California INSTRUMENTS

Revised
February 1985

INSTRUCTION MANUAL

MODEL 1001TC

Invertron®

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ASSEMBLY REFERENCE DESIGNATOR	DRAWING NUMBER	TITLE
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A1	D4100-710	PRE-AMPLIFIER, P.C. BOARD ASSEMBLY
A2	E4100-419	POSITIVE POLARITY AMPLIFIER, P.C. BOARD ASSEMBLY
A3	E4100-420	NEGATIVE POLARITY AMPLIFIER, P.C. BOARD ASSEMBLY
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A1, A2, A3 and A6	E4100-087	1001TC SCHEMATIC DIAGRAM

SPECIFICATIONS

MODEL 1001TC 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.

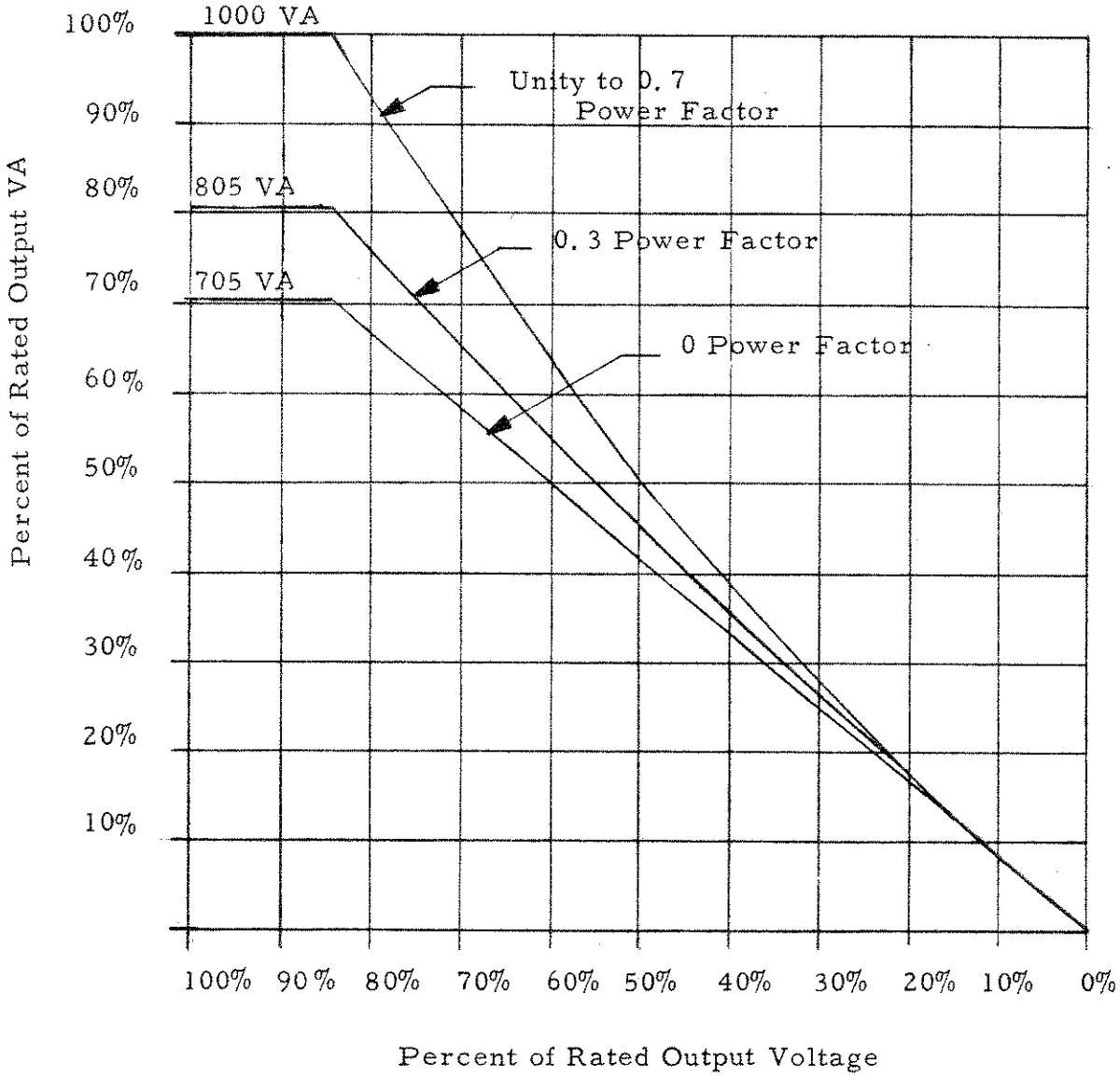
POWER OUTPUT:	1000 VA at 110 to 130 volts rms output from unity to ±0.7 power factor. See derating chart for operation at other output voltages and/or power factor.
OUTPUT VOLTAGE RANGES:	0 to 130 volts rms and 0 to 260 volts rms as determined by rear panel straps.
TOTAL HARMONIC DISTORTION:	Less than 0.30% distortion from 200Hz to 600Hz; less than 0.5% distortion from 45 Hz to 5 KHz.
AMPLITUDE STABILITY: (after one hour warm-up)	±0.25% for 24 hours at constant line, load and ambient temperature conditions.
LOAD REGULATION:	±1% over the range from 45Hz 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 0.1%.
LINE REGULATION:	±0.25% of full output for a ±10% line change.
*FULL POWER FREQUENCY RANGE:	45 Hz to 5 KHz.
FREQUENCY RESPONSE:	±0.5 dB from 45Hz to 5 KHz.
AC NOISE LEVEL:	80 dB below full output with input shorted; 60 dB below full output at full rated power output.
OVERLOAD AND SHORT CIRCUIT PROTECTION:	Complete protection from overloads and short circuits is provided. Automatic reset occurs when overload is removed.

*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.

THERMAL PROTECTION:	Thermal overload circuit is activated if overload exists for a prolonged time period; if the unit is operated at an excessive ambient temperature; or if heatsink fan failure occurs. Automatic reset occurs when heatsink temperature returns to normal operating temperature.
AMPLIFIER DRIVE REQUIREMENTS: (normally obtained from plug-in oscillator)	5 volts rms (maximum) produces 130 volts rms.
AC INPUT LINE:	210 to 250 volts rms. Unit may be wired for the following single phase voltages on special order: 115 VAC, 208 VAC, 220 VAC, and 240 VAC.
AC INPUT FREQUENCY:	48 to 65 Hz. (400 Hz available on special order.)
AC INPUT POWER:	2800 watts maximum under worst case line and full rated load conditions.
OPERATING TEMPERATURE RANGE:	0 to 55°C.
FRONT PANEL METER:	0 to 150 volt and 0 to 300 volt AC voltmeter provides ±1% of full scale accuracy at 400 Hz and ±3% of full scale accuracy over the range from 45 Hz to 5 KHz.
DIMENSIONS:	8.75" high x 19" wide x 21" deep. (22.22cm x 48.26cm x 53.34cm)
NET WEIGHT:	140 lbs.
SHIPPING WEIGHT:	150 lbs.
FRONT PANEL FINISH:	Grey, 26440 per Federal Standard 595 with black silk-screened lettering.

POWER DERATING CHART FOR MODEL 1001TC 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 10KHz; 3.0 to 1.0 factor at 15KHz; and 4.0 to 1.0 factor at 20KHz.)



GENERAL DESCRIPTION

1.1 INTRODUCTION

This instruction manual contains information on the installation, operation, calibration and maintenance of the California Instruments Model 1001TC 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 1001TC Power Amplifier is a solid state, high performance, low distortion power source that provides up to 1000 VA output when used with the proper plug-in oscillator. The Model 1001TC Power Source is illustrated in Figure 1-1. Full power output is available in two different voltage ranges and over the frequency range from 45 Hz to 5 KHz. These full power voltage ranges are:

1) 110 to 130 volts rms for normal single phase 115 volt applications and for three phase 208 to 225 volt line-to-line applications.

2) 220 to 260 volts rms for normal single phase 230 volt applications and for three phase 208 to 260 volt applications where open delta operation is acceptable.

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 2000 VA two phase power (Model 2000TC/2-2), or 2000 VA of three phase power (Model 2000TC/2-3D) in the open delta configuration. Three power amplifiers will provide 3000 VA of three phase power in the wye configuration (Model 3000TC/3-3).

1.3 ACCESSORY EQUIPMENT

The following accessories are available for use with the California Instruments Model 1001TC 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.

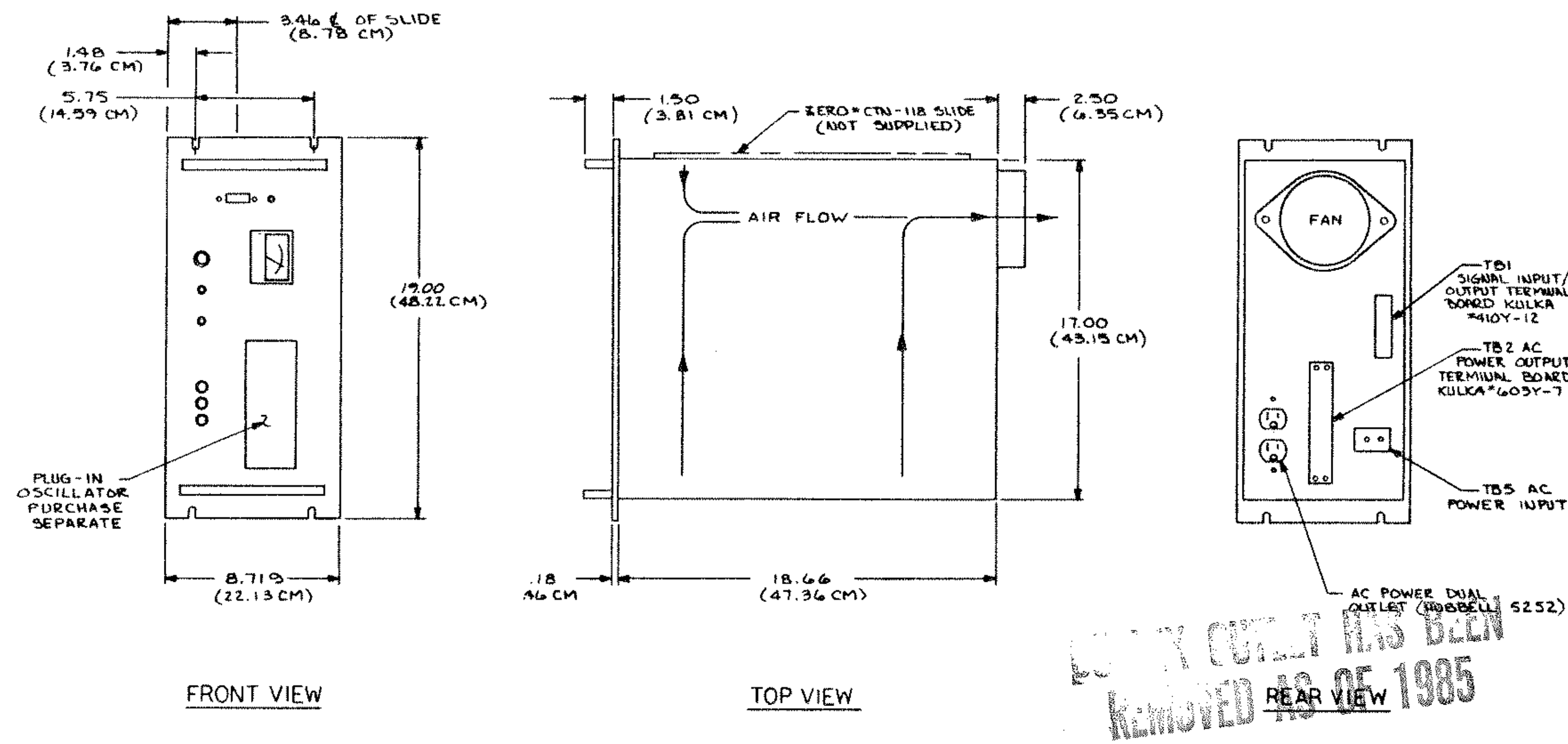
1.3.2 Series 800T Variable Frequency Oscillators. These general purpose Wien bridge oscillators provide one phase, two phase or three phase outputs over the range from 20 Hz to 20 KHz in three bands. Units with single phase output are designated as 800T-20/20K-1-1ϕ, two phase oscillators are designated as 800T-20/20K-1-2ϕ and three phase oscillators are designated as 800T-20/20K-1-3ϕ. Calibration accuracy is ±1 per cent at 25°C. The total harmonic distortion is less than 0.25 percent from 20 Hz to 20 KHz. Several versions of the 800T oscillator are also available which operate over a more restricted frequency range, but which provide improved frequency resolution.

1.3.3. Series 815T Fixed Frequency Oscillators. These low-cost fixed frequency oscillators provide one-phase, two-phase or three-phase outputs over the range from 45 Hz to 10 KHz. Units with single-phase output are designated as 815T-Freq.-.1-1ϕ; two-phase oscillators are designated as 815T-Freq.-.1-2ϕ; and three-phase oscillators are designated as 815T-Freq.-.1-3ϕ. Frequency accuracy is ±0.1 percent at 25°C. Amplitude stability is ±.25 percent per 24 hours at 25°C and varies less than 0.01 percent per degrees centigrade. Harmonic distortion is less than 0.2 percent from 45 Hz to 10 KHz.

1.3.4 Series 835T Programmable Oscillators. These oscillators provide control of voltage amplitude, frequency, and phase angle in multiphase applications. Programming by either parallel BCD or IEEE-488 (1978) is available. These units are packaged in a separate 3.5 inch rack mountable chassis.

1.3.5 The Model 847T Programmable Oscillator is a digitally synthesized, crystal controlled oscillator featuring programmable amplitude and frequency via IEEE-488 BUS or BCD parallel. The 847T Oscillators are available in single-phase, two-phase 90°, three-phase 120° WYE, and three-phase 60° DELTA configurations.

1.3.6 Series 850T Oscillators. These oscillators are decade dialing, digitally synthesized, and crystal controlled. Basic accuracy is ±0.005% of set frequency. Amplitude stability is 0.02% per 24 hours at 23°C, ±0.01% per C maximum average temperature coefficient from 0 to 55°C. The total harmonic distortion is less than 0.15 percent from 45 Hz to 999.9 Hz, less than 0.3 percent 45 Hz to 9999 Hz.



1. FRONT PANEL DIMENSION PER W.E./E.I.A. STANDARD.

NOTES: (UNLESS OTHERWISE SPECIFIED)

REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE

DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = 30'

BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓

DWG SIZE C

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TITLE OUTLINE DRAWING 1000VA POWER SOURCE

MODEL 1001TC

RELEASE | CHECKER | DESIGN | DRFTSMN | PURCHASING | PROJ ENGR | CHF ENGR

DASH NO. | QTY REQD | NEXT ASSEMBLY | EFF ON | AUTH

CALIFORNIA INSTRUMENTS

CONTRACT NO. | CODE IDENT 16067

DWG NO. C4100-902 | REV —

SCALE 1/4 | SHEET 1 OF 1

CALICO 7-80

C4100-902 | 1

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.

INSTALLATION AND OPERATION

2.1 UNPACKING

The California Instruments Model 1001TC 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 1001TC 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 reconnection of power transformer T1, remove all existing jumpers from the primary winding.

Nominal Input Voltage	Operating line Voltage Range	Power Transformer Connections	Front Panel Circuit Breaker Value
115 volts rms	103.5-126.5 volts rms	jumper pins 1 and 3; jumper pins 2 and 6; connect load side of circuit breaker to pin 6.	30 ampere 250 volt circuit breaker
208 volts rms	187.2-228.8 volts rms	jumper pins 2 and 3; connect load side of circuit breaker to pin 4.	20 ampere 250 volt circuit breaker
220 volts rms	198-242 volts rms	jumper pins 2 and 3; connect load side of circuit breaker to pin 5.	20 ampere 250 volt circuit breaker
230 volts rms	207-253 volts rms	jumper pins 2 and 3; connect load side of circuit breaker to pin 6.	20 ampere 250 volt circuit breaker
240 volts rms	216-264 volts rms	jumper pins 2 and 3; connect load side of circuit breaker to pin 7.	15 ampere 250 volt circuit breaker

2.2.2 The Model 1001TC has been designed to operate over the line frequency range from 48 to 65 Hz. On special order, units will be supplied to operate from the 400 Hz. line.

2.2.3 The normal input power, at rated output, is between 1800 and 2800 watts depending on line and load conditions. During "turn-on" the peak transient will generally exceed 3500 watts.

2.3 CIRCUIT BREAKER REQUIREMENTS

The Model 1001TC Power Source uses a 30 ampere Heinemann AM1-30A curve 3 circuit breaker for operation from the 115 volt AC line. A Heinemann AM1-20A curve 3 circuit breaker is used for operation from the 208 volt through 230 volt AC lines, and a AM1-15A curve 3 circuit breaker used for operation from the 240 volt AC lines. **Substitution of circuit breaker type or current rating may cause permanent damage to the unit.**

2.4 OUTPUT VOLTAGE RANGE AND METER RANGE

The output voltage range is determined by the strapping of terminal strip TB2 located on the rear of the Model 1001TC Power Source. The power source is on the 130 volt range when TB2 terminal 3 is connected to TB2 terminal 4 and TB2 terminal 5 is connected to TB2 terminal 6. The 0 to 150 volt meter range is selected by connecting TB2 terminal 2 to TB2 terminal 3. The 0 to 130 volt output may be taken across pin 3 and pin 6 of TB2, or at the rear panel parallel blade power receptacle J5, or across J2 and J3 located on the front panel as desired.

The power source is on the 260 volt range when TB2 terminal 4 is connected to TB2 terminal 5. The 0 to 300 volt meter range is selected by connecting TB2 terminal 1 to TB2 terminal 3. The 0 to 260 volt output may be taken across pin 3 and pin 6 of TB2, or at the rear panel parallel blade power receptacle J5, or across J2 and J3 located on the front panel, as desired.

2.5 ACCEPTANCE TEST PROCEDURE

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. If the unit appears in good condition, perform the following:

2.5.1 Connect the AC line input to an AC power line of the proper voltage and frequency as determined by either the serial number tag on the unit or by inspection of the wiring to the primary of the power transformer (see Section 2.2 of this instruction manual). Use number 10 wire to connect the AC power line to the AC input terminals at the rear of the unit if the unit is being operated from the 115 volt AC line; use number 12 wire if the unit is being operated from the 208 volt through 240 volt AC power line. Connect a 5 KW Variac and a 5 KW wattmeter in series with the AC line. Turn the variac up to the required line voltage and then apply AC line power to the power source. The Model 1001TC Power Source should draw less than 250 watts under no load conditions at mid-line voltage. If a problem is encountered, perform step 4.3.2 of the CALIBRATION PROCEDURE.

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 45Hz 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 as determined 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 Per Cent Power Load Resistance
0-130 volts rms	130 volts rms	16.9 ohms	33.8 ohms
0-260 volts rms	260 volts rms	67.6 ohms	135.2 ohms

2.5.4 Connect the proper 1000 watt load resistor to TB2-3 and TB2-6 on the rear of the power source. Connect an oscilloscope, such as a Tektronix Model 533A, across this load resistor.

2.5.5 Using the GAIN control and 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 2000 to 2200 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 percent 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. If the 50 percent overload remains across the output for more than a few seconds, the front panel circuit breaker may be tripped.

2.5.7 Remove the 50 percent overload resistor and the output should automatically return to normal provided that the front panel circuit breaker has not been tripped.

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 will be tripped if the short circuit remains across the output for a period of time.

2.5.9 If it is desired to check the Model 1001TC Power Source on the 260 volt range, select this range as described in Section 2.4 of this instruction manual and repeat steps 2.5.3 through 2.5.8 of this procedure.

2.5.10 The CALIBRATION PROCEDURE given in Section 4.0 of this manual should be followed if a more detailed evaluation of the unit is required at this time.

2.6 MECHANICAL INSTALLATION

The Model 1001TC Power Source has been designed for rack mounting in a standard 19 inch rack. The unit should be supported from the bottom with a shelf-track or supported from the sides with a pair of rack slides (Zero Mfg. Co. part number CTN118).

The cooling fan on 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 fans and the rear door of the mounting cabinet. Also, the air intake holes on the sides and rear of the power source must not be obstructed.

2.7 INPUT POWER WIRING

The Model 1001TC Power Source will operate from single phase input voltages from 103.5 volts to 264 volts rms in five ranges as described in Section 2.2 of this manual. For 115 volt power, the input lines should have a capacity of 30 amperes or greater. If 187.2 to 264 volt AC power lines are used, their capacity should be 20 amperes or greater.

2.8 OUTPUT POWER WIRING

The power output wires should be large enough to avoid excessive line voltage drops. The internal regulation control is capable of providing greater than 2 per cent overregulation for all normal load conditions. If it is desired to provide a zero output impedance at the load side of the power wiring, it is necessary that these line drops be limited to approximately 1 to 2 per cent of the required output voltage. The following table lists the minimum acceptable wire size for a 1.0 per cent line drop assuming a 1000 VA output at a distance of 20 feet from the power source to the load.

Output Voltage	Maximum Line Drop	Load Current	Loop Length	Minimum Required Wire Size
115 volts	1.15 volts	8.7 amperes	40 ft.	# 15
230 volts	2.30 volts	4.35 amperes	40 ft.	# 21

The wire size should be reduced 3 sizes everytime that the distance between the power source and load is doubled.

2.9 FRONT PANEL CONTROLS

2.9.1 The circuit breaker, located on the front panel of the Model 1001TC Power Source, is used to switch the POWER to the unit "on". At that time the amber indicator lamp located above this switch should illuminate.

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

2.9.3 The front panel METER has a full scale of 0 to 150 volts and 0 to 300 volts and measures the output voltage of the power source to an accuracy of ±1 percent of full scale at 400Hz and ±3 percent of full scale from 45Hz to 5KHz. The 150 volt meter scale is used with the 130 volt range of the power source by connecting pin 2 of TB2 to pin 3 of TB2. The 300 volt meter scale is used with the 260 volt range of the power source by connecting pin 1 of TB2 to pin 3 of TB2.

2.9.4 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 nonlinear load such as an AC motor load or an incandescent lamp load.

2.9.5 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.

2.9.6 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 percent of the reactance of the shunt capacitor at the operating frequency of the system.

2.10 OPERATION OVER EXTENDED FREQUENCY RANGE

2.10.1 This power source must not be driven at signal frequencies below 20Hz or above 20KHz, otherwise permanent damage to the unit may occur. For operation in the region between 20Hz and 45Hz and for operation in the region between 5KHz and 20KHz, derate the output voltage and output power according to Table 2-2 in order to provide reliable operation of the power source.

TABLE 2-2			
Output Frequency	Maximum Safe Sine Wave Output Voltage (rms)		Maximum VA Output at Maximum Safe Output Voltage with ±0.7 Power Factor Load
	130 Volt Range	260 Volt Range	
20 Hz	57.8V	115.6V	440 VA
30 Hz	86.7V	173V	740 VA
40 Hz	115.6V	231V	1000 VA
45 Hz to 5KHz	130V	260V	1000 VA
5 KHz to 10 KHz	65V	130V	250 VA
15 KHz	43.3V	86.7V	105 VA
20 KHz	32.5 V	65V	60 VA

3.1 GENERAL

The California Instruments Model 1001TC Power Source is an all silicon solid state 1000 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 G 1 is used to amplify the input signal to such a level so as to supply adequate drive to the power amplifier G2.

The power amplifier G2 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 G2 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, G1.

The over-all negative feedback is taken from the feedback winding of T2 back to the inverting input of the preamplifier and provides a closed loop gain of 5.5 from the arm of potentiometer R1 to the primary of T2.

The two 130 volt secondary windings of T2 are connected in parallel for the 0 to 130 volt output and are connected in series for the 0 to 260 volt output.

The positive current 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 resistive divider network containing the regulation control, A1R6. As this positive feedback is increased from zero with potentiometer A1R6, the output impedance of the power source is reduced toward zero.

Power transformer T1, along with the associated rectifiers and filters, supply the operating voltages for the plug-in oscillator, the pre-amplifier G1 and the output amplifier G2.

3.2 DETAILED CIRCUIT DESCRIPTION

A schematic diagram for the Model 1001TC Power Source is shown in drawing E4100-087. All components mounted on the printed circuit board, 4100-710, are designated as a part of the A1 assembly. All components on the positive polarity output amplifier board, 4100-419 are designated as a part of the A2 assembly. All components on the negative polarity output amplifier board, 4100-420 are designated as a part of the A3 assembly. All other components are a part of the top assembly. For information on the plug-in oscillator, consult the applicable oscillator manual. The drawings give typical voltage levels and waveforms for the various sections of the power source.

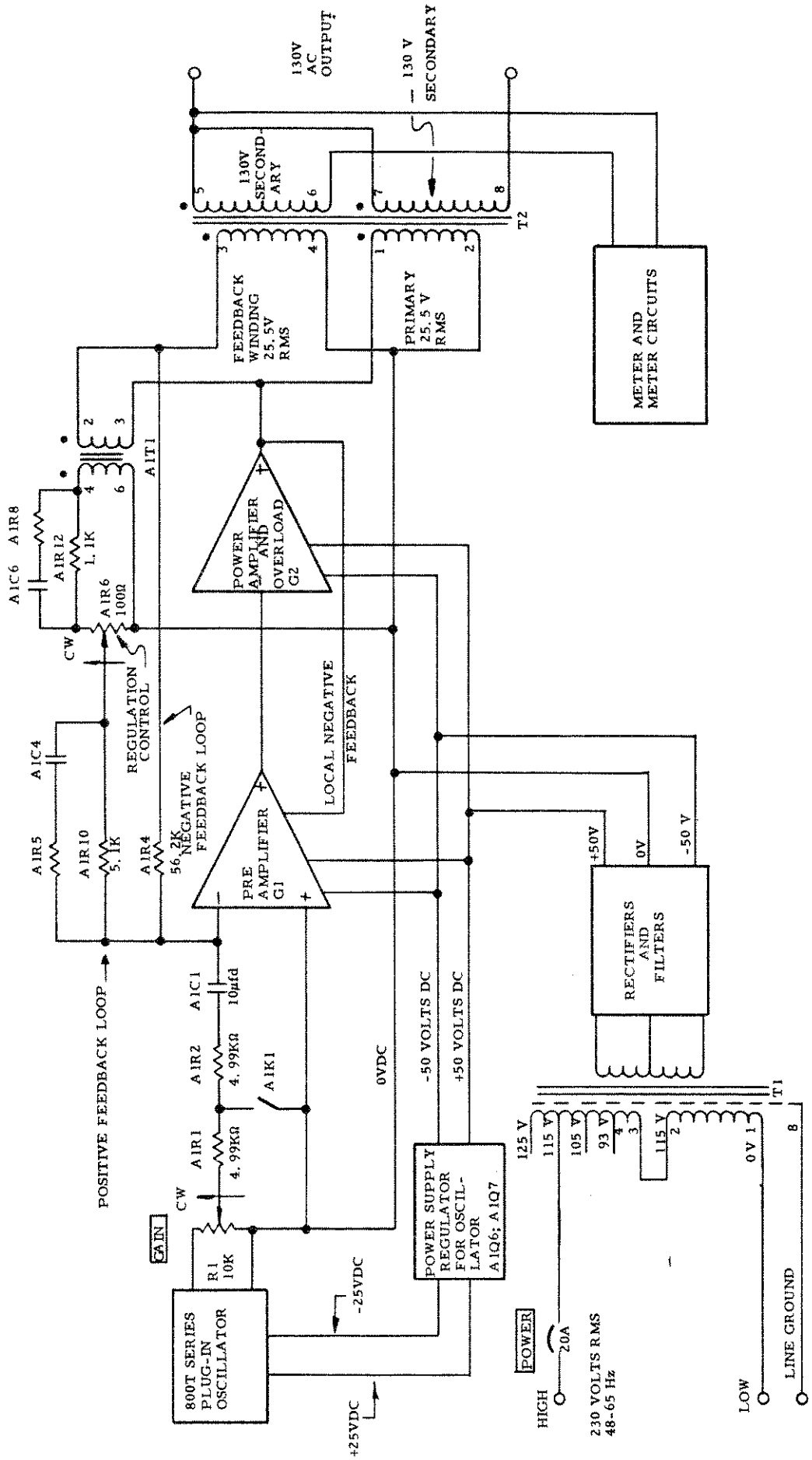


FIGURE 3-1. BLOCK DIAGRAM FOR MODEL 1001 TC POWER SOURCE

3.2.1 PRE-AMPLIFIER

The pre-amplifier G1 is a part of the A1 assembly and consists of integrated circuit A1U1, transistors A1Q1 and A1Q2 and associated components connected as a direct coupled differential amplifier. The open loop gain of this pre-amplifier is approximately 24 at 400 Hz and rolls off at 6 dB per octave above 5 KHz. Integrated circuit A1U1 is a transistor array which contains five active devices, two of which are not used in the pre-amplifier. Integrated circuits A1U1A and A1U1B are connected in the differential amplifier configuration and provide a voltage gain of approximately 12 at 400 Hz. Capacitor A1C2 and resistor A1R20 provide a high frequency step roll off from 5 KHz to 200 KHz.

Potentiometer A1R15, in the emitter circuit of A1U1A and A1U1B, is used to adjust the DC bias at the primary of T2 to zero volts with no signal.

Integrated circuit A1U1C is connected as a zener diode and provides a -6 volt reference voltage for the emitters of A1U1A and A1U1B.

Transistor A1Q1 and A1Q2 are used in the differential amplifier configuration and provide an open loop voltage gain of approximately 2 at 400 Hz.

3.2.2 POWER AMPLIFIER

The power amplifier G2 mechanically consists of the remainder of the A2 board and the A3 board. Electrically, the power amplifier consists of transistors A1Q3 through A1Q5, A2Q1 through A2Q15, A3Q1 through A3Q15, and associated components.

Resistors A1R35 and A1R36 are connected so as to supply a constant current to bias the output stage. This is accomplished by bootstrapping the junction of A1R35 and A1R36 back to the primary of the output transformer T2 via capacitor A1C11. Static DC bias for the output stage is developed across diodes A1CR4 and A1CR5. This allows the output stage to operate as a Class A amplifier for no load or low VA load conditions and to operate nearly as a class B amplifier for large load conditions.

Transistor A1Q5 and associated components are connected in the grounded emitter configuration. Local **negative feedback** is provided by A1C9, A1C10, A1C19, A1R24, A1R34 and A1R38. The local feedback limits the gain of this stage to 36 at 400 Hz. The gain falls off at 6 dB per octave above 25 KHz.

The positive polarity output amplifier A2 consists of A2Q1 through A2Q15 connected as emitter followers. These transistors supply a total of 68 amperes peak during the positive one-half cycle of the output waveform when the power source is loaded to 1000 VA output at 84.6 per cent of rated output voltage (worst case condition within specification limits). These positive output amplifier transistors and their associated heatsink can dissipate over 820 watts with less than a 50°C case temperature rise with an air flow of 60 cfm per heatsink assembly.

The negative polarity output amplifier A3 consists of transistors A3Q1 through A3Q15 connected in the quasi-complementary symmetry configuration. These transistors supply a total of 68 amperes peak during the negative one-half cycle of the output waveform when the power source is loaded to 1000 VA output at 84.6 per cent of rated output voltage (worst case condition within specification limits). These negative output amplifier transistors and their associated heatsink can dissipate over 820 watts with less than a 50°C case temperature rise with an air flow of 60 cfm per heatsink assembly.

When the power source is delivering its full rated output voltage, the primary of the output transformer has a 25.5 volt rms signal.

3.2.3 OVERLOAD PROTECTION

The overload protection circuitry is also shown in drawing E4100-087 and consists of A1Q3, A1Q4 and associated components.

Transistor A1Q3 and associated components are connected as a clamp circuit which is used to protect the positive polarity output amplifier during periods of overload or short circuit. This is accomplished by sensing the load current flowing through A2R3 and applying the resultant voltage drop to the emitter-base junction of A1Q3 through a suitable attenuator network. During periods of overload, the emitter-base junction of A1Q3 is forward biased sufficiently to allow the collector circuit of A1Q3 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 A1R47 is used to set the current level where the overload protection circuit is activated.

Transistor A1Q4 and associated components are used in a similar fashion to protect the negative polarity output amplifier. The only differences are that the control voltage for A1Q4 is sensed across A3R2 and potentiometer A1R50 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 push-pull output stage. Resistors A1R40, A1R42, A1R45, A1R46, A1R48 and A1R49 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

The load current in the secondary of the output transformer T2 is reflected back into the power primary winding producing an IR drop across the power primary winding. The negative feedback winding is connected so as to buck out the $L \frac{di}{dt}$ drop in the power primary winding. The remaining differential signal is applied to the primary of transformer A1T1 and converted into a single-ended signal at the secondary of A1T1. This signal is then applied to the base of A1U1B through a divider network consisting of A1R5, A1R6, A1R8, A1R10, A1R12 and capacitors A1C4, A1C5 and A1C6. Potentiometer, A1R6, which is accessible from the bottom of the 1001TC, is used to adjust the amount of positive feedback and thereby adjust the output impedance of the power source.

3.2.8 POWER SUPPLY

A schematic diagram for the DC power supply is a part of drawing E4100-087. This power supply delivers ±50 volts ±5 per cent at 19.0 amperes DC with less than 2.5 volts peak-to-peak ripple from the 230 volt, 60 Hz AC line. These unregulated supplies consist of rectifier diodes A1CR1 through A1CR4 and filter capacitors C1 and C2 connected in a conventional fashion.

3.2.9 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 a dual scale with a full scale range of 0 to 150 volts AC and 0 to 300 volts AC. The meter rectifiers and scaling circuitry are a part of the A6 assembly. The meter 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 150 volt scale.

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 A1Q8 and associated components. The emitter-base junction of A1Q8 is driven from the voltage developed at the emitter of A2Q3 through a suitable attenuator network. Potentiometer A1R53 is adjusted at the factory so that the excessive load lamp DS3 is activated at the same time that the overload protection transistors A1Q3 and A1Q4 are activated.

3.2.5 THERMAL OVERLOAD INDICATOR LAMP

The front panel thermal overload indicator lamp is activated by thermal switch A2S1, located on the positive polarity heatsink, during periods of excessive heatsink temperature. This switch closes when the heatsink temperature exceeds approximately 105°C and opens when the heatsink temperature drops below approximately 90°C. Thermal switch A2S1 is also used to activate relay A1K1 when the heatsink temperature is excessive. This, in turn, removes the drive signal to A1U1A and allows the Class B power amplifier to return to normal temperature.

3.2.6 OVERALL NEGATIVE FEEDBACK

The overall negative feedback loop is a single-ended operational feedback loop taken from the feedback winding of T2 back to the base of A1U1B via resistors A1R4, A1R7 and capacitor A1C3. This feedback network limits the mid-band closed loop voltage gain of the amplifier to 5.5 from the arm of potentiometer R1 to the primary of T2.

This overall feedback loop provides approximately 30 dB of negative feedback over the range from 45 Hz to 5 KHz. The feedback rolls off at approximately 9 dB per octave for frequencies greater than 10 KHz. The purpose of this feedback loop is to insure that the frequency response, distortion, gain and amplitude stability specifications are met and/or exceeded.

A low frequency negative feedback loop is taken from the power amplifier primary winding of T2 back to the base of A1U1B through A1R11 and A1R18, This loop limits the closed loop voltage gain of the amplifier to approximately 2.3 at DC and thereby provides improved DC bias stability for the amplifier.

3.2.7 POSITIVE CURRENT FEEDBACK

The positive current feedback loop generates a positive current feedback proportional to the load current in the secondary of T2. This is accomplished in the following fashion:

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.

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 1001TC 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, 47 to 65 Hz AC line. For lower values of AC line voltage, 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 0 to 260 volt range. The following table illustrates the change in measurement voltage and impedance level when evaluating the power source on both output voltage ranges.

TABLE 4-1

Rated Output Voltage.	130V AC	260V AC
84.6% of Rated Output Voltage.	110V AC	220V AC
Resistive Load for 1000 VA Output At Rated Output Voltage.	16.9Ω	67.6Ω
Resistive Load for 1000 VA Output at 84.6% of Rated Output Voltage.	12.1Ω	48.4Ω

Section 2.4 of this instruction manual indicates the procedure required to change output voltage range and Section 2.8 indicates some potential problems associated with output wiring IR drop on both voltage ranges. When checking load regulation and amplitude stability, care should be taken to use a four-wire connection such that the external load and the measurement equipment have completely separate wiring from terminal strip TB2 at the rear of the power source.

4.2 TEST EQUIPMENT REQUIRED

The following test equipment is required to perform the calibration procedure assuming that the input line voltage has a nominal value of 230 volts rms and that the power source is tested on the 0 to 130 volt AC range. Some equipment substitutions will be required if this is not the case.

a) Oscilloscope, Tektronix 533A with "W" plug-in, or equivalant.

b) 7.5 KVA Variac® General Radio W5 OHM or equivalent.

c) 5.0 KVA Wattmeter, Simpson Electric or equivalent.

d) Distortion Analyzer, H.P. 334A or equivalent.

e) Differential Voltmeter, Fluke 883A or equivalent.

f) Multi-range 1000 watt load box or individual 1000 watt power resistors, as defined in Table 4-1. Dale type NHL resistors or equivalent.

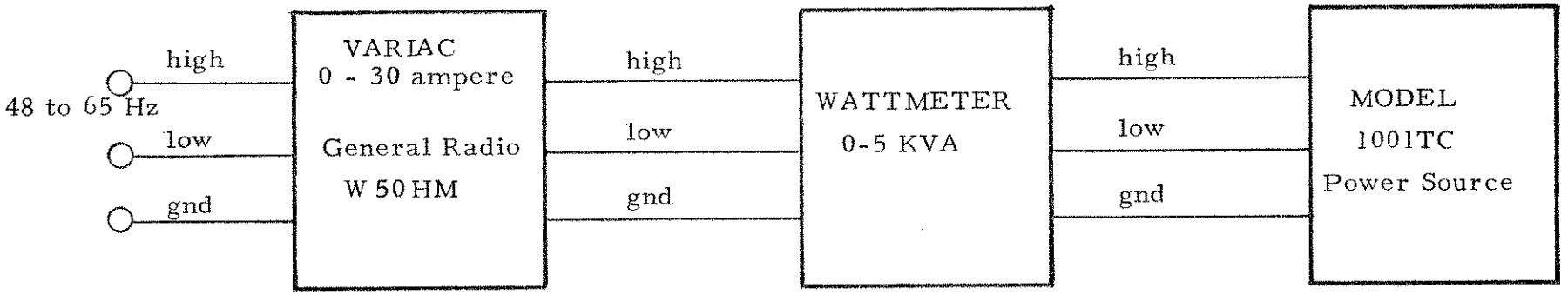
g) Expanded Scale (about 115 VAC) strip chart recorder, Voltron Model 89.038 or equivalent.

h) Multimeter, Triplet 630 NA or equivalent.

4.3 INITIAL ADJUSTMENTS

4.3.1 Connect the Model 1001TC Power Source as shown in Figure 4-1. Turn the GAIN control fully counterclockwise. Adjust the line voltage to its nominal value with the variac®. Turn the POWER switch "on". The wattmeter should indicate 250 watts or less at nominal line voltage. If a problem is encountered, perform step 4.3.2 below.

4.3.2 Remove the top and bottom covers from the unit and connect the differential voltmeter between terminal 1 and terminal 2 of T2. Adjust potentiometer A1R15 (see figure 4-2) so that the DC voltage across the primary of T2 is 0.00 volts ±10 millivolts. This balances and minimizes the collector current in both halves of the output stage. If the power is still greater than 250 watts, resistor A1R37 may be reduced in value and the test repeated.



See Table 2-1 for AC line input wiring to the Model 1001TC Power Source. Unit is normally wired for 207 to 253 volt AC line operation.

FIGURE 4-1. Test set up for initial adjustments of Model 1001TC Power Source

4.3.3 Connect the differential voltmeter to the power output terminals at the rear of the unit and select the 0 to 130 volt range. Adjust the GAIN control for a 130 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 260 volt range at TB2 according to the procedures given in Section 2.4 of this manual. Set the oscillator to 400 Hz and adjust the output to exactly 260 volts while reading the differential voltmeter. Select resistor A1R5 so that the front panel meter and the differential voltmeter correlate within one per cent. Vary the frequency from 45Hz to 5 KHz and check that the front panel meter reads within ±3 per cent of the correct value.

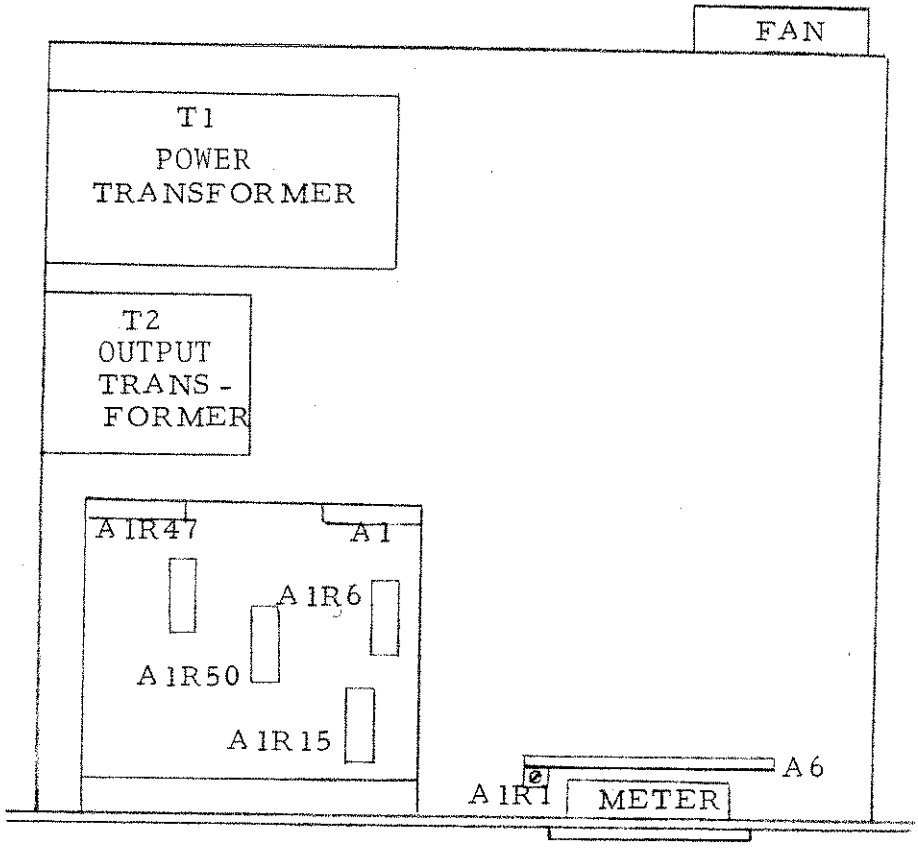
4.4 AC LINE INPUT POWER and OVERLOAD ADJUSTMENT

4.4.1 Connect the Model 1001TC Power Source as shown in Figure 4-3. Select the 130 volt range with the straps on TB2 and adjust the output voltage of the power source to 110 volts rms (84.6 per cent of rated output voltage) at 400 Hz. Close switch S2 (12.1 ohm load) and readjust the output voltage slightly, if required, in order to maintain a 110 volt output. The power source should deliver a clean sine wave output with less than 0.30 per cent distortion. Vary the frequency from 45 Hz to 5 KHz and check that the distortion does not exceed 0.50 per cent over the AC input line voltage range of 207 to 253 volts while maintaining the output voltage at 110 volts rms. Adjust potentiometer A1R47 so that no clipping or excessive distortion occurs on the positive peak of the output waveform under worst case conditions outlined above. Adjust potentiometer A1R50 so that no clipping or excessive distortion occurs on the negative peak of the output waveform under worst case conditions outlined above. These two adjustments may interact somewhat, so care should be taken not to move one adjustment excessively without checking the effect on the other adjustment.

4.4.2 With the AC input line voltage adjusted to its maximum value (normally 253 volts AC), close switch S2 and set the output voltage to 110 volts rms at 400 Hz. The AC line wattmeter should indicate less than 2800 watts.

4.4.3 Repeat step 4.4.2 except close switch S1 instead of S2 and set the output voltage to 130 volts rms (100 per cent of rated output voltage). Maintain the input AC line voltage at 253 volts rms. The AC line wattmeter should indicate less than 2400 watts.

4.4.4 Repeat step 4.4.2 except open switch S1 (no load on output of power source). The AC line wattmeter should indicate less than 300 watts with a line voltage of 253 volts rms.



BOTTOM VIEW

FIGURE 4-2. Internal Adjustments for Model 1001TC Power Source

4.4.5 This procedure may be performed for the 0 to 260 volt range if desired. In this case, the load impedance and output voltage levels should be taken from those given in Table 4-1.

4.5 VOLTAGE, POWER OUTPUT and HARMONIC DISTORTION

4.5.1 Connect the Model 1001TC Power Source as shown in Figure 4-3. Select the 130 volt range with the straps on TB2. Adjust the variac to provide a 230 VAC line input and allow the power source to warm up a few minutes. Set the oscillator output to 400 Hz and adjust the output of the amplifier with the GAIN control to provide 130 volts rms (100 per cent of rated output). Close switch S1 so that the 16.9 ohm load is across the output of the power source.

4.5.2 Vary the AC line voltage from 207 to 253 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 percent 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 0.5 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 0.3 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 0.5 per cent over the full line voltage range.

4.5.6 Repeat steps 4.5.1 through 4.5.5 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 0.3 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 the 0 to 260 volt range, if desired. In this case, 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 1001TC Power Source as shown in Figure 4-3. Select the 130 volt range with the straps on TB2. Set the oscillator frequency to 400 Hz. Close switch S1 (16.9 ohm load) and adjust the output of the power amplifier to 130 volts rms (100 per cent of rated output voltage) at 400 Hz.

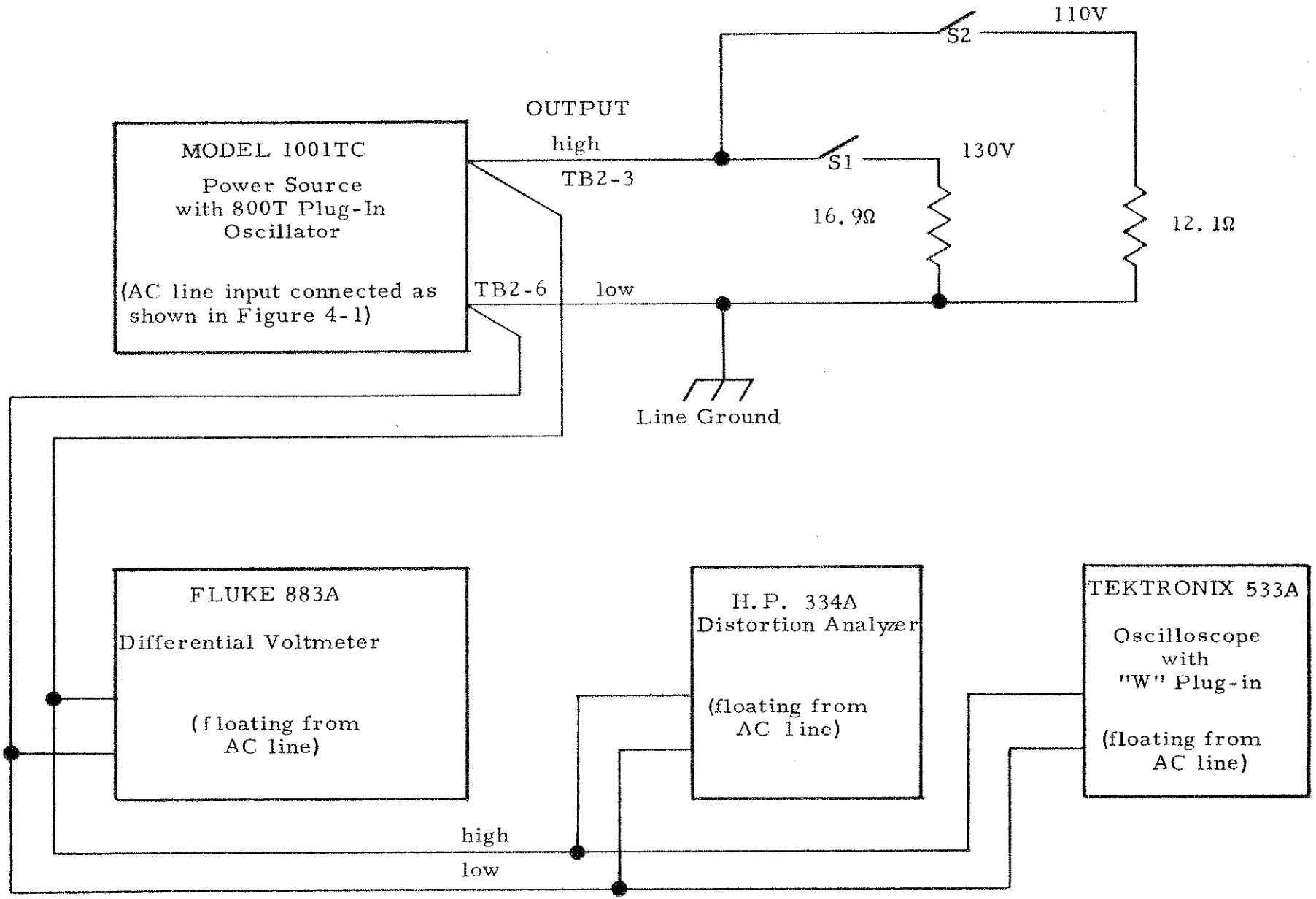


FIGURE 4-3. Test circuit for Model 1001TC Power Source

4.6.2 Vary the line voltage from 207 volts to 253 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.

4.6.4 Set the frequency of the oscillator to 45 Hz and repeat 4.6.1 and 4.6.2. The change in 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.

4.6.5 This procedure may be performed for the 0 to 260 volt range, if desired. In this case, the load impedance and output voltage level should be taken from those given in Table 4-1.

4.7 LOAD REGULATION ADJUSTMENT

4.7.1 Connect the Model 1001TC Power Source as shown in Figure 4-3. Check that the load is connected across TB2-3 and TB2-6 at the rear of the power source. The output voltage may be monitored either at the rear or the front of the power source. If it is monitored at the rear of the power source, care should be taken to use four-wire sensing. Adjust the output voltage of the Model 1001TC Power Source to 110 V rms output (84.6 per cent of rated output voltage) at 400 Hz.

4.7.2 Place the differential voltmeter on the 1000 volt AC range and connect it across the front panel output terminals of the power source. Adjust A1R6 so that the output voltage variation is less than 100 millivolts as the 12.1 ohm load is added and removed. Maintain the line voltage at 230 volts during this test.

4.7.3 Set the frequency of the oscillator to 5 KHz. Adjust the output amplitude of the power source to 110 volts rms with no load on the output of the power source. The output of the power source should change less than ±1.10 volts when loaded with the 12.1 ohm resistor. Maintain the line voltage at 230 volts during this test.

4.7.4 Set the frequency of the oscillator to 45 Hz and repeat 4.7.3. The output of the power source should change less than ±1.10 volts.

4.7.5 This procedure (steps 4.7.1 through 4.7.4) may be performed for the 0 to 260 volt range, if desired. In this case, the load impedance and output voltage levels should be taken from those given in Table 4-1. The load regulation must remain within a ±1 per cent band from 45 Hz to 5 KHz.

4.8 AMPLITUDE STABILITY

4.8.1 Connect the Model 1001TC 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 13.23 ohm (1000 VA) load to the output terminals at the rear of the power source and check that the regulation 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 within ±3 degrees C for this test.

4.8.3 This procedure may be performed for the 0 to 260 volt range, if desired. In this case, 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 1001TC 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 5 KHz 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 ±7.7 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 ±7.7 volts rms from 45 Hz to 5 KHz.

4.9.4 This procedure may be performed for the 0 to 260 volt range, if desired. In this case, 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 1001TC 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 per cent 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).

4.10.3 Remove the plug-in oscillator and short pins 1 and 2 together of the small 12 pin terminal strip TB1 located on the rear panel of the Model 1001TC. 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 the TB1 and then insert the plug-in oscillator into the 1001TC.

4.10.4 Steps 4.10.1 through 4.10.3 may be performed on the 260 volt range, if desired. 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	130V AC	260V AC
Peak-to-Peak Noise Level with 1000 VA Load (see 4.10.2).	0.311 volts p-p	0.622 volts p-p
Rms Noise Level at No Load (see 4.10.3)	11.0mv rms	22.0mv rms

4.11 0.7 LAGGING POWER FACTOR

4.11.1 Connect the Model 1001TC Power Source as shown in Figure 4-3. Select the load circuit to correspond with the required output voltage range. Figure 4-4 illustrates the load circuit and gives load parameter values for 1000 VA 0.7 power factor at 400 Hz with 84.6 per cent of rated output voltage from the power source. This represents the worst case inductive load for maximum power dissipation inside the power source.

4.11.2 Set the oscillator frequency to 400 Hz and adjust the GAIN control for 84.6 per cent of rated output voltage. Check that the power source produces a stable output with no high-frequency oscillation or excessive distortion. Refer to Section 4.5 of this instruction manual for the procedure to measure harmonic distortion. This distortion must be less than 0.3 per cent at 400 Hz.

4.11.3 The regulation 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 regulation control. In this case, rotate the internal regulation control until zero regulation is obtained at the specific frequency and load condition.

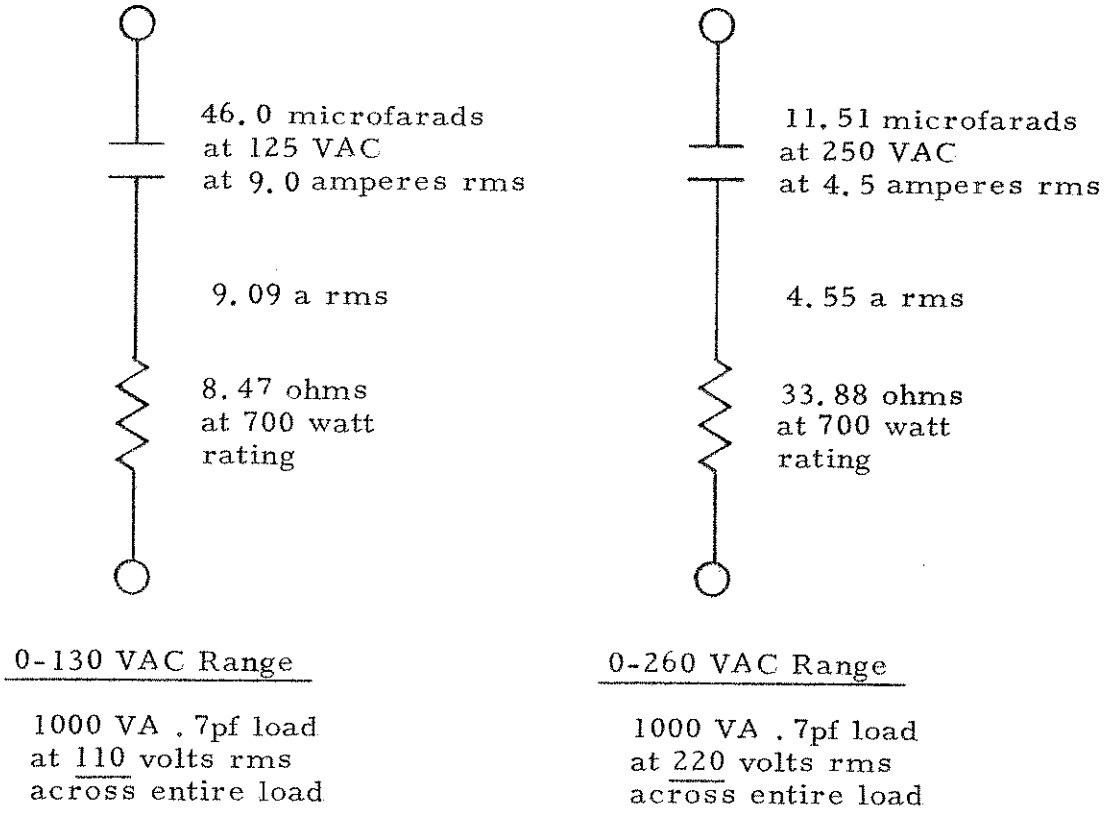


FIGURE 4-5. Circuit for 1000 VA. 0.7 Leading Power Factor Load at 400 Hz.

4.11.4 The AC line input power is 2800 watts maximum with a 0.7 power factor load at 84.6 per cent of rated output voltage and an input line voltage of 253 volts rms.

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

4.12 0.7 LEADING POWER FACTOR

4.12.1 Connect the Model 1001TC Power Source as shown in Figure 4-3. Select the load circuit to correspond with the required output voltage range. Figure 4-5 illustrates the load circuit and gives load parameter values for 1000 VA 0.7 power factor operation at 400 Hz with 84.6 per cent of rated output voltage from the power source. This represents the worst case capacitive load for maximum power dissipation inside the power source.

4.12.2 Set the oscillator frequency to 400 Hz and adjust the GAIN control for 84.6 per cent of the rated output voltage. Check that the power source produces a stable output with no high frequency oscillation or excessive distortion. Refer to Section 4.5 for the procedure to measure harmonic distortion. This distortion must be less than 0.3 per cent at 400 Hz.

4.12.3 The regulation 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 regulation control. In this case, rotate the internal regulation control until zero regulation is obtained at the specific frequency and load condition.

4.12.4 The AC line input power is 2800 watts maximum with an 0.7 power factor load at 84.6 per cent of rated output voltage and an input line voltage of 253 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.

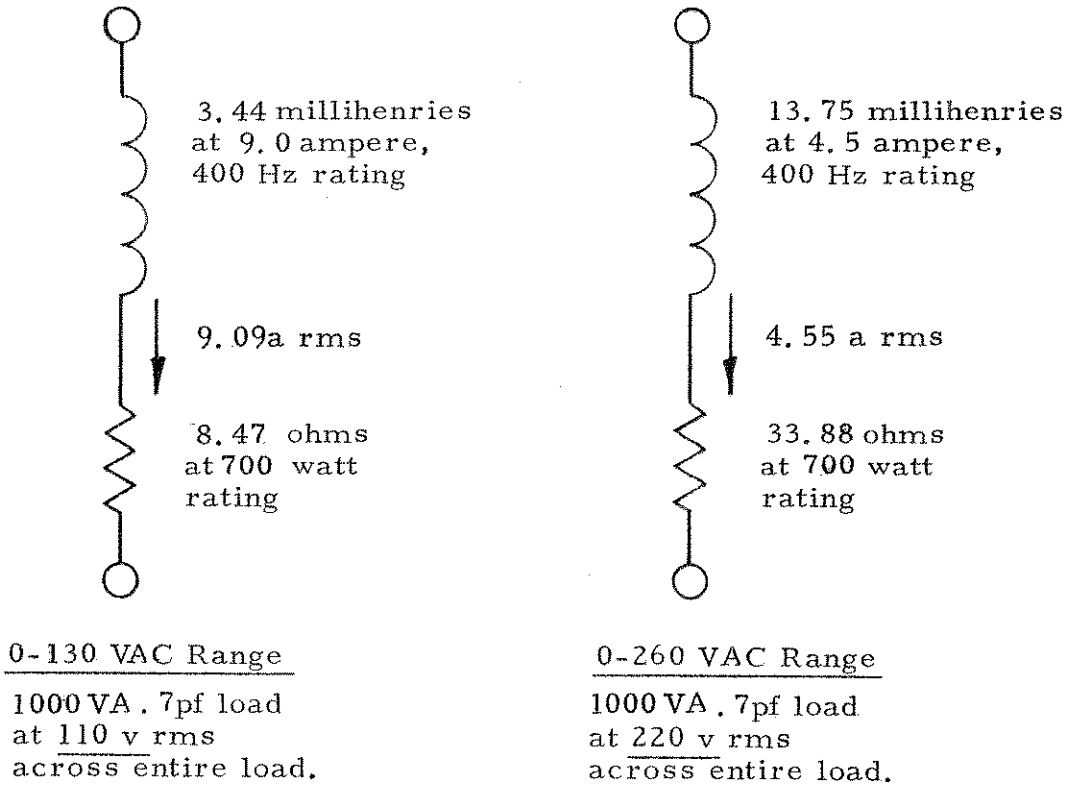


FIGURE 4-4. Circuit for 1000 VA 0.7 Lagging Power Factor Load at 400 Hz.

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.

5.1 GENERAL

The California Instruments Model 1001TC 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 6 months.

CAUTION

Failure to keep the heatsinks clean will reduce their thermal transfer efficiency somewhat and could eventually 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 TB1 on the rear of the power source.

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 diodes A1CR2 and A1CR6.

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

6.1 GENERAL

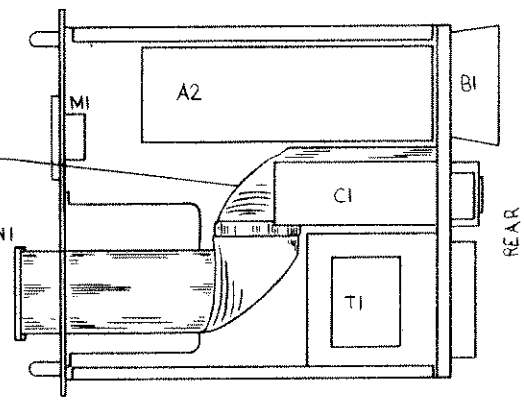
This section contains schematics and mechanical diagrams necessary for operation and maintenance of the Model 1001TC AC Power Source. The schematic diagrams illustrate the circuit while the mechanical assemblies indicate the part placement.

6.2 REFERENCE DESIGNATIONS

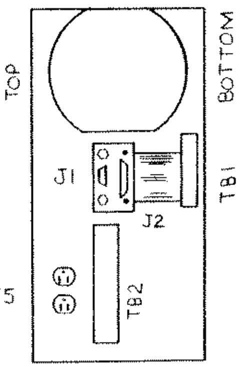
Partial reference designators are shown on schematic and mechanical drawings. Prefix these reference designators with assembly and/or sub-assembly designation for the complete reference designator. For example:

Assembly/Sub-Assembly	Component	Component Designation
A1	C8	A1C8
None	T1	T1

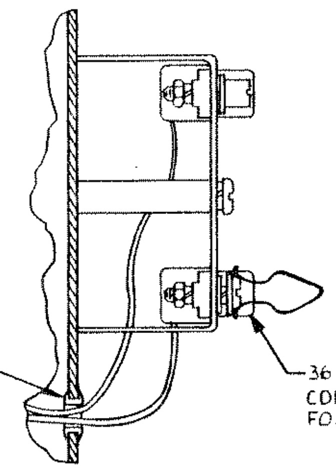
REV	DESCRIPTION	DATE	APPROVED
	SEE SHT ONE		



OPTION GPIB CABLE ASSY
SHOWN ARE FOR MODELS 1001TC & 1201TC
TOP REMOVED FOR CLARITY



DUPLEX OUTLET HAS BEEN
REMOVED AS OF 1985



DETAIL ASSEMBLY OF CONNECTORS
TO REAR PANEL
USE CABLE KIT ASSY 4845-406-1
OR 4845-406-2

4100-401 J

REQD PER ASSY	ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL SPECIFICATION	CODE IDENT	NOTE NO.
	-1	ASSEMBLY				

LIST OF MATERIAL

QTY REQD	USED ON	NEXT ASSY
	1001TC & 1201TC	

DIM IN INCHES TOLERANCES XXX ± .010 XX ± .03 X° ± 30'

BREAK ALL SHARP CORNERS & EDGES

MACH SURFACES √

DWG SIZE C

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FINISH

TITLE
TOP ASSEMBLY,
1000 VA PWR SOURCE

RELEASE	R. Lidyard	6/9/83
PROJ ENG	[signature]	6/9/83
CHECK	[signature]	6/7/83
DESIGN	[signature]	6-8-83
DRAFT	S. [signature]	5/4/83

ADDITIONAL APPROVALS

California Instruments
A DIVISION OF AMSTAR TECHNICAL PRODUCTS CO. INC.
SAN DIEGO CALIFORNIA

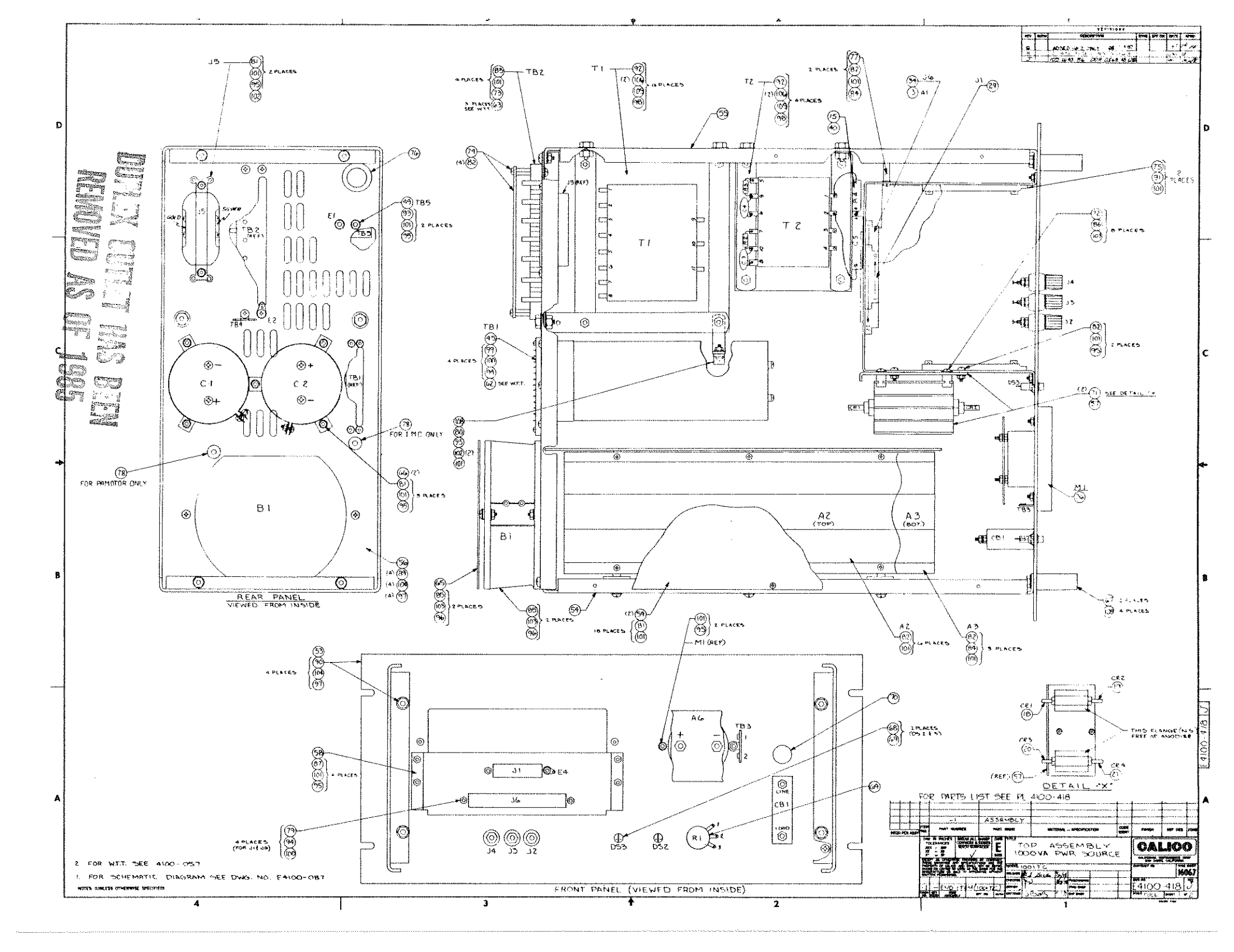
CONTRACT NO

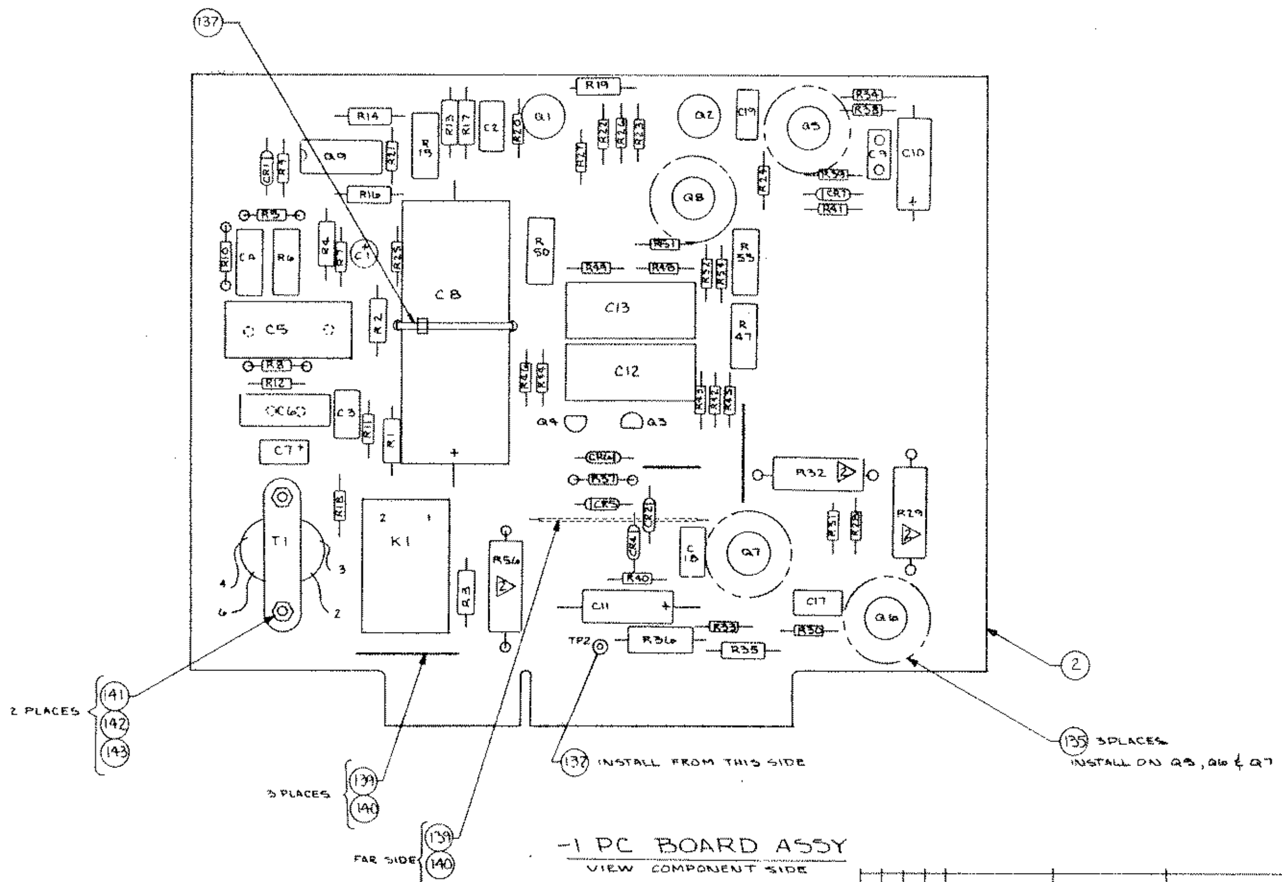
CODE IDENT 16067

DWG NO 4100-418 REV J

SCALE NONE SHEET 2 OF 2

NOTES: (UNLESS OTHERWISE SPECIFIED)


REAR PANEL
VIEWED FROM INSIDE
FRONT PANEL (VIEWED FROM INSIDE)
DETAIL "X"
FOR PARTS LIST SEE PL 4100-418
FOR IMC ONLY
FOR PMMOTOR ONLY
T1
T2
A2 (TOP)
A3 (BOT.)
B1
C1
C2
TB1
TB2
TB3
TB4
TB5
J1
J2
J3
J4
J5
J6
M1
CB1
R1
DS2
DS3
E1
E4
A6
TOP ASSEMBLY
1000VA PWR SOURCE
CALICO
4100-418
J
14067
E
2. FOR W.T.T. SEE 4100-057
1. FOR SCHEMATIC DIAGRAM SEE DWG. NO. E4100-087
NOTES: UNLESS OTHERWISE SPECIFIED



-1 PC BOARD ASSY

VIEW COMPONENT SIDE

⚠ INSTALL R29, R32 & R56 .25 OFF PC BOARD.

1. FOR SCHEMATIC SEE DWG NO. E 4100-087

NOTES: (UNLESS OTHERWISE SPECIFIED)

PL 4100-710-1 PARTS LIST SHEET 4 & ON				
ITEM NO.	PART NUMBER	PART NAME	MATERIAL – SPECIFICATION	CODE IDENT

TITLE: PC BOARD ASSEMBLY PREAMPLIFIER A1

MODEL: 1001TC

CALICO — CALIFORNIA INSTRUMENTS CORP SAN DIEGO, CALIFORNIA

CODE IDENT: 16067

DWG NO. D4100-710 REV B

SIZE D

SCALE 2x — SHEET 2 OF 7

-1 | 1 | 4100-418-1 (NEXT ASSEMBLY)

DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = 30'

BREAK ALL SHARP CORNERS & EDGES; MACH SURFACES ✓

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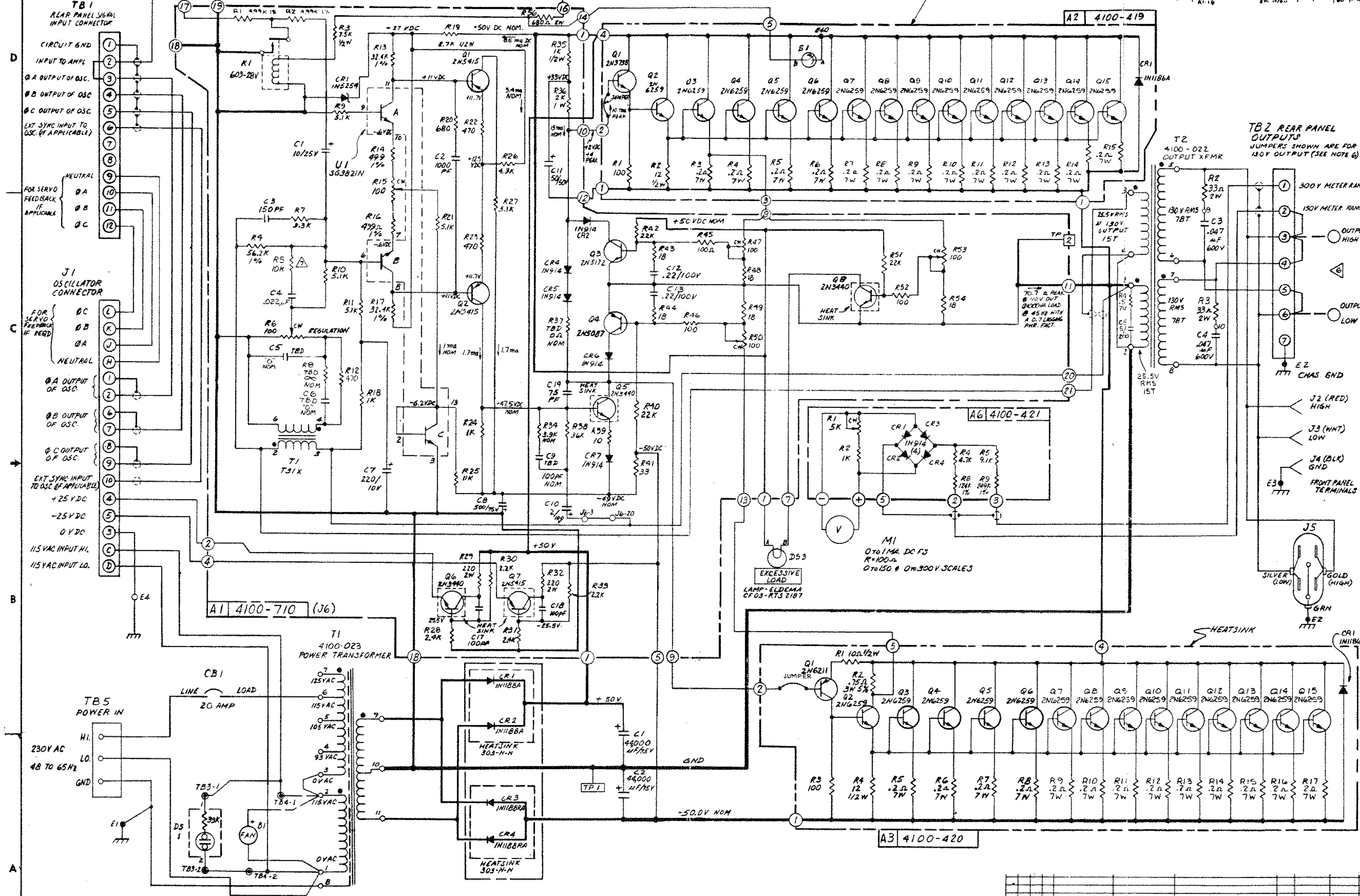
D4100-710 B



5 PREFIX PART NO. WITH APPROPRIATE BD NO. (EXAMPLE: R1 ON BD A1 = A1R1)
4 FOR WIRE TAB TABLE SEE
3 FOR TOP ASSEMBLY DRAWING SEE 4100-418
2. ALL RESISTORS ARE IN OHMS, 1/4W 5%.
1. ALL CAPACITANCE IS IN MICROFARADS
NOTES: (UNLESS OTHERWISE SPECIFIED)

6 FOR 260V OUTPUT, REMOVE ALL EXISTING JUMPERS FROM TB2 AND ADD JUMPERS FROM TB2-4 TO TB2-5 & TB2-1 TO TB2-3. CONNECT EXTERNAL LOAD FROM TB2-3 TO TB2-6.

7 R5 MAYBE ADJUSTED TO PROVIDE PROPER LOAD REGULATION AT 5KHz. THE VALUE OF R5 MUST NOT BE LESS THEN 2.7K.

REVISIONS

REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APPD
A	DDR	PROTYPE CLEAN-UP AB 1-10-79				
B	DDR	A1R12 WAS 1.1K AB 6-5-79				
C	DL	E.C.O. 953 4-20-79			[illegible]	[illegible]
D	DC	REMOVED CONN. FROM A1-11 TO A1-18			[illegible]	[illegible]

QTY REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE

TITLE: SCHEMATIC DIAGRAM 1000VA AC POWER SOURCE

DWG SIZE: E

MODEL: 1001TC

CODE IDENT: 16067

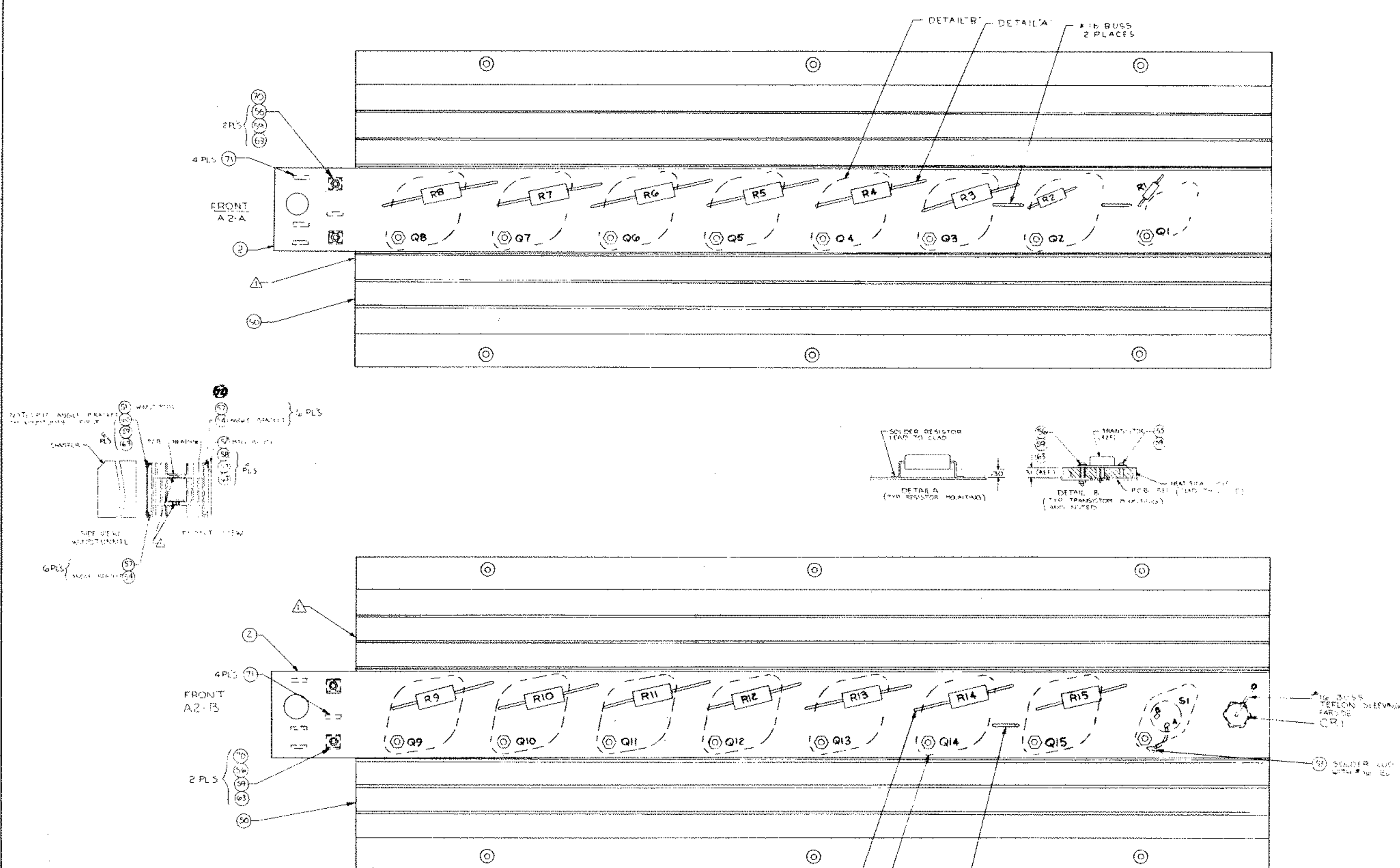
DWG NO. E4100-087 REV D

SCALE: NONE SHEET 1 OF 1

DRAFTSMAN: J. Butts

PROJ ENGR: J. Rouse

REV	AUTH	DESCRIPTION			DATE	APPD
C		ADD ITEM # 72				



-1 ASSEMBLY (A2)

ALL CLAD SHOWN IS NEAR SIDE

WIRE TAB TABLE				
NO.	FROM	TO	AWG	COLOR
1	A2A-1	A2B-1	12	WHT
2	A2A-4	A2B-4	12	WHT
3	A2A-17	A2B-17	20	WHT
4	A2A-16	A2A-6	20	WHT
5	A2BS1-B	A2B-7	20	WHT

2. FOR SCHEMATIC SEE DWG. 4100-0187.

△ MARK ASSY. DASH NO. APPROX AS SHOWN.

NOTES: UNLESS OTHERWISE SPECIFIED

FOR PARTS LIST SEE 4100-419-1

ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES	ZONE

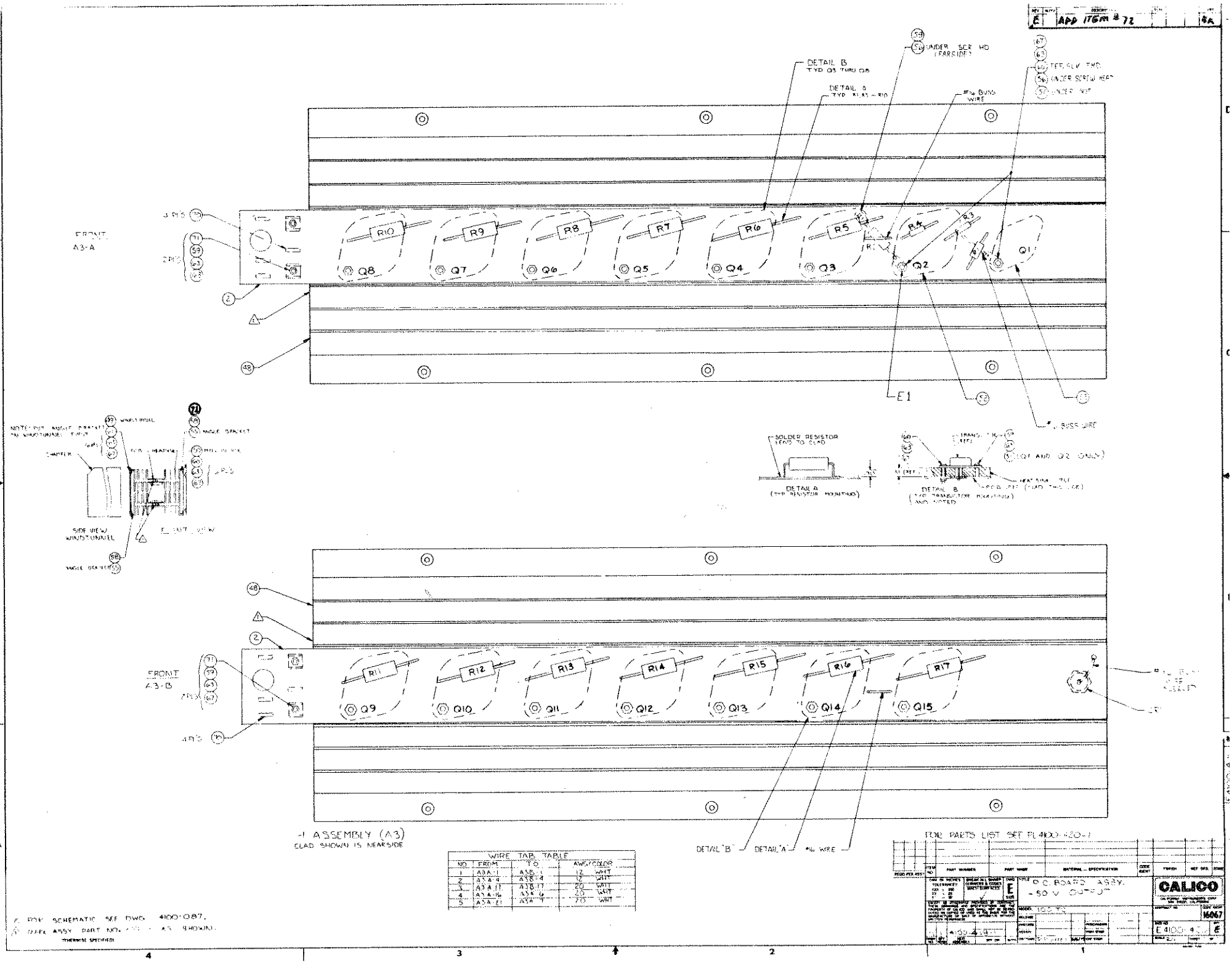
TITLE: P.C. BOARD ASSY. +50 V OUTPUT

DWG SIZE: E

CALICO — CALIFORNIA INSTRUMENTS CORP. SAN DIEGO, CALIFORNIA

CODE IDENT: 16067

DWG NO.: E 4100-419 — REV C



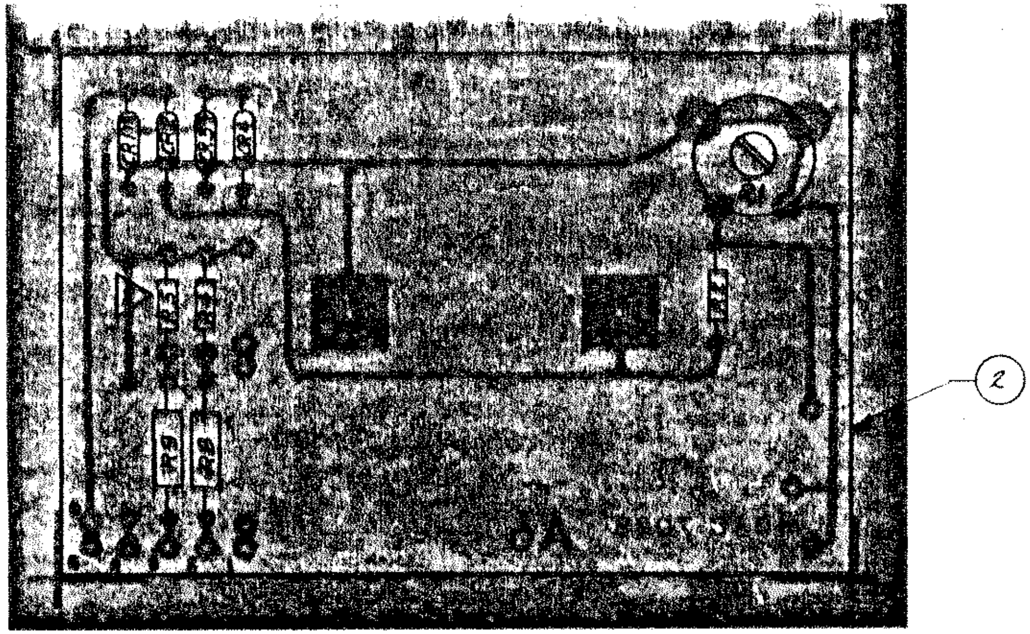
-1 ASSEMBLY (A3)
CLAD SHOWN IS NEARSIDE

WIRE TAB TABLE			
NO.	FROM	TO	AWG/COLOR
1	A3A-1	A3B-1	12 WHT
2	A3A-9	A3B-9	12 WHT
3	A3A-17	A3B-17	20 WHT
4	A3A-16	A3A-6	20 WHT
5	A3A-21	A3A-7	20 WHT

2. FOR SCHEMATIC SEE DWG 4100-087.
3. PWB ASSY PART NO. [illegible] - A3 SHOWN.
UNLESS OTHERWISE SPECIFIED

REVISIONS

REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
A		ADD -2 & -3 ASSY'S			11-26-84	



-1, -2, -3 ASSY'S

FOR PARTS LIST SEE PL 4100-421-1, -2, -3

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE

DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = .30'

BREAK ALL SHARP CORNERS & EDGES MACH SURFACES √

DWG C SIZE

TITLE VOLTMETER BOARD ASSY A6

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MODEL 1001TC

DASH NO.	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH
-1	1	4100-418-1		

RELEASE: [signature] 11/30/76
CHECKER: [signature] 11/17/76
DESIGN
DRFTSMN: [signature] 11/8/77
PURCHASING
PROJ ENGR
CHF ENGR

CALIFORNIA INSTRUMENTS

CONTRACT NO.
CODE IDENT 16067
DWG NO. C4100-421
REV A
SCALE 2/1
SHEET 1 OF 1

CALICO F-102

2 MOUNT R4 & R5 FAR SIDE

1. FOR SCHEMATIC SEE E4100-087

NOTES: (UNLESS OTHERWISE SPECIFIED)

REPLACEABLE PARTS

7.1 GENERAL

This section contains ordering information and complete list of replaceable parts. Parts are listed by major assembly in alphanumerical order of their reference designators. Description, manufacturers' part number, manufacturers' code ident number (see Appendix A for list of manufacturers), and California Instruments' stock number are indicated.

7.2 ORDERING INFORMATION

In order to provide our customers with prompt service on replacement parts, please provide the following information, when applicable, for each part ordered:

a) Model number and serial number of the instrument.

b) California Instruments part number of the sub-assembly where component is located.

c) Component reference designator.

d) Component description.

e) Component manufacturer's number and code ident.

f) California Instruments stock number.

All replacement parts orders should be placed with California Instruments, Division of Amstar Technical Products Co., Inc., San Diego, California, 92111-1266.

7.3 COMPUTER GENERATED PARTS LISTS

The following information is included as an explanation of the computer formatted parts list column.

7.3.1 "Seq. No." - Sequence number; the reference designator or the component, or (if there is no reference designator) the balloon number (bubble or "find" number) on the face of the assembly drawing or the top assembly drawing. They are listed in alpha-numerical order.

7.3.2 "Component Item No." - This is California Instruments part number. Please use this number when ordering spares.

7.3.3 "Description, Truncated" - A brief description of the item. Abbreviations are per MIL-STD-12 or industry accepted standards.

7.3.4 "Engineering Drawing No." - This is used for one of the following:

a) The document/specification number generated by California Instruments to control the part.

b) The generic part number (military specification or industry accepted standard).

c) The primary vendor's catalog part number. An asterisk at the end of the number indicates number is longer than that shown (contact California Instruments if the full number is required).

7.3.5 "Vendor" - This is the FSCM code identification (see Appendix A).

7.3.6 "Quan" and "U/M" - The requirements per unit of measure such as: "2 each"; "1 lb."; "4 oz."; or "6 SI" (square inches).

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
	4100-057-0	HARNESS ASSY,JUMPER	4100-057 REV A	16067	1.0	EA
	4100-057-1	HARNESS ASSY	4100-057 REV E	16067	1.0	EA
	4100-425-1	FRONT PANEL ASSY	4100-425	16067	1.0	EA
CB1	270039	CIRCUIT BREAKER,20A,250V	AM12-20-250-5-6	74193	1.0	EA
CR1	310221	DIODE,RECT,40A,400V,DO5	1N1188A	07716	1.0	EA
CR2	310221	DIODE,RECT,40A,400V,DO5	1N1188A	07716	1.0	EA
CR3	310257	DIODE,RECT,40A,400V,DO5	1N1188RA	07716	1.0	EA
CR4	310257	DIODE,RECT,40A,400V,DO5	1N1188RA	07716	1.0	EA
DS1	241021	LAMP,GAS,AMBER,120V	BG03ACSNE2H/33K	03797	1.0	EA
DS2	250309	LAMP,INCAND,RED	CF03-RTS-2187	03797	1.0	EA
DS3	250309	LAMP,INCAND,RED	CF03-RTS-2187	03797	1.0	EA
E4	250115	LUG,RING,SOLDER,#4	1412-4	83330	1.0	EA
J2	240041	BINDING POST,RED	DF-31RC	58474	1.0	EA
J3	240090	BINDING POST,WHT	DF-31WTC	58474	1.0	EA
J4	240040	BINDING POST,BLK	DF-31BC	58474	1.0	EA
M1	CIC800	METER,DC,ANLG,MA,0-1	CIC800-0	16067	1.0	EA
M1	CIC800-18	MTR FACE,MTL,W/4050-100	CIC800/4995-285	16067	1.0	EA
R1	570128	POT,PNL,10K,1/2W,PREC	B4010-012-1	16067	1.0	EA
TB3	250052	TERMINAL STRP, 2TERM,1MT	863	83330	1.0	EA
53	110655-1	PANEL,FRONT W/4100-227	4100-227-1	16067	1.0	EA
57	110659	BRACKET,MOUNTING,H/S	4100-232-7	16067	1.0	EA
58	110136	BRACKET,PLUG-IN,OSC	4100-211-1	16067	1.0	EA
64	240233	KNOB,BLK	PS-70-2-BLK	21604	1.0	EA
67	240224	HANDLE,FLT,S/S,6"	11520-S-0832-4	06540	2.0	EA
68	250078	SOCKET,LAMP	Q-082-2K	03797	2.0	EA
69	250077	MTG CLIP,LAMP	Q-081-905	03797	2.0	EA
71	210456	HEATSINK,DO10	303S-N-N	05820	2.0	EA
72	210457	INSULATOR,HEATSINK,TFE	TYPE 104	05820	8.0	EA
75	241124	GUIDE,PWB,4.15"	33-9016-12-01-*	91662	2.0	EA
77	210090	STANDOFF,6-32 X 11/4"	8428	83330	1.0	EA
	4100-426-1	REAR PANEL ASSY	4100-426	16067	1.0	EA
B1	241172	FAN,6",115VAC,50/60HZ	MODEL 12	99743	1.0	EA
C1	611065	CAP,AL,44000UF,75V	500443U075DG2B	00853	1.0	EA
C2	611065	CAP,AL,44000UF,75V	500443U075DG2B	00853	1.0	EA
E2	250047	LUG,RING,SOLDER,#6	1416-6	83330	1.0	EA
J5	241073	CONN,AC RCPT,3W,DUP,125V	5252	74545	1.0	EA
TB1	241123	TERMINAL BLK,12TERM, 5A	410-Y-12	75382	1.0	EA
TB2	250327	TERMINAL BLK, 7TERM,50A	603-Y-7	75382	1.0	EA
TB4	250052	TERMINAL STRP, 2TERM,1MT	863	83330	1.0	EA
TB5	240321	TERMINAL BLK, 3TERM,85A	9-85-3	75382	1.0	EA
56	110658-1	PANEL,REAR W/4100-230	4100-230-1	16067	1.0	EA
62	250090	JUMPER,TERMINAL BLOCK	410J	75382	1.0	EA
63	250328	JUMPER,TERMINAL BLOCK	603-J	75382	3.0	EA
65	210074	FAN GUARD	5506	23936	1.0	EA
66	241052	CAP CLAMP, 3"	4586-2	56289	2.0	EA
73	210063	STANDOFF,6-32 X 1/2"	2322	83330	4.0	EA
76	210611	GROMMET,RUBBER,3/4"DIA	2186	83330	1.0	EA
78	210088	GROMMET,RUBBER,5/16"DIA	2151	08065	1.0	EA
93	210067	SCREW,PNH,S/S,6-32X1-1/2	MS51957-36	81349	2.0	EA
99	210396	SCREW,RDH,S/S,4-40X1/2	4-40X1/2 ROUND	81349	4.0	EA
	4100-427-1	SIDE RAIL ASSY,RIGHT	4100-427	16067	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
C3	611066	CAP,MYLAR,.047UF,600V	6DP-3-473	72136	1.0	EA
C4	611066	CAP,MYLAR,.047UF,600V	6DP-3-473	72136	1.0	EA
C5	610632	CAP,MYLAR,5UF,200V	210B1C505	14752	1.0	EA
R2	540069	RES,CARB,2W,33 OHM	RC42GF330J	81349	1.0	EA
R3	540069	RES,CARB,2W,33 OHM	RC42GF330J	81349	1.0	EA
R4	550143	RES,PWR,7W,.5 OHM,3%	RS-7-.5 OHM	91637	1.0	EA
T1	710319	TRANSFORMER,INPUT	4100-023-1	16067	1.0	EA
T2	710318	TRANSFORMER,OUTPUT	4100-022-1	16067	1.0	EA
55	110657	SIDE RAIL,RIGHT	4100-229-7	16067	1.0	EA
92	210220	BOLT,HEX,S/S,1/4-20X3/4	1/4-20X3/4	81349	8.0	EA
98	210298	NUT,HEX,S/S,1/4-20	MS35649-2254	81349	8.0	EA
105	210459	WASHER,SPLT,1/4	MS35338-139	81349	8.0	EA
106	210097	WASHER,FLAT,1/4	MS15795-810	81349	8.0	EA
A1	4100-710-1	PC ASSY,PREAMP	4100-710 REV C1	16067	1.0	EA
A2	4100-419-1	HEATSINK ASSY,OUT DRIVER	4100-419 REV B1	16067	1.0	EA
A3	4100-420-1	HEATSINK ASSY,OUT DRIVER	4100-420 REV D2	16067	1.0	EA
A6	4100-421-1	PC ASSY,METER,VOLT	4100-421 REV 0	16067	1.0	EA
54	110656	SIDE RAIL,LEFT	4100-228-7	16067	1.0	EA
59	110368	COVER,TOP & BOTTOM	4050-225-7	16067	2.0	EA
74	250329	MARKER STRP, 7TERM,603Y	MS603-Y-7-NPG	75382	1.0	EA
79	FS1018	SCREW,PNH,S/S,4-40X1/2	MS51957-17	81349	4.0	EA
80	FS1032	SCREW,PNH,S/S,6-32X1/2	MS51957-30	81349	1.0	EA
81	FS1030	SCREW,PNH,S/S,6-32X3/8	MS51957-28	81349	27.0	EA
82	FS1028	SCREW,PNH,S/S,6-32X5/16	MS51957-27	81349	12.0	EA
83	FS1036	SCREW,PNH,S/S,6-32X3/4	MS51957-32	81349	14.0	EA
84	FS1001	SCREW,FLH,S/S,6-32X5/16	MS24693-C25	81349	4.0	EA
85	FS1051	SCREW,PNH,S/S,8-32X5/8	MS51957-46	81349	4.0	EA
86	FS1051	SCREW,PNH,S/S,8-32X5/8	MS51957-46	81349	8.0	EA
87	FS1031	SCREW,PNH,S/S,6-32X7/16	MS51957-29	81349	4.0	EA
88	FS1059	SCREW,PNH,S/S,10-32X5/8	MS51958-64	81349	4.0	EA
89	FS1056	SCREW,PNH,S/S,10-32X3/8	MS51958-61	81349	4.0	EA
90	FS1060	SCREW,FLH,S/S,10-32X5/8	MS24696-C273	81349	4.0	EA
91	FS1024	SCREW,PNH,S/S,6-32X3/16	MS51957-25	81349	4.0	EA
92	210220	BOLT,HEX,S/S,1/4-20X3/4	1/4-20X3/4	81349	2.0	EA
94	FS1066	NUT,HEX,S/S,4-40	MS35649-244	81349	8.0	EA
95	FS1064	NUT,HEX,S/S,6-32	MS35649-264	81349	18.0	EA
96	FS1065	NUT,HEX,S/S,8-32	MS35649-284	81349	4.0	EA
97	FS1067	NUT,HEX,S/S,10-32	MS35650-304	81349	4.0	EA
98	210298	NUT,HEX,S/S,1/4-20	MS35649-2254	81349	2.0	EA
100	FS1068	WASHER,INTER,S/S,#4	MS35333-70	81349	10.0	EA
101	FS1069	WASHER,INTER,S/S,#6	MS35333-71	81349	41.0	EA
102	FS1080	WASHER,FLAT,S/S,#6	MS15795-806	81349	1.0	EA
103	FS1070	WASHER,INTER,S/S,#8	MS35333-72	81349	4.0	EA
104	FS1071	WASHER,INTER,S/S,#10	MS35333-73	81349	4.0	EA
105	210459	WASHER,SPLT,1/4	MS35338-139	81349	2.0	EA
106	210097	WASHER,FLAT,1/4	MS15795-810	81349	4.0	EA
108	FS3005	CABLE CLAMP,5/16"ID	CLE-5/16	51705	1.0	EA
109	FS1046	SCREW,FLH,S/S,8-32X5/8	MS24693-C51	81349	4.0	EA

PARENT ITEM NO. 4100-057-1 | DESCRIPTION HARNESS ASSY
ENGR DRAW 4100-057 REV E |

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
J1	410032	CONN,PC EDGE,10 PIN	8BD10S-0	81312	1.0	EA
J6	410151	CONN,PC EDGE,22 PIN,POL	8BD22S-15	81312	1.0	EA
1	FS2012	LUG,RING,CRIMP,12/10-10	R4170F	14726	11.0	EA
2	FS2004	LUG,RING,CRIMP,12/10-6	R4183F	14726	6.0	EA
3	FS2001	LUG,RING,CRIMP,22/18-10	R4149SF	14726	4.0	EA
4	FS2003	LUG,RING,CRIMP,8-10	R3031BF	14726	6.0	EA
5	FS2005	LUG,RING,CRIMP,16/14-10	R4161F	14726	6.0	EA
6	FS2007	LUG,S/O,F,CRMP,22/18-1/4	S09615SF	14726	6.0	EA
7	FS2015	LUG,S/O,F,CRMP,12/10-1/4	S09301F	14726	4.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
CR1	310210	DIODE,ZNR,27V,.5W,10%	1N5254	04713	1.0	EA
CR2	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR4	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR5	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR6	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR7	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
C1	610738	CAP,TANT,10UF,25V	T362A106M025AS	05397	1.0	EA
C2	610051	CAP,MICA,1000PF,500V	CM06F102J03	81349	1.0	EA
C3	610030	CAP,MICA,150PF,500V	CM05F151J03	81349	1.0	EA
C4	610531	CAP,MYLAR,.022UF,100V	1DP-1-223K	72136	1.0	EA
C5	FS7002	CAP,TBD	TBD	81349	1.0	EA
C6	FS7002	CAP,TBD	TBD	81349	1.0	EA
C7	610766	CAP,TANT,220UF,10V	T3620227M010AS	05397	1.0	EA
C8	610536	CAP,AL,500UF,75V	39D507G075HL4	56289	1.0	EA
C9	610027	CAP,MICA,100PF,500V	CM05F101J03	81349	1.0	EA
C10	611028	CAP,AL,2UF,100V	TE1401	56289	1.0	EA
C11	610371	CAP,AL,50UF,50V	TE1307	56289	1.0	EA
C12	610566	CAP,MYLAR,.22UF,100V	1DP-3-224	72136	1.0	EA
C13	610566	CAP,MYLAR,.22UF,100V	1DP-3-224	72136	1.0	EA
C17	610027	CAP,MICA,100PF,500V	CM05F101J03	81349	1.0	EA
C18	610027	CAP,MICA,100PF,500V	CM05F101J03	81349	1.0	EA
C19	610020	CAP,MICA,75PF,500V	CM05E750J03	81349	1.0	EA
K1	245156	RELAY,CRADLE,1C,2A,28V	603-28V	14655	1.0	EA
Q1	330141	TRANSISTOR,SS,PNP,TO5	2N5415	95303	1.0	EA
Q2	330141	TRANSISTOR,SS,PNP,TO5	2N5415	95303	1.0	EA
Q3	330219	TRANSISTOR,SS,NPN,TO92	2N5172	81349	1.0	EA
Q4	330204	TRANSISTOR,SS,PNP,TO92	2N5087	04713	1.0	EA
Q5	330090	TRANSISTOR,SS,NPN,TO39	2N3440	81349	1.0	EA
Q6	330090	TRANSISTOR,SS,NPN,TO39	2N3440	81349	1.0	EA
Q7	330141	TRANSISTOR,SS,PNP,TO5	2N5415	95303	1.0	EA
Q8	330090	TRANSISTOR,SS,NPN,TO39	2N3440	81349	1.0	EA
Q9	330203	TRANSISTOR,ARRAY,NPN,DIP	SG3821N	34333	1.0	EA
R1	560238	RES,FILM,1/4W,4.99K,1%	RN60C4991F	81349	1.0	EA
R2	560238	RES,FILM,1/4W,4.99K,1%	RN60C4991F	81349	1.0	EA
R3	520134	RES,CARB,1/2W,7.5K OHM	RC20GF752J	81349	1.0	EA
R4	560706	RES,FILM,1/4W,56.2K,1%	RN60C5622F	81349	1.0	EA
R5	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R6	570153	POT,1T,PC,100 OHM,1/4W	X201R101B	71450	1.0	EA
R7	510064	RES,CARB,1/4W,3.3K OHM	RC07GF332J	81349	1.0	EA
R8	FS7000	RES,CARB,1/4W,TBD	RC07GF...	81349	1.0	EA
R9	510069	RES,CARB,1/4W,5.1K OHM	RC07GF512J	81349	1.0	EA
R10	510069	RES,CARB,1/4W,5.1K OHM	RC07GF512J	81349	1.0	EA
R11	510069	RES,CARB,1/4W,5.1K OHM	RC07GF512J	81349	1.0	EA
R12	510045	RES,CARB,1/4W,470 OHM	RC07GF471J	81349	1.0	EA
R13	560567	RES,FILM,1/4W,32.4K,1%	RN60D3242F	81349	1.0	EA
R14	560262	RES,FILM,1/4W,499 OHM,1%	RN60D4990F	81349	1.0	EA
R15	570153	POT,1T,PC,100 OHM,1/4W	X201R101B	71450	1.0	EA
R16	560262	RES,FILM,1/4W,499 OHM,1%	RN60D4990F	81349	1.0	EA
R17	560567	RES,FILM,1/4W,32.4K,1%	RN60D3242F	81349	1.0	EA
R18	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R19	520044	RES,CARB,1/2W,2.7K OHM	RC20GF272J	81349	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
R20	510049	RES,CARB,1/4W,680 OHM	RC07GF681J	81349	1.0	EA
R21	510069	RES,CARB,1/4W,5.1K OHM	RC07GF512J	81349	1.0	EA
R22	510045	RES,CARB,1/4W,470 OHM	RC07GF471J	81349	1.0	EA
R23	510045	RES,CARB,1/4W,470 OHM	RC07GF471J	81349	1.0	EA
R24	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R25	510077	RES,CARB,1/4W,11K OHM	RC07GF113J	81349	1.0	EA
R26	510067	RES,CARB,1/4W,4.3K OHM	RC07GF432J	81349	1.0	EA
R27	510069	RES,CARB,1/4W,5.1K OHM	RC07GF512J	81349	1.0	EA
R28	510061	RES,CARB,1/4W,2.4K OHM	RC07GF242J	81349	1.0	EA
R29	540064	RES,CARB,2W,220 OHM	RC42GF221J	81349	1.0	EA
R30	510060	RES,CARB,1/4W,2.2K OHM	RC07GF222J	81349	1.0	EA
R31	510061	RES,CARB,1/4W,2.4K OHM	RC07GF242J	81349	1.0	EA
R32	540064	RES,CARB,2W,220 OHM	RC42GF221J	81349	1.0	EA
R33	510060	RES,CARB,1/4W,2.2K OHM	RC07GF222J	81349	1.0	EA
R34	510066	RES,CARB,1/4W,3.9K OHM	RC07GF392J	81349	1.0	EA
R35	520034	RES,CARB,1/2W,1K OHM	RC20GF102J	81349	1.0	EA
R36	530022	RES,CARB,1W,2K OHM	RC32GF202J	81349	1.0	EA
R37	FS5120	WIRE,BUS,MIL-W-3861 "S"	AWG 20	81349	1.0	IN
R38	510089	RES,CARB,1/4W,36K OHM	RC07GF363J	81349	1.0	EA
R39	510005	RES,CARB,1/4W,10 OHM	RC07GF100J	81349	1.0	EA
R40	510084	RES,CARB,1/4W,22K OHM	RC07GF223J	81349	1.0	EA
R41	510017	RES,CARB,1/4W,33 OHM	RC07GF330J	81349	1.0	EA
R42	510084	RES,CARB,1/4W,22K OHM	RC07GF223J	81349	1.0	EA
R43	510011	RES,CARB,1/4W,18 OHM	RC07GF180J	81349	1.0	EA
R44	510011	RES,CARB,1/4W,18 OHM	RC07GF180J	81349	1.0	EA
R45	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R46	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R47	570153	POT,1T,PC,100 OHM,1/4W	X201R101B	71450	1.0	EA
R48	510011	RES,CARB,1/4W,18 OHM	RC07GF180J	81349	1.0	EA
R49	510011	RES,CARB,1/4W,18 OHM	RC07GF180J	81349	1.0	EA
R50	570153	POT,1T,PC,100 OHM,1/4W	X201R101B	71450	1.0	EA
R51	510084	RES,CARB,1/4W,22K OHM	RC07GF223J	81349	1.0	EA
R52	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R53	570153	POT,1T,PC,100 OHM,1/4W	X201R101B	71450	1.0	EA
R54	510011	RES,CARB,1/4W,18 OHM	RC07GF180J	81349	1.0	EA
R56	540049	RES,CARB,2W,680 OHM	RC42GF681J	81349	1.0	EA
T1	710130	TRANSFORMER	T31X	81095	1.0	EA
2	160294	PWB,PRE-AMPLIFIER	4100-710-7	16067	1.0	EA
132	250076	TERMINAL,TURRET,SOLID	2010B-1	88245	1.0	EA
135	240120	HEATSINK	TXBF-032-025B	98978	4.0	EA
137	FS3009	WIRE TIE,31/2	WRN-31/2	51705	1.0	EA
139	FS5122	WIRE,BUS,MIL-W-3861 "S"	AWG 16	81349	1.0	IN
140	FS6012	TUBING,TEFLON,AWG 16	TFT-200-16-NAT.	92194	1.0	IN
141	FS1011	SCREW,PNH,S/S,4-40X1/4	MS51597-13	81349	2.0	EA
142	FS1066	NUT,HEX,S/S,4-40	MS35649-244	81349	2.0	EA
143	FS1068	WASHER,INTER,S/S,#4	MS35333-70	81349	2.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
CR1	310221	DIODE,RECT,40A,400V,DO5	1N1188A	07716	1.0	EA
Q1	330100	TRANSISTOR,PWR,NPN,TO66	2N3738	81349	1.0	EA
Q2	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q3	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q4	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q5	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q6	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q7	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q8	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q9	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q10	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q11	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q12	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q13	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q14	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q15	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
R1	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R2	520117	RES,CARB,1/2W,12 OHM	RC20GF120J	81349	1.0	EA
R3	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R4	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R5	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R6	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R7	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R8	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R9	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R10	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R11	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R12	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R13	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R14	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R15	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
S1	270066	THERMO-SWITCH	3450-87-149	14604	1.0	EA
2	160295	PWB,HEATSINK,OUT DRIVER	4100-711-7	16067	2.0	EA
50	210641	HEATSINK	4100-231-7	16067	2.0	EA
51	210642	WIND TUNNEL,HEATSINK	4100-233-7	16067	1.0	EA
52	210643	INSULATOR,MOUNT,HEATSINK	4100-234-7	16067	3.0	EA
53	250094	LUG,RING,SOLDER,#4	1416-4	83330	1.0	EA
54	110357	BRACKET,ANGLE	612	91333	12.0	EA
55	FS1011	SCREW,PNH,S/S,4-40X1/4	MS51957-13	81349	16.0	EA
56	FS1018	SCREW,PNH,S/S,4-40X1/2	MS51957-17	81349	16.0	EA
57	FS1014	SCREW,FLH,S/S,4-40X1/4	MS24693-C2	81349	12.0	EA
58	FS1017	SCREW,FLH,S/S,4-40X7/16	MS24693-C5	81349	6.0	EA
59	FS1072	WASHER,SPLT,S/S,#4	MS35338-135	81349	47.0	EA
60	FS1006	SCREW,PNH,S/S,4-40X5/16	MS51957-14	81349	5.0	EA
63	FS1066	NUT,HEX,S/S,4-40	MS35649-244	81349	16.0	EA
66	FS4001	THERMAL COMPOUND	THERMALCOTE	13103	.1	OZ
70	250326	TERMINAL,QCK CLP,DUAL	580	79963	4.0	EA
71	250315	TERMINAL,QCK CLP,PB,MALE	835	79963	8.0	EA
72	210728	FSTNR,RVT,POP,1/8X.357	AD44ABS	07707	6.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
CR1	310221	DIODE,RECT,40A,400V,DO5	1N1188A	07716	1.0	EA
Q1	330183	TRANSISTOR,PWR,PNP,TO66	2N5211	95303	1.0	EA
Q2	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q3	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q4	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q5	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q6	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q7	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q8	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q9	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q10	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q11	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q12	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q13	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q14	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
Q15	330281	TRANSISTOR,PWR,NPN,TO3	57334 (2N6259)	81349	1.0	EA
R1	520006	RES,CARB,1/2W,10.0 OHM	RC20GF100J	81349	1.0	EA
R2	550216	RES,PWR,3W,.75 OHM,5%	RS-2B-.75 OHM	91637	1.0	EA
R3	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R4	520117	RES,CARB,1/2W,12 OHM	RC20GF120J	81349	1.0	EA
R5	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R6	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R7	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R8	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R9	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R10	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R11	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R12	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R13	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R14	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R15	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R16	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
R17	550118	RES,PWR,7W,.2 OHM,3%	RS-7-.2 OHM	91637	1.0	EA
2	160295	PWB,HEATSINK,OUT DRIVER	4100-711-7	16067	2.0	EA
48	210641	HEATSINK	4100-231-7	16067	2.0	EA
49	210642	WIND TUNNEL,HEATSINK	4100-233-7	16067	1.0	EA
50	210643	INSULATOR,MOUNT,HEATSINK	4100-234-7	16067	3.0	EA
51	210076	INSULATOR,SHLDR,NYL,#4	NY04-040	08289	4.0	EA
52	330192	INSULATOR,MICA,TO3	DM123	08289	1.0	EA
53	330186	INSULATOR,MICA,TO66	TYPE TO65	08289	1.0	EA
55	110357	BRACKET,ANGLE	612	91833	12.0	EA
56	250094	LUG,RING,SOLDER,#4	1416-4	83330	3.0	EA
57	FS4001	THERMAL COMPOUND	THERMALCOTE	13103	.1	OZ
58	FS1014	SCREW,FLH,S/S,4-40X1/4	MS24693-C2	81349	12.0	EA
59	FS1011	SCREW,PNH,S/S,4-40X1/4	MS51957-13	81349	15.0	EA
60	FS1018	SCREW,PNH,S/S,4-40X1/2	MS51957-17	81349	15.0	EA
61	FS1006	SCREW,PNH,S/S,4-40X5/16	MS51957-14	81349	6.0	EA
62	FS1015	SCREW,PNH,S/S,4-40X7/16	MS51957-16	81349	6.0	EA
63	FS1072	WASHER,SPLT,S/S,#4	MS35338-135	81349	40.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
67	FS1065	NUT,HEX,S/S,4-40	MS35649-244	81349	15.0	EA
70	250315	TERMINAL,QCK CLP,PB,MALE	836	79963	8.0	EA
71	250326	TERMINAL,QCK CLP,DUAL	580	79963	4.0	EA
72	210728	FSTNR,RVT,POP,1/8X.357	AD44A3S	07707	6.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NUMBER	VENDOR	QTY	UM
CR1	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR2	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR3	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR4	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
R1	575036	POT,1T,PC,5K,1/4W	U201R502B	71450	1.0	EA
R2	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R4	510068	RES,CARB,1/4W,4.7K OHM	RC07GF472J	81349	1.0	EA
R5	510075	RES,CARB,1/4W,9.1K OHM	RC07GF912J	81349	1.0	EA
R8	560435	RES,FILM,1/4W,124K,1%	RN60C1243F	81349	1.0	EA
R9	560539	RES,FILM,1/4W,249K,1%	RN60C2493F	81349	1.0	EA
2	157003	PWB,METER,VOLT	4050-702-7	16067	1.0	EA

Appendix A

Code	Name	City	State
0000A	Electricord	Westfield	PA
0000C	Jackson Bros.	Weedon, Surrey	GB
0000S	OPSDA	Edison	NJ
0000W	Milton Ross Co.	Southampton	PA
0000Z	Tamco	Los Angeles	CA
00AAC	ITAC	Santa Clara	CA
00AAD	Flessey	Westlake Village	CA
00AAG	Le France	Philadelphia	PA
00AAH	Jan Crystal	Ft. Myers	CA
00AAL	Data Components, Inc.	Santa Monica	CA
00AAM	Kraus & Naimer	Santa Monica	CA
00AAN	Ritz Instrument Transformer Co.	Redondo Beach	CA
00AAS	Switches Incorporated	Mt. View	CA
00544	Metal-Cal Div., Avery Prod. Corp.	Inglewood	CA
00779	AMF Inc.	Harrisburg	PA
00853	Sangamo Electric Co.	Pickens	SC
00866	Gow Eng. Co., Inc.	City of Industry	CA
01002	G.E. Co., Ind. & Pwr. Cap. Dept.	John St. Hudson Falls	NY
01121	Allen-Bradley Co.	Milwaukee	WI
01139	G.E. Co., Silicone Products Dept.	Waterford	NY
01295	Texas Instruments	Dallas	TX
02111	Spectrol Electronics	City of Industry	CA
02335	Fairchild Controls Corp.	Hicksville, LI	NY
02375	American Insulating Machinery Co.	Philadelphia	PA
02538	Texas Electronics Co.	Dallas	TX
02660	Amphenol Corporation	Broadview	IL
02799	Use Code #77176		
03507	General Electric Company	Syracuse	NY
03508	General Electric Company	Syracuse	NY
03797	Eldema Corporation	Compton	CA
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls	NJ
03911	Clairex Corporation	New York	NY
04009	Arrow-Hart and Hegeman Elec. Co.	Hartford	CT
04713	Motorola Semiconductor Prod., Inc.	Phoenix	AZ
04963	3-M	St. Paul	MN
05245	Corcom Inc.	Chicago	IL
05276	Pomona Electronics Co., Inc.	Pomona	CA
05397	Kemet, Union Carbide Corp.	Cleveland	OH
05820	Wakefield Engineering, Inc.	Wakefield	MA
06383	Panduit Corp.	Tinley Park	IL
06514	Stanton, Wyco Metal Products	N. Hollywood	CA
06540	Amathom Elect. Hardware	New Rochelle	NY
06665	Precision Monolithics Inc.	Santa Clara	CA
06776	Robinson Nugent, Inc.	New Albany	IN
06915	Richco Plastics, Co.	Chicago	IL
07088	Kelvin Electric Company	Van Nuys	CA
07263	Fairchild Camera and Instr. Corp.	Mt. View	CA
07387	Bircher Corporation	Los Angeles	CA
07556	Unitrack Calabro Plastics	Upper Derby	PA
07633	Epoxy Prod. Co., Allied Prod. Corp.	New Haven	CT
07716	IRC Incorporated	Burrington	JA
08065	Accurate Rubber and Plastics Co.	San Diego	CA
08261	Spectra Strip	Garden Grove	CA
08289	Elinn-Delbert Co., Inc.	Pomona	CA
08357	Bristol Co.	Toronto	CANADA
08524	Deutsch Fastener Corp.	Los Angeles	CA
08730	Vemaline Products Co.	Franklin Lakes	NJ
08779	Signal Transformer Co.	Brooklyn	NY
09353	C and K Components	Newton	MA
10389	Chicago Switch Inc.	Chicago	IL
11815	Cherry Rivet Div., Townsend Co.	Santa Ana	CA
12406	Elpac, Incorporated	Fullerton	CA
12697	Clarostat Mfg. Co., Incorporated	Dover	NH
13103	Thermalloy Company	Dallas	TX
14099	Semtech Corporation	Newbury Park	CA
14604	Elmwood Sensors Inc.	Cranston	RI
14655	Cornell-Dubilier Elect. Corp.	Newark	NJ
14726	Hollingsworth Co.	Phoenixville	PA
14752	Electro Cube, Incorporated	San Gabriel	CA
15238	ITT Semiconductors	Lawrence	MA
15636	Elec-trol	Northridge	CA
15801	Fenwall Electronics	Framingham	MA
15818	Amelco Teledyne, Incorporated	Mt. View	CA
15912	Ansley	Los Angeles	CA
16067	California Instruments Company	San Diego	CA
16758	Delco Radio Div., General Motors	Kokomo	IN
16956	Dennison	Framingham	MS
18076	Umpco	City of Industry	CA
18178	Vactec, Inc.	Maryland Heights	MO
18324	Signetics	Sunnyvale	CA
18612	Vishay Instruments Inc.	Malvern	PA
18677	Scambe Mfg. Co.	Monterey Park	CA
18722	RCA	Mountaintop	PA
18736	Voltronics Corp.	Hanover	NJ
19080	The Robinson Company	Hawthorne	CA
21604	Buckeye Stamping Company	Columbus	OH
22599	Elastic Stop Nut Corporation	Van Nuys	CA
23050	Product Components Corp.	Hastings-on-Hudson	NY
23976	Pamotor, Incorporated	San Francisco	CA
24931	ECC	Burlington	MA
24446	General Semiconductor Industries Inc.	Tempe	AZ
25076	Fanelco Inc.	Paramount	CA
25497	Meter Master	Los Angeles	CA
25806	American Zettler, Inc.	Costa Mesa	CA
27014	National Semi-Conductor Corp.	Santa Clara	CA
27191	Cutler-Hammer, Inc.	Milwaukee	WI
27264	Molex	Downers Grove	IL
27556	JMP Electronic Products	Santa Fe Springs	CA
27603	Varo, Incorporated	N. Garland	TX
27832	Hughes Aircraft	Newport Beach	CA

Code	Name	City	State
28480	Hewlett-Packard Co.	Palo Alto	CA
28520	Heyman Mfg. Company (Heyco)	Kenilworth	NJ
30029	International Components Corp.	Asbury Park	NJ
30983	Electra/Midland (Mepco/Electra)	San Diego	CA
30161	Avid Engineering Inc.	Laconia	NH
30897	Dorand Company	Sylmar	CA
31951	Tridge Inc.	Pittsburgh	PA
32997	Intersil	Cupertino	CA
33859	Bivar, Inc.	Santa Ana	CA
33906	Jewell Electrical Instruments Inc.	Manchester	NH
33916	Kingsbacher Murray Co.	Los Angeles	CA
33955	Ducommun Inc.	Los Angeles	CA
34333	Silicon General	Westminster	CA
34649	Intel Corporation	Santa Clara	CA
44655	Oxnite Manufacturing Company	Skokie	IL
45722	Perfection	Clifton	NJ
46384	Penn. Eng. and Mfg. Corp.	Doylestown	PA
50522	Monsanto, Electronic Special Products	Cupertino	CA
51162	Aries Electronics Inc.	Frenchtown	NJ
51705	ICO/Rally	Palo Alto	CA
52072	Circuit Assembly Corp.	Costa Mesa	CA
54467	Power-One Co.	Camarillo	CA
56289	Sprague Electric Company	North Adams	MA
58474	Superior Electric Company	Bristol	CT
59730	Thomas and Betts Company	Elizabeth	NJ
63743	Ward Leonard Electric Co.	Mt. Vernon	NY
70318	Alimeta, Screw Prod. Co.	Garden City	NY
70903	Belden Manufacturing Co.	Chicago	IL
71218	Bud Industries, Inc.	Willoughby	OH
71279	Cambridge Thermionic Corp.	Cambridge	MA
71400	Bussman Mfg. Div. McGraw-Edison Co.	St. Louis	MO
71450	CTS Corporation	Elkhart	IN
71468	ITT Cannon Electric Inc.	Los Angeles	CA
71590	Centralab Div. Globe-Union, Inc.	Milwaukee	WI
71707	Coto-Coil	Providence	RI
71744	Chicago Miniature Lampworks	Chicago	IL
71785	TRW Cinch	Chicago	IL
71984	Dow Corning Corp.	Midland	MI
72136	Elmenco (Electro Motive)	Willimantic	CT
72619	Dialight Corporation	Brooklyn	NY
72699	General Instruments	Newark	NJ
72982	Erie Technological Products Inc.	Erie	PA
73138	Beckman Instruments, Inc.	Fullerton	CA
73734	Federal Screw Products, Inc.	Chicago	IL
74193	Heinemann Electric Company	Trenton	NJ
74545	Harvey Hubbell, Inc.	Bridgeport	CT
74868	Illinois Condenser Co.	Chicago	IL
74970	E.F. Johnson Company	Waseca	MN
75042	TRW Electronic Components	Philadelphia	PA
75383	Kulka Electric Corporation	Mt. Vernon	NY
75915	Littelfuse Incorporated	Des Plaines	IL
77122	United-Carr Inc., Fatwin Division	Watertury	CT
77342	Potter and Brumfield Div., AMF	E. Princeton	IN
78189	Shakeproof Div., Illinois Tool Works	Chicago	IL
78553	Tinnerman Products, Inc.	Cleveland	OH
79136	Johns-Manville Products Corp.	Chicago	IL
79136	Waldes Kohinoor Inc.	Long Island City	NY
79963	Zierick Mfg. Corporation	New Rochelle	NY
80031	Mepco/Electra	Morristown	NJ
80223	United Transformer Co.	New York	NY
80294	Bourns, Incorporated	Riverside	CA
81095	Triad Transformer Corp.	Venice	CA
81312	Winchester Electronics	Oakville	CT
81349	Military Specification or Commercial Generic Number		
81607	Race Products Co.	Chicago	IL
82194	Standard Grigsby	Aurora	IL
82389	Switchcraft, Incorporated	Chicago	IL
82877	Rotron Manufacturing Co., Inc.	Woodstock	NY
82893	Vector Electronics Inc.	Sylmar	CA
83330	Herman H. Smith, Inc.	Brooklyn	NY
83486	Elco Tool and Screw Corp.	Rockford	IL
86684	RCA	Harrison	NJ
87034	Marco-Cal Industries	Anaheim	CA
88245	Useco Div., Litton Industries	Van Nuys	CA
90201	Mallory Capacitor Company	Indianapolis	IN
91637	Dale Electronics, Inc.	Columbus	NE
91662	Elco Corporation	Willow Grove	PA
91833	Keystone Electronics Corp.	New York	NY
92194	Alpha Wire Corporation	Elizabeth	NJ
94222	Southco, Incorporated	Lester	PA
95503	RCA	Cincinnati	OH
95987	Weclesser Company, Inc.	Chicago	IL
97525	Electronic Engineering Co.	Santa Ana	CA
98159	Rubber Teck, Incorporated	Gardena	CA
98291	Sealetto Corp.	Mamaroneck	NY
98736	Zero Mfg. Co. (West)	Burbank	CA
98978	IERC	Burbank	CA
99742	IMC	Maywood	CA
99800	Delevan Electronics Corporation	Aurora	NY

Revision J
January 5, 1982

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS, Division of Amstar Technical Products Co., Inc., 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 tubes, 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, and including the model number and serial number. On receipt of this information, service data or a Return Material Authorization (RMA) number will be given. Fill in RMA No. blank on shipping label attached opposite these instructions, 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 as soon as 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.