

INSTRUCTION MANUAL

JQE 55-5MVPY-26997

POWER SUPPLY

KEPCO INC.
An ISO 9001 Company.

MODEL JQE 55-5MVPY-26997 POWER SUPPLY INSTRUCTION MANUAL

ORDER NO.

REV. NO.

IMPORTANT NOTES:

- 1) This manual is valid for the following Model and associated serial numbers:

MODEL	SERIAL NO.	REV. NO.
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- 2) A Change Page may be included at the end of the manual. All applicable changes and revision number changes are documented with reference to the equipment serial numbers. Before using this Instruction Manual, check your equipment serial number to identify your model. If in doubt, contact your nearest Kepco Representative, or the Kepco Documentation Office in New York, (718) 461-7000, requesting the correct revision for your particular model and serial number.
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Declaration of Conformity

Application of Council directives: **73/23/EEC (LVD)**
93/68/EEC (CE mark)

Standard to which Conformity is declared:

EN61010-1:2001 (Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1)

Manufacturer's Name and Address: **KEPCO INC.**
131-38 SANFORD AVENUE
FLUSHING, N.Y. 11352 USA

Importer's Name and Address:

REPRESENTATIVE COPY

Type of Equipment: **Component Power Supply**

Model No.: *[PRODUCT MODEL NUMBER]*

Year of Manufacture:

I, the undersigned, declare that the product specified above, when used in conjunction with the conditions of conformance set forth in the product instruction manual, complies with the requirements of the Low Voltage Directive 73/23/EEC, which forms the basis for application of the CE Mark to this product.

Place: **KEPCO Inc.**
131-38 Sanford Ave.
Flushing, N.Y.11352 USA

Saul Kupferberg
(Full Name)

Date: _____

VP OF SALES
(position)

Conditions of Conformance

When this product is used in applications governed by the requirements of the EEC, the following restrictions and conditions apply:

1. For European applications, requiring compliance to the Low Voltage Directive, 73/23/EEC, this power supply is considered a component product, designed for "built in" applications. Because it is incomplete in construction, the end product enclosure must provide for compliance to any remaining electrical safety requirements and act as a fire enclosure. (EN61010-1:2001, Cl. 6, Cl. 7, Cl.8, and Cl. 9)
2. This power supply is designed for stationary installation, with mains power applied via a detachable power supply cord or via direct wiring to the source power terminal block.
3. This power supply is considered a Class 1 (earthed) product. It is intended for use as part of equipment meant for test, measurement and laboratory use, and is designed to operate from single phase, three wire power systems. This equipment must be installed within a suitably wired equipment rack, utilizing a three wire (grounded) mains connection. See wiring section of this manual for complete electrical wiring instructions. (EN61010-1:2001, Cl.6.10.1)
4. This power supply has secondary output circuits that are considered hazardous, and which exceed 180W output power at a potential of 2V or more.
5. The output wiring terminals of this power supply has not been evaluated for field wiring and, therefore, must be properly configured by the end product manufacturer prior to use.
6. This power supply employs a supplementary circuit protector in the form of a circuit breaker mounted on the front panel. This circuit breaker protects the power supply itself from damage in the event of a fault condition. For complete circuit protection of the end product, as well as the building wiring, it is required that a primary circuit protection device be fitted to the branch circuit wiring. (EN61010-1:2001, Cl. 9.5)
7. Hazardous voltages are present within this power supply during normal operation. All operator adjustments to the product are made via externally accessible switches, controls and signal lines as specified within the product operating instructions. There are no user or operator serviceable parts within the product enclosure. Refer all servicing to qualified and trained Kepco service technicians.

SAFETY INSTRUCTIONS

1. Installation, Operation and Service Precautions

This product is designed for use in accordance with EN 61010-1 and UL 3101 for Installation Category 2, Pollution Degree 2. Hazardous voltages are present within this product during normal operation. The product should never be operated with the cover removed unless equivalent protection of the operator from accidental contact with hazardous internal voltages is provided:



There are no operator serviceable parts or adjustments within the product enclosure. Refer all servicing to trained service technician.



Source power must be removed from the product prior to performing any servicing.



This product is factory-wired for the nominal a-c mains voltage indicated on the rating nameplate located adjacent to the source power connection on the product's rear panel. To reconfigure the product input for other nominal mains voltages as listed herein, the product must be modified by a trained service technician.

2. Grounding

This product is a Class 1 device which utilizes protective earthing to ensure operator safety.



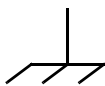
The PROTECTIVE EARTHING CONDUCTOR TERMINAL must be properly connected prior to application of source power to the product (see instructions on installation herein) in order to ensure safety from electric shock.



PROTECTIVE EARTHING CONDUCTOR TERMINAL - This symbol indicates the point on the product to which the protective earthing conductor must be attached.



EARTH (GROUND) TERMINAL - This symbol is used to indicate a point which is connected to the PROTECTIVE EARTHING TERMINAL. The component installer/ assembler must ensure that this point is connected to the PROTECTIVE EARTHING TERMINAL.



CHASSIS TERMINAL - This symbol indicates frame (chassis) connection, which is supplied as a point of convenience for performance purposes (see instructions on grounding herein). This is not to be confused with the protective earthing point, and may not be used in place of it.

3. Electric Shock Hazards

This product outputs hazardous voltage and energy levels as a function of normal operation. Operators must be trained in its use and exercise caution as well as common sense during use to prevent accidental shock.



This symbol appears adjacent to any external terminals at which hazardous voltage levels as high as 500V d-c may exist in the course of normal or single fault conditions.



This symbol appears adjacent to any external terminals at which hazardous voltage levels in excess of 500V d-c may exist in the course of normal or single fault conditions.

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SECTION 1 - INTRODUCTION

1.1 SCOPE OF MANUAL

This manual contains instructions for the installation, operation and maintenance of the specially modified Kepco JQE 55-5MVPY-26977, "HALF-RACK" Power Supplies, manufactured by Kepco, Inc., Flushing, New York, U.S.A. This model is one of a group of three specially modified JQE power supplies (see Table 1-1) referred to, hereafter referred to as JQE Special Power Supplies or JQE Specials. Additional copies of this manual can be downloaded from the Kepco web site at <http://www.kepcopower.com/support/opmanls.htm#jqe>.

1.2 GENERAL DESCRIPTION

The Kepco JQE Special Power Supplies are general purpose, precision regulated voltage sources in the "half-rack" configuration. JQE Power Supplies feature full range voltage control and current limit adjustment by means of multi-turn front panel controls. JQE Special power supplies have linear, full-dissipation series-regulators (NPN) driven by an integrated circuit operational amplifier. A sharp current-limit circuit enables current control operation of the power supply. The output of the JQE power supply is programmable. All necessary connections are available on terminals at the rear barrier-strips.

The compact design of the JQE Specials was made possible by a unique heatsink design of exceptional efficiency in combination with highly reliable low-noise fans. All JQE power supplies feature all-silicon design with conservatively rated components for added reliability.

JQE special power supplies are identical in their mechanical dimensions (Refer to FIG. 1-3) and in their electrical specifications, except as noted in Table 1-1.

1.3 FEATURES.

The three JQE Specials include the following features:

- a) Two panel meters which permit simultaneous monitoring of the output voltage and output current.
- b) Overvoltage Protection. This protection acts simultaneously on the circuit breaker's voltage coil and the electrical "crowbar" that shorts the output through a silicon-controlled rectifier (SCR) if the output voltage exceeds a preadjustable limit (see paragraph 1.7.5a) for specifications).
- c) Zero and full scale voltage calibration for local front panel voltage control.
- d) Zero and full scale current calibration for CURRENT LIMIT "B"
- e) Full scale current calibration for CURRENT LIMIT "A"
- f) Zero and full scale current calibration for CURRENT MONITOR
- g) Full scale calibration for remote resistive voltage control
- h) Overvoltage protection adjustment
- i) Overvoltage protection delay adjustment

The main chassis frame of the power supply is constructed from cold-rolled steel, as is the perforated wrap-around cover. Front panel material is aluminum (Refer to FIG. 1-3 for finish).

1.4 ACCESSORIES

- a) RACK ADAPTOR (for two units); Kepco Model RA 24. Fits standard EIA rack-dimensions.
- b) FILLER PANEL, to cover empty slot if RA 24 is used for one unit only: Kepco Model RFP 24-2.

1.5 SPECIFICATIONS, GENERAL

- a) AC INPUT: 105 to 125V AC or 210 to 250V AC (selectable, refer to PAR. 2.3), 46 to 65 Hz, single phase (consult factory for operation on power line frequencies above 65 Hz.). Refer to the table of model specifications (Table 1-1) for the AC input current for each model.
- b) OPERATING TEMPERATURE RANGE: -20°C to $+71^{\circ}\text{C}$ (without derating of the output).
- c) STORAGE TEMPERATURE: -40°C to $+85^{\circ}\text{C}$.
- d) COOLING: High efficiency, single bearing fan, (permanently lubricated) with special low noise non-metal blade.
- e) ISOLATION: A maximum of 500 Volts (d-c or p-p) can be connected between chassis and either output terminal.

1.6 SPECIFICATIONS, ELECTRICAL

Table 1-1 indicates specifications for parameters that vary for different JQE Special models. Table 1-2 lists electrical specifications that apply to all JQE Special models.

TABLE 1-1. JQE SPECIAL MODELS, ELECTRICAL SPECIFICATIONS

MODEL NUMBER	DC OUTPUT RANGE		CURRENT LIMIT		OUTPUT IMPEDANCE		MAXIMUM INPUT AMPS @ 125V AC
	(VOLTS)	(AMPS)	"A" (AMPS)	"B" (AMPS)	VOLTAGE MODE d-c OHMS + SERIES L	CURRENT MODE d-c OHMS + SHUNT C	
JQE 15-12MVPY-26954	0 - 15	0 - 5	5	4.5	$63\mu\Omega + 0.5\mu\text{H}$	$5\text{K}\Omega + 300\mu\text{F}$	2.0
JQE 55-5MVPY-26955	0 - 55	0 - 5	5	2.7	$550\mu\Omega + 1\mu\text{H}$	$18\text{K}\Omega + 850\mu\text{F}$	5.0
JQE 55-5MVPY-26997	0 - 55	0 - 5	5	5	$550\mu\Omega + 1\mu\text{H}$	$18\text{K}\Omega + 850\mu\text{F}$	5.0
JQE 150-1.5MVPY-26956	0 - 150	0 - 1.5	1.5	0.4	$63\text{m}\Omega + 2\mu\text{H}$	$50\text{K}\Omega + 440\mu\text{F}$	4.6

- a) VOLTAGE RECOVERY TIME: (for step load current), $<50\mu\text{sec}$.
- b) OVERSHOOT: No output voltage overshoot from turn-on, turn-off, or power failure for output settings above 25% of maximum rated output voltage. Below 25%, output voltage overshoot is a function of load current and is negligible for loads in excess of 10% of the maximum rated load current.

TABLE 1-2. JQE SPECIAL MODELS, COMMON ELECTRICAL SPECIFICATIONS

INFLUENCE QUANTITY	OUTPUT EFFECTS		AMPLIFIER OFFSETS ⁽³⁾	
	VOLTAGE MODE ΔE_O	CURRENT MODE ΔI_O ⁽²⁾	VOLTAGE MODE ΔE_O	CURRENT MODE ΔI_O
Source effect: 105-125/210-250V a-c	<0.0005%	<0.005%	<10 μ V	<2nA
Load effect: no load - full load for voltage mode: full load for current limit mode: short-circuit	<0.005% or 0.2mV ⁽¹⁾	3mA	<200 μ V	<5nA
Time effect: 8 hours (drift)	<0.01% or 1mV	< 0.1%	<20 μ V	<2nA
Temperature effect: per °C	<0.01%	<0.1%	<20 μ V	<5nA
Ripple and Noise ⁽⁴⁾	Ripple	<0.2mV	<0.02% of I_O max	-
	Noise	<1.0mV	<0.1% of I_O max	-

(1) Whichever is greater.

(2) Current Mode Output Effects (ΔI_O) are measured across an external sensing resistor. This resistor must be a high quality, wirewound unit, with a wattage at least 10 times the actual power dissipated, have a Temperature Coefficient of 20 parts per million or better, include adequate cooling, and drop a sample voltage of 1.0 Volt at the measuring current. A resistor built as a 4-terminal network is recommended. Current feedback is exercised with an internal 20 PPM feedback resistor.

(3) Offsets and the reference contribute to output effect ΔE_O , by the equation

$$\Delta E_O = \Delta E_{ref} (R_f / R_i) \pm \Delta E_{io} (1 + R_f / R_i) (R_f)$$

where R_f is the feedback resistor and R_i is the input resistor from the signal reference. Use the offsets to calculate output effects when external input/feedback elements are substituted for the internal reference and voltage control in special applications.

(4) Valid with one output terminal grounded or connected so that the common mode current (see PAR. 1.5e) does not flow through the load or (in current mode) through a sensing resistor. Evaluated in the 20Hz to 10MHz frequency range.

1.7 SPECIFICATIONS, PERFORMANCE

1.7.1 VOLTAGE CONTROL CHANNEL

- a) LOCAL OUTPUT VOLTAGE CONTROL: 10-turn precision potentiometer at the front panel, resolution: 0.1% of the maximum rated output voltage (E_O max.). When the E_{OUT} LOC-REM switch (accessible through the top cover) is set to LOC (towards the front panel), this pot controls output voltage from zero to E_O max. Both ZERO and FS (full scale) calibrations are provided. Local voltage control from the front panel is enabled by the link installed on the rear panel terminal block TB501, between terminals 6 (RVC) and 7 (RPV1); the remote voltage control resistor between terminals 7 (RPV1) and 8 (RPV2) must be removed.
- b) REMOTE OUTPUT VOLTAGE CONTROL: When the E_{OUT} LOC-REM switch (accessible through the top cover) is set to REM (towards the rear panel), external control can be exercised by resistance (1000 ohms per volt of output); refer to Section 3 for details. This allows the output to be controlled from zero to E_O max with an accuracy of 0.1% of E_O nominal. Both ZERO (same as LOCAL ZERO) and FS (full scale) calibrations are provided. Remote voltage control using resistance is enabled by removing the link installed on the rear panel terminal block TB501 between terminals 6 (RVC) and 7 (RPV1) and installing the voltage control resistor between terminals 7 (RPV1) and 8 (RPV2).

NOTE: The default ZERO voltage calibration done at the factory is for local control. Because the front panel voltage control potentiometer has a value higher than zero (usually 0.05% of the nominal value of the potentiometer) when set to the full counterclockwise position, the ZERO calibration is inaccurate if the remote control resistor reaches a perfect zero. Therefore, when operating with a remote control resistor in voltage mode, it is recommended that the ZERO and FULL SCALE adjustments be recalibrated (see PAR 4.5.2.2. and 4.5.5).

- c) REMOTE ERROR SENSING: Rear terminals provide for connection of error sensing leads directly at the load. The four-terminal load connection compensates for the voltage drop along the load wires. Up to 0.5 Volt per load wire can be compensated using remote sensing.

1.7.2 CURRENT LIMIT CONTROL CHANNEL

- a) LOCAL OUTPUT CURRENT LIMIT CONTROL "A": 10-turn precision potentiometer at the front panel, controls the current limit from less than 10% to 100% of the rated output current (I_o) (see Table 1-3). Current control "A" accuracy is 0.5% of I_o nominal.

TABLE 1-3. CURRENT LIMIT VALUES

MODEL	CURRENT LIMIT "A" NOMINAL VALUE (AMPS)	CURRENT LIMIT "B" NOMINAL VALUE (AMPS)
JQE 15-12MVPY-26954	5	4.3
JQE 55-5MVPY-26955	5	2.7
JQE 55-5MVPY-26997	5	5
JQE 150-1.5MVPY-26956	1.5	0.4

- a) LOCAL AND REMOTE OUTPUT CURRENT LIMIT CONTROL "B": A 10-turn precision potentiometer at the front panel controls the current limit from 1% to 105% of the nominal "B" value (see Table 1-3). Current control "B" accuracy is 0.5% of the nominal "B" value. When Current Limit "B" is active, if the unit is operating in current limit mode, the lowest value of current limit "A" and "B" functions as the current limit for the unit. Current control "B" is enabled by the link installed on the rear panel terminal block TB502 between pin 1 (REF) and pin 2 (RPC1); if this link is removed, only current control "A" is active.

When Current Limit "B" is active, remote resistive control is possible by connecting an external variable resistance between terminal 2 (RPC1) and terminal 3 (RPC2) of TB502. The external resistance will be in parallel with the 500 Ohm front panel LIMIT "B" potentiometer. A zero ohm external resistance will reduce current limit "B" to approximately 1% of the nominal "B" value. The adjustment curve is non-linear, proportional to:

$$5 + \frac{(R_{int})(R_{ext})}{R_{int} + R_{ext}}$$

where

R_{ext} is the external resistive control value in Ohms

R_{int} is the front panel Current Limit Control "B" value (500 Ohms nominal value for full clockwise position).

1.7.3 CURRENT MONITOR

A current monitor voltage output is available to externally monitor output current. This output signal is available at rear terminal block TB503 across terminals 1 (+C MON) and 2 (-C MON).

The transfer factor of the current monitor signal is 50mV/A (5mV/A for JQE 55-5MVPY-26997). Both ZERO and FS calibrations for the Current Monitor signal are provided.

The Current Monitor signal accuracy is 1% of the nominal Current Limit "A" value. The internal impedance of the C-MON output signal is less than 50Ohms. The recommended withdraw current from this output is 2mA. This output is protected against temporary or permanent short-circuit. The short-circuit current is 5mA.



WARNING

The C. MON signal is referenced to –OUTPUT (INTERNAL), prior to the 0.01Ohm sensing resistor of the C. MON circuitry. Care must be taken when handling this signal to avoid short-circuiting the output of the unit

1.7.4 DYNAMICS

- a) VOLTAGE RECOVERY FOR STEP-LOAD CURRENT: The time required for the stabilized output voltage to recover within the load effect band (or 2 mV, whichever is greater) is less than 50 microseconds.
- b) CURRENT RECOVERY FOR STEP-LOAD VOLTAGE: The time required for the stabilized output current to recover within the load-effect band is governed by an (exponential) RC time constant, where "R" represents the load resistance and "C" is the tabulated (Table 1-1) shunt capacitance.
- c) PROGRAMMING SPEED: The rate at which the JOE power supply responds to a step-program is determined by the setting of the current limit control, the value of the load resistance and the tabulated (Table 1-1) shunt capacity.
- d) OUTPUT IMPEDANCE (See Table 1-1): The DC and low frequency value is given by the tabulated (Table 1-2) load effects. With increasing frequency, the output impedance becomes asymptotic to the tabulated (Table 1-1 series inductance (Voltage Mode) or shunt capacitance (Current Mode).

1.7.5 GENERAL

- a) CROWBAR SPECIFICATIONS: The electronic "crowbar" circuit consists of a silicon controlled rectifier (SCR) and a sensing amplifier. If the output voltage exceeds a previously set adjustable limit, the power supply output is shorted by the SCR and the input circuit breaker is tripped off.
 - 1) Adjustable Limit Range: 5% of E_{Onom} to $1.3 \times E_{Onom}$.
 - 2) Triggering Time: 5 - 10 μ S, with adjustable delay ($25 \pm 5\mu$ S to $180 \pm 40\mu$ S) to minimize false triggering.
 - 3) Threshold: Limit point may be set to within 5% of E_{Onom} , or 0.25 Volt, whichever is greater.
- b) METERS: Two 2 inch, recessed panel meters, 3% of full scale accuracy are provided for output voltage and current monitoring.

1.8 SPECIFICATIONS, MECHANICAL

- a) DIMENSIONS AND FINISH: Refer to Mechanical Outline Drawing, Figure 1-1.
- b) BAIL: A retractable bail is provided for convenient bench operation of the power supply.

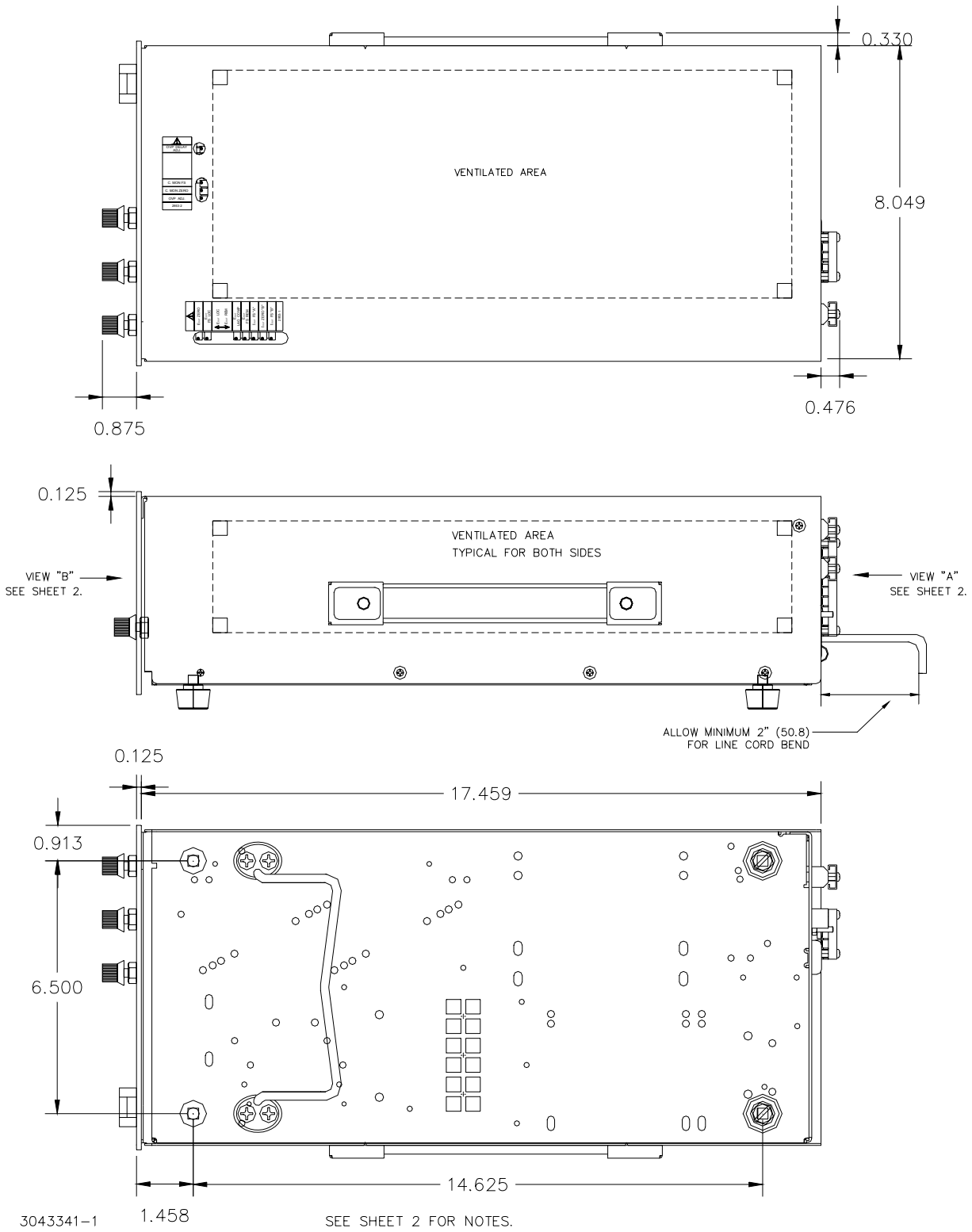
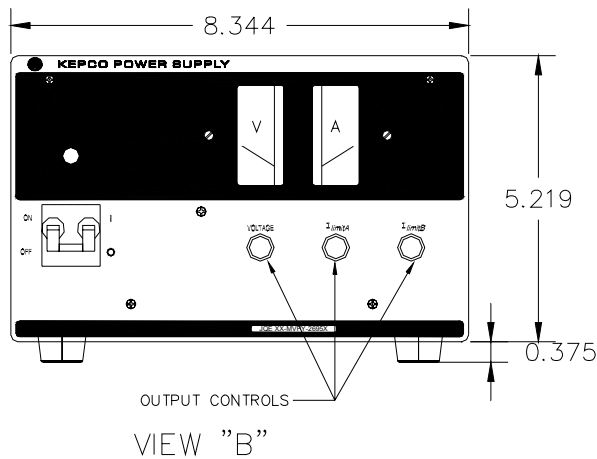
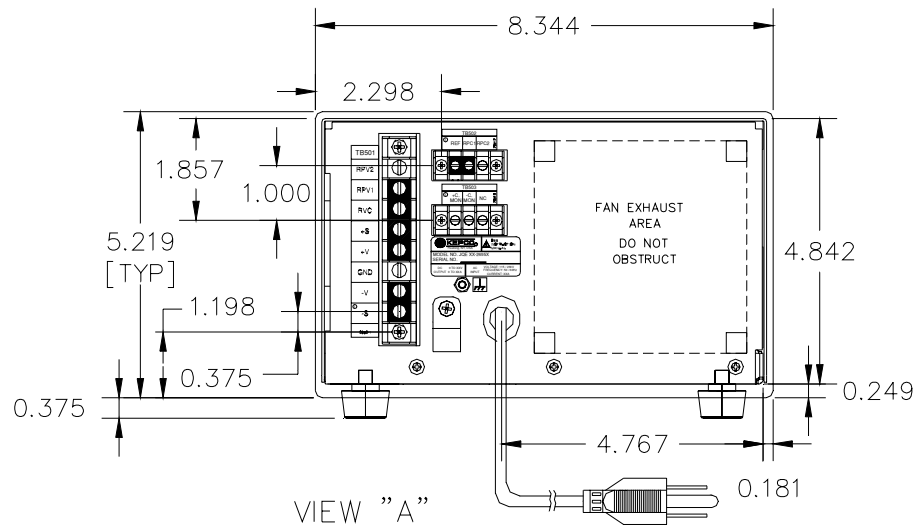


FIGURE 1-1. MECHANICAL OUTLINE DRAWING (SHEET 1 OF 2)



NOTES:

- 1) MATERIAL:
 - A) CHASSIS AND BACK PLATE: NO. 16 GA C.R.S.
 - B) FRONT PANEL: 1/8 THICK ALUMINUM
 - C) COVER: NO. 18 GA C.R.S.
- 2) FINISH:
 - A) CHASSIS AND BACK PLATE: CADMIUM PLATE WITH CHROMATE WASH.
 - B) FRONT PANEL: LIGHT GRAY PER FEDERAL STD 595. COLOR NO. 26440
 - C) COVER: CHARCOAL GRAY VINYL TEXTURE
- 3) RACK MOUNTING: REMOVE (4) FEET FROM BOTTOM OF CHASSIS.
- 4) (4) PLASTIC MOUNTING INSERT UNDER FEET, FOR 8-18 X 5/8 SELF-THREADING SCREWS (WITH 1/8 THICK MOUNTING PLATE).
- 5) DIMENSIONS IN PARENTHESIS ARE IN MILLIMETERS.
- 6) TOLERANCES:
 - A) BETWEEN MOUNTING HOLES $\pm 1/64$ (± 0.4).
 - B) ALL FRONT PANEL DIMENSIONS TO MIL-STD-189.
 - C) ALL OTHER DIMENSIONS $\pm 1/32$ (± 0.8), EXCEPT AS NOTED.

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FIGURE 1-1. MECHANICAL OUTLINE DRAWING (SHEET 2 OF 2)

SECTION 2 - INSTALLATION

2.1 UNPACKING AND INSPECTION

This instrument has been thoroughly inspected and tested prior to packing and is ready for operation. After careful unpacking, inspect for shipping damage before attempting to operate. Perform the preliminary operational check as outlined in PAR. 2.5. If any indication of damage is found, file an immediate claim with the responsible transport service.

2.2 TERMINATIONS

a) **Front Panel:** Refer to Figure 2-1 and Table 2-1.

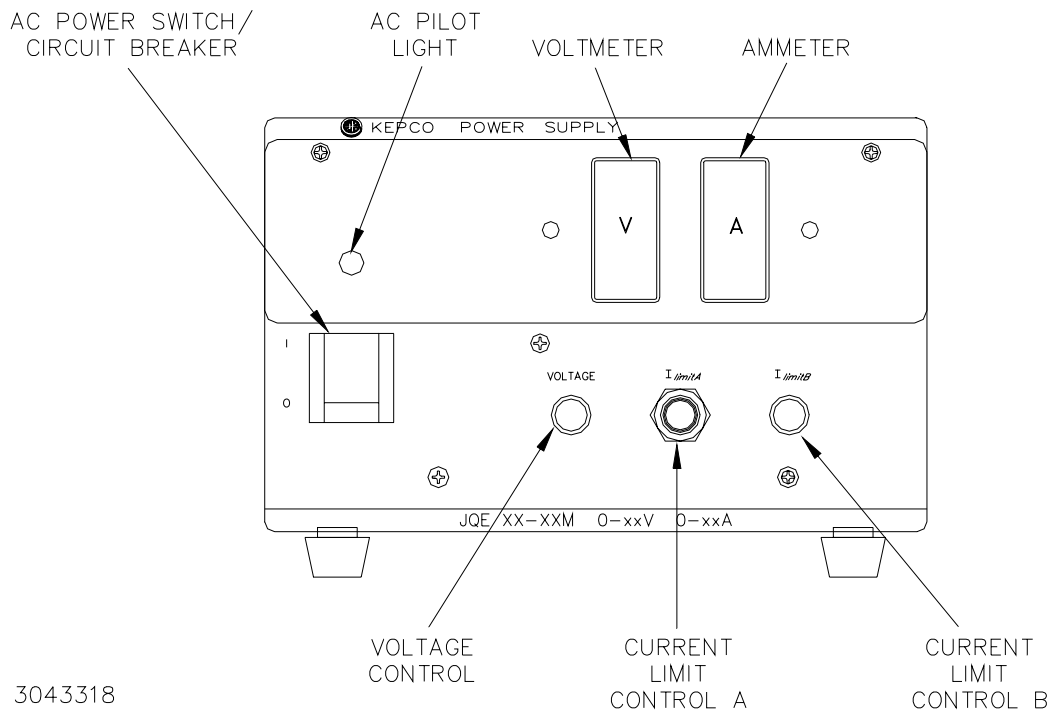


FIGURE 2-1. FRONT PANEL CONTROLS AND INDICATORS, JQE SPECIAL MODELS

TABLE 2-1. FRONT PANEL CONTROLS AND INDICATOR FUNCTIONS

CONTROL OR INDICATOR	FUNCTION
AC POWER CIRCUIT BREAKER	Turns a-c power to unit ON or OFF and protects power supply input circuitry.
AC PILOT LIGHT	Energizes when unit is turned ON and a-c power is applied to the unit.
VOLTMETER	Monitors output voltage 0 to E_O max.
AMMETER	Monitors output current 0 to I_O max. "A"
VOLTAGE CONTROL	Adjusts output voltage from 0 to E_O max.
CURRENT LIMIT CONTROL "A"	Adjusts current limit A from 10% to 100% of I_O max. "A"
CURRENT LIMIT CONTROL "B"	Adjusts current limit B from 1.0% to 105% of I_O max. "B"

b) Rear Panel: Refer to Figure 2-2 and Table 2-3.

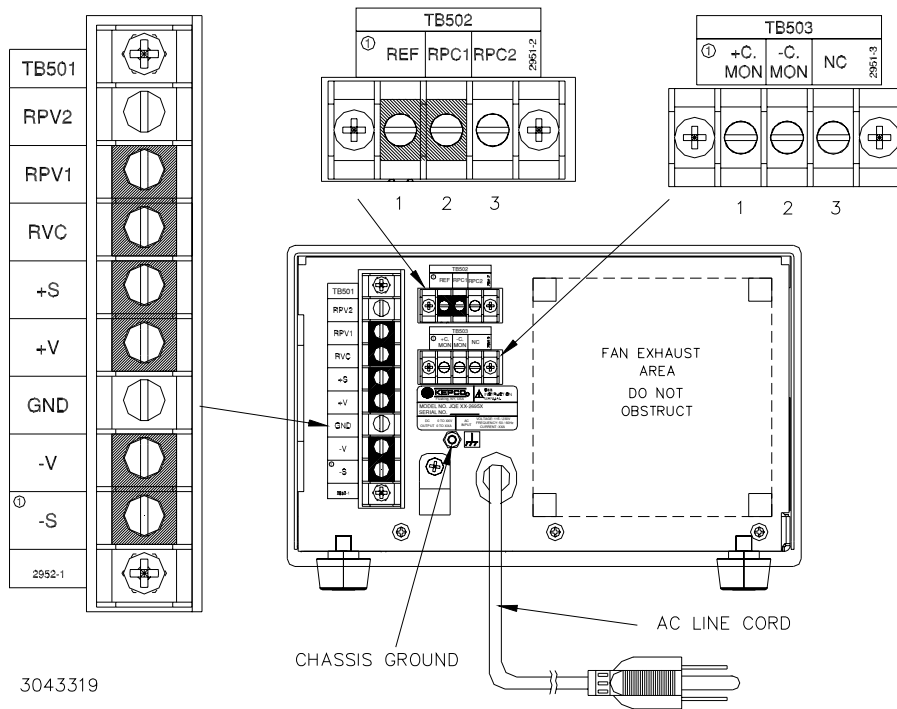
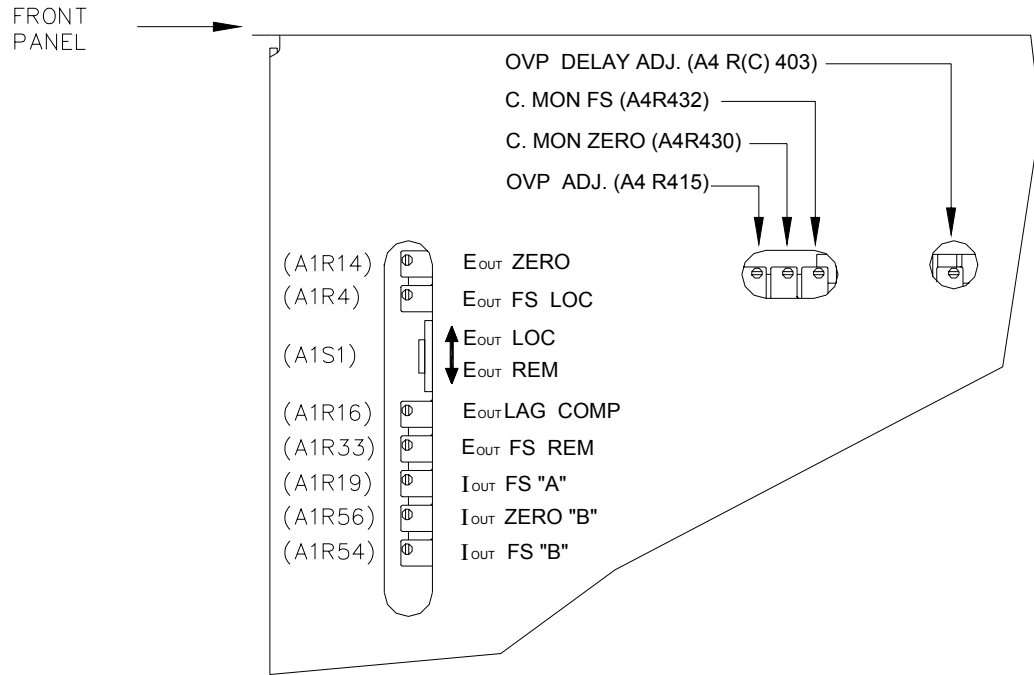


FIGURE 2-2. REAR PANEL TERMINATIONS, JQE SPECIAL MODELS

TABLE 2-2. REAR PANEL TERMINATION FUNCTIONS

TERMINATION		FUNCTION
TB501 8-terminal terminal block (Output, Sense and Remote Voltage Control connections)	(1) -S	Output Sense (-)
	(2) -V	Power Output (-)
	(3) GND	Chassis Ground
	(4) +V	Power Output (+)
	(5) +S	Output Sense (+)
	(6) RVC	Resistive Voltage Control: Connected to one end of front panel VOLTAGE control potentiometer
	(7) RPV1	Remote Programming Voltage Control (1) is the null (summing junction) for the voltage loop: Used for external (remote) resistive control.
	(8) RPV2	Remote Programming Voltage Control (2): Used for external (remote) resistive control.
TB 502 3-terminal terminal block (Remote Current Programming connections)	(1) REF	Reference: Summing junction for current limit control "B."
	(2) RPC1	Remote Programming Current 1: Internal and external (remote) resistive control 1.
	(3) RPC2	Remote Programming Current 2: Internal and external (remote) resistive control 2.
TB 503 3-terminal terminal block (Current Monitor connections)	(1) +CM	Current Monitor (+) Positive terminal for current monitor (voltage) signal.
	(2) -CM	Current Monitor (-) Negative terminal for current monitor (voltage) signal.
	(3) NC	Not Connected.
Chassis Ground	EARTH - GND must be connected to this stud to ensure safe operation of the unit.	
AC Line Cord	Three-wire, single phase safety line cord.	
NOTE: JQE Specials are shipped with links in place connecting the following pairs of terminals: RPV1 and RVC, +S and +V, -S and -V on TB501 and REF and RPC1 on TB502.		

c) Internal Adjustments and Calibrations: Refer to Figure 2-3 and Table 2-3.



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TOP COVER (PARTIAL TOP VIEW)

FIGURE 2-3. LOCATION OF INTERNAL ADJUSTMENTS

TABLE 2-3. INTERNAL ADJUSTMENTS

REFERENCE DESIGNATION	CONTROL	PURPOSE	ADJUSTMENT PROCEDURE
A4R(C)403	OVP DELAY ADJ	Adjusts delay time of Overvoltage Protection.	PAR. 4.4
A4R432	C. MON FS	Calibrates full scale for the current monitor signal.	PAR. 4.6.4
A4R430	C. MON ZERO	Calibrates zero for the current monitor signal.	PAR. 4.5.3
A4R415	OVP ADJ	Adjusts Overvoltage Protection level.	PAR.4.4
A1R14	E _{OUT} ZERO	Calibrates zero for output voltage.	PAR. 4.5.2
A1R4	E _{OUT} FS LOC	Calibrates full scale for output voltage controlled from front panel VOLTAGE potentiometer (local).	PAR. 4.5.2.1
A1S1	E _{OUT} LOC – E _{OUT} REM	Enables output voltage control from either front panel (local) or remote location using a variable resistance.	PAR. 4.5.5
A1R16	E _O LAG COMP	Adjusts for stability (eliminates oscillation) in voltage mode.	PAR. 4.3
A1R33	E _O FS REM	Calibrates full scale output voltage using remote resistive control.	PAR. 4.5.2.2
A1R19	I _{OUT} FS "A"	Calibrates full scale for output current limit "A."	PAR. 4.6.5
A1R56	I _{OUT} ZERO "B"	Calibrates zero for output current limit "B."	PAR. 4.6.2
A1R54	I _{OUT} FS "B"	Calibrates full scale for output current limit "B."	PAR. 4.6.3

2.3 AC INPUT REQUIREMENTS

This power supply is normally supplied for operation on a single phase, nominal 115V AC line. For conversion to 230V AC line operation, refer to FIG. 2-4. Remove the two wire jumpers between transformer terminals indicated. Re-connect one (1) jumper between terminals indicated. Do not change any other wiring on the transformer.

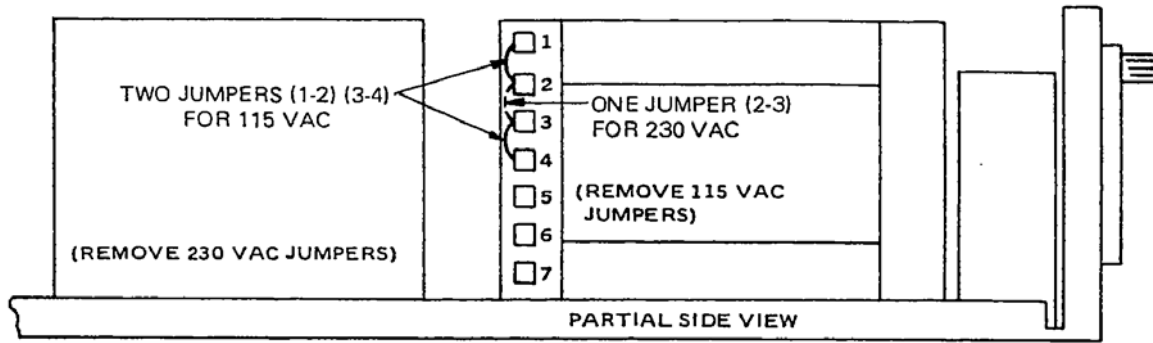


FIGURE 2-4. CONVERSION TO 230V AC LINE OPERATION

2.4 COOLING

The power transistors and rectifiers in this power supply are maintained within their operating temperature range by means of a high efficiency heat-sink assembly, coded by an internal fan. SIDE PANEL OPENINGS AND THE TOP OF THE CASE MUST BE KEPT CLEAR FROM OBSTRUCTIONS TO INSURE PROPER AIR CIRCULATION. Periodic cleaning of the interior of the power supply is recommended. If the power supply is rack mounted, or installed into confined spaces, care must be taken that the ambient temperature does not rise above the limit specified (Refer to Section 1).

2.5 PRELIMINARY OPERATIONAL CHECK

A simple operational check after unpacking and before equipment installation is advisable to ascertain whether the power supply has suffered damage resulting from shipping. Refer to Figures 2-1 and 2-2 for location of operating controls and electrical connections.

1. Connect power supply to 115V AC line or refer to paragraph 2.3 for 230V AC operation if required.
2. Verify that the following links are installed at the rear panel (see Figure 2-2) and that the connection is tight:
 - TB501 between -S and -V terminals
 - TB501 between +S and +V terminals
 - TB501 between RVC and RPV1 terminals
 - TB502 between REF and RPC1 terminals
3. Turn CURRENT LIMIT CONTROL "A" and "B" full clockwise. Turn VOLTAGE CONTROL fully counterclockwise.
4. Connect a DVM to terminal +S and DVM return to -S of TB501 at the rear panel.
5. Turn AC POWER circuit breaker "on." The AC PILOT LIGHT should be energized. Slowly turn VOLTAGE CONTROL clockwise and verify the front panel voltmeter shows a gradual

increase of the output voltage up to E_O nominal. Verify that when the VOLTAGE control is fully clockwise, the DVM voltage reads E_O nominal ($\pm 0.1\%$ E_O nominal).

6. Check the "crowbar" action of the overvoltage protection by adjusting the output voltage to E_O nominal using the front panel VOLTAGE control. Through the access hole in the top cover, slowly adjust the OVP ADJ pot counterclockwise until the input circuit breaker trips. Turn the OVP ADJ pot 1/4 turn clockwise. Turn AC POWER circuit breaker "on" and verify that the unit stays on.
7. Turn AC POWER circuit breaker "off." Place a precision 4-terminal shunt across the output. Connect the DVM to the shunt's sensing terminals (DVM return to the sensing terminal of the shunt that is connected to $-V$ power terminal at TB501). Turn CURRENT LIMIT CONTROL "A" fully clockwise and CURRENT LIMIT CONTROL "B" fully counterclockwise.
8. Turn AC POWER circuit breaker "on." Slowly turn front panel CURRENT LIMIT CONTROL "B" clockwise and observe the gradual increase in output current at the front panel ammeter. Check that at the full clockwise position of the CURRENT LIMIT CONTROL "B" the DVM reads $1.05 \times I_O$ nominal "B" value ($\pm 0.5\%$ I_O nominal "B" value).

NOTE: Use the following formula to obtain output current I_O from the DVM voltage readings:

$$I_O \text{ (Amperes)} = \frac{V_{\text{DVM}} \text{ (Volts)}}{R_{\text{SHUNT}} \text{ (Ohms)}}$$

2.6 INSTALLATION (REFER TO FIGURE 1-1, OUTLINE DRAWING)

The JQE specials may be used as a bench-operated instrument. A retractable "bail" is provided to lift the power supply front to a convenient viewing and operating angle. If the supply is to be rack-mounted, the bail, the two rear feet and the side handles must be removed.

For all installations into confined spaces, care must be taken that the temperature immediately surrounding the unit does not exceed the maximum specified ambient temperature (71°C).

2.7 GROUNDING

AC GROUND. The power supply is equipped with a 3-wire safety line cord and polarized plug. The third (green) wire in the line cord is connected to the chassis and the case of the unit.



WARNING

For safe operation It is recommended that the rear panel stud marked $\pi\pi$ be connected to the appropriate earth ground.

DC GROUND. The DC output is isolated from the AC power line and from any direct connection to chassis or ground. The maximum voltage that can be supported between either output terminal and ground or chassis is 500V DC plus the maximum output voltage of the power supply. Either side of the output may be grounded. A convenient grounding terminal is provided at the rear terminal block TB501 GND terminal.

SECTION 3 - OPERATION

3.1 STANDARD POWER SUPPLY OPERATION, LOCAL CONTROL

3.1.1 GENERAL

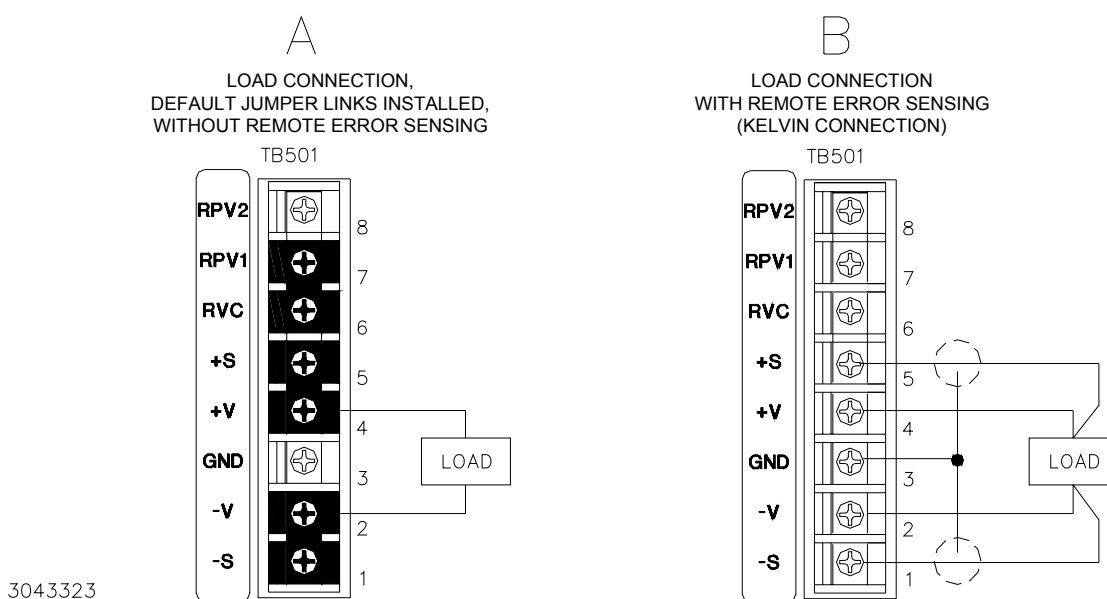
The Power Supply is shipped from the factory with three (3) removable jumper links in place at the rear barrier strip TB501 as shown in FIG. 3-1, as well as a link between REF and RPC1 terminals of rear barrier strip TB502 that enables the front panel CURRENT LIMIT "B" control. THESE LINKS MUST BE IN PLACE AND SECURED TIGHTLY for standard local operation. Loose terminal links or wires at the barrier strip will cause malfunction of the power supply.

3.2 LOAD CONNECTION

The load may be connected in either of the two ways illustrated (Figure 3-1).

3.2.1 LOCAL ERROR SENSING (SEE FIGURE 3-1A.)

This type of load connection is recommended for constant load applications. Install the links between +S and +V terminals and between -S and -V terminals of TB501 at the rear panel. Load connecting wires should be as heavy as practicable, since load wire voltage drops will degrade regulation performance. Twisting of load wires will help to preserve the low output impedance as well as reduce the coupled and radiated noise of the power supply.



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FIGURE 3-1. LOAD CONNECTION SHOWING A FLOATING LOAD

3.2.2 REMOTE ERROR SENSING (SEE FIGURE 3-1B.)

Remove the links between +S and +V terminals and between -S and -V terminals of TB501 at the rear panel. Specified regulation performance DIRECTLY AT THE LOAD requires the use of

remote error sensing. A twisted, shielded pair of wires from the sensing terminals directly to the load will compensate for load wire voltage drops up to 0.5 volt per wire (Refer to Figure 3-1B). Observe polarities: for example, the positive sensing wire (from TB 501 +S) goes to the positive load terminal (connected to terminal +V).

To keep the DC voltage drop in the load connecting wires to a minimum, and to preserve the dynamic characteristics of the power supply (AC stability, output impedance and recovery time), load wires should be as short as possible and as large in diameter as practicable. Error sensing leads should be #22 AWG and as short as possible. Both lead pairs should preferably be tightly twisted. For minimum ripple and noise pick-up, the error sensing leads must be shielded. The shield should be returned to the ground point of TB501.

3.2.3 GROUNDED LOAD CONNECTION

If the load has one end connected to EARTH-GND, then connect the load termination connected to EARTH-GND to +V of TB501 at the rear panel for better output noise performance (see Figure 3-2A). For this configuration the voltage across the load will be negative with respect to chassis GND,

If the load is floating, but it is desired to have the JQE having the output with a certain polarity with respect to chassis GND, connect locally at TB501, either + V terminal to GND for a negative output voltage referenced to chassis GND (see Figure 3-2B), or connect -V terminal to GND for a positive output voltage referenced to chassis GND (see Figure 3-2C).

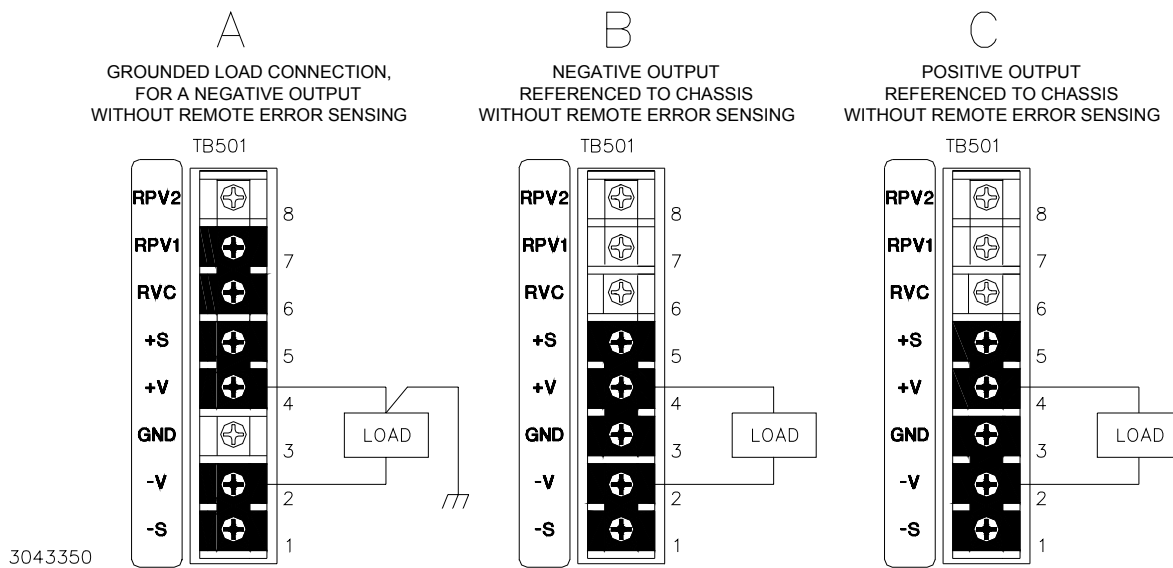


FIGURE 3-2. GROUNDED LOAD CONNECTIONS

3.3 OUTPUT ADJUSTMENT

Once the load is connected to the output terminals of the power supply as described in the previous paragraphs, the operating voltage may be adjusted to the desired value by turning the VOLTAGE CONTROL and observing the front panel VOLTMETER.

If the link is present between terminals REF and RPC1 of barrier strip TB502 at the rear panel, CURRENT LIMIT CONTROL "A" is recommended to be set fully clockwise, then use either CURRENT LIMIT CONTROL "B" or the remote resistance connected between terminals RPC1 and RPC2 of barrier strip TB502 to control the current limit.

If the link is removed between terminals REF and RPC1 of barrier strip TB502 at the rear panel, both CURRENT LIMIT CONTROL "B" and the remote control of current limit via terminals RPC1 and RPC2 are disabled; use CURRENT LIMIT CONTROL "A" to establish the current limit.

CURRENT LIMIT CONTROL "A" or "B" may also be set to intermediate values, as desired, by first turning the AC POWER circuit breaker to the "off" position and then placing a short circuit across the output. Turn AC POWER circuit breaker "on." Now the required operating current is adjusted by turning CURRENT LIMIT CONTROL "A" or "B" to the value needed. For a more precise current limit adjustment use a 4-terminal shunt connected at the output as specified in PAR. 2.5 step 7. The range for current limit "A" is 10% to 100% of I_O nominal "A." The range for current limit "B" is 1% to 105% of I_O nominal "B." Turn off the unit and remove the short-circuit or shunt. After the short is removed from the output, the voltage protection can be set.

With the OVP ADJ potentiometer set fully clockwise, set the output voltage as described above. Turn the OVP ADJ potentiometer slowly counterclockwise, until the power supply output "crow-bars," indicated by the output voltage going to zero and the circuit breaker tripping. Turn the OVP ADJ potentiometer 1/4 turn clockwise. A too close adjustment towards the operating voltage may lead to spurious triggering, especially if the "delay" adjustment is set for maximum sensitivity. The minimum "threshold" voltage protection adjustable is 5% of E_O nominal. Adjust the OVP DELAY ADJ potentiometer if required. This control is factory adjusted for maximum sensitivity, consistent with reliable operation without spurious triggering. It needs re-adjustment only if extremely sensitive loads must be triggered in the shortest time possible and if some spurious triggering can be tolerated. Now the load can be connected to the power supply and operation can commence.

3.4 INTRODUCTION TO REMOTE PROGRAMMING

3.4.1 GENERAL

A few general remarks may be in order to familiarize the user of this equipment with the terminology and basic equations pertaining to remote programming of Kepco Power Supplies. Electrically, the power supply, consists of the unregulated DC source (E_U), the pass element (E_P), the DC error amplifier (A_V) and a comparison circuit which resembles a four-arm electrical bridge. (Refer to Figure 3-3). The elements of the bridge are arranged to produce a virtual zero at the amplifier input when the bridge circuit is at balance ($V_{AA}' = 0$). Any tendency for the output voltage to change in relation to the reference voltage (E_r) creates an error signal (E) which, by means of negative feedback and the amplifier, tends to correct the output voltage towards restoration of bridge balance.

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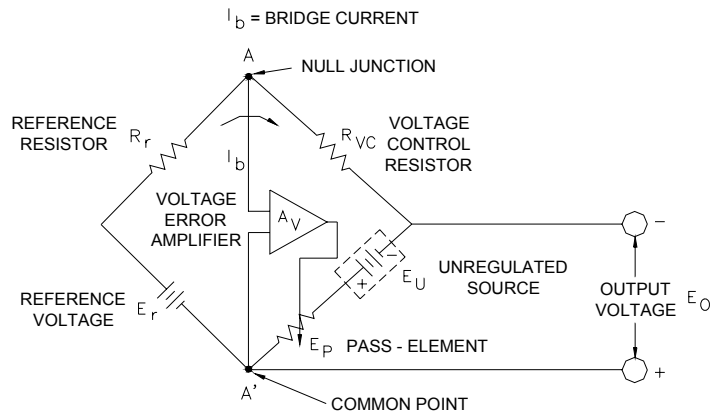
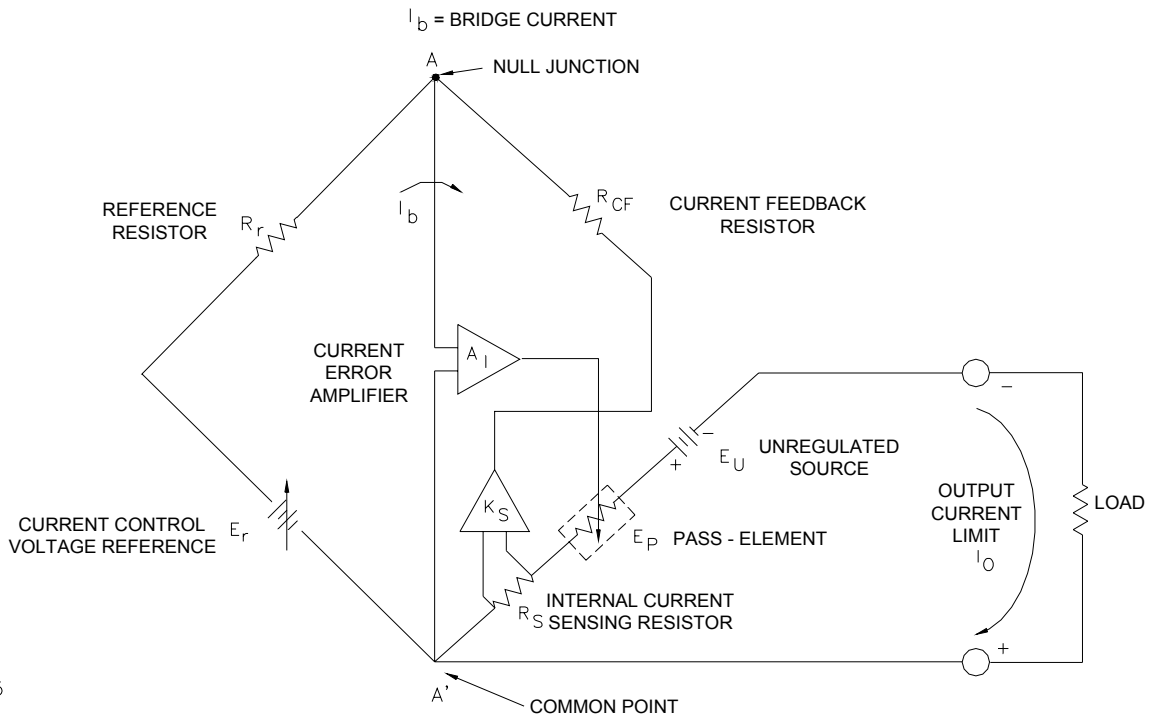


FIGURE 3-3. COMPARISON BRIDGE (SIMPLIFIED) FOR VOLTAGE MODE

A similar bridge representing power supply operation in CURRENT LIMIT mode is shown in Figure 3-4



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FIGURE 3-4. COMPARISON BRIDGE (SIMPLIFIED) FOR CURRENT MODE

3.4.2 EQUATIONS SHOWING THE OPERATION OF THE KEPKO BRIDGE

The following relationships govern the operation of the Kepco Bridge at balance in voltage mode, i.e., with $VAA' = 0$.

$$\frac{E_O}{E_r} = \frac{R_{VC}}{R_r} \quad (1)$$

Where: E_O = Output Voltage
 E_r = Reference Voltage
 R_r = Reference Resistance
 R_{VC} = Voltage Control Resistance
 I_b = Bridge Control Current

$$\frac{E_r}{R_r} = I_b \quad (2)$$

$$E_O = I_b R_{VC} \quad (3)$$

The ratio of Ohms control - resistance needed per volt output is termed the "CONTROL RATIO." It is 1000 Ohms/Volt for remote resistive control only. For local control the ratio is determined by the front panel VOLTAGE control potentiometer value and tolerance.

As can be seen from equation (1), the output voltage E_O can be controlled by varying any one of the three quantities. Rewriting equation (1) we have

$$E_O = \frac{E_r}{R_r} \times R_{VC}$$

The ration $\frac{E_r}{R_r}$ constitutes the bridge control current I_b (Eq. (2)).

Therefore we can write $E_O = I_b R_{VC}$ (Eq. (3)).

Making I_b a precision quantity establishes a precise programming ratio, so that the accuracy of E_O is solely dependent upon R_{VC} . This mode of operation is referred to as Resistance Programming and is covered in detail in PAR. 3.6.

NOTE: For all programming and adjustment components, use high quality, wire-wound resistors with a T.C. of 20 p.p.m or better.

Similar relationships can be described for operation in Current Limit mode. The following relationships govern the operation of the Kepco Bridge at balance in current mode, i.e., with $VAA' = 0$.

$$\frac{I_O R_S K_S}{E_r} = \frac{R_{CF}}{R_r} \quad (4)$$

Where: E_O = Output Voltage
 E_r = Reference Voltage
 R_r = Reference Resistance
 I_b = Bridge or Control Current
 K_S = Current Sensing Amplification Factor
 R_S = Current Sensing Resistor
 R_{CF} = Current Feedback Resistor

$$I_O = \frac{R_{CF}}{K_S R_S R_r} E_r \quad (5)$$

$$I_O = \frac{R_{CF}}{K_S R_S} \frac{E_r}{R_r} \quad (6)$$

$$I_O = \frac{R_{CF}}{K_S R_S} I_b \quad (7)$$

The ratio of $\frac{R_{CF}}{K_S R_S}$ termed the "CONTROL RATIO," gives the current (in mA) needed to obtain one Ampere of output current where R_S is in Ohms and R_{CF} is in KOhms.

3.5 GENERAL RULES FOR REMOTE PROGRAMMING

All remote programming applications require the observance of a few basic rules to insure proper functioning of the power supply in the particular mode of operation selected. These rules should be remembered before each application, and especially if malfunctioning of the programming set-up is experienced.

3.5.1 GROUNDING

Ground loops due to multiple and indiscriminate grounding of various equipment are the cause of the majority of complaints about "high ripple or noise." They can be easily avoided by grounding the power supply at one point only to which all shielded cables and equipment cases are connected. If possible, one side (preferable the positive one) of the power supply output should also be grounded.

3.5.2 CONNECTIONS

All external connections, especially the rear barrier strip terminal screws, must be tight. Series malfunctions may be caused by open feedback loops, error sensing lines or programming connections.

3.5.3 PROGRAMMING RESISTORS

Programming resistors should be high quality wirewound units with temperature coefficients of 20 parts per million or better. Their wattage rating must be at least 10 times the actual power dissipated. Although the control current through these resistors is only 1 mA, an error current spike exists when programming large voltage excursions. The peak of the current is limited by the internal 500 Ohm resistor and depends upon the magnitude of output voltage swing. The time constant is determined by the internal 500-Ohm resistor and the unit's output capacitance given in Table 1-1 for current mode.

3.5.4 EXTERNAL SWITCHING

If step-switch devices are used in resistance programming, they must be of the "make before break" variety to avoid programming infinity. Programming resistors must have a voltage rating at least equal to the maximum output voltage of the power supply.

3.6 OUTPUT VOLTAGE PROGRAMMING WITH EXTERNAL RESISTANCE

The output voltage of the Power Supply may be controlled remotely by an external resistance, replacing the built-in voltage control resistance which is disconnected at the rear barrier strip; this is accomplished by removing the link between terminals RVC and RPV1 at terminal block TB501 at the rear panel. Refer to Figure 3-5 and install a variable resistance across terminals RPV1 and RPV2 of TB501. To maintain a calibrated "programming ratio" of 1000 Ohms/V, the switch labelled E_{OUT} LOCAL - E_{OUT} REMOTE (accessible through the top cover) must be set to E_{OUT} REMOTE. The value of the programming resistance may be calculated by referring to the transfer function derived earlier (Eq. 1)

$$E_O = R_{VC} \times \frac{E_T}{R_T} \quad (1)$$

Since $E_r/R_r = I_b$ (2), it follows that $E_o = I_b R_{VC}$ (3).

Referring to Equation (3), since I_b is 1mA (precisely adjusted as shown in PAR. 4.5.5), for every Volt of output, 1000 Ohms control resistance must be provided.

1. Determine value of programming resistor(s) for output voltage desired.
2. Using two-wire, shielded cable, connect the chosen resistors to terminals RPV1 and RPV2 at terminal block TB501 on the rear panel. Connect the shield to the GND terminal of TB501.
3. The output voltage (Volts) will be $1\text{mA} \times R_{VC}$, (where R_{VC} is in KOhms).

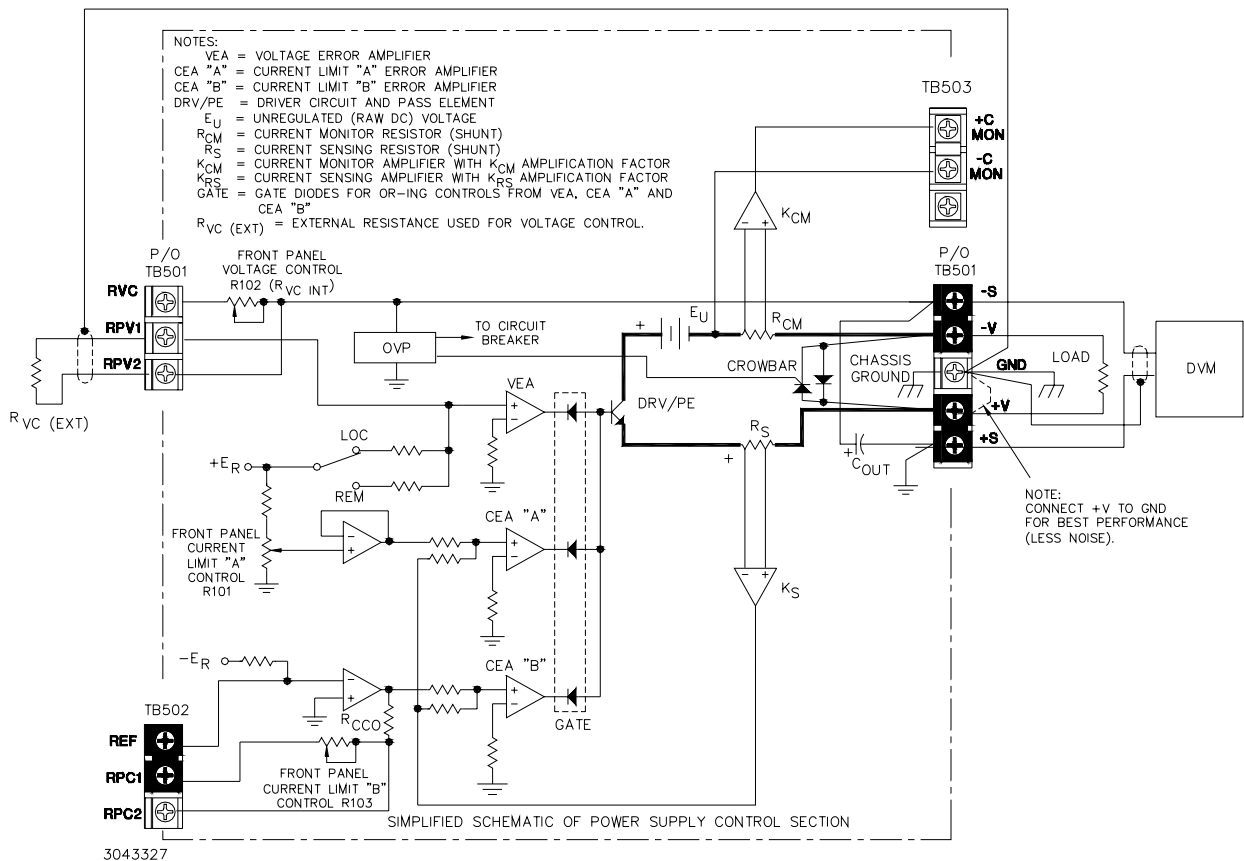


FIGURE 3-5. REMOTE RESISTANCE PROGRAMMING (VOLTAGE MODE)

3.7 CONSTANT CURRENT OPERATION

JQE special power supplies will deliver constant current depending on the output voltage and output current limit settings as well as the load value. In constant current operating mode, the voltage comparison bridge is interconnected with the internal current sensing resistor, R_S , and a current control, R_{CC} (as shown in Figure 3-6) to maintain a constant voltage drop across R_S . In this way, an adjustable constant load current is obtained. Characteristic of the constant current supply is ability to change its output voltage automatically in order to maintain a constant current through a range of possible load resistances. The range of output voltage that the supply can

deliver and simultaneously maintain constant current, is referred to as the "COMPLIANCE VOLTAGE."

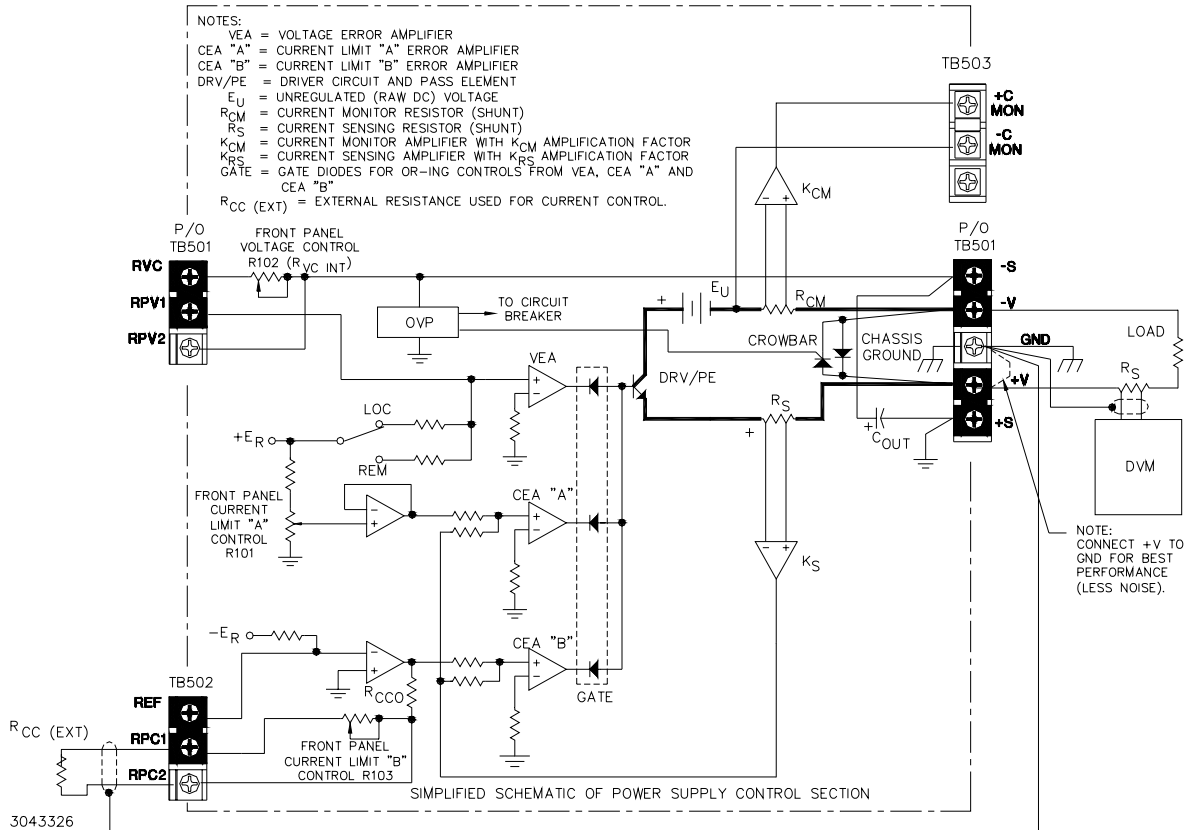


FIGURE 3-6. REMOTE RESISTANCE PROGRAMMING (CURRENT MODE)

3.8 OUTPUT CURRENT PROGRAMMING WITH EXTERNAL RESISTANCE

If Current limit "B" is enabled, the Current Limit "B" value, controlled by the I_{LIM B} front panel control, can be modified by a remote resistance. This is accomplished by first installing a link between terminals REF and RPC1 of TB502 at the rear panel and set front panel control I_{LIM A} fully clockwise. Then refer to Figure 3-6 and connect a remote resistance between terminals RPC1 and RPC2 of TB502 at the rear panel.

The remote current control limit value will be determined by the following equation:

$$(I_{lim B})_e = (I_{lim B})_i \cdot \frac{R_{cco} + \frac{R_{cci} \times R_{cce}}{R_{cci} + R_{cce}}}{R_{cco} + R_{cci}}$$

where

$(I_{\text{lim B}})_e$ = Current limit "B" determined by the external resistance connected to terminals RPC1 and RPC2 of TB502.

$(I_{\text{lim B}})_i$ = Current limit "B" determined by the internal resistance only (with external resistance disconnected).

R_{cco} = 5 Ohms (tolerance $\pm 1\%$) = the initial value of internal current control "B" for full counterclockwise position.

R_{cci} = the value of internal current control "B." The current value of R_{cci} can be measured with the unit turned off, using a digital ohmmeter connected between terminals RPC1 and RPC2 of rear barrier strip TB502. The nominal value of R_{cci} for fully clockwise position is 500 Ohms (tolerance $\pm 5\%$).

R_{cce} = the value of external resistance connected in parallel with internal current control "B."

NOTE: If R_{cci} and R_{cce} are much higher than R_{cco} , the above equation can be simplified as:

$$(I_{\text{lim B}})_e = (I_{\text{lim B}})_i \cdot \frac{R_{\text{cce}}}{R_{\text{cci}} + R_{\text{cce}}}$$

SECTION 4 - CALIBRATION

4.1 GENERAL

It is recommended that both output voltage and output current limit calibrations be performed in sequence, however it is permissible to do only one if the other is known to be calibrated. Required test equipment is listed in PAR. 4.2. E_{Onom} , I_{Onom} , I_{Limit} "A" and I_{Limit} "B" are listed in Table 1-1 for each model.

4.2 TEST EQUIPMENT REQUIRED

The following test equipment is required to perform the calibration procedures in this section.

- a). Resistive load, variable, with ON/OFF and SHORTING SWITCH and capable of dissipating the full output power of the unit under test.
- b). Digital DC voltage monitor (DVM), digital voltmeter, or power supply analyzer.
- c). External programming Resistor: value in KOhms: $E_{Onom}/1\text{mA}$, tolerance: 0.01%.
- d). Precision Current Sensing Resistor (Shunt): 0.1 Ohm, $\pm 0.1\%$, 50W, 20ppm/ $^{\circ}\text{C}$.
- e). AC ripple monitor, sensitivity better than 1 mV. Ballantine Model 302C. or Hewlett Packard Model 400H or Oscilloscope, vertical sensitivity better than 0.1 mV/cm.

4.3 LAG NETWORK ADJUSTMENT

An a-c stability control in the form of a lag network has been provided in this power supply. This network has been factory adjusted for maximum amplifier stability when operating into a resistive load. Re-adjustment is indicated if components affecting the a-c characteristics of the amplifier must be replaced, or if the load connected to the power supply contains excessive capacitance or inductance, causing a-c instability (usually indicated by high-frequency oscillation as observed with an oscilloscope across the power supply load). In such cases, the lag network should be adjusted so that stable operation is resumed. In extreme cases if adjustment of the lag network should not prove sufficient, twisted load and error sensing wires or decoupling capacitance directly across the load may provide a solution to the problem.

1. Connect the power supply to the particular operating load using +V and -V terminals of TB501 at the rear panel.
2. Use an oscilloscope connected across the load to monitor oscillation.
3. Turn on the JQE special power supply and adjust E_{Onom} LAG COMP potentiometer (accessible through top cover) so that the output is free of oscillation while the unit is operating in Voltage Mode with the designated load.
4. Turn the JQE special power supply off and disconnect load from +V and -V terminals of TB501 at the rear panel.

4.4 OVERVOLTAGE PROTECTION (OVP) TEST AND ADJUSTMENT

1. Use the VOLTAGE control at the front panel to set the output voltage to a typical operational voltage as measured by either the front panel voltmeter or by an external DVM.

2. Turn OVP DELAY ADJ potentiometer (accessible through top cover) to approximately the middle position (five turns from one end).
3. Slowly, turn the OVP ADJ potentiometer counterclockwise until the power supply circuit breaker trips OFF. Then turn OVP ADJ potentiometer clockwise 1/4 turn.
4. Turn on the JQE special power supply. The circuit breaker should not trip and the output voltage, measured by either the front panel voltmeter or by the external DVM, should be the same as step 1 above.

NOTE: The OVP circuit causes the circuit breaker to trip and initiates the Output Crowbar, a solid state switch (thyristor) across the output. Adjust OVP DELAY ADJ potentiometer so that the circuit breaker does not trip while the unit is operating with your particular load and application. To avoid tripping the circuit breaker unnecessarily, for example upon encountering load transients, a compromise must be made between the following:

- Rapid OVP action (minimum tolerance for output overvoltage):
OVP DELAY ADJ set to full counterclockwise position and
 - Maximum delay of OVP action (where some overvoltage is acceptable):
OVP DELAY ADJ set to full clockwise position.
5. Repeat steps 1 through 4 above for any desired operational output voltage above 5% E_{Nom} .

4.5 OUTPUT VOLTAGE CALIBRATION

The output voltage calibration consists of the following calibration procedures which must all be performed in sequence: Pre-calibration Setup (PAR 4.5.1), Zero Output Voltage (PAR 4.5.2), Zero Current Monitor (PAR 4.5.3), Local Full Scale (FS) Output Voltage (PAR 4.5.4), and Remote Full Scale (FS) Output Voltage (PAR 4.5.5).

4.5.1 VOLTAGE PRE-CALIBRATION SETUP

Turn the power supply off and verify the following:

1. At the rear panel links between -S and -V, +S and +V, RVC and RPV1 on TB501 and between REF and RPC1 of TB502 are installed and securely tightened
2. Set the E_{OUT} LOC-REM switch (accessible through top cover) to LOC position (towards the front panel).
3. Turn front panel I_{lim} "A" and I_{lim} "B" controls to the full clockwise position.
4. Turn front panel VOLTAGE control to the full counterclockwise position.

4.5.2 ZERO OUTPUT VOLTAGE CALIBRATION

Zero Output voltage is calibrated for either the local front panel VOLTAGE control (PAR 4.5.2.1) or an external resistance used for remote programming of output voltage (4.5.2.2).

4.5.2.1 ZERO OUTPUT VOLTAGE (LOCAL PROGRAMMING) CALIBRATION

The following procedure calibrates the front panel VOLTAGE control for 0V output when set to minimum. Due to slight resistance present even when the VOLTAGE control is set to minimum, this calibration may not be accurate in remote mode where an external resistance is used for remote programming of the output (see PAR. 4.5.2.2 if using remote programming).

1. Connect DVM between +S and -S of TB501 with the DVM reference terminal connected to -S terminal.
2. Turn ON the unit, and allow unit to operate for 10 to 15 minutes before proceeding.
3. Adjust E_{OUT} ZERO potentiometer (accessible through top cover) until output voltage reads 0V (tolerance: +0.025% of E_{Onom} to +0.05% of E_{Onom}).

4.5.2.2 ZERO OUTPUT VOLTAGE (REMOTE PROGRAMMING) CALIBRATION

The following procedure calibrates the output for 0V when using an external resistance for remote programming of the output. See PAR. 4.5.2.1 if using front panel VOLTAGE control to program the output.

1. Remove the link between terminals RVC and RPV1 of TB501 at the rear panel.
2. Connect the External Programming resistor (see PAR. 4.2) between terminals RPV1 and RPV2 of TB501 at the rear panel.
3. Set the E_{OUT} LOC-REM switch (accessible through top cover) to REM position (towards the back panel)
4. Connect DVM between terminals +S and -S of TB501 with the DVM reference terminal connected to -S terminal.
5. Turn the unit on and adjust the external programming resistance for minimum output voltage and allow unit to operate for 10 to 15 minutes before proceeding.
6. Adjust E_{OUT} ZERO potentiometer (accessible through top cover) until output voltage reads 0V (tolerance -0 to +0.025% of E_{Onom}).
7. Restore pre-calibration settings (PAR 4.5.1, steps 1 through 4).

4.5.3 ZERO CURRENT MONITOR CALIBRATION

1. At the rear panel. connect DVM to +C.MON of TB503, referenced to -C.MON of TB503.
2. Adjust C.MON ZERO potentiometer (accessible through top cover) until Output Current Monitor signal reads 0V (tolerance ± 0.1 mV).

4.5.4 LOCAL FULL SCALE (FS) OUTPUT VOLTAGE CALIBRATION

1. Set front panel VOLTAGE control to the full clockwise position.
2. Connect DVM between +S and -S of TB501 with the DVM reference terminal connected to -S terminal.

3. Adjust FS LOC potentiometer (accessible through top cover) until output voltage reads E_{Onom} (V) (tolerance $\pm 0.1\%$ of E_{Onom}).

4.5.5 REMOTE FULL SCALE (FS) OUTPUT VOLTAGE CALIBRATION

1. Turn the JQE special power supply off.
2. Remove the link between terminals RVC and RPV1 of TB501 at the rear panel.
3. Connect the fixed External Programming resistor (see PAR. 4.2) between terminals RPV1 and RPV2 of TB501 at the rear panel. The resistor value should be $E_{Onom}(\text{Volts})/1\text{mA}$ in KOhms, tolerance: 0.01%
4. Set the E_{OUT} LOC-REM switch (accessible through top cover) to REM position (towards the back panel)
5. Turn the unit on and adjust E_{OUT} FS REM potentiometer (accessible through top cover) until output voltage reads $E_{Onom}(V)$ (tolerance $\pm 0.1\%$ of E_{Onom}).

4.6 OUTPUT CURRENT LIMIT CALIBRATION

Output current limit calibration consists of the following procedures: Pre-Calibration setup (PAR. 4.6.1), Zero (Minimum) Output Current Limit "B" (PAR. 4.6.2), Full Scale (maximum) Output Current Limit "B" (PAR. 4.6.3), Full Scale Current Monitor (PAR. 4.6.4), Full Scale Output Current Limit "A" (PAR. 4.6.5).

4.6.1 CURRENT LIMIT PRE-CALIBRATION SETUP

1. Current measurements are made by measuring the voltage drop across the sense resistor (see PAR. 4.2) and then converting the result to current using the following formula. It is critical that the actual value of the sense resistor be measured accurately.
 R_{SENSE} = the measured value of the sense resistor in ohms (0.01% accuracy).

$$\text{Calculated output current [Amperes]} = (V_{DVM} [\text{Volts}]) / R_{SENSE} [\text{Ohms}]$$

2. Turn the JQE special power supply off and, if connected, remove the external remote programming resistor from terminals RPV1 and RPV2 of TB501.
3. Install link between terminals RVC and RPV1 of TB501.
4. Set the E_{OUT} LOC-REM switch (accessible through top cover) to LOC position (towards the front panel).
5. Turn front panel I_{lim} "A" control to the full clockwise position.
6. Turn front panel I_{lim} "B" controls to the full counterclockwise position.
7. Turn front panel VOLTAGE control to the full clockwise position.
8. Connect precision 4-terminals Current Sensing Resistor (Shunt) (see PAR 4.2) across the output, between terminals +V and -V of TB501 at the rear panel.
9. Connect the DVM to the Shunt's sensing terminals with the DVM reference terminal connected to the terminal closest to the -V terminal on TB501. Use the Shunt measured value to correct the Output Current DVM readings.

4.6.2 ZERO (MINIMUM) OUTPUT CURRENT LIMIT "B" CALIBRATION

1. Turn ON the unit, and allow unit to operate for 10 to 15 minutes before proceeding.
2. Adjust I_{OUT} ZERO "B" potentiometer (accessible through top cover) for current of 1% of Current Limit "B" (see Table 1-1) (minimum output) in Amperes, tolerance $\pm 0.5\%$ of Current Limit "B."
JQE 15-12MVPY-26954 = 0.043A \pm 0.021A
JQE 55-5MVPY-26955 = 0.027A \pm 0.013A
JQE 55-5MVPY-26997 = 0.05A \pm 0.025A
JQE 150-1.5MVPY-26956 = 0.004A \pm 0.002A

4.6.3 FULL SCALE (MAXIMUM) OUTPUT CURRENT LIMIT "B" CALIBRATION

1. Turn front panel I_{lim} "B" control to the full clockwise position.
2. Adjust I_{OUT} FS "B" potentiometer (accessible through top cover) for 105% of Current Limit "B" (see Table 1-1), tolerance $\pm 0.5\%$ of Current Limit "B."
JQE 15-12MVPY-26954 = 4.515A \pm 0.021A
JQE 55-5MVPY-26955 = 2.835A \pm 0.013A
JQE 55-5MVPY-26997 = 5.25A \pm 0.025A
JQE 150-1.5MVPY-26956 = 0.420A \pm 0.002A
3. Record the value for use during FS Current Monitor calibration (PAR. 4.6.4).

4.6.4 FS CURRENT MONITOR CALIBRATION

1. Connect DVM to terminal +C.MON referenced to terminal -C.MON of TB503 at the rear panel.
2. Adjust C.MON FS potentiometer (accessible through top cover) for DVM reading of ($K_{CM} \times I_{Onom}$) in mV, tolerance: $\pm 0.01 \times K_{CM} \times I_{Onom}$ in mV. NOTE: I_{Onom} is the value recorded in step 3 of PAR. 4.6.3 above, K_{CM} is the nominal value of the current monitor transfer factor: 50mV/A (5mV/A for JQE 55-5MVPY-26997).

4.6.5 FULL SCALE OUTPUT CURRENT LIMIT "A" CALIBRATION

1. a) Turn the JQE special power supply off.
2. b) Remove the link between REF and RPC1 of TB502.
3. Turn front panel I_{lim} "A" controls to the full clockwise position.
4. Turn the JQE special power supply on.
5. Adjust I_{OUT} FS "A" potentiometer (accessible through top cover) for 100% of Current Limit "A" (see Table 1-1), tolerance $\pm 0.5\%$ of Current Limit "A".
JQE 15-12MVPY-26954, JQE 55-5MVPY-26955 and JQE 55-5MVPY-26997 = 5.0A \pm 0.025A
JQE 150-1.5MVPY-26956 = 1.5A \pm 0.0075A
6. Turn off the unit and restore the link between REF and RPC1 terminals at TB502 at the rear panel.

SECTION 5 - THEORY OF OPERATION

5.1 SIMPLIFIED DIAGRAM DISCUSSION

Referring to Figure 5-1, the main power transformer converts the line voltage to the required levels needed to produce the d-c operating voltages for the Main and Auxiliary Supplies. The main power supply is in series with the pass elements and the current sensing RESISTOR and produces the output voltage. The main pass elements are changing their series resistance to keep the output voltage constant. The necessary drive for this change is produced by the driver circuit which, in turn, receives its command signals either from current error amplifier A or B or the voltage error amplifier.

The output voltage is constantly compared to the voltage reference source, while the output current, monitored by the current sensing resistor, is compared to the current reference source. Any change, in either output voltage or current, is amplified by the associated amplifier and transferred to the diode-gate which feeds directly into the driver circuit which produces the needed drive signal for the main pass elements, thus either keeping the output voltage constant, or, if the signal from the current limit amplifier is dominant, limiting the output current to the pre-adjusted value.

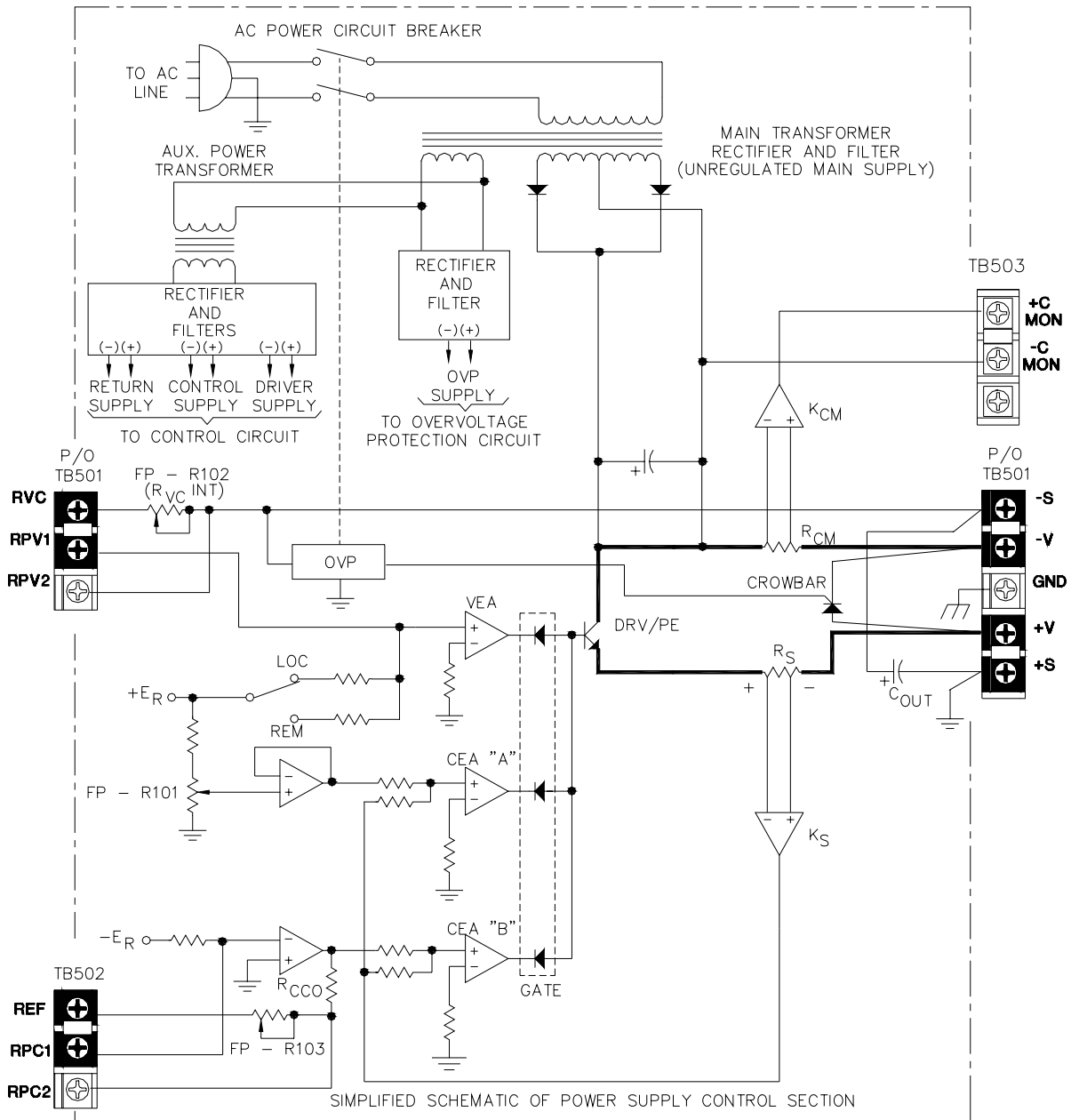
The Overvoltage Crowbar is connected across the output terminals of the power supply. A portion of the output voltage is continuously compared to an internal reference. If an overvoltage occurs; the SCR "crowbar" will short-circuit the output immediately. Recycling takes place automatically, since the a-c input power is removed by the tripping of the circuit breaker.

5.2 CIRCUIT DESCRIPTION

For the purpose of analysis, the circuitry of the JQE special power supplies may be divided into several sections which are individually described below. The overall schematic diagram (Figure 7-8) and the detailed schematic diagrams (Figures 7-9 through 7-11) illustrate the circuitry described in this section.

5.2.1 A-C INPUT CIRCUIT.

A-C line power is introduced through the a-c input barrier-strip or a heavy-duty three-wire line cord with safety plug. The use of a grounded a-c power outlet will automatically ground the power supply, since the third wire of the line cord is directly connected to the metal chassis and case. Once the a-c power circuit breaker (CB101) is closed, the primary of the main transformer (T201), the fan (B201) and the a-c pilot light (DS101) will be energized. The two primary windings of the main transformer are either connected in parallel (for 115V a-c nominal line voltage) or in series (for 230V a-c nominal line voltage). The a-c power circuit breaker (CB101), aside from switching the a-c primary power, has the function of disconnecting the power supply from the a-c line in case of input overloads, short circuits, heatsink overtemperature or output overvoltage. CB101 has two sensing coils, one of which is always in series with one of the primary windings on T201 (T2-T5), whether the main transformer is wired for 115V or for 230V a-c. The second sensing coil of CB101 is in series with the secondary winding on T201 which generates operating potential for the overvoltage protection circuit (T201-T6, T7). If an overload occurs, due to either internal component failure or crowbar action of the voltage protector, the coil is energized sufficiently to activate the trip mechanism of CB101, thus disconnecting the power supply from the a-c line.



- NOTES:
- VEA = VOLTAGE ERROR AMPLIFIER
 - CEA "A" = CURRENT LIMIT "A" ERROR AMPLIFIER
 - CEA "B" = CURRENT LIMIT "B" ERROR AMPLIFIER
 - DRV/PE = DRIVER CIRCUIT AND PASS ELEMENT
 - E_U = UNREGULATED (RAW DC) VOLTAGE
 - R_{CM} = CURRENT MONITOR RESISTOR (SHUNT)
 - R_S = CURRENT SENSING RESISTOR (SHUNT)
 - K_{CM} = CURRENT MONITOR AMPLIFIER WITH K_{CM} AMPLIFICATION FACTOR
 - K_{RS} = CURRENT SENSING AMPLIFIER WITH K_{RS} AMPLIFICATION FACTOR
 - GATE = GATE DIODES FOR OR-ING CONTROLS FROM VEA, CEA "A" AND CEA "B"

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FIGURE 5-1. JQE SPECIAL POWER SUPPLY, SIMPLIFIED SCHEMATIC DIAGRAM

Since the primary coil of the AUXILIARY POWER TRANSFORMER (T202) is in parallel with the secondary for the overvoltage protection circuit, any failure in the auxiliary circuits, reflecting back to the primary of the auxiliary power transformer (T202) will also activate the sensing coil of CB101 and shut down the power supply. A thermal sensing element (S301) is mounted to the heatsink assembly (A3) to protect the series regulator transistors from overtemperature. If the preset temperature on S301 is exceeded, its contact closes and energizes the sensing coil of CB101, resulting once more in the tripping of the a-c power circuit breaker and subsequent removal of the a-c input power from the power supply.

5.2.2 MAIN D-C SUPPLY

The main d-c power is derived from a center-tapped secondary winding on T201. A full-wave rectifier circuit with silicon diodes (CR201, CR202) operates into a capacitor input filter (C201 or C201/C202) which is paralleled by a bleeder resistor (R202). The main d-c supply delivers the output current via the series regulator or pass-element.

5.2.3 PASS-ELEMENT SECTION

The pass element section varies in complexity according to the output voltage and current rating of the particular model. The NPN silicon pass-transistors of the JQE are located on high-efficiency heatsinks and are cooled by a fan (B201). These models have a single heatsink assembly (A3) with NPN transistors. The number of transistors depends on the individual model. While in the low voltage/high output current models ($E_O < 36$ Volts) all pass-transistors are arranged in a parallel circuit, higher voltage models ($E_O > 36$ Volts) use a series/parallel configuration in the arrangement of their pass-transistors. However complex the pass-element section, for analytical purposes it can be reduced to a single pass-transistor. Electrically, this pass-element is part of a series circuit consisting of the unregulated main d-c power supply, the external load and the pass-transistor. The output voltage of the power supply is kept constant, regardless of variations in the unregulated supply, by changing the series resistance of the control element (the pass-transistor) in the described series circuit. The necessary base-drive for the pass-transistors to affect the change in series resistance is supplied by the "Darlington" connected driver stages. The main driver stages, in turn, receive their base signals from the pre-driver stage (A1Q2).

5.2.4 VOLTAGE ERROR AMPLIFIER (VEA)

The main function of the voltage error amplifier A11C1 (see Figure 7-9) is to amplify the d-c error signal, derived from the comparison bridge, to a level suitable to pass the diode gate circuit and drive the pre-driver stage A1Q2. The voltage error amplifier is a d-c coupled, high-gain operational amplifier. The amplifier input may be disconnected from the internal comparison bridge circuit, and programmed externally. Although the amplifier is used in the non-inverting configuration, a positive input signal will produce a negative power supply output with respect to the "common" (plus sensing terminal +S), since the pass-elements provide another signal inversion. If a link is installed between TB501, terminals 6 (RVC) and 7 (RPVC1) (see Figure 7-8) and the E_{OUT} LOCAL - E_{OUT} REMOTE switch is set to E_{OUT} LOCAL, the output voltage is controlled by front panel VOLTAGE control R102. When the link between TB501, terminals 6 (RVC) and 7 (RPVC1) is removed and the E_{OUT} LOCAL - E_{OUT} REMOTE switch is set to E_{OUT} REMOTE, output voltage can be controlled by an external resistance connected across TB501, terminals 7 (RPVC1) and 8 (RPVC2).

5.2.5 CURRENT LIMIT CIRCUIT

The differential input of the current sensing amplifier, A11C2A, is connected to the current sensing resistor ($R_S = R203$). The amplified voltage drop across the current sensing resistor is continuously compared to the reference voltage, set by the current limit control. As long as the

amplified voltage developed across R_S (due to load current flow) is less than the preset reference level, the current limit amplifier will be biased to its inactive state and will not affect the output. If the output current increases however, the voltage drop across R_S will overcome the reference level set by the current limit control. The current limit amplifier will be activated and produce a drive signal at the diode gate greater than the output of the voltage error amplifier, thereby taking control away from the voltage error amplifier and transferring the power supply into current limit mode. Since both the current limit amplifier and voltage error amplifier are coupled through the diode gate circuit to the pre-driver stage A1Q2, the amplifier with the greater (negative) output will control the pass transistors and therefore the output.

Current Limit "A" uses A1IC3 as the current error amplifier, while Current Limit "B" uses A1IC4. The reference for Current Limit "A" is delivered by A1IC2B, using R101 (front panel Current Limit "A" control) as the controlling potentiometer. Current Limit "B" uses A1IC5 as the reference stage using R103 (front panel Current Limit "B" control) as the controlling potentiometer. If the link between terminal block TB502, terminals 1 (REF) and 2 (RPC1) is installed, both current limit "A" and "B" loops are enabled, however the one with the lowest current limit value controls the unit. If Current Limit "B" is in control, this value may be modified by a remote resistance connected across TB502, terminals 2 (RPC1) and 3 (RPC2). If the link between block TB502, terminals 1 (REF) and 2 (RPC1) is removed, Current Limit "B" is disabled.

5.2.6 OVERVOLTAGE PROTECTION CIRCUIT AND CURRENT MONITOR

Input and output connections for the overvoltage protection circuit (VP) are made via a single connector, P401/J407. The circuit receives a-c voltage derived from a secondary of the main transformer (T201). The a-c is rectified by a conventional bridge rectifier (A4CR1), capacitor filtered by the input filter capacitor (A4C1) and shunt regulated by a 15V zener diode (A4CR3). A 6.5-Volt source, derived from the pre-regulated DC voltage by means of shunt regulator A4IC1, provides a stable reference source referenced to C1 (-) (minus).

The overvoltage protection circuit contains output sensing voltage differential amplifier IC2 and voltage comparator IC3A. This circuit compares the output sensing voltage with the adjustable voltage limit level. Once triggered, the comparator's output is integrated (A4CR14, A4C6, and A4C9), providing an adjustable delay through R(C)403 and A4IC3B.

In the event of an overvoltage, resulting either from external causes or from internal power supply failure, the circuit become active. A4CR402 will be turned on, producing an output pulse.

As the first S.C.R. (CR402) is conducting, it performs two functions: It shorts out the DC supply for the voltage protection circuit, thereby creating an overcurrent in one of the circuit breaker coils. Simultaneously, CR402 generates a firing pulse for the main S.C.R. (CR203), which through its "crowbar" action short-circuits the power supply output. The a-c circuit breaker (CB101) trips due to the action of the first S.C.R. (CR402), disconnecting the power supply from the power line. The protection circuit is automatically re-activated with the "turn-on" of the power supply via CB101.

The current monitor circuit (A4IC4) amplifies the signal across the second current sensing resistor (A4R24) connected in the -OUTPUT leg of the power supply. The transfer factor is 50mV/A (5mV/A for JQE 55-5MVPY-26997). The current monitor signal is available at terminals +C MON and -C MON of terminal block TB503 at the rear panel.

5.2.7 AUXILIARY SUPPLIES

AMPLIFIER POWER SUPPLY. This full wave, bridge rectified source is derived from a secondary winding on the auxiliary transformer (T202). Rectified by A1CR8, the supply is capacitor fil-

tered by A1C2. A current regulator stage, A1Q3, followed by a string of zener diodes, A1CR10 to A1CR13, provides the operating voltage for the amplifiers, $\pm 13.5\text{V}$ and $\pm 6.2\text{V}$ reference voltages.

PRE-DRIVER COLLECTOR SUPPLY. A full wave rectified (A1CR6) and capacitor filtered (A1C7) supply is derived from a secondary winding on T202. It delivers collector voltage to the pre-driver stage A1Q2.

CONSTANT CURRENT RETURN SUPPLY. This full-wave rectified auxiliary supply is derived from the winding of the auxiliary power transformer. Rectified by A1CR1 and filtered by A1C1, constant current is applied to the base of the pass transistors (via the constant current generator stage A1Q1, thus insuring the control of the Pass-Element for zero output voltage and/or zero output current.

5.2.8 METERING CIRCUIT

Both output voltage and output current are monitored by dual range front panel meters (M101, M102). While the output voltage is measured directly across error sensing terminals 1 (-S) and 5 (+S) of terminal block TB501, the output current is measured indirectly as a voltage drop across the current sensing resistor (R203).

SECTION 6 - MAINTENANCE

6.1 GENERAL

This section covers maintenance procedures, installation of optional components, calibration and test measurements of the JQE Special Power Supplies. Conservative rating of components and the non-congested layout should keep maintenance problems to a minimum. If trouble does develop however, the easily removed wrap-around cover and the plug-in feature of the circuit boards provide exceptional accessibility to all components of the supply.

6.2 DISASSEMBLY/REASSEMBLY (REFER TO FIGURE 6-1.)



WARNING

Turn power off and disconnect unit from power source before disassembling.

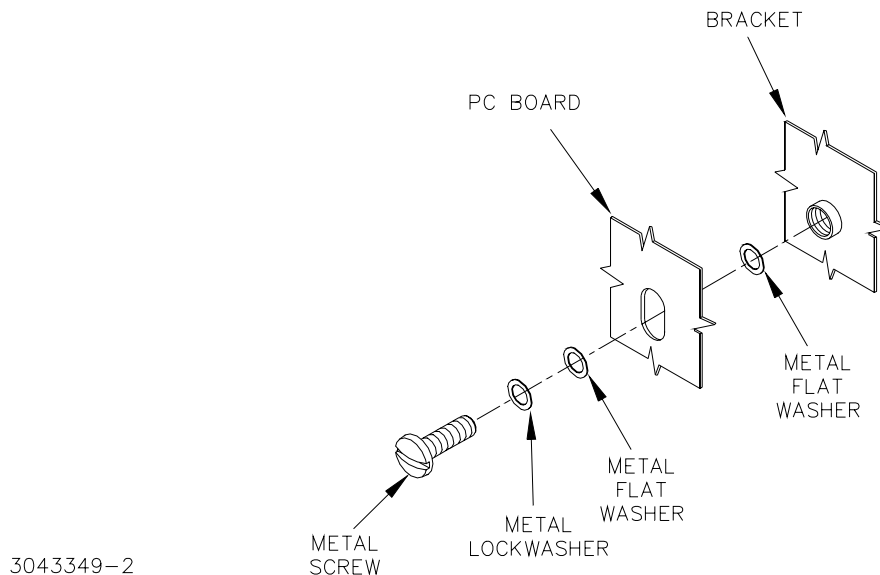
6.2.1 COVER REMOVAL

The wrap-around cover may be taken off by loosening and removing its twelve (12) holding screws, five (5) on each side and two (2) on the front panel.

6.2.2 A1 CIRCUIT BOARD REMOVAL

The A1 printed circuit board is mounted with two (2) screws and either two (2) or six (6) washers as shown in Figure 6-1, which are removed from the side. Set aside hardware for reassembly. After removal of the four printed circuit board edge connectors and 3-wire cables from A1J1 and A1J2, the board may be lifted from its slide-guide.

REASSEMBLY NOTES: A1 circuit board is floating; be sure to reassemble the hardware as shown in Figure 6-1 to maintain electrical isolation from the bracket and avoid inadvertent shorts.



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FIGURE 6-1. A1 PC BOARD, REASSEMBLY

6.2.3 A5 TERMINAL BLOCK CIRCUIT BOARD REMOVAL

Separate rear panel from the chassis by removing three screws at the bottom of the rear panel. Unplug the PC board edge connector, two 2-wire cables from A5J1 and A5J2 and tag and disconnect wires from six Quick-disconnect connectors A5J5, A5J12, A5J7, A5J4, A5J6 and A5J10. Remove the plastic covers from the three terminal strips TB501, TB502, TB503. Separate A5 board and two insulators from rear panel by removing five nuts and five washers accessed from inside the unit.

REASSEMBLY NOTES: Remember to reinstall the two insulators between A5 board and the rear panel.

6.2.4 A3 HEAT SINK REMOVAL

The heat sink assembly is mounted with four (4) screws to the chassis bottom. After the screws are taken out, the heat sink may be removed after disconnecting the PC board edge connector(s) and the wires from the Quick-disconnect terminals: one from the heat sink (model 26954 only) and two from the thermal switch.

6.2.5 A4 OVERVOLTAGE PROTECTION CIRCUIT BOARD REMOVAL

Remove the two holding screws as indicated (Refer to Figure 6-1). Separate the edge connector at the bottom and lift the circuit board and bracket assembly out of the chassis. Disconnect the 2-wire cables from A4J1 and A4J2 and the wires from Quick-disconnect connectors A4J4 and A4J5. The circuit board can be separated from the bracket by removing two nuts and washers.

6.2.6 REASSEMBLY.

Reassembly of all components takes place in reverse order of the above described procedures.

6.3 TROUBLESHOOTING

Modern, high performance power supplies require thorough understanding of the problems involved in repairing complex, solid state circuitry. Servicing beyond simple parts replacements should consequently be attempted only by personnel thoroughly familiar with solid state component techniques and with experience in closed loop circuitry.



WARNING

**The heat sink and main rectifier are electrically isolated from the chassis.
The metal parts of these components are at high d-c voltage levels
referenced to chassis**

Troubleshooting charts, showing resistance and voltage readings, are of very limited usefulness with feedback amplifiers and are not included here. Instead a detailed circuit description (Section 5), parts location diagrams, simplified functional schematics and a main schematic and detailed schematic diagrams are presented.

The following basic steps in a case of power supply malfunctioning may also be found useful:

1. If power supply does not function at all. Check all power connections and make certain, power supply is connected to the correct line voltage (it is normally delivered for 115V AC operation). Verify that the input voltage is present at the a-c outlet where the unit is plugged in.

2. No D-C Output:

- Check rear terminal block jumper (link) connections for correct placement and tight seat (Refer to FIG. 5-1).
- Check auxiliary supply voltages for A1 and A4 boards for 115V a-c input (see Table 6-1)

TABLE 6-1. AUXILIARY SUPPLY VOLTAGES

MEASUREMENT POINT	JQE 15-12MVPY-26954	JQE 55-5MVPY-26955 AND 26997	JQE 150-1.5MVPY-26956	NOTES
A1C2 (-)	-30V ±1.6V	-30V ±1.6V	-30V ±1.6V	Referenced to +S Terminal
A1C10 (+)	+1.35V ±0.7V	+1.35V ±0.7V	+1.35V ±0.7V	Referenced to +S Terminal
A1C11 (-)	-1.35V ±0.7V	-1.35V ±0.7V	-1.35V ±0.7V	Referenced to +S Terminal
A1CR3 cathode	+6.2V ±0.3V	+6.2V ±0.3V	+6.2V ±0.3V	Referenced to +S Terminal
A1CR17 anode	-6.2V ±0.3V	-6.2V ±0.3V	-6.2V ±0.3V	Referenced to +S Terminal
A1C7 (+)	+7.6V ±0.15V	+11.7V ±0.2V	+12.8V ±0.3V	Referenced to +S Terminal
A1CR19 cathode	+6.8V ±0.3V	+6.8V ±0.3V	+6.8V ±0.3V	Referenced to +S Terminal
A1C1 (-)	-16.2V ±0.3V	-16.5V ±0.3V	-16.5V ±0.3V	Referenced to -V Terminal
A1R1 (common with A1Q1 emitter)	-10.3V ±0.6V	-10.3V ±0.6V	-10.3V ±0.6V	Referenced to -V Terminal
A4C1 (+)	+29.5V ±0.6V	+27.5V ±0.6V	+30.3V ±0.6V	Referenced to -V Terminal
A4CR3 cathode	+15.0V ±0.8V	+15.0V ±0.8V	+15.0V ±0.8V	Referenced to -V Terminal
A4R3 (common with A4IC1 pin 3)	+6.5V ±0.3V	+6.5V ±0.3V	+6.5V ±0.3V	Referenced to -V Terminal
A4CR10 anode	-6.5V ±0.3V	-6.5V ±0.3V	-6.5V ±0.3V	Referenced to +S Terminal

1. High D-C Output: If the output voltage is high and not controllable by the voltage control, identical steps as outlined in step 2 above for No d-c output are advisable. In addition, if the condition persists, check the following:

- Check the pre-driver transistor* (A1Q1) and the main driver (Q305) as well as all pass-element transistors located on heat sink assembly A3.
- Check the voltage control resistor (R102) for continuity. Monitor output with an oscilloscope and observe ripple wave-form and amplitude. If high frequency oscillations are observed, proceed as directed by PAR. 4.3. High 60 Hz ripple is often due to failure in one of the rectifier circuits.

2. Input Circuit Breaker Trips at Power-up

- Set the OVP ADJ potentiometer 1/4 turn clockwise.
- For local operation, verify that EOUT LOC-REM switch is set to LOC position (towards front panel). Verify that link between terminals RVC and RPV1 of TB501 on the rear panel is installed.

- For remote operation, verify that EOUT LOC-REM switch is set to REM position (towards rear panel). Verify that link between terminals RVC and RPV1 of TB501 on the rear panel is removed. Verify remote programming resistor is connected between terminals RPV1 and RPV2 of TB501 on the rear panel.

3. Input Circuit Breaker Trips During Operation

- Use properly rated (output current) twisted pair wires for power terminal (+V, -V) connections as well as remote error sensing
 - If remote error sensing is used, use properly rated (#22AWG recommended) twisted pair wires for sense terminal (+S, -S) connections to the load.
 - If the unit is operated at full power with maximum input voltage, check that the ambient operating temperature surrounding the unit is within specified limits (see PAR 1.5).
 - Verify that the pass-element transistors are tight to the heat sink and that silicone grease was used between the transistor and heat sink. If problem recurs, replace thermoswitch mounted on heat sink assembly.
4. If the power supply is basically functioning, but poor performance is evident, inspect the test set-up to make certain the source of the trouble is not external.
 5. Poor regulation in any of the regulating modes is usually traceable to incorrectly connected loads or faulty measurement techniques. Perform measurements as described in Paragraph 6.4.2.
 6. Oscillation of the output voltage or output current is often due to a load with a large inductive component. Twisted load wires of sufficient diameter and held as short as practical, are often the solution to the problem. Refer to PAR. 4.3 for lag network adjustment.
 7. Kepco Application Engineers are available for consultation or direct help in difficult service or application problems.

6.4 POWER SUPPLY MEASUREMENTS

Measurement of the significant parameters of a power supply is a requirement for incoming inspection, periodic maintenance, or after component replacement. Since the measurements require special techniques to ensure correct results, suggestions for their performance are given below.

6.4.1 REQUIRED TEST EQUIPMENT.

1. Constant AC supply voltage with provisions for "stepping" the voltage over a specified region (105-125V); a variable autotransformer is generally adequate, if it is rated to deliver the input current of the unit under test.
2. Resistive load, variable, with ON/OFF and SHORTING SWITCH and capable of dissipating the full output power of the unit under test.
3. DC voltage monitor, digital voltmeter, or power supply analyzer.
4. Current sensing resistor, for current regulation measurements, four-terminal device.

5. AC ripple monitor, sensitivity better than 1 mV. Ballantine Model 302C. or Hewlett Packard Model 400H.
6. Optional: Oscilloscope, vertical sensitivity better than 0.1 mV/cm.

6.4.2 MEASUREMENT INSTRUCTIONS

- a. Output Voltage Measurement. The principle governing this method of measurement is simple: DO NOT MEASURE ANY VOLTAGE DROPS DUE TO LOAD CURRENT FLOW. This can only be avoided by measuring regulation directly at the sensing leads.
- b. Source and Load Effect in Voltage Mode is defined as the amount of output voltage change resulting from a specified change of line voltage or from a change in load resistance. It can be expressed as an absolute change ΔE_O or as a percentage in reference to the total output voltage E_O :

$$\% \text{ Voltage Effect} = \frac{\Delta E_O}{E_O} \times 100\%$$

- c. Current Source and Mode Effect in Current Mode is defined as the amount of output current change resulting from a specified change in line voltage or from a change in load resistance. It can be expressed as an absolute change ΔI_O , or as a percentage in reference to the total output current I_O :

$$\% \text{ Current Effect} = \frac{\Delta I_O}{I_O} \times 100\%$$

- d. RMS ripple may be monitored on a true RMS-reading instrument connected in parallel with the regulation analyzer leads. Careful wire dressing and shielding, as well as good a-c grounding are of the utmost importance if valid measurements are expected. An oscilloscope may also be used for p-p readings of noise and ripple. An approximate RMS reading can be calculated from the p-p reading of the oscilloscope if the reading is divided by three.

SECTION 7 - ELECTRICAL PARTS LIST AND DIAGRAMS

7.1 GENERAL

This section contains the schematic diagrams, the parts location diagrams, and a list of all replaceable electrical parts. All components are listed in alpha-numerical order of their reference designations. Consult your Kepco Representative for replacement of parts not listed here.

7.2 ORDERING INFORMATION

To order a replacement part or inquire about parts not listed in the parts list, address order or inquiry either to your authorized Kepco Sales Representative or to:

KEPCO, INC.
131-38 Sanford Avenue
Flushing, NY 11355

Specify the following information for each part:

- Power Supply Model number, Serial number, and Revision number stamped on the nameplate of the unit.
- Kepco part number. See Parts List.
- Circuit Reference Designation. See Schematic Diagram.
- Description. See Parts List.

To order a part not listed in the parts list, give a complete description and include its function and location.

NOTE: Kepco does not stock or sell complete power supply subassemblies as described here and elsewhere in the instruction manual. Some of the reasons are listed below:

1. Replacement of a complete subassembly is a comparatively rare necessity.
2. Kepco's subassemblies are readily serviceable, since most of them are the "plug-in" type.
3. The nature of a closed loop power supply system requires that subassembly replacement be followed by careful measurement of the total power supply performance. In addition, depending on the function of the subassembly, extensive alignment may be required to restore power supply performance to specified values.

If repairs involving subassembly replacements are required, please contact your local Kepco representative or the Kepco Sales Engineering department in Flushing, New York, NY.

7.3 ABBREVIATIONS USED IN KEPKO PARTS LISTS

7.3.1 REFERENCE DESIGNATORS

A = Assembly	FX = Fuse Holder	M = Meter
B = Blower (Fan)	IC = Integrated Circuit	P = Plug
C = Capacitor	J = Jack	Q = Transistor
CB = Circuit Breaker	K = Relay	R = Resistor
CR = Diode	L = Inductor	T = Transformer
DS = Device. Signaling (Lamp)	LC = Light-Coupled Device	TB = Terminal Block
F = Fuse	LED = Light Emitting Diode	X = Socket

7.3.2 DESCRIPTIVE ABBREVIATIONS

A = Ampere	FXD = Fixed	PWR = Power
a-c = Alternating Current	Ge = Germanium	RAD = Radial
AMP = Amplifier	H = Henry	RECT = Rectifier
AX = Axial	Hz = Hertz	RECY = Recovery
CAP = Capacitor	IC = Integrated Circuit	REG = Regulated
CER = Ceramic	K = Kilo (10^3)	RES = Resistor
CT = Center-tap	m = Milli (10^{-3})	RMS = Root Mean Square
°C = Degree Centigrade	MFR = Manufacturer	Si = Silicon
d-c = Direct Current	MET = Metal	S-end = Single Ended
DPDT = Double Pole, Double Throw	n = Nano (10^{-9})	SPDT = Single Pole, Double Throw
DPST = Double Pole, Single Throw	NC = Normally Closed	SPST = Single Pole, Single Throw
ELECT = Electrolytic	p = Pico (10^{-12})	Stud Mt. = Stud Mounted
F = Farad	PC = Printed Circuit	TAN = Tantalum
FILM = Polyester Film	POT = Potentiometer	TSTR = Transistor
FLAM = Flammable	PIV = Peak Inverse Voltage	μ = Micro (μ) (10^{-6})
FP = Flame-Proof	p-p = Peak to Peak	V = Volt
°F = Degree Fahrenheit	ppm = Parts Per Million	W = Watt
		WW = Wire Wound



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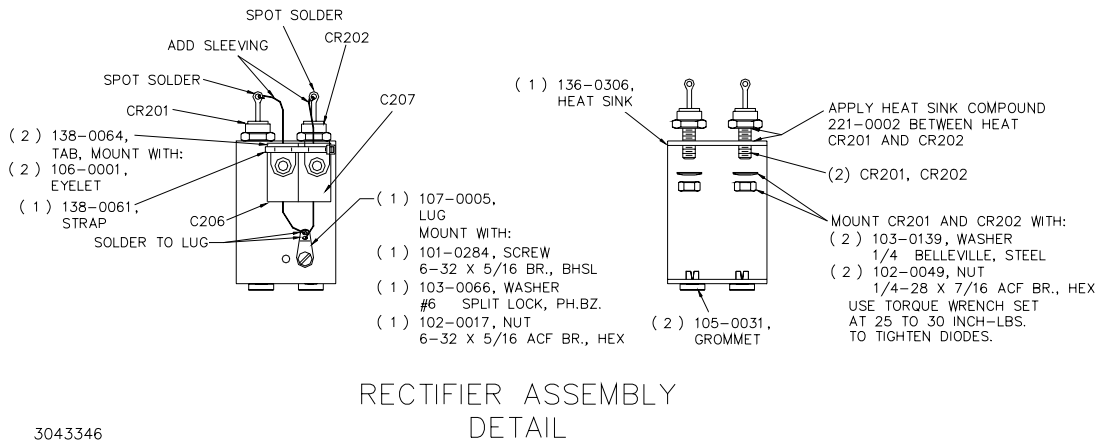
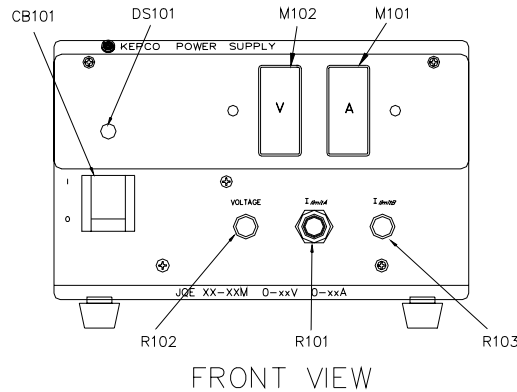
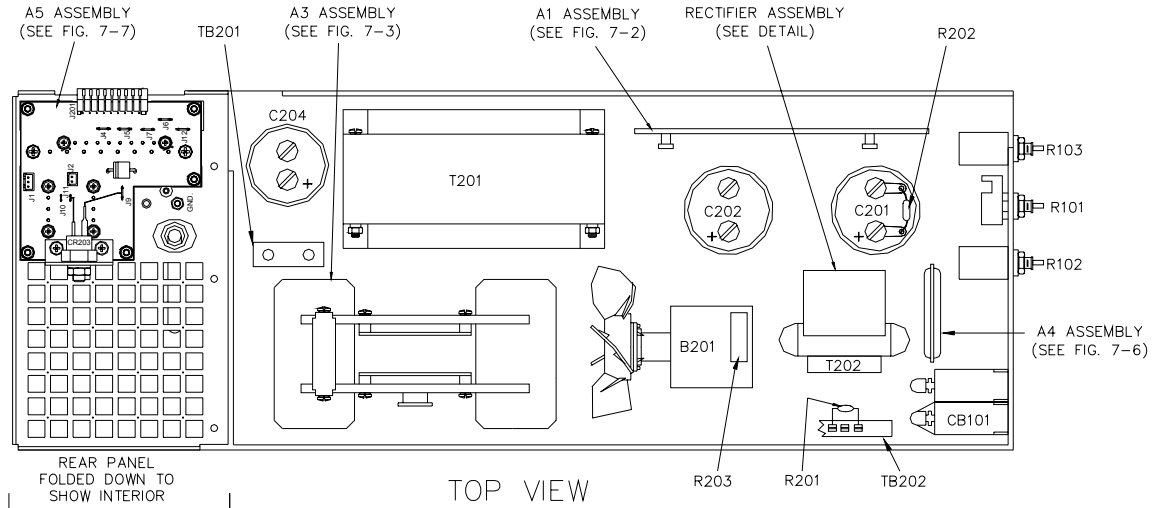
REPLACEMENT PARTS LIST

JQE 55-5MVPY-26997

POWER SUPPLY (Figure 7-1)

CODE: 1306467

REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
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FIGURE 7-1. JQE 55-5MVPY-26997 POWER SUPPLY, COMPONENT LOCATIONS

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.

**KEPCO****REPLACEMENT PARTS LIST**

JQE 55-5MVPY-26997

POWER SUPPLY (Figure 7-1)

CODE: 1306467

REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
@A1	1	MOUNTING BKT.	KEPCO 128-1966	128-1966	1
@A1	1	ASSY., MOUNTING BKT.,	KEPCO 128-1967	128-1967	1
@B201	1	BLADE, FAN 4.25 DIA, 7/32 HUB	KEPCO 149-0031	149-0031	1
B201	1	FAN, 3-POLE MOTOR 115VAC, 50/60HZ	FASCO (JAKEL) J238-087-8157	148-0049	1
CB101	1	CIRCUIT BREAKER, (HYDRAULIC MAGNETIC), 2POLE 250VAC 1A/3A	SENSATA TECHNOLOGY UPGH-14-725-2	127-0388	1
CR201/CR202/ C207/C206	1	RECT. ASS'Y (COMPONENTS LISTED SEPARATELY)	KEPCO 124-0409	124-0409	
C207, C206	2	CAP., MYLAR, METALLIZED, 0.47UF, 10%,400V (PART OF RECT ASSY 124-0409)	AEROVOX INC. AFE00047440MGLBK	117-0332	1
CR201, CR202	2	RECT., SI, 300V, 15A (PART OF RECT ASSY 124-0409)	INTERNATIONAL RECT. 1N3211	124-0164	1
CR203	1	RECT., THYRISTOR (SCR)	INTERNATIONAL RECT. 40RCS10	124-0358	1
C201, C202	2	CAP., ELECTROLYTIC, CAN-TYPE, 8600UF, + 75 -20%, 100V	CORNELL DUBILIER DCMC862U100AC2A	117-1306	1
C204	1	CAP., ELECTROLYTIC, CAN-TYPE, 2200UF, 20%, 75V		117-1081	1
DS101	1	DEVICE, SIGNALING, NEON W/INT RES, RD LENS, 115VAC	CHICAGO MIN- IATU~2110QAX1	152-0087	1
M101	1	METER, DC, SINGLE SCALE, 0- 5A, 2.0", 2%	HONEYWELL MODEL 504	135-0419	1
M102	1	METER, DC, SINGLE SCALE, 0- 60V, 2.0" 2%	HONEYWELL MODEL 504	135-0408	1
R101	1	RES., VAR., MULTITURN, POTEN- TIOMETER, 2 KOHM , 2W, 5%	BOURNS INCORPORP 3590S-1-202	115-1153	1
R102	1	RES., VAR., MULTITURN, POTEN- TIOMETER, 60 KOHM , 2W, 5%	BOURNS INCORPORP 3540S-1-603	115-2181	1
R103	1	RES., VAR., MULTITURN, POTEN- TIOMETER, 0.5 KOHM , 2W, 5%	BOURNS INCORPORP 3590S-1-501L	115-3191	1
R201	1	RES., FIX., POWER, AX. LEADS, 4 KOHM, 5W, 5%	VISHAY DALE CW-5 OR RS-5	115-0753	1
R202	1	RES., FIX., POWER, AX. LEADS, 7.5 OHM, 5W, 5%	VISHAY DALE CW0057R500JB12	115-0982	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.
PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLEY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.



KEPCO REPLACEMENT PARTS LIST

JQE 55-5MVPY-26997

POWER SUPPLY (Figure 7-1)

CODE: 1306467

REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
R203	1	RES., FIX., POWER, SHUNT (4 TERMINAL), 0.1 OHM , 50W, 1%	TEPRO OF FLORIDA TMK-50	115-2356	1
T201	1	TRANSFORMER, POWER	KEPCO 100-1813	100-1813	1
T202	1	TRANSFORMER, AUX	KEPCO 100-1865	100-1865	1

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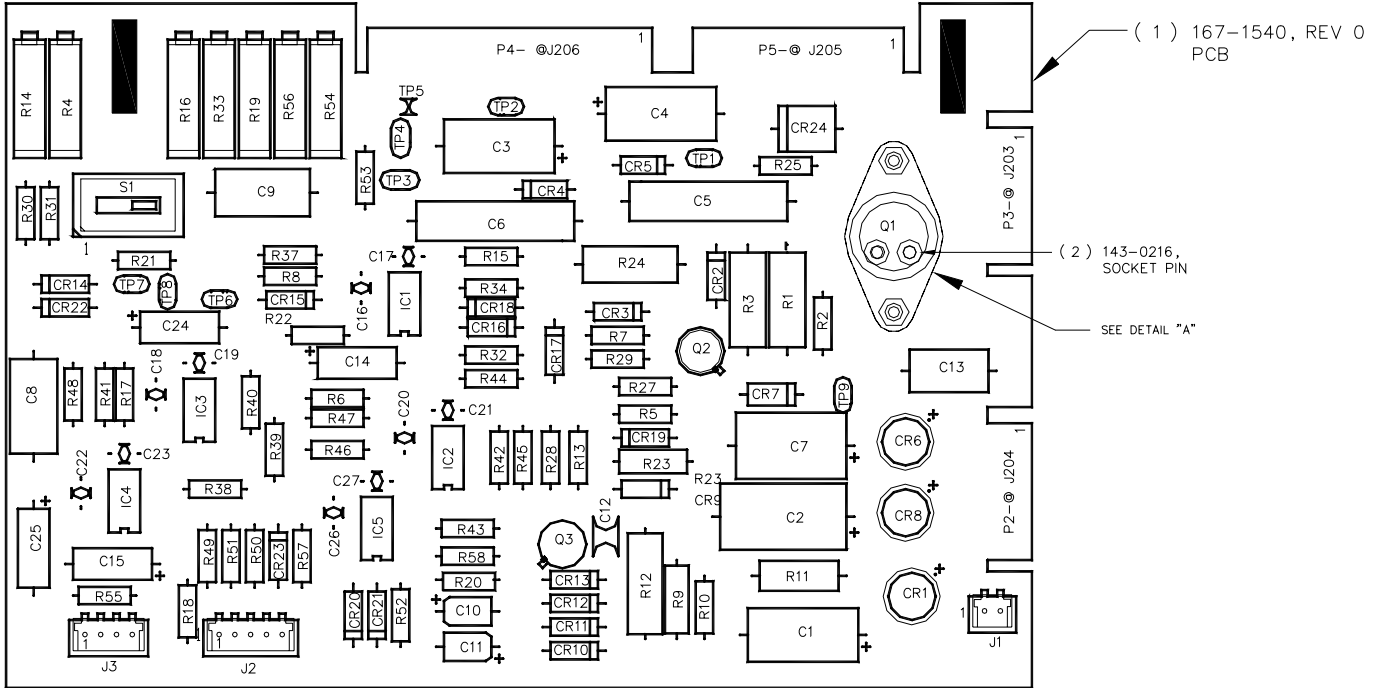
REPLACEMENT PARTS LIST

JQE 55-5MVPY-26997

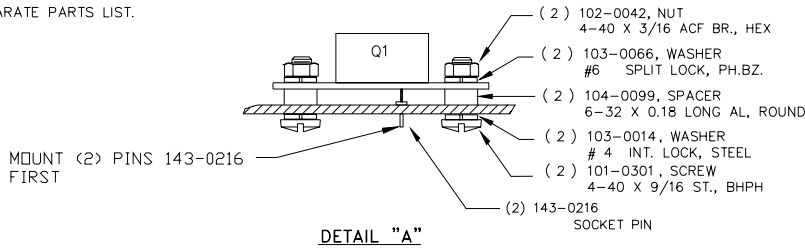
ASSEMBLY A1 (Figure 7-2)

CODE: 2362723

REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
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NOTE: NOT ALL PARTS USED. SEE SEPARATE PARTS LIST.



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FIGURE 7-2. JQE 55-5MVPY-26955 A1 ASSEMBLY, COMPONENT LOCATIONS

CR1, CR6, CR8	3	RECT., ENCAPSULATED BRIDGE 200V 1A	FAIRCHILD W02G	124-0346	1
CR2, CR10, CR11, CR12, CR13, CR19	6	DIODE, ZENER, 6.8V, 5%	MICROSEMI CORP. 1N5235BTR	121-0080	1
CR2, CR17	2	DIODE, REFERENCE, 6.2V, 5%	ON SEMICONDUCTOR 1N821 TAPE/REEL	121-0041	1
CR4, CR5	2	RECT., SI, AX. LEADS, 3000V, 200MA	RECTRON, USA R3000-F	124-0178	1
CR7	1	RECT., SI 100V 1.5A	DIOTEC ELECTRON 1N5392	124-0133	1
CR9	1	DIODE, ZENER, 6.5V, 5%	AMERICAN POWER 1N763-1	121-0028	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION. PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.

**KEPCO****REPLACEMENT PARTS LIST**

JQE 55-5MVPY-26997

ASSEMBLY A1 (Figure 7-2)

CODE: 2362723

REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
CR14, 15, 16, 18, 22, 23	6	RECT., SWITCHING DIODE, 75V 0.4A	AMERICAN POWER 1N4148-AMMO	124-0437	1
CR20, CR21	2	DIODE, ZENER, 5.6V, 5%	AMERICAN POWER DEV. 1N752A	121-0066	1
C1, C7	2	CAP., ELECTROLYTIC, AX. LEADS, 220UF, 20%, 25V	ILLINOIS CAPACITOR 227TTA025M	117-0713	1
C2	1	CAP., ELECTROLYTIC, AX. LEADS, 100UF, 20%, 50V	ILLINOIS CAPACITOR 107TTA050M	117-0646	1
C3, C4	2	CAP., ELECTROLYTIC, AX. LEADS, 220UF, 20%, 16V	CORNELL DUBILIER MALLORY #SKA221M016AT	117-0512	1
C5	1	CAP., MYLAR, METALLIZED, 0.1UF, 20%, 600V	AMERICAN SHIZUKI X663F 0.1 20% 600VDC	117-0316	1
C6	1	CAP., MYLAR, METALLIZED, 1UF, 10%, 200V	CORNELL DUBILIER CDE# MMP2W1K	117-0395	1
C8	1	CAP., MYLAR, METALLIZED, 0.047UF, 10%, 200V	SPRAGUE 192P5039	117-0362	1
C9	1	CAP., MYLAR, METALLIZED, 0.047UF, 10%, 200V	SPRAGUE 192P5039	117-0362	1
C10, C11	2	CAP., TANTALUM, 6.8UF, 20%, 35V	BC COMPONENTS 40MS685D035M0A	117-0968	1
C12	1	CAP., CERAMIC, 0.005UF, + 80 -20%, 500V	VISHAY CERA-MIT 5TSD50RE	117-0061	1
C13, C14	2	CAP., MYLAR, METALLIZED, 2200PF, 10%, 200V	CORNELL DUBILIER WMC2D22K	117-0659	1
C16-C23, C26, C27	10	CAP., CERAMIC, 0.1UF, 10%, 50V	VISHAY AMERICAS A104K15X7R5-UAA	117-1052	1
C25	1	CAP., MYLAR, METALLIZED, 0.01UF, 20%, 200V	VISHAY SPRAGUE 192P103X0200P303	117-0353	1
IC1	1	I.C., OPERATIONAL AMPLIFIER	T.I. UA741CP	250-0025	1
IC2	1	I.C., DUAL PRECISION OP.AMP	LINEAR TECH. LT1013CN8	250-0198	1
IC3, IC4, IC5	3	I.C., PRECISION SINGLE SUPPLY OP.AMP	PMI OP-90GP	250-0216	1
J1	1	JACK, SOCKET, POWER, CONNECTOR, 2 PINS HEADER, PC MT	JST CORP. B2B-XH-A	143-0799	1
J2	1	JACK, SOCKET, CABLE CONNECTOR, 5 PINS HEADER, PC MT	JST CORP. B5B-XH-A	143-0811	1
J3	1	JACK, SOCKET, CABLE CONNECTOR, 4 PINS HEADER, PC MT	JST CORP. B4B-XH-A	143-0810	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

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**KEPCO****REPLACEMENT PARTS LIST**

JQE 55-5MVPY-26997

ASSEMBLY A1 (Figure 7-2)

CODE: 2362723

REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
Q1	1	TRANSISTOR, SI, NPN, POWER	SOLID STATE 2N3441	119-0071	1
Q2	1	TRANSISTOR, SI, NPN, SMALL SIGNAL	RAYTHEON MFG CO 1190094	119-0094	1
Q3	1	TRANSISTOR, SI, NPN, SMALL SIGNAL	MICROSEMI CORP. 2N3019	119-0059	1
R1	1	RES., FIX., CARBON FILM, 240 OHM , 1/2W, 5%		115-0484	1
R2	1	RES., FIX., CARBON FILM, 6.2 KOHM , 1/4W, 5%	KOA/SPEER CF-1/4 T52 A 622J	115-2258	1
R3	1	RES., FIX., CARBON FILM, 620 OHM , 1W, 5%		115-0496	1
R4, R19, R33	3	RES., VAR., MULTITURN, TRIMMER, 1 KOHM , 3/4W, 10%	BOURNS INCORP 3009P-1-102	115-2456	1
R5	1	RES., FIX., CARBON FILM, 560 OHM , 1/4W, 5%	IRC, INC. CF 1/4-561-J	115-2210	1
R6, R37	2	RES., FIX., PRECISION, METAL FILM, 5.62 KOHM , 1/8W, 1%	VISHAY DALE CCF555K62FKR36	115-2409	1
R7, R29	2	RES., FIX., PRECISION, METAL-FILM, 750 OHM , 1/4W, 1%	IRC, INC. GP 55 100 7500 F T&R	115-2259	1
R8	1	RES., FIX., PRECISION, METAL FILM, 5.76 KOHM , 1/8W, 1%	IRC, INC. GP55-100-5761-F	115-2222	1
R9	1	RES., FIX., CARBON FILM, 220 OHM , 1/2W, 5%	YAGEO CF-50	115-0470	1
R10	1	RES., FIX., PRECISION, METAL-FILM, 82.5 KOHM , 1/4W, 1%	VISHAY DALE RN60D	115-2012	1
R11	1	RES., FIX., CARBON FILM, 3.9 KOHM , 1W, 5%	OHMITE OM3925A52	115-2122	1
R12	1	RES., FIX., CARBON FILM, 1.5 KOHM , 1W, 5%	YAGEO CFR-100 JTJ52 1K5	115-0664	1
R13, R28	2	RES., FIX., CARBON FILM, 2.2 KOHM , 1/4W, 5%	RCD COMPONENTS CF25 2201 J TB	115-2382	1
R14	1	RES., VAR., MULTITURN, TRIMMER, 100 KOHM , 3/4W, 10%	BOURNS INCORP 3009P-1-104	115-2399	1
R15	1	RES., FIX., PRECISION, METAL FILM, 10 KOHM , 1/8W, 1%	VISHAY DALE CCF-55-1002-F-1/4W	115-2174	1
R16	1	RES., VAR., MULTITURN, TRIMMER, 500 OHM , 3/4W, 10%	BOURNS INCORP 3009P-1-501	115-2398	1
R20, R25, R27, R58	4	RES., FIX., CARBON FILM, 10 OHM , 1/4W, 5%	IRC, INC. CF 1/4-100-J	115-2230	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.
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**KEPCO****REPLACEMENT PARTS LIST**

JQE 55-5MVPY-26997

ASSEMBLY A1 (Figure 7-2)

CODE: 2362723

REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
R21	1	RES., FIX., CARBON FILM, 12 KOHM , 1/4W, 5%	IRC GBT 1/4	115-2276	1
R22	1	RES., FIX., PRECISION, METAL FILM, 301 OHM , 1/8W, 1%	IRC CEA TYPE RN55D3010F	115-2261	1
R23	1	RES., FIX., CARBON FILM, 27 OHM , 1/4W, 5%	IRC, INC. CF-1/4 270 J	115-2317	1
R24	1	RES., FIX., CARBON FILM, 12 KOHM , 1W, 5%		115-0090	1
R30, R31	2	RES., FIX., PRECISION, METAL FILM, 43.2 KOHM , 1/8W, 1%	IRC CEA RN55D4322F	115-2380	1
R32, R52	2	RES., FIX., PRECISION, METAL- FILM, 511 OHM , 1/4W, 1%	RCD COMPONENTS RCD GP55-5110-FTW	115-2092	1
R34	1	RES., FIX., PRECISION, METAL FILM, 210 OHM , 1/8W, 1%	IRC RN55D100F	115-2177	1
R38, R49	2	RES., FIX., PRECISION, METAL FILM, 1.24 KOHM , 1/8W, 1%	VISHAY DALE CCF-50 1241 F R36	115-2507	1
R39, R40, R44, R45, R51	5	RES., FIX., PRECISION, 2.49 KOHM , 1/8W, 0.1%	VISHAY DALE PTF-56 2K490 B T-13 R36	115-2970	1
R41, R48	2	RES., FIX., PRECISION, METAL FILM, 100 OHM , 1/8W, 1%	VISHAY DALE CCF-55 1000 F R36	115-2598	1
R42, R43	2	RES., FIX., METAL FILM, 4.99 KOHM , 1/8W, 0.1%	VISHAY DALE PTF-56 4K99 B T-13 R36	115-2863	1
R46	1	RES., FIX., PRECISION, METAL FILM, 499 KOHM , 1/8W, 1%	VISHAY DALE CCF-55 4993 F R36	115-2309	1
R47	1	RES., FIX., PRECISION, METAL FILM, 8.06 KOHM , 1/8W, 1%	VISHAY DALE CMF-55, 8061, F, T-0	115-2445	1
R50		RES., FIX., PRECISION, 1.24 KOHM , 1/8W, 0.1%	YAGEO MFR-12 FTF52 1K24	115-2507	1
R53	1	RES., FIX., PRECISION, METAL FILM, 4.75 KOHM , 1/8W, 1%	VISHAY DALE CCF-55 4751 F R36	115-2490	1
R54	1	RES., VAR., MULTITURN, TRIM- MER, 2 KOHM , 3/4W, 10%	BOURNS INCORP 3009P-1-202	115-2405	1
R56	1	RES., VAR., MULTITURN, TRIM- MER, 10 KOHM , 3/4W, 10%	BOURNS INCORP 3009P-1-103	115-2481	1
R57	1	RES., FIX., PRECISION, 5 OHM , 1W, 1%	VISHAY DALE RS-1A-5 OHM 1%	115-1374	1
S1	1	SWITCH, PRINTED CIRCUIT, DIP 4P DT 20VDC .4A	AUGAT ALCOSWITCH ASE42RG	127-0451	1
TP1-TP4, TP6-TP9	8	TEST POINT, 0.1" LEAD SPACING	COMPONENTS CORP ATP-402-10	173-0029	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.



REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
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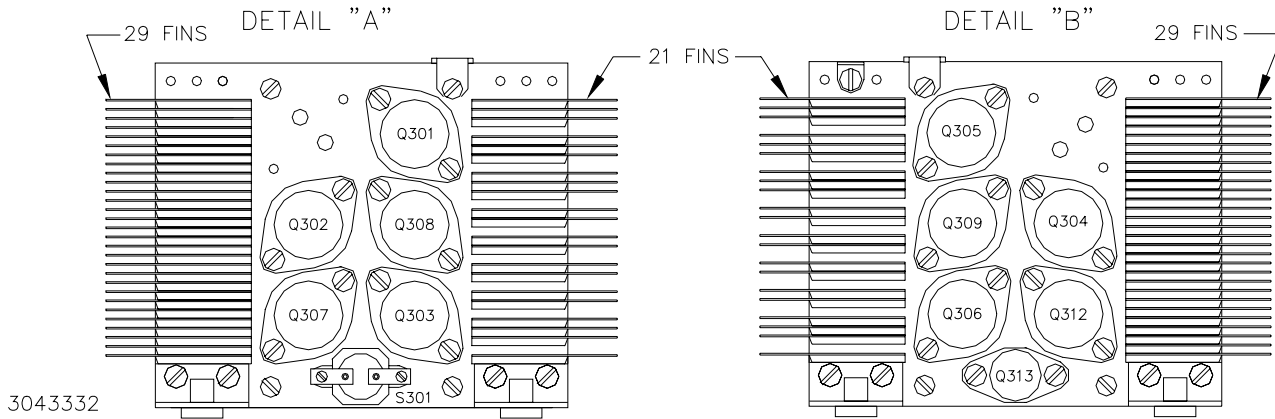
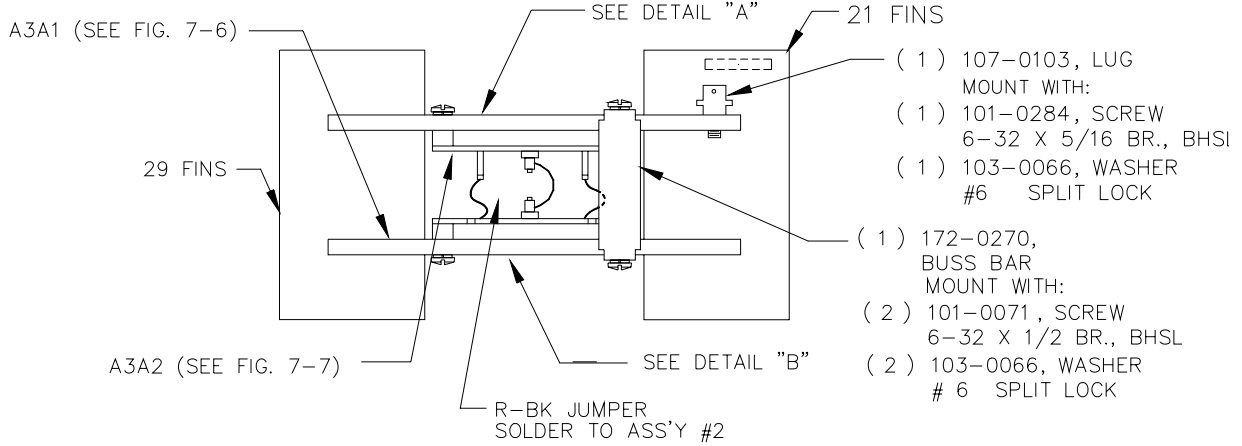


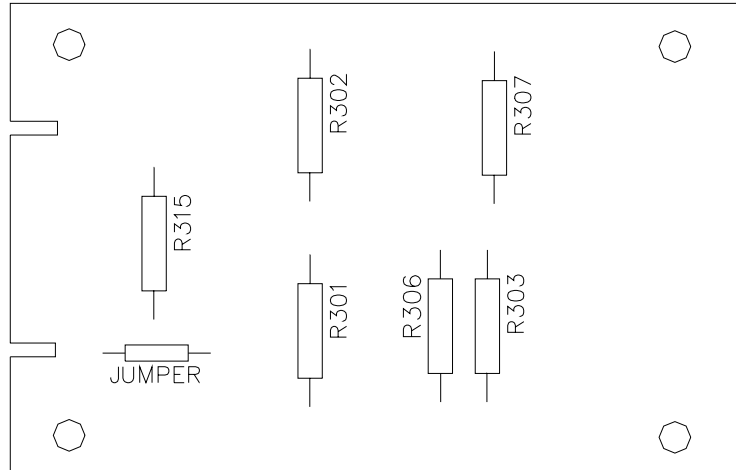
FIGURE 7-3. JQE 55-5MVPY-26997M A3 ASSEMBLY, COMPONENT LOCATIONS

Q301-Q309, Q312	10	TRANSISTOR, SI, NPN, POWER	ON SEMICONDUCTOR 2N3773	119-0091	1
Q313	1	TRANSISTOR, SI, NPN, POWER	CENTRAL SEMICON 2N3584	119-0104	1
S301	1	SWITCH, THERMOSTAT (N.O.), SP ST	HONEYWELL/ELMWOOD #2450G-8081-0084	127-0248	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION. PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.



REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
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3043347

NOTE: NOT ALL PARTS USED. SEE SEPARATE PARTS LIST.

FIGURE 7-4. JQE 55-5MVPY-26997 A3A1 ASSEMBLY, COMPONENT LOCATIONS

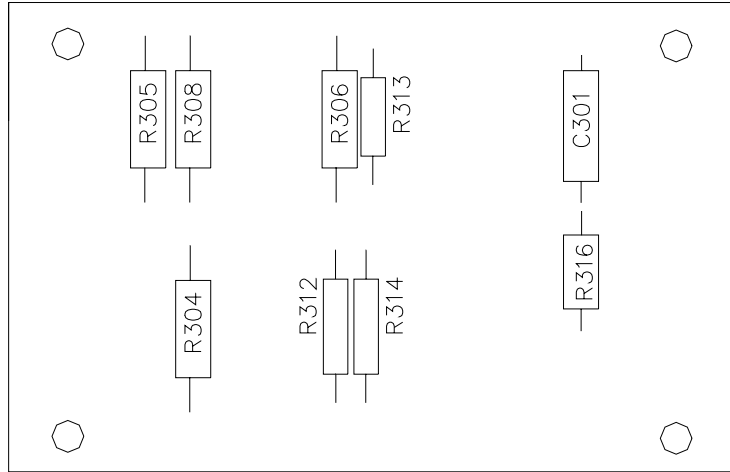
R301, R302, R303, R307, R309	5	RES., FIX., POWER, AX. LEADS, 0.6 OHM , 3W, 3%	VISHAY DALE ELE CW-2B 0.6 OHM 3%	115-2138	1
R315	1	RES., FIX., POWER, AX. LEADS, 1.6 KOHM , 5W, 5%	TEPRO OF FLORIDA TS 5W	115-2133	1
N/A	1	JUMPER, BB #20GA MOLDED	IRC, INC. ZEROHM 1/4W MOLDED	172-0298	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.



REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
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3043348

NOTE: NOT ALL PARTS USED. SEE SEPARATE PARTS LIST.

FIGURE 7-5. JQE 55-5MVPY-26997 A3A2 ASSEMBLY, COMPONENT LOCATIONS

C301	1	CAP., MYLAR FILM, 1500PF, 10%, 200V	CORNELL DUBILIE WMC2D15K	117-0950	1
R304, R305, R306, R308	4	RES., FIX., POWER, AX. LEADS, 0.6 OHM , 3W, 3%	VISHAY DALE ELE CW-2B 0.6 OHM 3%	115-2138	1
R312	1	RES., FIX., CARBON FILM, 3 6 OHM , 1/2W, 5%	YAGEO #CF-50	115-2216	1
R313	1	RES., FIX., CARBON FILM, 120 OHM , 1/2W, 5%	IRC GBT-1/2	115-1136	1
R314	1	RES., FIX., CARBON FILM, 330 OHM , 1/2W, 5%	YAGEO CFR-50JTJ52330R	115-0804	1
R316	1	JUMPER, BB #20GA MOLDED	IRC, INC. ZEROHM 1/4W MOLDED	172-0298	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION. PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.



REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
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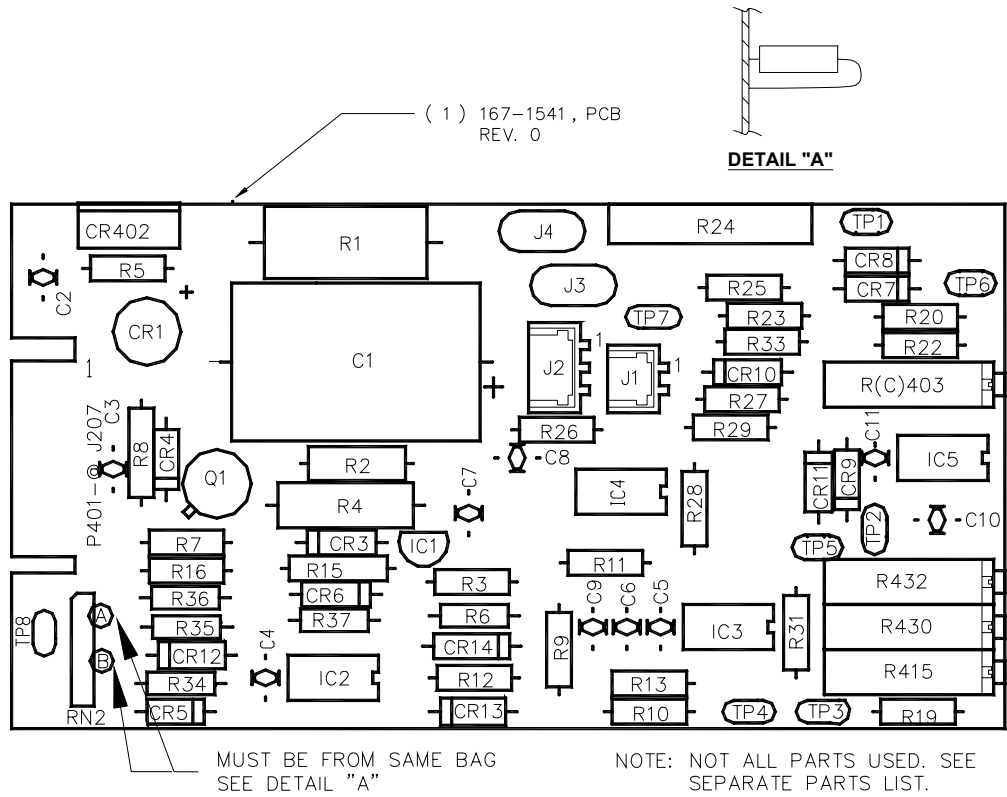


FIGURE 7-6. JQE 55-5MVPY-26997 A4 ASSEMBLY, COMPONENT LOCATIONS

CR1	1	RECT., ENCAPSULATED BRIDGE 200V 1A	FAIRCHILD SEMIC W02G	124-0346	1
CR3	1	DIODE, ZENER, 15V, 5%	AMERICAN POWER 1N4744A AMMO PACK	121-0057	1
CR4, CR6	2	DIODE, ZENER, 4.7V, 5%	PHILIPS SEMICON 1N4732A *	121-0091	1
CR5, CR7, CR8	3	RECT., SWITCHING DIODE, 75V, 0.4A	AMERICAN POWER 1N4148-AMMO	124-0437	1
CR9	1	RECT., SI, AX. LEADS, 3000V, 200MA	RECTRON, USA R3000-F	124-0178	1
CR10	1	DIODE, ZENER, 6.5V, 5%	AMERICAN POWER 1N763-1	121-0028	1
CR11, CR12, CR13, CR9	4	RECT., SI, SCHOTTKY, AX. LDS. 40V, 1A	ON SEMICONDUCTO 1N5819RLG	124-0578	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.

**KEPCO****REPLACEMENT PARTS LIST**

JQE 55-5MVPY-26997

ASSEMBLY A4 (Figure 7-6)

CODE: 2362739

REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
CR14	1	DIODE, CURRENT REGULATOR, 1N5297	CENTRAL SEMICON CCL0750	121-0083	1
CR402	1	RECT., THYRISTOR (SCR), 200V, 8A	CENTRAL SEMICON CS220-8B	124-0350	1
C1	1	CAP., ELECTROLYTIC, AX. LEADS, 140UF, +100 -10%, 40V	SANGAMO COMPONE 052FE141Q040B	117-0706	1
C2, C4, C5, C7, C8, C10, C11,	7	CAP., CERAMIC, 0.1UF, 10%, 50V	VISHAY AMERICAS A104K15X7R5-UAA	117-1052	1
C3	1	CAP., CERAMIC, 0.047UF, 10%, 50V	BC COMPONENTS (A473K17X7RFVWJ	117-1054	1
C6, C9	2	CAP., CERAMIC, 0.01UF, 10%, 50V	VISHAY BC COMPO A103K15X7RF5-UAA	117-1053	1
C12	1	CAP., TANTALUM, 4.7UF, 10%, 15V	SPRAGUE CAPACIT 173D475X9015VW	117-1112	1
C13	1	CAP., CERAMIC, 1000PF, 10%, 200V	VISHAY BC COMPO A102K15X7RK5-UAA	117-1084	1
IC1	1	I.C. ADJ. REFERENCE (2.5-37V) 600UA-100MA	MOT. TL431AILP	250-0239	1
IC2	1	I.C. PRECISION SINGLE SUPPLY OP.AMP	PMI OP-90GP	250-0216	1
IC3	1	I.C. DUAL VOLTAGE COMPARATOR OP.AMP.	NAT. LM393AN	250-0228	1
IC4	1	I.C. PRECISION INSTRUMENTATION AMPLIFIER	BURR-BROWN INA118P	250-0332	1
IC5	1	I.C. LOW INPUT OFFSET VOLTAGE OP. AMP	PRECISN MONO OP-07CP	250-0146	1
J1	1	JACK, SOCKET, POWER, CONNec- TOR, 2 PINS HEADER, PC MT	JST CORP. B2B-XH-A	143-0799	1
J2	1	JACK, SOCKET, POWER, CONNec- TOR, 3 PINS HEADER, PC MT	JST CORP. B3B-XH-A	143-0800	1
J3, J4	2	JACK, QUICK CONNECT (MALE), PC MOUNT	ZIERICK MIDWEST 82237-21	107-0362	1
PCB	1	PWB ASSY REV#1	KEPCO 167-1541	167-1541	1
Q1	1	TRANSISTOR, SI, NPN, SMALL SIG- NAL,	RAYTHEON MFG CO 1190094	119-0094	1
R1	1	RES., FIX., CARBON FILM, 330 OHM , 2W, 5%	RCD COMPONENTS CF200S 3300 J TB	115-0882	1
R2	1	RES., FIX., CARBON FILM, 510 OHM , 1/2W, 5%	KOA/SPEER CF1/2 511 J T52A	115-0824	1

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**KEPCO****REPLACEMENT PARTS LIST**

JQE 55-5MVPY-26997

ASSEMBLY A4 (Figure 7-6)

CODE: 2362739

REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
RN2A/RN2B	2	RES, NET RATIO 11:1 RN2A: 54.9K/RN2B: 4.99K	PRECISION RESIS PR9139	234-0041	1
R3	1	RES., FIX., PRECISION, METAL-FILM, 4.02 KOHM , 1/4W, 1%	VISHAY DALE ELE CCF554K02FKE36	115-3021	1
R4	1	RES., FIX., POWER, AX. LEADS, 0.5 OHM , 3W, 3%	VISHAY DALE ELE CW02BR5000HS70	115-1880	1
R5, R8	2	RES., FIX., CARBON FILM, 1 KOHM , 1/4W, 5%	IRC, INC. CF-1/4 102 J T&R	115-2238	1
R6	1	RES., FIX., PRECISION, 2.49 KOHM , 1/8W, 0.1%	VISHAY DALE ELE PTF-56 2K490 B T-13 R36	115-2970	1
R7	1	RES., FIX., CARBON FILM, 10 OHM , 1/4W, 5%	IRC, INC. CF 1/4-100-J	115-2230	1
R9	1	RES., FIX., PRECISION, METAL FILM, 49.9 KOHM , 1/8W, 1%	VISHAY DALE ELE CMF5549K900FEEA	115-2755	1
R10	1	RES., FIX., PRECISION, METAL-FILM, 7.5 KOHM , 1/4W, 1%	IRC CES RN60D7501F	115-1853	1
R11, R26, R27, R28, R29	5	RES., FIX., PRECISION, METAL FILM, 4.99 KOHM , 1/8W, 1%	VISHAY DALE ELE CFF-55 4991 F R36	115-2401	1
R12, R13, R22	3	RES., FIX., PRECISION, METAL FILM, 1 KOHM , 1/4W, 1%	VISHAY DALE ELE CCF-55-1001-F-R36	115-2180	1
R15	1	RES., FIX., PRECISION, METAL FILM, 15 KOHM , 1/8W, 1%	IRC, INC. GP55 100 1502 F T&R	115-2452	1
R16	1	RES., FIX., CARBON FILM, 100 OHM , 1/4W, 5%	IRC, INC. CF 1/4 101 J T&R	115-2231	1
R19	1	RES., FIX., PRECISION, METAL-FILM, 150 OHM , 1/4W, 1%	VISHAY DALE ELE CCF-55	115-2091	1
R20	1	RES., FIX., PRECISION, METAL FILM, 2 KOHM , 1/8W, 1%	VISHAY DALE ELE CCF-55 2001 F R36	115-2334	1
R23, R25, R31	3	RES., FIX., PRECISION, METAL FILM, 10 KOHM , 1/8W, 1%	VISHAY DALE ELE CCF-55-1002-F-1/4W	115-2174	1
R24	1	RES., FIX., POWER, SHUNT (4 TERMINAL), 0.001 OHM , 3W, 1%	ISOTEK CORPOPAT PBV-R001-1.0	115-3025	1
R33	1	RES., FIX., CARBON FILM, 2.2 KOHM , 1/4W, 5%	RCD COMPONENTS CF25 2201 J TB	115-2382	1
R34, R35, R36, R37	4	RES., FIX., METAL FILM, 100 KOHM , 1/8W, 0.1%	VISHAY DALE ELE CMF-55 1003 B T-9 R36	115-2864	1
RC403, R415, R432	3	RES., VAR., MULTITURN, TRIMMER, 10 KOHM , 3/4W, 10%	BOURNS INCORPOR 3009P-1-103	115-2481	1
R430	1	RES., VAR., MULTITURN, TRIMMER, 500 OHM , 3/4W, 10%	BOURNS INCORPOR 3009P-1-501	115-2398	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

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**KEPCO****REPLACEMENT PARTS LIST**

JQE 55-5MVPY-26997

ASSEMBLY A4 (Figure 7-6)

CODE: 2362739

REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
TP1-TP7	7	TEST POINT, 0.1" LEAD SPACING	COMPONENTS CORP ATP-402-10	173-0029	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.
PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.



KEPCO REPLACEMENT PARTS LIST

JQE 55-5MVPY-26997

ASSEMBLY A5 (Figure 7-7)

CODE: 2362727

REFERENCE DESIGNATOR	QTY.	DESCRIPTION	MFRS. NAME & PART NO. (SEE BOTTOM NOTE)	KEPCO PART NO.	REC. SPARE PART QTY.
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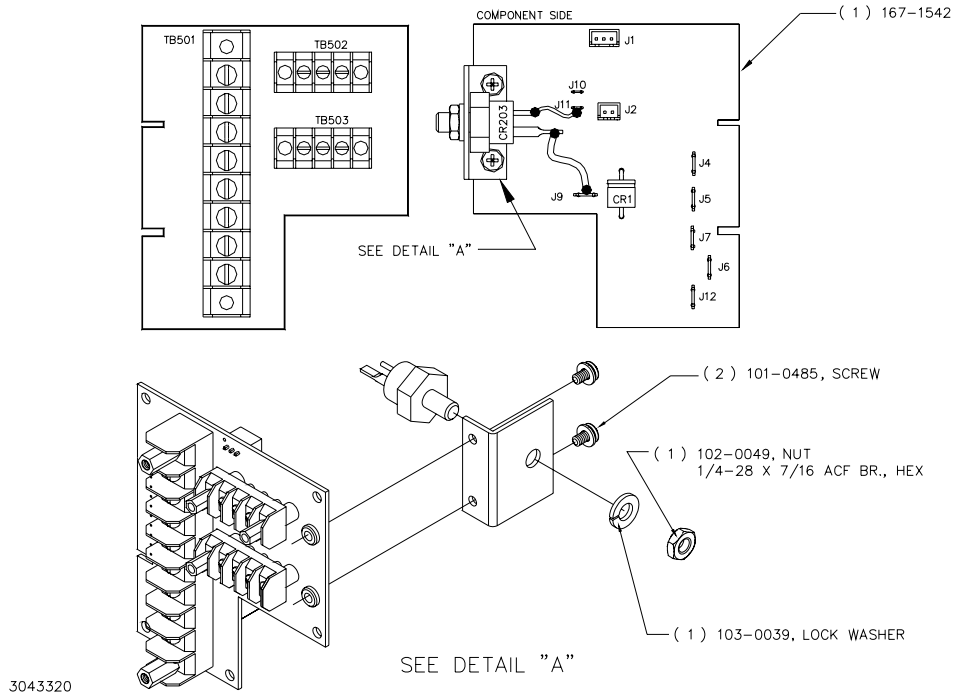


FIGURE 7-7. JQE 55-5MVPY-26997 A5 ASSEMBLY, COMPONENT LOCATIONS

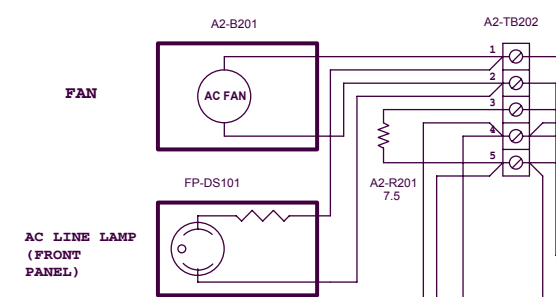
@J201	1	SOCKET, CONNECTOR PRINTED CIRCUIT, 9 PINS	AMP INC.(TYCO) 582375-9	143-0215	1
CR1	2	RECT., THYRISTOR (SCR), 100V 40A	INTERNATIONAL RECT 40RCS10	124-0358	1
J1	1	JACK, SOCKET, POWER, CONNECTOR, 3 PINS HEADER, PC MT	JST CORP. B3B-XH-A	143-0800	1
J2	1	JACK, SOCKET, POWER, CONNECTOR, 2 PINS HEADER, PC MT	JST CORP. B2B-XH-A	143-0799	1
J4, J5, J6, J7, J8, J9	6	JACK, QUICK CONNECT (MALE), QC 0.250"W PC MOUNT	ZIERICK MIDWEST 82237-21	107-0362	1
J10, J11	2	JACK, QUICK CONNECT (MALE), 0.110"W QC PC MT., VERTICAL	ZIERICK MIDWEST K22053-22	107-0384	1
TB501	1	TERMINAL BLOCK, , BRR TERM STRIP, PC MT, 8 CKT	CURTIS INDUSTRIES 38010-08-0	167-1539	1
TB502, TB503	2	TERMINAL BLOCK, , BRR TERM STRIP, PC MT, 3 CKT	CURTIS INDUSTRIES SEIPX03	167-1538	1

NOTE: REPLACEMENT PARTS MAY BE ORDERED FROM KEPCO, INC. ORDERS SHOULD INCLUDE KEPCO PART NUMBER AND DESCRIPTION.

PLEASE NOTE: THE MANUFACTURER'S NAME AND PART NUMBER LISTED FOR EACH ITEM ON REPLACEMENT PARTS LISTS REPRESENTS AT LEAST ONE SOURCE FOR THAT ITEM AND IS LISTED SOLELY FOR THE CONVENIENCE OF KEPCO EQUIPMENT OWNERS IN OBTAINING REPLACEMENT PARTS LOCALLY. WE RESERVE THE RIGHT TO USE EQUIVALENT ITEMS FROM ALTERNATE SOURCES. KEPCO, INC.

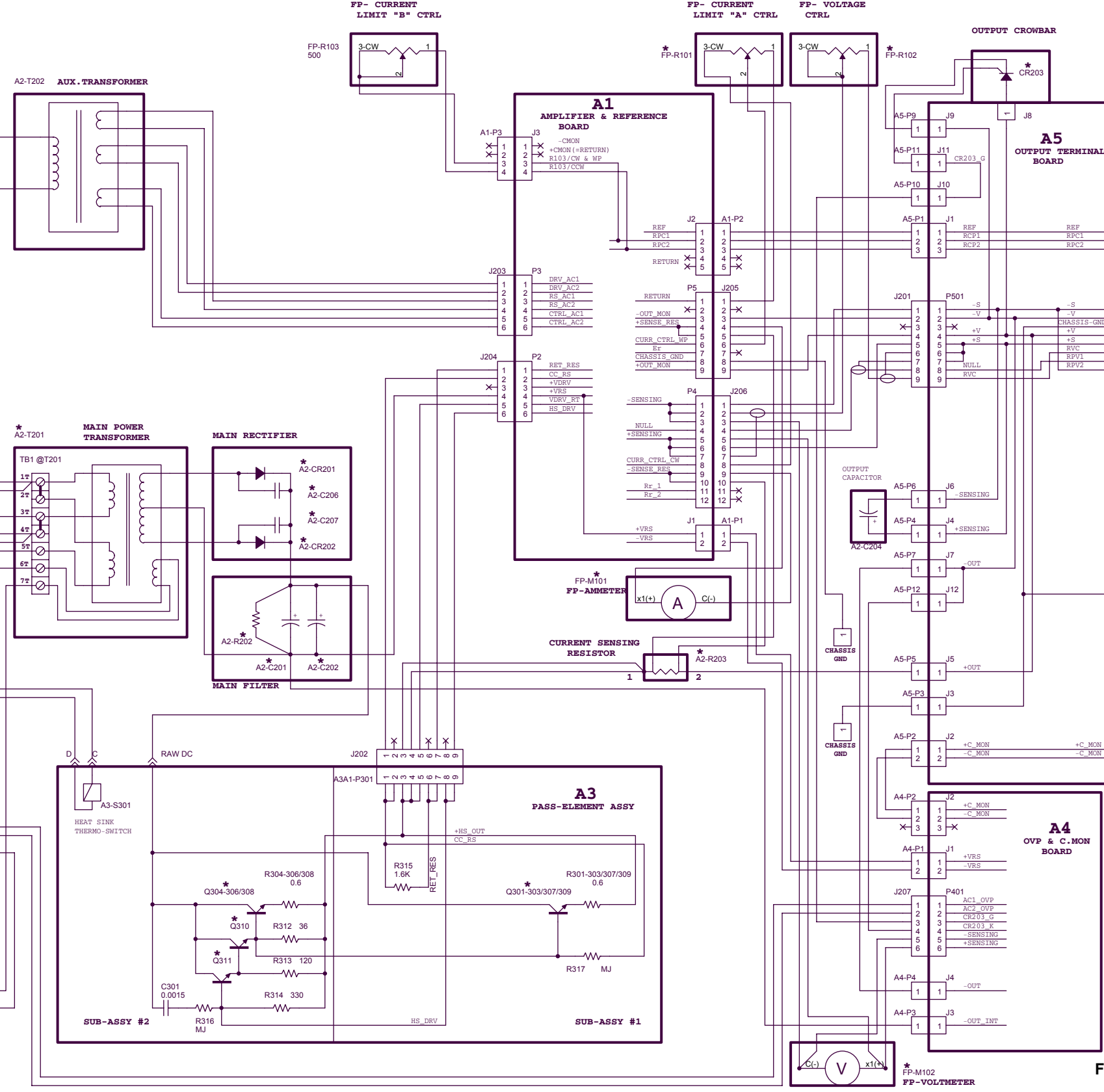
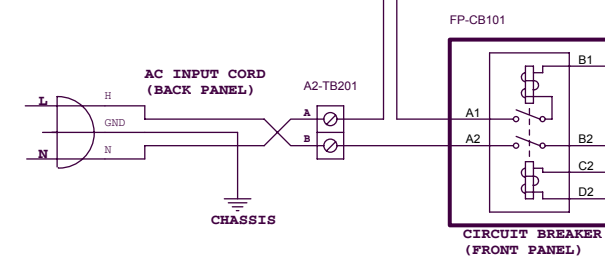
NOTES:

- 1) Resistor values in "ohms" and Capacitor values in "microfarads", unless otherwise specified.
- 2) Consult Parts List for the components marked with "*" symbol.
- 3) TB502 link between pin 1 & 2 (factory default) enables the Current Limit Control "B". Remove the link to disable it.
- 4) TB501 links between pin 1 & 2 and between pin 4 & 5 (factory default) set the PS in local error sensing. Remove the links for remote error sensing (=Kelvin connection).
TB501 link between pin 6 & 7 (factory default) enables the Front Panel Voltage Control, together with the A1-S1 set to LOC position. Remove the link, together with A1-S1 set to REM position, to enable a Remote Resistive Voltage Control.

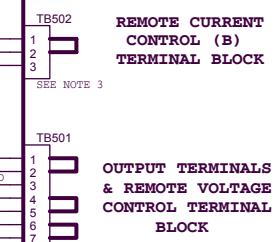


PROPRIETARY DATA
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A2- CHASSIS LEVEL
FP- FRONT PANEL LEVEL
BP- BACK PANEL LEVEL



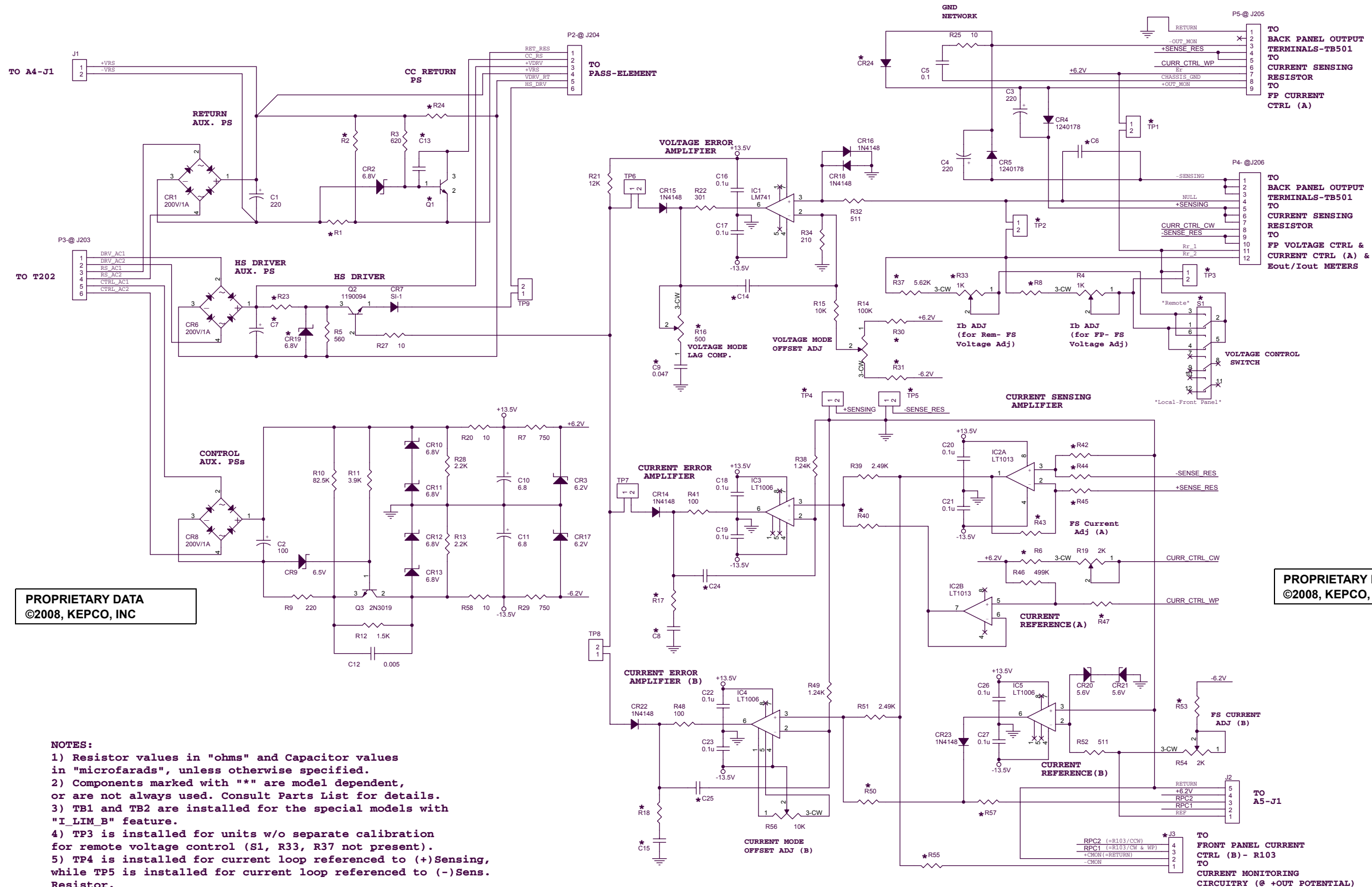
BACK PANEL



PROPRIETARY DATA
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FIGURE 7-8. JQE 55-5MPY-26997, OVERALL SCHEMATIC DIAGRAM

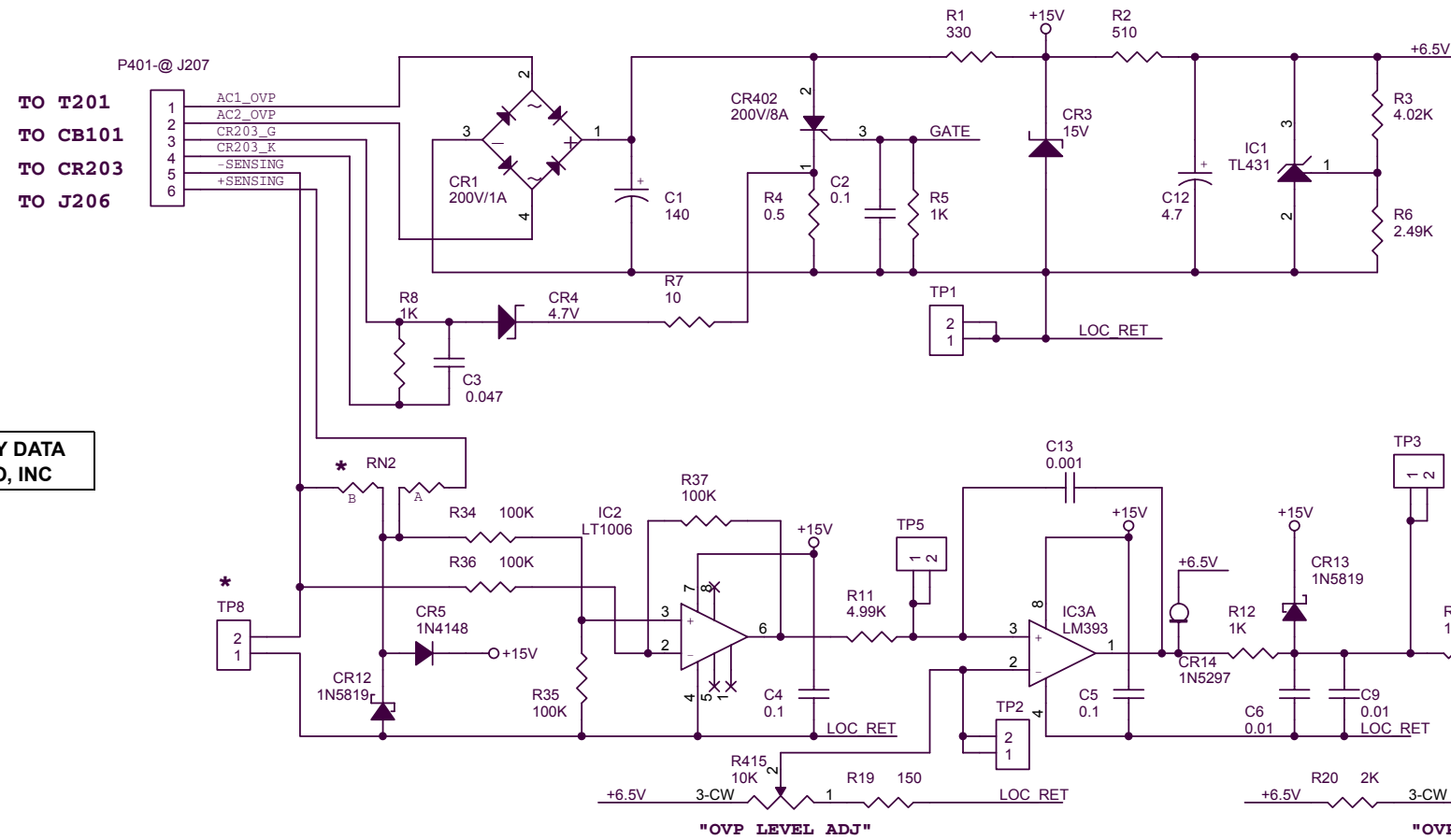


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PROPRIETARY DATA
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- NOTES:**
- 1) Resistor values in "ohms" and Capacitor values in "microfarads", unless otherwise specified.
 - 2) Components marked with "*" are model dependent, or are not always used. Consult Parts List for details.
 - 3) TB1 and TB2 are installed for the special models with "I LIM B" feature.
 - 4) TP3 is installed for units w/o separate calibration for remote voltage control (S1, R33, R37 not present).
 - 5) TP4 is installed for current loop referenced to (+)Sensing, while TP5 is installed for current loop referenced to (-)Sens. Resistor.

FIGURE 7-9. A1, AMPLIFIER AND REFERENCE BOARD A1, SCHEMATIC DIAGRAM

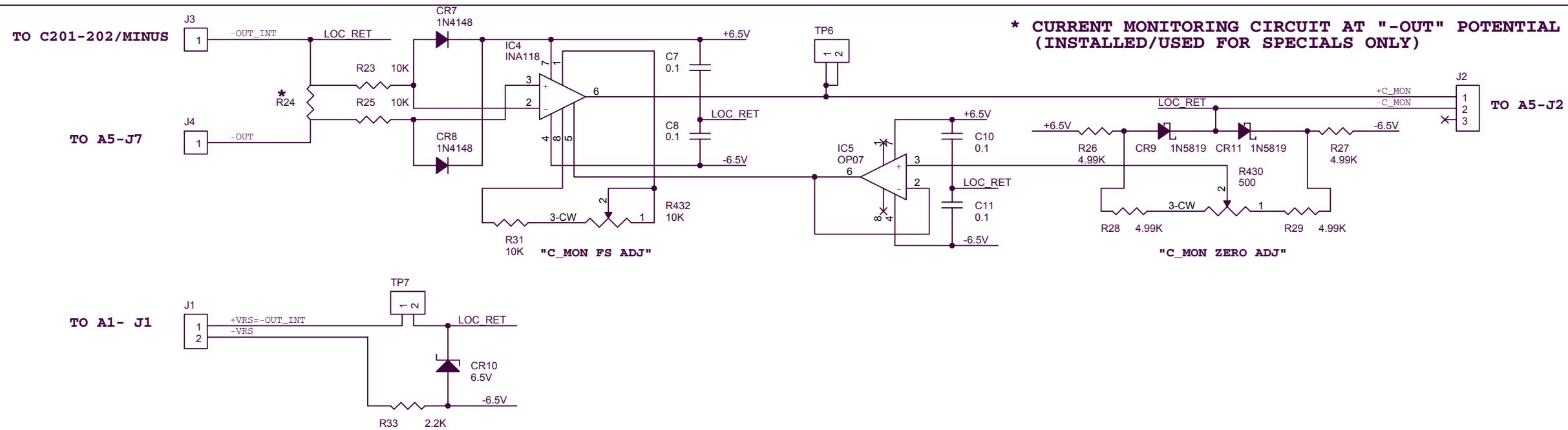


OVP CIRCUIT

- NOTES:
- 1) Resistor values in "ohms" and Capacitor values in "microfarads", unless otherwise specified.
 - 2) Components/ circuits marked with "*" are model dependent, or are not always used. Consult Parts List for details.
 - 3) TP8 is installed for regular JQE units, w/o the current monitoring circuit.

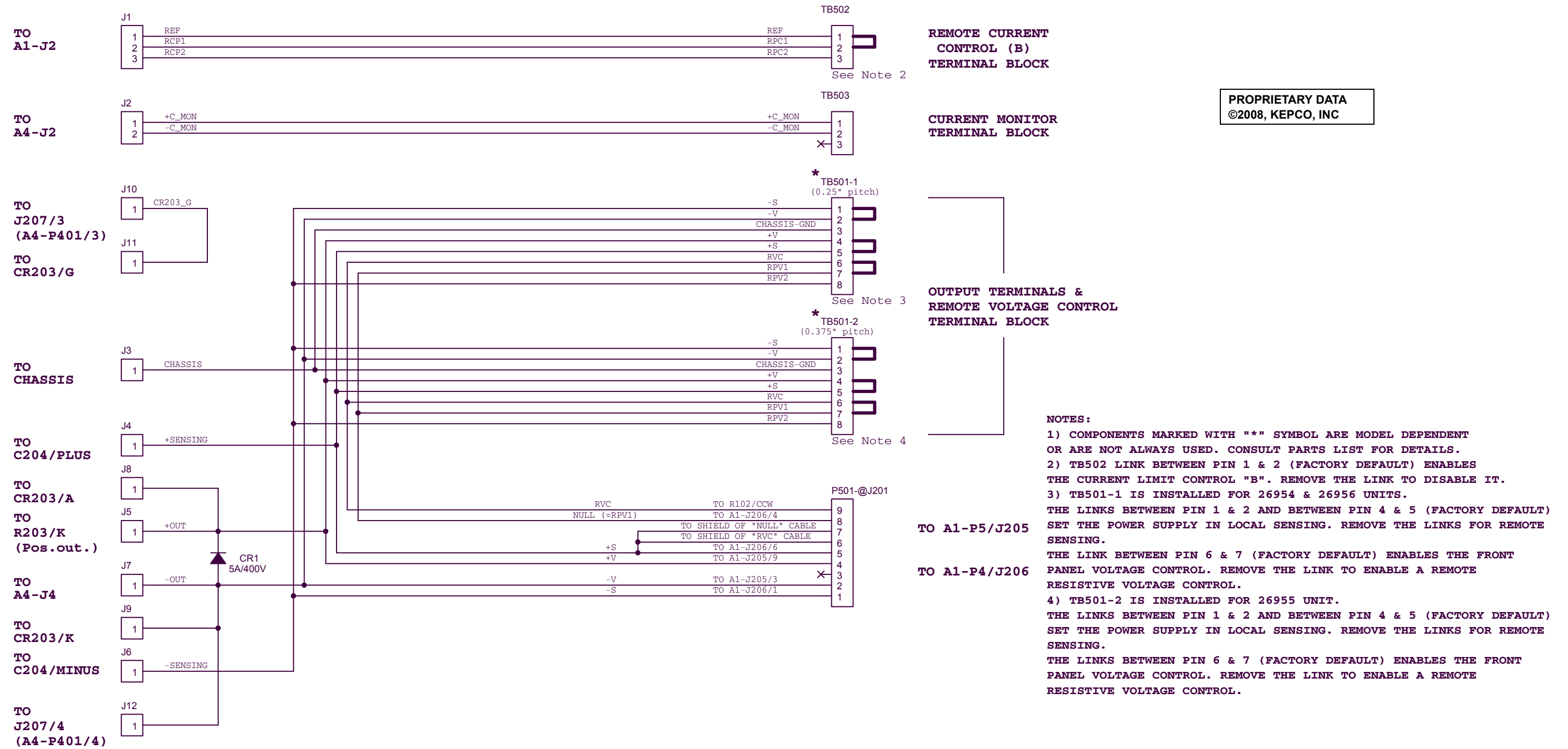
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*** CURRENT MONITORING CIRCUIT AT "-OUT" POTENTIAL (INSTALLED/USED FOR SPECIALS ONLY)**

FIGURE 7-10. OVERVOLTAGE PROTECTION AND CURRENT MONITOR BOARD A4, SCHEMATIC DIAGRAM



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FIGURE 7-11. OUTPUT TERMINALS BOARD A5, SCHEMATIC DIAGRAM

