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THE POWER SUPPLIER™
SINCE 1946

146-1971b

KEPCO'S BOP FAMILY OF FOUR QUADRANT BIPOLAR POWER SUPPLIES/ AMPLIFIERS

BOP 100W, 200W and 400W (Linear)

D MODELS: Standard - Digital Meter
100W Models: 5V, 20V, 50V, 100V
200W Models: 5V, 20V, 36V, 50V, 72V. 100V, 200V
400W Models: 20V, 36V, 50V, 72V. 100V

L MODELS: Optimized for Inductive Loads
C MODELS: Optimized for Capacitive Loads
-4886 MODELS: GPIB Control
-802E MODELS: LAN/Ethernet Control

BOP 40W High Voltage (Linear)

500V, 1000V

BOP High Power (Switch Mode)

1KW, 2KW, 3KW, 4KW, 5KW MG MODELS: Standard
GPIB, RS 232: 6V, 10V, 20V, 25V, 36V, 50V, 72V, 100V

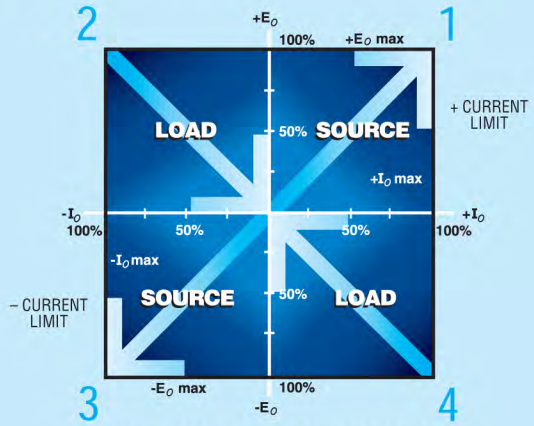
1KW GL, MGL MODELS: Optimized for Very Low Ripple and Noise
GPIB, RS 232 Control: 10V, 20V, 36V, 50V

1KW EL, MEL MODELS: Optimized for Very Low Ripple and Noise
LAN/Ethernet, RS 232 Control: 10V, 20V, 36V, 50V

WHAT IS A 4 QUADRANT POWER SUPPLY?

Conventional d-c power supplies operate in a single quadrant of the voltage-current axis, delivering stabilized and adjustable d-c voltage or current to a load. They may be voltage stabilized, meaning that the current varies with the load, or they may be current stabilized, meaning that the voltage varies with the load.

Kepco's BOP operate in all four quadrants of the voltage-current axis, therefore their output may swing seamlessly from negative to positive voltage and the output current may also swing from positive to negative values. The result of this is that BOP will function as a source or a sink, meaning it will either deliver power to a load or absorb power from a load. In order to do that, the BOP is built as a power amplifier with a bipolar output, having a frequency bandwidth much larger than a regular power supply. The frequency bandwidth is model and option dependent.



FOUR-QUADRANT OPERATION FROM A KEPCO BOP POWER SUPPLY

In quadrant 1 of the volt-ampere axis, both voltage and current are positive so the BOP power supply is able to deliver power to a load. In quadrant 3 both are negative and the BOP is also a source. In quadrants 2 and 4, however, the voltage and current are of opposite polarity. In these two quadrants the BOP will act as a sink, absorbing power. **The sinking may be transient in nature as BOP absorbs energy stored in reactive elements or it may be steady state, when for example, BOP controls the discharge of a battery or acting as an electronic load, constant current for an external voltage source, or a constant voltage for an external current source.**

BOP 1KW (Switch-Mode)

Using switch-mode technology for low dissipation when sinking power from an active load, the BOP 1KW recuperate the energy for reuse. The key to this is a bi-directional a-c input power factor correcting (PFC) circuit, which allows transparent energy interchange without dissipative internal sinking.

The BOP 1KW has two primary control channels: voltage or current. Either of these may be controlled from full plus setting to full minus setting. To assure that they will intersect in one of the two source quadrants to form a closed boundary as do conventional unipolar power supplies, four auxiliary limit channels are provided: plus voltage, minus voltage, plus current and minus current. These four are controllable from a very small value to the nominal values. Their control does not pass through zero as do the primary voltage and current channels. The intersection of whichever primary control channel is engaged by the load and the respective limit channel does form a closed boundary, and a variable load automatically crosses over from the primary channel to the limit channel.

CE This KEPCO product is backed by a firm 5-YEAR WARRANTY

BOP 1KW MODEL TABLE

MODEL[1]	d-c OUTPUT RANGE		CLOSED LOOP GAIN		OUTPUT IMPEDANCE			
	VOLTAGE[2] V d-c	CURRENT A d-c	VOLTAGE CHANNEL G_V (V/V)	CURRENT CHANNEL G_I (A/V)	VOLTAGE MODE		CURRENT MODE	
					SERIES R mΩ	SERIES L µH	SHUNT R Ω	SHUNT C µF
1000 WATT								
BOP 6-125	0 to ±6	0 to ±125	0.6	12.5	0.05	1.5	24	1150
BOP 10-100	0 to ±10	0 to ±100	1.0	10.0	0.1	2.0	50	1100
BOP 20-50	0 to ±20	0 to ±50	2.0	5.0	0.40	8.3	200	371
BOP 25-40	0 to ±25	0 to ±40	2.5	4.0	0.63	15.8	313	165
BOP 36-28	0 to ±36	0 to ±28	3.6	2.8	1.30	25	640	103
BOP 50-20	0 to ±50	0 to ±20	5.0	2.0	2.50	50	1250	55
BOP 72-14	0 to ±72	0 to ±14	7.2	1.4	5.14	104	2570	33
BOP 100-10	0 to ±100	0 to ±10	10.0	1.0	10.0	163	5000	16

(1) Add MG suffix for models with built-in GPIB interface, keypad and color display. Add ME suffix for models with built-in ethernet/LAN interface, keypad and color display.
(2) When connecting active loads, the steady-state voltage of the active load must not exceed the maximum voltage rating of the BOP. Otherwise the overvoltage protection will shutdown the power supply.

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BOP 1KW FEATURES

- Full 4-quadrant, 1000 watt, source-sink operation.
- Energy regeneration, during sink-mode, through a patented bi-directional PFC circuit.
- Meets the EN61000-3-2 harmonic limits. A built-in EN55011 Class A input EMI filter is provided.
- High efficiency switch-mode operation.
- Output voltage from ±6V to ±100V.
- Full digital control with built-in standard GPIB. Compatible with IEEE 488.2. Accepts standard SCPI commands. VISA and EPICS drivers provided. Also supports RS 232 bus.
- LAN/ethernet interface optional. Large graphic color LCD, displays settings and output voltage and current.
- Keypad control from front panel with menu to access functions.
- Calibration adjustments are made via the remote interface or locally from the keypad and are stored in non-volatile memory. Calibration is password protected.
- CE; Complies with the requirements of the Low Voltage Directive 73/23/EEC, the Marking and Declaration Directive 93/28/EEC, and the EMC Directive 89/336/EEC.
- Built-in complex waveform generator.
- Parallel (max. 5 units) or Serial (max. 3 units) connection of identical units. Parallel and Series connecting cables are required; contact factory for pricing.

YOU CAN MODEL MANY REAL-WORLD PHENOMENA IN WHICH POLARITY OR DIRECTION IS AN ISSUE

RIGHT/LEFT UP/DOWN HOT/COLD
CLOCKWISE/COUNTERCLOCKWISE
CHARGE/DISCHARGE FORWARD/REVERSE

APPLICATIONS FOR KEPCO'S BOP 1KW

Automotive
Battery and Motor
Simulation and Testing

Wafer Deposition
and Electroplating

Magnet Applications
Particle Beam Correctors and Injectors,
Medical Imaging, etc.

Solar Panel Research and Testing

Electronic Load with
Energy/Power Regeneration

For full specs, visit our Web site at www.kepcopower.com/bophi.htm

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BOP 1KW INPUT CHARACTERISTICS

SPECIFICATIONS		RATING/DESCRIPTION	CONDITION
a-c Voltage	nominal	230V a-c	Single phase
	range	176-264V a-c	
Frequency	nominal	50/60 Hz	
	range	47-63 Hz	
Current	176V a-c	9.5A (7.5A)*	Maximum
	264V a-c	6.4A (4.4A)*	Maximum
Power Factor	source	0.99	Nominal output power Complies with EN 61000-3-2
	sink	0.97	
Efficiency		65% (56%)*	Minimum when sourcing
Switching Frequency		70 KHz ±5% (50KHz ±5%)*	Active PFC for source and sink

* BOP 6-125MG only.

BOP 1KW PROGRAMMING/DISPLAY CHARACTERISTICS

SPECIFICATIONS		RATING/DESCRIPTION	CONDITION
Analog Control	voltage or current main channel	-10V to +10V	Full range output
	± voltage and ± current protection limit channel	+0.05V to +10V	0.5% to 100% of nominal range
Digital Control	local	Panel-mounted keypad	Direct entry
	remote	IEEE 488-2 (GPIB)	SCPI
	remote	RS 232	
	remote	RS 485 (BITBUS)	Used for series and parallel configurations
	remote	LAN/ethernet (optional)	Internet/web browser
Display	front panel	4" backlit LCD displays all functions	
	remote	All parameters read back on RS 232 and GPIB buses	

BOP 1KW GENERAL (ENVIRONMENTAL) SPECIFICATIONS

SPECIFICATIONS		RATING/DESCRIPTION	CONDITION
Temperature	operating	0 to +50°C	Full rated load
	storage	-20 to +85°C	
Cooling		Two internal fans	Exhaust to the rear
Humidity		0 to 95% RH	Non-condensing
Shock		20g, 11msec ±50% half sine	Non-operating
Vibration	5 -10 Hz	10mm double amplitude	3-axes, non-operating
	10-55 Hz	2g	3-axes, non-operating
Altitude		Sea level to 10,000 ft.	

BOP 1KW PHYSICAL CHARACTERISTICS

SPECIFICATIONS		RATING/DESCRIPTION	CONDITION
Dimensions	English	5.25" x 19" x 21.5"	H x W x D
	metric	133.3 x 482.6 x 546.1 mm	
Weight	English	53 lbs	
	metric	24.1kg	

BOP 1KW OUTPUT CHARACTERISTICS

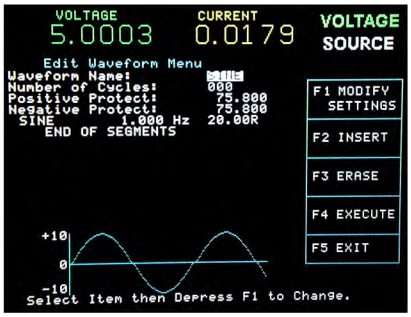
SPECIFICATIONS		RATING/DESCRIPTION	CONDITION
Type of Stabilizer		Voltage/Current 4-quadrant	Switch mode
Switching Frequency		100KHz ±5%	Output stage
Source Adjustment Range	voltage	-100% to +100% of rating	0-50°C
	current	-100% to +100% of rating	
Sink Adjustment Range	voltage	-100% to +100% of rating	0-50°C, recuperated energy is sent back into line for general reuse
	current	-100% to +100% of rating	
Voltage Stabilization in Voltage Mode	source effect	0.05% of rating	min-max input voltage
	load effect	0.1% of rating	0-100% load current
	time effect (drift)	0.02% of rating	0.5 - 8 hours
	temperature effect	0.02%/°C of rating	0-50°C
	ripple	2% $E_o$max p-p	Includes switching noise
	noise	0.2% $E_o$max rms	
Current Stabilization in Current Mode	source effect	0.05% of rating	min-max input voltage
	load effect	0.2% of rating	0-100% load current
	time effect (drift)	0.02% of rating	0.5 - 8 hours
	temperature effect	0.02%/°C of rating	0-50°C
	ripple	2% $I_o$max p-p	Includes switching noise
	noise	0.2% $I_o$max rms	
Error Sensing		0.25 volts per wire(1)	Above rated output
Transient Recovery in Voltage Mode	maximum excursion	5% of nominal output	nominal voltage, 50% load step
	recovery time	200 µsec	Return within 0.1% of set voltage
Output Common Mode Voltage		300V(2)	Output to chassis ground
Series Operation		Master/slave	Maximum of 3 identical units, up to 300V max.
Parallel Operation		Master/slave	Maximum of 5 identical units
Output Protection Limiting		Voltage and current limited in four quadrants	
Output Stage Protection		Output overvoltage/ overcurrent, heat sink overtemperature, switchers overcurrent	Triggers latched shutdown protection of the output module and PFC stage. Recover by cycling power off, then on or by pressing **RESET** at the front panel
Input Stage Protection (PFC)		Internal overvoltage, undervoltage, overcurrent, heat sink overtemperature, fan inoperative	
		Input circuit breaker overcurrent	Trips circuit breaker to shut off unit
Small Signal Bandwidth	voltage channel	2 KHz maximum	Into nominal resistive load
	current channel	800 Hz maximum (600 Hz Maximum) (3)	Into short circuit
Rise/Fall Time	voltage channel	300/300 µsec	Into nominal resistive load
	current channel	500/500 µsec	Into short circuit

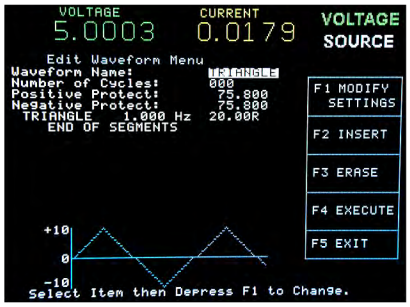
(1) or 1% of voltage rating (whichever is less).
(2) 500V for BOP 10-100MG/M
(3) BOP 6-125MG only.

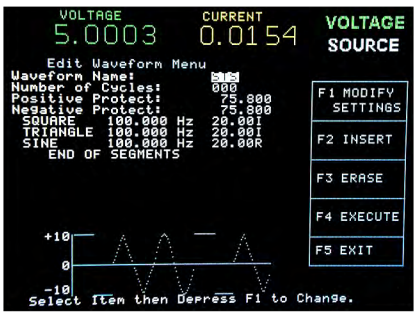
For full specs, visit our Web site at www.kepcopower.com/bophi.htm

BOP 1KW ALLOW FOR AUTOMATIC CREATION AND DISPLAY OF VARIOUS WAVEFORMS AND COMPLEX PATTERNS

The 1000-watt models have an internal waveform generator that allows a user to combine segments of a sinusoidal waveform, triangular waveform, a ramp, a saw tooth waveform and a square 50% duty cycle pulse, plus d-c to create a variety of arbitrary waveforms. 3,933 of points per basic waveform can be programmed with arbitrary phase relationships. The resulting waveshape can be repeated from 1 to 255 times. The waveshape can also be executed indefinitely until a stop command is received. The waveshape graphics are displayed on the front panel-mounted LCD display, which also shows both settings and actual d-c output values. The programmed waveshapes can be used to control either voltage or current with both positive and negative values. It is possible to reproduce an a-c sinusoid with differing degrees of distortion or dropouts for test purposes. Alternatively, varying amounts of "noise" can be added to a d-c output to gauge the effect on a test subject.







Complex Sine Waveform

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BOP 2KW TO 5KW MODEL TABLE

MODEL[1]	d-c OUTPUT RANGE		CLOSED LOOP GAIN		OUTPUT IMPEDANCE [3]			
	VOLTAGE[2] V d-c	CURRENT A d-c	VOLTAGE CHANNEL G_V (V/V)	CURRENT CHANNEL G_I (A/V)	VOLTAGE MODE		CURRENT MODE	
					SERIES R mΩ	SERIES L µH	SHUNT R Ω	SHUNT C µF
2000 WATT								
BOP 6-250	0 to ±6	0 to ±250	0.6	25.0	0.05	1.5	12	2300
BOP 10-200	0 to ±10	0 to ±200	1.0	20.0	0.1	2.0	25	2200
BOP 20-100	0 to ±20	0 to ±100	2.0	10.0	0.40	8.3	100	742
BOP 25-80	0 to ±25	0 to ±80	2.5	8.0	0.63	15.8	156.5	330
BOP 36-56	0 to ±36	0 to ±56	3.6	5.6	1.30	25	320	206
BOP 50-40	0 to ±50	0 to ±40	5.0	4.0	2.50	50	625	110
BOP 72-28	0 to ±72	0 to ±28	7.2	2.8	5.14	104	1285	66
BOP 100-20	0 to ±100	0 to ±20	10.0	2.0	10.0	163	2500	32
BOP 200-10	0 to ±200	0 to ±10	20.0	1.0	20.0	326	10000	8
3000 WATT								
BOP 6-375	0 to ±6	0 to ±375	0.6	37.5	0.05	1.5	8	3450
BOP 10-300	0 to ±10	0 to ±300	1.0	30.0	0.1	2.0	16.67	3300
BOP 20-150	0 to ±20	0 to ±150	2.0	15.0	0.40	8.3	66.67	1113
BOP 25-120	0 to ±25	0 to ±120	2.5	12.0	0.63	15.8	104.33	495
BOP 36-84	0 to ±36	0 to ±84	3.6	8.4	1.30	25	213.33	309
BOP 50-60	0 to ±50	0 to ±60	5.0	6.0	2.50	50	416.67	165
BOP 72-42	0 to ±72	0 to ±42	7.2	4.2	5.14	104	856.67	99
BOP 100-30	0 to ±100	0 to ±30	10.0	3.0	10.0	163	1666.67	48
4000 WATT								
BOP 6-500	0 to ±6	0 to ±500	0.6	50.0	0.05	1.5	6	4600
BOP 10-400	0 to ±10	0 to ±400	1.0	40.0	0.1	2.0	12.5	4400
BOP 20-200	0 to ±20	0 to ±200	2.0	20.0	0.40	8.3	50	1484
BOP 25-160	0 to ±25	0 to ±160	2.5	16.0	0.63	15.8	78.25	660
BOP 36-112	0 to ±36	0 to ±112	3.6	11.2	1.30	25	160	412
BOP 50-80	0 to ±50	0 to ±80	5.0	8.0	2.50	50	312.5	220
BOP 72-56	0 to ±72	0 to ±56	7.2	5.6	5.14	104	642.5	132
BOP 100-40	0 to ±100	0 to ±40	10.0	4.0	5.14	104	642.5	132
BOP 200-20	0 to ±200	0 to ±20	20.0	2.0	20.0	326	2500	32
5000 WATT								
BOP 6-625	0 to ±6	0 to ±625	0.6	62.5	0.05	1.5	120	230
BOP 10-500	0 to ±10	0 to ±500	1.0	50.0	0.1	2.0	2500	220
BOP 20-250	0 to ±20	0 to ±250	2.0	25.0	0.40	8.3	1000	74.2
BOP 25-200	0 to ±25	0 to ±200	2.5	20.0	0.63	15.8	1565	33
BOP 36-140	0 to ±36	0 to ±140	3.6	14.0	1.30	25	3200	20.6
BOP 50-100	0 to ±50	0 to ±100	5.0	10.0	2.50	50	6250	11
BOP 72-70	0 to ±72	0 to ±70	7.2	7.0	5.14	104	12850	6.6
BOP 100-50	0 to ±100	0 to ±50	10.0	5.0	10.0	163	25000	3.2

(1) Add MG suffix for models with built-in GPIB interface, keypad and color display.
Add ME suffix for models with built-in ethernet/LAN interface, keypad and color display.
(2) When connecting active loads, the steady-state voltage of the active load must not exceed the maximum voltage rating of the BOP. Otherwise the overvoltage protection will shutdown the power supply.
(3) Measured bandwidth of the unit.

BOP 2KW TO 5KW

BOP 2KW to 5KW Models are available from 0 to ±6V through 0 to ±200V output voltage, 0 to ±10A through 0 to ±625A output current (see table for models). Local control is by either encoder or keypad with a color front panel display. Remote control can be via GPIB, RS 232 or LAN/Ethernet.

2KW Model BOP 50-40MG

4KW Model BOP 6-500GL ready for shipping

This KEPCO product is backed by a firm 5-YEAR WARRANTY

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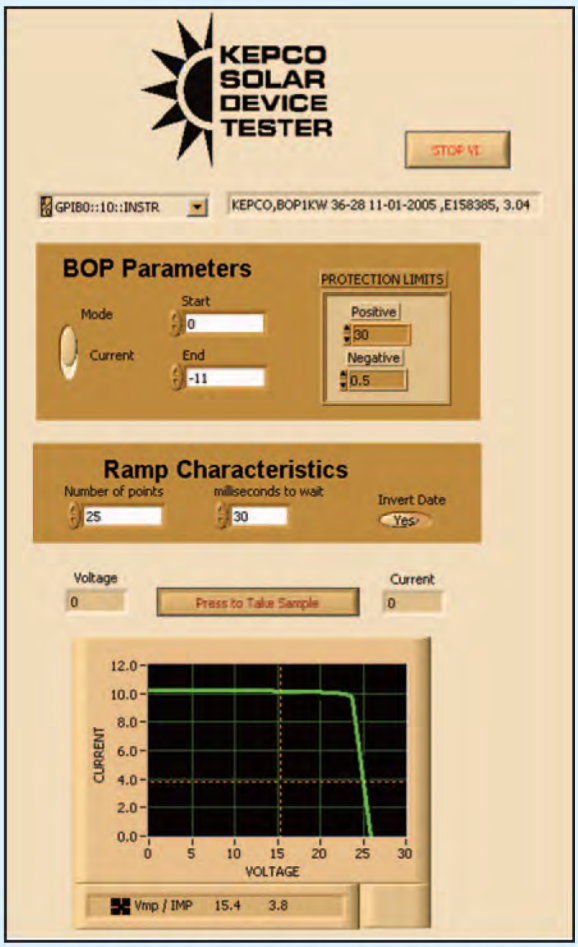
USING KEPCO BOP 1KW FOR SOLAR DEVICE TESTING

The Kepco BOP 1KW provides a one-step solution for test and characterization of solar cells and solar panels. A free LabView subvi allows rapid characterization of the solar device using only the BOP 1KW, eliminating the need for separate DVMs to measure voltage and current. The subvi is designed for both I-V Trace and Dark I-V testing, and can be plugged in or easily adapted to existing LabView test applications, even those previously using two DVMs. This solution offers lower cost, greater throughput and increased ROI when testing solar devices.

BOP 1KW SOLAR DEVICE TESTING FEATURES AND BENEFITS

- SOLAR DEVICE TESTING - Both I-V Trace and Dark I-V Tests supported.
- FLEXIBILITY - KEPCO BOP 1KW LabView Driver allows Solar Device testing while maintaining full functionality of the BOP 1KW Instrument Power Supply features.
- FASTER THROUGHPUT - 20mS per point.
- ROI - Test setups are quick and easy, require no special programming for synchronization, require no dedicated engineering resources to design and/or maintain components comprising a custom solution.
- LOWER COST AND SIMPLICITY - No need to purchase, maintain and calibrate two DVMs - Simplifies calibration, test setup and operation; no trigger connections needed.
- RELIABILITY - With all triggering and measurements done within BOP 1KW there are no synchronization or noise issues.
- PROVEN TECHNOLOGY - Enhancement of proven BOP 1KW technology.
- ENERGY CONSERVATION - Employs energy recuperation as well as active Power Factor Correction (PFC).



Demonstration Application Interface Showing User Inputs and Rendered I-V Curve Output

BOP 1KW GL SERIES OPTIMIZED FOR VERY LOW RIPPLE AND NOISE

The BOP-GL series models are a standard modification of the 1KW that have been optimized for exceptionally low current ripple and noise and improved stability (drift and temperature), making them ideal for driving inductive loads such as large magnets or motors. These bipolar power supplies pass smoothly through zero without switching to provide true ± voltage and ± current.

BOP-GL, -MGL, -EL, -MEL MODEL TABLE

MODEL (1)	d-c OUTPUT RANGE (2)		CLOSED LOOP GAIN		RIPPLE AND NOISE	
	E_O MAX V d-c	I_O MAX A d-c	VOLTAGE CHANNEL	CURRENT CHANNEL	VOLTAGE rms	CURRENT rms
1000 WATT						
BOP 10-100	0 to ±10	0 to ±100	1.0	10.0	0.02%	0.01%
BOP 20-50	0 to ±20	0 to ±50	2.0	5.0	0.02%	0.01%
BOP 36-28	0 to ±36	0 to ±28	3.6	2.8	0.02%	0.01%
BOP 50-20	0 to ±50	0 to ±20	5.0	2.0	0.02%	0.01%

(1) Models with GL suffix include built-in standard GPIB and RS 232 digital interfaces.
Models with MGL suffix include built-in standard GPIB and RS 232 digital interfaces plus front panel keypad and color display.
Models with EL suffix include built-in standard LXI Ethernet (LAN) and RS 232 digital interfaces.
Models with MEL suffix include built-in standard LXI Ethernet (LAN) and RS 232 digital interfaces plus front panel keypad and color display.
(2) For other Volt-Ampere combinations, please consult factory.
(3) When connecting active loads, the steady-state voltage of the active load must not exceed the maximum voltage rating of the BOP. Otherwise the overvoltage protection will shut down the power supply.

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BOP 40W HIGH VOLTAGE (Linear)

The Kepco Model BOP 500DM and BOP 1000DM are high voltage power sources, up to ±500V or ±1000V, respectively.

For full specs, visit our Web site at www.kepcopower.com/bophv.htm.

These combine the capabilities of fast programmable power supplies with a Class A output stage, which can respond bi-directionally from zero. They can be operated in either a "voltage stabilizing" or "current stabilizing" mode. To realize the full high speed potential of the BOP HV, the load characteristics should be mainly resistive. Load capacitance and inductance up to 0.01μF and 0.5mH can be tolerated without performance deterioration.

CE This KEPCO product is backed by a firm 5-YEAR WARRANTY

BOP HIGH VOLTAGE MODEL TABLE

MODEL	d-c OUTPUT RANGE		CLOSE LOOP GAIN		RIPPLE/NOISE		RISE/FALL TIME		BANDWIDTH	
			VOLTAGE CHANNEL	CURRENT CHANNEL						
	E_o max.	I_o max.	G_V (V/V)	G_I (mA/V)	VOLTAGE MODE	CURRENT MODE	VOLTAGE MODE (1)	CURRENT MODE (2)	VOLTAGE MODE (1)	CURRENT MODE (2)
BOP 500DM	±500V	±80mA	50	8.0	10mV	25μA	66μS	176μS	5.3kHz	2kHz
BOP 1000DM	±1000V	±40mA	100	4.0	10mV	25μA	194μS	233μS	1.8kHz	1.5kHz

(1) Full scale, Nominal resistive load.
(2) Full scale, short-circuit.

BOP MULTICHANNEL

4-Channel Low Power BOP comprised of four 400W channels.

10-Channel Low Power BOP comprised of six 400W channels and four 200W channels

BOP 100W, 200W AND 400W (Linear)

The BOP 100W, 200W and 400W are high-speed operational amplifiers with full 4-quadrant, bipolar operation.

The output is capable of both sustained d-c and the replication of arbitary a-c waveforms. Voltage and current outputs can be controlled smoothly and linearly through the entire rated plus and minus ranges, passing smoothly through zero with no polarity switching.

CE This KEPCO product is backed by a firm 5-YEAR WARRANTY

BOP 100W, 200W AND 400W FEATURES

- Source 100% and sink 50% of the output power rating.
- Separate control circuits for voltage and current with automatic crossover between main channel and limit channel.
- Controls and flag signals accessible through a 50-terminal port at the rear.
- Zeroable preamplifier available for scaling and summing external signals.
- Optional digital control via GPIB or RS 232. Add suffix -4886. Optional digital control via ethernet/LAN. Add suffix -802E. EPICS and VISA drivers available.
- Parallel and Series connection of identical models.
- Mounting in standard 19" racks
  RA 37: 3/4 rack size
  Mounting "ears" supplied: full rack size

BOP 100W, 200W AND 400W MODEL TABLE

MODEL (1) (5)	d-c OUTPUT RANGE		CLOSED LOOP GAIN		OUTPUT IMPEDANCE			
	VOLTAGE V d-c	CURRENT A d-c	VOLTAGE CHANNEL G_V (V/V)	CURRENT CHANNEL G_I (A/V)	VOLTAGE MODE		CURRENT MODE	
					SERIES R mΩ	SERIES L μH (2)	SHUNT R KΩ	SHUNT C μF (3)
100 WATT								
BOP 5-20D	0 to ±5	0 to ±20	0.5	2.0	10μΩ	4μH	5kΩ	10μF
BOP 20-5D	0 to ±20	0 to ±5	2.0	0.5	80μΩ	20μH	40kΩ	0.05μF
BOP 50-2D	0 to ±50	0 to ±2	5.0	0.2	0.5mΩ	100μH	50kΩ	0.05μF
BOP 100-1D	0 to ±100	0 to ±1	10.0	0.1	2.0mΩ	200μH	100kΩ	0.05μF
200 WATT								
BOP 5-30D	0 to ±5	0 to ±30	0.5	3.0	10μΩ	4μH	5kΩ	15μF
BOP 20-10D	0 to ±20	0 to ±10	2.0	1.0	40μΩ	40μH	20kΩ	0.05μF
BOP 36-6D	0 to ±36	0 to ±6	3.6	0.6	120μΩ	20μH	36kΩ	0.03μF
BOP 50-4D	0 to ±50	0 to ±4	5.0	0.4	0.25mΩ	50μH	50kΩ	0.02μF
BOP 72-3D	0 to ±72	0 to ±3	7.2	0.3	0.48mΩ	60μH	72kΩ	0.05μF
BOP 100-2D	0 to ±100	0 to ±2	10.0	0.2	1.0mΩ	80μH	100kΩ	0.03μF
BOP 200-1D	0 to ±200	0 to ±1	20.0	0.1	4.0mΩ	1.2mH	200kΩ	0.03μF
200 WATT DUAL CHANNEL (100W/CHANNEL)								
BOP 2X5-20D	0 to ±5	0 to ±20	0.5	2.0	10μΩ	4μH	5kΩ	0.3μF
BOP 2X20-5D	0 to ±20	0 to ±5	2.0	0.5	80μΩ	20μH	40kΩ	0.05μF
BOP 2X50-2D	0 to ±50	0 to ±2	5.0	0.2	0.5mΩ	100μH	50kΩ	0.05μF
BOP 2X100-1D	0 to ±100	0 to ±1	10.0	0.1	2.0mΩ	200μH	100kΩ	0.05μF
400 WATT								
BOP 20-20D	0 to ±20	0 to ±20	2.0	2.0	20μΩ	10μH	20kΩ	0.5μF
BOP 36-12D	0 to ±36	0 to ±12	3.6	1.2	60μΩ	50μH	36kΩ	0.4μF
BOP 50-8D	0 to ±50	0 to ±8	5.0	0.8	125μΩ	100μH	50kΩ	0.15μF
BOP 72-6D	0 to ±72	0 to ±6	7.2	0.6	240μΩ	200μH	72kΩ	0.1μF
BOP 100-4D	0 to ±100	0 to ±4	10.0	0.4	500μΩ	200μH	100kΩ	0.1μF
400 WATT DUAL CHANNEL (200W/CHANNEL)								
BOP 2X20-10D	0 to ±20	0 to ±10	2.0	1.0	40μΩ	50μH	20kΩ	0.1μF
BOP 2X36-6D	0 to ±36	0 to ±6	3.6	0.6	120μΩ	50μH	36kΩ	0.1μF
BOP 2X50-4D	0 to ±50	0 to ±4	5.0	0.4	0.25mΩ	100μH	50kΩ	0.05μF
BOP 2X72-3D	0 to ±72	0 to ±3	7.2	0.3	0.48mΩ	200μH	72kΩ	0.05μF
BOP 2X100-2D	0 to ±100	0 to ±2	10.0	0.2	1.0mΩ	200μH	100kΩ	0.05μF

(1) Optional digital control va GPIB or RS232. Add suffix -4886.
(2) For determining dynamic impedance in voltage mode.
(3) For determining dynamic impedance in current mode. (4) Same size as 400W models.
(5) To specify digital display, substitute the suffix letter "D" for the suffix letter "M."

APPLICATIONS FOR KEPCO'S BOP 100W, 200W AND 400W

Automotive
Battery and Motor Simulation and Testing

Wafer Deposition and Electroplating

Magnet Applications
Beam Steering, Medical Imaging, etc.

Solar Panel Research and Testing

For full specs, visit our Web site at www.kepcopower.com/bop.htm.

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OPTIMIZE BOP 100W, 200W AND 400W FOR DRIVING INDUCTIVE LOADS TO 1 HENRY

As an option (L suffix) Kepco's 100W, 200W and 400W BOP models may be optimized for driving inductive loads. These BOP units are designed to operate in a stable manner in Current or Current Limit Mode for loads up to 1 Henry. They are also stable with any R-L series load combination.

To prevent voltage limit operation, the equivalent impedance of the R-L series load at the working frequency must be lower than the nominal resistive load value (nominal output voltage / nominal output current).

All specifications of the unit in voltage mode are unchanged from the standard model. The specifications listed in the table to the right are for inductive load models in Current Mode. All other specifications are identical to the standard BOP.

In current mode the bandwidth of the BOP is reduced when operating with a resistive load. Correspondingly, the rise and fall time of the unit is increased (model dependent). Further, it is possible to reduce the bandwidth in current mode in a predictable way, using one customer-installed component on the rear programming connector of the BOP (see Bandwidth Correction Chart).

APPLICATIONS FOR KEPCO'S BOP INDUCTIVE LOAD MODELS

Automotive Battery and Motor Simulation and Testing

Wafer Deposition and Electroplating

Magnet Applications
Particle Beam Correctors and Injectors, Medical Imaging, etc.

Solar Panel Research and Testing

Electronic Load with Energy/Power Regeneration

Battery Research and Testing

Audio Equipment Testing

Avionics Testing

Driving Vibration Tables

Testing Actuators

For more information on the BOP Inductive Load Models visit www.kepcopower.com/bop-ind.htm

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BOP INDUCTIVE LOAD SPECIFICATIONS

MODEL / SPECIFICATION (1)(5)	BANDWIDTH (DC TO F-3dB)		RISE/FALL TIME (2)	RECOVERY TIME CONSTANT AT STEP LOAD (3)	LOAD EFFECT RESISTIVE LOAD, NOMINAL (4)
	RESISTIVE LOAD, NOMINAL	INDUCTIVE LOAD, 2mH			
100 WATT					
BOP 5-20DL 0 to ±5V, 0 to ±20A	3.9 KHz	55 KHz	90µS	100µS	3 ppm/Hz
BOP 20-5DL 0 to ±20V, 0 to ±5A	3.4 KHz	2.3 KHz	55µS	380µS	12 ppm/Hz
BOP 50-2DL 0 to ±50V, 0 to ±2A	1.6 KHz	2.6 KHz	215µS	275µS	6 ppm/Hz
200 WATT					
BOP 5-30DL 0 to ±5V, 0 to ±30A	3.5 KHz	32 KHz	110µz	130µz	2 ppm/Hz
BOP 20-10DL 0 to ±20V, 0 to ±10A	6.4 KHz	2.3 KHz	55µS	380µS	12 ppm/Hz
BOP 36-6DL 0 to ±36V, 0 to ±6A	3.9 KHz	1.5 KHz	90µS	123µS	6 ppm/Hz
BOP 50-4DL 0 to ±50V, 0 to ±4A	1.2 KHz	1.5 KHz	300µS	330µS	20 ppm/Hz
BOP 72-3DL 0 to ±72V, 0 to ±3A	4.5 KHz	4.5 KHz	80µS	200µS	28 ppm/KHz
BOP 100-2DL 0 to ±100V, 0 to ±2A	2.2 KHz	3.1 KHz	160µS	400µS	47 ppm/Hz
BOP 200-1DL 0 to ±200V, 0 to ±1A	1.2 KHz	2.0 KHz	250µS	300µS	0.017%/Hz
400 WATT					
BOP 20-20DL 0 to ±20V, 0 to ±20A	10.0 KHz	2.5 KHz	35µS	190µS	3 ppm/Hz
BOP 36-12DL 0 to ±36V, 0 to ±12A	10.0 KHz	>5.4 KHz	35µS	125µS	3 ppm/Hz
BOP 50-8DL 0 to ±50V, 0 to ±8A	3.5 KHz	1.6 KHz	100µS	660µS	7 ppm/Hz
BOP 72-6DL 0 to ±72V, 0 to ±6A	2.1 KHz	2.2 KHz	155µS	250µS	50 ppm/Hz
BOP 100-4DL 0 to ±100V, 0 to ±4A	1.6 KHz	2.3 KHz	220µS	280µS	70 ppm/Hz

(1) All specifications listed are for inductive load models in Current Mode. All other specifications are identical to the standard BOP.
(2) 10% - 90%, nominal resistive load.
(3) Short-circuit, nominal resistive load.
(4) Load effect increases nonlinearly with frequency from the typical 0.5 mA in DC full scale (same as the standard unit) at the average rate listed.
(5) For GPIB control of the BOP, add suffix -4886, for Ethernet/LAN control add -802E after the model name. e.g, BOP 20-20DL-4886 or BOP 20-10DL-802E.

BOP INDUCTIVE LOAD - BANDWIDTH CORRECTION

MODEL	EXTERNAL CAPACITOR (ACROSS PINS 16 AND 18 OF PC 12 PROGRAMMING CONNECTOR)						
	0.01 µF	0.02 µF	0.05 µF	0.1 µF	0.2 µF	0.5 µF	1 µF
100 WATT							
BOP 5-20DL	2.6 KHz	1.8 KHz	0.9 KHz	0.5 KHz	0.25 KHz	0.12 KHz	0.06 KHz
BOP 20-5DL	2.4 KHz	1.3 KHz	0.6 KHz	0.3 KHz	0.15 KHz	0.06 KHz	0.04 KHz
BOP 50-2DL	1.4 KHz	1.12 KHz	0.87 KHz	0.44 KHz	0.25 KHz	0.11 KHz	0.06 KHz
200 WATT							
BOP 5-30DL	2.6 KHz	1.8 KHz	0.9 KHz	0.5 KHz	0.25 KHz	0.12 KHz	0.06 KHz
BOP 20-10DL	2.4 KHz	1.3 KHz	0.6 KHz	0.3 KHz	0.15 KHz	0.06 KHz	0.04 KHz
BOP 36-6DL	0.9 KHz	0.6 KHz	0.3 KHz	0.15 KHz	0.08 KHz	0.03 KHz	0.02 KHz
BOP 50-4DL	1.2 KHz	1.0 KHz	0.6 KHz	0.4 KHz	0.21 KHz	0.09 KHz	0.05 KHz
BOP 72-3DL	2.7 KHz	1.7 KHz	0.8 KHz	0.52 KHz	0.27 KHz	0.27 KHz	0.06 KHz
BOP 100-2DL	1.1 KHz	0.9 KHz	0.5 KHz	0.32 KHz	0.17 KHz	0.07 KHz	0.05 KHz
BOP 200-1DL	0.84 KHz	0.78 KHz	0.50 KHz	0.31 KHz	0.21 KHz	0.10 KHz	0.05 KHz
400 WATT							
BOP 20-20DL	3.3 KHz	2.0 KHz	0.8 KHz	0.8 KHz	0.25 KHz	0.1 KHz	0.6 KHz
BOP 36-12DL	4.0 KHz	2.4 KHz	1.0 KHz	1.0 KHz	0.27 KHz	0.11 KHz	0.06 KHz
BOP 50-8DL	1.2 KHz	0.7 KHz	0.31 KHz	0.31 KHz	0.1 KHz	0.04 KHz	0.02 KHz
BOP 72-6DL	1.4 KHz	1.1 KHz	0.6 KHz	0.6 KHz	0.21 KHz	0.09 KHz	0.05 KHz
BOP 100-4DL	1.3 KHz	1.1 KHz	0.8 KHz	0.8 KHz	0.3 KHz	0.15 KHz	0.08 KHz

OPTIMIZE BOP 200W AND 400W FOR DRIVING CAPACITIVE LOADS TO 10 MILLIFARADS

As an option (C suffix), Kepco's 200 Watt (except BOP 200-1D) and 400 Watt BOP models may be optimized for driving capacitive loads.

These BOP units are designed to operate in a stable manner in voltage or voltage limit mode for capacitive loads up to 10mF. They are also stable when driving any R-C parallel combination where load R is ≥ nominal value and C is ≤10mF. Load R (nominal value) = nominal output Voltage/nominal output Current (e.g., BOP 36-6DC, R = 36/6 = 6 Ohms). To prevent current limit operation, the equivalent impedance of the R-C parallel load circuit at the working frequency must be greater than the nominal R value.

Static specifications representing accuracy for various influence parameters are identical to the standard BOP models. Ripple and noise specifications are better (approximately 50% lower) for the C option units compared to the standard BOP.

In voltage mode, with a resistive load, the bandwidth of the BOP Capacitive Load is reduced versus the standard model, while the response time is increased (except the 20V model: see Specifications Chart). The frequency response variations can be practically eliminated by reducing the bandwidth in voltage mode in a predictable manner using an external user-installed component on the programming connector to increase the internal compensation capacitance (see Bandwidth Correction Chart).

In Current Mode the dynamic specifications are almost identical for all BOP C option models: 3-dB bandwidth of 4.9kHz and rise/fall time of 72μsec (lower bandwidth and higher rise/fall time than the standard BOP models).

BOP CAPACITIVE LOAD SPECIFICATIONS

MODEL / SPECIFICATION (1)(6)	BANDWIDTH (DC TO F-3dB)		RISE/FALL TIME (4)	RECOVERY TIME AT STEP LOAD (5)
	RESISTIVE LOAD, NOMINAL (2)	CAPACITIVE LOAD, 10μF (3)		
200 WATT				
BOP 20-10DC 0 to ±20V, 0 to ±10A	7.8 KHz	13.7 KHz	45μS	137μS
BOP 36-6DC 0 to ±36V, 0 to ±6A	7.0 KHz	8.5 KHz	50μS	183μS
BOP 50-4DC 0 to ±50V, 0 to ±4A	11.5 KHz	15 KHz	35μS	100μS
BOP 100-2DC 0 to ±100V, 0 to ±2A	2.0 KHz	2.6 KHz	175μS	575μS
400 WATT				
BOP 20-20DC 0 to ±20V, 0 to ±20A	4.8 KHz	5.3 KHz	75μS	225μS
BOP 36-12DC 0 to ±36V, 0 to ±12A	7.8 KHz	>10.3 KHz	45μS	136μS
BOP 50-8DC 0 to ±50V, 0 to ±8A	11.5 KHz	>15 KHz	35μS	100μS
BOP 72-6DC 0 to ±72V, 0 to ±6A	6.5 KHz	8.3 KHz	60μS	184μS
BOP 100-4DC 0 to ±100C, 0 to ±4A	5.0 KHz	6.7 KHz	70μS	228μS

(1) All specifications listed are for capacitive load models in Voltage Mode.
(2) For BOP 20-20MC, DC: nonuniformities of the frequency response creates a larger 3-dB bandwidth for the resistive load than for the standard BOP.
(3) Nonuniformities of the frequency response for the standard 10μF load create a larger 3-dB bandwidth than for the resistive load.
(4) 10% - 90%, with nominal resistive load.
(5) Load between infinity and nominal resistive values.
(6) For GPIB control of the BOP, add suffix -4886, for ethernet/LAN control add -802E after the model name. e.g, BOP 20-20DC-4886 or BOP 20-10DC-802E.

BOP CAPACITIVE LOAD - BANDWIDTH CORRECTION

MODEL	EXTERNAL CAPACITOR (ACROSS PINS 12 AND 14 OF PC 12 PROGRAMMING CONNECTOR)						
	1 nF	2.2 nF	4.7 nF	15 nF	33 nF	47 nF	100 nF
200 WATT							
BOP 20-10DC	7.0 KHz	5.5 KHz	4.6 KHz	2.3 KHz	1.2 KHz	1.0 KHz	0.5 KHz
BOP 36-6DC	6.3 KHz	5.2 KHz	4.1 KHz	1.8 KHz	1.1 KHz	0.7 KHz	0.3 KHz
BOP 50-4DC	11.0 KHz	9.0 KHz	7.0 KHz	3.0 KHz	1.5 KHz	1.0 KHz	0.5 KHz
BOP 100-2DC	2.0 KHz	1.9 KHz	1.6 KHz	1.1 KHz	0.6 KHz	0.5 KHz	0.3 KHz
400 WATT							
BOP 20-20DC	4.6 KHz	4.4 KHz	3.2 KHz	1.3 KHz	0.7 KHz	0.6 KHz	0.5 KHz
BOP 36-12DC	7.0 KHz	6.5 KHz	5.8 KHz	3.0 KHz	1.5 KHz	1.0 KHz	0.5 KHz
BOP 50-8DC	11.0 KHz	9.0 KHz	7.0 KHz	3.0 KHz	1.5 KHz	1.0 KHz	0.5 KHz
BOP 72-4DC	6.5 KHz	6.0 KHz	5.3 KHz	2.7 KHz	1.4 KHz	0.9 KHz	0.5 KHz
BOP 100-4DC	5.0 KHz	4.5 KHz	3.5 KHz	2.1 KHz	1.25 KHz	1.0 KHz	0.5 KHz

The listed bandwidth values are for C option units in Voltage Mode, nominal resistive load.

APPLICATIONS FOR KEPCO'S BOP CAPACITIVE LOAD MODELS

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