistor on to indicate a change of programmed values. This output will sink more than 2 milliamps to a TTL low logic output level (<.4 volts). The output is an open, collector optocoupler output. A pullup resistor to a + VDC must be connected to J7, pin 31. J7, pin 14, is the common output. Refer to Figure 3-2.

J5-32 EX SYNC HI: External Sync High signal. This is an input that can be used to synchronize the outputs of the AC Power Source. This input requires a logic high level of at least +4.5 VDC at 1.5 ma. The input should have a duty cycle of 50. J7-15 is the common input. The External Sync input is optically isolated. It must also be enabled from the SNC screen.

J7-36 REMOTE SHUTDOWN: This is a logic input that can be used to remove the programmed output voltage. A logic low on this pin will cause the output voltages to be programmed to 0.0 volts and the output relays to open. A logic high will cause the programmed output voltage to be restored at the output terminals. A contact closure between this pin and J7-27(DCOM) will simulate a logic low state

4. CALIBRATION PROCEDURE

4.1. GENERAL

The following calibration or any part of it may be performed to ensure that the AC power source remains within specification.

This procedure should always be performed after any repair has been made to the unit and, the power source is functioning normally.

This calibration procedure assumes that the power source is tested at 230C ambient temperature on the 135 volts range. Performance is similar on the 270 range. Output voltage measurements must be made at the power controller voltage sense point, otherwise voltage drops in output wiring may cause inaccurate measurements.

4.2. TEST EQUIPMENT REQUIRED

The following test equipment is required for performing the calibration procedure.

Digital Voltmeter (DVM)
Resistive Load: Refer to Table 4-1 for values
Precision Current Transformer: Pearson 110
Oscilloscope: Kikusui COS6100

4.3. GAIN ADJUSTMENTS

A gain adjust potentiometer is provided on the Current Limit Board A5. For the location of the gain adjustment potentiometer see Figure 4-1.

1.0 Remove all loads from the power source. Turn on the power source.

2.0 Monitor the output voltage between the output high and low with the DVM.

3.0 With the Remote Sense lines connected, adjust the output voltage for 100 volts.

4.0 Disconnect the Remote Sense lines and adjust R38 one the Current Limit Board until the output measures 115 volts ±0.25 volts.

5.0 Reconnect the Remote Sense leads.

Table 0-1: Configuration and Setup Value

MODEL	STANDARD	LV	HV	EHV
VOLTAGE RANGE	135/270	7.5/135	156/312	200/400
LOAD 2001L 1501L RESISTORS 751L	9.1Ω 10.9Ω 21.8Ω	2.3Ω 2.73Ω 5.45Ω	12.2Ω 14.59Ω 29.1Ω	20Ω 24Ω 47.9Ω
CLM A 2001L (MAXOUTPUT) 1501L AMPS 751L	14.8 12.34 6.18	29.6 24.70 12.37	12.8 10.68 5.36	10 8.34 4.17
PROGRAM VALUE 2001L 1501L FOR CAL. 751L	12 10 5	24 20 10	10 7.4 3.7	9 6.6 3.3
CURRENT LIMIT 2001L 1501L SET POINT 751L	12.6 10.7 5.4	25.2 21.4 10.7	10.5 8 4	9.5 7 3.5

4.4. CURRENT LIMIT ADJUSTMENT

1.0 Set the front panel Current Limit adjustment to its maximum clockwise position. Set the output voltage AMPLITUDE control to the maximum counterclockwise position. Adjust R17 on the Current Limit Board to its maximum clockwise position.

2.0 Monitor the output current with the external current transformer and AC DVM. Connect an oscilloscope to the output.

3.0 Set the output to the low voltage range and the frequency to 60 Hz.

4.0 Apply the load value from Table 4-1 to the power source output.

5.0 Increase the output amplitude slowly until the external AC current transformer indicates SET VALUE from Table 4-1. Slow turn R17 on the Current Limit Assembly in a counterclockwise direction until the OVERLOAD LED comes on.

Slowly readjust R17 in a clockwise direction just to a point where the OVERLOAD LED turns off.

4.5 CURRENT TRANSFORMER ADJUSTMENT

This adjustment is required if the Current Limit adjustment in the previous paragraph cannot be adjusted.

1.0 Apply the appropriate load form Table 4-1 to the power source output. Power source must be on the low voltage range.

Monitor the output current with a current transformer connected to the AC DVM.

2.0 Increase the output voltage with the amplitude control until the PROGRAM VALUE output current is obtained.

Example: 1501L is 10 Amps.

3.0 Measure the output from the Current Transformer between TP10 and TP1 (GND) on the Current Limit Board (A5).

4.0 Adjust R7 on the Range Relay Board so that TP10 reads .100V rms per amp of output current.

Example: 1501L is to be 1.00 volts for 10 amps.

Figure 0-1: Internal Adjustments and Jumper Locations

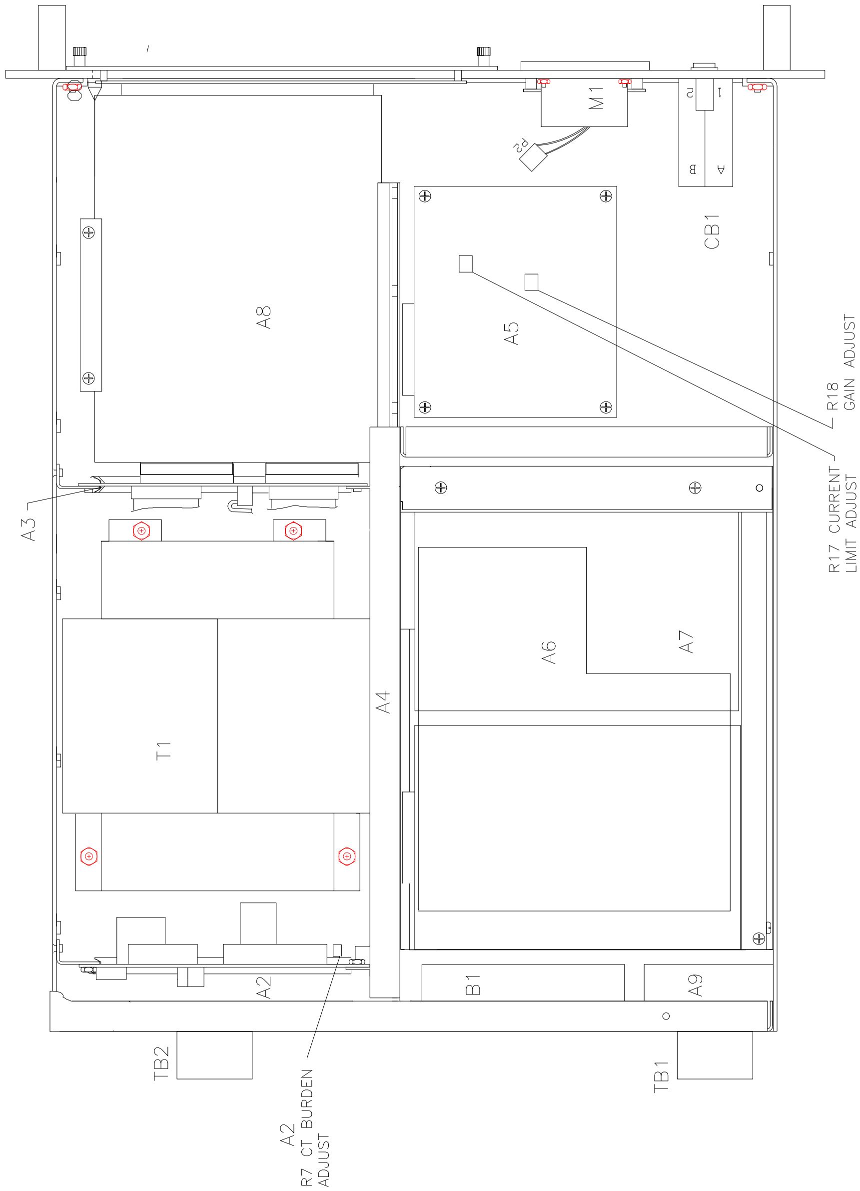
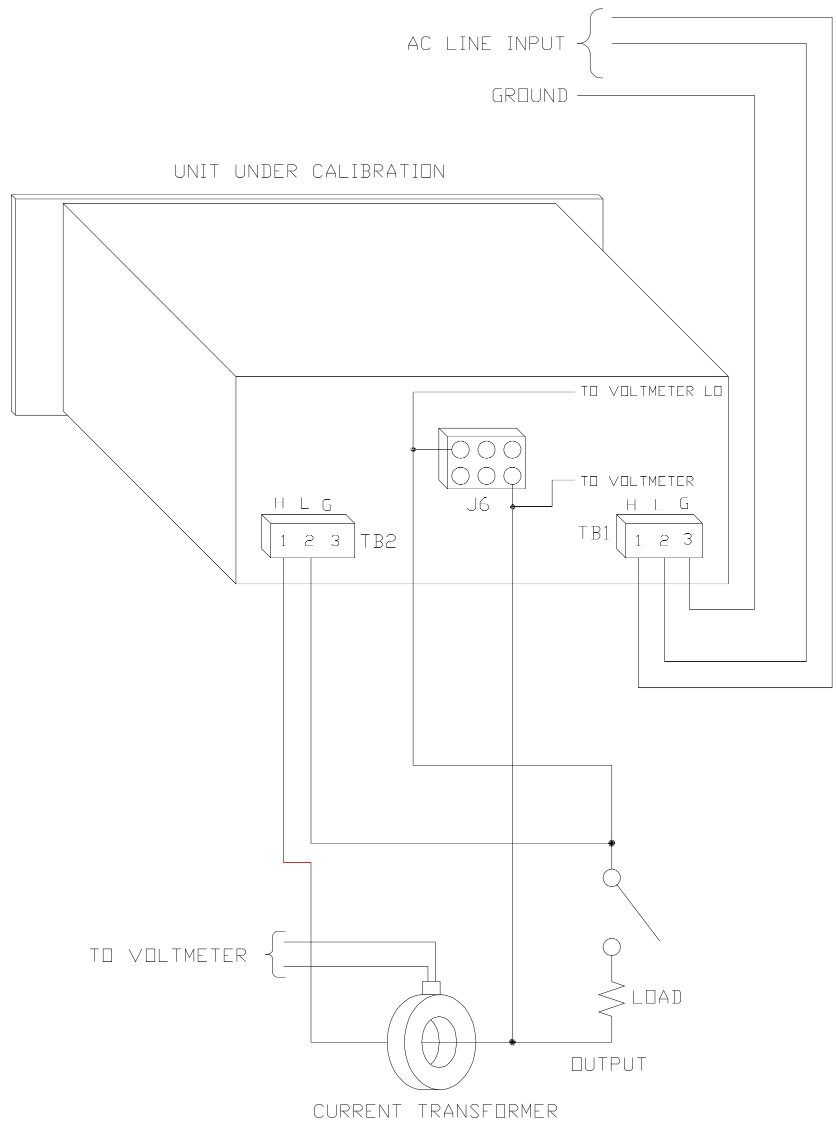


Figure 0-2: Equipment Hookup for Periodic Calibration



5.

THEORY OF OPERATION

5.1. GENERAL

An explanation of the circuits within the AC Power Source is given in this section. Refer to Figure 5-1 for the block diagram of the AC Power Source.

5.2. OVERALL DESCRIPTION

Input power at the rear panel is routed through the EMI filter and circuit breaker to the high current rectifier and the Power Supply Assembly, A6. The various DC supply outputs then go to the Mother Board, A4, then are directed to other modules.

The Programmable Oscillator Assembly, A8, generates the oscillator waveforms, power source controls and measurement signals. The oscillator assembly is connected to the rest of the power source through the Oscillator Interface Board, A3.

The Amplifier Module, A7, takes its DC supply voltages and input signal from the Mother Board, A4. It produces the high power output for the primary of the output transformer, T1. The output is routed through the Mother Board to the output transformer.

The Range Relay Board is identified as A2. This board assembly configures the secondaries of the output transformers for the correct output voltage range. The output from the AC Power Source is taken from the Range Relay Board.

The Current Limit Board is identified by A5. This board controls the amplifier gain and the programmable current limit.

5.3. INPUT POWER SUPPLY

This assembly is identified as A6. It generates the high power +300 VDC supply.

The input power supply also has circuits that generate auxiliary DC voltages identified as ±18V, ±15VSW, +8VSW and +8V.

The ±18V supplies are used for oscillator modules and the Current Limit Board. The +8V supply is used for the oscillator module. The ±15VSW and +8VSW supplies are used for the Amplifier Module.

The input power supply also generates 50 VDC and 15VSW1 from the 300 volt DC supply. The 50 VDC is used for fan and relay operation, +15VSW1 is used for the gate drive signal in the Amplifier Module.

5.4. CURRENT LIMIT BOARD

The Current Limit Board receives the oscillator signal from the Oscillator Module. The signal is directed to the input of the power amplifier. A gain adjustment is located on the board.

The current limit circuit is also located on the Current Limit Board. The circuit receives a DC signal from the Oscillator Module that is proportional to the current limit value. The DC signal is compared to the output current.

If the output current exceeds the programmed value, an attenuator will limit the output voltage to a value that will cause the AC Power Source to operate at a constant current.

5.5. INDICATOR BOARD

The Indicator Board, A1, has LED indicators for the HI RANGE, OVERTEMP and OVERLOAD conditions.

5.6. RANGE RELAY BOARD

The Range Relay Board has all of the AC Power Source relays. These relays are operated from +50 VDC. The output relay is controlled by the CNF Logic Line. The range relay is controlled by RNG HI line.

There is a current transformer on the Range Relay Board. This transformer generates an AC voltage that is proportional to the output current. A 10 amp load current is represented by 1.00 VAC at the output of the current transformer.

5.7. AMPLIFIER MODULE

The AC Power Source has a switchmode amplifier module to obtain high efficiency. The switchmode amplifier operates at 200 KHz.

The Amplifier Module obtains its input signal from the Current Limit Board. A 5.0 V rms input signal will generate a full scale output voltage at the output of the AC Power Source and 100.0 V rms on the primary of the output transformer.

The Amplifier Module requires a 300 VDC, ±15VSW, +8VSW and +15VSW1 supplies. The +300 VDC supply comes from the input power supply through a 15 amp fuse.

The Amplifier Module has a thermoswitch mounted on its heatsink. If the heatsink temperature exceeds 100 degrees C, the amplifier shuts down and sends an OVT signal to the oscillator module. A logic low on the OVT control line will cause the error message TEMP FAULT to be generated.

5.8. OSCILLATOR MODULE

The Oscillator Module is identified with the reference designator, A8. The module consists of two printed circuit assemblies. These assemblies are interconnected with a small Mother Board. The Oscillator Display Assembly is mounted to the small Mother Board and is connected to the Oscillator Module with a short ribbon cable. The Oscillator Module is a plug in module from the AC Power Source front panel.

5.8.1. Control Board

The Control board is mounted to a small panel that is mounted to the front panel of the power source. The small panel holds the Frequency Select dial, the Frequency Range select, the Amplitude Control, the Amplitude Range, and the Current Limit potentiometer.

The Control board generates a frequency that is 1024 times the dial setting. With the Frequency Range Select, the Waveform Board divides this frequency by 1, 10 or 100 depending on the range selection.

The Voltage Range switch controls the range relay.

5.8.2. Waveform Generator Board

The Waveform Generator Board will divide the frequency received from the Control Board by 1, 10 and 100 depending on the Frequency Range setting. The resulting waveform is square wave that has a frequency 1024 times the desired frequency.

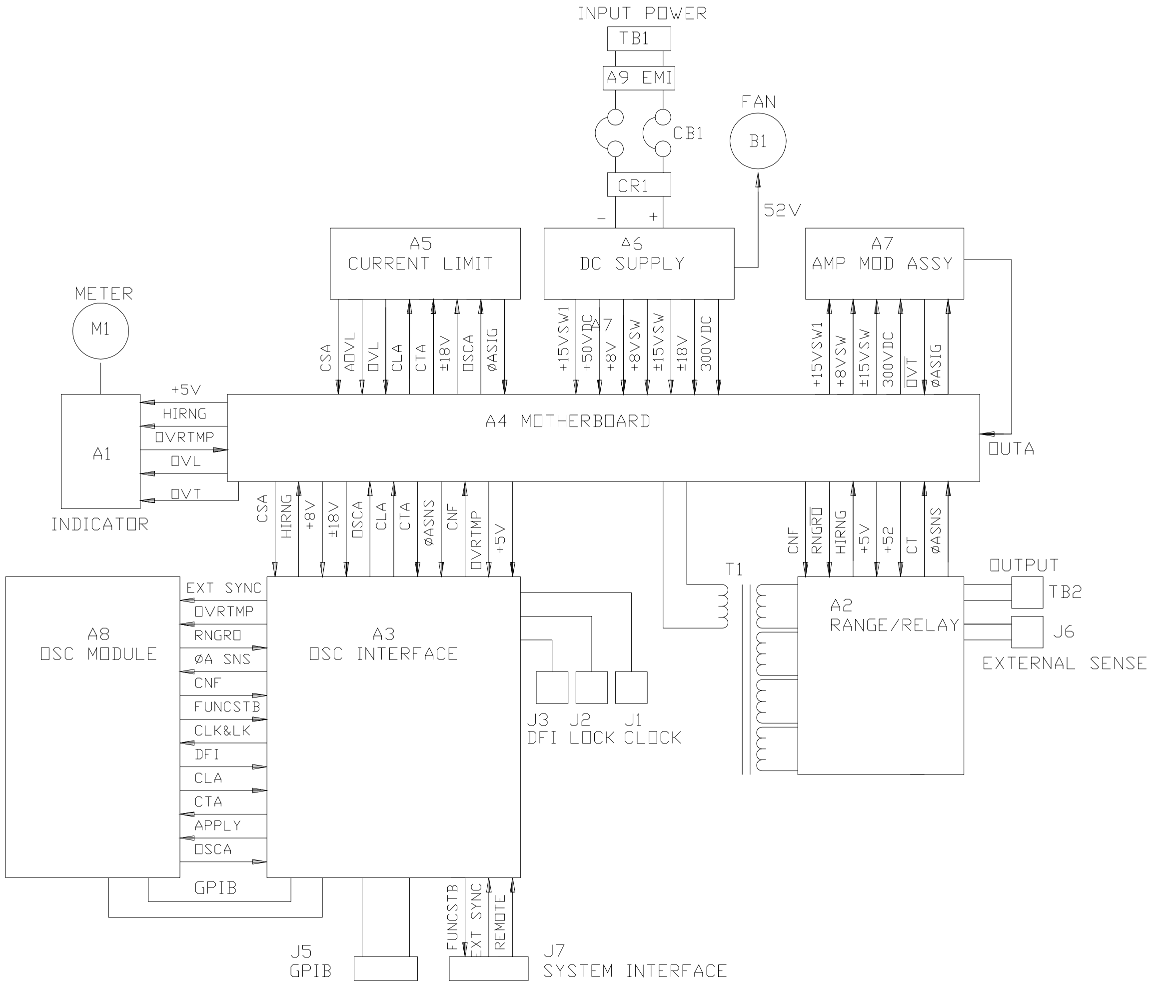
A divide down of this frequency is used to control the switch capacitor filter.

The clock is further divided down to generate the output frequency.

This clock is used to control the positive and negative reference to the switch capacitor filter. This reference is equal to the peak value of the sine wave.

Other circuits on the Waveform Generator board are used to detect frequency programmed outside the Range Limit. The oscillator output will go to zero until the programmed frequency is corrected. The oscillator output will interrupt momentarily during a voltage range change to reduce stress on the relay.

Figure 0-1: AC Power System Block Diagram



6.

MAINTENANCE AND TROUBLESHOOTING

6.1. GENERAL

This section describes the suggested maintenance and troubleshooting procedures. Table 6-1 lists the paragraph titles and page numbers for the Troubleshooting section. If the AC Power Source does not appear to function normally, use this section to isolate the problem. If the problem cannot be found using these steps, consult the factory.

Table 6-1

6.2. POOR OUTPUT VOLTAGE REGULATION

If the AC Power Source exhibits poor voltage regulation the following item may be at fault:

1. The Remote Sense lines are not connected at the same point monitored by the external voltmeter used for load regulation check.

   SOLUTION: Connect AC voltmeter to Remote Sense lines.

6.3. *OVERTEMPERATURE LAMP ON*

If the power source OVERTEMP lamp is on, the following may be at fault:

1. Ambient temperature is too high.

   SOLUTION: Operate power source between 0 and 50°C.

2. Fan or ventilation holes are blocked.

   SOLUTION: Remove obstructions.

3. Fan not working.

   SOLUTION: Replace fan. Consult factory.

6.4. *OVERLOAD LAMP ON*

The OVERLOAD lamp comes on when the output load current has exceeded the programmed current limit value. If the AC Power Source OVERLOAD lamp is on, the following items may be at fault:

1. The output is overloaded.

   SOLUTION: Remove the overload.

2. The programmable current limit level is set too low for the load being driven.

   SOLUTION: Compute and reprogram the correct programmable current limit level.

3. The programmable current limit is incorrectly calibrated.

   SOLUTION: Perform the calibration in paragraph 4.4.4.

4. Incorrect AC Power Source configuration.

6.5. DISTORTED OUTPUT

The AC Power Source output may have a distorted sine wave from the following causes:

1. The power source output is overloaded.

   SOLUTION: Remove the overload or program the current limit to a higher value. Observe power source capabilities. See Section 1.

2. The crest factor of the load current exceeds 4.0. With this condition the distortion will be much higher at frequencies above 100 Hz.

   SOLUTION: Reduce the load or program the current limit to a higher value.

6.6. NO OUTPUT

If the AC Power Source has no output at the rear panel terminal block, TB2, the following items may be at fault:

1. The Amplitude Control knob is set for minimum output voltage.

   SOLUTION: Increase the Amplitude Control.

2. The limit LED on the control panel is lit.

   SOLUTION: Change the frequency until the limit LED turns off. The output amplitude goes to zero when the limit is on.

3. There is no input to the power amplifiers from the oscillator. Check the oscillator signal at the system interface connector:

   J7-24 Oscillator Signal
   J7-7 Oscillator common/return

   Program 135.0 volts on the 135 volt range. The signal should be 5.74 ±0.5 VAC.

   SOLUTION: If there is no signal at the Systems Interface connector replace the oscillator. Refer to paragraph 6.8.

   SOLUTION: If the signal at the System Interface connector is greater than 5.74 VAC, it may be necessary to replace the respective amplifier. Refer to paragraph 6.9.

4. The internal amplifier fuse, F2, has failed.
   SOLUTION: Replace the fuse.

6.7. MODULE REMOVAL

Figure 6-1 shows the location of the internal modules and assemblies. The figure shows the Amplifier Module, A7, with the insulator removed.

6.8. OSCILLATOR MODULE REMOVAL/REPLACEMENT

If a fault is found that requires the replacement of the Oscillator Module (assembly A8) follow the following steps and refer to Figure 6-1 for the module locations:

1. Turn off the front panel circuit breaker.

2. Remove the Keyboard/Display assembly (Oscillator Module front panel) by loosening the two captive screws on its front panel.

3. Unplug the Oscillator Module, A8 by sliding out the package of PC assemblies with the front panel display.

4. The module is now removed. To replace the module follow these steps in reverse order.

6.9. AMPLIFIER REMOVAL/REPLACEMENT

If a fault has been found that indicates the failure of the amplifier module (assembly A7), check the condition of the +300 VDC fuse before replacing the amplifier. Refer to Figure 6-1 for the location of the fuse.

If it is determined that the amplifier module must be replaced perform the following procedure:

1. Turn off the input circuit breaker.

2. Disconnect AC input power at TB1.

3. Remove the AC Power Source top cover by removing (13) #6-32 x 5/16” FLH screws.

4. Remove the (2) #6-32 x 1” screws and lock washers that hold the amplifier module from the far end opposite the connector.

5. Remove (2) #6-32 x 3/8” screws and lock washers located near the connector, attaching the red insulator to the center bracket.

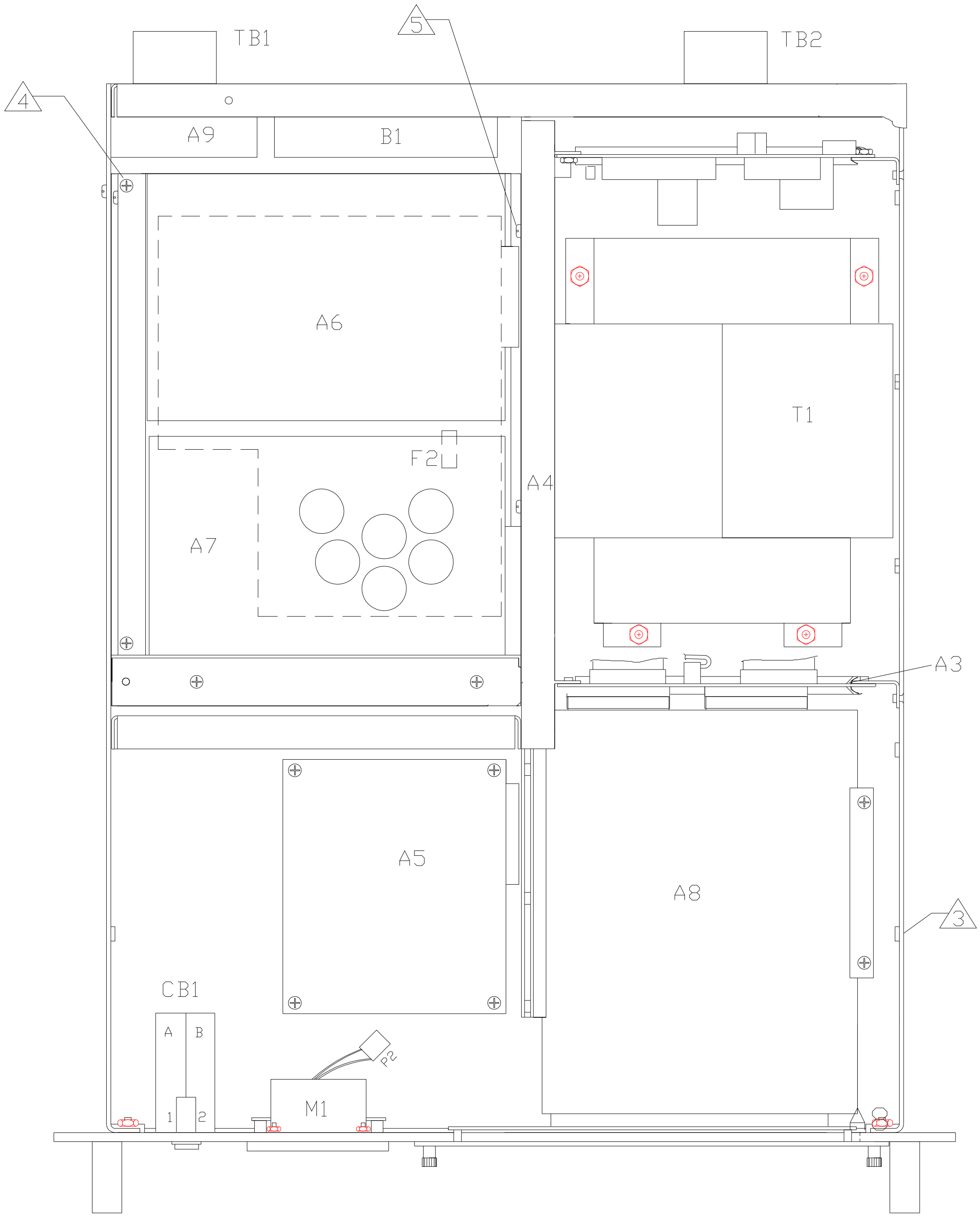
6. Remove the amplifier by lifting its end up and disconnecting from the connector.

7. The amplifier may be replaced by following this procedure in reverse order.

8. Check the amplifier 15 amp fuse (F2) located on the DC Supply Board, A6, and replace it if necessary.

9. After an amplifier has been replaced, readjust its gain. Refer to Section 4.

Figure 0-1: Module Location



7. REPLACEABLE PARTS

7.1. GENERAL

This section contains ordering information and a list of replaceable parts. The list includes the parts description and California Instruments part numbers.

7.2. ORDERING INFORMATION

In order to ensure prompt, accurate service, please provide the following information, when applicable for each replacement part ordered.

a. Model number and serial number of the instrument.

b. California Instruments part number for the subassembly where the component is located. (PARENT ITEM NO.)

c. Component reference designator. (SEQ NO.)

d. Component description.

e. Component manufacturers' FSCM number. (VENDOR)

f. California Instruments' part number (COMPONENT ITEM NO.)

All replaceable part orders should be addressed to:

California Instruments
Attention: Customer Service
9689 Towne Centre Drive
San Diego, CA 92121

TOP ASSEMBLY REPLACEABLE PARTS
FOR 2001L-M, 1501L-M, 751L-M
TOP ASSEMBLY NO: 4005-411-1

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	VENDOR	QTY
A1	4005-700-1	PC ASSY, INDICATOR,LIMIT	16067	1.0
A2	4005-705-1	PC ASSY, RANGE/RELAY	16067	1.0
A3	4005-702-1	PC ASSY, OSCILLATOR INTERFACE	16067	1.0
A4	4005-708-1	PC ASSY, MOTHER	16067	1.0
A5	4005-709-1	PC ASSY, CURRENT LIMIT	16067	1.0
A6	4008-712-1	PC ASSY, DC SUPPLY	16067	1.0
A7	4009-423-8	PC ASSY, HEATSINK, SW AMP	16067	1.0
A8	4005-404-5	PC ASSY, MODULE OSC.	16067	1.0
A9	4005-710-1	PC ASSY, EMI FILTER	16067	1.0
B1	241175	FAN, 4", 48 VDC	23936	1.0
F2	270167	FUSE,15A,250V	71400	1.0

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS CORPORATION warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, including the model number and serial number. On receipt of this information, service information or a Return Material Authorization (RMA) number will be given. Add RMA number to shipping label. .Pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No. or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS, San Diego, CA. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested when it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.