SPECIFICATIONS

MODEL 1501TC AC POWER SOURCE

All specifications are tested in accordance with standard California Instruments test procedures and apply with a stable, low distortion input signal as generated by a T series plug-in oscillator.

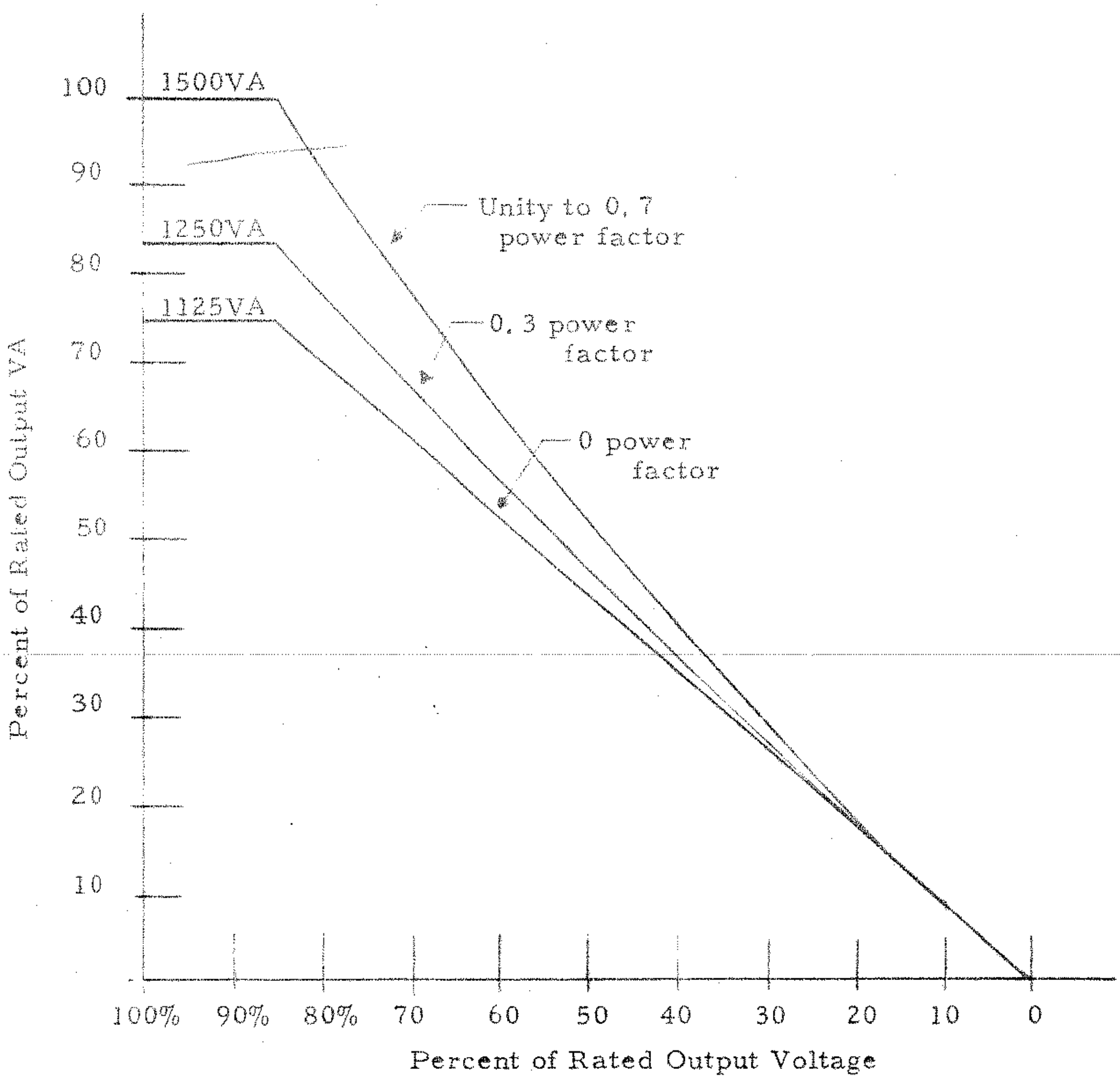
POWER OUTPUT:	1500 VA at 130 to 110 volts rms output with power factor of unity to ±0.7. See the derating chart on the following page for operation at lower voltages and/or power factor.
OUTPUT VOLTAGE RANGES: (Determined by rear loaded printed circuit card)	0 to 32.5 volts rms, 0 to 65 volts rms, 0 to 130 volts rms, and 0 to 260 volts rms.
TOTAL HARMONIC DISTORTION:	Less than 0.3% distortion at mid-band (200 Hz to 600 Hz), and less than 0.5% distortion from 45 Hz to 5 KHz.
AMPLITUDE STABILITY: (after one hour warm-up)	±0.25 percent for 24 hours at constant line, load and ambient temperature conditions.
LOAD REGULATION: * (on 120 volt range)	±1% over the range from 45 Hz to 5 KHz when tested at unity power factor. In addition, a load regulation adjustment permits the regulation to be adjusted to zero at any given line voltage, signal frequency and load conditions. Control resolution is 0.02%.
LINE REGULATION:	±0.25 percent of full output for a ±10 percent line change.
FULL POWER FREQUENCY RANGE: **	45 Hz to 5 KHz.
FREQUENCY RESPONSE:	±0.5 dB from 45 Hz to 5 KHz.

* Load regulation degrades slightly on the 32.5 volt, 65 volt and 260 volt ranges for operation above 1.0 KHz. See Section 4.7.5 of this instruction manual for test procedure on these ranges.

** This power source may be used over the 20 Hz to 20 KHz frequency range provided the output voltage and the output VA are derated according to Table 2-2 in this instruction manual; otherwise, permanent damage to the unit may occur.

POWER DERATING CHART FOR MODEL 1501TC POWER SOURCE

(Applys over the range from 45 Hz to 5 KHz. Derate the curve for output VA by 2.0 to 1.0 factor at 10 KHz; 3.0 to 1.0 factor at 15 KHz and 4.0 to 1.0 factor at 20 KHz).



GENERAL DESCRIPTION

1.1 INTRODUCTION

This instruction manual contains information on the installation, operation, calibration, and maintenance of the California Instruments Model 1501TC Power Source. Detailed schematics, parts location drawings, calibration procedures, and theory of operation are also contained for the aid of maintenance personnel.

1.2 GENERAL DESCRIPTION

The California Instruments Model 1501TC Power Amplifier is a solid state, high performance, low distortion power source that provides up to 1500 VA output when used with the proper plug-in oscillator. The Model 1501TC Power Source is illustrated in Figure 1-1. Full power output is available in four different voltage ranges and over the frequency range from 45 Hz to 5 KHz. These full power voltage ranges are:

1) 27.5 to 32.5 volts rms for applications where four units are to be stacked to provide 6000 VA at 120 volts,

2) 55 to 65 volts rms for applications where two units are to be stacked to provide 3000 VA at 120 volts,

3) 110 to 130 volts rms for normal single phase 115 volt applications and for three phase 208 volt line-to-line applications,

4) 220 to 260 volts rms for normal single phase 230 volt applications.

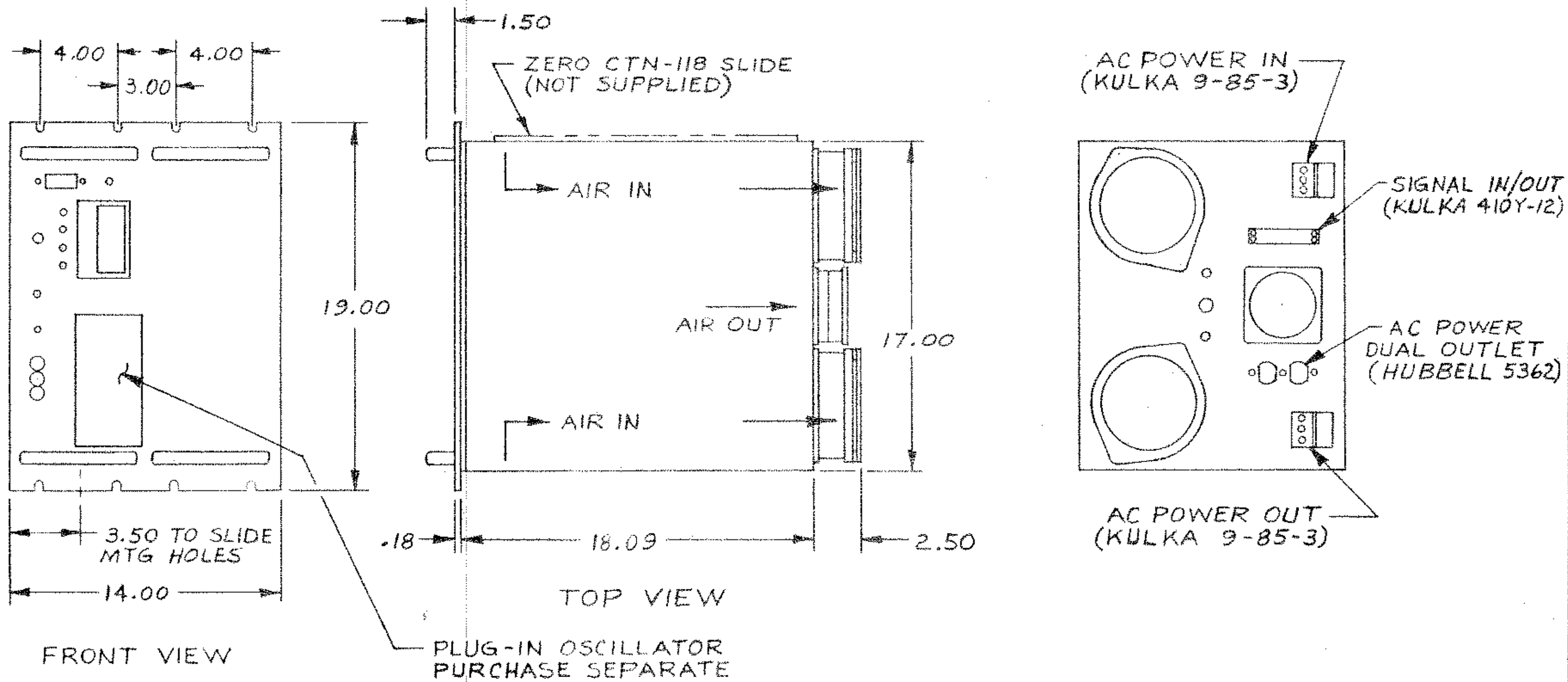
For two phase and three phase operation, at least two power amplifiers must be combined together with the applicable multi-phase oscillator. Two power amplifiers will provide a total of 3000 VA two phase power, or 3000 VA of three phase power in the open delta configuration. Three power amplifiers will provide 4500 VA of three phase power in the wye configuration.

1.3 ACCESSORY EQUIPMENT

The following accessories are available for use with the California Instruments Model 1501TC Power Source:

1.3.1 Zero Manufacturing Company Model CTN118 rack slides. These rack slides may be bolted directly to the sides of the unit, if required.

1.3.2 Model 4100-703 Extender Card. This card allows the pre-amplifier printed circuit board to be extended above the unit for service work.



NOTES: (UNLESS OTHERWISE SPECIFIED)

1. FRONT PANEL DIMENSIONS PER W.E./E.I.A STD.

OUTLINE DRAWING
1000 VA, 1200 VA & 1500 VA POWER SOURCE

MODEL: 1001-T ; 1201-T ; 1501TC

CALICO — CALIFORNIA INSTRUMENTS CORP. SAN DIEGO, CALIFORNIA

CODE IDENT: 16067

DWG NO. C4100-900 — REV /

SCALE 1/4 — SHEET 1 OF 1

DWG SIZE: C

DIM IN INCHES. BREAK ALL SHARP CORNERS & EDGES.

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALICO AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

C4100-900 /

WARNING

HIGH VOLTAGE (250 VAC)

Voltages up to 250 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. Avoid contact with pin C and pin D of the plug-in oscillator, the primary power circuits, and the output circuits of the power source.

2.1 UNPACKING

The California Instruments Model 1501TC Power Source is shipped in a cardboard container with protective inner packing. Do not destroy the packing container until the unit has been inspected for possible damage in shipment.

2.2 POWER REQUIREMENTS

2.2.1 The Model 1501TC Power Source has been designed to operate from any one of the following AC line voltages: 115 volts, 208 volts, 220 volts, 230 volts or 240 volts rms. The power transformer is normally wired at the factory for operation from the 230 volt line. Table 2-1 below indicates how the primary connections to the power transformer are made for various AC input line voltages.

TABLE 2-1

NOTE

Prior to reconnecting power transformer T1, remove all existing jumpers from the primary windings.

NOMINAL INPUT VOLTAGE	OPERATING LINE VOLTAGE RANGE	POWER TRANSFORMER CONNECTIONS	FRONT PANEL CIRCUIT BREAKER VALUE
115 volts rms	105-125 volts rms	jumper pins 1 and 3; jumper pins 2 and 6; connect load side of circuit breaker to pin 6.	60 ampere 118.00
208 volts rms	190-226 volts rms	jumper pins 2 and 3; connect load side of circuit breaker to pin 4.	30 ampere
220 volts rms	201-239 volts rms	jumper pins 2 and 3; connect load side of circuit breaker to pin 5.	30 ampere
230 volts rms	210-250 volts rms	jumper pins 2 and 3; connect load side of circuit breaker to pin 6.	30 ampere
240 volts rms	219-261 volts rms	jumper pins 2 and 3; connect load side of circuit breaker to pin 7.	30 ampere

BRENDA-215
BILL-213

2.5.2 Using either a California Instruments 800T Series Oscillator or a suitable external low distortion sine wave oscillator, set the oscillator to the desired frequency (between 45 Hz and 5 KHz) and adjust the output of the oscillator to 5 volts rms. The amplifier input is available at pin 2 (tie oscillator ground to pin 1) of the small terminal strip TB1 located on the rear of the unit, if the external oscillator is employed. Tie a jumper strap from pin 2 to pin 3 of TB1 if an 800T Series Plug-in Oscillator is being used as the signal source.

2.5.3 Select the proper output voltage range according to the procedure given in Section 2.4 of this instruction manual. The following table lists the proper external load for full power output on each of the voltage ranges.

OUTPUT VOLTAGE RANGE	OUTPUT VOLTAGE	FULL POWER LOAD RESISTANCE	50 PERCENT POWER LOAD RESISTANCE
0-32.5 volts rms	32.5 volts rms.	0.704 ohms	1.408 ohms
0-65 volts rms	65 volts rms	2.817 ohms	5.633 ohms
0-130 volts rms	130 volts rms	11.27 ohms	22.53 ohms
0-260 volts rms	260 volts rms	45.07 ohms	90.13 ohms

2.5.4 Connect the proper 1500 watt load resistor to the large output terminals at the rear of the power source which are labeled "AC POWER OUTPUT HIGH-LOW". Connect a Tektronix Model 533A Oscilloscope or equivalent across this load resistor.

2.5.5 Using the GAIN control and the proper range on the front panel METER, set the output voltage to the rated voltage of the unit as determined in Section 2.5.3 of this manual. The power line wattmeter should read 3700 to 4100 watts at mid-line. Check on the oscilloscope for peak clipping or excessive distortion of the sine wave output.

2.5.6 With the output still adjusted as determined in 2.5.5, place a resistor in parallel with the external load resistor to provide a 50% overload on the output of the power source; the value of this resistor is given in Section 2.5.3 of this manual. The signal on the oscilloscope should exhibit significant clipping on both the positive and negative peaks.

2.5.7 Remove the 50 percent overload resistor and the output should automatically return to normal.

2.5.8 Place a short circuit in parallel with the external load resistor and then remove the short circuit after a few seconds. The signal on the oscilloscope should go to zero and then return to normal when the short circuit is removed. The front panel circuit breaker may be activated if the short circuit remains across the output for a period of time.

2.9 FRONT PANEL CONTROLS

2.9.1 The circuit breaker, located on the front panel of the Model 1501TC Power Source, is used to switch the POWER to the unit "ON." At this time the amber indicator lamp located above this circuit breaker should glow.

2.9.2 The GAIN control is used to adjust the output voltage level of the power source. In the case of a multi-phase power source, the gain control is turned nearly fully clockwise and then used as a fine gain trim control. The amplitude of the output of the multi-phase system is controlled by the amplitude control located on the multi-phase oscillator.

2.9.3 The REG control is recessed behind the front panel and is screw driver adjustable. This control is used to vary the output impedance of the power source. Turning this control in the clockwise direction reduces the output impedance of the power source. If this control is rotated far enough in the clockwise direction, the power source will exhibit a negative output impedance and may be used to compensate for line voltage drops between the output of the power source and the load. Section 2.8 includes additional information on the possible application of this control.

2.9.4 The RANGE lamps on the front panel indicate which output voltage range, 0 to 32.5 volts, 0 to 65 volts, 0 to 130 volts or 0 to 260 volts is activated by the rear loaded printed circuit card. The corresponding voltmeter ranges are 0 to 40 volts, 0 to 80 volts, 0 to 160 volts and 0 to 320 volts, full scale, respectively.

2.9.5 The EXCESSIVE LOAD lamp on the front panel indicates if the power source is being loaded excessively. This lamp may be activated momentarily during start-up of a non-linear load such as an AC motor load or an incandescent lamp load.

2.9.6 The THERMAL OVERLOAD lamp on the front panel indicates if the output stage is operating at an excessive temperature. When this occurs, the output power is automatically reduced to zero. When the heatsink cools sufficiently, the output power will automatically return to its previous value.

2.9.7 The front panel circuit breaker will be activated if the power source is loaded with an excessive amount of shunt capacitive load. If shunt capacitors are used to correct the power factor of an inductive load, connect a small amount of resistance in series with the shunt capacitor. The value of this resistor should be equal to approximately 10 per cent of the reactance of the shunt capacitor at the operating frequency of the system.

THEORY OF OPERATION

3.1 GENERAL

The California instruments Model 1501TC Power Source is an all silicon solid state 1500 VA amplifier and with companion oscillator is designed to provide reliable sine wave AC power over the frequency range from 45 Hz to 5 KHz.

A block diagram for the amplifier is shown in Figure 3-1. The pre-amplifier A1G1 is used to amplify the input signal to such a level so as to supply adequate drive to the power amplifier A1G2.

The power amplifier A1G2 provides the necessary sine wave signal to drive the output transformer T2. The output transformer has floating secondary windings which allow the load to float from the amplifier and oscillator circuitry.

The power amplifier A1G2 contains the overload and short circuit protection circuitry. A local negative feedback loop is taken from the output of the power amplifier back to the pre-amplifier, A1G1.

The overall negative feedback is taken from the feedback winding of the output transformer back to one input of the pre-amplifier via resistor A1R7. This feedback provides a closed loop gain of 20 from the high side of A1R5 to the primary of T2.

The positive feedback signal is generated by sensing the IR drop across the primary of T2 and applying this signal to transformer A1T1. Transformer A1T1 converts this differential signal into a single-ended signal and applies it to the input of the pre-amplifier through a divider network containing the regulation control R2. As this positive feedback is increased from zero with potentiometer R2, the output impedance of the power source is reduced toward zero.

The multiple secondary of transformer T2 is inner connected by means of a rear loaded printed circuit board, assembly A9. The rotation of this board is used to determine the output voltage range of the power source. This board also controls the front panel range lights and the range of the front panel voltmeter.

Power transformer T1, along with the associated rectifiers and filters, supply the operating voltages for the plug-in oscillator, the pre-amplifier A1G1, and the output amplifier A1G2.

Relay A1K1 is used to remove the drive signal from the pre-amplifier during periods of excessive heat sink temperature.

3.2 DETAILED CIRCUIT DESCRIPTION

A schematic diagram for the Model 1501TC Power Source is shown in drawing E4150-078, with the exception that the circuitry contained on the pre-amplifier circuit board (assembly A1), the meter board (assembly A6), the output voltage range selector board (assembly A9), and the plug-in oscillator. A schematic for the pre-amplifier circuit board is given in drawing D4150-077 and a schematic for the meter circuit is given in drawing B4050-072. A schematic for the range selector board is given in drawing D4150-079. For information on the plug-in oscillator, consult the applicable oscillator manual. These drawings give typical voltage levels and waveforms for the various sections of the power source.

3.2.1 PRE-AMPLIFIER

The amplifier A1G1 is a part of the A1 assembly and consists of transistors A1Q1 through A1Q6 and associated components connected as a direct coupled differential amplifier. The open loop gain of this pre-amplifier is approximately 50 at 400 Hz and rolls off at 6 dB per octave from 5 to 10 KHz.

Transistor A1Q1 is a dual field effect transistor used in the differential source follower configuration to provide a high input impedance and a gain of approximately 1.0. Potentiometer A1R11 is used to adjust the DC bias at the primary of T2 to zero volts with no signal.

Transistor A1Q2 is a dual transistor used in a differential Configuration and provides a gain of approximately 12.5 400 Hz. Capacitor A1C6 and resistor A1R20 provide a high frequency step roll off from 5 KHz to 10 KHz.

Transistor A1Q3 and associated components are connected as a constant current source which provides the emitter current for A1Q2. This current source is designed to sink 2 milliamperes from the junction of A1R14 and A1R15 to the -10 volt supply.

Transistors A1Q4, A1Q5 are used in the differential amplifier configuration and provide an open loop gain of 4 at 400 Hz.

Transistor A1Q6 and associated components are connected as a constant current source which provides 8 milliamperes to the junction of A1R19 and A1R21.

3.2.2 POWER AMPLIFIER

The power amplifier A1G2 mechanically consists of the remainder of the A1 board and the large heatsinks designated as the A2 through A5 assemblies. Electrically, the power amplifier consists of transistors A2Q1 through A2Q10, A3Q1 through A3Q10, A4Q1 through A4Q10, A5Q1 through A5Q10, A1Q7 through A1Q12 and associated components.

collector circuit of A1Q12 to conduct a significant portion of the base drive normally available to A2Q1. This limits the base drive to A2Q1 and hence limits the available current from the positive polarity output amplifier during periods of overload. Potentiometer A1R54 is used to set the current level where the overload protection circuit is activated.

Transistor A1Q11 and associated components are used in a similar fashion to protect the negative polarity output amplifier (assemblies A4 and A5). The only differences are that the control voltage for A1Q11 is sensed across A4R11 and potentiometer A1R57 is used to set the overload current level.

The rated VA output of the power source is, to a large extent, determined by the power dissipation in the quasi-complementary symmetry output stage. This power dissipation is determined by the power factor of the load, the output VA level of the amplifier, and to the actual output voltage expressed as a percentage of the rated output voltage. The derating chart, given in the specifications, expresses this derating in a graphical form.

The design of the overload circuitry is such that the overload level is determined by the same three parameters that determine the power dissipation in the Class B output stage. Resistors A1R48, A1R49, A1R51, A1R52, A1R55 and A1R56 have been selected so that the overload protection circuit and the power factor derating chart track one another quite closely in the region between 0 volts output and 84.6 per cent of rated output voltage. In the region between 84.6 per cent of rated output voltage and 100 per cent of rated output voltage, the rated VA output of the power source is limited by an arbitrary rating and as a result, the overload circuit allows a somewhat greater power output than that specified for the power source. The unit will be reliable in this mode of operation; however, output distortion and/or other specifications may be excessive.

3.2.4 EXCESSIVE LOAD INDICATOR LAMP

The front panel EXCESSIVE LOAD indicator lamp is activated by transistor A1Q10 and associated components. The emitter-base junction of A1Q10 is driven from the voltage developed across A2R3 through a suitable attenuator network. Potentiometer A1R53 is adjusted at the factory so that the EXCESSIVE LOAD lamp DS1 is activated at the same time that the overload protection transistors A1Q11 and A1Q12 are activated.

3.2.5 THERMAL OVERLOAD INDICATOR LAMP

The front panel THERMAL OVERLOAD lamp DS7 is activated by either thermal switch A2S1 or A4S1 if the heat sink temperature exceeds approximately 105°C. When this occurs, relay A1K1 is also closed which removes the drive signal from the preamplifier and reduces the output power to zero. When the heat sink temperature drops below approximately 90°C, the thermal overload is used to adjust the amount of positive feedback and thereby adjust the output impedance of the power source.

3.2.9 POWER SUPPLY

A schematic diagram for the DC power supply is part of drawing E4150-078. This power supply delivers ± 27.5 volts ± 5 per cent at 60 amperes DC with less than 3.5 volts peak-to-peak ripple. from the 115 volt, 60 Hz AC line. Under no load conditions the ±27.5 volt supplies will deliver approximately ±34 volts DC from the 115 volt 60 Hz AC line. These unregulated supplied consist of rectifier diodes A7CR1 through A7CR4 and filter capacitors A8C1 through A8C8 connected in a conventional fashion.

3.2.10 FRONT PANEL METER

The front panel meter M1 has a full scale sensitivity of 0 to 1 milliampere DC and an internal resistance of approximately 100 ohms. The meter has four scales with full scale ranges of 0 to 40 volts AC, 0 to 80 volts, 0 to 160 volts AC and 0 to 320 volts AC. The meter rectifiers and scaling circuitry are counted on the rear of the meter.

The meter circuitry is designated as the A6 assembly and is shown in drawing B4050-072. This circuitry consists of rectifier diodes A6CR1 through A6CR4, potentiometer A6R1 and associated components. The four rectifier diodes are connected so as to form a full wave bridge rectifier. Potentiometer A6R1 is used to shunt a small portion of the meter current and provide a sensitivity adjustment on the 40 volt scale. Resistors A6R3, A6R4 and A6R5 are set at the factory to provide proper tracking on the 320 volt, 160 volt and 80 volt ranges, respectively.

The meter range is automatically switched as the rotation of the rear loaded voltage range board is changed. The 40 volt full scale range of the meter is used with the 0-32.5 volt range of the power source, the 80 volts full scale range of the meter is used with the 0 to 65 volt range of the power source, the 160 volt full scale range of the meter is used with the 0 to 130 volt range of the power source, and the 320 volt full scale range of the meter is used with the 0 to 260 volt range of the power source.

3.2.10 OUTPUT VOLTAGE RANGE

The output voltage range is controlled by the rotation of printed circuit board A9. A schematic for this printed circuit board is shown in drawing 4150-079. The primary purpose of this printed circuit board is to interconnect the multiple secondary windings of T2 in various fashions depending on the desired output voltage range. Table 3-1 on the following page illustrates this interconnection.

WARNING

HIGH VOLTAGE (260 VAC)

Voltages up to 260 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. Avoid contact with pin C and pin D of the plug-in oscillator, the primary power circuits, and the output circuits of the power source.

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CALIBRATION PROCEDURE

4.1 GENERAL

The following calibration procedure, or any part of it, may be performed on a routine basis to insure that the Model 1501TC Power Source remains within specified tolerances. This procedure should always be performed after any repairs have been made to the unit. This procedure also covers test methods for the following power source adjustments and specifications:

a) Initial Adjustments.

b) AC Line Input Power and Overload Adjustment.

c) Voltage, Power Output and Harmonic Distortion.

d) Line Regulation

e) Load Regulation Adjustment.

f) Amplitude Stability.

g) Frequency Response.

h) AC Noise Level.

i) 0.7 Lagging Power Factor.

j) 0.7 Leading Power Factor.

This calibration procedure assumes that the power source will be operated from the 230 volt 48 to 65 Hz AC line. For operation from the 115 volt AC line, a 120 volt variac and a 120 volt wattmeter must be substituted for those called out in this procedure. Consult Section 2.2.1 of this instruction manual for operation from other than the 230 volt AC line.

This calibration procedure further assumes that the power source is tested on the 0 to 130 volt range. Performance is very similar on the other three ranges. The following table illustrates the change in measurement voltage and impedance level when evaluating the power source on various output voltage ranges.

4.3 INITIAL ADJUSTMENTS

4.3.1 Connect the Model 1501TC Power Source as shown in Figure 4-1. Turn the GAIN control fully counter-clockwise. Adjust the line voltage to its nominal value with the variac. Turn the POWER switch "on". The wattmeter should indicate 400 watts or less at nominal line voltage. If a problem is encountered, perform step 4.3.2. below.

4.3.2 Turn the unit on its side and remove the bottom cover. Connect the differential voltmeter between terminal 1 and terminal 2 of T2. Adjust potentiometer A1R11 so that the DC voltage across the primary of T2 is 0.00 volts ±5 millivolts. This balances and minimizes the collector current in both halves of the output stage. If the input power is still excessive, reduce the size of resistor A1R58 somewhat.

4.3.3 Connect the differential voltmeter to the power output terminals at the rear of the unit and select the 0 to 32.5 volt range with the rear loaded printed circuit board. Adjust the GAIN control for a 32.5 volt output with the oscillator set to 400 Hz. Adjust the meter calibration control A6R1 so that the front panel meter and the differential voltmeter correlate within one per cent of each other. Vary the frequency from 45 Hz to 5 KHz and check that the front panel meter reads within ±3 per cent of the correct value.

4.3.4 Remove power from the unit and select the 0 to 65 volt range with the rear loaded printed circuit board. Set the oscillator to 400 Hz and adjust the output to exactly 65 volts while reading the differential voltmeter. Select resistor A6R5 so that the front panel meter and the differential voltmeter correlate within one per cent. Vary the frequency from 45 Hz to 5 KHz and check that the front panel meter reads within ± 3 per cent of the correct value.

4.3.5 Remove power from the unit and select the 0 to 130 volt range with the rear loaded printed circuit board. Set the oscillator to 400 Hz and adjust the output to exactly 130 volts while reading the differential voltmeter. Select resistor A6R4 so that the front panel meter and the differential voltmeter correlate within one per cent. Vary the frequency from 45 Hz to 5 KHz and check that the front panel meter reads within ± 3 per cent of the correct value.

4.3.6 Remove power from the unit and select the 0 to 260 volt range with the rear loaded printed circuit board. Set the oscillator to 400 Hz and adjust the output to exactly 260 volts while reading the differential voltmeter. Select resistor A6R3 so that the front panel meter and the differential voltmeter correlate within one per cent. Vary the frequency from 45 Hz to 5 KHz and check that the front panel meter reads within ± 3 per cent of the correct value.

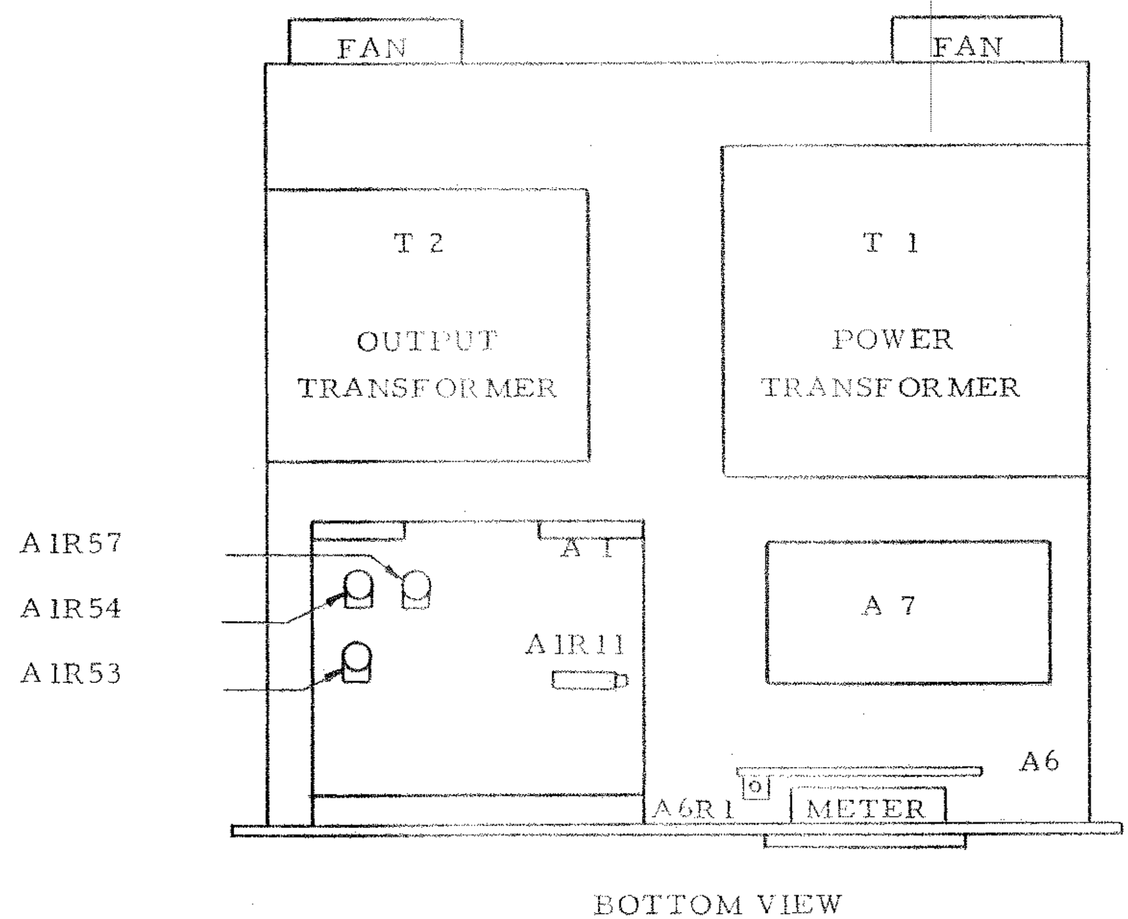

FIGURE 4-2. Internal Adjustments for Model 1501TC Power Source.

4.5.2 Vary the AC line voltage from 210 to 250 volts with the variac and check that no significant clipping is observed on the sine wave output with the oscilloscope. The harmonic distortion must be less than 0.3 per cent over the full line voltage range.

4.5.3 Set the oscillator output to 45 Hz and adjust the output of the power source to 130 volts rms with the GAIN control. Repeat step 4.5.2. The harmonic distortion must be less than 0.50 per cent over the full line voltage range.

4.5.4 Set the oscillator output to 600 Hz and adjust the output of the power source to 130 volts rms with the GAIN control. Repeat step 4.5.2. The harmonic distortion must be less than 0.30 per cent over the full line voltage range.

4.5.5 Set the oscillator output to 5 KHz and adjust the output of the power source to 130 volts rms with the GAIN control. Repeat step 4.5.2. The harmonic distortion must be less than 0.50 per cent over the full line voltage range.

4.5.6 Repeat steps 4.5.1 through 4.5.4 except set the output of the power source to 110 volts rms (84.6 per cent of rated output) and close switch S2 instead of S1. The harmonic distortion must be less than 0.30 per cent from 200 Hz to 600 Hz, and less than 0.5 per cent from 45 Hz to 5 KHz.

4.5.7 This procedure may be performed for any of the other output voltage ranges, rather than the 0 to 130 volt range, if desired. In this case, the rear loaded printed circuit board should be rotated to provide the proper output voltage range. The load impedance and output voltage levels should be taken from those given in Table 4-1.

4.6 LINE REGULATION

4.6.1 Connect the Model 1501TC Power Source as shown in Figure 4-3. Select the 130 volt range with the rear loaded printed circuit board. Set the oscillator frequency to 400 Hz. Close switch S1 (11.27 ohm load) and adjust the output of the power amplifier to 130 volts rms (100 per cent of rated output voltage) at 400 Hz.

4.6.2 Vary the line voltage from 210 volts to 250 volts AC and measure the change in output voltage of the power amplifier. This change should be less than 0.65 volts rms.

4.6.3 Set the frequency of the oscillator to 5 KHz and repeat 4.6.1 and 4.6.2. The change in the output voltage should be less than 0.65 volts rms.

NOTE

Care should be taken to insure that the output amplitude of the oscillator remains stable and independent of line conditions during this test.

band from 45 Hz to 5KHz on the 65 volt and 260 volt output ranges The load regulation must remain within a ± 1 per cent band from 45Hz to 1.0 KHz, within a ± 2 per cent band from 45 Hz to 2KHz, and within a ± 7.5 per cent band from 45 Hz to 5KHz on the 32.5 volt range.

NOTE

Care should be taken to insure that the output amplitude of the oscillator remains stable and independent of load conditions during this test.

4.8 AMPLITUDE STABILITY

4.8.1 Connect the Model 1501TC Power Source as shown in Figure 4-3. Adjust the AC input line voltage to 230 volts rms. Adjust the output of the power source to provide 115 volts rms output (88.5 per cent of rated output voltage) at 400 Hz. Connect a 8.82 ohm (1500 VA) load to the output terminals at the rear of the power source and check that the REG control has been set to provide a zero output impedance.

4.8.2 Connect an AC expanded scale (about 115 volts rms) strip chart recorder across the output terminals of the power source and record the drift during a 24 hour period. This drift should be less than ± 0.29 volts rms. Disregard the drift during the first hour, as this represents initial warm-up drift. Care should be taken to insure that the ambient temperature is held constant at ± 3 degrees centigrade for this test.

4.8.3 This procedure may be performed for any of the other output voltage ranges, rather than the 0 to 130 volt range, if desired. In this case, the rear loaded printed circuit board should be rotated to provide the proper output voltage range. The load impedance and output voltage level should be taken from those given in Table 4-1 consistent with the dynamic range of the specific expanded scale strip chart recorder employed for the test.

4.9 FREQUENCY RESPONSE

4.9.1 Connect the Model 1501TC Power Source as shown in Figure 4-3. Adjust the input AC line voltage to 230 volts rms. Adjust the output of the power source to provide 130 volts output (100 per cent of rated output voltage) at 400 Hz.

4.9.2 Vary the output frequency of the oscillator from 45 Hz to 5KHz and monitor the output voltage of the power source with a differential voltmeter under no-load conditions. The output of the power source should vary less than ± 7.70 volts rms from 45 Hz to 5 KHz.

4.9.3 Close switch S1 and repeat 4.9.1 and 4.9.2. The output of the power source should vary less than ± 7.70 volts rms from 45 Hz to 5 KHz.

4.9.4 This procedure may be performed for any of the other output voltage ranges, other than the 0 to 130 volt range, if desired. In this case, the rear loaded printed circuit board should be rotated to provide the proper output voltage range. The load impedance and output voltage level should be taken from those given in Table 4-1. The output must vary less than ± 0.5 dB from 45 Hz to 5 KHz.

4.10 AC NOISE LEVEL

4.10.1 Connect the Model 1501TC Power Source as shown in Figure 4-3. Adjust the line voltage to 230 volts rms. Adjust the output of the power source to provide 110 volts rms (84.6% of rated output voltage) at 400 Hz.

4.10.2 Close switch S2 and monitor the output of the power source with the Tektronix 533A Oscilloscope with a "W" plug-in. Using the offset feature of the "W" plug-in, observe the positive peak of the output voltage at a vertical sensitivity of .2 volt per centimeter and a sweep rate of 5 milliseconds per centimeter. The peak-to-peak noise and ripple should not exceed .311 volts (60 dB below full output). The noise and ripple output may be slightly greater if the power source is tested at an output frequency of less than 200 Hz.

4.10.3 Remove the plug-in oscillator and short pins 1 and 2 together of the terminal strip TB1 located on the rear panel of the Model 1501TC. The AC rms noise in the output should now be less than 11.0 millivolts rms (80 dB below full output) when read on the differential voltmeter. Remove the short from pins 1 and 2 of TB1 and then insert the plug-in oscillator into the 1501TC.

4.10.4 Steps 4.10.1 through 4.10.3 may be performed on any of the other output voltage ranges, if desired. In this case, the rear loaded printed circuit board should be rotated to provide the proper output voltage range. The load impedance and output voltage level should be taken from those given in Table 4-1. The following chart gives the acceptable noise level output on each voltage range.

Rated Output Voltage	32.5 VAC	65 VAC	130 VAC	260 VAC
Peak-to-Peak Noise Level with 1500 VA Load (See 4.10.2)	0.078 V p-p	0.156 V p-p	0.311 V p-p	0.622 V p-p
RMS Noise Level at No Load (See 4.10.3)	2.75 mv rms	5.5 mv rms	11.0 mv rms	22 mv rms

load adjustments, A1R54 and A1R57, may have to be rotated counterclockwise slightly with a 0.7 power factor load to meet the 0.30 per cent distortion specification.

4.12.3 The REG control usually does not require significant readjustment in order to provide a zero regulation with a 0.7 power factor load at 400 Hz. If the unit is to be operated at a 0.7 power factor in the high frequency region, i.e., 2 KHz to 5 KHz, then it may be necessary to readjust the REG control. In this case, rotate the front panel REG control until zero regulation is obtained at the specific frequency and load condition.

4.12.4 The AC line input power is 5000 watts maximum with an 0.7 power factor load at rated output voltage and an input line voltage of 250 volts rms.

4.12.5 The above tests may be repeated at frequencies other than 400 Hz provided that the capacitance of the series capacitor is changed inversely proportional to the absolute value of the test frequency. For example, at 1 KHz the capacitance value must be divided by 2.5. The series resistance value remains unchanged.

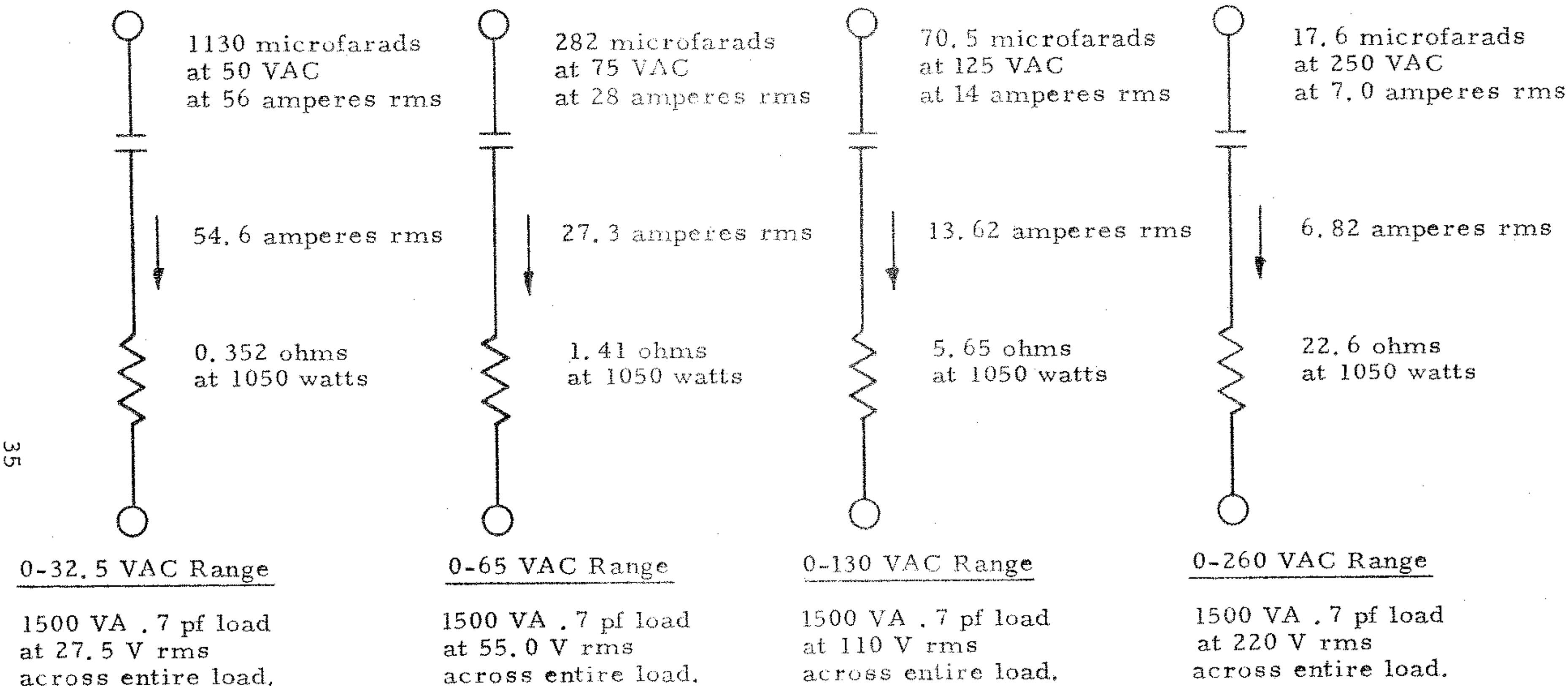

FIGURE 4-5. Load Circuit for 0.7 Leading Power Factor at 400 Hz.

5.1 GENERAL

The California Instruments Model 1501TC Power Source is a solid state unit and should require a minimum of maintenance. However, it is forced air cooled and will accumulate some dust with time. The power transistor heatsinks should receive a forced air bath at intervals not to exceed six months.

CAUTION

Failure to keep the heatsinks clean will reduce their thermal transfer efficiency somewhat and could cause failure of the power source.

5.2 TROUBLESHOOTING

5.2.1 If a problem appears in the power source, it must be isolated to a specific section of the unit. Before servicing the amplifier, check that the AC power input to the unit is of the proper amplitude and frequency. Check that the signal input to the power amplifier is also of the proper amplitude (approximately 5 volts rms) and frequency (45 Hz to 5 KHz). Check that the output load on the power amplifier is not excessive or that the load starting transients are not excessive. Check that the output of the oscillator is coupled to the input of the power amplifier through the 12 pin connector on the rear of the power amplifier.

5.2.2 If the problem has been resolved to be in the power amplifier, first check all DC power supply voltages. Information concerning power supply ripple and voltage tolerance is given in Section 3.2.8 of this instruction manual.

5.2.3 Check that the quasi-complementary symmetry output amplifier is operating properly and is not drawing excessive current under no load conditions. Section 3.2.2 of this instruction manual describes the operation of this output amplifier.

5.2.4 Check that the overload circuitry is operating properly. The overload circuit may be disabled by removing A1CR13 and A1CR14.

5.2.5 If the problem has been resolved to be in the oscillator, consult the applicable oscillator instruction manual.