

QUICK START GUIDE



KEPCO An ISO 9001 Company.

BOP
2X-DG SERIES



BIPOLAR 2X-DG SERIES DUAL CHANNEL OPERATIONAL POWER SUPPLY

I — INTRODUCTION

1.1. SCOPE OF MANUAL. This Quick Start Guide covers simple installation and local operation of the Kepco BOP 2X-DG Series Dual Channel Bipolar Operational Power Supply, hereafter referred to as BOP 2X-DG. Complete specifications, features and instructions are found in the full BOP 2X-DG Series Operator Manual that can be downloaded free from the Kepco web site at:

www.kepcopower.com/support/opman1s.htm#bop-op

For a complete description of the GPIB/RS 232 interface installed in each channel of the BOP 2X-DG, refer to the BIT 4886 Operator Manual which can be downloaded free from the Kepco web site at:

www.kepcopower.com/support/opman1s.htm#bit

1.2. DESCRIPTION.

Kepco's Series BOP 2X-DG dual-channel BOP models are 200W and 400W power supplies. Each channel is a separate power supply, completely isolated, independent and functionally identical. The 200W units have two 100W channels and the 400W units have two 200W channels. The channels are completely isolated, but share two digital front panel meters (without affecting isolation) which display d-c output voltage and current for the channel selected by the front panel Channel select switch. A single power cord powers both channels; separate on-off circuit breakers turn each channel on/off separately.

Each BOP 2X-DG channel is a linear stabilizer with two bipolar control loops (voltage or current mode), selectable and individually controllable by remote signals applied to the PC 15 programming connector at the rear panel. These two principal control loops are each protected by bipolar limit circuits. The positive and negative current or voltage limit points can be remotely programmed simultaneously or Individually. Automatic crossover between each principal control loop and the limit loops is provided. Only one principle loop (voltage or current) can control the output at any one time.

Each channel can operate automatically in all four voltage-current quadrants; it can act as either a source (output voltage is the same polarity as output current) or a sink (output voltage is opposite the polarity of output current). An example is shown in Figure 1 where the BOP channel is programmed to deliver a sine wave output and the load

produces a phase shift between the output voltage and current. See BOP 2X-DG Series Operator Manual (PAR. 1.1) for limits on long-term operation in sink mode.

Remote On-Off Feature. A remote on-off feature provides isolated remote on-off control of the output; an associated flag signal is configured at the PC 15 programming connector.

Units are shipped for 115V a-c operation (105V to 125V a-c), 57 to 63Hz. For operation at 104V a-c, 208V a-c or 230V a-c refer to the full Operator Manual (PAR 1.1).

GPIB OPERATION. The BOP 2X-DG includes a GPIB interface that accepts IEEE 488 digital data bus information from a computer in the form of SCPI commands which then independently controls the output of either channel as determined by the GPIB address.

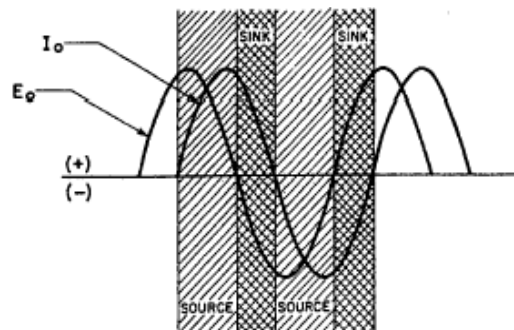


FIGURE 1. SINK OPERATION PRODUCED BY LOAD PHASE SHIFT

1.3. OPTIONS. Models optimized to operate in current mode with large inductive loads are identified by suffix L. Models optimized to operate in voltage mode with large capacitive loads are identified by suffix C.

1.4. EQUIPMENT SUPPLIED.

- Two PC 15 programming connectors. One PC 15 programming connectors **MUST be** installed at the rear panel of each channel to enable operation.
- 115V a-c Line Cord NEMA 5-15P-C13

1.5. ACCESSORIES (NOT SUPPLIED)

- KIT 219-0630 - USB interface capability (1 per channel required)
- Slides

II — SAFETY.

Exercise care in making all connections to and from the BOP terminals.



WARNINGS

1. Remove a-c power from the BOP 2X-DG 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.
3. The BOP 2X-DG 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 GND terminal of the rear panel terminal block to a reliable a-c source ground point.
4. THE COM OUTPUT TERMINALS OF THE BOP 2X-DG MAY EITHER FLOAT OR BE GROUNDED. Leave the output terminal floating when an externally grounded device is used at either the programming input or the output, or for a grounded load. For noise reduction ground a single return terminal on either the programming device, the BOP or the load configuration. See "D-C Signal Ground." on page 4 for the maximum allowable floating voltage for the output terminals.

III — INSTALLATION

3.1. UNPACKING. The power supply 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 Checkout (PAR. 3.5). If any indication of damage is found, file an immediate claim with the responsible transport service.

3.2. STARTUP DEFAULT. The Device Address (GPIB address) for the each channel is set by means of DIP switches CH1S1 and CH2S1, positions 1 through 5 (Figure 1) which can be accessed through the top cover of the BOP. CH1S1 is factory preset to address 6 (channel 1). CH2S1 is factory preset to address 7 (channel 2). If a different Device Address is required in your system, there are 30 (1-30) possible choices (see Table 1).

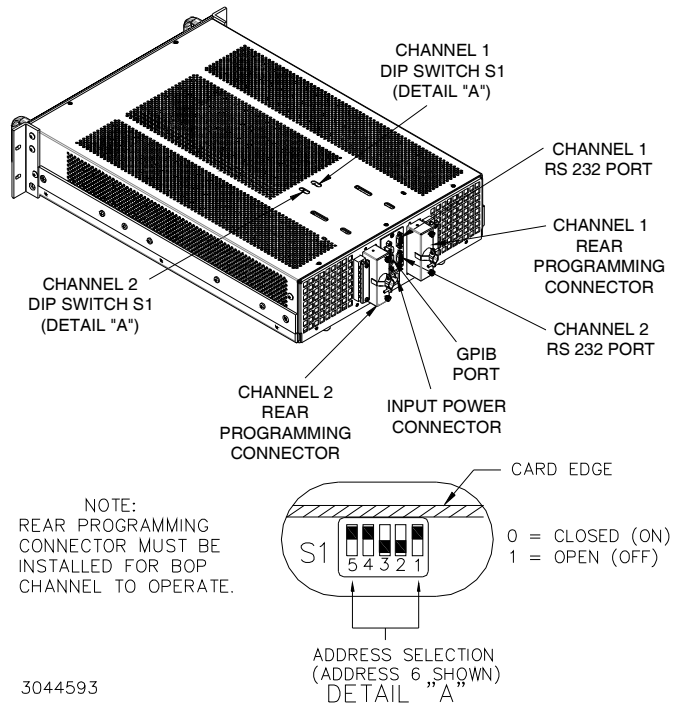


FIGURE 2. SETTING THE GPIB ADDRESS

TABLE 1. DEVICE ADDRESS SELECTION

DECIMAL ADDRESS	SELECTOR SWITCH S1 SECTION (SIGNAL LINE)				
	A5	A4	A3	A2	A1
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16	1	0	0	0	0
17	1	0	0	0	1

TABLE 1. DEVICE ADDRESS SELECTION (CONT'D)

DECIMAL ADDRESS	SELECTOR SWITCH S1 SECTION (SIGNAL LINE)				
	A5	A4	A3	A2	A1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1
24	1	1	0	0	0
25	1	1	0	0	1
26	1	1	0	1	0
27	1	1	0	1	1
28	1	1	1	0	0
29	1	1	1	0	1
30	1	1	1	1	0

NOTE:

0 = CLOSED (ON) (Towards printed circuit board)
 1 = OPEN (OFF) (Away from printed circuit board)

3.3. GPIB CONNECTION.

Connect BOP to the GPIB bus using a standard GPIB cable connected to the 24-pin GPIB connector at the rear panel (see Figure 5). **CAUTION: Ensure the GPIB addresses are different for the two channels.** Address 6 (default) connects to channel 1, address 7 (default) connect to channel 2.

3.4. RS 232 CONNECTION.

From the BOP RS 232 port (see Figure 5 and Table 5) use either a standard RS 232 cable to connect to any RS-232 computer port or use a standard RS 232-to-USB cable to connect to a USB port of a Windows computer. A USB adapter (Kepco P/N 118-1394) is provided as an accessory in KIT 219-0630 (1 per channel required) along with installation instructions. Note that the RJ45 patch cord and RJ45 to DB9 adapter mentioned in the KIT are inside the BOP 2X-DG series; ignore KIT installation instructions referring to these items. Instructions for KIT 219-0630 can be downloaded from the Kepco web site at:

www.kepcopower.com/support/opmanls.htm#0630

The GPIB address controls the baud rate: 1 or 9 selects 19200, 3 or 11 selects 38400, all other addresses select 9600 (default).

3.5. CHECKOUT PROCEDURE.

1. Connect BOP channel 1 or 2 to either: GPIB bus (see PAR 3.3) or an external RS-232 controller (see {PAR 3.4).
2. Apply power to BOP channel. The BOP will beep for less than 1 second, then will be ready for use.
3. Send the ***IDN?** query to channel 2 via either the GPIB or RS 232 port.

For BOP 2X20-10DG channel 1 as an example, verify that the unit responds with **KEPCO,BIT 4886 20-10,E1233456A 11/10/98,1.81-1.81**. Channel 2 responds with **KEPCO,BIT 4886 20-10,E1233456B 11/10/98,1.81-1.81**.

4. Send **VOLT?** Verify that unit responds with **0** (indicating voltage is set to 0, the power-up condition).
5. Send **OUTPUT ON;VOLT MAX**. Verify that the BOP power supply provides maximum output voltage (e.g., 20V d-c. for BOP 2X20-10DG).
6. Send **FUNC:MODE CURR**. Verify that BOP front panel current LED lights.
7. Send **FUNC:MODE VOLT**. Verify that BOP front panel voltage LED lights.
8. Send ***TST?** and verify response is 0. This verifies the bit 4886 microprocessor is operating correctly.
9. With no load connected, send **DIAG:TST?** and verify response is 0. **CAUTION:** This test swings the output to Volt Max and Volt Min at full power. If a Load is connected, damage to the load may occur, or the test may fail due to the load effect on unit output voltage

3.6. INSTALLING THE POWER SUPPLY. These models are shipped with fixed angle brackets and chassis slide support bars installed and are ready for mounting in a 19-inch rack.

3.7. CONNECTIONS. Connections to the load are made using the rear panel terminations.

LOAD CONNECTIONS. Connect the load between OUT (output) and COM (common) terminals at the rear panel. **Sense connections are required; otherwise the unit will not operate properly.**

LOCAL SENSE CONNECTIONS. For local sensing the OUT and COM terminals are connected to the adjacent S (sense) terminals. The unit is shipped with local sensing links in place at the rear panel.

REMOTE SENSE CONNECTIONS. Remote sensing (connecting the corresponding S terminals to the OUT and COM terminations at the load instead of at the BOP) can compensate for load wire losses up to 0.5V per wire (0.25V per wire on models with rated output less than 20V). Remote sensing is recommended for minimum load effect in voltage mode for a remote load. Use twisted pairs: #22 AWG for output sense lines and wires rated for the nominal output current of the power supply for power leads. See full Operator Manual (see PAR. 1.1) for remote sensing requirements.

GROUNDING NETWORK. The unit is shipped with a link installed between GND NET and GND terminals at the rear panel to enable the Grounding Network. This network reduces noise/ripple that may be present at the output when the output is not grounded.

INPUT A-C CONNECTIONS. Install the line cord (supplied) at the rear panel and connect to 115V a-c, 60Hz (105V to 125V a-c, 47 to 63Hz) mains. For operation at 104V a-c, 208V a-c or 230V a-c refer to the full Operator Manual (see PAR 1.1).

A-C GROUND. The 3-wire line cord with 3-prong safety plug (supplied), in combination with a properly grounded a-c power outlet, automatically grounds the BOP 2X-DG case. If an adapter for a non-grounded outlet is used, the case must be grounded separately using the GND terminal at the rear panel terminal block. The ground wire must be rated for at least the BOP input current (as noted on nameplate at rear of unit).

D-C SIGNAL GROUND. Specified ripple and noise figures for BOP power supplies are valid only with the COM side of the output load circuit returned to a ground point. The BOP circuits, including output and programming terminals, have no d-c connection to the chassis.

Each output terminal of each BOP channel can be “floated” up to 250 volts (d-c or peak) off chassis ground. The common mode current (leakage from output to ground) is less than 50 μ A (rms) or 5 mA (p-p) at 115V a-c, 60 Hz power input. To avoid common mode current from affecting the BOP output, the system (including the programming device, if used, load, and BOP) can have a single connection to ground (earth ground). The d-c ground wire must be rated for the nominal output current of the BOP (e.g., for BOP 20-10D, use rating of 10A).

Multiple signal grounds in the system may cause “ground-loop” and instability problems, since noise signals develop across the impedances between the multiple ground points. The exact physical location of the “best” single ground point must be carefully selected for minimum ripple/noise output and to avoid the possibility of output current flowing through the return path of an external programming signal.

REAR PROGRAMMING CONNECTOR, PC 15. Control of each channel is via the associated rear panel programming connector. (See Figures 3, 4, and 6). Table 2 lists the functions of each terminal. For more details, refer to the BOP 2X-DG Operator Manual (see PAR. 1.1).

TABLE 2. REAR PROGRAMMING CONNECTOR TERMINAL FUNCTIONS

TERMINAL (Figure 4)	FUNCTION
1	Current Limit Reference
3	Voltage Limit Reference
15 13 2 4	<p>Preamp “B”</p>
11 9 5 7	<p>Preamp “A”</p>
6	+E _O Limit Input
8	+I _O Limit Input
32	-E _O Limit Input
34	-I _O Limit Input
10	Current Monitoring
20	Voltage Monitoring
12, 14	Voltage Mode Compensating Terminals
16, 18	Current Mode Compensating Terminals
17	Voltage Comparison Amp Input
19	Current Comparison Amp Input
21	On-off Controlling Logic
22	-10V Reference Voltage 4mA Max
28	+10V Reference Voltage 4mA Max
23, 25, 27, 29, 31, 33	Sensing Common
24	Circuit Breaker Control
26, 36	Turn-off Signal Output
30	Voltage Mode/Current Mode control
35	Local/Remote control
37	+5V
38	I _O Limit Flag
39	E _O Limit Flag
40	E _O Mode Flag

**TABLE 2. REAR PROGRAMMING CONNECTOR
TERMINAL FUNCTIONS (CONT'D)**

TERMINAL (Figure 4)	FUNCTION
42	I _O Mode Flag
41	Non-isolated Turn-off Signal Input
43, 44, 45	Not Used.
46	/ON-OFF_FLAG
47, 49	Optically Isolated Turn-off Signal Input
48	ISO_GND
50	ON-OFF_CTRL

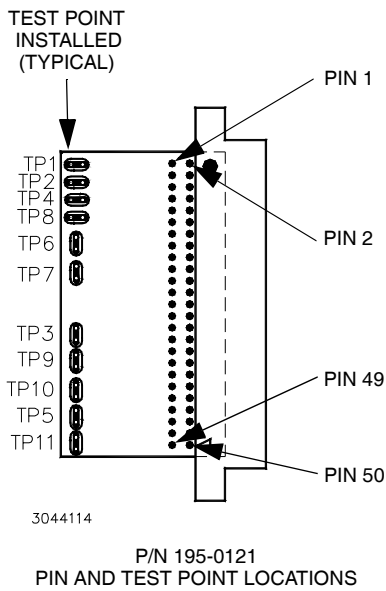


FIGURE 3. REAR PROGRAMMING CONNECTOR, PIN AND TEST POINT LOCATIONS

3.8. COOLING. The components in the BOP 2X-DG power supply rely on forced air cooling. FRONT AND REAR 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 2X-DG 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 (~131°F).

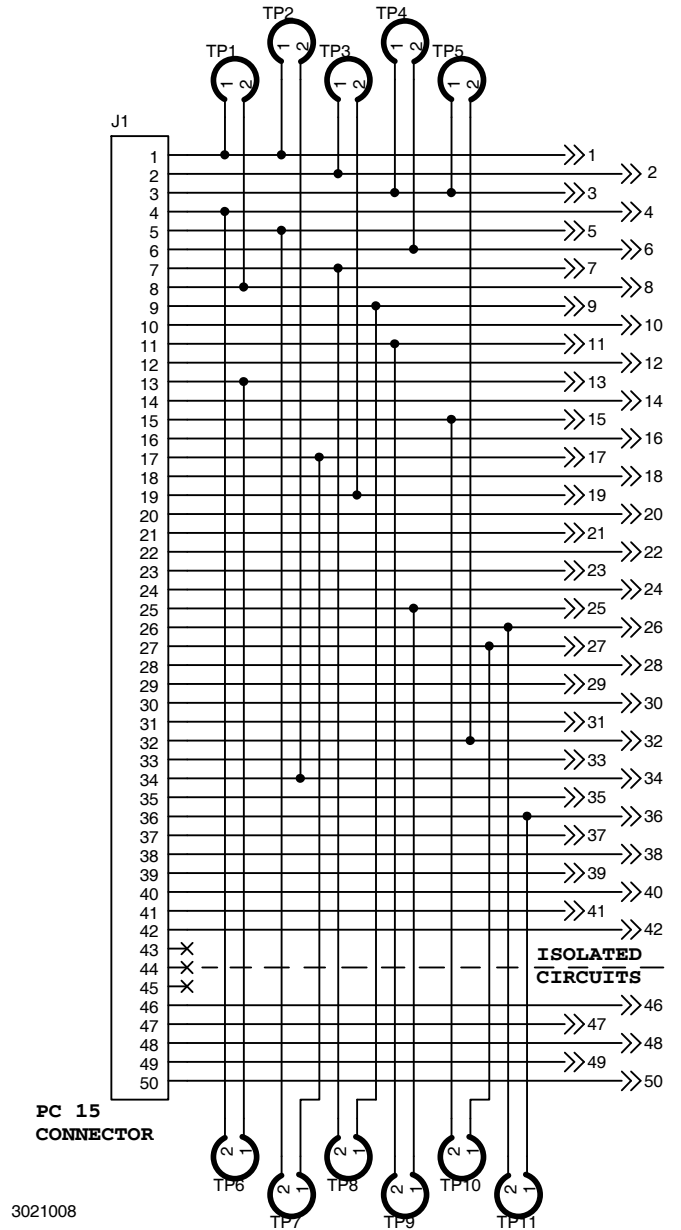


FIGURE 4. REAR PROGRAMMING CONNECTOR, WIRING DIAGRAM

IV — OPERATION

Each BOP channel can now be controlled via either the RS 232 or GPIB ports using IEEE 488 and SCPI commands. The applicable commands and queries are listed in Table 3 and 4, respectively. For a full description of all commands as well as remote programming information, refer to the BIT 4886 Operator Manual (see PAR. 1.1)

TABLE 3. IEEE 488.2 COMMANDS/QUERIES

COMMAND	Function
*CLS	Clear Status Command - clears status data.
*ESE, ?	Standard Event Status Enable Command programs Standard Event Status Enable register, Query returns register mask.
*ESR?	Event Status Register Query returns register contents, then clears register.
*IDN?	Identification Query returns identification character string.
*OPC, ?	Operation Complete Command causes power supply to set status bit 0 (Operation Complete) when pending operations are complete When Query returns "1" operations are complete.
*OPT?	Options Query lists option functionality.
*RCL	Recall Command restores power supply to previously saved settings.
*RST	Rest Command resets power supply to power on default state.
*SAV	Save Command saves present power supply settings for later recall.
*SRE, ?	Service Request Enable Command sets the condition of Service Request Enable register. Query reads register.
*STB	Status Byte Register Query reads Status Byte Register without clearing it.
*TRG	Trigger Command triggers power supply to preprogrammed values of output current and voltage.
*TST?	Self Test Query Initiates power supply self test.
*WAI	Wait-To-Continue Command requires completion of previously issued commands and queries before continuing.

TABLE 4. SCPI COMMANDS/QUERIES

COMMAND	Function
INIT[:IMM]	INITiate[:IMMEDIATE] Command enables a single trigger.
INIT:CONT, ?	INITiate:CONTinuous Command enables/disables continuous triggers; query shows trigger enabled/disabled status.
MEAS:CURREN?	MEASure[:SCALAR]:CURRENt[:DC]? Query measures actual current.
MEAS:VOLT?	MEASure[:SCALAR]:VOLTage[:DC]? Query measures actual voltage.
OUTP, ?	OUTPut[:STATe] Command enables (1 or ON) or disables (0 or OFF) the power supply output. Query shows if output is on (1) or off (0).
FUNC:MODE, ?	[SOURce:]FUNCTION:MODE Command establishes operating mode of power supply VOLT = voltage, CURREN = current. Query shows mode.
FUNC:MODE :TRIG, ?	[SOURce:]FUNCTION:MODE:TRIGger establishes operating mode of power supply when TRIGger command is sent. Query returns mode programmed.
LIST:CLEAR	[SOURce:]LIST:CLEAR Command Clears all list entries by setting all pointers to 0.
LIST:COUN, ?	SOURce:]LIST:COUNt Command establishes how many times the list is executed. Query shows programmed setting.
LIST:COUN :SKIP	[SOURce:]LIST:COUNt:SKIP Command allows beginning steps of list-generated waveform to be run once, then ignored. Query shows how many steps to skip after the first time.
LIST:CURREN?	SOURce:]LIST:CURRENt Command adds current value (in Amps) to list. Query identifies parameters (main channel) entered for list.
LIST:CURREN :POIN?	[SOURce:]LIST:CURRENt:POINt? Query identifies the total number of points in a list and next location to be filled.
LIST:DIR, ?	[SOURce:]LIST:DIRection Command establishes which direction to run list. Query shows programmed direction.
LIST:DWEL, ?	[SOURce:]LIST:DWELI Command determines how long the main channel parameters will be active. Query shows programmed dwell times.
LIST:DWEL :POIN?	[SOURce:]LIST:DWELI:POINt? Query identifies number of locations with dwell times.
LIST:GEN, ?	[SOURce:]LIST:GENeration Command establishes the order for executing the list. Query shows selection of either default or user sequence.
LIST:QUER, ?	[SOURce:]LIST:QUERy Command determines first location to be queried by LIST:SEQ?; Query shows programmed location.
LIST:MODE, ?	[SOURce:]LIST:MODE Command determines dwell time resolution SLOW (default) or FAST. Query shows mode.

TABLE 4. SCPI COMMANDS/QUERIES (CONT'D)

COMMAND	Function
LIST:SEQ, ?	[SOURce:]LIST:SEQuence Command determines execution order for list data points (not recommended for new designs). Query shows user execution sequence for list.
LIST:VOLT, ?	SOURce:]LIST:VOLTage Command adds voltage value (in Volts) to list. Query identifies parameters (main channel) entered for list.
LIST:VOLT :POIN?	SOURce:]LIST:VOLTage:POINts? Query identifies total number of points in a list.
CURR, ?	SOURce:]CURRent[:LEVel][:IMMEDIATE][:AMPLitude] Command programs output current (actual current depends on load). Query shows programmed current or maximum/minimum current allowed.
CURR:MODE, ?	SOURce:]CURRent:MODE Command allows user to execute (LIST) or stop (FIX) a list, or to execute a transient (TRAN). Query identifies active current mode.
CURR:RANG, ?	[SOURce:]CURRent[:LEVel]RANGe Command sets output current range, 1 = full scale, 4 = 1/4 scale. Query shows programmed current range.
CURR:RANG :AUTO	[SOURce:]CURRent[:LEVel]RANGe:AUTO Command sets current range to automatic.
CURR:TRIG, ?	SOURce:]CURRent[:LEVel]TRIGgered[:AMPLitude] Command programs current value of trigger. Query shows programmed value.
VOLT, ?	[SOURce:]VOLTage[:LEVel][:IMMEDIATE][:AMPLitude] Command programs output voltage (actual voltage depends on load). Query returns programmed value.
VOLT:MODE	SOURce:]VOLTage:MODE Command allows user to execute (LIST) or stop (FIX) a list, or to execute a transient (TRAN). Query identifies active voltage mode.
VOLT:RANG, ?	[SOURce:]VOLTage[:LEVel]RANGe Command sets output voltage range, 1 = full scale, 4 = 1/4 scale. Query shows programmed voltage range.
VOLT:RANG :AUTO	[SOURce:]VOLTage[:LEVel]RANGe:AUTO Command sets voltage range to automatic.
VOLT:TRIG, ?	SOURce:]VOLTage[:LEVel]TRIGgered[:AMPLitude] Command programs voltage value of trigger. Query shows programmed value.
STAT:OPER :COND?	STATus:OPERation:CONDition Query returns value of the Operation Condition Register.
STAT:OPER :ENAB	STATus:OPERation:ENABle Command sets Operation Enable Register mask. Query reads register.
STAT:OPER?	STATus:OPERation[:EVENT] Query returns the value of the Operation Event register.
STAT:PRES	STATus:PRESet Command disables reporting of all status events.
STAT:QUES?	STATus:QUESTionable[:EVENT]? Query returns value of Questionable Event register.

TABLE 4. SCPI COMMANDS/QUERIES (CONT'D)

COMMAND	Function
STAT:QUES :COND?	STATus:QUESTionable:CONDition? Query returns value of Questionable Condition Register.
STAT:QUES :ENAB, ?	STATus:QUESTionable:ENABle Command programs Questionable Condition Enable register. Query reads register.
SYST:BEEP	SYSTem:BEEP Command causes the unit to emit a brief audible tone.
SYST:COMM :SER:ECHO, ?	SYSTem:COMMunication:SERial:ECHO Command enables (ON) or disables (OFF) echo mode. Query indicates if echo is on or off.
SYST:COMM :SER:PACE, ?	SYSTem:COMMunication:SERial:PACE Command enables (XON) or disables (NONE) data flow control via the serial interface. Query shows enabled or disabled.
SYST:ERR?	SYSTem:ERRor? Query posts error messages to the output queue.
SYST:ERR :CODE?	SYSTem:ERRor:CODE? Query returns 3-character error code without the ASCII definition string.
SYST:ERR :CODE:ALL?	SYSTem:ERRor:CODE:ALL? Query returns a comma-separated list of all error codes.
SYST:PASS :CEN	SYSTem:PASSword:CENable Command Sets password enable if password matches.
SYST:PASS :CDIS	SYSTem:PASSword:CDISable Command disables password access if password matches.
SYST:PASS :NEW	SYSTem:PASSword:NEW Command establishes new password.
SYST:PASS :STAT?	SYSTem:PASSword:STATe? Query shows password state: enabled (1) or disabled (0).
SYST:REM,	SYSTem:REMote Command sets unit to remote (1 or ON) or local (0 or OFF) mode if using RS 232. Query shows programmed mode.
SYST:SEC:IMM	SYSTem:SECurity:IMMEDIATE Command initializes all NVRAM variables to factory defaults.
SYST:SET, ?	SYSTem:SET Command establishes Device Clear, Line Feed, and Reset functions. Query shows programmed functions.
SYST:VERS?	SYSTem:VERSion? Query identifies SCPI Version implemented.

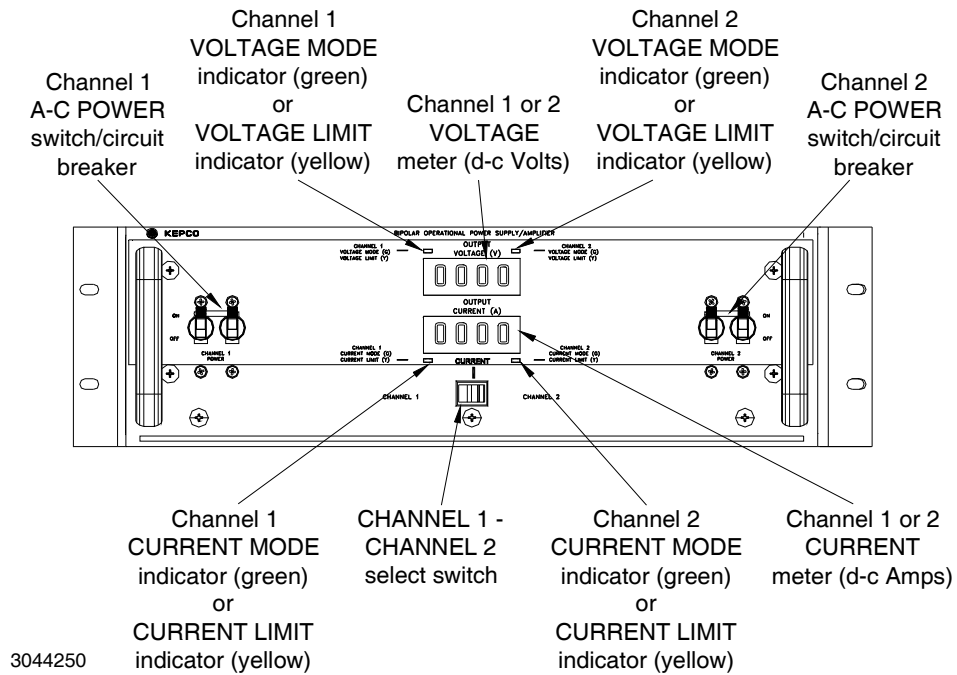


FIGURE 5. BOP 2X-DG SERIES, FRONT PANEL CONTROLS AND INDICATORS

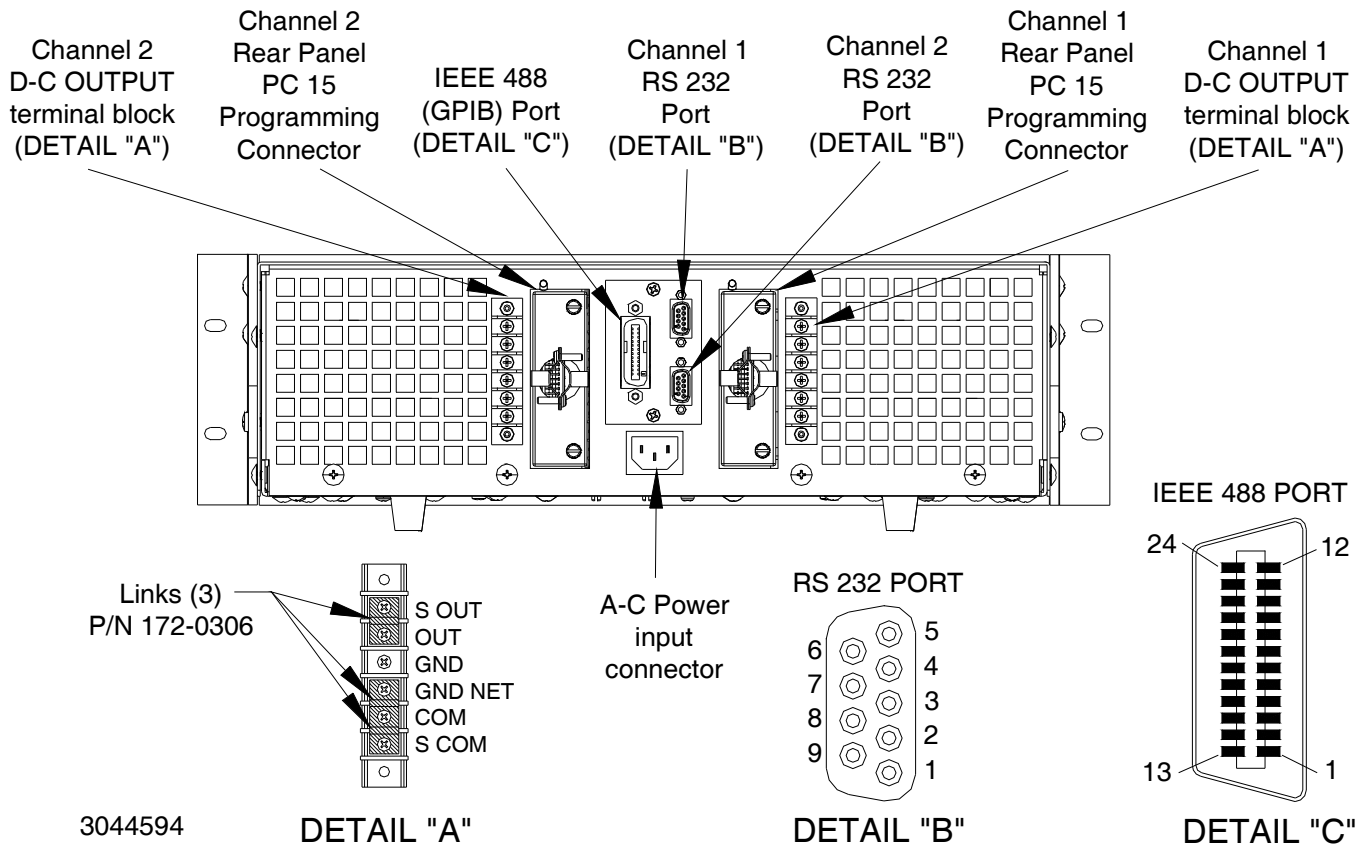


FIGURE 6. BOP 2X-DG SERIES REAR PANEL TERMINATIONS

4.1. ADDITIONAL FEATURES. The following features of the BOP 2X-DG power supply are covered in the full BOP 2X-DG Operator Manual (see PAR. 1.1).

- BOP Channel Operation with Remote Control of the Voltage Control Channel
- BOP Channel Operation with Remote Control of the Current Control Channel
- Using a BOP Channel as an Amplifier
- Remote Control of a BOP Channel Current Limit
- Remote Control of a BOP Channel Voltage Limit
- Series and Parallel Connection of BOP Channels
- Remote On-Off Control.

The following additional features are covered in the BIT 4886 Operator Manual (see PAR. 1.1).

- Programming an Output channel via the GPIB interface.
- Calibration of an Output channel via the GPIB interface.

TABLE 5. RS 232 DB9 PIN FUNCTIONS

DB9 Pin	Purpose
5	Return for pins 2 and 3.
3	Carries data from the Kepco power supply to the controller.
2	Carries data from the controller to the Kepco power supply.

