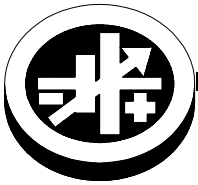


# INSTRUCTION SHEET



**KEPCO** An ISO 9001 Company.

**CABLE  
KIT  
219-0445**

## CABLE KIT NO. 219-0445 BOP 1000W MODELS (2) IN PARALLEL

### I. DESCRIPTION.

This kit contains the three cables, Power Output, Bitbus and Master/Slave Control, required to operate two 1000 Watt BOP High Power models in parallel, effectively doubling the output current capacity. Only two identical models may be configured to operate in parallel. Table 1 lists the equipment supplies in this Kit.

**TABLE 1. EQUIPMENT SUPPLIED**

Item	Purpose	Kepeco Part Number
Power Output Cable	Connects the power output terminals of the slave unit (OUT and COMMON) to the corresponding power output terminals of the master.	118-1112
Master/Slave Control Cable	Connects the slave control ports of the master and slave for parallel operation.	118-1107
Bitbus Cable	Allows communication between Master and Slave via Bitbus	118-1108
Instruction Manual	Provides installation and operation instructions for operating two 1000W BOP models in Parallel	228-1472

This manual is arranged as follows:

- Section I lists the equipment supplied.
- Section II explains how to install the cables and configure the two units to operate in parallel, including initial calibration.
- Section III describes how to calibrate a previously installed parallel configuration.
- Section IV lists the specifications for the parallel combination.
- Section V provides special operating instructions for the parallel combination.

### II. INSTALLATION.

**WARNING**

**BE SURE ALL POWER IS DISCONNECTED FROM  
POWER SUPPLIES BEFORE INSTALLING CABLES**

NOTE: The following procedure assumes that both individual units are properly calibrated. If not, refer to the associated technical manuals to calibrate the individual units prior to connecting them as a parallel pair. Perform all calibration steps for both master and slave unit.

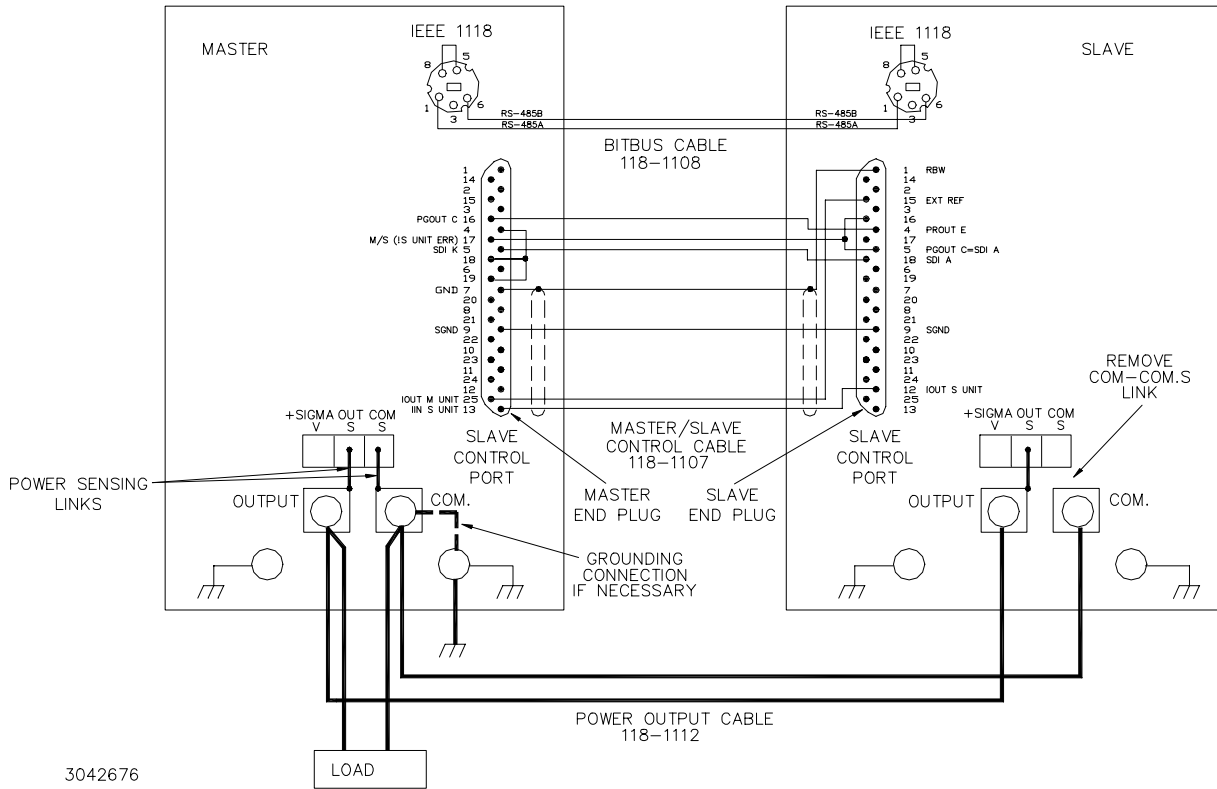
1. Before powering up the parallel combination, connect the Power Output, Bitbus, and Master/Slave Control cables (supplied) to the master and slave units in parallel star type configuration (load connected to the master output) as shown in Figure 1 for local sensing or Figure 2 for remote sensing. Always remove link between COM and COM S terminals for the slave. For a master configured for remote sensing, remove both links between OUT and OUT S and between COM and COM S terminals.

**CAUTION: The connectors of the Master/slave Control cable are marked Master and Slave. Make sure these are installed properly. Installing the cable backwards (cable connector marked MASTER installed in a slave, cable connector marked SLAVE installed in a master) can cause irreparable damage.**

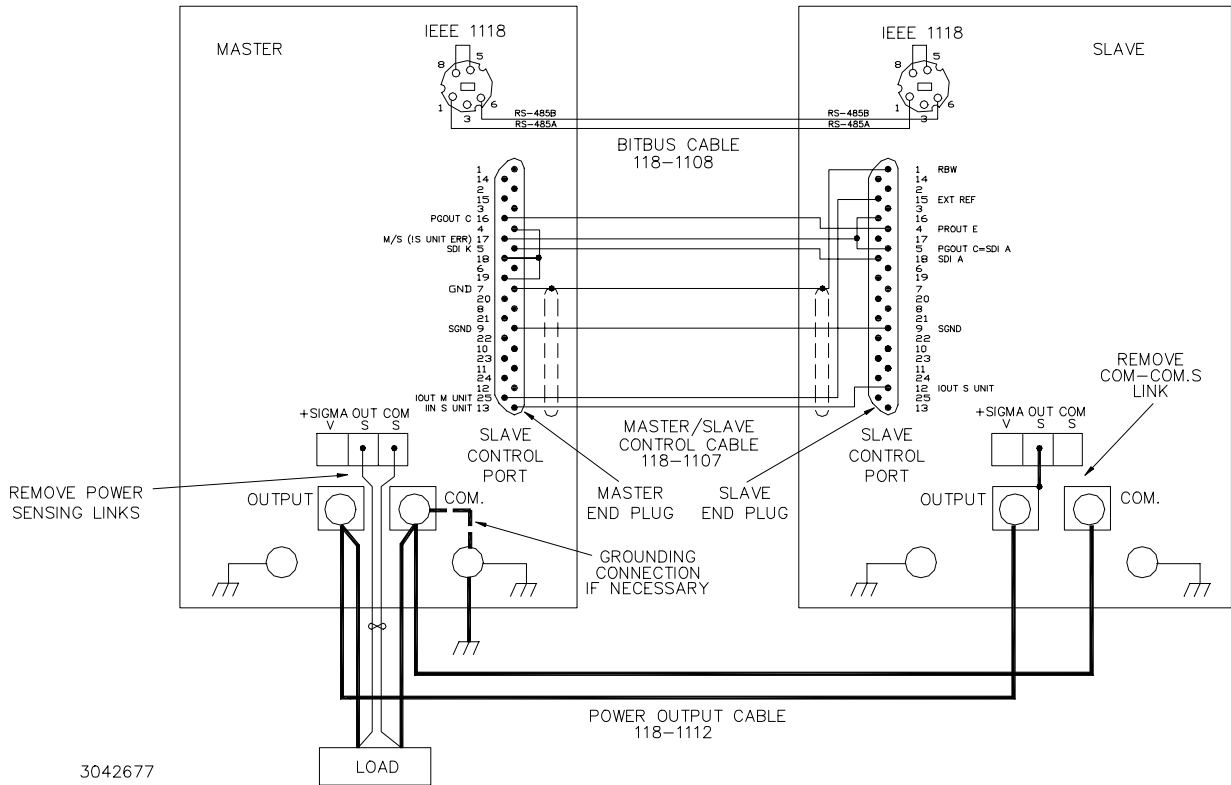
NOTE: To power down the combination, first press the STANDBY key on the master to disable the output, then turn off the slave followed by the master.

2. To configure the unit to be designated as a slave proceed as follows:
  - a. Turn on power only to the unit to be designated as a slave.
  - b. From the main screen (power on default), press **F5** to enter the Settings Menu.
  - c. From the Settings menu, gain access to the Protected Settings menu by first entering the password. Scroll through the password characters using **ADJUST** control and **RIGHT** or **LEFT** to select the character position, then press **ENTER**. The status message changes to **Protected settings enabled**. (If unsuccessful, use **RIGHT** or **LEFT** to highlight the incorrect character and **ADJUST** control to fix it, or press **CLEAR** to start over.)
  - d. Press **F4** to enter the Protected Settings Menu.
  - e. From the Protected Settings menu, highlight **Unit Type** (use **ADJUST** control or the **UP** or **DOWN** keys) and press **F1** to modify. Highlight **SLAVE #1** and press **F1** apply the change.
  - f. From the Protected Settings menu, under **Unit Type** highlight **Expansion** and press **F1** to modify. Highlight **Parallel** and press **F1** to apply the change.
  - g. Exit the Protected Settings menu and return to main screen by pressing **F4** to save the settings upon power-up. The unit goes to REMOTE mode, the status message reads **MASTER Module not found**, the Fault indicator is lit, and the unit continues to beep once a minute until the master is found. The only function key displayed is **F1** - LOCAL.

**CAUTION: The unit has now been properly configured as a slave to be controlled only by the master. Do not use the slave keypad, RS 232 port or GPIB port to try to control the slave.**



**FIGURE 1. INTERCONNECTIONS FOR PARALLEL OPERATION OF TWO (2) BOP HIGH POWER MODELS USING LOCAL SENSING**

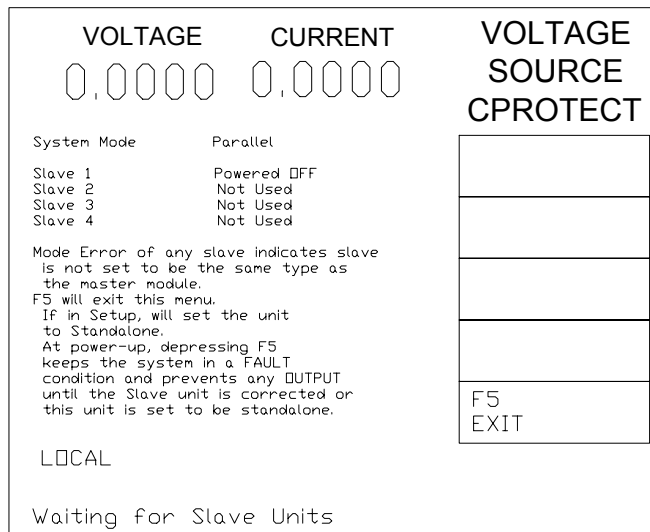


**FIGURE 2. INTERCONNECTIONS FOR PARALLEL OPERATION OF TWO (2) BOP HIGH POWER MODELS USING REMOTE SENSING**

3. Turn on the unit to be configured as a master and note that upon power up the FAULT light will go on (this is normal). Proceed as follows:
    - a. From the main screen, press **F5** to enter the Settings Menu.
    - b. From the Settings menu, gain access to the Protected Settings menu by first entering the password (see Step 2c above).
    - c. From the Protected Settings menu, highlight **Unit Type** (use **ADJUST** control or **↑** or **↓** keys) and press **F1** to modify. Highlight **Master +1** and press **F1** to apply the change.
    - d. From the Protected Settings menu, under **Unit Type** highlight **Expansion** and press **F1** to modify. Highlight **Parallel** and press **F1** to apply the change.
    - e. Exit the Protected Settings menu by pressing **F4** to test the system and to save the settings for subsequent power-up cycles. The display shows the master power-up screen (see Figure 3).
- NOTE: Pressing **F5** to exit will cause the unit to revert to a standalone unit.
- f. The power-up master module screen (Figure 3) changes to show the status of Slave 1 (see Table 2).

If the slave is recognized as ready, after about 10 seconds the master LCD reverts to the Power On Default screen (see Figure 4). The slave also displays the Power On Default screen (see Figure 5), except the unit will be in Current Mode, no function keys are active and the Status message at the bottom is **KPAD Locked**, indicating the keypad is disabled. The fault indicators on both units are off.

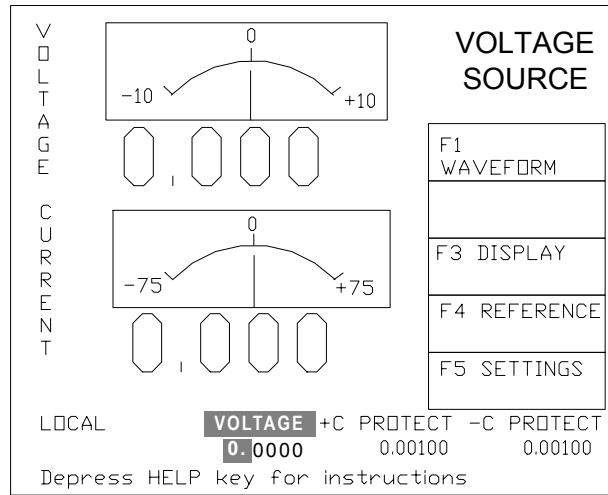
If the master power-up screen is still displayed after 10 seconds, the slave was not properly recognized. Pressing **F5** or turning power off, then on again, reconfigures the unit as a standalone unit. Verify that the BITBUS cable is installed correctly. Verify that the slave has been properly configured as a slave per step 2 above. Repeat step 3. If the power up screen still does not revert to the power on default screen, refer to troubleshooting.



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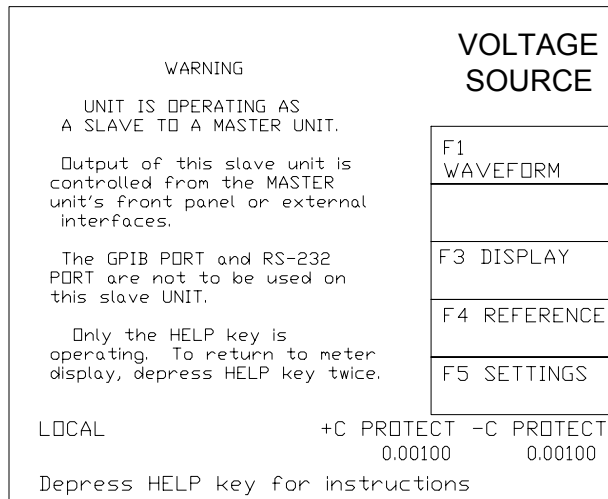
**FIGURE 3. MASTER POWER UP SCREEN**

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**FIGURE 4. POWER ON DEFAULT SCREEN FOR MASTER UNIT**

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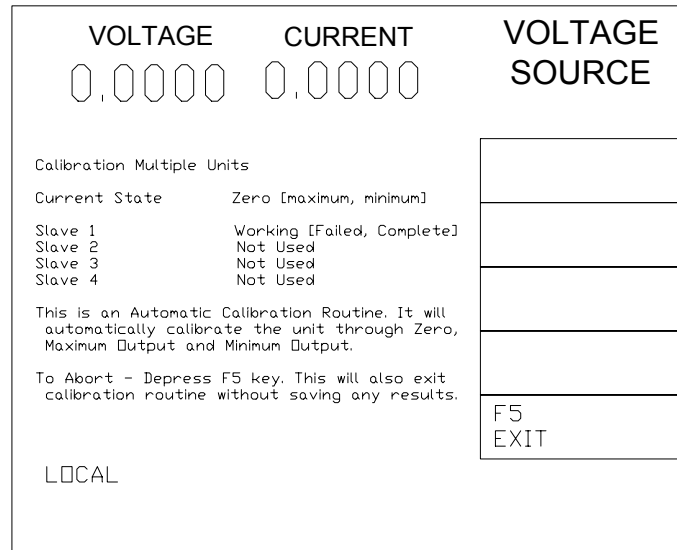
**FIGURE 5. POWER ON DEFAULT SCREEN FOR SLAVE UNIT**

**TABLE 2. SLAVE STATUS MESSAGE DEFINITIONS (DISPLAYED ON MASTER POWER UP SCREEN)**

DISPLAYED STATUS (see Figure 3, SLAVE 1)	MEANING
Ready	Unit is ready for operation.
STANDBY	Unit's FAULT indicator is on.
Powered OFF	Unit is not responding to polls via BITBUS.
Failed	Unit's FAULT indicator is on, and hardware error has been detected.
Not Used	Unit is not part of parallel configuration
Unknown	Waiting for interface communication

4. At the master unit calibrate the parallel combination as follows:
  - a. From the main screen, press to enter the Settings Menu.

- b. From the Settings menu, gain access to the Protected Settings menu by first entering the password (see step 2c above).
- c. Press **F2** from the Protected Settings menu to begin Calibration. The LCD shows  
**Calibration Multiple Units**  
**Connect a short across Master Power Output.**  
**Depress any Key to continue.**  
 After connecting a short across output terminals of master, depress any key on the keypad.



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**FIGURE 6. CALIBRATION SCREEN**

- d. Press **F3** from the main calibration menu to select Multiple. The Calibration Screen (Figure 6) is displayed. The status of the process is updated as calibration proceeds (this may take approximately three minutes). The Current State is updated from zero to maximum and minimum as the current calibration proceeds (voltage calibration is not required for the parallel pair).
  - e. When the calibration is complete the LCD displays  
**PLEASE REMOVE SHORT FROM**  
**OUTPUTS OF POWER SUPPLIES**  
**Depress Any Key to continue.**  
 After removing the short, depress any key on the keypad.
  - f. When prompted, enter the calibration date (8 characters maximum, any format) using **ADJUST** control to scroll through the characters and **ADJUST** or **ADJUST** to select the character position, then press **ENTER**.
  - g. Exit the Calibration menu by pressing **F4** to save the settings upon power-up.
5. Adjust the limits to reflect the increased current capacity of the parallel combination as follows:

- a. From the main screen, press **F5** to enter the Settings Menu.
  - b. From the Settings menu, press **F2** to enter the Modify Limits menu. Press **F2** to restore defaults. The values for +Current Max, -Current Min and ±Current Protect Max/Min should now be for the parallel combination.
  - c. Exit the Modify Limits menu by pressing **F4** to save the settings upon power-up.
6. Verify that the output is zero and remove the short across the output of the parallel configuration.

NOTE: Changing the password of the parallel pair (i. e., the master) does not change the password of the slave unit. It is recommended that the slave unit password be recorded and be readily accessible when calibration of the slave unit is required.

### III. CALIBRATING AN EXISTING PARALLEL CONFIGURATION

If the individual units of a parallel combination need to be calibrated proceed as follows:

1. Power down the combination: first press the STANDBY key on the master to disable the output, then turn off the slave, followed by the master.
2. Disconnect the master/slave cable connections.
3. Turn on power to both units in any order.
4. The slave unit will power up in **REMOTE** and will display **LOCAL LOCKOUT**. To restore **LOCAL** control, press **F1** to set the unit to **LOCAL** mode.
5. If calibration is to be done via the front panel keypad, refer to the front panel calibration procedure in the associated technical manual and calibrate both units. If the calibration is to be done via the GPIB (using either SCPI commands or the soft panel) both master and slave units must be temporarily reconfigured as standalone units:
  - a. From the main screen (power on default), press **F5** to enter the Settings Menu.
  - b. From the Settings menu, gain access to the Protected Settings menu by first entering the password (see PAR. II, step 2c).
  - c. From the Protected Settings menu, highlight **UNIT TYPE** (use **ADJUST** control or arrow keys) and press **F1** to modify. Highlight **STANDALONE** and press **F1** to apply the change.
  - d. From the Protected Settings menu, highlight **MULTIPLE UNITS** and press **F1** to modify. Highlight **NONE** and press **F1** to apply the change.
  - e. Exit the Protected Settings menu and return to main screen by pressing **F5**.
  - f. Calibrate the master and slave units by referring to the applicable calibration procedure in the associated technical manual.
  - g. Turn off power to both units (since step e exited without saving the settings, this restores the previous master/slave settings).
6. Refer to Figure 1 for local sensing or Figure 2 for remote sensing and connect the master and slave units in parallel star type configuration (load connected to master) using the Master/slave Control, Power Output and Bitbus cables.

7. Verify the master unit is in STANDBY, then connect a short across the output of the parallel configuration (see Figure 1 or Figure 2).
8. At the master unit calibrate the parallel combination as follows:
  - a. From the main screen, press **F5** to enter the Settings Menu.
  - b. From the Settings menu, gain access to the Protected Settings menu by first entering the password (see step 2c above).
  - c. Press **F2** from the Protected Settings menu to begin Calibration.
  - d. Press **F3** from the main calibration menu to select Multiple. Monitor the LCD to see the status while calibration of the parallel configuration proceeds automatically (this may take approximately 3 minutes).
  - e. When the calibration is complete, the LCD will display **PLEASE REMOVE SHORT FROM OUTPUTS OF POWER SUPPLIES Depress Any Key to continue.**
  - f. When prompted, enter the calibration date using **ADJUST** control to scroll through the characters and **←** or **→** to select the character position, then press **ENTER**.
  - g. Exit the Calibration menu by pressing **F4** to save the settings upon power-up.
9. Remove the short across the output of the parallel configuration.

#### IV. SPECIFICATIONS

Table 3 lists the model parameters unique to a parallel combination of two 1000W BOP Power Supplies. Table 4 lists the general specifications applicable all the parallel combinations listed in Table 3.

**TABLE 3. MODEL PARAMETERS FOR TWO (2) HIGH POWER BOP 1000 WATT UNITS (PARALLEL)**

Model	d-c Output Range		Closed Loop Gain	
	$E_O$ Max	$I_O$ Max	Voltage Channel	Current Channel
TWO 1000 WATT MODELS				
BOP 10-75MG	±10V d-c	±150A d-c	1.0	15.0
BOP 20-50MG	±20V d-c	±100A d-c	2.0	10.0
BOP 36-28MG	±36V d-c	±56A d-c	3.6	5.5
BOP 50-20MG	±50V d-c	±40A d-c	5.0	4.0
BOP 72-14MG	±72V d-c	±28A d-c	7.2	2.8
BOP 100-10MG	±100V d-c	±20A d-c	10.0	2.0



**TABLE 4. GENERAL SPECIFICATIONS FOR TWO (2) HIGH POWER 1000W BOP UNITS  
CONNECTED IN PARALLEL**

SPECIFICATION		RATING/DESCRIPTION	CONDITION
<b>INPUT CHARACTERISTICS</b>			
a-c voltage	nominal	230 Va-c	Single phase
	range	176 - 264 Va-c	
Frequency	nominal	50-60 Hz	>65 Hz, leakage exceeds spec
	range	47 - 65 Hz	
Current	176 Va-c	19A	maximum
	264 Va-c	13A	maximum
Power factor	Source	0.99 minimum	nominal output power
	Sink	0.97 minimum	
Efficiency		65%	minimum
Switching frequency		80 KHz	PFC Stage
EMC Compliance		EN61326-1 (1997)	Class A equipment
EMC immunity to:	ESD	EN61000-4-2	Electrostatic discharge
	Radiated RF	EN61000-4-3	
	EFT	EN61000-4-4	Electrical fast transient/burst
	Surges	EN61000-4-5	
	Conducted RF	EN61000-4-6	
EMC emissions	Conducted	EN61000-3-2	harmonics
		EN61000-3-3	fluctuation & flicker
	Conducted	EN55011/CISPR11	0.15 to 30 MHz
	Radiated	EN55011/CISPR11	30 to 1000 MHz
Leakage current		3.5 mA	230V a-c 47-63 Hz
Insulation coordination	Input	Installation Category II	
		Overvoltage Category II	
	Output	Installation Category II	
		Overvoltage Category II	
Pollution degree		2	
<b>OUTPUT CHARACTERISTICS</b>			
Type of stabilizer		Voltage-current, 4-quadrant	Switch mode
Switching frequency		100KHz	Output Stage
Source adjustment range	voltage	-100% to +100% of rating	0 to 50 deg C
	current	-100% to +100% of rating	
Sink adjustment range	voltage	-100% to +100% of rating	Recuperated energy is sent back into line for reuse
	current	-100% to +100% of rating	
Programming resolution / accuracy	Voltage	14 bits / 0.2%	
	Current	14 bits / 0.5%	
	Limits	12 bits / 0.5%	voltage or current
Readback resolution / accuracy	Voltage	16 bits / 0.2%	main or limit channel
	Current	16 bits / 0.5%	main or limit channel
Readback rate/array	measurement rate	1 ms (default)	range: 0.25-25ms
	measurement array	64 samples	

**TABLE 4. GENERAL SPECIFICATIONS FOR TWO (2) HIGH POWER 1000W BOP (CONTINUED) UNITS CONNECTED IN PARALLEL**

SPECIFICATION		RATING/DESCRIPTION	CONDITION
<b>OUTPUT CHARACTERISTICS (Continued)</b>			
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)	0.05% of rating	0.5 through 24 hours
	temperature	0.05%/deg C of rating	0 to 50 deg C
	ripple and noise	2% E <sub>0</sub> max p-p	Includes switching noise
Current stabilization in current mode	source effect	0.05% of rating	min-max input voltage
	load effect	0.2% of rating	0-100% load voltage
	temperature	0.05%/deg C of rating	0 to 50 deg C
	ripple and noise	2% I <sub>0</sub> max p-p	Includes switching noise
Error sensing		0.25V per wire	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
Isolation	voltage	300V	Output to ground
Output limiting	voltage and current limited in four quadrants		
Output Stage Protection	Heatsink overtemperature, switchers overcurrent for master and slave units		Triggers latched shutdown protection of entire master/slave combination
Input Stage Protection (PFC)	Overvoltage, undervoltage, overcurrent, heat sink overtemperature, fan inoperative for master and slave units		Triggers latched shutdown protection of entire master/slave combination
	Circuit breaker overcurrent		Trips circuit breaker to shut off unit (master or slave)
<b>PROGRAMMING/DISPLAY CHARACTERISTICS</b>			
Small signal Bandwidth	voltage channel	2 KHz minimum	into nominal resistive load, 10% of rating
	current channel	400 Hz minimum	Into short circuit, 10% of rating
Rise/Fall Time	voltage channel	500/200 μsec	into nominal resistive load, 10-90%, 0 to ±100% of rating
	current channel	1.5/2.5 msec	into short circuit, 10-90%, 0 to ±100% of rating
Analog control	voltage channel	-10V to +10V	Full range output, 10K Ohm input impedance
	current channel	-10V to +10V	
Digital control	local	Panel-mounted keypad	Direct Entry
	remote	IEEE 488-2 (GPIB)	SCPI
	remote	RS 232	
	remote	RS 485 (BITBUS)	IEEE 1118
Display	front panel	4" backlit LCD displays all functions	
	remote	All parameters read back on GPIB or RS 232 buses	

**TABLE 4. GENERAL SPECIFICATIONS FOR TWO (2) HIGH POWER 1000W BOP (CONTINUED) UNITS CONNECTED IN PARALLEL**


SPECIFICATION		RATING/DESCRIPTION	CONDITION
<b>BOP HIGH POWER INTERFACE CHARACTERISTICS</b>			
Waveform Support	steps	1002	
	step dwell time	250µsec to 10 sec	
Storage	non-volatile	FLASH-type EEPROM 24Kbytes	
	** User setups	99	
	interface steps	99	
	** waveform display	1024 steps	
	** waveform - interface	1800 steps	
<b>GENERAL (ENVIRONMENTAL) CHARACTERISTICS</b>			
Temperature	operating	0 to +50 deg C	Full rated load
	storage	-20 to +85 deg C	
Cooling		Two internal fans per unit	exhaust to the rear
Humidity		0 to 95% RH	non-condensing
Shock		20g, 11msec ±50% half sine	non-operating
Vibration	5-10HZ:	10mm double amplitude	3 axes, non-operating
	10-55HZ:	2g	3 axes, non-operating
Altitude		sea level to 10,000 feet	
Safety Certification	a-c power	UL 3101-1 and EN 6101-1	Pending
** Optional Function. if you require an option that is not installed on your unit, please contact the factory for upgrade information.			

**V. OTHER CONSIDERATIONS**

When operating two units in parallel the following information supplements the Power Supply technical manual.

1. Apply power to the combination by first turning on the master, then turn on the slave. If the master is in STANDBY, depress the STANDBY key on the master to apply power to the output terminals. (To power down the combination, first press the STANDBY key on the master to disable the output, then turn off the slave, followed by the master.
2. When the units of a parallel configuration are first turned on there is a brief delay until both units are communicating over the BITBUS to form the parallel pair.

When the master is turned on, the unit initially displays the Power Up Status and Test screen (Figure 7), then displays the Master Power Up screen (Figure 3). As the master searches for slaves.

When the slave is turned on, the unit initially displays the Power Up Status and Test screen (Figure 7), then automatically goes to REMOTE mode. The status message reads **MASTER Module not found**, the Fault indicator is lit, and the unit continues to beep once a minute until the master is found. The only function key displayed is  - LOCAL.

When the master finally recognizes the slave, the master LCD reverts to the Power On Default screen (see Figure 3). The slave displays the Power On Default screen (see Figure 3), except the unit will be in Current Mode, no function keys are active and the Status message at the bottom is **KPAD Locked**, indicating the keypad is disabled. The fault indicators on both units are off.

3. Operation of the parallel combination is done by operating the master as described for a single unit in the High Power BOP Technical Manual. SCPI commands and front panel controls actions applied to the master affect the parallel combination. The LCD display of the master refers to the parallel combination, while the front panel LCD of the slave shows the actual voltage and current provided by the slave.

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GPIB	Address	06
Serial	BaudRate	Unknown
BitBus	Type	Unknown
Interface	Protocol	Unknown
Unit	Type	Unknown
+Voltage Limit		37.08
-Voltage Limit		37.08
+Current Limit		28.84
-Current Limit		28.84
Serial Number		E1236
Revisions		
Display		1.40
Interface		1.41
Analog		1.40
Test		
Display		Passed
Interface		Passed
Analog		Passed

**FIGURE 7. POWER UP STATUS AND TEST SCREEN**