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OPERATOR'S MANUAL

BOP (M) (D) 100W, 200W, 400W
BIPOLAR POWER SUPPLY

100W: BOP 20-5, BOP 50-2, BOP 100-1
200W: BOP 20-10, BOP 36-6, BOP 50-4, BOP 72-3, BOP 100-2, BOP 200-1
400W: BOP 20-20, BOP 36-12, BOP 50-8, BOP 72-6, BOP 100-4

KEPCO INC.
An ISO 9001 Company.

MODEL

BOP 100W, 200W, 400W
POWER SUPPLY

IMPORTANT NOTES:

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

MODEL	SERIAL NO.	REV. NO.

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.

3) The contents of this manual are protected by copyright. Reproduction of any part can be made only with the specific written permission of Kepco, Inc.

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INSTRUCTION MANUAL CORRECTION

KEPCO MODELS:
BOP 100W, BOP 200W, BOP 400W

LOAD REACTANCE, PARAGRAPH 1-10D, add the following:

There are two means of eliminating oscillation in the current loop operating with moderate inductive loads and moderate voltage and current:

1. Add capacitance in parallel with the output (inductive load). The value of capacitor can be from 0.1 uF to 1.0 uF depending on the value of the load inductance.

2. Add a series-connected resistor capacitor network in parallel with the output (inductive load). The value of resistor should be in the range of 100 to 500 Ohms and the value of capacitor should be 0.1 uF to 0.5 uF, depending on the load inductance value.

Both options are recommended when the BOP is used with very low frequency output into inductive loads.

NOTE: BOP 200W and 400W units may be converted to ML units in order to eliminate oscillation when dealing with a large range of inductive load values. This upgrade must be accomplished at the Kepco factory in Flushing New York and includes component changes and re-calibration of the unit. Please contact Kepco Sales for price and delivery schedule regarding this upgrade.

When driving heavy inductive loads with high currents, it is possible for the BOP and the load to be damaged by an A-C input power loss which prevents the load's stored energy from being dissipated inside the BOP. To avoid possible damage observe the following:

- Use UPS to supply the BOP.
- Set BOP output current and/or voltage to zero and turn off the BOP after the output current actually reaches a zero value.
- Use properly rated (voltage and current) bipolar transorbs or a properly rated bipolar crowbar element connected directly at the output of the BOP. An alternative is an A-C Normally Closed Contactor connected directly at the output of the BOP. These options may also be combined.

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AFTER PAR. 3-3 B) LOAD CONNECTION (I) and PAR. 3-3 C) LOAD CONNECTION (II) add the following:

Load connections to the BOP power supply are achieved via the OUTPUT and COMMON terminals located on either the front or the rear panel, **but not both**. Sense connections must be made from the same location (front or rear panel) as the output and common connections.

AFTER PAR. 3-3 D) A-C GROUND add the following:

The GROUND terminal is connected to CHASSIS of the unit and to the local EARTH-GROUND potential through the A-C power line cord. It can be used a) as a monitoring reference point, b) as a grounding point for the output of the unit, and c) for doubling the a-c power cord EARTH-GROUND connection if necessary by providing a separate connection to the local EARTH-GROUND point.

CAUTION: NEVER CONNECT THE BOP OUTPUT TERMINAL (OR THE LOAD TERMINAL TIED TO THE OUTPUT TERMINAL) TO EARTH-GROUND. OTHERWISE, IF THE CONTROLLING DEVICE IS GROUNDED, THE BOP CAN BE DAMAGED BY THE OUTPUT LIMIT CURRENT FLOWING INSIDE THE BOP ALONG THE PROGRAMMING SIGNAL RETURN PATH.

CAUTION: DO NOT CONNECT BOTH THE LOAD AND THE PROGRAMMING DEVICE RETURN (COMMON) TO EARTH-GROUND POTENTIAL AND DO NOT USE THE PROGRAMMING RETURN TERMINAL AS A TAP POINT FOR THE LOAD RETURN. OTHERWISE, IF THE COMMON POWER CONNECTION BETWEEN THE BOP AND THE LOAD IS LOST, THE BOP CAN BE DAMAGED BY OUTPUT CURRENT FLOWING INSIDE THE BOP ALONG THE PROGRAMMING SIGNAL RETURN PATH.

CAUTION: DO NOT USE THE PROGRAMMING RETURN TERMINAL AS A TAP POINT FOR THE LOAD RETURN BECAUSE THE BOP CAN BE DAMAGED BY OUTPUT CURRENT FLOWING INSIDE THE BOP ALONG THE PROGRAMMING SIGNAL RETURN PATH.

AFTER PAR. 3-3 E) D-C (SIGNAL) GROUND add the following:

The GROUNDING NETWORK terminal is tied to GROUND (CHASSIS) terminal through a series capacitor-resistor network. Connecting the GROUNDING NETWORK terminal to the COMMON terminal reduces common noise current flowing through the load and, if a BIT card is installed, it ensures that the dynamic swing of the output does not affect the digital section.

AFTER PAR. 3-3 J) EXTERNAL LEADS add the following:

K) EXTERNAL VOLTAGE MONITOR. Use signal E_O Monitor Output at pin 20 of the PC12 programming connector (see Figure 4-5) for external voltage monitoring. Caution should be exercised in handling this signal: use a series 5K resistor in combination with a high impedance monitoring device, or an external high impedance buffer between the BOP and the monitoring device. This signal is buffered by OPAMP IC23 (see Figure 6-4) which functions as a repeater for the signal coming from the RN3 matched pair divider connected at the output. There is no overvoltage protection. This stage is protected against short-circuit by the intrinsic protection of the OPAMP generating this signal. This signal is used by the BIT card if it is installed.

L) EXTERNAL CURRENT MONITOR. Use signal I_O Sensing Output at pin 10 of the PC12 programming connector (see Figure 4-5) for external current monitoring. This signal is not buffered. Use a series 5K resistor in combination with a high impedance monitoring device, or an external high impedance buffer between the BOP and the monitoring device. **CAUTION: An accidental short-circuit at this terminal while the unit is in Current mode or Current limit mode will damage the BOP power stage.** There is no overvoltage protection. This stage is protected against short-circuit by the intrinsic protection of the OPAMP generating this signal. This signal is used by the BIT card if it is installed.

DIGITAL CONTROL OF BOP POWER SUPPLIES, PARAGRAPH 3-46 add the following:

The SN and SNR Programmers and the BIT 488 cards described in this manual are older methods of controlling BOP power supplies via digital means. Although these products still function as described, the recommended method of digital control is now the use of Kepco's BIT 4886 16-bit plug-in card with resolution of $1/2^{16}$. This plug-in card provides talk-listen support for the IEEE 488.2 bus using SCPI commands. The BIT 4886 card allows a BOP to communicate as a stand-alone instrument, directly on the GPIB. The BIT 4886 card also allows the BOP to be programmed over the RS232C bus using either SCPI or CIIL commands via either an RS232-C terminal, or from a PC using a terminal emulation program with a baud rate of 9600, no parity, eight data bits and one stop bit. The downloadable BIT 4886 driver supports digital calibration (no manual pots) and multiple control and read-back ranges, For more information refer to: www.kepcopower.com/bit.htm.

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. 11355 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, and as such depends upon proper connection to protective earth for safety from electric shock. (EN61010-1 Cl. 6.5.4)

4. This power supply 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 Cl. 6.5.4 and Cl.6.10.1)

5. This power supply has secondary output circuits that are considered hazardous, and which exceed 240 VA at a potential of 2V or more.

6. 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.

7. 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)

8. 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.



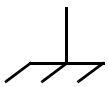
The PROTECTIVE EARTHING CONDUCTOR TERMINAL must be properly connected prior to application of source power to the product (see instructions on installation herein) in order to ensure safety from electric shock.



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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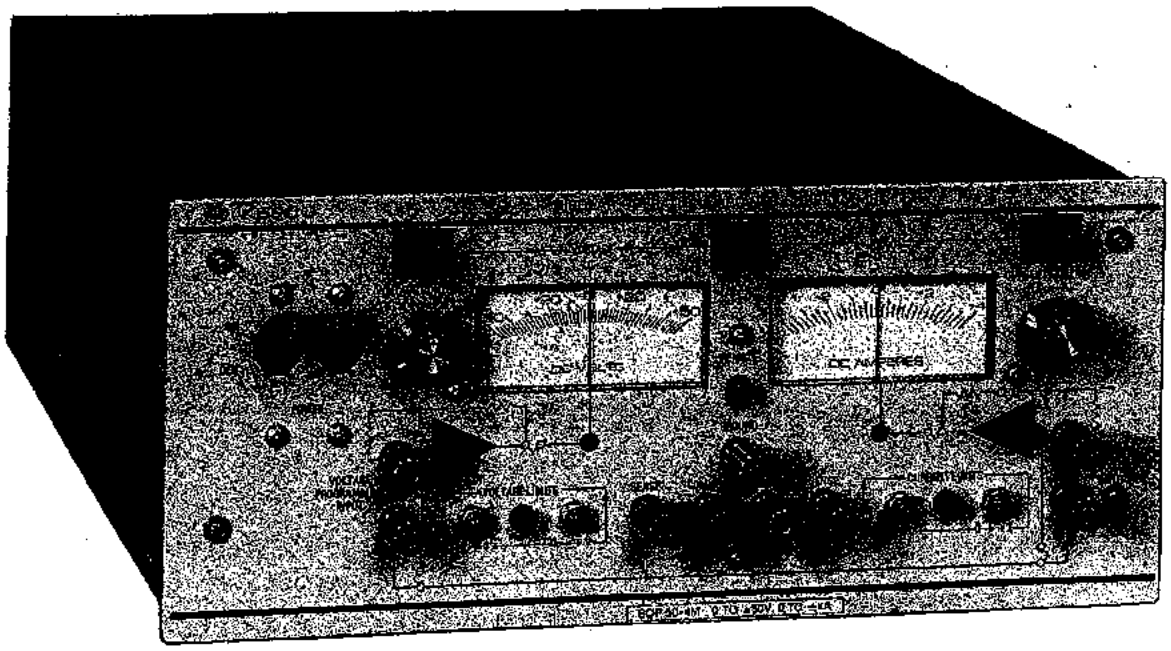
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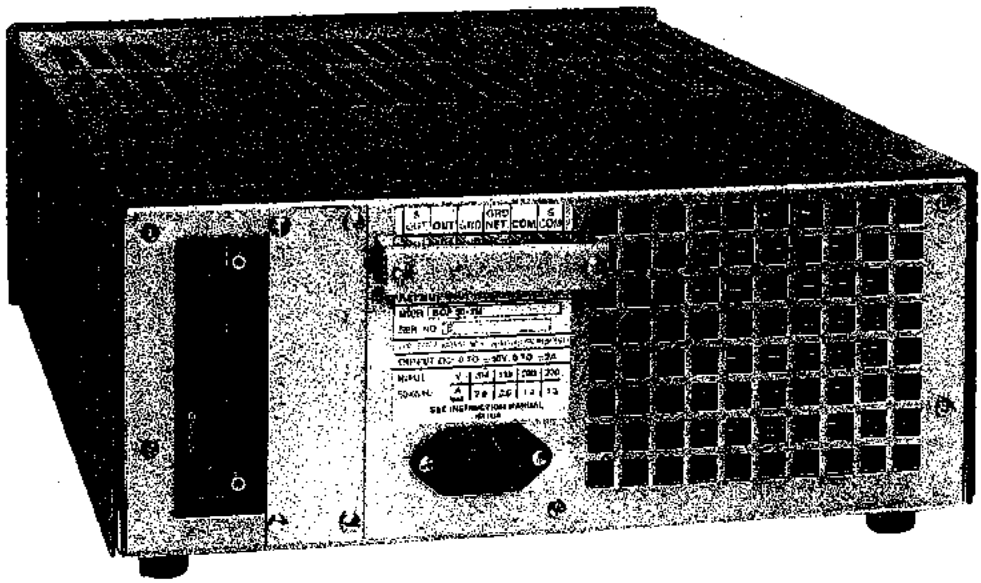


FIG. 1-1A KEPCO BIPOLAR OPERATIONAL POWER SUPPLY (¾ RACK BOP)

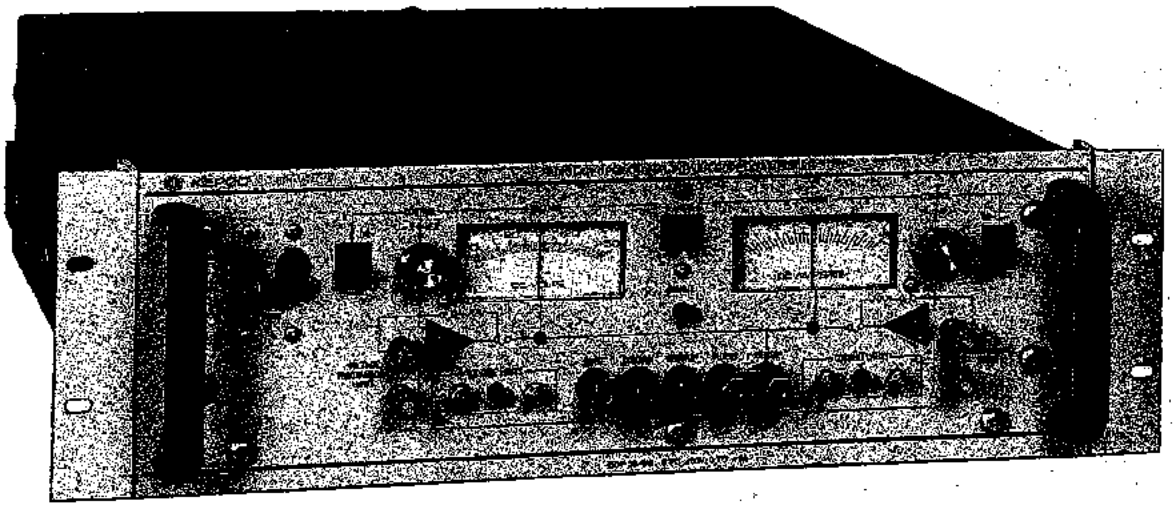




FIG. 1-1B KEPCO BIPOLAR OPERATIONAL POWER SUPPLY (FULL-RACK BOP)

SECTION I — INTRODUCTION

1-1 SCOPE OF MANUAL

1-2 This manual contains instructions for the installation and operation of the BOP series of Bipolar, operational power supplies, manufactured by Kepco Inc., Flushing, New York, U.S.A.

1-3 GENERAL DESCRIPTION

1-4 The Kepco series BOP Bipolar Power Supplies are fully dissipative, linear stabilizers for laboratory and systems applications. The BOP is an all solid-state design, featuring IC operational amplifiers in the control circuit section and silicon power transistors mounted on special fan-cooled heat sinks in the complementary power stage.

1-5 The BOP has two bipolar control channels (voltage or current mode), selectable and individually controllable either from their front panel controls, or by remote signals. Each of the principal control channels is protected by bipolar limit circuits. In these limit circuits the positive and negative current or voltage limit points can be manually set or remotely programmed simultaneously or individually. Automatic crossover between each principal control channel and its associated limit channel is provided.

1-6 All control and limit channels are connected to the complementary output stage via an "EXCLUSIVE OR" gate, so that only one channel is in control of the BOP output at any one time. The BOP output can be programmed over its full output range by a ± 10 volt signal applied to either one of the inputs to the voltage or the current channel. The limit control channels can be remotely controlled by a 0 to + 10 volt signal applied to their respective inputs. Two uncommitted preamplifiers, with both, inverting and non-inverting inputs available at the rear programming connector, can scale any programming source to the required input levels. Zero adjustments for both amplifiers are provided.

1-7 The BOP is a fast programmable power supply with considerable bandwidth and thereby sensitive to reactive loads. The dynamic specifications, given in Table 1-3, are valid for resistive loads only.

1-8 ELECTRICAL SPECIFICATIONS, GENERAL

A) INPUT SOURCE REQUIREMENTS: 95 to 113V a-c ***or*** 105 to 125V a-c ***or*** 190 to 226V a-c ***or*** 210 to 250V a-c, 50 to 65 Hz, selectable (refer to Section II, FIG. 2-3). The primary circuit is protected by a circuit breaker, effective at all input voltages. Input current and power are listed in the table below.

B) OPERATING TEMPERATURE RANGE: 0°C to +55°C.

C) STORAGE TEMPERATURE RANGE: −40°C to +85°C.

D) COOLING: By built-in, sealed bearing fans, exhausting to the rear of the BOP.

E) ISOLATION FROM GROUND: The BOP circuitry, its output and programming terminals have no d-c connection to the chassis. The COMMON terminal of the BOP can be operated up to 500 volts (d-c or peak) off a-c ground. The common mode current (leakage from output to ground) is less than 50 μA (rms) or 5 mA (p-p) at 115V a-c power input, 60 Hz.

MODEL	OUTPUT POWER	MAX. INPUT CURRENT	MAX. INPUT POWER	PACKAGE
BOP 20-5M	100W	2.9A	270W	¾ Rack
BOP 50-2M	100W	2.9A	270W	¾ Rack
BOP 100-1M	100W	2.9A	270W	¾ Rack
BOP 20-10M	200W	5.5A	540W	¾ Rack
BOP 36-6M	200W	5.1A	490W	¾ Rack
BOP 50-4M	200W	4.8A	450W	¾ Rack
BOP 72-3M	200W	5.1A	470W	¾ Rack
BOP 100-2M	200W	4.8A	450W	¾ Rack
BOP 200-1M	200W	5.5A	450W	Full Rack
BOP 20-20M	400W	11.2A	1115W	Full Rack
BOP 36-12M	400W	10.7A	1050W	Full Rack
BOP 50-8M	400W	9.6A	1000W	Full Rack
BOP 72-6M	400W	10.9A	1085W	Full Rack
BOP 100-4M	400W	9.2A	885W	Full Rack

Approximate maximum input current and power at 125V a-c, 60Hz.

1-9 ELECTRICAL SPECIFICATIONS, PERFORMANCE

A) OUTPUT RANGES: See Table 1-1

MODEL	d-c OUTPUT RANGE		CLOSED LOOP GAIN		OUTPUT IMPEDANCE			
			VOLTAGE CHANNEL	CURRENT CHANNEL	VOLTAGE MODE		CURRENT MODE	
	E_o max.	I_o max.	G_V (V/V)	G_I (A/V)	SERIES R	SERIES L	SHUNT R	SHUNT C
100 WATT								
BOP 20-5M	± 20V	± 5A	2.0	0.5	80μΩ	20μH	40kΩ	0.05μF
BOP 50-2M	± 50V	± 2A	5.0	0.2	0.5mΩ	100μH	50kΩ	0.05μF
BOP 100-1M	±100V	± 1A	10.0	0.1	2.0mΩ	200μH	100kΩ	0.05μF
200 WATT								
BOP 20-10M	± 20V	±10A	2.0	1.0	40μΩ	40μH	20kΩ	0.05μF
BOP 36-6M	± 36V	± 6A	3.6	0.6	120μΩ	20μH	36kΩ	0.03μF
BOP 50-4M	± 50V	± 4A	5.0	0.4	0.25mΩ	50μH	50kΩ	0.02μF
BOP 72-3M	± 72V	± 3A	7.2	0.3	0.48mΩ	60μH	72kΩ	0.05μF
BOP 100-2M	±100V	± 2A	10.0	0.2	1.0mΩ	200μH	100kΩ	0.03μF
BOP 200-1M(1)	±200V	± 1A	20.0	0.1	4.0mΩ	1.2mH	200kΩ	0.03μF
400 WATT								
BOP 20-20M	± 20V	±20A	2.0	2.0	20μΩ	10μH	20kΩ	0.5μF
BOP 36-12M	± 36V	±12A	3.6	1.2	60μΩ	50μH	36kΩ	0.4μF
BOP 50-8M	± 50V	± 8A	5.0	0.8	125μΩ	100μH	50kΩ	0.15μF
BOP 72-6M	± 72V	± 6A	7.2	0.6	240μΩ	200μH	72kΩ	0.1μF
BOP 100-4M	±100V	± 4A	10.0	0.4	500μΩ	200μH	100kΩ	0.1μF

(1) Same size as 400W models

TABLE 1-1 OUTPUT RANGE AND OUTPUT IMPEDANCE

B) OUTPUT EFFECTS: See Table 1-2.

STATIC SPECIFICATIONS

INFLUENCE QUANTITY		OUTPUT EFFECTS(1) VOLTAGE MODE TYPICAL	VOLTAGE MODE MAXIMUM	CURRENT MODE TYPICAL	CURRENT MODE MAXIMUM	PREAMPLIFIER(5) OFFSETS ΔE_{io}	PREAMPLIFIER(5) OFFSETS ΔI_{io}	REFERENCE ± 10V
SOURCE VOLTAGE (min-max):		<0.0005%	0.001%	<0.002%	0.005%	<5μV	<1nA	<0.0005%
LOAD (No Load-full load):		<0.001%	0.002%	<0.5mA	1mA	—	—	<0.0005%
TIME (8-hour drift):		<0.005%	0.01%	<0.01%	0.02%	<20μV	<1nA	<0.005%
TEMPERATURE, per °C:		<0.005%	0.01%	<0.01%	0.02%	<20μV	<1nA	<0.005%
RIPPLE and NOISE:(2)	rms	<1mV	3mV(4)	<0.01%	0.03%	—	—	—
	p-p(3)	<10mV	30mV(4)	<0.1%	0.3%	—	—	—

(1) Output effects, expressed as a percentage, are referred to the maximum rated output voltage or current.

(2) Measured with the common terminal grounded so that the common mode current does not flow through the load.

(3) Peak-to-peak ripple is measured over a 20 Hz to 10 MHz bandwidth.

(4) For BOP 200-1M the maximum ripple and noise is 5mV rms and 50mV p-p.

(5) To permit calculation of the effect of non-standard control current (less than the normal 1 mA) or non-standard gain ratios.

TABLE 1-2 OUTPUT EFFECTS, OFFSETS AND REFERENCE SPECIFICATIONS.

C) The BOP ***output effects,*** in response to the tabulated variations in the INFLUENCE QUANTITIES, are given in Table 1-2 for the built-in input and feedback resistor values of the voltage and current channel preamplifiers. The tabulated OFFSET VALUES (see Table 1-2) may be used to calculate the BOP ***output effects*** if the BOP voltage or current channel is remotely programmed and different values for the feedback resistors (R_f) and the input resistors (R_i) are used. In this case, the tabulated preamplifiers offsets and the values of the feedback and input resistors are combined in an "Error Equation", which represents the "Worst Case" output effect for the application at hand:

VOLTAGE MODE: $\Delta E_o = G_V [\pm \Delta E_{io} (1 + R_f/R_i) \pm \Delta I_{io} R_f \pm \Delta E_{ref}]$

CURRENT MODE: $\Delta I_o = G_I [\pm \Delta E_{io} (1 + R_f/R_i) \pm \Delta I_{io} R_f \pm \Delta E_{ref}]$

Where:
- ΔI_o = Total Output Current Change.
- G_V = Closed Loop Gain, Voltage Mode, (see Table 1-1).
- G_I = Closed Loop Gain, Current Mode, (see Table 1-1).
- ΔE_o = Total Output Voltage Change.
- ΔE_{ref} = Change in the Voltage Reference.
- ΔE_{io} = Change in Offset Voltage.
- ΔI_{io} = Change in Offset Current.
- R_f = External Feedback Resistor.
- R_i = External Input Resistor.

NOTE: Variations in the value of the feedback and input resistors are considered secondary effects in the Error Equation. See Section IV of this manual for the derivation of the Error Equation.

E) PEAK POWER: $\pm (E_o \text{ max}) (I_{o \text{ max}})$. **Where:** E_o max. = Maximum rated BOP output voltage. I_o max. = Maximum rated BOP output current.

F) DYNAMICS: The typical dynamic responses of the BOP output are tabulated in Table 1-3 in both the time domain (Output response to a step program) and in the frequency domain (bandwidth) for large and small signals.

MODEL	BANDWIDTH (D-C to f_{-3dB}) KHz (minimum) Mode		RISE & FALL TIME 10%-90% µsec (maximum) Mode		LARGE SIGNAL FREQUENCE (min) RESPONSE, KHz Mode		SLEWING RATE (minimum) Mode		RECOVERY STEP LOAD µsec (maximum) Mode	
	V	I	V	I	V	I	V	I	V	I
100 WATT										
BOP 20-5M	18	12	20	30	17	13	5V/µsec	0.15A/µsec	25	10
BOP 50-2M	18	12	20	30	17	13	5V/µsec	0.15A/µsec	25	10
BOP 100-1M	18	11	17	22	18	11	11V/µsec	70mA/µsec	40	25
200 WATT										
BOP 20-10M	18	6	20	60	17	7	2V/µsec	0.4A/µsec	80	20
BOP 36-6M	16	13	20	27	15	14	3V/µsec	0.5A/µsec	50	35
BOP 50-4M	23	14	14	25	15	11	4.5V/µsec	0.25A/µsec	40	30
BOP 72-3M	20	15	18	26	17	12	10V/µsec	0.15A/µsec	30	30
BOP 100-2M	22	15	18	26	17	12	10V/µsec	0.15A/µsec	30	30
BOP 200-1M	4.0	2.5	110	150	4.0	2.5	5V/µsec	15mA/µsec	150	120
400 WATT										
BOP 20-20M	9.5	10	35	35	8	10	1V/µsec	1.25A/µsec	100	75
BOP 36-12M	20	10	16	30	19	10	4V/µsec	0.75A/µsec	50	30
BOP 50-8M	24	10	14	35	24	11	7.5V/µsec	0.5A/µsec	40	30
BOP 72-6M	19	9.5	18	40	20	11	9V/µsec	0.4A/µsec	50	20
BOP 100-4M	18	14	22	30	16	10	10V/µsec	0.25A/µsec	40	30

TABLE 1-3 DYNAMIC SPECIFICATIONS, BOP 100W, BOP 200W AND BOP 400W MODELS

1-10 MISCELLANEOUS FEATURES

A) OUTPUT RANGE: The BOP can be locally (front panel) adjusted, or remotely programmed, from (−)100% to (+)100% of its specified d-c voltage and current range. The Class A bipolar output stage permits operation as either a SOURCE or a SINK. (See FIG. 1-2).

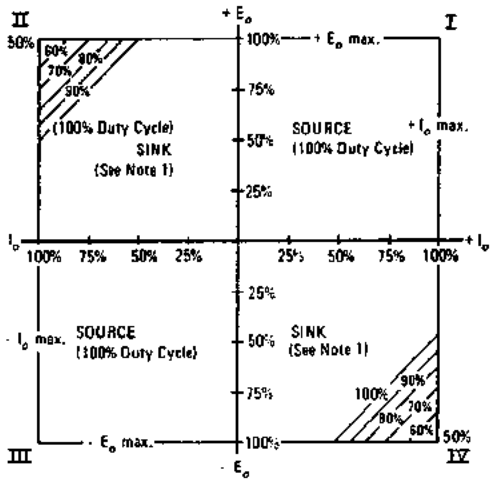


FIG. 1-2 BOP OUTPUT CHARACTERISTIC

NOTE: The values for $\pm E_{o\ max}$ and $\pm I_{o\ max}$ are listed in the model table.

NOTE: The duty cycle of the BOP operating in the SINK mode must be derated as shown on the graph.

Note: The BOP is operating as a SOURCE if the direction of its output voltage is ***the same*** as the direction of its output current. The BOP is operating as a SINK if the direction of its output voltage is ***opposite*** that of its output current. An illustrative case is shown in FIG. 1-3, where the BOP is programmed to deliver a sine wave output and where the load produces a phase shift between the output voltage and current.

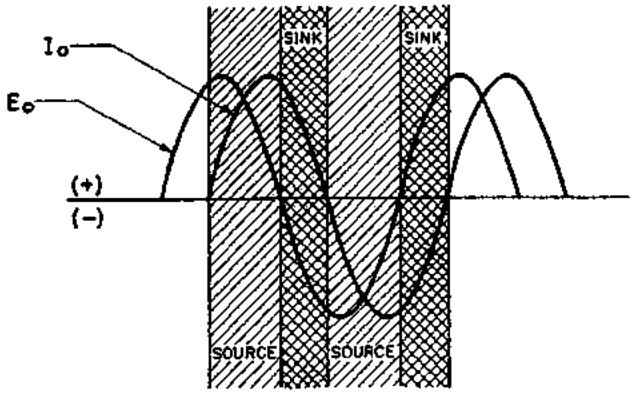
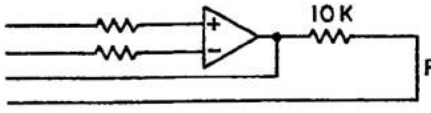
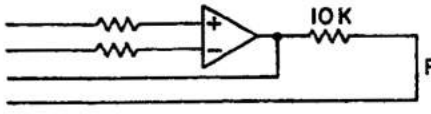


FIG. 1-3 BOP OUTPUT WAVE FORM WITH PHASE SHIFT

B) REAR PROGRAMMING CONNECTORS (See Table 2-2, items 22 and 23)

1) The external rear programming connector, called "PC-12" throughout this manual, is an unwired 50-pin edge connector, providing access to all circuit features. The BOP is delivered with one(1) PC-12 connector, with jumpers wired for local (front-panel) operation. Spare connectors may be purchased from Kepco under the model number "PC-12" for the unwired connector and "PC-15" for a connector wired for local operation. The pin-out for the rear programming connector or (PC-12) is shown below.

PIN	FUNCTION	DESCRIPTION
1	CURRENT LIMIT BIAS	Section III, paragraph 3-31
3	VOLTAGE LIMIT BIAS	Section III, paragraph 3-34
11 9 5 7	 PREAMP "A"	Section III, paragraph 3-11 for example
15 13 2 4	 PREAMP "B"	Section III, paragraph 3-28 for example
6	$+E_o$ LIMIT INPUT	Section III, paragraph 3-34
8	$+I_o$ LIMIT INPUT	Section III, paragraph 3-31
32	$-E_o$ LIMIT INPUT	Section III, paragraph 3-34
34	$-I_o$ LIMIT INPUT	Section III, paragraph 3-31
10	CURRENT SENSING AMP. OUTPUT	Analog output voltage (0 to ±10V, 1mA max.) proportional to the prevailing BOP output current for remote metering or monitoring.
20	VOLTAGE MONITOR AMP. OUTPUT	Analog output voltage (0 to ±10V, 1 mA max.) proportional to the prevailing BOP output voltage.
21,43, 44,45,46	NOT USED	
12,14	RESERVED (NOT TO BE USED)	
16,18	CURRENT MODE COMPENSATING TERMINALS	Section I, paragraph 1-10D
26,36	TURN-OFF SIGNAL OUTPUT	Section III, paragraph 3-83
24	CKT BREAKER CONTROL	Section III, paragraph 3-83
41	NON-ISOLATED TURN-OFF SIGNAL INPUT	Section III, paragraph 3-83
47/48, 49/50	OPTICALLY ISOLATED TURN-OFF SIGNAL INPUT	Section III, paragraph 3-83
17	VOLTAGE COMPARISON AMP. INPUT	An analog input voltage of 0 to ±10V will produce 0 to ± full output voltage or current.
19	CURRENT COMPARISON AMP. INPUT	
22	−10V REFERENCE VOLTAGE, 4mA MAX.	Section III, paragraph 3-11 for example
28	+10V REFERENCE VOLTAGE, 4mA, MAX.	
23 25 27 29 31 33	SENSING COMMON	————
30	VOLTAGE MODE COMMAND	Section I, paragraph 1-10L
35	LOCAL/REMOTE OUTPUT FLAG	Section III, paragraph 3-85
37	+5V	Built in TTL logic supply, 5V @ 40mA max.
38	I_o LIMIT FLAG	Section III, paragraph 3-85
39	E_o LIMIT FLAG	Section III, paragraph 3-85
40	E_o MODE FLAG	Section III, paragraph 3-85
42	I_o MODE FLAG	Section III, paragraph 3-85

2) AUXILIARY (OPTIONAL) PROGRAMMING CONNECTOR.
For standard BOP models, the space for this connector is covered. If the BOP contains accessory cards for digital programming, the cover is removed and access to the interface card is provided. The method of termination depends on the interface model. Refer to Section III, paragraphs 3-46 through 3-82.

3) Remote turn-off of the BOP by a contact closure, or by an optically isolated input signal.

4) Circuit breaker shut down prevention circuit.

5) REFERENCES: Two reference/bias sources (± 10V at 4 mA MAX.) are provided for control and biasing purposes. These reference sources are available at the rear programming connector (with reference to the "COMMON" terminal). Their specifications are tabulated in Table 1-2.

C) OFFSET NULLING: Controls are provided to zero the initial offsets (E_{io}, I_{io}) of the voltage and current control preamplifiers and the MAIN AMPLIFIERS.

D) LOAD REACTANCE: To realize the full high speed potential of the BOP, the load characteristics should be mainly resistive. Load capacitance and inductance up to 0.2 μF and 0.5 mHy respectively can be tolerated without performance deterioration. The BOP phase-gain versus frequency characteristic is determined by the corner frequency of the response curve ($f_{-3\,dB}$ breakpoint), as indicated in the Dynamic Specification Table (Table 1-3), and the Closed Loop Gain (G_v-Voltage Mode, G_i-Current Mode), as shown in Table 1-1
At unity gain crossover frequency, there is a substancial phase margin which assures stability into resistive loads. Additional phase shift is introduced, however, by reactive loads (RC-in voltage mode, RL-in current mode), which will reduce the phase margin at the unity gain crossover frequency and will cause peaking in the BOP's dynamic response.

If the load's corner frequency is below the BOP's, the system will be stable, but the frequency response will be governed by the load. When operating with inductive loads greater than 0.5 mHenry in the Current Mode, a compensating capacitor may be required across the Current Comparison Amplifier. Two terminals have been provided for this purposes at the Rear Programming Connector (PC-12, pins 16,18).

E) SERIES OR PARALLEL OPERATION: See Section III of this manual.

F) VOLTAGE CONTROL CHANNEL: (Refer to Section III - FIG. 3-1A). The BIPOLAR VOLTAGE AMPLIFIER, with a fixed gain (See Table 1-1 for gain value) is connected, via the MODE switch, to the (unity gain) VOLTAGE PREAMPLIFIER. If the VOLTAGE CONTROL switch is "on", the BOP output voltage can be locally controlled by means of the (front panel) (±) 10 volts bias source, from (−) 100% (through zero) to (+) 100% of the rated value. The VOLTAGE PREAMPLIFIER is provided with a ZERO control and all its terminals are available at the rear programming connector for remote control of the output voltage. Control methods are described in Section III of this manual.

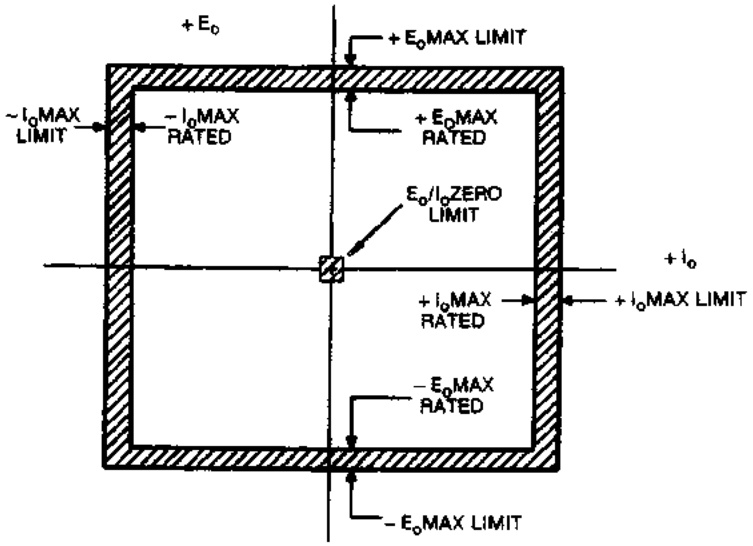
G) MODE SWITCH: The BOP is equipped with a front panel mounted MODE SWITCH, which selects bipolar voltage or bipolar current control. See paragraph 1-10L for remote MODE control.

H) CURRENT CONTROL CHANNEL (Refer to Section III-FIG. 3-1B). The BIPOLAR CURRENT AMPLIFIER, with a fixed gain (see Table 1-1 for gain value), is connected via the MODE switch to the (unity gain) CURRENT PREAMPLIFIER. If the CURRENT CONTROL switch is "on", the BOP output current can be locally (front panel) controlled (by means of the ± 10 volt bias source) from (−)100% (through zero) to (+)100% of the rated value. The CURRENT PREAMPLIFIER is provided with a ZERO control and all its terminals are available at the rear programming connector for remote control of the output current. Control methods are described in Section III of this manual.

J) BOUNDING: (Refer to Section III - FIG. 3-1C & D). The BOP has four output voltage/current limiting circuits (−) E_o LIMIT, (+) E_o LIMIT, (−) I_o LIMIT, (+) I_o LIMIT for overvoltage/overcurrent protection in either operating mode. All limiting circuits can be screwdriver adjusted by means of four front panel controls. In addition, all four limits can be remotely controlled by means of 0 to 10 volt d-c control voltages. The four limits may be programmed independently or the (±) voltage and (±) current limits can be controlled in pairs. The adjustable/programmable limit controls are backed-up by front panel-adjustable limit circuits which define the four boundaries [(±) E_o MAX and (±) I_o MAX.] of the BOP, and provide protection against accidental overprogramming of the adjustable limits.

1-10 J) (Cont'd)

The four boundary quantities (±) E_oMAX. and (±) I_o MAX. as applied to the LIMIT CHANNEL, are actually about 10% greater than the **rated** values E_oMAX. and I_oMAX. for each BOP model. Similarly, the quantities E_o ZERO and I_o ZERO are not really "zero", but approximately 0.2% of the **rated** E_o MAX. and I_o MAX. values for each BOP model. (See graph below).



K) MODE LIGHTS: Four (4) front panel (LED type) indicator lamps monitor the prevailing operating mode of the BOP. For each operating condition (VOLTAGE MODE, CURRENT MODE, ± E_o LIMIT, ± I_o LIMIT) the corresponding indicator lamp energizes. Simultaneous TTL flags available on the REAR PROGRAMMING CONNECTOR. See paragraph 1-10B.

L) REMOTE OPERATING MODE SELECTION. The operating mode of the BOP, normally selected by means of a manual switch on the front panel, may be remotely selected by a remote switch or TTL logic levels. Proceed as follows:

1) Wire the REMOTE/LOCAL FLAG line on the REAR PROGRAMMING CONNECTOR (PC-12, term. 35) to SENSING COMMON. This will cause the front-panel REMOTE LED to light and the front panel MODE switch will be disabled. ALL OTHER FRONT PANEL CONTROLS WILL STILL BE FUNCTIONAL.

2) The operating mode of the BOP may now be controlled by means of terminal 30 on PC-12. With an open terminal (or logic HIGH), the BOP will operate in the Voltage Mode. Returning terminal 30 to SENSING COMMON (or logic LOW) will change the operating mode to Current Mode.

M) STANDARDS: BOP models are designed and tested in accordance with NEMA Standard for Stabilized Power Supplies, d-c output, Publication No. PY-1-1972.

1-11 MECHANICAL SPECIFICATIONS

A) DIMENSIONS: See "Mechanical Outline Drawing", FIG. 1-4.

B) FINISH: See "Mechanical Outline Drawing", FIG.1-4.

C) FRONT PANEL METERS: Two (2) "zero center" meters, monitoring the ± d-c output voltage and the ± d-c output current, are provided; 2½ inches wide, recessed; Accuracy, ±2% full scale.

D) SHIPPING WEIGHT: ¾-RACK BOP MODELS: 51 lbs., 23 Kg, unpacked.
FULL RACK BOP MODELS: 75 lbs., 34 Kg, unpacked.

1-12 ACCESSORIES, SUPPLIED

A) REAR PROGRAMMING CONNECTOR, Kepco Model PC-12, 50-terminal printed circuit connector for all rear programming connections and flag-signal outputs, wired for local (front panel) control of the BOP output. This connector may be ordered wired under Kepco Model PC-15 and unwired as the Model PC-12.

B) (FULL-RACK BOP MODELS ONLY) MOUNTING FLANGES, for installation of the BOP into a standard (19 inch) equipment rack. A PAIR INCLUDED WITH EACH BOP.

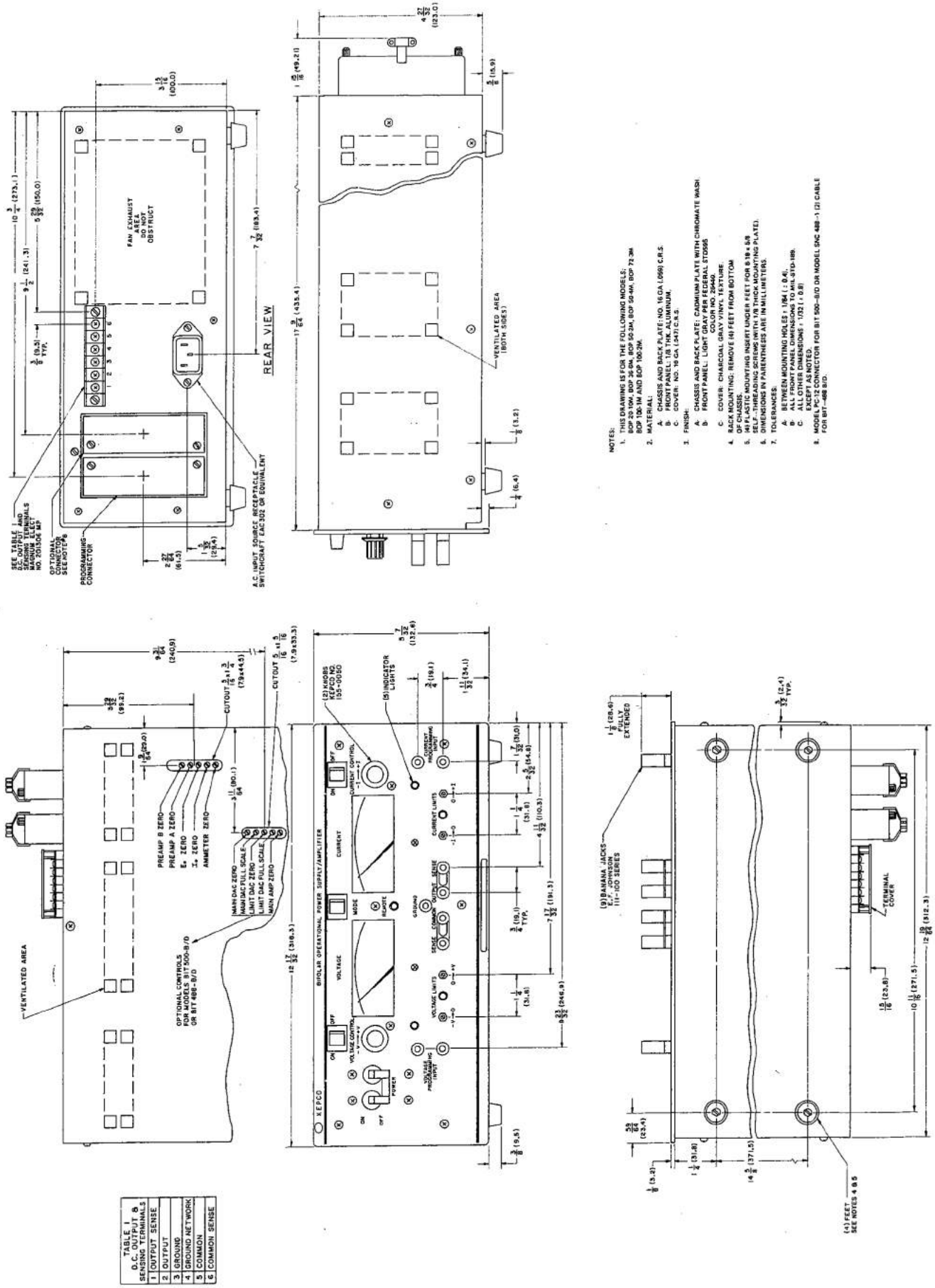
C) (FULL-RACK BOP MODELS ONLY) SIDE COVER PLATES, for bench top use, designed to finish the two sides of the instrument when the rack mounting-ears are not installed. A PAIR INCLUDED WITH EACH BOP.

1-13 ACCESSORIES, NOT SUPPLIED

A) REAR PROGRAMMING CONNECTOR, Kepco Model PC-12, unwired.

B) RACK ADAPTER, Kepco Model RA-24; for ¾-rack BOP models and one Kepco ¼-rack model. Filler panel available to cover the empty slot if ¼-rack model is not installed.

C) RACK ADAPTER, Kepco Model RA-37; for ¾-rack BOP models and one Kepco ¼-rack model. Filler panel available to cover empty slot if ¼-rack model is not installed.



NOTES:
1. THIS DRAWING IS FOR THE FOLLOWING MODELS: BOP 20-10M, BOP 36-6M, BOP 50-3M, BOP 50-4M, BOP 72-3M BOP 100-1M AND BOP 100-2M.
2. MATERIAL:
   A. CHASSIS AND BACK PLATE: NO. 16 GA (.059) C.R.S.
   B. FRONT PANEL: 1/8 THK. ALUMINUM.
   C. COVER: NO. 19 GA (.047) C.R.S.
3. FINISH:
   A. CHASSIS AND BACK PLATE: CADMIUM PLATE WITH CHROMATE WASH.
   B. FRONT PANEL: LIGHT GRAY PER FEDERAL STD595 COLOR NO. 26440.
   C. COVER: CHARCOAL GRAY VINYL TEXTURE.
4. RACK MOUNTING: REMOVE (4) FEET FROM BOTTOM.
5. OPTIONAL RACK MOUNTING INSERT UNDER FEET FOR 8.18 x 8.8 (4) PLASTIC MOUNTING INSERT (WITH 1/8 THICK MOUNTING PLATE) SELF-THREADING SCREWS
6. DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS.
7. TOLERANCES:
   A. BETWEEN MOUNTING HOLES ± 1/64 (± 0.4).
   B. ALL FRONT PANEL DIMENSIONS TO MIL-STD-189.
   C. ALL OTHER DIMENSIONS ± 1/32 (± 0.8)
8. MODEL PC12 CONNECTOR FOR BIT 500-B/D OR MODEL SNC 488-1 (2) CABLE FOR BIT-488 B/D.

TABLE I
O.C. OUTPUT & SENSING TERMINALS

1	OUTPUT SENSE
2	OUTPUT
3	GROUND
4	GROUND NETWORK
5	COMMON
6	COMMON SENSE

FIG. 1-4 MECHANICAL OUTLINE DRAWING, 3/4 RACK MODELS (SHEET 1 OF 2)

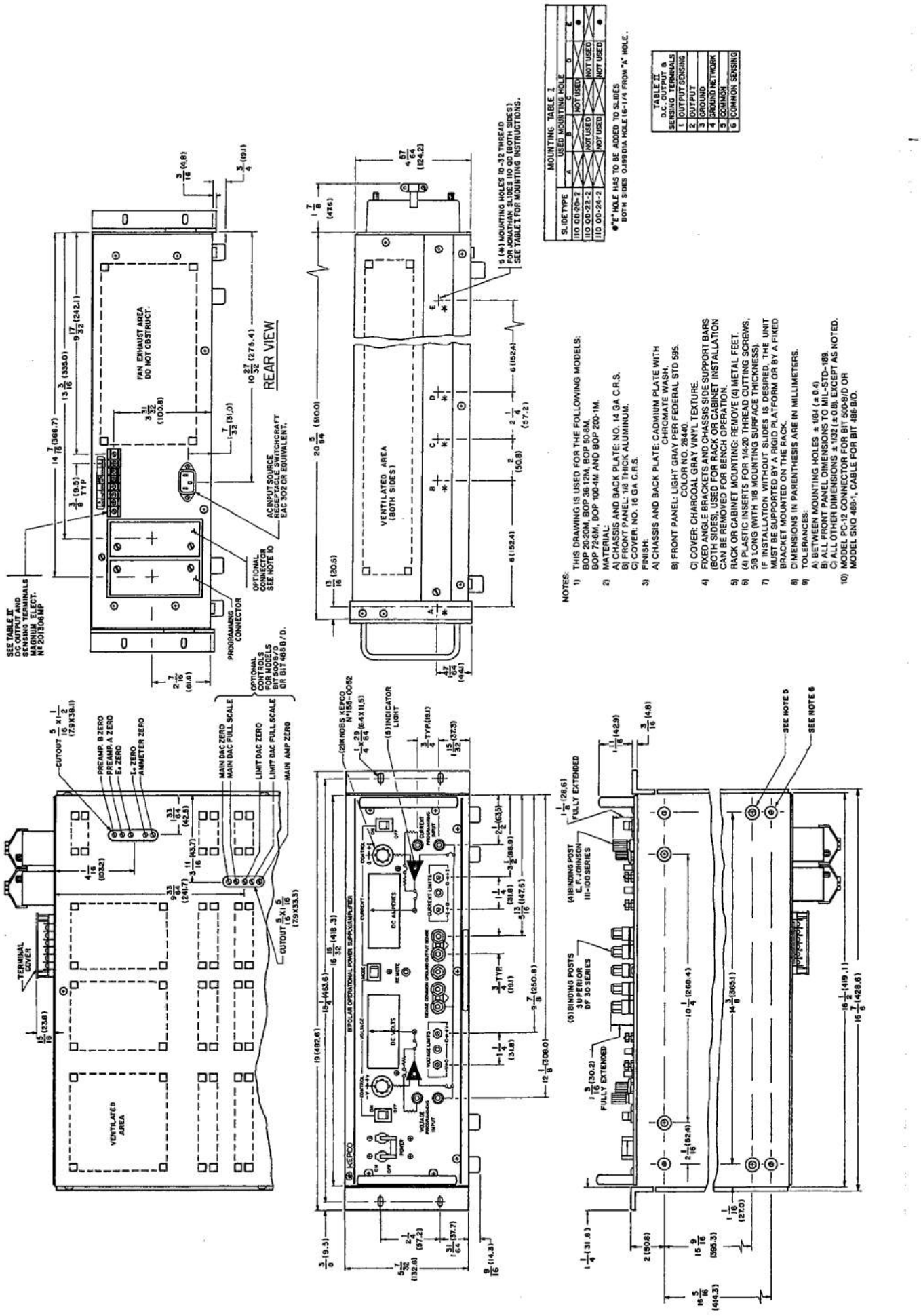


FIG. 1-4 MECHANICAL OUTLINE DRAWING, FULL RACK MODELS (SHEET 2 OF 2)

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 carefully unpacking, inspect for shipping damage before attempting to operate. Perform the preliminary operation check as outlined in Paragraph 2-8.. If any indication of damage is found, file an immediate claim with the responsible transport service.

2.2 TERMINATIONS

A) FRONT PANEL: Refer to FIG. 2-2A and Table 2-2.

B) REAR: Refer to FIG. 2-2B and Table 2-2.

C) INTERNAL CALIBRATION CONTROLS: Refer to FIG. 2-1 and Table 2-1.

TABLE 2-1 INTERNAL CALIBRATION CONTROLS.

REFERENCE DESIGNATION	CONTROL NAME	PURPOSE	ADJUSTMENT PROCEDURE
R15A (1)	OPTOCOUPLER LINEARITY	LC301 Optocoupler Linearization	Sect. III, Par. 3-87C
R31, 32	(±)10V CAL.	Reference Voltage Calibration	Sect. III, Par. 3-87A
R41	PREAMP "A" ZERO	Uncommitted Amplifier "A" Zero Adjustment	Sect. III, Par. 3-19
R42	PREAMP "B" ZERO	Uncommitted Amplifier "B" Zero Adjustment	Sect. III, Par. 3-30
R50	AMMETER ZERO	Sensing Amp. Offset Adjustment	Sect. III, Par. 3-87B
R81	E_O COMP AMP ZERO	Voltage Channel Zero Adjustment	Sect. III, Par. 3-16
R83	I_O COMP AMP ZERO	Current Channel Zero Adjustment	Sect. III, Par. 3-30
R316 (2) (R314 on BOP 200-1) (2)	I_O CAL.	Full Scale Output Current Calibration	Sect. III, Par. 3-87D

NOTES: (1) R15A for Model BOP 200-1M only.
(2) R316 (R314 on BOP 200-1M) applies only to the following Model Revision Numbers (or higher):
BOP 20-5M: REV. 4 BOP 20-10M: REV. 20 BOP 20-20M: REV. 17 BOP 36-6M: REV. 20
BOP 36-12M: REV. 16 BOP 50-2M: REV. 23 BOP 50-4M: REV. 15 BOP 50-8M: REV. 13
BOP 72-3M: REV. 12 BOP 72-6M: REV. 15 BOP 100-1M: REV. 26 BOP 100-2M: REV. 17
BOP 100-4M: REV. 16 BOP 200-1M REV. 10

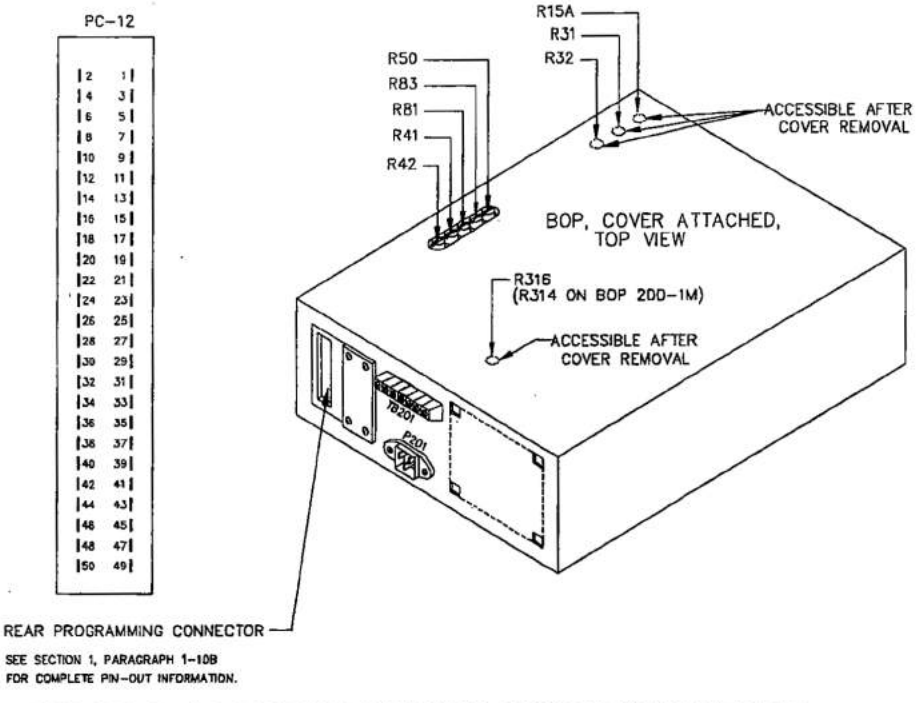
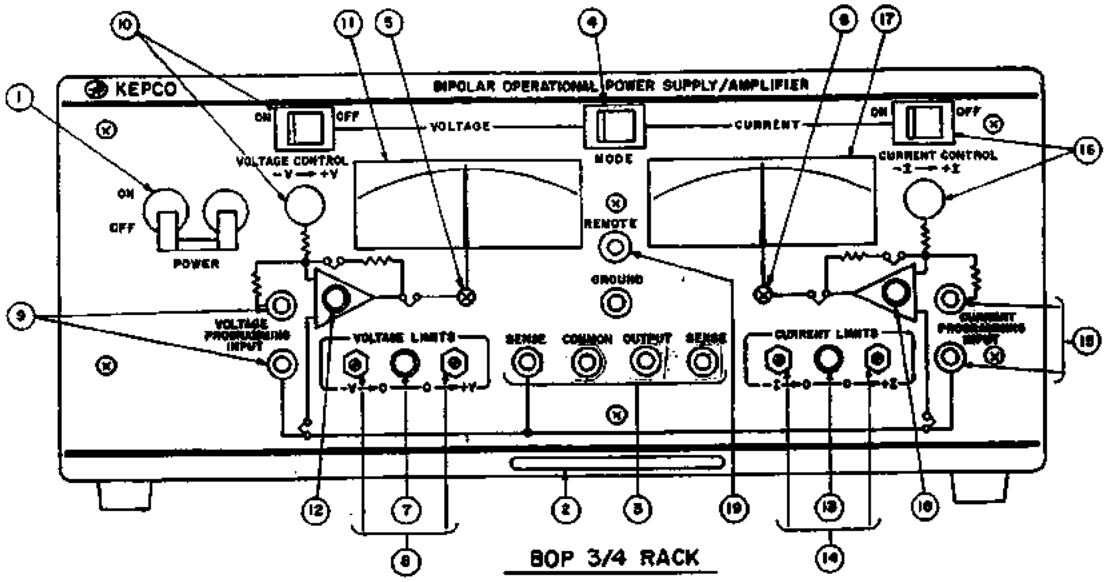
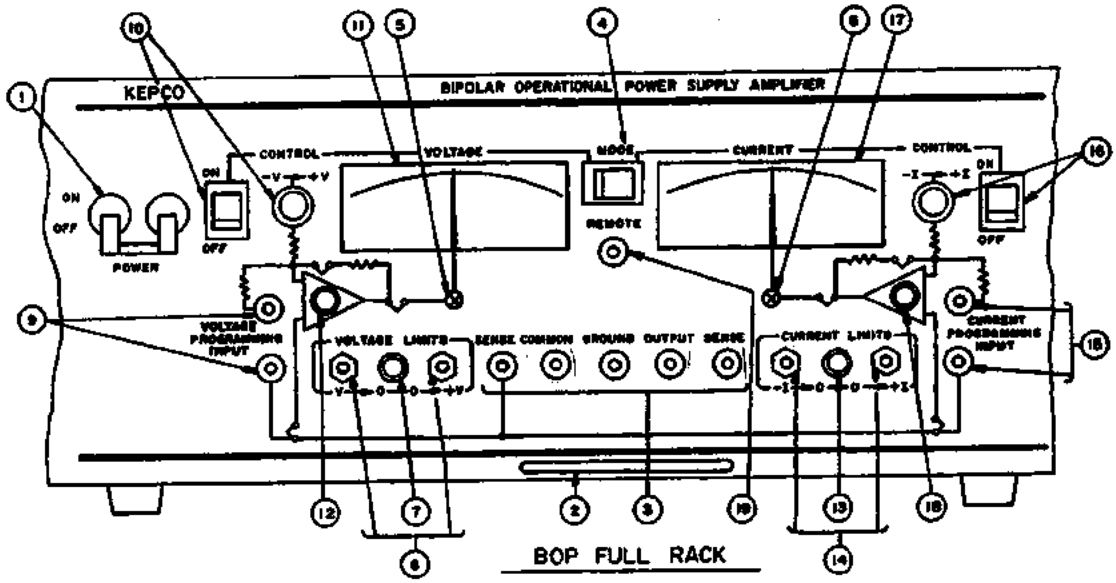


FIGURE 2-1. LOCATION OF INTERNAL CALIBRATION CONTROLS

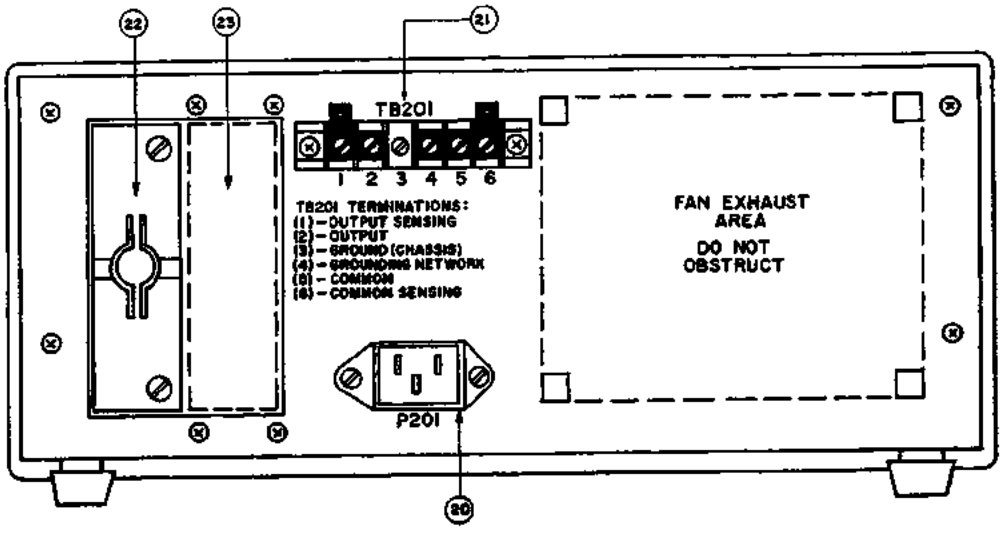


BOP 3/4 RACK



BOP FULL RACK

A) BOP FRONT TERMINATIONS AND CONTROLS



B) BOP REAR TERMINATIONS AND CONTROLS

FIG. 2-2 BOP TERMINATIONS AND CONTROLS

NO. (FRONT)	NAME OF CONTROL OR TERMINATION	FUNCTION
1	A-C POWER	A-C CIRCUIT BREAKER/POWER SWITCH.
2	N.A.	UNIT NAME PLATE
3	± OUTPUT COMMON, GROUND	OUTPUT AND SENSING TERMINALS WITH CHASSIS GROUND (PARALLEL WITH REAR BARRIER STRIP TERMINALS).
4	MODE	OPERATING MODE SELECTOR SWITCH FOR "VOLTAGE" OR "CURRENT" MODE.
5	N.A.	MECHANICAL VOLTMETER ZERO ADJUSTMENT.
6	N.A.	MECHANICAL CURRENT METER ZERO ADJUSTMENT.
7	VOLTAGE LIMIT	LED LAMP, INDICATING VOLTAGE LIMIT OPERATION.
8	± VOLTAGE LIMIT	CONTROLS FOR MANUAL ADJUSTMENT OF THE (±) VOLTAGE LIMITS.
9	INPUT	PROGRAMMING INPUT TERMINALS FOR VOLTAGE CONTROL CHANNEL.
10	VOLTAGE CONTROL	"ON-OFF" SWITCH AND VOLTAGE CONTROL, FOR MANUAL ADJUSTMENT OF THE BOP D-C OUTPUT VOLTAGE (WITH SWITCH "ON").
11	E_o METER	D-C OUTPUT VOLTMETER (READS ALSO AVERAGE A-C SIGNALS).
12	E_o MODE	LED LAMP, INDICATING VOLTAGE MODE OPERATION.
13	CURRENT LIMIT	LED LAMP, INDICATING CURRENT LIMITING OPERATION.
14	± CURRENT LIMIT	CONTROLS FOR MANUAL ADJUSTMENT OF THE (±) CURRENT LIMITS.
15	INPUT	PROGRAMMING INPUT TERMINALS FOR CURRENT CONTROL CHANNEL.
16	CURRENT CONTROL	"ON-OFF" SWITCH AND CURRENT CONTROL, FOR MANUAL ADJUSTMENT OF THE BOP D-C OUTPUT CURRENT (WITH SWITCH "ON").
17	I_o METER	D-C OUTPUT CURRENT METER (READS ALSO AVERAGE A-C SIGNALS).
18	I_o MODE	LED LAMP, INDICATING CURRENT MODE OPERATION.
19	REMOTE/LOCAL	LED LAMP, INDICATING BOP UNDER REMOTE CONTROL WHEN LIT.
NO. (REAR)		
20	P201	A-C POWER INPUT JACK. ACCEPTS 3-WIRE LINE CORD (SUPPLIED).
21	REAR TERMINALS (TB201)	REAR BARRIER STRIP WITH OUTPUT, SENSING AND GROUND TERMINALS.
22	PC-12	REAR PROGRAMMING CONNECTOR.
23	PC-12 FOR BIT-500 CARD OR SNO CABLE FOR BIT 488 CARD, OR 20-WIRE FLAT CABLE FOR PCA X-3 IF USED WITH TLD 488-16.	AUXILIARY (OPTIONAL) PROGRAMMING CONNECTOR.

TABLE 2-2 BOP TERMINATIONS AND CONTROLS

***NOTE:** Numbers correspond to those shown in FIG. 2-2.*

2-4 A-C INPUT REQUIREMENTS

2-5 This power supply is normally supplied for operation on a single phase, nominal 115V a-c line. For operation on other a-c source voltages, refer to FIG. 2-3. Check your prevailing nominal source voltage and change the links on the barrier strip of T201 according to the table provided in FIG. 2-3. The circuit breaker (CB101) remains equally effective at all input voltages.

A-C SOURCE	CONNECT LINKS
104V	(3)—(4), (7)—(8)
115V	(4)—(5), (6)—(7)
208V	(2)—(3), (8)—(9)
230V	(5)—(6)

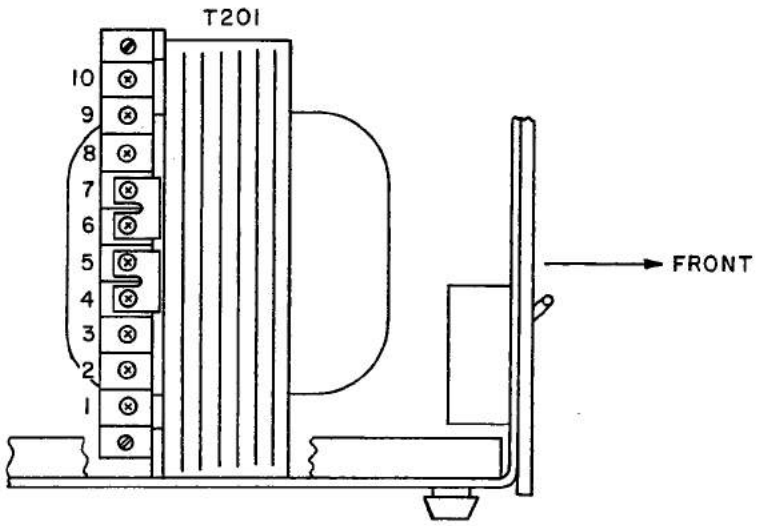


FIG. 2-3 A-C SOURCE VOLTAGE SELECTION.

2-6 COOLING

2-7 The components in the BOP power supply rely on forced air cooling for the maintenance of their operating temperature. SIDE PANEL OPENINGS AND THE TOP OF THE CASE MUST BE KEPT CLEAR FROM ALL OBSTRUCTIONS TO ENSURE AIR CIRCULATION. Periodic cleaning of the interior of the power supply is recommended. **If the BOP is rack-mounted or installed into confined spaces, care must be taken that the ambient temperature (the temperature immediately surrounding the power supply) does not rise above 55°C (≈ 157°F).**

2-8 PRELIMINARY CHECKOUT

NOTE: *THE REAR PROGRAMMING CONNECTOR (PC-12) MUST BE ATTACHED TO THE BOP AND MUST BE WIRED AS SHOWN ON THE SIMPLIFIED SCHEMATIC DIAGRAM, FIGURE 3-35, SECTION III.*

2-9 A simple operating check after unpacking and before permanent installation, is advisable to ascertain whether the BOP has suffered damage in shipment. *Refer to FIG. 2-2 and Table 2-2 FOR THE LOCATION AND DESIGNATION OF THE OPERATING CONTROLS AND TERMINALS. Proceed as follows:*

A) Connect the BOP to a 115V a-c source, or refer to paragraph 2-4 for conversion to other a-c input voltages if required.

B) ***Note:*** *The rear sensing links must be attached to the rear barrier strip (TB201) of the BOP as shown in FIG. 2-2 and the rear connector (PC-12) must be attached, wired for LOCAL CONTROL, and secured.*

C) Set the BOP front panel controls as follows (refer to FIG. 2-2). The controls will be identified here and in the following manual text with the nomenclature used in Table 2-2 and identifying numbers used in FIG. 2-2):

1) MODE switch (4), set to VOLTAGE.
2) VOLTAGE CONTROL (10), set SWITCH to "ON", VOLTAGE CONTROL to its extreme counterclockwise position.
3) A-C CIRCUIT BREAKER/POWER SWITCH (1) to "ON".

D) The "E_o MODE" Lamp (12) will be "on".

E) Turn the VOLTAGE CONTROL (10) clockwise through its range, while observing the front panel VOLTMETER (11). The BOP output voltage should smoothly respond, from the maximum negative output voltage, over zero, to the maximum positive output voltage of the BOP. Turn A-C CIRCUIT BREAKER/POWER SWITCH (1) "off".

F) Connect a short circuit between the (±) OUTPUT and the COMMON front panel output terminal (3). Set the BOP front panel controls as follows:

1) MODE SWITCH (4), set to "CURRENT".

2) CURRENT CONTROL (16), set SWITCH to "ON", CURRENT CONTROL to its maximum counterclockwise position.

3) A-C CIRCUIT BREAKER/POWER SWITCH (1) to "ON".

G) The "I_o MODE" Lamp (18) will be "on".

H) Turn the CURRENT CONTROL (16) clockwise through its range, while observing the front panel AMMETER (17). The BOP output current should smoothly respond, from the maximum negative output current, over zero, to the maximum positive ouput current of the BOP. Turn A-C CIRCUIT BREAKER/POWER SWITCH (1) "off". Remove the short circuit from the output terminals. THIS CONCLUDES THE PRELIMINARY CHECK-OUT OF THE BOP.

2-10 INSTALLATION FOR ¾ RACK BOP MODELS

2-11 These BOP models may be bench operated or installed in the RA-24 or RA-37 Rack Adaptors, as listed in Section I, Paragraph 1-13. Installation instructions are provided with the respective rack-adaptor models. For rack-mounting, or mounting onto any flat surface,the (4) bottom aluminum feet of the BOP must be removed. Four (4) plastic mounting inserts are provided on the bottom of the BOP chassis. See Section I, FIG. 1-4, "Mechanical Outline Drawing".

NOTE: *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 (55°C).*

2-12 INSTALLATION OF FULL-RACK BOP MODELS (Refer to Section I, Fig. 1-4 and to FIG. 2-4).

2-13 Full-rack BOP models are delivered with the FIXED ANGLE BRACKETS and the CHASSIS SIDE SUPPORT BARS installed. For bench operation, both of these components may be removed. The full-rack BOP unit may be installed into standard (19 inch) equipment racks, or onto any other flat surface. For installation, the four (4) bottom aluminum feet must be removed. If chassis slides are not used, the BOP may be installed onto any flat surface by means of the provided plastic mounting inserts on the bottom of the BOP chassis.

2-14 SLIDE INSTALLATION. The CHASSIS SLIDE SUPPORT BARS of the BOP are pre-drilled to accept JONATHAN SERIES 110 QD slides. The following slide models can be accomodated:

MODEL	MOUNTING HOLES USED				
	A	B	C	D	E
110 QD-20-2	X	X	0	X	DR
110 QD-22-2	X	0	X	0	X
110 QD-24-2	X	0	X	0	DR

KEY: X = HOLE USED, 0 = HOLE NOT USED, DR HOLE MUST BE DRILLED INTO CHASSIS PART OF SLIDE, EACH SIDE 0.199 DIA., 16¼" FROM "A" HOLE.

2-15 PROCEDURE (Refer to FIG. 2-4):

1) REMOVE SCREWS "A" through "E" from left and right CHASSIS SLIDE SUPPORT BARS. (Do not discard).
2) Determine the required hole-pattern for the selected slide model from the table.
3) Drill the "E" hole into both, left and right chassis section of slide if required.
4) Mount the chassis section of the slide to the left and right side of the BOP, as shown in FIG. 2-4. Use the same 10-32 x ½" Mounting Screws which you removed in step (1).

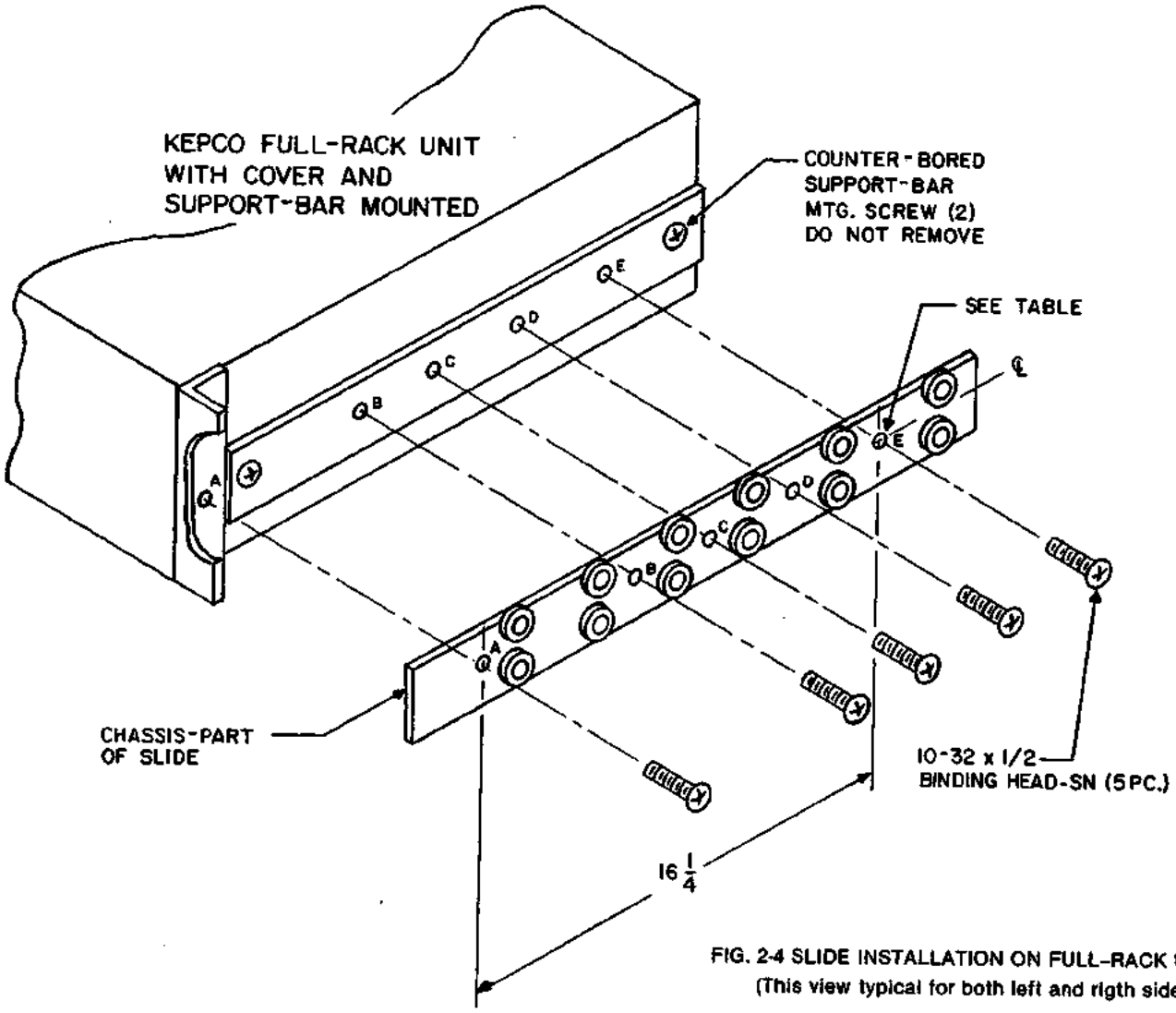


FIG. 2-4 SLIDE INSTALLATION ON FULL-RACK UNITS
(This view typical for both left and rigth side)

***NOTE:** If slide installation (as described above) is not desired, other means of supporting the unit in the rear must be provided (additional rear brackets or a solid platform, for example) since the front angle brackets alone are not sufficient to support the full weight of the unit.*

SECTION III—OPERATION

3-1 INTRODUCTION

3-2 BOP BIPOLAR OPERATIONAL POWER SUPPLIES can be used in a great variety of applications. As a PRECISION VOLTAGE or CURRENT SOURCE, the BOP output can be controlled locally by means of the front panel bipolar VOLTAGE and CURRENT controls or remotely by means of resistance or by voltage signals. Independently adjustable or remotely programmable limit circuits for both output voltage and output current protect a sensitive load from any overvoltage or overcurrent. As a BIPOLAR AMPLIFIER, the BOP output responds for example to such input signals as sine, square or triangular waves. A (±) 10 volt input signal will program the BOP output (voltage or current) through its rated output ranges. Built-in preamplifiers, for the voltage, as well as the current channel of the BOP, permit amplification of the control signals to the required amplitude and provide the interface with high as well as low impedance signal sources.

3-3 Detailed examples of the more popular applications are described in the following paragraphs. Before actual operation, however, the following general comments on the operation of the BOP should be carefully considered:

SAFETY PRECAUTIONS

1) Exercise care in making all connections to and from the BOP terminals. REMOVE A-C POWER FROM THE BOP BEFORE MAKING ANY CONNECTIONS.
2) Wires and/or cables, connected from the BOP terminals to external components or programming devices must be properly insulated and securely terminated on both sides to make accidental touch impossible. DO NOT USE BANANA PLUGS WITH EXPOSED SCREWS OR OTHER EXPOSED METAL PARTS AT THE FRONT PANEL OUTPUT TERMINALS!
3) The BOP chassis and cover must be safety-grounded to a reliable a-c source ground. A safety-ground may be established by using a grounded a-c power outlet or, if the latter is not available, by means of a separate wire, from the provided "ground" terminal to a reliable a-c source ground point.
4) THE COMMON OUTPUT TERMINAL OF THE BOP SHOULD BE SIGNAL GROUNDED. If for any reason, grounding of the output is not possible, additional precautions must be taken to make any access to the isolated output impossible.

A) DIAGRAMS. Application and test set up diagrams on the following pages show the symbolic and simplified representation of the BOP circuitry in four (4) separate diagrams, as indicated in FIG. 3-1. The diagrams represent the four programmable circuits of the BOP.

FIG. 3-1A: Voltage Control Channel.

FIG. 3-1B: Current Control Channel.

FIG. 3-1C: (±)E_o Limit Circuits.

FIG. 3-1D: (±)I_o Limit Circuits.

The ***complete*** simplified diagram is represented in the fold-out page at the end of Section IV. THE FOUR CIRCUITS CAN BE PROGRAMMED SEPARATELY AS DESCRIBED IN THE EXAMPLES IN THIS SECTION, OR THEY CAN BE USED SIMULTANEOUSLY AS THE APPLICATION REQUIRES, WITH THE EXCEPTION OF THE TWO (2) MAIN BIPOLAR VOLTAGE AND CURRENT CHANNELS WHICH ARE MANUALLY SELECTED BY THE FRONT PANEL MODE SWITCH OR REMOTELY BY TTL SIGNALS AND CANNOT BE OPERATED SIMULTANEOUSLY.

The numbered terminals in the diagrams correspond to the connector terminals on the REAR PROGRAMMING CONNECTOR. **The terminal designated C corresponds to pin numbers 23,25,27,29,31 or 33 on PC-12.**

NOTE: *BOP's have front and rear output terminals. Only the front terminals are shown on all subsequent simplified diagrams.*

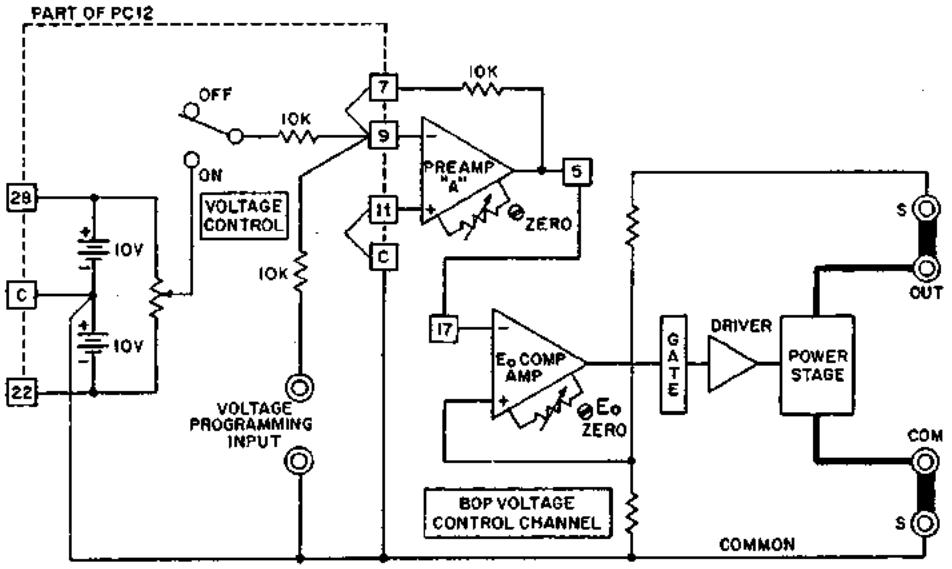


FIG. 3-1A BOP VOLTAGE CONTROL CHANNEL

NOTE: *Mode Switch position: "VOLTAGE".*

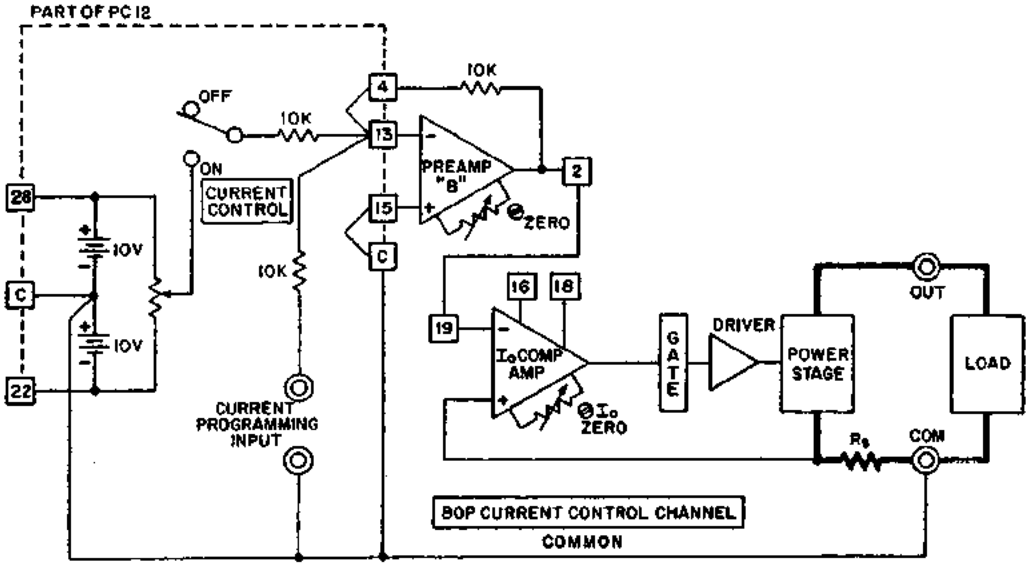


FIG. 3-1B BOP CURRENT CONTROL CHANNEL

NOTES: *1) Mode Switch position: "CURRENT".*

2) For inductive loads in excess of 0.5 mHy, the BOP output response may be optimized by placing a capacitor across terminals 16 and 18 of the I_o COMP. AMP.

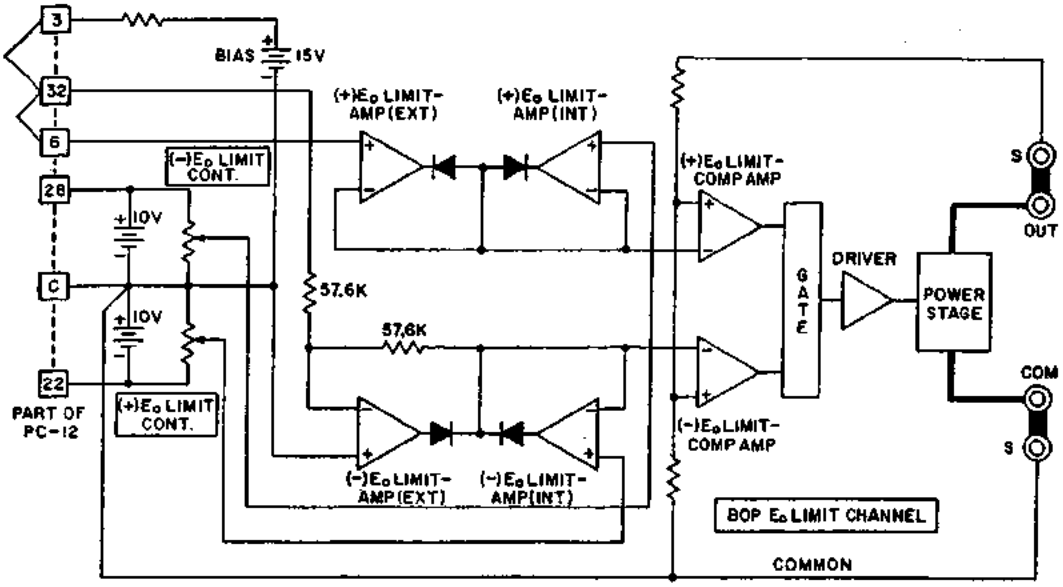


FIG. 3-1C BOP (±) VOLTAGE LIMITING CIRCUIT

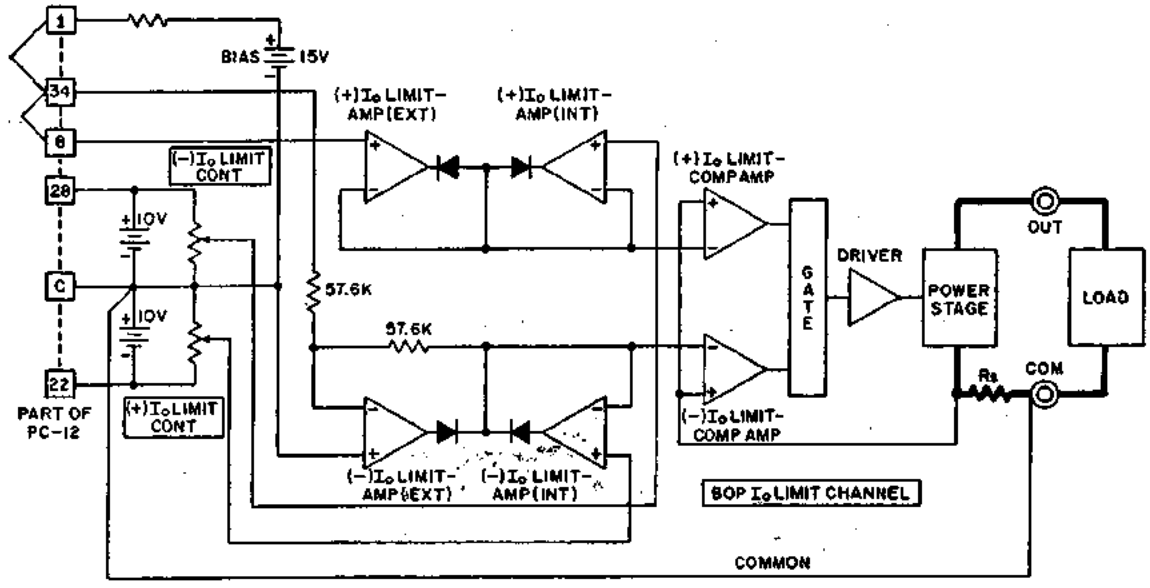


FIG. 3-1D BOP (±) CURRENT LIMITING CIRCUIT

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