OPERATOR'S MANUAL

KLP SERIES

POWER SUPPLY

1200 WATT PROGRAMMABLE POWER SUPPLY

KEPCO INC.
An ISO 9001 Company.

MODEL
KLP SERIES
POWER SUPPLY

ORDER NO.	REV. NO

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)

Data subject to change without notice.

P/N 243-0979-7A

KEPCO®
THE POWER SUPPLIER™

KEPCO, INC. ● 131-38 SANFORD AVENUE ● FLUSHING, NY. 11352 U.S.A. ● TEL (718) 461-7000 ● FAX (718) 767-1102
email: hq@kepcopower.com ● World Wide Web: http://www.kepcopower.com

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INSTRUCTION MANUAL CORRECTION

Please note the following corrections to the Manual material as indicated:

Not all models listed in Table 1-1 are available. Please contact the factory to verify availability.

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Declaration of Conformity

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

Standard to which Conformity is declared:

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

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

Importer's Name and Address:

REPRESENTATIVE COPY

Type of Equipment: **Component Power Supply**

Model No.: [*PRODUCT MODEL NUMBER*]

Year of Manufacture:

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

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

Saul Kupferberg
(Full Name)

Date: _______________

VP OF SALES
(position)

Conditions of Conformance

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

1. For European applications, requiring compliance to the Low Voltage Directive, 73/23/EEC, this power supply is considered a component product, designed for "built in“ applications. Because it is incomplete in construction, the end product enclosure must provide for compliance to any remaining electrical safety requirements and act as a fire enclosure. (EN61010-1:2001, Cl. 6, Cl. 7, Cl.8, and Cl. 9)

2. This power supply is designed for stationary installation, with mains power applied via a detachable power supply cord or via direct wiring to the source power terminal block.

3. This power supply is considered a Class 1 (earthed) product. It is intended for use as part of equipment meant for test, measurement and laboratory use, and is designed to operate from single phase, three wire power systems. This equipment must be installed within a suitably wired equipment rack, utilizing a three wire (grounded) mains connection. See wiring section of this manual for complete electrical wiring instructions. (EN61010-1:2001, Cl.6.10.1)

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

5. The output wiring terminals of this power supply has not been evaluated for field wiring and, therefore, must be properly configured by the end product manufacturer prior to use.

6. This power supply employs a supplementary circuit protector in the form of a circuit breaker mounted on the front panel. This circuit breaker protects the power supply itself from damage in the event of a fault condition. For complete circuit protection of the end product, as well as the building wiring, it is required that a primary circuit protection device be fitted to the branch circuit wiring. (EN61010-1:2001, Cl. 9.5)

7. Hazardous voltages are present within this power supply during normal operation. All operator adjustments to the product are made via externally accessible switches, controls and signal lines as specified within the product operating instructions. There are no user or operator serviceable parts within the product enclosure. Refer all servicing to qualified and trained Kepco service technicians.

SAFETY INSTRUCTIONS

1. Installation, Operation and Service Precautions

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

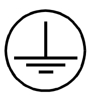
There are no operator serviceable parts or adjustments within the product enclosure. Refer all servicing to trained service technician.

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

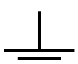
2. Grounding

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

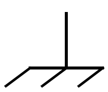
The PROTECTIVE EARTHING CONDUCTOR TERMINAL must properly connected prior to application of source power to the product (see instructions on installation herein) in order to ensure safety from electric shock.



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.

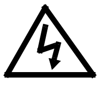


CHASSIS TERMINAL -This symbol indicates frame (chassis) connection, which is supplied as a point of convenience for performance purposes (see instructions on grounding herein). This is not to be confused with the protective earthing point, and may not be used in place of it.

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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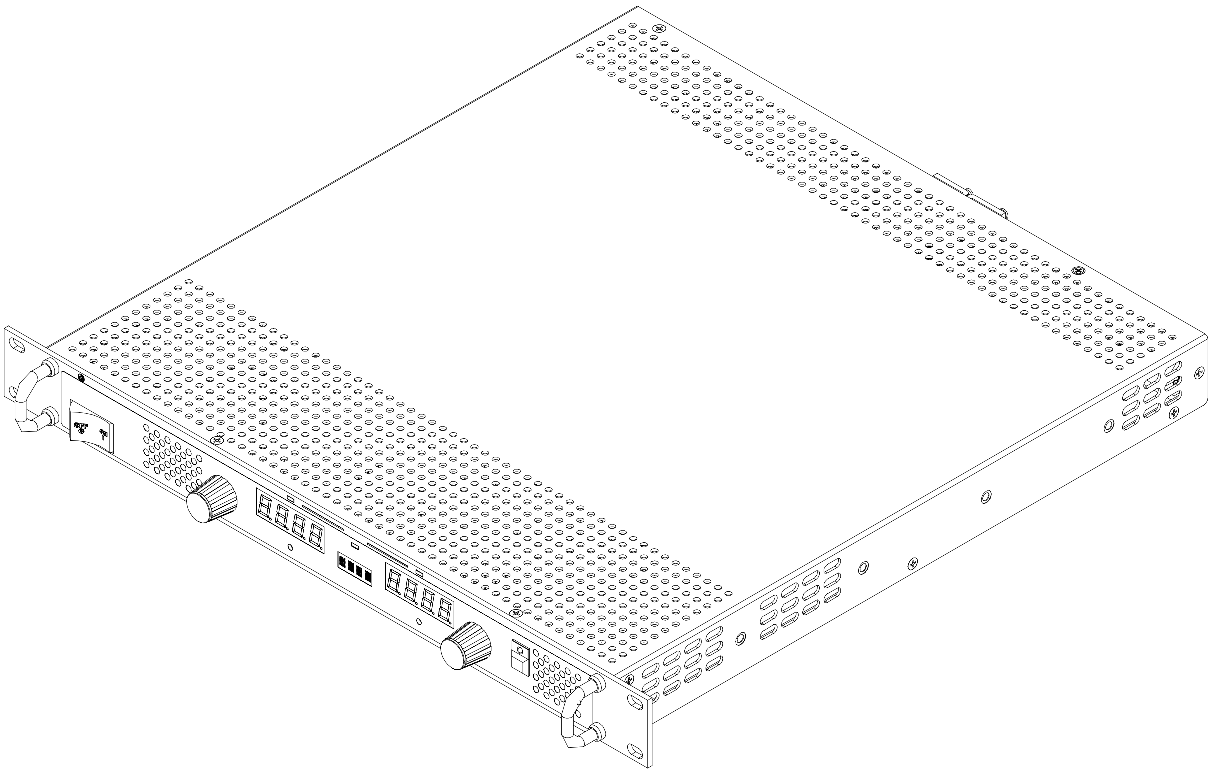


FIGURE 1-1. KLP SERIES POWER SUPPLY

SECTION 1 - INTRODUCTION

1.1 SCOPE OF MANUAL

This manual contains instructions for the installation, operation and service of the KLP series of 1200W output power, stabilized voltage or current, d-c power supplies manufactured by KEPCO, Inc., Flushing, New York, U.S.A.

WARNING

DANGEROUS AND LETHAL POTENTIALS ARE PRESENT, BOTH WITHIN THIS POWER SUPPLY, AND AT THE OUTPUT!

Before proceeding to use the power supply, read this manual very carefully. Caution must be used when working with, and making connections to, this power supply. Use only wires with the proper voltage rating for high voltage connections.

Unless otherwise specified, always connect the test and measuring equipment to the input power source using an isolating transformer having a suitable isolating voltage rating. Follow all instructions regarding the grounding of the test set-up. Refer all servicing to qualified service personnel only.

1.2 GENERAL DESCRIPTION

The KLP Power Supply Series (Figure 1-1) are autoranging, automatic crossover, 1200 watt voltage/current stabilizers with a full rectangular output characteristic within the voltage and current ranges listed in Table 1-1.

Eight models are available, as listed in Table1-1. For those models with the -1200 suffix, a multitude of virtual models can be configured from the front panel. For the -1200 models, the rated voltage, maximum current at rated voltage, rated current and maximum voltage at rated current parameters define the virtual models available within the limit of 1200 Watts of output power (see Figure 1-2).

KLP power supplies operate from wide range 88-265V a-c, 45-66 Hz or 125-420V d-c input source power. Since there are no internal adjustments, KLP Power Supplies offer excellent output voltage/current stability and easy calibration.

Output voltage and current are displayed on independent LED displays. Control of the KLP can be either local, via the front panel controls and displays, or remote - using either analog signals (applied to the Analog I/O Port), or digital programming via either the IEEE 488.2 (GPIB) or RS 232 communication bus. Digital control is done with 12 bits of resolution over the entire voltage/current range.

The full-rack cross section permits mounting in a standard 19-inch wide rack (for optional chassis slides, see Table 1-4). Load connections are made at the rear panel. Sensing, monitor, and current share terminals are also available at the rear panel. Outline dimensions are provided in Figure 1-3.

1.3 SPECIFICATIONS

Table 1-1 lists the parameters applicable to individual models. The maximum operating voltage and current for KLP models with the -1200 suffix are defined by the maximum voltage for rated current and maximum current for rated voltage values (see Table 1-1) within 1200 watts as shown in Figure 1-2. Table 1-2 lists general specifications applicable to all models except where otherwise noted.

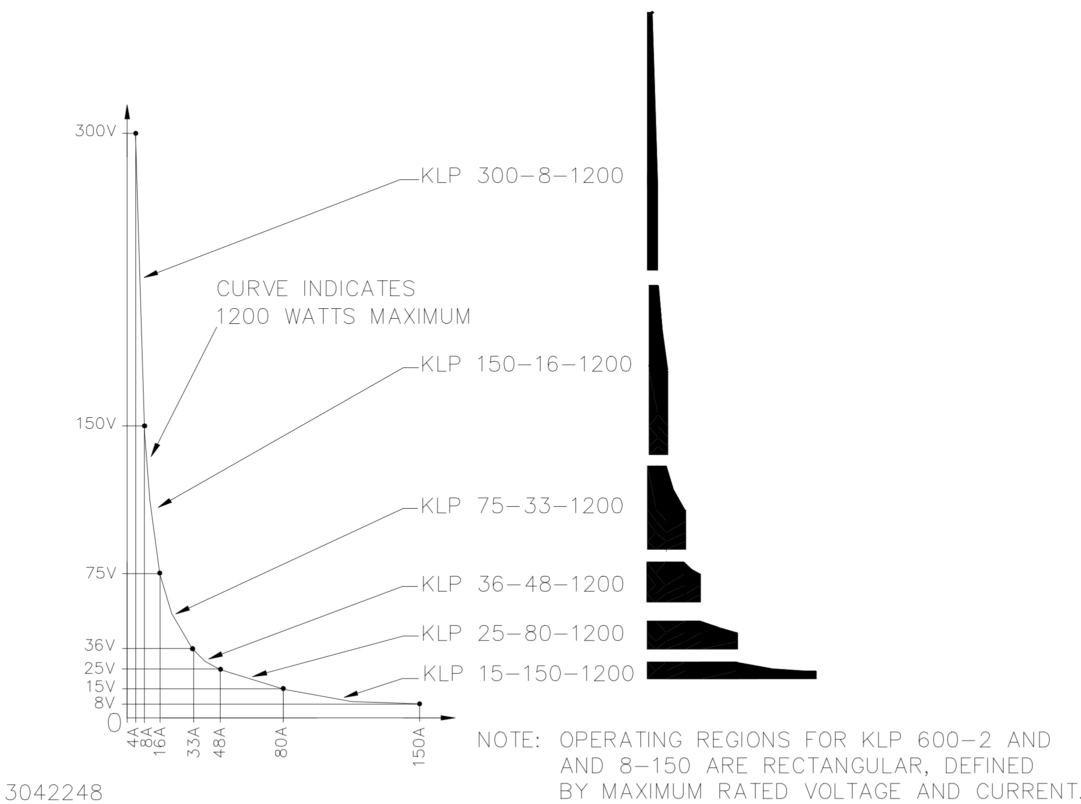


FIGURE 1-2. KLP OPERATING REGIONS

TABLE 1-1. MODEL PARAMETERS

Model number	Rated Voltage Range	Maximum current for rated voltage	Rated Current Range	Maximum voltage for rated current	Ripple and noise		Efficiency @115 Va-c
					rms	p-p(3)	
KLP 8-150(1)	0-8V	150A@8V	0-150A	8V@150A	10 mV	75 mV	82%
KLP 15-150-1200	0-15V(2)	80A@15V	0-150A(2)	8V@150A	10 mV	75 mV	82%
KLP 25-80-1200	0-25V(2)	48A@25V	0-80A(2)	15V@80A	10 mV	75 mV	82%
KLP 36-48-1200	0-36V(2)	33.3A@36V	0-48A(2)	25V@48A	10 mV	125 mV	83%
KLP 75-33-1200	0-75V(2)	16A@75V	0-33.3A(2)	36V@33.3A	10 mV	125 mV	84%
KLP 150-16-1200	0-150V(2)	8A@150V	0-16A(2)	75V@16A	10 mV	125 mV	86%
KLP 300-8-1200	0-300V(2)	4A@300V	0-8A(2)	150V@8A	20 mV	300 mV	87%
KLP 600-2A(1)	0-600V	2A@600V	0-2A	600V@2A	30 mV	400 mV	88%

(1) Conventional voltage/current stabilizer - no virtual models
(2) The maximum current and voltage are constrained by the 1200 watt power limitation, see figure 1-2
(3) Bandwidth: 20MHz

TABLE 1-2. KLP SPECIFICATIONS

SPECIFICATION		RATING/DESCRIPTION	CONDITION
INPUT CHARACTERISTICS			
a-c voltage	nominal	100-240 Va-c	Single Phase
	range	88-265 Va-c	Wide Range
d-c voltage	range	125-420 Vd-c	No regulatory approval
Frequency	nominal range	50-60 Hz	
	maximum	45-440 Hz	Increased Leakage above 66 Hz
Power Factor	typical	0.99	meets EN 61000-3-2
Maximum Input Current	120 Va-c	13A rms	Rated load (1200W)
	240 Va-c	6.5A rms	Rated load (1200W)
Inrush Current	265 Va-c	40A	Peak
	132 Va-c	20A	Peak
Input Fusing		Circuit Breaker	2-line
Low a-c Protection		Self protected	No Fixed Limits
Output hold up	typical	10 milliseconds	Ride Through
Leakage Current	115 Va-c, 60Hz	5mA	
	230 Va-c 50Hz	10mA	
OUTPUT CHARACTERISTICS			
Type of stabilizer		CV/CL	Voltage/Current
Adjustment range	voltage	0-100% of rated voltage	no minimum load required
	current	0-100% of rated current	no minimum load required
Source effect	voltage	0.01% E_{max}	over full source range
	current	0.01% I_{max}	
Load effect	voltage	0.01% E_{max}	over full load current range
	current	0.02% Imax	
Temperature effect	voltage	0.02%/deg C	0-50 deg C
	current	0.05%/deg C	
Time effect (drift)	voltage	0.05%/24hr	after 30 min warmup
	current	0.05%/24hr	
Error sensing		0.25 volts per wire	above rated output
Isolation voltage		600 Vd-c or peak	either output terminal to ground
Transient recovery for load change	excursion	1% of E_{max}	50% load step 2A/microsecond max
	recovery	0.2 msec	return to 0.1% of setting
Turnon/turnoff overshoot		same as load transient response limits	
Overvoltage protection	voltage	programmable	latched (1)
Overcurrent protection	current	programmable	latched (1)
Overtemperature protection		Shutdown	latched (1)
Open Load wire protection		Shutdown	latched (1)
Parallel operation		Active load sharing within 5% of Io rated	Up to 5 units, maximum

TABLE 1-2. KLP SPECIFICATIONS (Continued)

SPECIFICATION		RATING/DESCRIPTION	CONDITION
GENERAL (ENVIRONMENTAL) SPECIFICATIONS			
Temperature	operating	-20 to +50 deg C	Rated load. Derate at 25W per °C between 50 and 70°C.
	storage	-40 to +85 deg C	
Cooling		3 internal d-c 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 10000 ft.	0-3,000 ft: 100%, linear derating to 70% of power at 10,000ft.
PHYSICAL CHARACTERISTICS			
Dimensions	English	1.75'H x 19"W x 17.5"D	depth excluding connectors and terminal blocks (See Figure 1-3.)
	metric	44.45 x 482.6 x 443.7 mm	
Weight	English	15 lbs	
	metric	6.82kg	
Source power connector		IEC 320-C19 appliance inlet	250 Va-c, 16A (VDE); 125V a-c, 20A (UL)
Load connections	8-36V models	Nickel plated copper busbars	Provision for safety covers
	75-600V models	Shocksafe Euroblock	
Analog programming port.		15 pin D-sub	
Digital programming port	primary	Standard GPIB connector	IEEE 488.2 (GPIB)
	secondary	9 pin D-sub	RS 232
Direct output control		5 position low profile Euroblocks	
PROGRAMMING CHARACTERISTICS - LOCAL			
Local control		rotary encoders	panel mounted
Local control resolution	Coarse	~100 LSB/step	depress control for Fine resolution
	Fine	1 LSB/step	
Setting range		0-100% of rating	KLP will decrement limit to maintain 1200 W maximum
Power up settings	voltage	defaults to zero	DIP switch 3 set to off. (If DIP switch 3 set to ON, power up voltage and current set to last value set prior to power down.)
	current	defaults to minimal value	
Protection Limits (2)	Emax	20-120%	Programmable; accessed via front panel protect switch or IEE 488.2 bus command.
	Imax	60-120%	

TABLE 1-2. KLP SPECIFICATIONS (Continued)

SPECIFICATION		RATING/DESCRIPTION	CONDITION
PROGRAMMING CHARACTERISTICS - ANALOG			
Analog remote control	selection	Activate with jumper at analog programming connector	Recognized during power up.
	isolation	Safety Extra Low Voltage (SELV)	referenced to chassis
Programming by voltage	voltage	0-10V	Programmable
	current	minimal value-10V	
Programming by resistance	voltage	0-10K ohms	Programmable
	current	0-10K ohms	
Readback		0-10V proportional signal	Proportional to analog control voltage/resistance
Remote inhibit		TTL compatible	
Composite status flag		Isolated form C contacts	Programmable functions (PAR. 2.7.10)
Programming time		20 milliseconds	10% to 90% E_{out}
PROGRAMMING CHARACTERISTICS - DIGITAL			
Digital remote control	isolation	Safety Extra Low Voltage (SELV)	referenced to chassis
	format	compatible with SCPI protocols	W95, W98 and NT operating systems
Programming resolution		0.024% of Emax and Ilim	
Programming accuracy		0.05% of Emax and Ilim	
Readback resolution		0.024% of Emax and Ilim	
Readback accuracy		0.1% of Emax and Ilim	
Status reporting		OVP, OCP, OTP, output lead fault (OLF), fan failure, power loss	See PAR. 1.4.4 and 1.4.8

NOTES:
(1) Requires the a-c input to be recycled for restart
(2) OVP and OCP limit adjustment is disabled in Remote Analog Mode

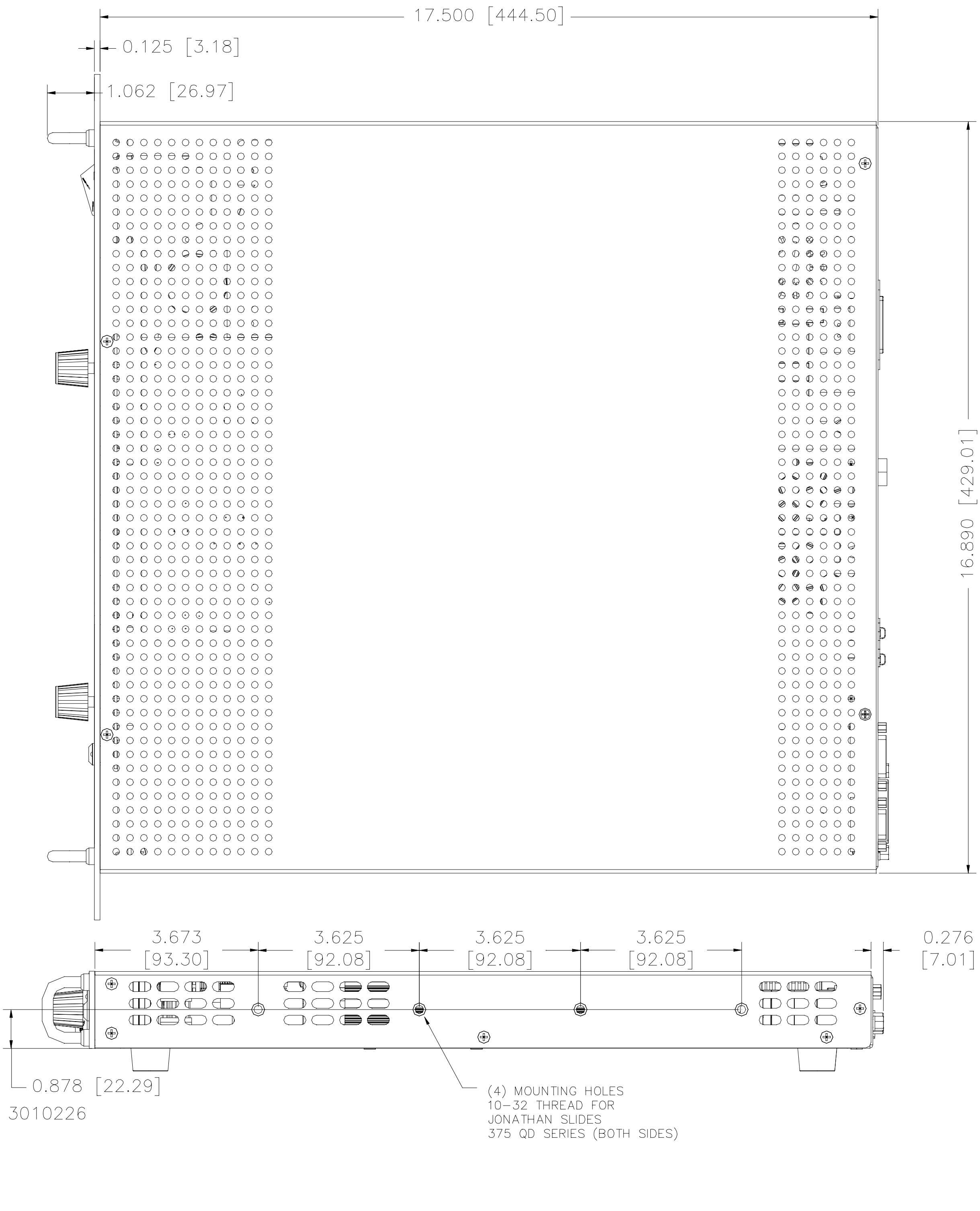
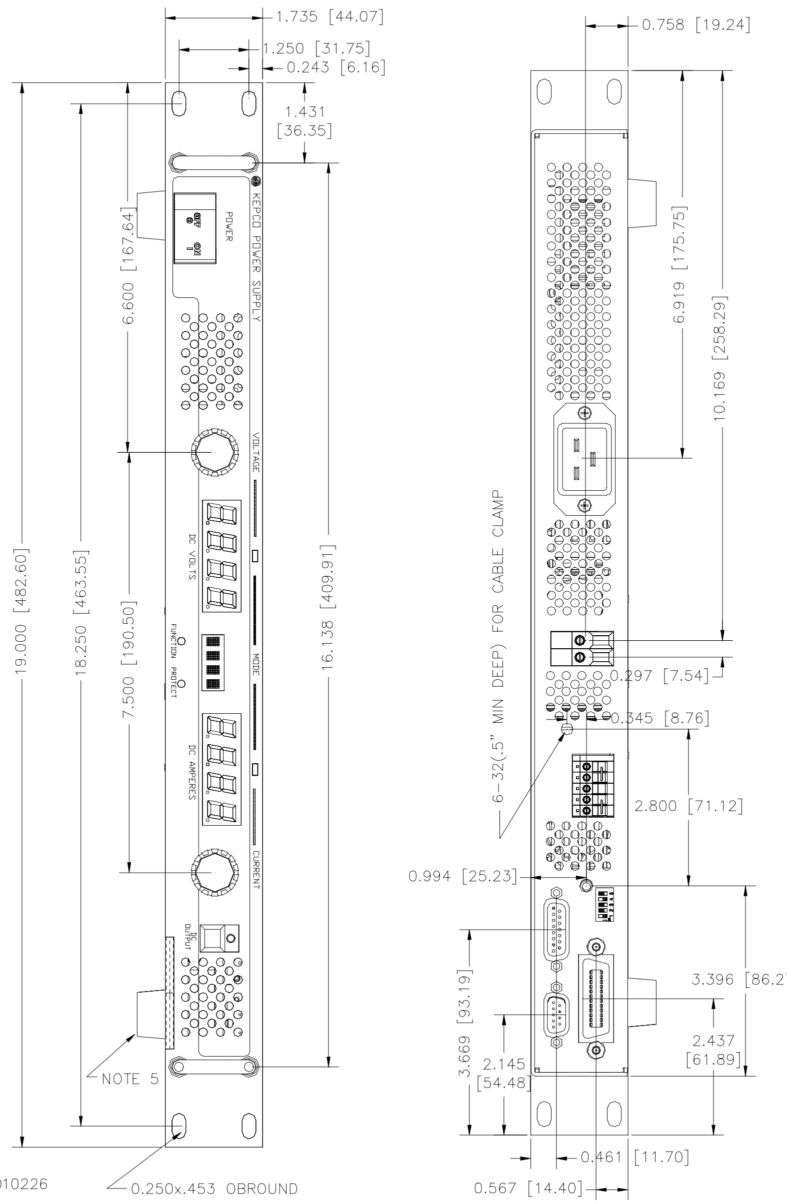


FIGURE 1-3. KLP SERIES POWER SUPPLY, MECHANICAL OUTLINE DRAWING (SHEET 1 OF 2)



NOTES:

1. MATERIAL:
   A) CHASSIS: 0.064 THK. ALUM. 5052-H32
   B) COVER: 0.064 THK. ALUM. 5052-H32
   C) FRONT PANEL: 0.125 THK. ALUM. 6061-T6

2. FINISH:
   A) CHASSIS, COVER AND BACKPLATE: YELLOW IRIDITE
   B) FRONT PANEL: KEPCO GREY,

3. DIMENSIONS IN PARENTHESES ARE IN MILLIMETERS

4. TOLERANCES:
   A) BETWEEN MOUNTING HOLES: ±1/64 (±0.4)
   B) ALL OTHER DIMENSIONS: ±1/32 (±0.8) EXCEPT AS NOTED

5. REMOVE 4 PLASTIC FEET BEFORE RACK INSTALLATION
   CAUTION: IF REINSTALLATION OF FEET IS NECESSARY, FAILURE TO REINSTALL FEET USING ALL HARDWARE SPECIFIED OR LONGER SCREW CAN RESULT IN DAMAGE TO THE UNIT.
   SCREW: 6-32 X 0.50 IN. (MAX), BHPH (P/N 101-0019)
   LOCKWASHER, #6, 0.018 IN. THK (P/N 103-0015)
   FLAT WASHER, #6, 0.028 IN. THK (P/N 103-0100)

FIGURE 1-3. KLP SERIES POWER SUPPLY, MECHANICAL OUTLINE DRAWING (SHEET 2 OF 2)

1.4 FEATURES

1.4.1 LOCAL CONTROL

Two front panel rotary encoders allow setting of voltage and current setpoints and limits. Operating mode of the power supply is indicated by lighting either a green (Constant Voltage) or amber (Constant Current) LED. The output can be enabled or disabled by the front panel DC OUTPUT switch; an associated indicator lights when the output is enabled (applied to the load). Two 4-character LEDs normally display actual output voltage and current, or programmed voltage and current limits in setpoint mode. A selectable feature allows the unit to power up set either to 0 Volts, minimum Amperes (default) or to the previous settings for voltage and current when the unit was powered down (see Table 2-2).

The voltage and current controls and their associated LED displays are also used with the FUNCTION switch and the 4-character status display for various other functions described in PAR. 3.2. A local lockout feature (see PAR. 3.2.2.1) prevents alteration of the power supply settings from the front panel when the power supply is operating in remote mode.

1.4.2 REMOTE CONTROL

Remote control of the KLP Power Supply can be accomplished either through digital or analog programming.

1.4.2.1 DIGITAL PROGRAMMING

Digital control is available directly via either the IEEE 488.2 (GPIB) or RS232 ports using SCPI commands. All features available in local mode can be accessed in remote mode through digital programming, as well as some that are only available via digital remote programming (PAR. 3.3.1). Front panel indicators showing operating mode and output voltage and current are active when digital programming is used. Refer to PAR’s. 3.3, 3.4 and 3.6 for more information.

1.4.2.2 ANALOG PROGRAMMING

KLP Power Supplies can also be controlled remotely using switch selectable voltage or resistance. Analog programming functions include voltage and current programming, enabling/disabling the output, and voltage and current readback (see PAR. 3.7).

Full scale programming/readback can be programmed using either an input analog voltage from 0 to 10V or by an input analog resistance from 0 to 10KOhms. See PAR. 3.7 for more information.

1.4.3 DIGITAL CALIBRATION

Internal adjustments of the KLP Power Supply are automatic. Calibration can be performed in either local or remote digital mode, using a calibrated DVM and a corresponding precision shunt resistor.

Calibration constants for programming and read-back activities are calculated by the microcontroller and stored in the non-volatile memory. No internal adjustments are necessary The previous calibration is saved and can be restored if desired. The original factory calibration can also be restored. Calibration is password-protected. Refer to Section 4 for more information.

1.4.4 OVERVOLTAGE/OVERCURRENT PROTECTION

Overvoltage and Overcurrent protection values can be individually programmed. The range for overvoltage and overcurrent values are 0.2 to 1.2 x $E_O$max, 0.6 to 1.2 x $I_O$max. If the output voltage/current exceeds the overvoltage/overcurrent protection value, the protection circuit latches the output off, flashes an overvoltage (OVP) or overcurrent (OCP) error message on the status display and sets a status bit that can be retrieved through the RS 232 or GPIB port. The N.O. and N.C. contacts of the relay provide status flags via the Analog I/O port connector. The default values are 1.2 x $E_O$max for overvoltage protection, and 1.2 x $I_O$max for overcurrent protection. Refer to PAR. 3.2.7 for more information.

1.4.5 USER-DEFINED VOLTAGE/CURRENT LIMITS (VIRTUAL MODELS)

The KLP Power Supply can be programmed to user-defined values that can be lower than the maximum values. For example, the KLP 36-48-1200, will automatically be limited to 1200 Watts as illustrated in Figure 1-2, however arbitrary limits, e.g., 40A@30V or 30A@35V can be established. Once the limits are set, setting values exceeding the limit values will not be accepted. Refer to PAR. 3.2.5 for more information.

1.4.6 STORAGE OF USER-PROGRAMMED ACTIVE SETTINGS

The KLP Power Supply contains 40 memory locations that can be used to store active settings. This feature is only available via digital remote programming. Values are stored in the nonvolatile memory, and are retained when the unit is turned off. Refer to PAR. 3.3.1.1 for more information.

1.4.7 USER-PROGRAMMED SEQUENCES

The KLP Power Supply contains 100 memory locations for programming sequences that can program the KLP to produce a variety of sequential output operations. Each memory location accommodates a value for voltage and current and a dwell time (how long the parameter is to be in effect). Values are stored in the volatile memory, and are lost when the unit is turned off. Refer to PAR. 3.3.1.2 for more information.

1.4.8 BUILT-IN PROTECTION

KLP Series Power Supplies provide built-in protection against the conditions listed below. In each case, a detected fault results in immediate latched shutdown of the power supply output. In addition, the status display flashes the appropriate indication and the status bit is set for retrieval through either of the digital programming ports. If the internal relay is configured for FAULT mode (factory default setting, see PAR. 1.4.9) the relay will toggle to provide a composite fault indication at the analog programming port. The indication time is limited by internal hold-up capacity for PWR faults (as the unit shuts down, when power is no longer sufficient to power the relay it de-energizes.

a. **Overtemperature (OTP).** Monitors heatsink temperature; trips if it exceeds factory set limit.

b. **Overvoltage (OVP) or overcurrent (OVC) at the output.** (See PAR. 1.4.4)

c. **Fan failure (FAN).** Monitors all three internal cooling fans; trips If failure of any fan.

d. **Output Lead Fault (OLF)**. Monitors output power and sense leads; trips if any discontinuity (open circuit) is detected.

e. **Source Power Loss (PWR).** Monitors internal d-c bus voltage at output of PFC; trips if low a-c input or PFC failure occurs.

1.4.9 INTERNAL RELAY

An internal relay provides common, normally open and normally closed contacts available to the user via the analog I/O connector. This relay is normally programmed (factory default) to energize upon detection of a system fault (FAULT mode). The relay may also be programmed to be energized either at the user's discretion using SCPI commands (MANUAL mode), or as part of a user-specified program using LIST commands (PROGRAM mode). Refer to PAR. 2.7.10 for details.)

1.4.10 MASTER/SLAVE CONTROL

For applications that require the use of multiple KLP power supply in either series (for higher voltage) or parallel (for redundancy or higher current) the master/slave feature allows a single power supply (the master) to automatically control both outputs to achieve the desired output. Refer to PAR. 2.7.8 for details

1.5 EQUIPMENT SUPPLIED

Equipment supplied with the unit is listed in Table 1-3.

TABLE 1-3. EQUIPMENT SUPPLIED

ITEM	PART NUMBER	QUANTITY
Source power connector	142-0381	1
Jumper (28 AWG or larger bus wire) for local sensing connections	172-0298	2
Analog I/O port mating connector	142-0528	1

1.6 ACCESSORIES

Accessories for the KLP Power Supply are listed in Table 1-4.

TABLE 1-4. ACCESSORIES

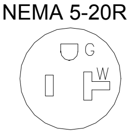
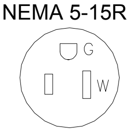
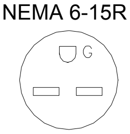
ITEM	FUNCTION	PART NUMBER
Line Cord Set (125V/20A)	2.5m long cord set, provides for source power connection. Mates with NEMA 5-20R receptacle (see adjacent figure). Supports rated load power over mains voltage range of 90-136V a-c. NEMA 5-20R 	118-0776
Line Cord Set (125V/15A)	2.5m long cord set, provides for source power connection. Mates with NEMA 5-15R receptacle (see adjacent figure). Supports restricted load power over mains voltage range of 90-136V a-c (contact Kepco Sales Engineering for details). NEMA 5-15R 	118-1136
Line Cord Set (250V/15A)	2.5m long cord set, provides for source power connection. Mates with NEMA 6-15R receptacle (see adjacent figure). Supports rated load power over mains voltage range of 180-265V a-c. NEMA 6-15R 	118-1137

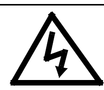
TABLE 1-4. ACCESSORIES (CONTINUED)

ITEM	FUNCTION	PART NUMBER
IEEE 488 (GPIB) Cable, 1m long	Connect KLP Power Supply to GPIB bus.	SNC 488-1
IEEE 488 (GPIB) Cable, 2m long	Connect KLP Power Supply to GPIB bus.	SNC 488-2
IEEE 488 (GPIB) Cable, 4m long	Connect KLP Power Supply to GPIB bus.	SNC 488-4
Chassis Slide (2)	Allows rack-mounted units to slide in and out.	108-0239 (Jonathan 375-QD Series)
Analog Connector Backshell	Locks analog port mating connector to KLP via jackscrews.	108-0204
Loop Back Test Connector	Used for verification of RS 232 operation.	195-0112

1.7 SAFETY

There are no operator serviceable parts inside the case. Service must be referred to authorized personnel. Using the power supply in a manner not specified by Kepco. Inc. may impair the protection provided by the power supply. Observe all safety precautions noted throughout this manual. Table 1-5 lists symbols used on the power supply or in this manual where applicable.

TABLE 1-5. SAFETY SYMBOLS

SYMBOL	MEANING
	CAUTION: RISK OF ELECTRIC SHOCK.
	CAUTION: REFER TO REFERENCED PROCEDURE.
WARNING	INDICATES THE POSSIBILITY OF BODILY INJURY OR DEATH.
CAUTION	INDICATES THE POSSIBILITY OF EQUIPMENT DAMAGE.

SECTION 2 - INSTALLATION

2.1 UNPACKING AND INSPECTION

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

2.2 TERMINATIONS AND CONTROLS

2.2.1 FRONT PANEL CONTROLS AND INDICATORS. Refer to Figure 2-1 and Table 2-1.

2.2.2 REAR PANEL CONNECTORS AND SWITCH. Refer to Figure 2-2 and Tables 2-2 through 2-6.

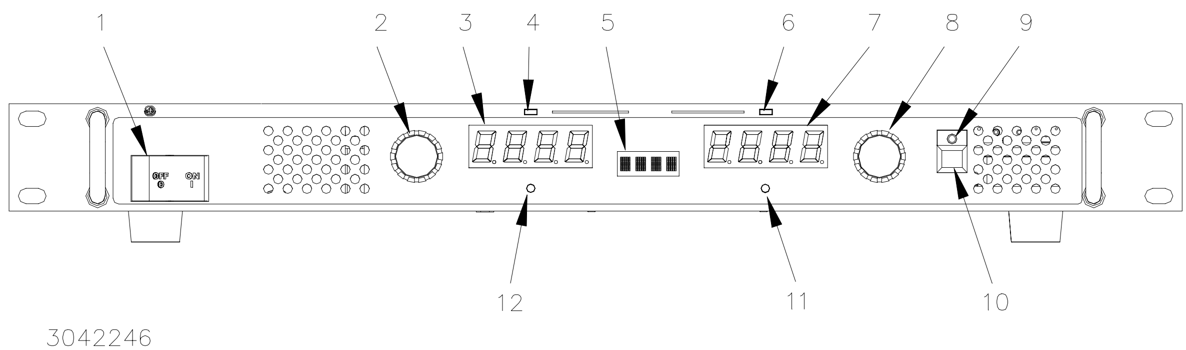


FIGURE 2-1. KLP SERIES, FRONT PANEL CONTROLS AND INDICATORS

TABLE 2-1. CONTROLS, AND INDICATORS

FIGURE 2-1 INDEX NO.	CONTROL OR INDICATOR	FUNCTION
1	POWER ON/OFF Circuit Breaker	Turns the power supply on or off. Applies input power to power supply internal circuits. Circuit breaker provides input overload protection.
2	VOLTAGE control/switch	Multifunction rotary encoder with momentary contact pushbutton switch. Rotate to set output voltage (PAR. 3.2.6) and overvoltage limit (PAR. 3.2.7). Also used to enter SET mode of voltage programming (PAR. 3.2.6.2), and to perform calibration (PAR.4.3).
3	DC VOLTS display	Four-digit LED display that shows voltage settings: a. Shows actual output voltage (default). b. Shows voltage set point (PAR. 3.2.6.2) or overvoltage limit when function selected (PAR. 3.2.7).
4	CV indicator	Green LED lights to indicate power supply is operating in constant voltage mode (see PAR. 3.2.6).
5	Status 4 character display	Displays active function or blinks for error messages. Normally blank (VOLTAGE and CURRENT LEDs display actual voltage and current).
6	CC indicator	Amber LED lights to indicate power supply is operating in constant current mode (see PAR. 3.2.6).

TABLE 2-1. CONTROLS, AND INDICATORS (CONTINUED)

FIGURE 2-1 INDEX NO.	CONTROL OR INDICATOR	FUNCTION
7	DC AMPERES display	Four-digit LED display that shows current settings: a. Shows actual output current (PAR.3.2.6). b. Shows current set point or overcurrent limit when function selected (PAR. 3.2.6.2). c. Shows GPIB address (PAR. 3.2.8), baud rate (PAR. 3.2.9). d. Shows password (PAR. 3.2.5 and PAR. 4.3).
8	CURRENT control/ momentary switch	Multifunction rotary encoder. Rotate to set output current (PAR. 3.2.6) and overcurrent limit (PAR. 3.2.7). Also used to enter SET mode of current programming (PAR. 3.2.6.2), change GPIB address (PAR. 3.2.8), change RS232 baud rate (PAR. 3.2.9), enter Virtual Model password (PAR. 3.2.5), and enter calibration password and perform calibration (PAR. 4.3)
9	DC OUTPUT indicator	Green LED lights when DC output is enabled. LED is off when output is disabled.
10	DC OUTPUT on/off switch	Enables or disables the DC Output. When output is disabled, current and voltage are programmed to minimal value and zero, respectively (PAR. 3.2.3). Also used to accept front panel inputs.
11	PROTECT momentary switch	Used to set overvoltage and overcurrent (PAR. 3.2.7) protection limits. NOTE: Requires a thin tool (e.g., end of paper clip) to press switch.
12	FUNCTION momentary switch	Used to enter calibration (PAR. 4.3), change GPIB address (PAR. 3.2.8) and change RS232 baud rate (PAR. 3.2.9) and (for -1200 models) set user-determined limits on voltage and current (virtual model) (PAR. 3.2.5). NOTE: Requires a thin tool (e.g., end of paper clip) to press switch.

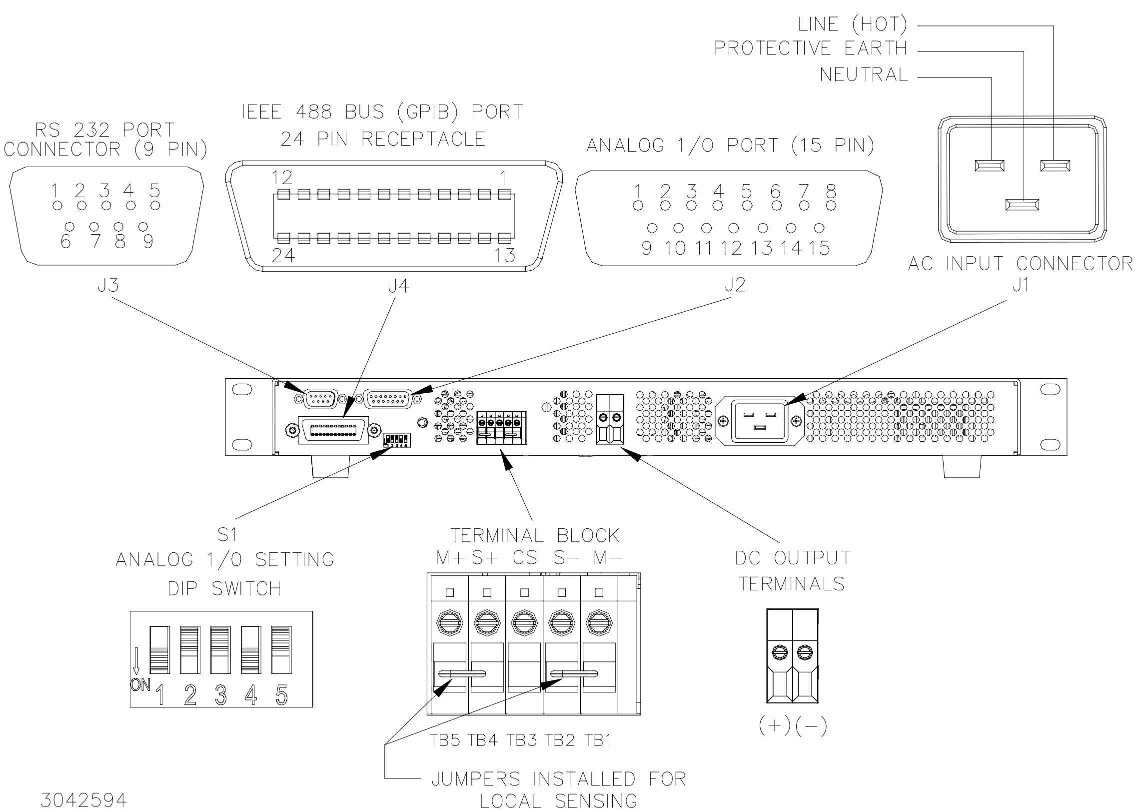


FIGURE 2-2. KLP SERIES (75V - 600V), REAR PANEL SWITCH AND CONNECTORS

TABLE 2-2. ANALOG I/O SWITCH FUNCTIONS

DIP SWITCH POSITION	FUNCTION	SETTINGS
1	Allows analog programming commands for **voltage** to be provided by either variable voltage (PAR. 3.7.3) or resistance (PAR. 3.7.2). When resistance mode is selected, an internal 1mA current generator provides the reference for voltage programming. (PAR. 3.7.2)	ON: Selects Resistance OFF: Selects Voltage
2	Allows analog programming commands for **current** to be provided by either variable voltage (PAR. 3.7.3) or resistance (PAR. 3.7.2). When resistance mode is selected, an internal 1mA current generator provides the reference for current programming.	ON: Selects Resistance OFF: Selects Voltage
3	When enabled (ON), allows retention of the last entered setpoint values for voltage and current in non-volatile memory for recall at the next power-up sequence. If not selected (OFF, default condition), the stored values will be 0 volts, minimum amps. The switch setting is detected upon unit power-up.	ON: Save and recall previous setpoint values upon power-up. OFF: Power-up set to 0 Volts and minimum current.
4	NOT USED	
5	Allows locking of the front panel controls. (see PAR. 3.2.2.1)	ON: Local controls locked. OFF: Local controls enabled

TABLE 2-3. IEEE 488 PORT CONNECTOR (J4) PIN ASSIGNMENTS

CONNECTOR	PIN	SIGNAL NAME	FUNCTION
IEEE 488 PORT	1	DI01	I/O Line
	2	DI02	I/O Line
	3	DI03	I/O Line
	4	DI04	I/O Line
	5	EOI	End or Identify
	6	DAV	Data Valid
	7	NRFD	Not Ready for Data
	8	NDAC	Not Data Accepted
	9	IFC	Interface Clear
	10	SRQ	Service Request
	11	ATN	Attention
	12	SHIELD	Shield
	13	DI05	I/O Line
	14	DI06	I/O Line
	15	DI07	I/O Line
	16	DI08	I/O Line
	17	REN	Remote Enable
	18	GND	Ground (signal common)
	19	GND	Ground (signal common)
	20	GND	Ground (signal common)
	21	GND	Ground (signal common)
	22	GND	Ground (signal common)
	23	GND	Ground (signal common)
	24	LOGIC GND	Logic Ground

TABLE 2-4. RS232 PORT CONNECTOR (J3) PIN ASSIGNMENTS

CONNECTOR	PIN	SIGNAL NAME	FUNCTION
RS232-C PORT	1	SGND	Signal Ground
	2	RXD	Receive Data
	3	TXD	Transmit Data
	4	DTR	Data Terminal Ready (protocol not used)
	5	SGND	Signal Ground
	6	DSR	Data Set Ready (protocol not used)
	7	RTS	Request To Send (protocol not used)
	8	CTS	Clear To Send (protocol not used)
	9	SGND	Signal Ground

TABLE 2-5. REAR TERMINAL BLOCK ASSIGNMENTS

TERMINAL	FUNCTION
M+	Positive output monitor connection (TB5) (see PAR. 2.7.5.1)
S+	Positive sense connection (TB4) (see PAR. 2.7.5.1)
CS	Current Share bus (TB3) (see PAR. 2.7.7.1)
S-	Negative sense connection (TB2) (see PAR. 2.7.5.1)
M-	Negative output monitor connection (TB1) (see PAR. 2.7.5.1)

TABLE 2-6. ANALOG I/O CONNECTOR (J2) PIN ASSIGNMENTS

PIN	SIGNAL NAME	FUNCTION
1	Cref	Analog signal which programs output current from zero to full scale. Voltage or resistance programming is selected via DIP switch position 2 (See Table 2-2). Refer to PAR. 3.7.3 for voltage programming and 3.7.2 for resistance programming.
2	FAULT_NO	Connected to FAULT_COM (pin 4) for fault condition. (1)
3	Vref	Analog signal which programs output voltage from zero to full scale. Voltage or resistance programming is selected via DIP switch position 1 (See Table 2-2). Refer to PAR. 3.7.3 for voltage programming and 3.7.2 for resistance programming.
4	FAULT_COM	Fault relay common. (1)
5		Reserved.
6	VOLT_RBACK	Analog signal which represents output voltage from zero to full scale. The full scale programming level sets the full scale readback level (see PAR. 4.3.3).
7	CURR_RBACK	Analog signal which represents output current from zero to full scale. The full scale programming level sets the full scale readback level (see PAR. 4.3.3).
8	REM_INH	Allows single signal to control output on/off. See PAR. 3.7.1. 0 = Output is off 1 = Output is on
9	GND	Ground
10	FAULT_NC	Connected to FAULT_COM (pin 4) for no fault condition (1)
11	GND	Ground
12	ANALOG_CTRL	Enables or disables analog programming (see PAR. 3.7). 1 = Analog programming disabled 0 = Analog programming accepted (use jumper on mating connector to connect to pin 9, 11, 13 or 15 (ground).
13	GND	Ground
14	EXT_TRG	Performs same function as SCPI *TRG command if unit is programmed via digital remote mode. Transition from 1 (+5V) to 0 (ground) causes values established by VTRIG and CTRIG commands to become VSET and CSET (see PAR. 3.3.1.3).
15	GND	Ground

(1) Refer to PAR. 2.7.10 to configure internal relay.

2.3 SOURCE POWER REQUIREMENTS

This power supply operates with the installed circuit breaker from either d-c or single phase a-c mains power over the voltage and frequency ranges specified in Table 1-2 without adjustment or modification.

2.4 COOLING

The power devices used within the power supply are maintained within their operating temperature range by means of internal heat sink assemblies cooled by three internal (d-c type) cooling fans.

ALL INLET AND EXHAUST OPENINGS AT THE FRONT AND REAR OF THE POWER SUPPLY CASE MUST BE KEPT CLEAR OF OBSTRUCTION TO ENSURE PROPER AIR ENTRY AND EXHAUST. Although not a requirement, it is recommended that side and top vent openings be clear of obstruction for more efficient cooling. Periodic cleaning of the power supply interior is recommended by authorized service personnel only (see KLP Service Manual for instructions).

If the power supply is rack mounted, or installed within a confined space, care must be taken that the ambient temperature, which is the temperature of the air immediately surrounding the power supply, does not rise above the specified limits (see Table 1-2).

2.5 PRELIMINARY OPERATIONAL CHECK

A simple operational check after unpacking and before equipment installation is advisable to ascertain whether the power supply has suffered damage resulting from shipping.

Refer to Figures 2-1 and 2-2 for location of operating controls and electrical connections. Table 2-1 explains the functions of operating controls/indicators and keypad keys, respectively.

NOTE: This test must be performed with IEEE 488, RS232, and ANALOG I/O ports disconnected, and ANALOG I/O SETTINGS switch positions 3 and 5 set to OFF.

1. With **POWER** circuit breaker set to OFF position, connect the power supply to source power (see PAR. 2.7.2).

2. With no load connected, set **POWER** circuit breaker to the ON position. Each time the unit is turned on an internal self-test is performed. After the test has been successfully completed, the unit displays the following:

   - The status display flashes **`MODL`** (model) for two seconds while the **DC VOLTS** display shows Eo_{MAX} and the **DC AMPERES** display shows Io_{MAX}. (E.g. for model 75-33-1200, **DC VOLTS** reads **`75`** and **DC AMPERES** reads **`33`**.)

   - Then the status display flashes **`VIRT`** (Virtual model) for two seconds while the **DC VOLTS** display shows Eo_{MAX} and the **DC AMPERES** display shows the current corresponding to 1200W. (E.g. for model 75-33-1200, **DC VOLTS** reads **`75`** and **DC AMPERES** reads **`16`**.)

   - Then the status display flashes **`PROT`** (protection limits) for two seconds while the **DC VOLTS** display shows 120% of Eo_{MAX} and the **DC AMPERES** display shows 120% of current corresponding to 1200W. (E.g. for model 75-33-1200, **DC VOLTS** reads **`90.0`** and **DC AMPERES** reads **`19.2`**.)

- Then the status display reads **SET** (setpoint mode), the **DC VOLTS** display reads **0000** Volts, the **DC AMPERES** display reads minimum Amperes (see Note 1, below).

NOTES: 1. A minimum programmed current (actual value depends on model) is required to ensure proper operation of the power supply under all load conditions. Programmed current is automatically set to be at least the minimum current.

2. If an error indication is blinking in the Status display, refer to Table 3-1 for an explanation of error codes.

3. Rotate **VOLTAGE** adjust knob clockwise. Verify that **DC VOLTS** display increases in large (X 100) increments.

4. Press and rotate **VOLTAGE** adjust knob clockwise. Verify the **DC VOLTS** display increases in finer increments than step 3.

5. Adjust **VOLTAGE** adjust knob clockwise until Status display reads **>MAX**. Tap either **VOLTAGE** or **CURRENT** adjust knob once to enter values. Verify Status display is blank

6. Connect a digital voltmeter (DVM) to the (M+) and (M–) terminals on the rear panel.

7. Press and release **DC OUTPUT** switch to enable the output. Verify **DC OUTPUT** indicator lights.

8. Compare the programmed output voltage value (step 5) with the voltage reading of the DVM; the difference between the two should not exceed 0.05% of the maximum voltage of the unit.

9. Compare the voltage reading of the **DC VOLTS** display with that of the DVM; the difference between the two should not exceed 0.1% of the maximum voltage of the unit.

10. Enter different value for output voltage, then repeat steps 8 and 9 using different values for programmed voltage.

11. Disable the output by pressing and releasing **DC OUTPUT** switch; verify front panel **DC VOLTS** and **DC AMPERES** displays read 0.0V and minimal current and the DC OUTPUT indicator is off.

2.6 INSTALLATION

2.6.1 RACK MOUNTING

The unit is intended to be mounted directly in a 19-inch wide rack. Optional slides (see Table 1-4) can be used.

2.7 WIRING INSTRUCTIONS

Interconnections between an a-c power source and the power supply, and between the power supply and its load are as critical as the interface between other types of electronic equipment. If optimum performance is expected, certain rules for the interconnection of source, power supply and load must be observed by the user. These rules are described in detail in the following paragraphs.

2.7.1 SAFETY GROUNDING

Local, national and international safety rules dictate the grounding of the metal cover and case of any instrument connected to the a-c power source, when such grounding is an intrinsic part of the safety aspect of the instrument.

KLP is provided with a three-terminal IEC appliance coupler for connection of the mains supply source, one terminal of which is dedicated for the protective earthing conductor; no other ground or earth connection is required, although the chassis may be separately connected to earth ground for noise or other performance considerations (frame grounding).

The instructions below suggest wiring methods which comply with these safety requirements; however, in the event that the specific installation for the power system is different from the recommended wiring, it is the customer's responsibility to ensure that all applicable electric codes for safety grounding requirements are met.

2.7.2 SOURCE POWER CONNECTIONS

Source power is connected to the power supply via the three-wire input power connector J1 located on the rear panel (see Figure 2-2).

The rear panel of the KLP power supply is equipped with an IEC 320 style recessed power inlet connector which provides interface to a 3-wire safety line cord via a polarized mating plug. A user-wirable mating connector is provided. Terminal assignment follows internationally accepted conventions (see Figure 2-2). It is the user's responsibility to ensure that all applicable local codes for source power wiring are met. Kepco also makes a variety of prefabricated line cord sets available for connecting KLP to source power via conventional box-mounted receptacles. Table 1-4 lists three popular cord set variants for North American applications. For other options please contact Kepco Sales Engineering with specific requirements.

WARNING

IT IS IMPERATIVE THAT THE USER PROVIDE ALL THREE SOURCE WIRE CONNECTIONS, AS THIS CONNECTION IS THE SAFETY GROUND PROVISION!

The user-wired mating connector requires size #14 AWG (minimum) conductors for all three connections.

2.7.3 D-C OUTPUT GROUNDING

Connections between the power supply and the load and sensing connections may, despite precautions such as shielding, twisting of wire pairs, etc., be influenced by radiated noise, or “pick-up”. To minimize the effects of this radiated noise the user should consider grounding one side of the power supply/load circuit. The success of d-c grounding requires careful analysis of each specific application, however, and this recommendation can only serve as a general guideline.

One of the most important considerations in establishing a successful grounding scheme is to avoid GROUND LOOPS. Ground loops are created when two or more points are grounded at different physical locations along the output circuit. Due to the interconnection impedance between the separated grounding points, a difference voltage and resultant current flow is superimposed on the load. The effect of this ground loop can be anything from an undesirable increase in output noise to disruption of power supply and/or load operation. The only way to avoid ground loops is to ensure that the entire output/load circuit is fully isolated from ground, and only then establish a single point along the output/load circuit as the single-wire ground point.

The exact location of the “best” d-c ground point is entirely dependent upon the specific application, and its selection requires a combination of analysis, good judgement and some amount of empirical testing. If there is a choice in selecting either the positive or negative output of the power supply for the d-c ground point, both sides should be tried, and preference given to the ground point producing the least noise. For single, isolated loads the d-c ground point is often best located directly at one of the output terminals of the power supply; when remote error sensing is employed, d-c ground may be established at the point of sense lead attachment. In the specific case of an internally-grounded load, the d-c ground point is automatically established at the load.

The power supply output terminals (located on the rear panel) for KLP Power Supplies are d-c isolated (“floating”) from the chassis in order to permit the user maximum flexibility in selecting the best single point ground location. Output ripple specifications as measured at the output are equally valid for either side grounded. Care must be taken in measuring the ripple and noise at the power supply: measuring devices which are a-c line operated can often introduce additional ripple and noise into the circuit.

There is, unfortunately, no “best” method for interconnecting the load and power supply. Individual applications, location and nature of the load require careful analysis in each case. It is hoped that the preceding paragraphs will be of some assistance in most cases. For help in special applications or difficult problems, consult directly with Kepco's Application Engineering Department.

2.7.4 POWER SUPPLY/LOAD INTERFACE

The general function of a voltage or current stabilized power supply is to deliver the rated output quantities to the connected load. The load may have any conceivable characteristic: it may be fixed or variable, it may have predominantly resistive, capacitive or inductive parameters; it may be located very close to the power supply output terminals or it may be a considerable distance away. The perfect interface between a power supply and its load would mean that the specified performance at the output terminals would be transferred without impairment to any load, regardless of electrical characteristics or proximity to each other.

The stabilized d-c power supply is definitely not an ideal voltage or current source, and practical interfaces definitely fall short of the ideal. All voltage-stabilized power supplies have a finite source impedance which increases with frequency, and all current-stabilized power supplies have a finite shunt impedance which decreases with frequency. The method of interface between the power supply output and the load must, therefore, take into account not only the size with regard to minimum voltage drop, but the configuration with regard to minimizing the impedance introduced by practical interconnection techniques (wire, bus bars, etc.). The series inductance of the load wire must be as small as possible as compared to the source inductance of the power supply: although the error sensing connection to the load compensates for the d-c voltage drop in the power leads, it cannot completely compensate for the undesirable output effects of the power lead inductance. These lead impedances (both power and sensing leads) are especially important if the load is a) constantly modulated or step-programmed, b) has primarily reactive characteristics, or c) where the dynamic output response of the power supply is critical to load performance.

2.7.5 LOAD CONNECTION - GENERAL

Load connections to the KLP power supply are achieved via the (+) and (–) DC OUTPUT bus bar connections located on the rear panel; (+M) and (–M) outputs are also available at terminal blocks (TB5 and TB1, respectively) located on the panel for connection of external monitoring equipment such as a DVM, oscilloscope, etc.

Configuration of local or remote sensing is facilitated by pre-installed jumpers which configure the unit for local sensing.as shown in Figure 2-2.

NOTE: REGARDLESS OF OUTPUT CONFIGURATION, OUTPUT SENSE LINES MUST BE CONNECTED FOR PROPER OPERATION, EITHER LOCALLY, OR AT THE LOAD (REMOTE). OBSERVE POLARITIES: THE +S TERMINAL MUST BE CONNECTED TO EITHER +M (LOCAL) OR +LOAD (REMOTE), AND THE –S TERMINAL MUST BE CONNECTED TO EITHER –M (LOCAL) OR –LOAD (REMOTE).

2.7.5.1 LOCAL SENSING/REMOTE SENSING SELECT

Local sensing (factory default configuration) is established by connecting terminal TB4 (+S) to TB5 (+M) and TB1 (–M) to TB2 (–S) (see Figure 2-2). The power supply is shipped with two jumpers installed to obtain local sensing.

Remote sensing is established by first removing the factory-installed local sensing jumpers between +S and +M and between –M and –S. The +S and –S lines must be connected at the load (see Figure 2-3). A high frequency bypass network consisting of two capacitors connected across the load as shown in Figure 2-3) is recommended to reduce noise in the sense loop.

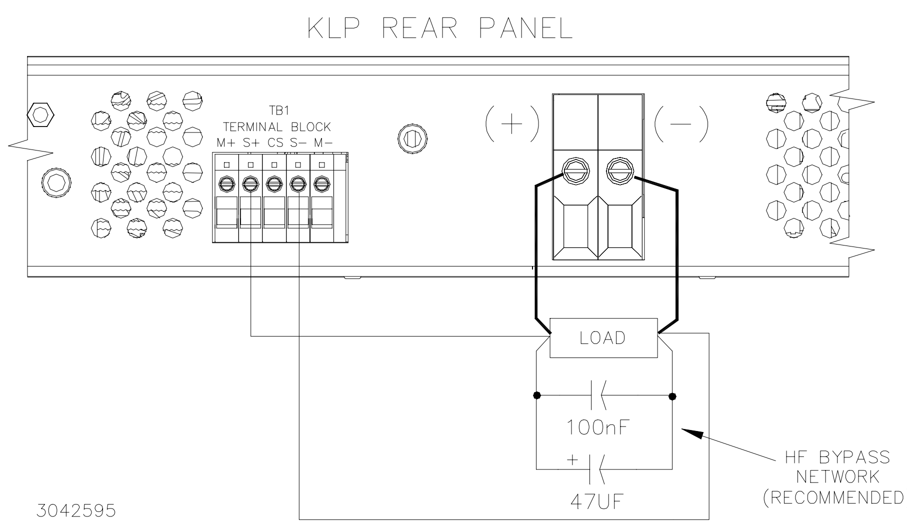


FIGURE 2-3. REMOTE SENSING

2.7.6 SERIES OPERATION

Units may be connected in series to obtain higher output voltages. Each power supply in the series may be protected by a clamping diode connected in its non-conducting direction in parallel with the output. This diode protects the power supply outputs against secondary effects in the event of a load short. (Note that this is NOT the same as the blocking diode used for parallel/redundant operation.) Selection of the clamping diode is entirely dependent upon output voltage/current parameters. The clamping diode must be rated for the maximum voltage and current of the series connection. Several clamping diodes in parallel may be required to meet the total current rating. The user must also respect the ±600V d-c maximum isolation from output to chassis when determining the maximum series voltage. Figure 2-4 shows a series connection of two KLP power supplies using remote sensing. Kepco strongly recommends that series applications employ master/slave control as described in PAR's. 2.7.8 and 3.2.10.

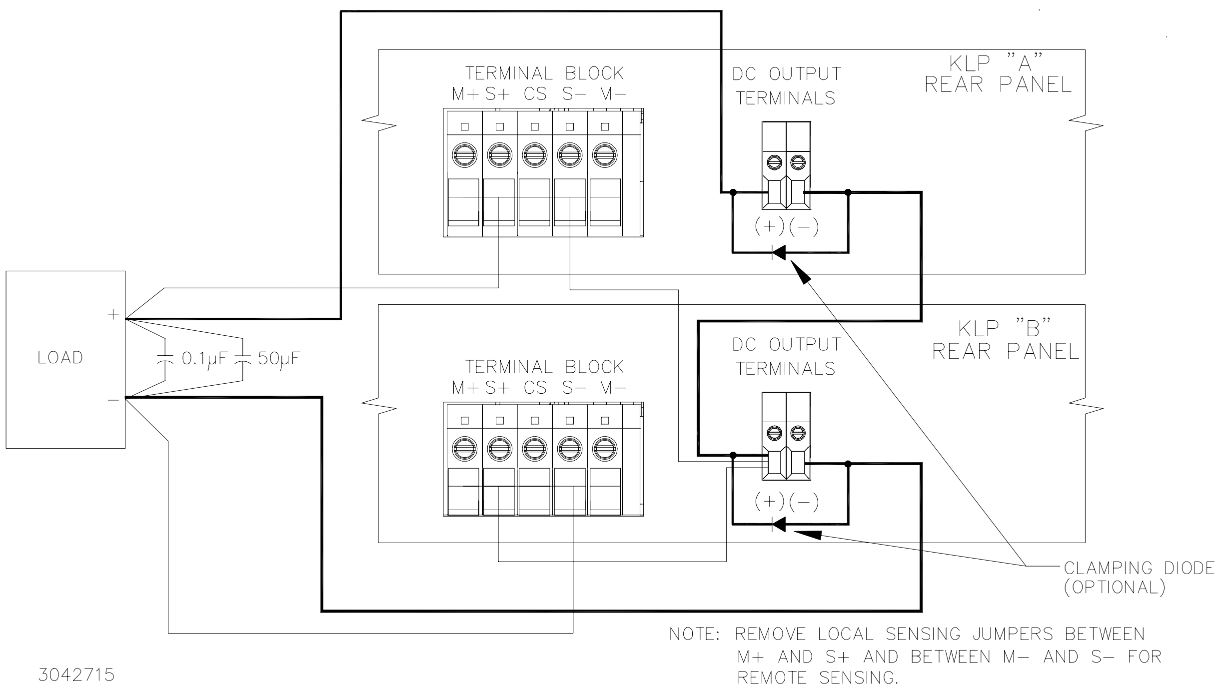


FIGURE 2-4. SERIES CONNECTION USING REMOTE SENSING

2.7.7 PARALLEL/REDUNDANT OPERATION

Identical KLP power supply models may be connected in parallel in order to provided increased output current to a common load (see Figure 2-5). This permits the user to obtain significantly higher load ratings than for a single KLP power supply. The number of power supplies required is determined by dividing the required load current by the current rating of the applicable KLP model, and rounding up to the next whole number when necessary. KLP power supplies utilize active current sharing circuitry to distribute the load current equally among the paralleled units. Redundant operation is achieved by paralleling one or more power supplies than the minimum number required to support the load; in this way, system operation is not compromised by the failure of a single power supply. Any number of KLP power supplies (N+M) can be wired for redundant operation as long as (N) power supplies can support the load, M representing the total number of failed power supplies. When operating KLP power supplies in any parallel configuration, load sharing ***must*** be implemented among the paralleled modules. Kepco strongly recommends that parallel/redundant applications employ master/slave control as described in PAR's. 2.7.8 and 3.2.10.

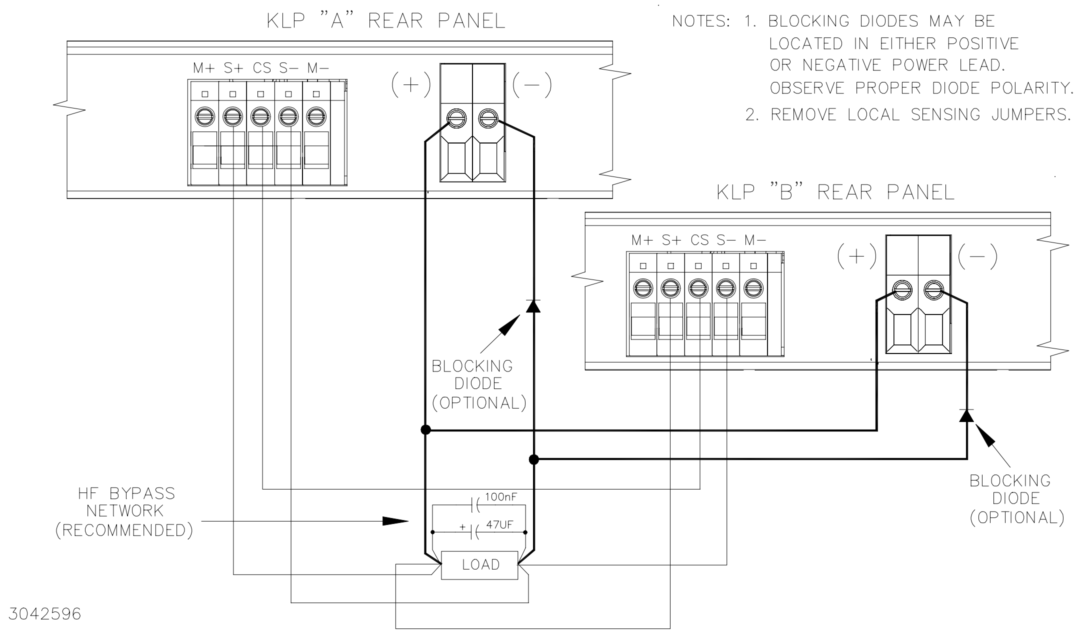


FIGURE 2-5. PARALLEL CONNECTIONS USING REMOTE SENSING

2.7.7.1 LOAD SHARING

When operating two or more power supplies in parallel, either for capacity or redundancy, it is desirable to distribute the load equally among all of the power supplies in order to improve performance, reduce stress and increase reliability. KLP power supplies incorporate active circuitry which forces multiple power supplies wired in parallel to share load current, both in voltage- and current-mode regulation. The KLP employs a single wire connection between paralleled power supplies, forming a master-slave relationship as follows: the highest voltage unit becomes the master, and all of the remaining units are slaved to it via the current share signal (CS, available at the rear panel terminal A3TB3, Figure 2-2), which boosts the slave outputs in order to increase load share. A maximum boost limit prevents the slave units from following a defective master into an overvoltage condition, or from creating a load hazard if either the slave itself or the load sharing system is defective.

When implementing load sharing, the user must ensure that all power supplies are attempting to regulate to the same voltage at the same location, and must minimize the possibility of load share signal corruption; the power supplies should, as nearly as possible, emulate a single large power supply. To this end, the following rules apply:

a. If possible, remote error sensing should be employed, with all error sensing connections terminated at the same physical point, and as close to the power supplies as possible; if local error sensing is required, power lead voltage drops must be minimized. Provide local noise decoupling capacitors across all sense wire termination points.

b. The power supplies should be located as near to each other as possible, with power terminations bussed together using adequately sized interconnections; the power supply/load inter-connections should be distributed evenly along the power supply output interconnection busses. This is especially important in high-current systems employing several power supply modules in parallel, where voltage drops in the interface connections can be significant in comparison to the load share signal voltage and introduce both d-c and a-c errors.

c. All power supply output voltages should be adjusted as closely as possible, and in any case within a 1% error band. Additionally, the current limit setpoints should be identical and high enough to support the load requirements; for (N+M) systems, this means setting the current limits high enough to tolerate loss of M power supplies and still support the load.

d. Minimize the current share signal wire interconnection lengths to reduce risk of noise influence.

2.7.8 MASTER/SLAVE CONFIGURATIONS

Master/slave configurations of power supply pairs can be used to allow changes to output voltage/current of a one supply (master) to the output of the other (slave). Both units of a master/slave configuration must be identical models. Master/slave control is implemented using the RS 232 ports. After connecting the series or parallel pair (see PAR. 2.7.6 or 2.7.7, respectively), use a null modem cable, minimum length 1 foot, DB9F-DB9F, to connect the RS 232 ports of both power supplies. Then refer to PAR. 3.2.10 to complete the setup of each power supply in the master/slave configuration.

2.7.9 ANALOG I/O CONNECTIONS

The Analog I/O Port connector, located on the rear panel of the KLP power supply (see Figure 2-2), provides access for all analog programming inputs and status signal outputs. In addition, an external trigger input is available for use with SCPI *TRG and TRIG commands. Refer to Table 2-6 for analog I/O programming signal pin assignments and descriptions.

These signals must be protected from radiated and conducted noise as well as from physical contact with non-valid driving sources. The following subsections address specific programming signal applications; in general, however, when accessing this connector from distant locations or high-noise environments, it is recommended that a shielded cable be used, with the shield terminated to the system's single point ground.

a. Analog Programming Enable (ANALOG_CTRL)
Connect pin 12 (Analog Control) to pin 9, 11, 13, or 15 (ground) to enable analog I/O programming.

b. External Voltage and Current Programming (V_Ref and C_Ref)
Twist the voltage programming signal V_Ref (pin 3), Current Programming signal C_Ref (pin 1) and ground (pin 9, 11, 13, or 15). Configure Analog I/O switch positions 1 and 2 to use either voltage or resistance as the programming source. Factory default for full scale output is 10V or 10 Kohms (see par. 4.3.3 to set lower values for full scale output).

c. Voltage and Current Readback (VOLT_RBACK and CURR_RBACK)
Twist the voltage readback signal VOLT_RBACK (pin 6), Current readback signal CURR_RBACK (pin 7) together with ground (pin 9, 11, 13, or 15). Full scale readback voltages are identical to selected full scale programming voltages (see PAR. 4.3.3).

d. Remote Inhibit (REM_INH)
Twist remote inhibit (pin 8) together with ground (pin 9, 11, 13, or 15).

e. Fault Connections (FAULT_NC, FAULT_COM, FAULT_NO
Twist normally open and normally closed fault relay signals FAULT_NC (pin 10) and

FAULT_NO (pin 2), respectively, together with FAULT_COM (pin 4). See PAR. 2.7.10 to configure internal relay.

f. External Trigger (EXT_TRIG)
External Trigger may be used with the SCPI TRIG commands (see PARs. B.48, B.58, and B.93 through B.96) during digital remote operation. For noise suppression it is recommended that wires from EXT_TRIG, pin 14 and ground (pin 9, 11, 13, or 15) be twisted together. The external trigger function is only active when set to “EXT” (see PAR. B.96). See PAR. 3.3.1.3 for additional information.

2.7.10 INTERNAL RELAY CONFIGURATION

By sending the appropriate SCPI command (see PAR. 3.3.1.4), the internal relay contacts available at pins 6, 7 and 8 of the Analog I/O connector can be configured to operate in one of three different ways.

- FAULT mode (factory default) - the relay energizes upon detection of a system fault.
- MANUAL mode - The relay is energized (ON) or de-energized (OFF) at the users discretion by sending SCPI commands.
- PROGRAM mode - The relay is energized (ON) or de-energized (OFF) as part of a user-specified program using the LIST commands.

SECTION 3 - OPERATION

3.1 GENERAL

This section explains how to operate the KLP Power Supply. Series KLP feature three modes of operation:

- Local Mode: This is the default operating mode, providing full access to all programming and readback functions via front panel displays, controls, and indicators (see PAR. 3.2).
- Digital Remote Mode (see PAR. 3.3): This mode is selected via commands transmitted through one of the two digital ports. One port is configured for IEEE-488 (GPIB) (see PAR. 3.5), while the other port is configured to accept commands based on RS-232 protocol (see PARs. 3.4).
- Analog Remote Mode: This mode is selected via a jumper wire at the analog programming port prior to initial turn-on, and provides limited access to programming and readback functions (see PAR. 3.7).

3.2 LOCAL MODE OPERATION

Local operation of the KLP Power Supply is accomplished via the front panel switches and controls illustrated in Figure 2-1 and described in detail in Table 2-1. Separate 4-digit LEDs display actual output voltage and current. as well as set points and limits. Status and fault indications are provided by a 4-character alpha-numeric display

3.2.1 TURNING THE POWER SUPPLY ON

1. To turn the power supply on, set **POWER** ON/OFF circuit breaker (1, Figure 2-1) to ON.
2. When the power supply is turned on, it performs a self-test and displays the following information:.
   - status display flashes `MODL` for 2 seconds while **DC VOLTS** and **DC AMPERES** displays show the maximum voltage and current capability of the unit.
   - status display flashes `VIRT` for 2 seconds while **DC VOLTS** and **DC AMPERES** displays show the maximum voltage and current allowed for a previously programmed virtual model.

   NOTE: To reprogram the maximum allowable voltage and/or current, refer to PAR. 3.2.5 to define a virtual model.

   - Status display flashes `PROT` for 2 seconds while **DC VOLTS** and **DC AMPERES** displays show previously stored OVP and OCP trigger levels. NOTE: to reprogram OVP or OVC, refer to PAR. 3.2.7.
   - If an error occurs, an error code is displayed in the status display (see Table 3-1).

3. After a successful self test, the default conditions upon power up are as follows:

- Status display shows **SET**,
- output is disabled (green **DC OUTPUT** indicator is off). If remote analog mode is selected (PAR. 3.7), output is enabled unless Remote Inhibit, pin 8 of the Analog I/O Connector (see Figure 2-2 and Table 2-6) is grounded.
- **DC VOLTS** and **DC AMPERES** displays show programmed output conditions: either 0 Volts, minimum Amperes (see NOTE, PAR. 3.2.1) or, if DIP switch position 3 enabled (see Table 2-2), previously saved setpoint values in effect upon power off.

NOTE: A minimum programmed current (actual value depends on model) is required to ensure proper operation of the power supply under all load conditions. Programmed current is automatically set to be at least the minimum current.

- Since the output is off, Constant Voltage (**CV**) mode indicator (green LED) and Constant Current (**CC**) indicator (amber LED) are off.

TABLE 3-1. POWER-UP BUILT-IN TEST ERROR CODES

ERROR CODE	MEANING
E310	System Error
E313	Calibration Memory Error
E315	Configuration Memory Error
E341	Memory Error (CRC)
E330	Self Test Error
Ecal	Calibration Error - The unit will try to restore the previous calibration.
Eclp	Previous Calibration Error - After detecting a Calibration Error (Ecal) and trying to use the previous calibration, an error was detected, and the unit will attempt to restore the factory calibration.
Eclf	Factory Calibration Error - The unit has failed to restore the factory calibration after failing to restore the previous calibration. The unit will not operate after this error has been displayed and must be referred for service.
NOTE: During power-up the power supply performs detailed software check sequences. If a failure is detected during power-up, the DC VOLTS and DC AMPERES displays are blanked and the Status display shows an error code. For errors that occur after power-up, refer to Appendix B, Table B-4 for typical error codes and possible causes. For these and all other error codes, refer to authorized service personnel for corrective action.	

3.2.2 SETTING LOCAL/REMOTE MODE

LOCAL MODE. When the power supply is turned on, it is automatically set to Local mode as long as Analog I/O port pin 12 is not grounded. In local mode the Status display is normally blank.

DIGITAL REMOTE MODE. The power supply will automatically go into digital remote mode when digital remote commands are accepted via the GPIB or RS232 ports. In digital remote mode the power supply normally shows **dRem** in the status display. When in digital remote mode, all front panel controls are disabled. If desired, local mode can be restored by pressing both **VOLTAGE** and **CURRENT** controls simultaneously; the power supply will then remain in local mode until another digital command is received, causing the unit to return to remote digital mode. To disable local mode entirely, see PAR. 3.2.2.1 for front panel lockout.

NOTE: During both LOCAL and DIGITAL REMOTE operation, the analog readback signals (voltage and current) remain available, as does the remote inhibit signal; only programming signals are disregarded.

ANALOG REMOTE: With power supply turned off, ground Analog I/O port pin 12. Refer to PAR. 2.7.9 to configure the Analog I/O Port; refer to Table 2-2 to configure the Analog I/O switch. When the power supply is turned on, the status display shows **aRem** (Analog Remote programming selected). The unit will accept Analog Remote commands (see PAR. 3.7) and front panel controls are disabled except that the **POWER** ON/OFF circuit breaker is operational. Local mode can be restored by pressing the **VOLTAGE** and **CURRENT** controls at the same time. Once local mode has been restored, analog remote programming is disabled until the unit is powered off, then on again. Digital queries are accepted while Analog Remote programming is active; digital commands are not accepted except for the front panel unlock command (see PAR. 3.2.2.1).

3.2.2.1 REMOTE WITH LOCAL (FRONT PANEL) LOCKOUT

To prevent unauthorized setting of the power supply to Local mode, a local lockout mode can be enabled which prevents the power supply from being restored to local mode via the front panel.

With the power supply turned off, set the ANALOG I/O DIP switch, position 5 (see Table 2-2) to ON. Now when the power supply is turned on the status display will read **aRwl**.(Remote with Local Lockout).

Once the front panel is locked, it can only be unlocked by either of the following:

- turn the power supply off, set ANALOG I/O DIP switch position 5 to OFF, and then power up again.
- send the following SCPI command via GPIB or RS232 port:
  SYST:KLOC OFF

NOTE: If the front panel is unlocked by SCPI command, the unit will be set to Remote with Local Lockout when it is turned on again. Set ANALOG I/O DIP switch position 5 to OFF to disable Remote with Local Lockout.

3.2.3 ENABLING/DISABLING OUTPUT POWER

When the power supply is turned on, the output is automatically disabled (**DC OUTPUT** LED is off) and the **DC VOLTS** and **DC AMPERES** displays show the programmed output voltage and current set points. If remote analog mode is selected (PAR. 3.7), output is enabled on power up unless Remote Inhibit, pin 8 of the Analog I/O Connected (see Figure 2-2 and Table 2-6) is grounded.

To enable the output, first exit **SET** mode by tapping either the **VOLTAGE** or **CURRENT** control, then press and release the **DC OUTPUT** switch. The associated green LED lights to indicate output power is applied to the load. Each time you exit **SET** mode, the setpoint values are stored for possible recall if the power supply is turned off or the output is disabled.

To disable the output, press and release the **DC OUTPUT** switch again. The **DC OUTPUT** indicator goes off.

While in the setpoint mode (Status display reads **SET**) the output cannot be turned on (pressing **DC OUTPUT** has no effect). If output was on while setpoint mode was entered, pressing **DC OUTPUT** will disable the output.

3.2.4 CHECKING VOLTAGE/CURRENT SETPOINTS

CAUTION: WHEN THE OUTPUT IS DISABLED, THE DC VOLTS AND DC AMPERES DISPLAYS SHOW THE ACTUAL OUTPUT VOLTAGE AND CURRENT. BEFORE ENABLING THE OUTPUT ALWAYS CHECK THE SETPOINTS TO AVOID POSSIBLE DAMAGE TO THE LOAD.

Check the voltage and current set points by tapping either the **VOLTAGE** or **CURRENT** control. The status display reads **SET**, and the **DC VOLTS** and **DC AMPERES** displays show the stored setpoints.

To accept the displayed value, tap the associated adjustment control again. To change the value, rotate the control (press the control in while rotating for fine adjustment), then tap the adjustment control again to accept the new setting.

NOTE: Before changing the setpoint, note the displayed setpoint. If you decide not to change the value after rotating the control, you must rotate the control to the value noted, then tap the adjustment control to accept.

3.2.5 DEFINING A VIRTUAL MODEL

The virtual model is defined by establishing a maximum programmable voltage and current for the unit within the 1200W power limitation and the maximum voltage and current ratings listed in Table 1-1. Once established, the unit will not accept programmed values beyond these values whether from the front panel in local mode, or from the digital (GPIB, or RS232) or analog input ports in remote mode. The virtual model settings are password-protected (see PAR. 4.4).

NOTE: Decreasing full scale voltage and/or current does not improve programming resolution.

A multitude of possible 1200W power supplies may be emulated by defining the maximum voltage and current. For example, some of the possible power supplies that a KLP 36-48-1200 can emulate are: 36V, 33A (1200W), 25V, 48A (1200W), 30V, 40A (1200W), 35V, 30A (1050W). Refer to Table 1-1 and Figure 1-2 for the acceptable operating regions for each model. Units without the -1200 suffix can be also be configured to reject programming values that exceed user-defined limits, however the maximum output power of 1200 Watts can only be achieved at the rated maximum values of voltage and current.

Whenever a virtual model is set, overvoltage and overcurrent protect limits (see PAR. 3.2.7) are reset to 120% of the new maximum value. Also, if position 3 of the Analog I/O DIP switch is set to recall previous setpoint values upon power-up (see Table 2-2), the previous setpoint value is cleared so that the intitial powerup after changing the virtual model will be at 0V, minimum A. In addition, the following parameters should be checked to ensure that there are no settings outside the range permitted by the new maximum programmable voltage and current:

- User-programmed sequences (see PAR. 3.3.1.1)
- Storage of User-programmed Active Settings (see PAR. 3.3.1.1)
- User-determined output Sequences (see PAR. 3.3.1.2)
- External Triggers: VOLT:TRIG and CURR:TRIG values (see PAR. 3.3.1.3).

• Sequences programmed using LIST commands.

To define a virtual model, proceed as follows. (To establish a virtual model using SCPI commands, use VOLT:LIM:HIGH (see PAR. B.52) and CURR:LIM:HIGH (see PAR. B.44), respectively.)

1. Using a thin tool (e.g., a paper clip), press the **FUNCTION** switch repeatedly until the status display reads **VIRT**. The **DC VOLTS** and **DC AMPERES** displays show the programmed maximum voltage and current of the virtual model. To exit without changing the virtual model, continue to press **FUNCTION** until Status display is blank. To change the values proceed to step 2.

2. Press the **DC OUTPUT** switch once. The status display shows **PASS** (password) (see PAR. 4.4) and the Current Display shows **0000**. Rotate **CURRENT** control to select a number from 0-9. Tap **CURRENT** control to advance to next digit. Repeat this process until all four digits have been selected. Tap **DC OUTPUT** switch to accept the number. When the password is accepted, the status display reads VIRT; proceed to step 3.

3. Rotate **VOLTAGE** and **CURRENT** controls until desired values appear in **DC VOLTS** and **DC AMPERES** displays. Pressing and holding the control in while turning provides a finer adjustment resolution. Under no conditions will the power supply accept limits beyond its maximum ratings of voltage and current. For models with -1200 suffix, as the primary parameter is increased, the power supply will automatically decrement the secondary parameter as necessary to maintain maximum output power at 1200 Watts. Maximum current shown on **DC AMPERES** display is automatically limited to 1200W maximum.

4. Press **DC OUTPUT** switch to accept virtual model settings. The unit displays **done**, then resets and repeats the power on sequence, showing the new virtual model parameters while the status display flashes **VIRT**. Then the default protection limits (based on selected virtual model settings) are displayed while the status display shows PROT. Last, the unit is placed in setpoint mode with the voltage and current displays reset to 0 volts, minimum amps.

NOTE: Accepting a new virtual model resets the setpoints to zero Volts and minimum Amperes (see NOTE, PAR. 3.2.1) and resets the OVP and OCP values to 120% of virtual model maximum. If DIP switch position 3 is enabled, stored values of voltage and current are cleared when the virtual model settings are saved.

3.2.6 SETTING VOLTAGE OR CURRENT

The **VOLTAGE** and **CURRENT** controls adjust output voltage and current limit, respectively, when the unit is in constant voltage (CV) mode and adjust voltage limit and output current, respectively, when the unit is in constant current (CC) mode. The mode (CV or CC) is determined by the load together with the programmed settings. As long as the voltage across the load produces a current that is less than the programmed Current setpoint, the unit operates in CV mode (voltage programmed to voltage setpoint, current limited by current setpoint). If the load changes to the point that current through the load reaches the current setpoint, the unit automatically enters CC mode (current programmed to current setpoint, voltage limited by voltage setpoint).

Output voltage or current can be set at the front panel in two ways: Real-time adjustment (PAR 3.2.6.1) or Setpoint adjustment (PAR. 3.2.6.2).

3.2.6.1 REAL-TIME VOLTAGE/CURRENT ADJUSTMENT

Rotating the associated control will change the output voltage or current in real-time only if the output is enabled. If the unit is in constant voltage mode (**CV** indicator lit) the **DC VOLTS** display shows the actual output voltage as the **VOLTAGE** control is rotated. Similarly, if the unit is in constant current mode (**CC** indicator lit) the **DC AMPERES** display shows the actual output current as the **CURRENT** control is rotated.

NOTE: If the unit is in CV mode, rotating the CURRENT control will affect the current limit even though the **DC AMPERES** display does not change since it is showing actual output current. Similarly, rotating the VOLTAGE control while in CC mode affects the voltage limit. To change the limits to a precise value, refer to PAR. 3.2.6.2, Setpoint Adjustment.

3.2.6.2 SETPOINT ADJUSTMENT

NOTE: Before changing the setpoint, note the displayed setpoint. If you decide not to change the value after rotating the control, you must manually reset the value to its original value using the following procedure.

Tap either the **VOLTAGE** or **CURRENT** control to initiate setpoint adjustment (status display reads SET). The previous setpoint is visible on the corresponding **DC VOLTS** or **DC AMPERES** display.

1. Rotate the corresponding control to change the setpoint as viewed on the corresponding LED display. Tap the adjustment control again to accept the new setting.

2. In the setpoint mode, both coarse (rotate the control) and fine (rotate while pressing control in) adjustment is available. The coarse adjustment is approximately 100X the fine adjustment resolution.

Setpoint adjust can be done with output either on or off, however the output can not be enabled while setpoint is active (See PAR. 3.2.3).

3.2.7 VIEWING/CHANGING OVERVOLTAGE OR OVERCURRENT PROTECTION VALUES

If the values set for overvoltage (OVP) or overcurrent (OVC) protection are reached, the output is automatically disabled and the unit must be cycled on and off to restore the output. A built-in feature prevents the unit from being programmed within 20% of OVP or 20% of OVC. For example, if OVP and OVC are set to 11V and 72A, respectively, programming of the output is automatically limited to 10V and 60A.

NOTE: When a virtual model is defined (PAR. 3.2.5), OVP and OVC are automatically set 20% and 20%, respectively, above the maximum programmable values established by the virtual model.

The OVP and/or OVC limits can be changed as follows:

1. Using a thin tool (e.g., end of paper clip), press and hold the **PROTECT** switch. The output is switched off, setting voltage to zero Volts, and current to a minimal value, and the status display shows **PR0T**. The **DC VOLTS** and **DC AMPERES** displays show the corresponding overvoltage and overcurrent protection setpoints while the **PROTECT** switch is held in.

2. To change the values, operate the corresponding adjustment control while holding the **PROTECT** switch in. When the **PROTECT** switch is released, the protection values showing in the **DC VOLTS** and **DC AMPERES** displays are entered as the new protection values.

NOTE: If either adjustment exceeds maximum programmable volts or amps, or if the adjustment is within 20% of OVP or 20% of OCP, the status display will show **>MAX**.

3.2.8 CHANGING GPIB ADDRESS

The factory default GPIB address is 6. To change the address from the front panel proceed as follows:

1. Using a thin tool (e.g., a paper clip), press the **FUNCTION** switch repeatedly until the status display reads **ADDR**; the active GPIB address is visible in the **DC AMPERES** display. To change the address, proceed to step 2.

2. Rotate the **CURRENT** control to change the GPIB address.

3. Tap the **DC OUTPUT** switch to accept the displayed GPIB address. The unit advances to the next function, Baud Rate, see PAR. 3.2.9.

3.2.9 CHANGING RS232 BAUD RATE

The factory default RS232 baud rate is 9600. To change the baud rate from the front panel proceed as follows:

1. Using a thin tool (e.g., a paper clip), press the **FUNCTION** switch repeatedly until the status display reads **BAUD**; the active baud rate is visible in the **DC AMPERES** display (value shown must be multiplied by 1000; e.g., 9600 is displayed as 9.6). To change the baud rate, proceed to step 2, otherwise, press **FUNCTION** to exit.

2. Rotate the **CURRENT** control to change the baud rate.

3. Tap the **DC OUTPUT** switch to accept the displayed baud rate. The unit advances to the next function, Virtual Model, see PAR. 3.2.5.

3.2.10 SETTING UP MASTER/SLAVE CONFIGURATIONS

Both units of a master/slave pair must be identical models. After connecting the RS 232 ports (see PAR. 2.7.8), proceed as follows to configure the individual units to be master or slave.

3.2.10.1 CONFIGURE POWER SUPPLY AS MASTER

1. Turn power on. If the unit comes up in setpoint mode (see PAR. 3.2.4), tap either the **CURRENT** or **VOLTAGE** controls to take the unit out of setpoint mode (status display goes from **SET** to blank).

2. Using a thin tool (e.g., a paper clip), press the **FUNCTION** switch repeatedly until the status display reads **M/S**.

3. Tap the **DC OUTPUT** switch once.

   - The status display reads either **SERI** (series) or **PARA** (parallel).

- The **DC VOLTS** display shows the number assigned to the unit (1 = master, 2 or above = slave).
- The **DC AMPERES** display shows the maximum number of units in the configuration.
- The factory default is standalone operation (**DC VOLTS** and **DC AMPERES** show **1**).

4. Specify either **SERI** (series configuration for higher voltage) or **PARA** (parallel configuration for higher current) using either the **VOLTAGE** or **CURRENT** control by ***holding in*** and rotating the control. Both connected units must be set the same, either **SERI** or **PARA**.
5. Specify the total number of units in the configuration to 2 by rotating the **CURRENT** control.
6. Specify the unit number to be assigned (1 = master) by rotating the **VOLTAGE** control.
7. Press **DC OUTPUT** to accept the displayed settings, or **FUNCTION** to abort and proceed to the next function.

NOTE: Until both units are configured properly, the displays will cycle as follows: status display will flash **E241** (hardware error), then **DC VOLTS,** status display and **DC AMPERES** flash **x OF y** where **x** = unit number and **y** = total number of units, the status display flashes the type of connection **SERI** (series) or **PARA** (parallel).

3.2.10.2 CONFIGURE POWER SUPPLY AS SLAVE

1. Turn power on. If the unit comes up in setpoint mode (see PAR. 3.2.4), tap either the **CURRENT** or **VOLTAGE** control to take the unit out of setpoint mode (status display goes from **SET** to blank).
2. Using a thin tool (e.g., a paper clip), press the **FUNCTION** switch repeatedly until the status display reads **M/S**.
3. Tap the **DC OUTPUT** switch once.
   - The status display reads either **SERI** (series) or **PARA** (parallel).
   - The **DC VOLTS** display shows the number assigned to the unit (1 = master, 2 or above = slave).
   - The **DC AMPERES** display shows the maximum number of units in the configuration.
   - The factory default is standalone operation (**DC VOLTS** and **DC AMPERES** show **1**).
4. Specify either **SERI** (series configuration for higher voltage) or **PARA** (parallel configuration for higher current) to be the same as the master by ***holding in*** either the **VOLTAGE** or **CURRENT** control and rotate the control. Both connected units must be set the same, either **SERI** or **PARA**.
5. Specify the total number of units in the configuration to 2 by rotating the **CURRENT** control.
6. Specify the unit number to be assigned (2 = slave) by rotating the **VOLTAGE** control.
7. Press **DC OUTPUT** to accept the displayed settings, or **FUNCTION** to abort and proceed to the next function.

NOTE: Until both units are configured properly, the displays will cycle as follows: status display will flash **E241** (hardware error), then **DC VOLTS,** status display and **DC AMPERES** flash **x OF y** where **x** = unit number and **y** = total number of units, the status display flashes the type of connection **SERI** (series) or **PARA** (parallel).

3.2.10.3 OPERATING THE MASTER/SLAVE CONFIGURATION

Once the master is configured, it searches for the slave specified. Until the slave is set up properly, the master status display will cycle as follows: status display will flash **E241** (hardware error), then **DC VOLTS,** status display and **DC AMPERES** flash **x OF y** where **x** = unit number and **y** = total number of units, the status display flashes the type of connection **SERI** (series) or **PARA** (parallel). When the slave is found, the status display of the slave reads **SLVE** and the **DC VOLTS** and **DC AMPERES** displays on the slave go blank. For the master/slave combination to work properly the number of slave units specified in the master (PAR. 3.2.10.1, step 5) must be found.

When the slave has been found, the master proceeds with the normal turn-on sequence and the unit proceeds to **SET** mode. The master front panel readouts show the total values for set point, voltage and current readback, virtual model (the virtual model and protection settings of the slave are automatically programmed to be the same as the master) and protection settings for the master/slave configuration. All controls on the slave are disabled. The parallel or series combination is controlled from the master using either the front panel, SCPI commands, or analog control.

- If analog control is used, only the master is configured for analog control (the slave is controlled digitally by the master).
- If Remote Inhibit is used, it should only be connected to the master.
- If **E241** (hardware error) is showing in the status display, the **FUNCTION** switch can be used to change the configuration
- If there is no communication between units for approximately 10 seconds, all units will turn off their output and the status display will flash **E241** (hardware error), then **xOFy** where **x** = unit number and **y** = total number of units, and finally the serial/parallel configuration setting **SERI** or **PARA**.

3.2.11 UTILITY FUNCTION

The Utility Function provides additional system information or access to special functions. These are:

- **VERS** - Display System Firmware Version (see PAR. 3.2.11.1)
- **MODL** - Display Model (see PAR. 3.2.11.2)
- **INVC** - Analog Input Voltage and Current A to D calibration voltages (see PAR. 3.2.11.3)
- **LBT** - Loop Back Test used to isolate RS 232 communication problems (see PAR. 3.4.2.5.
- **CAL** - Display last calibration date and/or begin Calibration (see PAR. 3.2.11.4)

1. Using a thin tool (e.g., a paper clip), press the **FUNCTION** switch repeatedly until the status display shows **UTIL**. Press the **DC OUTPUT** switch to enter the **UTIL** Menu.

2. Rotate either the **VOLTAGE** or **CURRENT** control in either direction to select the function as identified in the status display as listed above (clockwise selects the functions in the order described below, counterclockwise reverses the order).

3.2.11.1 DISPLAY SYSTEM FIRMWARE VERSION

Enter **`UTIL`** menu and rotate either **VOLTAGE** or **CURRENT** control until status display reads **`VERS`** (see PAR. 3.2.11).

- The **DC VOLTS** display identifies whether the firmware is the factory shipped firmware (**`Pri`** displayed) or field updated firmware (**`SEC`** displayed).
- The **DC AMPS** display shows the firmware version.

3.2.11.2 DISPLAY MODEL

Enter **`UTIL`** menu and rotate either **VOLTAGE** or **CURRENT** control until status display reads **`MODL`** (see PAR. 3.2.11).

- The **DC VOLTS** display shows the model voltage rating (e.g, 75 for KLP 75-33-1200).
- The **DC AMPS** display shows the model current rating (e.g, 33 for KLP 75-33-1200).

3.2.11.3 ANALOG INPUT FULL SCALE CALIBRATION

Enter **`UTIL`** menu and rotate either **VOLTAGE** or **CURRENT** control until status display reads **`INVC`** (see PAR. 3.2.11).

- The **DC VOLTS** display shows the analog input voltage value that produces the full scale output voltage established by the virtual model.
- The **DC AMPS** display shows the analog input voltage value that produces the full scale output current established by the virtual model.

1. To change the settings tap the **DC OUTPUT** switch.
2. Rotate **VOLTAGE** control to change the analog voltage value required to produce the full scale output voltage (for fine adjustment press in **VOLTAGE** control and hold while rotating).
3. Rotate the **CURRENT** control to change the change the analog voltage value required to produce the full scale output current (for fine adjustment press in **CURRENT** control and hold while rotating).
4. Tap the **DC OUTPUT** switch to accept the new settings or use a thin tool (e.g., a paper clip) to press the **FUNCTION** switch to cancel the operation.

3.2.11.4 CALIBRATION

Enter **`UTIL`** menu and rotate either **VOLTAGE** or **CURRENT** control until status display reads **`CAL`** (see PAR. 3.2.11).

- The **DC VOLTS** display shows the month and day of the active calibration date.
- The **DC AMPS** display shows the year of the active calibration date.

Tap the **DC OUTPUT** switch to proceed to the system calibration (see PAR 4.3).

3.3 DIGITAL REMOTE MODE PROGRAMMING USING SCPI COMMANDS

KLP Power Supplies may be programmed over a control bus using SCPI (Standard Commands for Programmable Instruments). SCPI provides a common language conforming to IEEE 488.2 for instruments used in an automatic test system. The control bus used must be either the IEEE 488 standard communication bus (General Purpose Interface Bus, GPIB) (see PAR. 3.5) or the RS232C bus (see PAR. 3.4). Refer to Table 2-3 for GPIB port and Table 2-4 for RS232 input/output signal allocations. All power supply functions available from the front panel can be programmed via remote commands, as well as some that are not available from the front panel (see PAR. 3.3.1).

This section includes a discussion of functions available only using digital remote programming (PAR. 3.3.1), GPIB bus protocols (PAR. 3.5), instructions for changing the GPIB address (PAR. 3.5.1), a discussion of the VISA (Virtual Instrumentation Software Architecture) driver supplied with the unit (PAR. 3.5.2), followed by an introduction to SCPI programming (PAR. 3.6).

3.3.1 ADDITIONAL FUNCTIONS AVAILABLE VIA DIGITAL REMOTE PROGRAMMING

Digital Remote Programming is accomplished through SCPI programming (PAR. 3.6). The following paragraphs summarize the functions available using the SCPI subsystems described in PAR. 3.6.3. For complete details regarding digital commands and queries, refer to Appendix A (IEEE 488.2 Commands/Queries) and Appendix B (SCPI Commands/Queries).

3.3.1.1 STORAGE OF USER-PROGRAMMED ACTIVE SETTINGS

The KLP Power Supply contains 40 memory locations that can be used to store active settings. Values are stored in the nonvolatile memory using the **`*SAV`** command (see Appendix A, PAR. A.11), and are retained when the unit is turned off. The active settings can then be restored by issuing the **`*RCL`** command (see Appendix A, PAR. A.9). These setting are cleared when a calibration is performed.

If a virtual model setting (maximum voltage or current, see PAR. 3.2.5) is changed, and a stored setting is outside the range established by the new virtual model, the following occurs: when the setting is recalled, the stored value is reset to the default minimum (zero V or minimum A) and an error message notes that the requested value is out of range.

3.3.1.2 USER-DETERMINED OUTPUT SEQUENCES

Using the LIST commands (see Appendix B), up to 100 locations are available for programming the KLP output. These locations enable the user to program the output using multiple command sequences which may be initiated by a single command. The repeatable user-determined sequences are stored in volatile memory and are retained until reprogrammed, the power supply is turned off, a calibration is performed, or a **`LIST:CLEar`** command is received. If a virtual model setting (maximum voltage or current, see PAR. 3.2.5) is changed, and a programmed value is outside the range established by the new virtual model, the following occurs: when the program is executed, the programmed value is reset to the default minimum (zero V or minimum A) and an error message notes that the requested value is out of range.

Each location defines values for the active channel (either output voltage or output current), a dwell time duration (between 0.010 and 655.36 seconds) for the programmed settings, and the state of the internal relay. By programming the output to change in small increments, complex outputs can be generated. Figure B-3 illustrates the use of the LIST commands to output a user-generated sequence from the KLP.

NOTES: 1. When programming sequential voltage levels, it is important to set the Overvoltage to accommodate the highest voltage of the sequence. Otherwise, when going from higher to lower voltage levels, the overvoltage protection will trip and shut down the unit because the overvoltage setting registers faster than the power supply can attain the lower voltage.

2. To operate the internal relay using the LIST commands, first configure the internal relay to PROGRAM (see PAR. 2.7.10), then use the **`LIST:CONTrol`** command (see PAR. B.19) to control the relay.

3.3.1.3 EXTERNAL TRIGGERING

If external trigger mode is selected, grounding the EXT_TRG line (J2 pin 14 to pin 9, 11, 13 or 15) creates the trigger event at which time the trigger values (preset values **`VOLT:TRIG`** and **`CURR:TRIG`**) will become the setpoint values (Vset and Cset) for the power supply. Refer to PARs. A.15, B.48, B.58, and B.96. The **`VOLT:TRIG`** and **`CURR:TRIG`** values are reset to the default minimum (zero V or minimum A) when the unit is calibrated

If a virtual model setting (maximum voltage or current, see PAR. 3.2.5) is changed, and a trigger level is outside the range established by the new virtual model, the following occurs: when the unit is triggered, the **`VOLT:TRIG`** or **`CURR:TRIG`** value is reset to the default minimum and an error message notes that the requested value is out of range.

3.3.1.4 INTERNAL RELAY CONFIGURATION

By sending the appropriate SCPI command, the internal relay contacts available at pins 6, 7 and 8 of the Analog I/O connector can be configured to operate in one of three different ways.

FAULT mode (factory default) - the relay energizes upon detection of a system fault. This mode is set by sending the SCPI command **`DIAG:RELay:MODE FAUlt`**.

MANUAL mode - The relay is energized (ON) or de-energized (OFF) at the users discretion by sending SCPI commands. This mode is set by sending the SCPI command **`DIAG:RELay:MODE MANual`**. Once MANUAL mode has been configured, send either **`DIAG:RELay:ON`** or **`DIAG:RELay:1`** to energize the relay, or **`DIAG:RELay:OFF`** or **`DIAG:RELay:0`** to de-energize the relay.

PROGRAM mode - The relay is energized (ON) or de-energized (OFF) as part of a user-specified program using the LIST commands. This mode is set by sending the SCPI command **`DIAG:RELay:MODE PROGram`**.

3.4 RS232-C OPERATION

The KLP Power Supply may be operated via an RS232-C terminal, or from a PC using a terminal emulation program. The default settings are as follows:

- Baud rate: 9600 (no jumper between RTS and CTS on RS 232 port)
- Parity: None
- Data Bits 8
- Stop Bits 1
- Echo ON
- XON OFF

3.4.1 SERIAL INTERFACE

The serial interface behaves like the GPIB interface in that the command is parsed after receiving a control character of either a Line Feed or Carriage Return. The serial interface supports six special control characters. The six special control characters are:

Escape ($1B_H$)	Causes the input buffer to be cleared. This character is used to ensure that the buffer is empty when the host powers on since it is possible that the KLP Power Supply was previously powered on and received some characters prior to the initialization of the host computer.
Backspace (08_H)	Causes the last character in the input buffer to be removed from the input buffer queue.
Carriage Return ($0D_H$)	Causes the input buffer to be parsed by the KLP Power Supply.
Line Feed ($0A_H$)	Causes the input buffer to be parsed by the KLP Power Supply.
> and <	The > character turns on the echo mode upon receipt of the character. The < character turns off the echo mode. The message "echo off" or "echo on" will be displayed to confirm this.

3.4.2 RS 232 IMPLEMENTATION

The following paragraphs are provided to help the user understand how the RS 232 serial interface is implemented in the KLP Power Supply. Since the RS 232 protocol does not use a parity bit, the echo mode is the default method used to ensure reliable communication between the command originator (computer) and the KLP Power Supply, thus avoiding a more complex "handshake" protocol.

When the KLP Power Supply is in the RS 232 echo mode it returns all data sent to the host controller. The KLP Power Supply provides two additional options that allow handshake communication: the Prompt method and the XON XOFF method. In standard echo mode the controller must verify that each character is echoed back by the KLP. As shown in Figure 3-1, there are times when the KLP does not echo back the character from the controller, requiring that the controller resend the character. By using the handshake options (prompt and XON XOFF) the host controller can ensure that serial data interrupts occurring after parsing of the incoming message do not result in lost data.

Figure 3-1 illustrates the default echo mode, the prompt method and the XON XOFF method described in the following paragraphs.

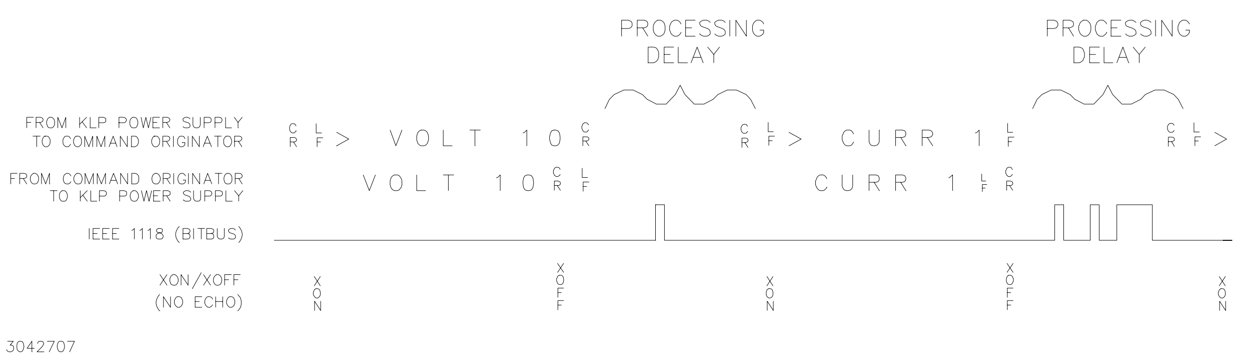


FIGURE 3-1. RS 232 IMPLEMENTATION

Only four control characters (characters between 00_H and $1F_H$) are acknowledged by the power supply:

- Carriage Return (CR, $0D_H$)
- Line Feed (LF, $0A_H$)
- Back Space (BS, 08_H)
- Escape (ESC, $01B_H$)

BS deletes the last character entered, with the exception of CR or LF characters. Either the CR or LF character acts as the line terminator, initiating parsing of the ASCII data sent to the KLP Power Supply by the command originator. When the line is parsed, the KLP sends the line terminator sequence CR LF to the command originator.

The ESC character is used for synchronization, causing the KLP Power Supply to reset its input buffer and return a CR LF sequence.

All non-control characters are sent via the serial port of the command originator. The control character BS is echoed as BS Space BS. Only the first control character is returned in response to either a CR LF or LF CR character sequence (see Figure 3-1).

3.4.2.1 ECHO MODE

Echo mode is the default method of ensuring data is transferred without errors. Each byte (character) is echoed back to the sender where it is verified as the same character that was just sent. If the character is incorrect or missing, the sender sends the character again until the correct character is verified as having been received.

All non-control characters are sent via the serial port of the command originator. The control character BS is echoed as BS Space BS. Only the first control character is returned in response to either a CR LF or LF CR character sequence (see Figure 3-1).

3.4.2.2 PROMPT METHOD

The command originator sends a message line (command) to the KLP Power Supply and waits until the prompt sequence CR LF > ($3E_H$, 62_{10}) is received. The KLP sends the prompt sequence CR LF > to the command originator indicating the power supply is ready to receive the next command and data will not be lost. The prompt method is similar to the echo method described above, except that the command originator does not have to compare each character and repeat any characters dropped. The operation of the KLP is identical for echo mode and prompt mode; implementation of prompt mode is at the command originator.

3.4.2.3 XON XOFF METHOD

The XON XOFF method allows the KLP Power Supply to control when the command originator is allowed to send data. The command originator can only send data after the XON (transmission on) character (011_H) has been received; the command originator stops sending data after receiving the XOFF (transmission off) character (013_H), and waits until the XON character is received before sending additional data. The XON XOFF method can be implemented independently of the echo method using the special commands described below (PAR 3.4.2.4).

Control characters, either CR or LF, are returned as XOFF CR if echo mode is on, and as XOFF if echo mode is off. XOFF stops data from the command originator and the KLP returns the normal sequence of CR LF (if echo mode is enabled).

3.4.2.4 SPECIAL COMMANDS

The serial parser supports the command RSMODE to allow quick changes to RS 232 protocol.

RSMODEn This command is used to implement the XON XOFF method and control whether echo mode is on or off. The **RSMODE** sequence is followed by a number **n**: 0, through 5, defined in Table 3-2. This command must be the first command on a line.

TABLE 3-2. XON XOFF CONTROL

VALUE OF n	ECHO	PROMPT	XON XOFF
0	OFF	OFF	DISABLED
1	ON	ON	DISABLED
2	OFF	ON	DISABLED
3	OFF	OFF	ENABLED
4	ON	ON	ENABLED
5	OFF	ON	ENABLED

3.4.2.5 ISOLATING RS 232 COMMUNICATIONS PROBLEMS

A Loop Back test can be run from the KLP front panel to aid in isolating RS 232 communications problems.

1. With the power supply in local mode, use a thin tool (e.g., a paper clip), to press the **FUNCTION** switch repeatedly until the status display shows **UTIL**. Press the **DC OUTPUT** switch to enter the Utilities menu. Rotate either the **VOLTAGE** or **CURRENT** control until the status display shows **LBT** (Loop Back Test). At this point the VOLTS display will show **- - - -**.

2. With the power supply's RS 232 port open (no connections), press the **DC OUTPUT** switch once to run the test. The **VOLTS** display should show FAIL; if it reads PASS, the power supply is defective and requires repair.

3. Install the loop-back test connector (195-0112, see Table 1-4) at the RS 232 port, located on the rear panel of the power supply (J3, Figure 2-2). (If the loop back test connector is not available, install a jumper from pin 2 to pin 3 of the RS 232 port connector.) Press the **DC OUTPUT** switch once to rerun the test. The **VOLTS** display should now read **PASS**; if it reads **FAIL**, the power supply is defective and requires repair.

4. To test the integrity of the cable assembly connecting the power supply RS 232 port to the computer, remove the loop back test connector or jumper and connect the cable in its place. Install a jumper wire from pin 2 to pin 3 at the opposite end of the cable and repeat the test of (step 3) above. If the **VOLTS** display reads **FAIL**, the cable is either the improper type (not null modem) or defective. If the **VOLTS** display reads **PASS**, the cable is correct. Remove the jumper and reconnect the cable to the computer.

5. To exit the utitlies menu, press the **FUNCTION** switch repeatedly until the status display is blank.

   If each of the above steps is completed successfully, the problem lies in the computer hardware and/or software. Refer to the Product Support area of the Kepco website for additional information regarding RS 232 Communications problems: www.kepcopower.com/support.

3.5 IEEE 488 (GPIB) BUS PROTOCOL

Table 3-3 defines the interface capabilities of the KLP power supply (Talker/Listener) relative to the IEEE 488 (GPIB) bus (reference document *ANSI/IEEE Std 488: IEEE Standard Digital Interface for Programmable Instrumentation*) communicating with a Host Computer—Controller (Talker/Listener). Tables 3-4 and 3-5 define the messages sent to the KLP, or received by the KLP, via the IEEE 488 bus in IEEE 488 command mode and IEEE 488 data mode, respectively. These messages are enabled during the “handshake” cycle, with the KLP power supply operating as either a Talker or a Listener.

TABLE 3-3. IEEE 488 (GPIB) BUS INTERFACE FUNCTIONS

FUNCTION	SUBSET SYMBOL	COMMENTS
Source Handshake	SH1	Complete Capability (Interface can receive multiline messages)
Acceptor Handshake	AH1	Complete Capability (Interface can receive multiline messages)
Talker	T6	Basic talker, serial poll, unaddress if MLA (My Listen Address) (one-byte address)
Listener	L4	Basic listener, unaddress if MTA (My Talk Address) (one-byte address).
Service Request	SR1	Complete Capability. The interface sets the SRQ line true if there is an enabled service request condition.
Remote/Local	RL1	Complete capability. Interface selects either local or remote information. In local mode the KLP executes front panel commands, but can be set to remote mode via IEEE 488 bus. When in Remote mode all front panel keys are disabled except LOCAL. LOCAL key can be disabled using keypad lockout command (see Appendix B, PAR. B.82) so that only the controller or a power on condition can restore Local mode.
Parallel Poll	PP0	No Capability
Device Clear	DC1	Complete Capability. KLP accepts DCL (Device Clear) and SDC (Selected Device Clear).
Device Trigger	DT1	Respond to *TRG and <GET> trigger functions.
Controller	C0	No Capability

TABLE 3-4. IEEE 488 (GPIB) BUS COMMAND MODE MESSAGES

MNEMONIC	MESSAGE DESCRIPTION	COMMENTS
DCL	Device Clear	Received
GET	Group Execute Trigger	Received
GTL	Go To Local	Received
IFC	Interface Clear	Received
LLO	Local Lockout	Received
MLA	My Listen Address	Received
MTA	My Talk Address	Received
OTA	Other Talk Address	Received (Not Used)
RFD	Ready for Data	Received or Sent
SDC	Selected Device Clear	Received
SPD	Serial Poll Disable	Received
SPE	Serial Poll Enable	Received
SRQ	Service Request	Sent
UNL	Unlisten	Received
UNT	Untalk	Received

TABLE 3-5. IEEE 488 (GPIB) BUS DATA MODE MESSAGES

MNEMONIC	MESSAGE DESCRIPTION	COMMENTS
DAB	Data Byte	Received or Sent
END	End	Received or Sent
EOS	End of String	Received or Sent
RQS	Request Service	Sent
STB	Status Byte	Sent

3.5.1 CHANGING THE GPIB ADDRESS

See PAR. 3.2.8.

3.5.2 KLP VISA INSTRUMENT DRIVER

The VISA instrument driver simplifies programming with a VISA compatible GPIB controller. and Includes 1) source code (C) for all VISA functions, and 2) a complete programming reference manual which can be used to program one or more KLP power supplies using a virtual front panel observed on a computer monitor.

Download the latest VISA driver from the Kepco website at
http://www.kepcopower.com/drivers.htm

Although the software drivers supplied by Kepco are VISA compliant, they also require the installation of the proper 16-bit VISA driver from your GPIB card supplier. Many vendors supply this software with the hardware; National Instruments (http://www.natinst.com) has the driver for their cards available on the internet at a file transfer site (ftp://ftp.natinst.com — find the folder for support and VISA drivers). The driver to be installed is the win16 driver, even if your system is running under Windows 95 or Windows NT.

3.6 SCPI PROGRAMMING

SCPI (Standard Commands for Programmable Instruments) is a programming language conforming to the protocols and standards established by IEEE 488.2 (reference document *ANSI/IEEE Std 488.2, IEEE Standard Codes, Formats, Protocols, and Common Commands*). SCPI commands are sent to the KLP Power Supply as ASCII output strings within the selected programming language (PASCAL, BASIC, etc.) in accordance with the manufacturer's requirements for the particular GPIB controller card used.

Different programming languages (e.g., BASIC, C, PASCAL, etc.) have different ways of representing data that is to be put on the IEEE 488 bus. It is up to the programmer to determine how to output the character sequence required for the programming language used. Address information (GPIB address) must be included before the command sequence. (See PAR.3.5.1 to establish the KLP Power Supply GPIB address.)

3.6.1 SCPI MESSAGES

There are two kinds of SCPI messages: program messages from controller to power supply, and response messages from the power supply to the controller. Program messages consist of one or more properly formatted commands/queries and instruct the power supply to perform an action; the controller may send a program message at any time. Response messages consist of formatted data; the data can contain information regarding operating parameters, power supply state, status, or error conditions.

3.6.2 COMMON COMMANDS/QUERIES

Common commands and queries are defined by the IEEE 488.2 standard to perform overall power supply functions (such as identification, status, or synchronization) unrelated to specific power supply operation (such as setting voltage/current). Common commands and queries are preceded by an asterisk (*) and are defined and explained in Appendix A. Refer also to syntax considerations (PARs 3.4.3 through 3.4.6).

3.6.3 SCPI SUBSYSTEM COMMAND/QUERY STRUCTURE

Subsystem commands/queries are related to specific power supply functions (such as setting output voltage, current limit, etc.) Figure 3-3 is a tree diagram illustrating the structure of SCPI subsystem commands used in the KLP Power Supply with the "root" at the left side, and specific commands forming the branches. The following paragraphs introduce the subsystems; subsystem commands are defined and explained in Appendix B.

3.6.3.1 ABORT SUBSYSTEM

This subsystem allows pending trigger levels to be cancelled.

3.6.3.2 DISPLAY SUBSYSTEM

This subsystem returns the character string displayed in the Status display.

3.6.3.3 TRIGGER SUBSYSTEM

This subsystem enables the trigger system. When an internal trigger is enabled, the triggering action will occur upon receipt of a GPIB <GET>, *TRG or TRIGger command. When an external trigger is enabled, the triggering action occurs when a ground is applied to J2, pin 14. If a trigger circuit is not enabled, all trigger commands are ignored.

3.6.3.4 LIST SUBSYSTEM

The LIST subsystem is represented by the 100 memory locations (groups of settings) which are stored in the volatile memory. Each setting contains values for: Current, Voltage, Dwell, and Relay. The range for the first two values is the maximum available range for the specific power supply. The range for the dwell time is between 0.01 and 655.36 seconds. If the relay is configured to PROGRAM (see PAR. 2.7.10), it can be set to 1 (on, energized) or 0 (off, de-energized).

3.6.3.5 MEASURE SUBSYSTEM

This query subsystem returns the voltage and current measured at the power supply's output terminals.

3.6.3.6 OUTPUT SUBSYSTEM

This subsystem controls the power supply's voltage and current outputs

3.6.3.7 STATUS SUBSYSTEM

This subsystem programs the power supply status register. The power supply has two groups of status registers: Operation and Questionable. Each group consists of three registers: Condition, Enable, and Event.

3.6.3.8 SYSTEM SUBSYSTEM

This subsystem controls the RS 232 port, GPIB address, passwords, security, language, keyboard lockout, and compatibility with older Kepco equipment.

3.6.3.9 [SOURCE:]VOLTAGE AND [SOURCE:]CURRENT SUBSYSTEMS

These subsystems program the output voltage and current of the power supply.

3.6.3.10 CALIBRATE SUBSYSTEM

The KLP series of power supplies support software calibration. A full calibration consists of a voltage calibration and a current calibration. Both voltage and current calibrations consist of a zero and a full scale calibration. There are two ways to perform the calibration: locally using the front panel keys, or remotely sending commands through the GPIB bus. These two ways cannot be combined.

In order to enter the calibration mode the correct calibration access code (password) must be entered. If the password has been forgotten call the factory and a secret password (which has been assigned to your power supply) will be provided. During the calibration, new calibration data is computed which is than stored in the non volatile memory.

The equipment required for calibration is specified in PAR. 4.2.

Because the voltage measured will be used as reference for calibration, the DVM itself must be calibrated accurately. During voltage calibration, the voltage, overvoltage and voltage readback are calibrated and during current calibration the current, overcurrent and current readback are calibrated. The normal procedure is to calibrate voltage first and then current. However, you do not have to do a complete calibration each time. If required, you may calibrate only the voltage or the current and then proceed to saving the calibration results. For voltage calibration all loads must be disconnected and the sense terminals connected to the corresponding output terminals. The digital voltmeter will be connected to the output of the power supply. For current calibration after disconnecting all loads an appropriate shunt resistor will be connected across output terminals and the digital voltmeter will be connected across the sense terminals of the shunt resistor.

3.6.4 PROGRAM MESSAGE STRUCTURE

SCPI program messages (commands from controller to power supply) consist of one or more ***message units*** ending in a ***message terminator*** (required by Kepco power modules). The message terminator is not part of the syntax; it is defined by the way your programming language indicates the end of a line ("newline" character). The message unit is a keyword consisting of a single command or query word followed by a message terminator (e.g., CURR?<newline> or TRIG<end-of-line>). The message unit may include a data parameter after the keyword separated by a space; the parameter is usually numeric (e.g., CURR 5<newline>), but may also be a string (e.g., OUTP ON<newline>). Figure 3-2 illustrates the message structure, showing how message units are combined. The following subparagraphs explain each component of the message structure.

NOTE: An alternative to using the message structure for multiple messages defined in the following paragraphs is to send each command as a separate line. In this case each command must use the full syntax shown in Appendix B.

3.6.4.1 KEYWORD

Keywords are instructions recognized by a decoder within the KLP, referred to as a "parser." Each keyword describes a command function; all keywords used by the KLP are listed in Figure 3-3.

Each keyword has a long form and a short form. For the long form the word is spelled out completely (e.g. STATUS, OUTPUT, VOLTAGE, and TRIGGER are long form keywords). For the short form only the first three or four letters of the long form are used (e.g., STAT, VOLT, OUTP, and TRIG). The rules governing short form keywords are presented in Table 3-6.

You must use the rules above when using keywords. Using an arbitrary short form such as ENABL for ENAB (ENABLE) or IMME for IMM (IMMEDIATE) will result in an error. Regardless of which form chosen, you must include all the letters required by that form.

To identify the short form and long form in this manual, keywords are written in upper case letters to represent the short form, followed by lower case letters indicating the long form (e.g., IMMediate, EVENt, and OUTPut). The parser, however, is not sensitive to case (e.g., outp, OutP, OUTPUt, ouTPut, or OUTp are all valid).

TABLE 3-6. RULES GOVERNING SHORTFORM KEYWORDS

IF NUMBER OF LETTERS IN LONGFORM KEYWORD IS:	AND FOURTH LETTER IS A VOWEL?	THEN SHORT FORM CONSISTS OF:	EXAMPLES
4 OR FEWER	(DOES NOT MATTER)	ALL LONG FORM LETTERS	MODE
5 OR MORE	NO	THE FIRST FOUR LONG FORM LETTERS	MEASure, OUTPut, EVENt
	YES	THE FIRST THREE LONG FORM LETTERS	LEVel, IMMediate, ERRor

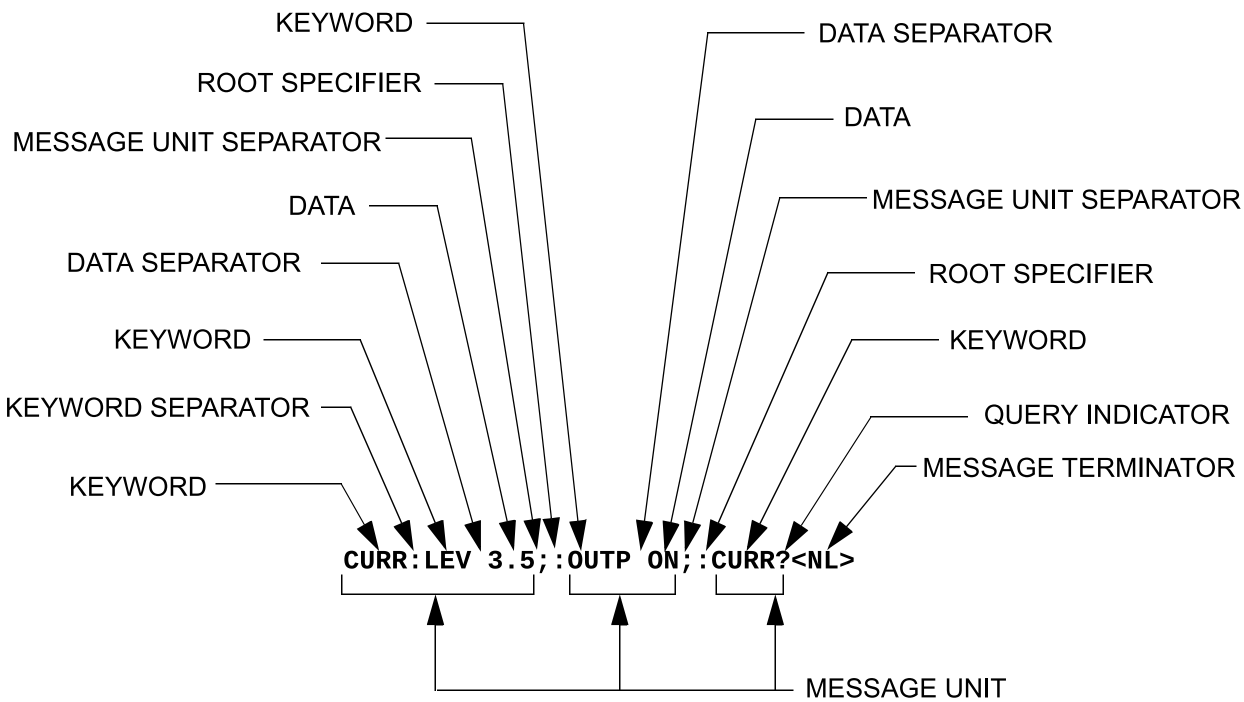


FIGURE 3-2. MESSAGE STRUCTURE

3.6.4.2 KEYWORD SEPARATOR

If a command has two or more keywords, adjacent keywords must be separated by a colon (:) which acts as the keyword separator (e.g., CURR:LEV:TRIG). The colon can also act as a root specifier (paragraph 3.4.4.7).

3.6.4.3 QUERY INDICATOR

The question mark (?) following a keyword is a query indicator. This changes the command into a query. If there is more than one keyword in the command, the query indicator follows the last keyword. (e.g., VOLT? and MEAS:CURR?).

3.6.4.4 DATA

Some commands require data to accompany the keyword either in the form of a numeric value or character string. Data always follows the last keyword of a command or query (e.g., VOLT:LEV:TRIG 14 or SOUR:VOLT? MAX

3.6.4.5 DATA SEPARATOR

Data must be separated from the last keyword by a space (e.g., VOLT:LEV:TRIG 14 or SOUR:VOLT? MAX

3.6.4.6 MESSAGE UNIT SEPARATOR

When two or more message units are combined in a program message, they must be separated by a semicolon (;) (e.g., VOLT 15;MEAS:VOLT? and CURR 12; CURR:TRIG 12.5).

3.6.4.7 ROOT SPECIFIER

The root specifier is a colon (:) that precedes the first keyword of a program message. This places the parser at the root (top left, Figure 3-3) of the command tree. Note the difference between using the colon as a keyword separator and a root specifier in the following examples:

VOLT:LEV:IMM 16 Both colons are keyword separators.

:CURR:LEV:IMM 4 The first colon is the root specifier, the other two are keyword separators.

VOLT:LEV 6;:CURR:LEV 15 The second colon is the root specifier, the first and third are keyword separators

:INIT ON;:TRIG;:MEAS:CURR?;VOLT? The first three colons are root specifiers.

3.6.4.8 MESSAGE TERMINATOR

The message terminator defines the end of a message. One message terminator is permitted:

- new line (<NL>), ASCII 10 (decimal) or 0A (hex)

NOTE: Kepco power supplies ***require*** a message terminator at the end of each program message. The examples shown in this manual assume a message terminator will be added at the end of each message. Where a message terminator is shown it is represented as <NL> regardless of the actual terminator character.

ROOT : (colon)

ABORt subsystem
- ABORt

CALibrate subsystem
- CALibrate
  - :CEXTernal
  - :CGAin
  - :CURRent
    - :LEVel (MIN | MAX, ZERO)
    - [:DATA] val
  - :DATA
  - :DPOT
  - :SAVE <date> optional
  - :STATe <boolean> ,password
  - :STATe?
  - :VEXTernal
  - :VGAin
  - :VOLTage
    - :LEVel (MIN | MAX, ZERO)
    - [:DATA] val
  - :ZERO

DISPlay subsystem
- DISPlay
  - [:WINDow]:TEXT[:DATA]?

OUTPut subsystem
- OUTPut
  - [:STATe] ON or OFF
  - [:STATe]?

TRIGger subsystem
- TRIGger
  - [:IMMediate]
    - :CONTinuous bool
    - :CONTinuous?
  - :SOUR BUS | EXT

[SOURce:] subsystem
- [SOURce:]
- VOLTage
  - [:LEVel]
    - [:IMMediate]
      - [:AMPLitude] val
      - [:AMPLitude]? MIN, MAX
    - :TRIGgered
      - [:AMPLitude] val
      - [:AMPLitude]? MIN, MAX
  - :PROTection
  - :PROTection? MIN, MAX
  - :LIMit
    - :HIGH val
    - :HIGH? MIN, MAX
- CURRent
  - [:LEVel]
    - [:IMMediate]
      - [:AMPLitude] val
      - [:AMPLitude]? MIN, MAX
    - :TRIGgered
      - [:AMPLitude] val
      - [:AMPLitude]? MIN, MAX
  - :PROTection
  - :PROTection? MIN, MAX
  - :LIMit
    - :HIGH val
    - :HIGH? MIN, MAX

LIST subsystem
- LIST
  - :CLE
  - :CONT
  - :CONT?
  - :COUN
    - :SKIP
    - :SKIP?
  - :COUN?
  - :CURRent
    - [:LEVel] val
    - [:LEVel]?
    - :POINt?
  - :DIR
  - :DIR?
  - :DWELl
  - :DWELl?
    - :POINt?
  - :QUERy
  - :QUERy?
  - :VOLTage
    - [:LEVel] val
    - [:LEVel]?
    - :POINt?
  - :INDex val
  - :INDex?
  - :SEQuence
    - :STARt val
    - :STARt ?
    - :NEXT val
    - :NEXT?
  - :DWELl val
  - :DWELl?

STATus subsystem
- STATus
  - :OPERation
    - :CONDition?
    - :ENABle val
    - :ENABle?
    - [:EVENt]?
  - :PRESet
  - :QUEStionable
    - :CONDition?
    - :ENABle val
    - :ENABle?
    - [:EVENt]?
    - :VOLTage
      - :CONDition?
      - :ENABle val
      - :ENABle?
      - :[:EVENt]?
    - :CURRent
      - :CONDition?
      - :ENABle val
      - :ENABle?
      - :[:EVENt]?

SYSTem subsystem
- SYSTem
  - :COMM
    - :GPIB:ADDR val
    - :GPIB:ADDR?
    - :SER:BAUD val
    - :SER:ECHO (0 | 1)
    - :SER:ECHO?
    - :SER:ENAB (0 | 1)
    - :SER:PACE (NONE | XON)
    - :SER:PROM (0 | 1)
    - :SER:PROM?
  - :ERRor
    - [:NEXT]?
    - :CODE?
      - [:NEXT]?
      - :ALL?
  - :KLOCk <boolean>
  - :KLOCk?
  - :LANGuage(SCPI | COMPatibility)
  - :PASSword
    - [:CENAble] (code)
      - :STATe?
    - :CDISenable (code)
    - :NEW <oldpass>,<newpass>
  - :SECUrity
    - :IMMediate
  - :SET
  - :VERSion?

MEASure subsystem
- MEASure
  - [:SCALar]:CURRent[:DC]?
  - [:SCALar]:[VOLTage][:DC]?

FIGURE 3-3. TREE DIAGRAM OF SCPI COMMANDS USED WITH KLP POWER SUPPLY

3.6.5 UNDERSTANDING THE COMMAND STRUCTURE

Understanding the command structure requires an understanding of the subsystem command tree illustrated in Figure 3-3. The “root” is located at the top left corner of the diagram. The parser goes to the root if:

- a message terminator is recognized by the parser
- a root specifier is recognized by the parser

Optional keywords are enclosed in brackets [ ] for identification; optional keywords can be omitted and the power supply will respond as if they were included in the message. The root level keyword [SOURce] is an optional keyword. Starting at the root, there are various branches or paths corresponding to the subsystems. The root keywords for the KLP Power Supply are :ABORt, :CALibrate, :DISPlay, :INITiate, :LIST, :MEASure, :OUTPut, [:SOURce], :STATus, :SYSTem and :TRIGger. Because the [SOURce] keyword is optional, the parser moves the path to the next level, so that VOLTage, CURRent, and FUNCtion commands are at the root level.

Each time the parser encounters a keyword separator, the parser moves to the next indented level of the tree diagram. As an example, the STATus branch is a root level branch that has three sub-branches: OPERation, PRESet, and QUEStionable. The following illustrates how SCPI code is interpreted by the parser:

STAT:PRES<NL>
The parser returns to the root due to the message terminator.

STAT:OPER?;PRES<NL>
The parser moves one level in from STAT. The next command is expected at the level defined by the colon in front of OPER?. Thus you can combine the following message units STAT:OPER? and STAT:PRES;

STAT:OPER:COND?;ENAB 16<NL>
After the OPER:COND? message unit, the parser moves in one level from OPER, allowing the abbreviated notation for STAT:OPER:ENAB.

3.6.6 PROGRAM MESSAGE SYNTAX SUMMARY

- Common commands begin with an asterisk (*).

- Queries end with a question mark (?).

  - Program messages consist of a root keyword and, in some cases, one or more message units separated by a colon (:) followed by a message terminator. Several message units of a program message may be separated by a semicolon (;) without repeating the root keyword.

  - If a program message has more than one message unit, then a colon (:) must precede the next keyword in order to set the parser back to the root (otherwise the next keyword will be taken as a subunit of the previous message unit).

    e.g., the command **`meas:volt?;curr?`** will read output voltage and output current since both **`volt?`** and **`curr?`** are interpreted as subunits of the **`meas`** command.

  - Several commands may be sent as one message; a line feed terminates the message. Commands sent together are separated by a semicolon (;). The first command in a message starts at the root, therefor a colon (:) at the beginning is not mandatory.

e.g., the command **meas:volt?;:curr?** will read output voltage and programmed current since the colon preceding **curr?** indicates that **curr?** is not part of the **meas** command and starts at the root.

- UPPER case letters in mnemonics are mandatory (short form). Lower case letters may either be omitted, or must be specified completely (long form)
  e.g., **INSTrument** (long form) has the same effect as **INST** (short form).
- Commands/queries may be given in upper/lower case (long form)
  e.g., **SoUrCe** is allowed.
- Text shown between brackets [ ] is optional.
  e.g., **:[SOUR]VOLT[:LEV] TRIG** has the same effect as **:VOLT TRIG**

3.6.7 STATUS REPORTING

The status reporting of the KLP power supply follows the SCPI and IEEE 488.2 requirements. The serial poll response of the KLP power supply provides summary bits of the status and error reporting system. The simplest status report is the command valid reporting and data availability, This successful decoding of a command string generates no error and is indicated by the bit 3 of the serial poll response being a zero. The setting of bit 4 in the status byte indicates data is available to the controller in response a command query message.

3.6.7.1 STATUS REPORTING STRUCTURE

The status reporting of the KLP uses four status registers, illustrated in Figure 3-4. These registers are the Questionable, Operation, Standard Event and Service Request registers. The Questionable and Operation registers are 16 bit registers and the Standard Event and Service Request registers are 8 bits. These four registers are referred to as condition registers. Each of the four condition registers is associated with two related registers: an event register which holds unlatched events reported in real-time by the instrument and is cleared by reading the register, and an enable register which allows the contents of the event register to be passed through to set the associated condition register.

A zero to one transition of a condition register is added to the event register if the specific bit in the enable register is also a 1. Reading an event register clears all of the bits found in the event register. If any bits are set in an event register, the following condition register bit is then set. For example, if the STAT:QUES:ENB (enable) register has bit 0 set and a voltage error is detected, the event registers bit 0 is set. The 1 in the event register causes bit 3 of the status byte to be asserted. The Service Request register is ANDed with its enable register for all bits except bit 6. The result is placed in bit 6 of the Service Request register. If bit 6 is a 1 (true), it causes the power supply to assert the SRQ line to the host controller.

Figure 3-4 also shows that if the error/event queue is not empty, bit 3 is set in the Service Request register and bit 4 indicates that a message is available in the output buffer.

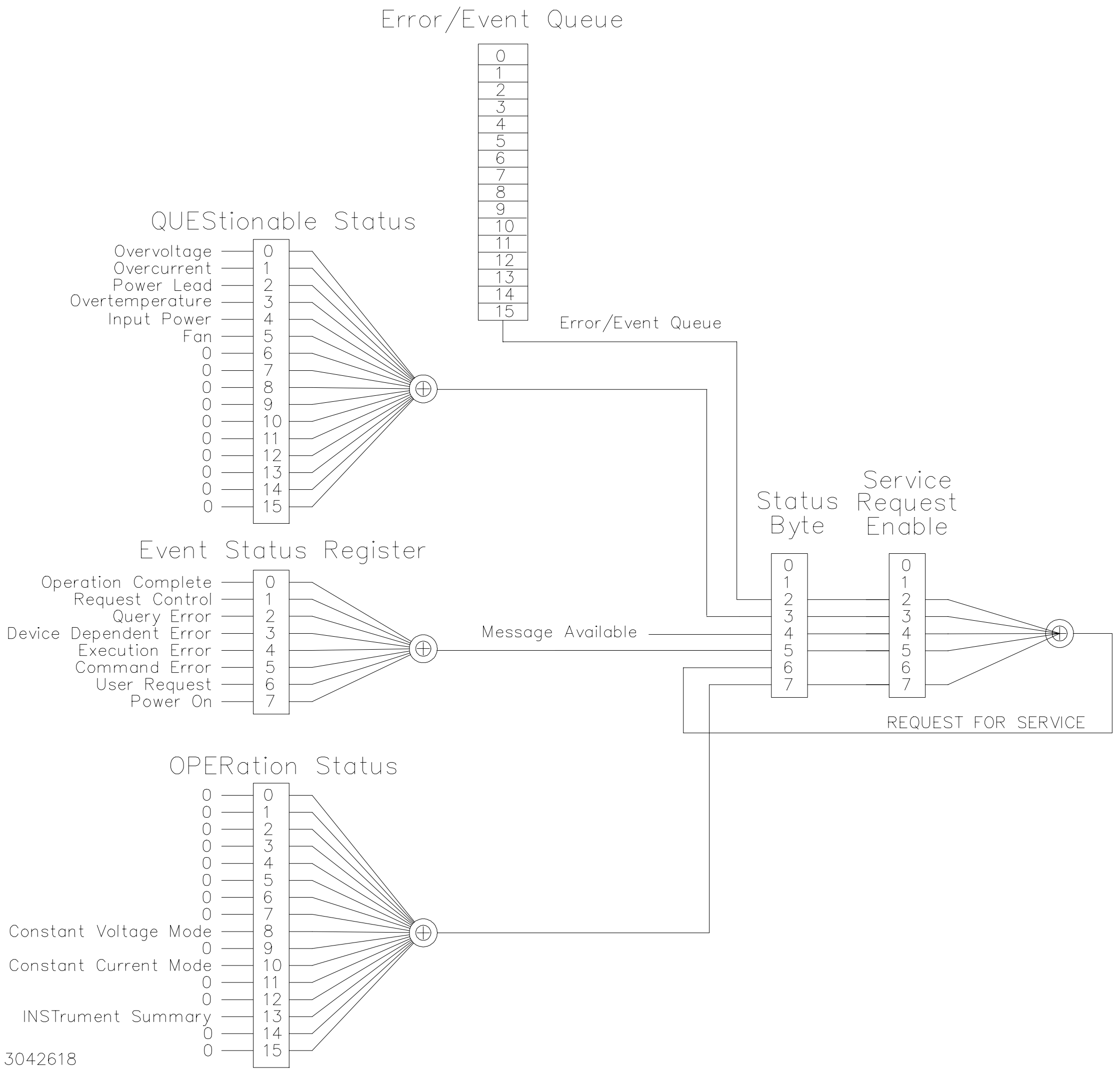


FIGURE 3-4. STATUS REPORTING STRUCTURE

3.6.7.2 OPERATIONAL STATUS REGISTER

The OPERational condition register contains conditions which are a part of the instrument's normal operation. The definition of each of these bits (condition register) is as follows:

- 1 through 7 - Not Used — always zero.
- 8 - Constant Voltage — 1 indicates the instrument is in constant voltage mode.
- 9 - Not Used — always zero.
- 10 - Constant Current — 1 indicates the instrument is in constant current mode.
- 11 through15 - Not Used — always zero.

3.6.7.3 QUESTIONABLE STATUS REGISTER

The QUEStionable condition register (see Figure 3-4) contains status bits representing data/signals which give an indication of the quality of various aspects of the signal.

A bit set in the QUEStionable condition register indicates that the data currently being acquired or generated is of questionable quality due to some condition affecting the parameter associated with that bit.

- 0 - Overvoltage Error — 1 indicates an overvoltage fault has been detected.
- 1 - Overcurrent Error — 1 indicates an overcurrent fault has been detected.
- 2 - Power Lead Error — 1 indicates that sense lead connections are not complete.
- 3 - Overtemperature Error — 1 indicates a thermal error has been detected.
- 4 - Input Power Error — 1 indicates input mains error.
- 5 - Fan Error — 1 indicates inoperative fan.
- 6 - 15 Not Used — always zero.

3.6.8 SCPI PROGRAM EXAMPLES

Refer to Appendix B, Figures B-1 through B-7 for examples illustrating the use of SCPI commands.

Figure 3-5 is an example of a program using SCPI commands to program the KLP Power Supply. The program illustrated is for a configuration using an IBM PC or compatible with a National Instruments GPIB interface card. (It will be necessary to consult the manufacturer's data to achieve comparable functions with an interface card from a different manufacturer.) This program sets output voltage (Voltage mode) or voltage limit (Current mode) to 5V, and current limit (Voltage mode) or output current (Current mode) to 1A, then reads the measured (actual) voltage and current, then prints the measurements.

3.7 REMOTE PROGRAMMING USING ANALOG SIGNALS

The voltage and current inputs (Vref and Cref, respectively) of the Analog I/O Port (see J2, Figure 2-2 and Table 2-2) are normally inactive. These are activated by connecting pin 12 of J2 to one of the four GND pins: J2 pin 9, 11, 13 or 15 before turning the power supply on. Once the power supply is turned on the status display reads **aRem**. While the power supply is in analog remote mode, digital queries related to status and readback will be accepted and executed. The following paragraphs provide detailed information for using analog programming signals.

NOTE: Optimum resolution is achieved with 10V programming input which is equivalent to full scale. Decreasing the analog voltage equivalent to full scale (see PAR. 4.3.3) will cause a corresponding decrease in programming resolution.

With the exception of Vref and Cref, all the other Analog I/O Port functions are active regardless of the status of the analog control signal applied to J2 pin 12. These include fault relay: FAULT_NO (pin 2), FAULT_COM (pin 4), FAULT_NC (pin 10); voltage and current readbacks: VOLT_RBACK (pin 6) and CURR_RBACK (pin 7); external trigger: EXT_TRG (pin 14) and remote inhibit: REM_INH (pin 8).

3.7.1 ENABLING/DISABLING THE OUTPUT USING ANALOG CONTROL

Enabling and disabling the output is accomplished via the analog I/O port using pin 8. Logic 0 (ground) turns the output off, Logic 1 (open) turns the output on.

```
/***********************************************************************/
/*    Sample Program For KEPCO power supply, using National Instruments   */
/*    GPIB interface card and IBM PC or compatible computer              */
/***********************************************************************/

#include <stdio.h>
#include "decl.h"

char rd_str[80];                        // Input buffer
char dat_str[80];                       // Output buffer
int  bd,adr;

main() {
   adr = ibfind("DEV6");                // Open DEV6 (defined by IBCONF)
   bd = ibfind ("GPIB0");               // Open GPIB card
   ibsic (bd);                          // Send Interface Clear
   ibsre(bd,1);                         // Set remote line true

   strcpy(dat_str,"VOLT 5;CURR 1");     // Define a set command
   strcat(dat_str,"\r\n");              // Append delimiter
   ibwrt(adr,dat_str,strlen(dat_str));  // Send string to power supply

   strcpy(dat_str,"MEAS:VOLT?;CURR?");  // Define a measure command
   strcat(dat_str,"\r\n");              // Append delimiter
   ibwrt(adr,dat_str,strlen(dat_str));  // Send string to power supply

   strset(rd_str,'\0');                 // Clear input buffer
   ibrd(adr,rd_str,64);                 // Read result of measure
   printf("received : %s\n",rd_str);    // Print voltage and current

}
```

FIGURE 3-5. TYPICAL EXAMPLE OF KLP POWER SUPPLY PROGRAM USING SCPI COMMANDS

3.7.2 PROGRAMMING WITH EXTERNAL RESISTANCE

Figure 3-6 is a simplified diagrams of the KLP showing the switch configuration and external connections required for analog programming using an external resistance.

1. Overvoltage and Overcurrent settings must be established via either local programming or digital remote programming prior to initiating Analog Remote programming. (see PAR. 3.7.4.)

2. Turn off power and configure the Analog I/O DIP switch (Figure 2-2) as follows:

   SW1: ON (Program output voltage via resistance)
   SW2: ON (Program output current via resistance)
   SW3: Not applicable when in remote analog programming mode
   SW4: Not used
   SW5: Either OFF (Local controls enabled) or ON (Local controls locked)

3. Configure Analog I/O Port J1 (Figure 2-2) by referring to Table 2-6 and Figure 3-6.

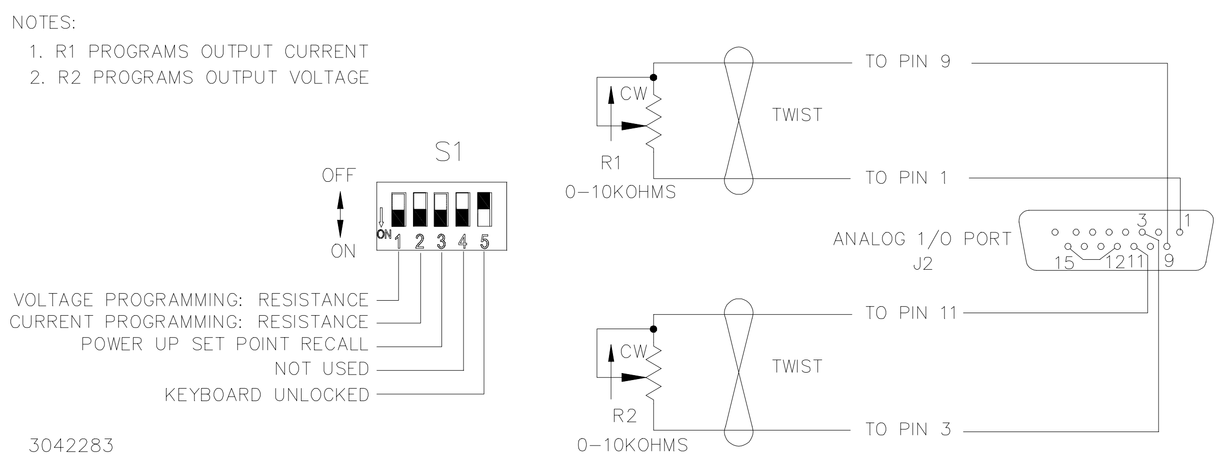


FIGURE 3-6. ANALOG PROGRAMMING OF OUTPUT VOLTAGE OR CURRENT USING RESISTANCE

With the power supply configured as shown in Figure 3-6 and assuming the load causes the power supply to operate in voltage mode, varying external resistor R2 from 0 to 10K causes the output voltage of the power supply to vary linearly from 0 to full scale, while R1 can be used to adjust the current limit. When the power supply operates in current mode, R2 will adjust the voltage limit and R1 will adjust output current.

Factory default full scale (F.S.) resistance programming is 10K ohms based on F.S. programming voltage of 10V. To set full scale resistance to a lower value, see PAR. 4.3.3 to change the F.S. programming voltage to a lower value, then adjust based on 1000 ohms/Volt.

3.7.3 PROGRAMMING WITH EXTERNAL VOLTAGE

Figure 3-7 is a simplified diagrams of the KLP showing the switch configuration and external connections required for analog programming using an external voltage.

1. Virtual Model (PAR. 3.2.5) and Overvoltage and Overcurrent settings (PAR. 3.7.4) must be established via either local programming or digital remote programming prior to initiating Analog Remote programming.

2. Turn off power and configure the Analog I/O DIP switch (Figure 2-2) as follows:

   SW1: OFF (Program output voltage via voltage)
   SW2: OFF (Program output current via voltage)
   SW3: Not applicable when in remote analog programming mode
   SW4: Not used
   SW5: Either OFF (Local controls enabled) or ON (Local controls locked)

3. Configure Analog I/O Port J1 (Figure 2-2) by referring to Table 2-6 and Figure 3-7.

4. Refer to PAR. 3.7.4 to change overvoltage or overcurrent setting in analog programming mode.

With the power supply configured as shown in Figure 3-7 and assuming the load causes the power supply to operate in voltage mode, varying source voltage V2 from 0 to maximum causes the output voltage of the power supply to vary linearly from 0 to full scale, while V1 can be used to adjust the current limit. When the power supply operates in current mode, V2 will adjust the voltage limit and V1 will adjust output current.

Factory default full scale (F.S.) voltage programming is 10V. To set full scale voltage programming to a lower value, see PAR. 4.3.3

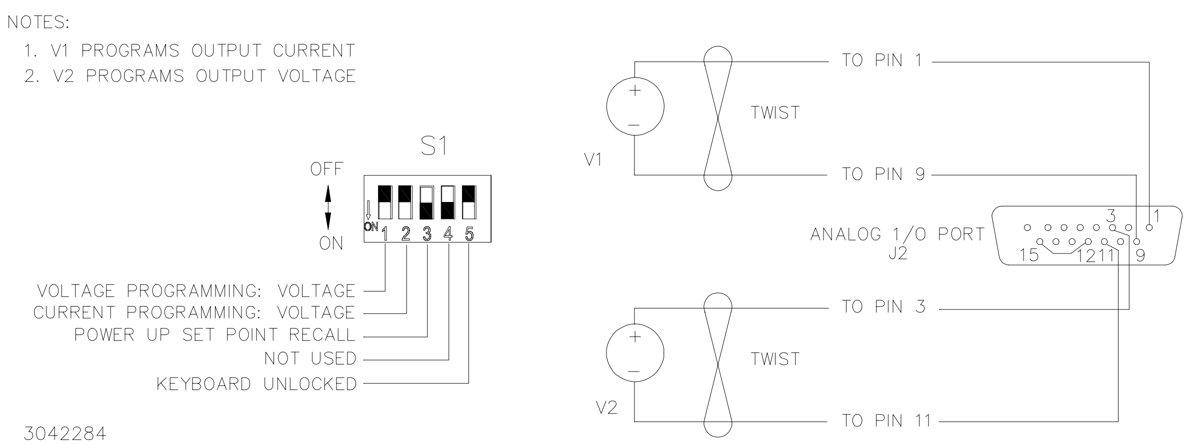


FIGURE 3-7. ANALOG PROGRAMMING OF OUTPUT VOLTAGE OR CURRENT USING VOLTAGE

3.7.4 CHANGING OVERVOLTAGE OR OVERCURRENT PROTECTION VALUES IN ANALOG PROGRAMMING MODE

Overvoltage and overcurrent values can not be changed using analog remote programming; this can only be done by issuing a command via the GPIB or RS232 port, or via local mode from the front panel (enter local mode by pressing the VOLTAGE and CURRENT adjustment controls at the same time).

If the panel is locked and RS 232 or GPIB access is not possible, turn the power supply off, set ANALOG I/O DIP switch position 5 to OFF, and then power up again to unlock the panel (PAR.3.2.2.1). After the settings have been changed, turn the power supply off, set ANALOG I/O DIP switch position 5 to ON to relock the panel, then turn on the power supply to restore Analog Remote Programming (status display reads aRem).

SECTION 4 - CALIBRATION

4.1 GENERAL

This section contains the calibration instructions for the Power Supply. It is recommended that the user be familiar with Local Mode operation (PAR.3.2) before calibrating the unit.

A full calibration consist of a voltage calibration and a current calibration. Both voltage and current calibrations consist of a zero and a full scale calibration. There are two ways to perform the calibration: locally using the front panel keys or remotely sending commands through the GPIB bus. These two ways cannot be combined.

External calibration calibrates the precise user-defined reference voltages used that will be equivalent to full scale output when external analog programming is used.

NOTE: Calibrating the unit resets all internal memory locations used for saving active settings (*SAV, *RCL), programmed sequences using the LIST commands, and trigger levels established by CURR:TRIG and VOLT:TRIG. These parameters are returned to the default minimum (0V, minimum A).

In order to enter the calibration mode the correct calibration access code (password) must be entered. If the password has been forgotten, call the factory and a special password (which has been assigned to your power supply) will be provided. During the calibration, new calibration data is computed which is then stored in the nonvolatile memory when the SAVE command is issued.

4.2 EQUIPMENT REQUIRED

The following equipment is required to calibrate the KLP Power Supply.

- Digital Voltmeter (DVM) with 6 digits resolution an at least 0.002% accuracy for d-c measurements.
- Precision Shunt Resistor (with a tolerance of 0.01%, power rating of at least 10 times larger than the maximum stress, and a temperature coefficient equal to or better than 20 ppm per degree C).

NOTES:
- Because the voltage measured will be used as reference for calibration, the DVM used must be accurately calibrated prior to calibrating the power supply.
- Proper cooling of the external precision shunt resistor ensures the accuracy of the calibration.

4.3 CALIBRATION PROCEDURES

For voltage calibration all loads must be disconnected and the sense terminals connected to the corresponding output terminals. The digital voltmeter will be connected to the output of the power supply. For current calibration after disconnecting all loads an appropriate shunt resistor will be connected across the output terminals and the digital voltmeter will be connected across the sense terminals of the shunt resistor.

1. Turn off power supply and disconnect load from output bus bar at the rear of the unit.
2. Verify that power supply is configured for local error sensing (PAR. 2.7.5.1).

3. For voltage calibration connect DVM to (M+,S+) and (M-,S-) of terminal block at the rear of power supply.

4. For current calibration connect an appropriate shunt resistor across the output terminals and connect DVM shunt resistor terminals.

5. Turn on power supply, exit **SET** mode by tapping either **VOLTAGE** or **CURRENT** control and using a thin tool (e.g., a paper clip), press **FUNCTION** switch repeatedly until status displays reads **UTIL**. Rotate either **VOLTAGE** or **CURRENT** control until status display reads **CAL**.

6. Tap **DC OUTPUT** switch to enter calibration mode. Status display reads "**PASS**" and **CURRENT DISPLAY** reads **0000** while the unit waits for the calibration password to be entered. The leftmost digit will be flashing.

7. Rotate **CURRENT** control to select a number from 0-9. Tap **CURRENT** control to advance to next digit. Repeat this process until all four digits have been selected. Tap **DC OUTPUT** switch to accept the number.

8. If password is incorrect, the status display reads "**ERR**". Repeat step 7 to enter the correct password, or press the **FUNCTION** switch to exit calibration

9. If password is correct, status display reads **V ?**. Tapping either **VOLTAGE** or **CURRENT** control continuously cycles through all the calibration choices. The status display reads: **V ?** for voltage calibration **C ?** for current calibration, **EXT?** for remote analog calibration, and **EXIT** to save the calibrated results. Tap the **FUNCTION** switch to exit calibration WITHOUT saving any calibration data (see PAR. 4.3.4). Tap the **DC OUTPUT** switch to select the displayed choice.

NOTE: Calibrations may be done in any order.

10. Proceed to PAR. 4.3.1 for voltage calibration, PAR 4.3.2 for current calibration, PAR. 4.3.3 for external calibration or PAR. 4.3.4 to exit calibration

4.3.1 VOLTAGE CALIBRATION

During voltage calibration, the voltage, voltage readback and remote analog voltage readback are calibrated.

1. Minimum voltage is first; the status display reads **V_0**. Monitor DVM and rotate the **VOLTAGE** control to increase or decrease the output voltage until the DVM reads as close as possible to minimum rated voltage.

2. Tap the **DC OUTPUT** switch to accept the value. The status display then reads **VMAX**. Monitor DVM and rotate the **VOLTAGE** control to increase or decrease the output voltage until the DVM reads as close as possible to maximum rated voltage.

3. Tap the **DC OUTPUT** switch to accept the value. The status display then reads **OUTV**. Connect the DVM to ANALOG I/O PORT J2, pin-9 (M–) and pin-3 (M+). Rotate the **VOLTAGE** control to increase or decrease the output voltage until the DVM reads as close as possible to 10V.

4. Tap the **DC OUTPUT** switch to accept the value. The status display reads **C ?**. Tap the **DC OUTPUT** switch to proceed to Current Calibration (see PAR. 4.3.2), or tap either **VOLTAGE** or **CURRENT** control to advance to next choice

4.3.2 CURRENT CALIBRATION

During current calibration, the current, current readback and analog current readback are calibrated.

1. The status display reads **LOAD**. When the shunt and DVM are connected per PAR. 4.3, step 4, tap the **DC OUTPUT** switch. The status display reads **CMAX**.

2. Rotate the **CURRENT** control to increase or decrease the DVM reading until the DVM reading corresponds as closely as possible to maximum rated current (Calculate current as follows:
   I (Amperes) = DVM reading (Volts) / Shunt Resistance (Ohms).

3. Tap the **DC OUTPUT** switch to accept the value. The status display reads **C_0**. Rotate the **CURRENT** control to increase or decrease the DVM reading until the DVM reading corresponds as closely as possible to minimum rated current (Calculate current as follows:
   I (Amperes) = DVM reading (Volts) / Shunt Resistance (Ohms).

4. Tap the **DC OUTPUT** switch to accept the value. The status display reads **CMAX**. Rotate the **CURRENT** control to increase or decrease the DVM reading until the DVM reading corresponds as closely as possible to maximum rated current (Calculate current as follows:
   I (Amperes) = DVM reading (Volts) / Shunt Resistance (Ohms).

5. Tap the **DC OUTPUT** switch to accept the value. The status display reads **OUTC**. Connect the DVM to ANALOG I/O PORT J2, pin-9 (M–) and pin-1 (M+). Rotate the **CURRENT** control to increase or decrease the output voltage until the DVM reads as closely as possible to 10V.

6. Tap the **DC OUTPUT** switch to accept the value. The status display reads **EXT?**. Tap the **DC OUTPUT** switch to proceed to External Calibration (see PAR. 4.3.2), or tap either **VOLTAGE** or **CURRENT** control to advance to next choice

4.3.3 EXTERNAL CALIBRATION

During external calibration the external analog reference voltages used to establish full scale output current and voltage are calibrated and defined. The factory default calibration is 10V programs full scale output, however the following procedure allows any d-c value up to 10V to program full scale, while a voltage proportionately less programs a corresponding decrease in the output.

NOTE: The full scale programming voltage has a 1:1 correspondence with the external readback; i.e., 10V full scale programming voltage results in a 10V full scale readback. If the full scale programming voltage is changed to a value other than 10V, the full scale readback voltage is changed accordingly.

1. The status display reads **INPV**. Refer to PAR 3.7 to connect the reference voltage used to define full scale output voltage. as the source as described in PAR 3.7.

2. When the reference voltage is at the desired value, tap the **DC OUTPUT** switch to accept the value. When the calibration is saved, this analog voltage will be equivalent to full scale output voltage. **The full scale output voltage is determined by the virtual settings in effect.**

3. The status display reads **INPC**. Connect the reference voltage used to define full scale output current as described in PAR 3.7.

4. When the reference voltage is at the desired value, tap the **DC OUTPUT** switch to accept the value. When the calibration is saved, this voltage value will be equivalent to full scale output current. **The full scale output current is determined by the virtual settings in effect.**

5. The status display reads `EXIT`. Proceed to PAR. 4.3.4 to exit calibration.

4.3.4 CALIBRATION EXIT

NOTE: using a thin tool (e.g., a paper clip), tap the **FUNCTION** switch to exit calibration WITHOUT saving any calibration data. If no calibrations were completed, then the unit advances to the next function as if the **FUNCTION** switch was pressed.

1. When the status display reads `EXIT`, tap the **DC OUTPUT** switch to save the calibration.

2. The status display reads `DATE`. The **DC VOLTS** display represents MMDD (month, day) and the **DC AMPS** display represents YYYY (year). The factory calibration date is displayed with the first digit blinking as a starting point to enter the current date. Rotate either the **VOLTAGE** or **CURRENT** controls to change the digit, then tap either control to move to the next digit.

NOTE: For purposes of traceability the user is strongly urged to enter the calibration date upon completion of calibration. If a date is not entered, no date is saved.

3. Tap **DC OUTPUT** switch to accept date. If any calibration (voltage, current or external) was completed, the unit will save the new calibration. The status display reads "DONE" while calibration is being saved.

4. Once saved the unit enters Virtual Model mode. Follow the procedure in PAR 3.2.5 to set the virtual model.

NOTE: The virtual model is always reset following calibration. If voltage calibration is completed (regardless of whether or not current calibration is completed), the virtual model voltage is set for maximum rated voltage, and current is set to the value corresponding to 1200 Watts. If ONLY current calibration is completed, the virtual model current will be set for maximum rated current and voltage is set to the value corresponding to 1200 Watts.

4.4 CHANGING THE CALIBRATION PASSWORD

The 4-digit password is required for to enter calibration mode. The factory default password is listed in Table 4-1.

TABLE 4-1.FACTORY DEFAULT CALIBRATION PASSWORDS

MODEL	PASSWORD
KLP 8-150	8150
KLP 15-150-1200	1515
KLP 25-80-1200	2580
KLP 36-48-1200	3680
KLP 75-33-1200	7533
KLP 150-16-1200	1516
KLP 300-8-1200	3008
KLP 600-2	6002

To change the password from the front panel proceed as follows:

1. Hold the **PROTECT** switch in and use a thin tool (e.g., a paper clip), to press the **FUNCTION** switch. Status display reads **PASS.**

NOTE: To exit this procedure without changing the password, rotate the **VOLTAGE** control.

2. Tap the **DC OUTPUT** switch. Status display reads **OLD?**.
3. Rotate the **CURRENT** control until **DC AMPERES** display shows old password. Tap the **DC OUTPUT** switch to enter. Status display shows **NEW?.**
4. Rotate the **CURRENT** control until **DC AMPERES** display shows new password. Tap the **DC OUTPUT** switch to enter. Status display shows **RPT?**.
5. Rotate the **CURRENT** control until **DC AMPERES** display reads new password. Tap the **DC OUTPUT** switch to enter. Status display reads **DONE** and the unit returns to setpoint mode.

4.5 RESTORING PRIOR CALIBRATION VALUES

Calibration values for KLP are stored in three separate locations designated: Factory, Previous and Working. Each time the unit is calibrated, the Working values are moved to Previous, and the new calibration values are stored in Working. It is possible to replace the Working calibration values with either the Previous or the Factory calibration values; contact Kepco Sales Engineering for details.

APPENDIX A - IEEE 488.2 COMMAND/QUERY DEFINITIONS

A.1 INTRODUCTION

This appendix defines the IEEE 488.2 commands and queries used with the KLP Power Supply These commands and queries are preceded by an asterisk (*) and are defined and explained in Figures A-1 through A-14, arranged in alphabetical order. Table A-1 provides a quick reference of all IEEE 488.2 commands and queries supported in the KLP Power Supply.

TABLE A-1. IEEE 488.2 COMMAND/QUERY INDEX

COMMAND	PAR.	COMMAND	PAR.
*CLS	A.2	*RST	A.10
*ESE, ?	A.3, A.4	*SAV	A.11
*ESR?	A.5	*SRE, ?	A.12, A.13
*IDN?	A.6	*STB?	A.14
*OPC, ?	A.7, A.8	*TRG	A.15
*RCL	A.9	*TST?	A.16

A.2 *CLS — CLEAR STATUS COMMAND

***CLS**

Syntax: *CLS

Description: **Clears status data.** Clears the following registers without affecting the corresponding Enable Registers: Standard Event Status Register (ESR), Operation Status Event Register, Questionable Status Event Register, and Status Byte Register (STB). Also clears the Error Queue. Related commands: *OPC, *OPC?. (See example, Figure A-1.)

A.3 *ESE — STANDARD EVENT STATUS ENABLE COMMAND

***ESE**

Syntax: *ESE <integer> where <integer> = positive whole number: 0 to 255 per Table A-2.
Default Value: 0

Description: **This command programs the standard Event Status Enable register bits.** The contents function as a mask to determine which events of the Event Status Register (ESR) are allowed to set the ESB (Event Summary Bit) of the Status Byte Register. Enables the Standard events to be summarized in the Status Byte register (1 = set = enable function, 0 = reset = disable function). All of the enabled events of the standard Event Status Enable register are logically ORed to cause ESB (bit 5) of the Status Byte Register to be set (1 = set = enable, 0 = reset = disable). (See example, Figure A-1.)

TABLE A-2. STANDARD EVENT STATUS ENABLE REGISTER AND STANDARD EVENT STATUS REGISTER BITS

CONDITION	PON	NU	CME	EXE	DDE	QUE	NU	OPC
BIT	7	6	5	4	3	2	1	0
VALUE	128	64	32	16	8	4	2	1

PON Power On
NU (Not Used)
CME Command Error
EXE Execution Error
DDE Device Dependent Error
QUE Query Error

A.4 *ESE? — STANDARD EVENT STATUS ENABLE QUERY

*ESE?

Syntax: *ESE?   Return value: Integer> value per Table A-2.

Description: **Returns the mask stored in the Standard Event Status Enable Register.** Contents of Standard Event Status Enable register (*ESE) determine which bits of Standard Event Status register (*ESR) are enabled, allowing them to be summarized in the Status Byte register (*STB). All of the enabled events of the Standard Event Status Enable Register are logically ORed to cause ESB (bit 5) of the Status Byte Register to be set (1 = set = enable function, 0 = reset = disable function). (See example, Figure A-1.)

A.5 *ESR? — EVENT STATUS REGISTER QUERY

*ESR?

Syntax: *ESR?
Return value: <integer> (Value = contents of Event Status register as defined in Table A-2.)

Description: **Causes the power supply to return the contents of the Standard Event Status register. After it has been read, the register is cleared.** The Standard Event Status register bit configuration is defined in Table A-2 (1 = set, 0 = reset). The error bits listed in Table A-2 are also related to error codes produced during parsing of messages and to errors in the power supply (see PAR. B.79)

- Any 1xx type error sets the Command error bit (5) see.
- Any 2xx type error sets the Execution error bit (4).
- Any 3xx type error sets the Device error bit (3). The Device error bit will be set when Current Error or Voltage Error is detected and the corresponding Status Questionable bit is set (see PAR. B.28).
- Any 4xx type error sets the Query error bit (2).

Related Commands: *CLS, *ESE, *OPC. (See example, Figure A-1.)

A.6 *IDN? — IDENTIFICATION QUERY

*IDN?

Syntax: *IDN?
Return value: Character string

Description: **Identifies the instrument.** This query requests identification. The power supply returns a string which contains the manufacturer name, the model, the serial number and the firmware level. The character string contains the following fields: <Manufacturer>, <Model>, <Manufacturing Data>, <Firmware revision> where: <Manufacturer> = KEPCO, <Model> = KLP V V CC (V V is Eo_{MAX}, CC is Io_{MAX},) <Manufacturing Data>=DDMMYY-NNNNNN (DD=day, MM=month, and YY=year of manufacture, NNNNNN=unit number) <Firmware revision>=n.m (n.m revision, e.g, 1.0) (See example, Figure A-1.)

A.7 *OPC — OPERATION COMPLETE COMMAND

*OPC

Syntax: *OPC

Description: **Causes power supply to set status bit 0 (Operation Complete) when pending operations are complete** This command sets Standard Event Status Register bit 0 (see Table A-2) to “1” when all previous commands have been executed and changes in output level have been completed. This command does not prevent processing of subsequent commands, but bit 0 will not be set until all pending operations are completed. (1 = set = enable function, 0 = reset = disable function). (See example, Figure A-1.) As an example, the controller sends command(s), then sends *OPC. If controller then sends *ESR?, the power supply responds with either a “0” (if the power supply is busy executing the programmed commands), or a “1” (if the previously programmed commands are complete). (See example, Figure A-1.)

A.8 *OPC? — OPERATION COMPLETE QUERY

Syntax: *OPC?

Return value: <1> (ASCII) placed in output queue when power supply has completed operation.

Description: **Indicates when pending operations have been completed.** When all pending operations are complete (all previous commands have been executed and changes in output level have been completed) a “1” is placed in the Output Queue. Subsequent commands are inhibited until the pending operations are completed. *OPC? is intended to be used at the end of a command line so that the application program can monitor the bus for data until it receives the “1” from the power supply Output Queue. (See example, Figure A-1.)

*CLS	Power supply clears status data.
*ESE 60	Power supply enables bits 5, 4, 3 and 2, allowing command error, execution error, device dependent error and query error to set the Event Status Summary bit when an STB command is executed.
*ESE?	Returns 60, (value of the mask) verifying that bits 5, 4, 3 and 2 are enabled.
*ES	Unknown command will set command error (Bit 5).
*ESR?	Returns 32 (bit 5 set), indicating Command Error has occurred since the last time the register was read.
*IDN?	Power supply returns: KEPCO, KLP75-33.3, 012403-000021, 1.0.
*OPC	Allows status bit 0 to be set when pending operations complete
VOLT 35;CURR 30	Sets output voltage to 35V, output current to 30A
*ESR	Returns 129 (128 + 1, power on, bit 7 = 1, operation complete, bit 1 = 1)
*ESR	Returns 0 (event status register cleared by prior *ESR?)
VOLT 41.5;CURR 21.5	Sets output voltage to 41.5V, output current to 21.5A,
*OPC?	Puts “1” on output bus when command operations are complete.
VOLT 40;CURR 23.5	Sets output voltage to 40V, output current to 23.5A,
*RST	Power supply reset to power on default state.
*SRE 40	When ESB or QUES bits are set (Table A-3), the Request for Service bit will be set.
*SRE?	Returns the value of the mask (40).
*STB?	For example, the Power supply responds with 96 (64 + 32) if MSS and the Event Status Byte (Table A-3) summary bit have been set. The power supply returns 00 if no bits have been set.
VOLT 25	Power supply voltage commanded to 25V.
VOLT:TRIG 31.2	Programs power supply voltage to 31.2V when *TRG received.
INIT	Trigger event is initialized.
*TRG	Power supply reverts to commanded output voltage of 31.2V.
*TST?	Power supply executes self test and responds with 0 if test completed successfully, with 1 if test failed.

FIGURE A-1. GPIB COMMANDS

A.9 *RCL — RECALL COMMAND

***RCL**

Syntax: *RCL <integer> (1 to 99)

Description: **Restores power supply to previously defined levels of output voltage, output current and triggers.** This command selects one of the 40 power supply memory locations, each of which stores values for output current, and output voltage and trigger levels. Executing *RCL recalls the previously defined trigger settings from memory and places them in the trigger control section of the firmware. Executing a second *RCL will cause the values in the trigger control section to be moved to the KLP output channel, allowing the power supply to operate with the recalled trigger information. The following parameters are affected by *RCL: VOLT:TRIG, CURR:TRIG, and FUNC:MODE:TRIG.

A.10 *RST — RESET COMMAND

***RST**

Syntax: *RST

Description: **Resets power supply to the power on default state.** The power supply is programmed to the power on values of the following parameters: CURR[:LEV][:IMM] = 0, VOLT[:LEV][:IMM] = 0, CURR:PROT[:LEV] = max overcurrent value (see Table 1-2, VOLT:PROT[:LEV] = (maximum overvoltage value (see Table 1-2), OUTP[:STAT] = ON. (See example, Figure A-1.)

A.11 *SAV — SAVE COMMAND

***SAV**

Syntax: *SAV <integer> (1 to 40)

Description: **Saves the present state of output voltage, output current and trigger values, to the specified memory location.** This command stores the present state of the power supply to one of 40 memory locations in non-volatile Memory. The following parameters are stored by *SAV: VOLT:TRIG, CURR:TRIG, and FUNC:MODE:TRIG. The stored values can be restored by the *RCL command. NOTE: If a Virtual Model setting (see PAR 3.2.5) is changed, previously stored settings may be outside the range established by the new virtual model. In this case, when *RCL is executed, the value is cleared to the default minimum (0V, minimum A) and an "out of range" error message is generated.

A.12 *SRE — SERVICE REQUEST ENABLE COMMAND

***SRE**

Syntax: *SRE<integer> where <integer> = value from 0 - 255 per Table A-3, except bit 6 cannot be programmed.

Description: **Sets the condition of the Service Request Enable register.** The Service Request Enable register determines which events of the Status Byte Register are summed into the MSS (Master Status Summary) and RQS (Request for Service) bits. RQS is the service request bit that is cleared by a serial poll, while MSS is not cleared when read. A "1" (1 = set = enable, 0 = reset = disable) in any Service Request Enable register bit position enables the corresponding Status Byte bit to set the RQS and MSS bits. All the enabled Service Request Enable register bits then are logically ORed to cause Bit 6 of the Status Byte Register (MSS/RQS) to be set. Related Commands: *SRE?, *STB?. (See example, Figure A-1.)

TABLE A-3. SERVICE REQUEST ENABLE AND STATUS BYTE REGISTER BITS

CONDITION	OPER	MSS RQS	ESB	MAV	QUES	ERR QUE	NU	NU
BIT	7	6	5	4	3	2	1	0
VALUE	128	64	32	16	8	4	2	1

OPER	Operation Status Summary
MSS	Master Status Summary
RQS	Request for Service
ESB	Event Status Byte summary
MAV	Message available
QUES	QUEStionable Status Summary
ERR QUE	1 or more errors occurred (see PAR. B.79)
NU	(Not Used)

A.13 *SRE? — SERVICE REQUEST ENABLE QUERY

***SRE?**

Syntax: *SRE? Response: <integer> = value from 0 - 255 per Table A-3.

Description: **Reads the Service Enable Register.** Used to determine which events of the Status Byte Register are programmed to cause the power supply to generate a service request (1 = set = function enabled, 0 = reset = function disabled). Related Commands: *SRE, *STB? (See example, Figure A-1.)

A.14 *STB? — STATUS BYTE REGISTER QUERY

***STB?**

Syntax: *STB? Response: <integer> value from 0 to 255 per Table A-3.

Description: **Reads Status Byte Register without clearing it.** This Query reads the Status Byte Register (bit 6 = MSS) without clearing it (1 = set = function enabled, 0 = reset = function disabled). The register is cleared only when subsequent action clears all set bits. MSS is set when the power supply has one ore more reasons for requesting service. (A serial poll also reads the Status Byte Register, except that bit 6 = RQS, not MSS; and RQS will be reset.) Related Commands: *SRE, *SRE?. (See example, Figure A-1.)

A.15 *TRG — TRIGGER COMMAND

***TRG**

Syntax: *TRG

Description: **Triggers the power supply to be commanded to preprogrammed values of output current and voltage.** When the trigger is armed (checked by examining WTG bit in Status Operational Condition register) *TRG generates a trigger signal. The trigger will change the output of the power supply to the output voltage and current levels specified by VOLT:TRIG and CURR:TRIG commands and clear the WTG bit in the Status Operation Condition register. If INIT:CONT has been issued, the trigger subsystem is immediately rearmed for subsequent triggers, and the WTG bit is again set to 1. *TRG or GET are both addressed commands (only devices selected as listeners will execute the command).Related Commands: ABOR, INIT, TRIG, CURR:TRIG, VOLT:TRIG. (See example, Figure A-1.)

A.16 *TST? — SELF TEST QUERY

***TST?**

Syntax: *TST? Returned value: 0 or 1 (0 = pass test, 1 = fail test)

Description: **Power Supply test.**This query causes the power supply to do a self test and provide the controller with pass/fail results. A cyclic redundancy check (CRC) is performed on non-volatile RAM. A “1” is returned if there is an error.

APPENDIX B - SCPI COMMAND/QUERY DEFINITIONS

B.1 INTRODUCTION

This appendix defines the SCPI subsystem commands and queries used with the KLP Power Supply. Subsystem commands are defined in PAR. B.3 through B.92, arranged Alphabetically in groups as they appear in the tree diagram, Figure 3-3. Table B-1 provides a quick reference of all SCPI subsystem commands and queries used in the Interface Card.

TABLE B-1. SCPI SUBSYSTEM COMMAND/QUERY INDEX

COMMAND	PAR.	COMMAND	PAR.
ABORt	B.3	[SOUR:]VOLT:LIM:HIGH, ?	B.52, B.53
CAL:CEXT	B.4	[SOUR:]VOLT:MOD, ?	B.54, B.55
CAL:CGA	B.5	[SOUR:]VOLT:PROT:LEV, ?	B.56, B.57
CAL:CURR:LEV	B.6	[SOUR:]VOLT[:LEV]:TRIG[:AMP]?	B.58, B.59
CAL:CURR[:DATA]	B.7	STAT:OPER:COND?	B.60
CAL:DPOT	B.8	STAT:OPER:ENAB, ?	B.61, B.62
CAL:SAVE	B.9	STAT:OPER[:EVENT]?	B.63
CAL:STAT, ?	B.10, B.11	STAT:PRES	B.64
CAL:VEXT	B.12	STAT:QUES[:EVENT]?	B.65
CAL:VGA	B.13	STAT:QUES:COND?	B.66
CAL:VOLT:LEV	B.14	STAT:QUES:ENAB, ?	B.67, B.68
CAL:VOLT[:DATA]	B.15	SYST:COMM:GPIB:ADDR, ?	B.69, B.70
CAL:ZERO	B.16	SYST:COMM:SER:BAUD	B.71
[SOUR:]LIST:CLE	B.18	SYST:COMM:SER:ECHO, ?	B.72, B.73
[SOUR:]LIST:CONT, ?	B.19, B.20	SYST:COMM:SER:ENAB	B.74, B.75
[SOUR:]LIST:COUN, ?	B.21, B.22	SYST:COMM:SER:PACE	B.76
[SOUR:]LIST:COUN:SKIP, ?	B.23, B.24	SYST:COMM:SER:PROM, ?	B.77, B.78
[SOUR:]LIST:CURR, ?	B.25, B.26	SYST:ERR?	B.79
[SOUR:]LIST:CURR:POIN?	B.27	SYST:ERR:CODE?	B.80
[SOUR:]LIST:DIR, ?	B.28, B.29	SYST:ERR:CODE:ALL?	B.81
[SOUR:]LIST:DWEL, ?	B.30, B.31	SYST:KLOCK, ?	B.82, B.83
[SOUR:]LIST:DWEL:POIN?	B.32	SYST:LANG, ?	B.84, B.85
[SOUR:]LIST:QUER, ?	B.33, B.34	SYST:PASS:CENA	B.86
[SOUR:]LIST:VOLT, ?	B.35, B.36	SYST:PASS:CDIS	B.87
[SOUR:]LIST:VOLT:POIN?	B.37	SYST:PASS:NEW	B.88
MEAS:CURR?	B.38	SYST:PASS:STAT?	B.89
MEAS:VOLT?	B.39	SYST:SEC	B.90
OUTP[:STAT], ?	B.40, B.41	SYST:SET	B.91
[SOUR:]CURR[:LEV][:IMM][:AMP], ?	B.42, B.43	SYST:VERS?	B.92
[SOUR:]CURR:LIM:HIGH, ?	B.44, B.45	TRIG:INIT[:IMM]	B.93
[SOUR:]CURR:PROT[:LEV], ?	B.46, B.47	TRIG:INIT:CONT, ?	B.94, B.95
[SOUR:]CURR[:LEV]:TRIG[:AMP], ?	B.48, B.49	TRIG:SOUR	B.96
[SOUR:]VOLT[:LEV][:IMM][:AMP], ?	B.50, B.51		

B.2 NUMERICAL VALUES

The SCPI data parser on the KLP supports a maximum of 8 digits after the decimal point and a maximum integer of 4 x 10^8. Any values greater than these are not processed by the device and no error is generated. The largest string that can be received or transmitted by the KLP is 253 characters.

All numerical data is returned in scientific notation, digits with decimal point and Exponent, e.g., 2.71E1 for 27.1 after calibration constants have been applied. Thus. for example, VOLT 14;VOLT? may return 1.39997E1 which indicates that the unit has been calibrated to provide 13.9997V for a programmed value of 14V, within the calculation accuracy of the KLP. Error "-120" results from syntactical errors, e.g., the exponent exceeds 8, a letter is identified, etc. Error "-222" is produced if the value exceeds the range of acceptable values for the parameter.

B.3 ABORt COMMAND — ABOR

Syntax: Short Form: ABOR   Long Form: ABORt

Description: **Cancels previously stored trigger levels, resets WTG.** The ABORt command cancels any pending trigger levels previously stored by the CURR:TRIG or VOLT:TRIG commands. The pending level is set equal to the corresponding immediate value. ABORt also resets the WTG (Wait TriGger) bit in the Operation Condition status register. If TRIG:INIT:CONT ON has been programmed, the trigger system re-arms itself immediately after ABORt, thereby setting WTG. WTG is bit 5 in the STATUS OPERATION CONDITION register. The ABORt is executed each time power is turned on. Related Commands: TRIG:INIT, *RST, *TRG. (See example, Figure B-1.)

B.4 CALibrate:CEXTernal COMMAND — CAL:CEXT

Syntax: Short Form: CAL:CEXT {MAX}
Long Form: CALibrate:CEXTernal {MAX}

Description: **Selects External Reference full scale current calibration, only effective with power supply in Calibrate status.** CAL:CEXT MAX selects maximum positive external reference full scale current calibration. **Related Commands:** CAL:DPOT, CAL:ZERO. (See example, Figure B-2.)

B.5 CALibrate:CGAin COMMAND — CAL:CGA

Syntax: Short Form: CAL:CGA {MAX}
Long Form: CALibrate:CGAin {MAX}

Description: **Selects External Reference full scale current calibration, only effective with power supply in Calibrate status.** CAL:CGA MAX selects maximum positive external reference current calibration. **Related Commands:** CAL:STAT, CAL:VOLT, CAL:CURR, CAL:ZERO, CAL:DPOT, CAL:SAVE. (See example, Figure B-2.)

B.6 CALibrate:CURRent:LEVel COMMAND — CAL:CURR:LEV

Syntax: Short Form: CAL:CURR:LEV {MIN | MAX}   Long Form: CALibrate:CURRent:LEVel {MIN | MAX}

Description: **Selects Current calibration, only effective with power supply in Calibrate status.**
CAL:CURR:LEV MIN selects Current Zero Calibration. CAL:CURR:LEV MAX selects Current Full Scale Calibration. Normally Current Zero is done first, then Current Full Scale Calibration. Related Commands: CAL:STAT, CAL:VOLT, CAL:CURR, CAL:ZERO, CAL:SAVE. (See example, Figure B-2.)

B.7 CALibrate:CURRent[:DATA] COMMAND — CAL:CURR

Syntax: Short Form: CAL:CURR {ZERO | MAX}
Long Form: CALibrate:CURRent {ZERO | MAX}

Description: **Selects Current calibration, only effective with power supply in Calibrate status.**
CAL:CURR ZERO selects Current Zero Calibration.CAL:CURR MAX selects Current Full Scale Calibration. Normally Current Zero is done first, then Current Full Scale Calibration. **Related Commands:** CAL:STAT, CAL:ZERO, CAL:DPOT, CAL:SAVE. (See example, Figure B-2.)

B.8 CALibrate:DPOT COMMAND

CAL:DPOT

Syntax: Short Form: CAL:DPOT {N} Long Form: CALibrate:DPOT {N}
N = integer

Description: **Provides coarse adjustment of the output during calibration to within 5% of maximum and 2% of nominal; increases or decreases output by 50 LSB increments.** Acceptable values of N are within ±32, corresponding to ±1600 (50 x 32) LSB's. CAL:DPOT -N decreases output voltage by N LSBs. CAL:VOLT N increases output voltage by N LSBs. This command is used during calibration to adjust the output for Zero calibration as well as Full Scale Positive calibration. Output voltage is monitored on a calibrated digital multimeter and increased or decreased as required using this command. Output current is monitored on a calibrated digital multimeter (reading voltage at the sense terminals of the shunt resistor) and increased or decreased as required using this command. This command is only effective if Calibration status and either Voltage Zero, Voltage Maximum. Current Zero or Current Maximum calibration are active. CAL:STAT, CAL:VOLT, CAL:CURR, CAL:CGA, CAL:VGA, (See example, Figure B-2.)

B.9 CALibrate:SAVE COMMAND

CAL:SAVE

Syntax: Short Form: CAL:SAVE Long Form: CALibrate:SAVE
Short Form: CAL:SAVE DATE <string> Long Form: CALibrate:SAVE DATE <string>
where DATE is optional allowing <string> of up to 12 contiguous characters identifying calibrations date to be saved. Active DATE <string > is returned by *IDN? query.

Description: **Saves computed calibration values in non-volatile memory.** This command saves only the calibration values computed after entering Calibration status. If, for example, only Voltage calibration was performed, these are the only values saved. Previous values are not lost, and can be restored This command should be the last command before exiting Calibrate status. **Related Commands:** CAL:STAT, CAL:DPOT, CAL:VOLT, CAL:CURR, CAL:ZERO. (See example, Figure B-2.)

B.10 CALibrate:STATus COMMAND

CAL:STAT

Syntax: Short Form: CAL:STAT <boolean>
Long Form: CALibrate:STATe <boolean>
where boolean = 0 or OFF, 1 or ON

Description: **Sets the power supply to Calibrate state.** <boolean> 1 or ON causes power supply to enter Calibrate state. <boolean> 0 or OFF causes power supply to exit Calibrate state. If the wrong password was used, or the password was not enabled, error message -224 is posted to the queue. **Related Commands:** CAL:STAT, CAL:VOLT, CAL:CURR, CAL:ZERO, CAL:DPOT, CAL:SAVE. (See example, Figure B-2.)

B.11 CALibrate:STATus? QUERY

CAL:STAT?

Syntax: Short Form: CAL:STAT? Long Form: CALibrate:STATus?
Return Value: <DATA>
where DATA = ZERO-ZERO, VOLTAGE-ZERO, VOLTAGE-MAX, VEXTERNAL-MAX, CURRENT-ZERO, CURRENT-MAX, CEXTERNAL-MAX

Description: **Identifies whether the power supply is in Calibrate status and indicates which calibration step is active Returns the long form of the calibration command being executed followed by the output condition (maximum, minimum or zero).** OFF indicates power supply is not in Calibrate state. ZERO-ZERO indicates power supply is at 0V, 0A, waiting for connection of load resistor. The following explanations are for typical return values: VOLTAGE-ZERO indicates full scale zero offset voltage adjustment is active. VOLTAGE-MAXIMUM indicates full scale maximum (positive) voltage adjustment is active. VOLTAGE-MINIMUM indicates full scale minimum (negative) voltage adjustment is active. CURRENT-ZERO indicates full scale zero offset current adjustment is active. CURRENT-MAXIMUM indicates full scale maximum (positive) current adjustment is active. CURRENT-MINIMUM indicates full scale minimum (negative) current adjustment is active. **Related Commands:** CAL:STAT, CAL:VOLT, CAL:CURR, CAL:ZERO, CAL:DPOT, CAL:SAVE, CAL:VGA, CAL:VEXT, CAL:CGA, CAL:CEXT. (See example, Figure B-2.)

B.12 CALibrate:VEXTernal COMMAND

CAL:VEXT

Syntax: Short Form: CAL:VEXT {MAX}
Long Form: CALibrate:VEXTernal {MAX}

Description: **Selects External Reference full scale voltage calibration, only effective with power supply in Calibrate status.** CAL:VEXT MAX selects external reference full scale voltage calibration. **Related Commands:** CAL:STAT, CAL:ZERO, CAL:SAVE. (See example, Figure B-2.)

NOTE: Power supply assumed to be operating in constant voltage mode.

OUTP ON	Output enabled.
OUTP?	Power supply returns “1” (output enabled).
VOLT 75; CURR 1.5E-1	Power supply output programmed to go to 75V, current limit 0.15A
TRIG:INIT:CONT ON	Continuous triggers enabled.
TRIG:INIT:CONT?	Power supply returns “1.”
VOLT:TRIG 31.5;CURR:TRIG 3e-1	Power supply output programmed to return to 31.5V, current limit 0.3A upon receipt of trigger.
*TRG	Power supply output returns to 31.5V,current limit 0.3A.
VOLT 32.1; CURR 5e-2	Power supply output programmed to go to 32.1V, current limit 0.05A
MEAS:VOLT?	If actual value of output voltage is 32.09V, power supply returns 3.209E1.
MEAS:CURR?	If actual value of output current is 0.0483A, power supply returns 4.83E-2.
FUNC:MODE?	Returns VOLT if power supply operating in constant voltage mode, CURR for constant current mode.
CURR:TRIG?	Returns 3E-1 (current value established by CURR:TRIG.
VOLT:TRIG?	Returns 31.5 (voltage value established by VOLT:TRIG.
ABOR	Pending trigger levels changed to 32.1V, 0.05A (immediate values)
VOLT 37.7; CURR 2.5E-1	Power supply output programmed to go to 37.7V, 0.25A
*TRG	Power supply output returns to 37.7V, current limit 0.25A.
TRIG:INIT:CONT 0	Triggers disabled.
TRIG:INIT:CONT?	Power supply returns “0.”
OUTP OFF	Output disabled.
OUTP?	Returns 0 (output disabled).
MEAS:VOLT?	Returns 0. (measured output voltage).
VOLT?	Returns 37.7.(programmed output voltage)
CURR?	Returns 2.5E-1 (programmed current 0.25A)
CURR? MAX	Returns 1.6E1 (assuming maximum allowable current for power supply being addressed is 16A, i.e. KLP 75-33-1200).
CURR? MIN	Returns 0 (minimum allowable current).
CURR:PROT 3.8E-1	Current protection set to 0.38A.
CURR?	Returns 2.5E-1 (programmed current 0.25A)
CURR:PROT?	Returns 3.8E-1, indicating programmed overcurrent protection current value = 0.38A.
CURR:PROT?MAX	For KLP 75-33-1200, returns 1.76E2 (17.6A, see Table 1-2).
SYST:VERS?	Returns 2003.0.

FIGURE B-1. PROGRAMMING THE OUTPUT

B.13 CALibrate:VGAin COMMAND

CAL:VGA

Syntax: Short Form: CAL:VGA {MAX}
Long Form: CALibrate:VGAin {MAX}

Description: **Selects External Reference full scale voltage calibration, only effective with power supply in Calibrate status.** CAL:VGA MAX selects maximum external reference voltage calibration. **Related Commands:** CAL:STAT, CAL:VOLT, CAL:CURR, CAL:ZERO, CAL:DPOT, CAL:SAVE. (See example, Figure B-2.)

B.14 CALibrate:VOLTage:LEVel COMMAND

CAL:VOLT:LEV

Syntax: Short Form: CAL:VOLT:LEV {MIN | MAX} Long Form: CALibrate:VOLTage:LEVel {MIN | MAX}

Description: **Selects Voltage calibration, only effective with power supply in Calibrate status.** CAL:VOLT:LEV MIN selects Voltage Zero Calibration. CAL:VOLT:LEV MAX selects Voltage Full Scale Calibration. Normally Voltage Zero is done first, then Voltage Full Scale Calibration. Related Commands: CAL:STAT, CAL:VOLT, CAL:CURR, CAL:ZERO, CAL:SAVE. (See example, Figure B-2.)

NOTE: Refer to PARs. 4.2 and 4.3 for equipment and connections required for calibration.

```
SYST:PASS:CEN 1234      Power supply enters Calibrate status.
CAL:STAT?               Returns 1 indicating power supply in Calibrate status.
CAL:PASS 6789           Password changed from 1234 to 6789.
CAL:VOLT:LEV MIN        Voltage Zero Calibration selected.
CAL:VOLT 1              Output voltage increased
  --- Execute CAL:VOLT 1 and CAL:VOLT 0 as required to achieve calibration (see PAR. 4.3)
CAL:VOLT:LEV MAX        Voltage Full Scale Calibration selected.
CAL:VOLT 0              Output voltage decreased.
  --- Execute CAL:VOLT 1 and CAL:VOLT 0 as required to achieve calibration (see PAR. 4.3)
CAL:ZERO                Output voltage and current set to zero.
 ---                    * User disconnects shunt and connects DVM to output.
CAL:CURR:LEV MIN        Current Zero Calibration selected.
CAL:CURR 0              Output current decreased.
  --- Execute CAL:CURR 1 and CAL:CURR 0 as required to achieve calibration (see PAR. 4.3)
CAL:CURR:LEV MAX        Current Full Scale Calibration selected. (See NOTE below.)
CAL:CURR 0              Output current decreased.
  --- Execute CAL:CURR 1 and CAL:CURR 0 as required to achieve calibration (see PAR. 4.3)
CAL:SAVE                Calibration values saved.
CAL:STAT 0              Power supply exits Calibrate mode.
CAL:STAT?               Returns 0 indicating power supply not in Calibrate status
```

FIGURE B-2. USING CALIBRATION COMMANDS AND QUERIES

B.15 CALibrate:VOLTage[:DATA] COMMAND

CAL:VOLT

Syntax: Short Form: CAL:VOLT {ZERO | MAX}
Long Form: CALibrate:VOLT ZERO | MAX}

Description: **Selects Voltage calibration, only effective with power supply in Calibrate status.** CAL:VOLT ZERO selects Voltage Full Scale Zero Calibration. CAL:VOLT MAX selects Voltage Full Scale Calibration. Normally Voltage Zero is done first, then Voltage Full Scale Calibration. **Related Commands:** CAL:STAT, CAL:ZERO, CAL:DATA, CAL:DPOT, CAL:SAVE. (See example, Figure B-2.)

B.16 CALibrate:ZERO COMMAND

CAL:ZERO

Syntax: Short Form: CAL:ZERO Long Form: CALibrate:ZERO

Description: **Sets output to zero while calibration equipment connections are changed.**This command is used when changing from Voltage to Current calibration or vice-versa. CAL:ZERO sets output voltage and current to zero. The user then connects or disconnects the shunt resistor or the digital voltmeter from the output terminals of the power supply as required for the subsequent Voltage or Current calibration. The next command should select the new parameter to be calibrated. **Related Commands:** CAL:STAT, CAL:VOLT, CAL:CURR, CAL:SAVE. (See example, Figure B-2.)

B.17 DISPlay:TEXT? QUERY **DISP:TEXT?**

Syntax: Short Form: DISP:TEXT? Long Form: DISPlay:TEXT]?
Return Value: Character string displayed on front panel Status display.

Description: **Returns the text displayed on front panel Status display.** Returns the character string displayed on Status display.

B.18 [SOURce:]LIST:CLEar COMMAND **LIST:CLE**

Syntax: Short Form: LIST:CLE Long Form: LIST:CLEar>

Description: **Clears all list entries by setting all pointers to 0.** Also sets LIST:DIR to UP, LIST:GEN to DSEQ, Related Commands: All LIST commands (See example, Figure B-3.)

B.19 [SOURce:]LIST:CONtrol COMMAND **LIST:CONT**

Syntax: Short Form: LIST:CONT<boolean> Long Form: LIST:CONTrol><boolean>
where boolean = 0 or OFF, 1 or ON

Description: **If relay control set to PROGRAM, allows user to energize (1 or ON) or de-energize (0 or OFF) internal relay.** . Related Commands: LIST:CONT?, DIAG:RELay:MODE. (See PAR 2.7.10.)

B.20 [SOURce:]LIST:CONtrol? QUERY **LIST:CONT?**

Syntax: Short Form: LIST:CONT?<boolean> Long Form: LIST:CONTrol? <boolean>
return value = 0 (OFF, de-energized) or 1 (ON, energized)

Description: **Identifies whether internal relay is energized (1) or de-energized (0).** Related Commands: LIST:CONT, DIAG:RELay:MODE. (See PAR 2.7.10.)

B.21 [SOURce:]LIST:COUNt COMMAND **LIST:COUN**

Syntax: Short Form: LIST:COUN<int_value 0 to 255> Long Form: LIST:COUNt> <int_value 0 to 255>

Description: **Establishes how many times the list is executed.** Allows user to establish how many times the list (established by LIST:GEN DSEQ or LIST:GEN SEQ and LIST:SEQ) is executed. The order (beginning to end or end to beginning) is determined by LIST:DIR. For LIST:COUN 0, the unit will execute the sequence indefinitely until either a VOLT:MODE FIXED, or PROG:STOP command is received. Related Commands: LIST:GEN, LIST:SEQ, LIST:DIR. (See example, Figure B-3.)

B.22 [SOURce:]LIST:COUNt? QUERY **LIST:COUN?**

Syntax: Short Form: LIST:COUNT? Long Form: LIST:COUNt?
Return Value: <int_value>

Description: **Identifies how many times the list will be executed.** Returns value set by LIST:COUN command. (See example, Figure B-3.)

B.23 [SOURce:]LIST:COUNt:SKIP COMMAND **LIST:COUN:SKIP**

Syntax: Short Form: LIST:COUN:SKIP nn Long Form: LIST:COUNt:SKIP nn
nn = <int_value 0 to 255>

Description: **Allows beginning steps of list-generated waveform to be run once, then ignored.**

When a list is to be repeated using LIST:COUNT, this command allows the user to skip the first nn steps once the full set has been executed. After the first iteration (which executes all steps), the first nn steps are skipped. The LIST:COUN:SKIP command allows the user to precondition a list-generated waveform by setting unique conditions at the beginning that are not repeated for the rest of the repetitions. LIST:CLEar sets nn to 0. Only works in LIST:DIR UP mode, if LIST:DIR DOWN is issued, this command has no effect. Related Commands: LIST:COUN, LIST:COUN:SKIP?, LIST:SEQ, LIST:DIR, LIST:CLE. (See example, Figure B-3.)

B.24 [SOURce:]LIST:COUNt:SKIP? QUERY — LIST:COUN:SKIP?

Syntax: Short Form: LIST:COUN:SKIP? Long Form: LIST:COUNt:SKIP?
Return Value: <int_value>

Description: **Identifies how many steps will skipped the first time the list is executed.** Returns value set by LIST:COUN:SKIP command. (See example, Figure B-3.)

B.25 [SOURce:]LIST:CURRent COMMAND — LIST:CURR

Syntax: Short Form: LIST:CURR <exp_value>, <exp_value>, . . . (to max of 100 data points)
Long Form: LIST:CURRent <exp_value>, <exp_value>, . . . (to max of 100 data points)
<exp_value> = digits with decimal point and Exponent, e.g., 2.71E1 for 27.1

Description: **Adds the current value (in Amps) to list.** This command sequentially adds LIST:CURRent values to the main channel List Data Table. Starting location is indicated by LIST:CURR:POIN? The maximum number of entries is 100. Since the input buffer of the KLP has a limit of 253 characters, multiple commands are necessary to complete the full 100 entries of the list. If LIST:VOLT has any entries, an error message: -221,"Settings conflict" is posted in the error queue. Related Commands: LIST:CURR:POIN?. (See example, Figure B-3.)

B.26 [SOURce:]LIST:CURRent? QUERY — LIST:CURR?

Syntax: Short Form: LIST:CURR? Long Form: LIST:CURRent?
Return Value: <value1>, <value2>, . . . to <value16>

Description: **Identifies the parameters (main channel) entered for the list.** Starting at location established by LIST:QUERy, returns comma-separated list of up to 16 values indicating the main channel parameters entered. i.e., the contents of main channel List Data Table. Related Commands: LIST: CURR, LIST:QUERy. If LIST:VOLT has any entries, an error message: -221,"Settings conflict" is posted in the error queue. (See example, Figure B-3.)

B.27 [SOURce:]LIST:CURRent:POINts? QUERY — LIST:CURR:POIN?

Syntax: Short Form: LIST:CURR:POIN? Long Form: LIST:CURRent:POINts?
Return Value: <value> (0 to 1001)

Description: **Identifies the total number of points in a list and the next location to be filled by LIST:CURR command.** The LIST:CURR pointer is initially at 0 via LIST:CLE. For each data point entered by a LIST:CURR command the list pointer is incremented If LIST:CURR:POIN? returns 5, the LIST:CURR pointer is at 5 indicating there are 6 data points comprising the list. If LIST:VOLT has any entries, an error message: -221,"Settings conflict" is posted in the error queue.Related Commands: LIST:CURR. (See example, Figure B-3.)

B.28 [SOURce:]LIST:DIRection COMMAND — LIST:DIR

Syntax: Short Form: LIST:DIR (UP|DOWN) Long Form: LIST:DIRection (UP|DOWN)

Description: **Allows the list to be executed from beginning to end (UP) or from end to the beginning (DOWN).** *RST or LIST:CLEar sets the list to the UP direction (beginning to end)**.** Works with both LIST:GEN DSEQ and LIST:GEN SEQ commands. Related Commands: LIST:GEN. LIST:SEQ, LIST:DWEL?. (See example, Figure B-3.)

B.29 [SOURce:]LIST:DIRection? QUERY — LIST:DIR?

Syntax: Short Form: LIST:DIR? Long Form: LIST:DIRection?
Return Value: <value> (UP or DOWN)

Description: **Identifies the for executing the list established by LIST:DIR.** Related Commands: LIST: DIR. (See example, Figure B-3.)

B.30 [SOURce:]LIST:DWELl COMMAND — LIST:DWEL

Syntax: Short Form: LIST:DWEL <value> (0.010 to 655.35),<value>,<value>, . . . to maximum of 100 values
Long Form: LIST:DWELl <value> (0.010 to 655.35),<value>,<value>, . . . to maximum of 100 values

Description: **Determines how long the main channel parameters will be active.** Sets time value (from 0.010 to 655.35) in seconds for List:Dwell locations of the List Data Table. The main channel (either voltage or current) is determined by the load. If LIST:DWEL is entered for only location 0, that time duration will apply to all steps when either VOLT:MODE LIST or CURR:MODE LIST is executed. Related Commands: VOLT:MODE, LIST:CURR, LIST:VOLT, LIST:DWEL?, LIST:SEQ. (See example, Figure B-3.)

B.31 [SOURce:]LIST:DWELl? QUERY **LIST:DWEL?**

Syntax: Short Form: LIST:DWEL? Long Form: LIST:DWELl?
Return Value: <value>

Description: **Identifies the dwell times entered for the list.** Starting at location established by LIST:QUERy, returns comma-separated list of up to 16 values indicating the dwell time parameters entered. i.e., the contents of LIST:DWEL locations of the List Data Table. Related Commands: LIST: DWEL, LIST:QUERy. (See example, Figure B-3.)

B.32 [SOURce:]LIST:DWELl:POINts? QUERY **LIST:DWEL:POIN?**

Syntax: Short Form: LIST:DWEL:POIN? Long Form: LIST:DWELl:POINts?
Return Value: <value> (0 to 1001)

Description:**Identifies the number of locations for which time values have been entered and the next location to be filled by a LIST:DWEL command.** If LIST:DWEL:POIN? returns 6, dwell times have been entered for locations 0 through 5 and location 6 is the next to be filled by a LIST:DWEL command. LIST:DWEL, LIST:DWEL:POIN. (See example, Figure B-3.)

B.33 [SOURce:]LIST:QUERy COMMAND **LIST:QUER**

Syntax: Short Form: LIST:QUER <int_value>
Long Form: LIST:QUERy <int_value>
int_value = 0 to 1001

Description: **Determines first location to be queried by LIST:SEQ? query.** Related Commands: LIST:SEQ?. LIST:QUER?. (See example, Figure B-3.)

B.34 [SOURce:]LIST:QUERy? QUERY **LIST:QUER?**

Syntax: Short Form: LIST:SEQ? Long Form: LIST:SEQuence?
Return Value: <int_value>

Description: **Identifies first location to be queried by LIST:SEQ?, LIST:VOLT?, LIST:CURR?, LIST:DWEL? queries.** Related Commands: LIST:QUER, LIST:SEQ. (See example, Figure B-3.)

B.35 [SOURce:]LIST:VOLTage COMMAND **LIST:VOLT**

Short Form: LIST:VOLT[:LEV] <exp_value>, <exp_value>, . . . (to max of 100 data points)
Long Form: LIST:VOLTage[:LEVel] <exp_value>, <exp_value>, . . . (to max of 100 data points)
<exp_value> = digits with decimal point and Exponent, e.g., 2.71E1 for 27.1

Description: **Adds the voltage value (in Volts) to list.** This command sequentially adds LIST:VOLTage values to the main channel List Data Table locations. LIST:CLE sets starting location to 0. Next location indicated by LIST:VOLT:POIN? The maximum number of entries is 100. Since the input buffer of the KLP has a limit of 253 characters, multiple commands are necessary to complete the full 100 entries of the list. If LIST:CURR has any entries, an error message: -221,"Settings conflict" is posted in the error queue. Related Commands: LIST:VOLT:POIN?, LIST:CLE, *RST. (See example, Figure B-3.)

B.36 [SOURce:]LIST:VOLTage? QUERY **LIST:VOLT?**

Syntax: Short Form: LIST:VOLT? Long Form: LIST:VOLTage?
Return Value: <value1>, <value2>, . . . to <value16>

Description: **Identifies the parameters (main channel) entered for the list.** Starting at location established by LIST:QUERy, returns comma-separated list of up to 16 values indicating the main channel parameters entered. i.e., the contents of the main channel List Data Table. Related Commands: LIST: VOLT, LIST:QUERy. If LIST:CURR has any entries, an error message: -221,"Settings conflict" is posted in the error queue. (See example, Figure B-3.)

NOTES:	Examples below are intended only to illustrate command functions. Refer to PAR. 4.1.1 for programming techniques to optimize performance.
LIST:CLEAR	Initializes the list processor to add entries, clears main channel (LIST:CURR or LIST:VOLT) and LIST:DWEL data tables.
LIST:dwell .010	Sets the time duration for location 0 to be 0.010 second (Since dwell times for the rest of the locations in the list are not entered before running the list, the dwell time will be 0.010 second for all locations.
LIST:VOLT 0,2,4,6,8,10,12,14,16,18,20	Starting at location 0 (0), up to location 10 (20), fills the list with 11 data points.
LIST:VOLT:POIN?	Returns 11. Indicates that 11 data points have been entered, and location 11 is the next location to be filled (for the 12th data point.
	NOTE: See PAR. B.2 for format and accuracy of all numerical data returned.
LIST:QUERY?	Returns 0 (pointer cleared by LIST:CLE).
LIST:VOLT?	Returns 0,2,4,6,8,10,12,14,16,18,20 (the contents of locations 0 through 10). (See PAR. B.2 for format and accuracy of numerical data.)
list:volt 18,16,14,12,10,8,6,4,2,0	Adds 10 points to the list (location 11 through 20). List now has 21 points.
LIST:VOLT:POIN?	Returns 21 (the next location to be filled by LIST:VOLT).
LIST:VOLT?	Returns 0,2,4,6,8,10,12,14,16,18,20,18,16,14,12,10,8,6,4,2,0 (the contents of locations 0 through 15).
LIST:QUERY 16	Start LIST queries from location 16.
LIST:QUERY 32	Start LIST queries from location 32.
LIST:COUNT 100	Specifies that when VOLT:MODE LIST is issued, the user-determined sequence will be executed 100 times. (44 steps in the list will be executed 100 times)
LIST:COUN:SKIP 4	Specifies that the first 4 steps of the sequence will only be executed the first time through the list. For the subsequent 99 iterations established by LIST:COUNT 100, location 0 (0V) will last 10 milliseconds.
CURR 1;VOLT -20	initializes the KLP output
OUTPUT ON	Turns the output on (KLP now provides 20 volts)
VOLT:MODE LIST	Executes the list. For 40 milliseconds the KLP outputs 0V, then outputs a staircase triangle wave from 0V to +20V and back down to 0V. This staircase will have a uniform spacing between voltage changes of 10 milliseconds and will repeat 100 times.
VOLT?	Returns 0 (the last step in the list sets the unit to 0V.

FIGURE B-3. USING LIST COMMANDS AND QUERIES (SHEET 1 OF 2)

LIST:COUN:SKIP?	Returns 4. Skip first 4 steps after the first time through count.
LIST:COUN:SKIP 0	Specifies no steps to be skipped after the first time through the count.
LIST:COUNT?	Returns 100.
LIST:COUNT 10	Determines that the list will be repeated 10 times when executed.
LIST:COUNT?	Returns 10.
VOLT:MODE LIST	Initiates execution of the list. The unit outputs a sawtooth waveform that increases from 0V to 20V to 0V and repeats 10 times.
VOLT?	Returns 0, (the last step in the list set the unit to 0V.
LIST:VOLT:POIN?	Returns 21 (the next location to be filled by LIST:VOLT).
LIST:VOLT 10,5,0	Add 3 points to the list (location 21 through 23).
LIST:COUN?	Returns 10 indicating that the list will be repeated 10 times when executed.
LIST:DIR?	Returns UP (the default.)
LIST:DIR DOWN	Reverses the sequence order.
VOLT:MODE LIST	The list (24 steps) is executed. The output starts at 0V, goes to 5V, to 10V to 0V then increases to 20V in 2V steps and repeats 10 times. The sawtooth is similar to the previous sawtooth.
LIST:QUERy 0	Sets query pointer to zero.
LIST:DWEL:POIN?	Returns 1 indicating the next dwell time will be entered in location 1.
LIST:DWELL .01,.01,.01,.01,.01,.01,.01,.01,.01	
	Enters dwell time of 0.01 seconds in locations 1 through 9.
LIST:DWELL 1	Enters dwell time of 1 second in location 10.
VOLT:MODE LIST	the list is not executed, the unit returns error -221,Settings Error indicating the lists are not balanced.
LIST:DWELL:POINTS?	Returns 11 to indicate the dwell list has 11 entries
LIST:VOLT:POINTS?	Returns 24 to indicate the voltage list has 24 entries.
LIST:DWELL .01,.01,.01,.01,.01,.01,.01,.01,.01,.01,.1,.1,.1	
	Dwell times are entered in locations 11 through 23.
DWELL:POINTS?	Returns 24 indicating there are now 24 step dwell times on the list.
LIST:QUER?	Returns 0 indicating list queries will start from location 0
LIST:QUER 18	Causes list queries to start at location 18
LIST:DWEL?	Returns 01,.01,.01,.1,.1,.1 (the dwell times for locations 18 through 23.
LIST:VOLT?	Returns 4,2,0,10,5,0
LIST COUNT 0	List will repeat indefinitely.
VOLT:MODE LIST	The list is executed. Stair case wave now consists of 24 steps of .01 seconds except for the 0V step (location 10) which outputs 0V for 1 second. The end of the staircase has three steps of 0.1 second.
VOLT:MODE FIX	Stops execution of the list
VOLT?	Returns 20 (the last step in the list set the unit to 20V.
VOLT: 4	Programs output to 4V
VOLT:MODE TRAN .05	Prepares for a voltage transient lasting 0.05 seconds.
VOLT: 3	Output goes to +3V for 0.05 second, then returns to 4V.

FIGURE B-3. USING LIST COMMANDS AND QUERIES (SHEET 2 OF 2)

B.37 [SOURce:]LIST:VOLTage:POINts? QUERY **LIST:VOLT:POIN?**

Syntax: Short Form: LIST:VOLT:POIN? Long Form: LIST:VOLTage:POINts?
Return Value: <value> (0 to 1001)

Description: **Identifies the total number of points in a list and the next location to be filled by LIST:VOLT command.** The LIST:VOLT pointer is initially at 0 via *RST or LIST:CLE. For each data point entered by a LIST:VOLT command the list pointer is incremented If LIST:VOLT:POIN? returns 5, the LIST:VOLT pointer is at 5 indicating there are 5 data points comprising the list (locations 0 though 4) and location 5 is the next to be filled. If LIST:CURR has any entries, an error message: -221,"Settings conflict" is posted in the error queue. Related Commands: LIST:VOLT. (See example, Figure B-3.)

B.38 MEASure[:SCALar]:CURRent[:DC]? QUERY **MEAS:CURR?**

Syntax: Short Form: MEAS[:SCAL]:CURR[:DC]? Long Form: MEASure[:SCALar]:CURRent[:DC]?
Return Value: <num_value> (digits with decimal point and Exponent)

Description: **Measures actual current.** This query returns the actual value of output current (measured at the output terminals) as determined by the programmed value of voltage and current and load conditions. (See example, Figure B-1.) NOTE: The SCPI convention for this command allows the controller to establish the range and accuracy of the measurement if nn,nn is added after the question mark; the KLP accepts this format but sets the command warning bit (13) in the status questionable register and ignores the extra characters.

B.39 MEASure:VOLTage[:SCALar][:DC]? QUERY **MEAS:VOLT?**

Syntax: Short Form: MEAS[:SCAL]:VOLT[:DC]? Long Form: MEASure[:SCALar]:VOLTage[:DC]?

Description: **Measures actual voltage.** This query returns the actual value of output voltage (measured at the output terminals) as determined by the programmed value of voltage and current and load conditions. (See example, Figure B-1.) NOTE: The SCPI convention for this command allows the controller to establish the range and accuracy of the measurement if nn,nn is added after the question mark; the KLP accepts this format but sets the command warning bit (13) in the status questionable register and ignores the extra characters.

B.40 OUTPut[:STATe] COMMAND **OUTP**

Syntax: Short Form: OUTP[:STAT] <boolean> Long Form: OUTPut[:STATe] <boolean>
<boolean>=(0 or OFF, 1 or ON)

Description: **Enables or disables the power supply output (see PAR.3.7.1 for disabling if analog programming used).** Upon power up the output is enabled (OUTP ON). When OUTP OFF is executed, the digitally programmed values of voltage and current are saved, then voltage and current are programmed to 0; analog programming is not affected. When OUTP ON is executed, the power supply output is restored to the previously saved programmed values. The saved values of voltage and current can be viewed by VOLT? and CURR? queries. Related Commands: OUTP?. (See example, Figure B-1.)

B.41 OUTPut[:STATe] QUERY **OUTP?**

Syntax: Short Form: OUTP[:STAT]? Long Form: OUTPut[:STATe]?
Return Value: <int_value> (0 or 1)

Description: **Indicates whether power supply output is enabled or disabled.** Returns 0 if output disabled, returns 1 if output enabled. Related Commands: OUTP. (See example, Figure B-1.)

B.42 [SOURce:]CURRent[:LEVel][:IMMediate][:AMPlitude] COMMAND **CURR**

Syntax: Short Form: [SOUR:]CURR[:LEV][:IMM][:AMP] <exp_value>
Long Form: [SOURce:]CURRent[:LEVel][:IMMediate][:AMPlitude] <exp_value>
<exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Sets programmed current level at power supply output.** This command programs output current to a specific value; actual output current will depend on load conditions. If the value exceeds the maximum for the model being programmed, error message -222,"Data out of range" is posted in output queue. If value programmed exceeds the CURR:LIM:HIGH value, a value corresponding to the current limit will be programmed. Related Commands: CURR:LIM:HIGH. (See example, Figure B-1.)

B.43 [SOURce:]CURRent[:LEVel][:IMMediate][:AMPlitude] QUERY **CURR?**

Syntax: Short Form: [SOUR:]CURR[:LEV][:IMM][:AMP]? MIN, MAX
Long Form: [SOURce:]CURRent[:LEVel][:IMMediate][:AMPlitude]? MIN, MAX
Return Value:<exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Returns either the programmed value, maximum value, or minimum value of current.** The CURR? query returns the programmed value of current. Actual output current will depend on load conditions. The CURR?MAX query returns the maximum current allowed for a particular model. CURR? Returns programmed current value. CURR? MAX returns maximum current allowed for power supply. CURR? MIN returns minimum current allowed for power supply (always 0). Related Commands: CURR. (See example, Figure B-1.)

B.44 [SOURce:]CURRent:LIMit:HIGH COMMAND **CURR:LIM:HIGH**

Syntax: Short Form: [SOUR:]CURR:LIM:HIGH <exp_value>
Long Form: [SOURce:]CURRent:LIMit:HIGH <exp_value>
<exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Sets Virtual Model maximum programmable limit for power supply output current (see PAR. 3.2.5).** If the value is out of the acceptable current range for the power supply model, error message -222,"Data out of range" is posted in the output queue. If the user tries to set an output current value larger than the CURR:LIM:HIGH setting, a value corresponding to the current limit will be programmed and error message -301,"Value bigger than limit" is posted in the output queue. Once the limit is established, the unit will not allow values higher than the programmed limit. NOTE: If the Virtual Model maximum prgrammable current limit is changed, previously stored trigger levels, (PAR. B.48), stored settings (PAR. A.11) or progrogrammed sequences using the LIST commands may be outside the range established by the new virtual model. In this case, prior to execution, the value is cleared to the default minimum (minimum A) and an "out of range" error message is generated. This command is password protected, requires SYST:PASS:CENAble prior to execution. Related Commands: CURR, SYST:PASS:CENA. (See example, Figure B-4.)

B.45 [SOURce:]CURRent:LIMit:HIGH? QUERY **CURR:LIM:HIGH?**

Syntax: Short Form: [SOUR:]CURR:LIM:HIGH? Long Form: [SOURce:]CURRent:LIMit:HIGH?
Return Value:<exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Returns value representing Virtual Model current limit set by CURR:LIM:HIGH command.** Related Commands: CURR:LIM:HIGH, CURR. (See example, Figure B-4.)

B.46 [SOURce:]CURRent:PROTection[:LEVel] COMMAND **CURR:PROT**

Syntax: Short Form: [SOUR:]CURR:PROT[:LEV] <exp_value>
Long Form: [SOURce:]CURRent:PROTection[:LEVel] <exp_value>
<exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Sets overcurrent protection level for power supply.** If the value is out of the acceptable overcurrent range for the power supply model, error message -222,"Data out of range" is posted in the output queue. If the power supply output exceeds the current protection level programmed, then the power supply output is disabled (programmed to 0) and the OV bit in the Questionable Condition status register is set. (See example, Figure B-4.)

B.47 [SOURce:]CURRent:PROTection[:LEVel]? QUERY **CURR:PROT?**

Syntax: Short Form: [SOUR:]CURR:PROT[:LEV]? {MIN | MAX}
Long Form: [SOURce:]CURRent:PROTection[:LEVel]? {MIN | MAX}
Return Value: <exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Returns value representing current protection level.**CURR:PROT? returns value set by CURR:PROT. CURR:PROT?MAX returns maximum current protection value (see Table 1-2). This value is determined at the factory and cannot be changed by the user. CURR:PROT?MIN returns the minimum current protection value (always 0). (See example, Figure B-4.)

Description: **Returns the current value established by CURR:TRIG command.** (See example, Figure B-1.)

B.48 [SOURce:]CURRent:[:LEVel]TRIGgered[:AMPlitude] COMMAND **CURR:TRIG**

Syntax: Short Form: [SOUR:]CURR[:LEV]:TRIG[:AMP] <exp_value>
Long Form: [SOURce:]CURRent[:LEVel]:TRIGgered[:AMPlitude] <exp_value>
<exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Programs current value to be transferred to output by *TRG commands.** Actual output current will depend on load conditions. If the value exceeds the maximum for the model being programmed, error message -222,"Data out of range" is posted in output queue. If value exceeds CURR:LIM:HIGH value, a value corresponding to the current limit will be programmed. Related Commands: CURR. (See example, Figure B-1.)

B.49 [SOURce:]CURRent:[:LEVel]TRIGgered[:AMPlitude]? QUERY **CURR:TRIG?**

Syntax: Short Form: [SOUR:]CURR[:LEV]:TRIG[:AMP]?
Long Form: [SOURce:]CURRent[:LEVel]:TRIGgered[:AMPlitude]?
Return Value: <exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

NOTE: The power supply is assumed to be operating in constant voltage (CV) mode.

VOLT 421; CURR 1.1e-1	Power supply programmed to voltage limit 421V, 0.11A.
CURR?	Returns 1.1E-1.
CURR:LIM:HIGH 3.3e-1	Current limit set to 0.33A.
CURR:LIM:HIGH?	Returns 3.3e-1
CURR 4.2e-1	Power supply output current programmed to 0.33A, error message -301 posted.
CURR?	Returns 3.3e-1
CURR 2.5e-1	Power supply output current programmed to 0.25A
CURR?	Returns 2.5e-1 0.25A).
CURR:PROT 1.6e-1	Unit shuts down if current exceeds 160 mA.

FIGURE B-4. PROGRAMMING CURRENT

B.50 [SOURce:]VOLTage[:LEVel][:IMMediate][:AMPlitude] COMMAND **VOLT**

Syntax: Short Form: [SOUR:]VOLT[:LEV][:IMM][:AMP] <exp_value>
Long Form: [SOURce:]VOLTage[:LEVel][:IMMediate][:AMPlitude] <exp_value>
<exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Sets programmed voltage level at power supply output.** This command programs output voltage to a specific value; actual output voltage will depend on load conditions. If the value exceeds the maximum for the model being programmed, error message -222,"Data out of range" is posted in output queue. If value programmed exceeds the VOLT:LIM:HIGH value, a value corresponding to the voltage limit will be programmed. Related Commands: VOLT:LIM:HIGH. (See example, Figure B-1.

B.51 [SOURce:]VOLTage[:LEVel][:IMMediate][:AMPlitude]? QUERY **VOLT?**

Syntax: Short Form: [SOUR:]VOLT[:LEV][:IMM][:AMP]? {MIN | MAX}
Long Form: [SOURce:]VOLTage[:LEVel][:IMMediate][:AMPlitude]? {MIN | MAX}

Description: **Identifies programmed voltage, maximum allowable voltage, or minimum voltage (always 0).** The VOLT? query returns the programmed value of voltage. Actual output voltage will depend on load conditions. The VOLT?MAX query returns the maximum voltage allowed for a particular model (e.g., 25V for ABC25-4DM). VOLT? MINReturns minimum voltage allowed for power supply (always 0). Related Commands: VOLT. (See example, Figure B-5.)

B.52 [SOURce:]VOLTage:LIMit:HIGH COMMAND **VOLT:LIM:HIGH**

Syntax: Short Form: [SOUR:]VOLT:LIM:HIGH <exp_value>
Long Form: [SOURce:]VOLTage:LIMit:HIGH <exp_value>
<exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Sets Virtual Model limit for maximum power supply output voltage (see PAR. 3.2.5).** If the value is out of the acceptable current range for the power supply model, error message -222,"Data out of range" is posted in the output queue. If the user tries to set an output voltage value larger than the VOLT:LIM:HIGH setting, a value corresponding to the voltage limit will be programmed and error message -301,"Value bigger than limit" is posted in the output queue. NOTE: If the Virtual Model voltage limit is changed, all associated parameters are cleared and must be reprogrammed (see PAR. 3.2.5). Once the limit is established, the unit will not allow values higher than the programmed limit. NOTE: If the Virtual Model maximum prgrammable voltage limit is changed, previously stored trigger levels, (PAR. B.58), stored settings (PAR. A.11) or progrogrammed sequences using the LIST commands may be outside the range established by the new virtual model. In this case, prior to execution, the value is cleared to the default minimum (0V) and an “out of range” error message is generated. This command is password protected, requires SYST:PASS:CENAble prior to execution.This command is password protected, requires SYST:PASS:CENAble prior to execution. Related Commands: VOLT, SYST:PASS:CENA. (See example, Figure B-5.)

B.53 [SOURce:]VOLTage:LIMit:HIGH? QUERY VOLT:LIM:HIGH?

Syntax: Short Form: [SOUR:]VOLT:LIM:HIGH? Long Form: [SOURce:]VOLTage:LIMit:HIGH?
Return Value: <exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Returns value representing Virtual Model voltage limit set by VOLT:LIM:HIGH command.** Related Commands: VOLT:LIM:HIGH, VOLT. (See example, Figure B-5.)

B.54 [SOURce:]VOLTage:MODe COMMAND VOLT:MOD

Syntax: Short Form: [SOUR:]VOLT:MOD (FIX | LIST | TRAN) nn
Long Form: [SOURce:]VOLTage:MODe (FIXed | LIST | TRANsient) nn
nn = <value> = time in seconds for transient

Description: **Allows the user to execute or stop a list, or to execute a transient.** The default mode is FIXed: the power supply executes commands normally, and LIST commands can be issued to establish the parameters and sequence of a list.

When VOLT:MODe LIST is issued, a list is executed (See LIST commands and Figure B-3). While the list is being executed, LIST commands are not accepted and will produce a command error. Issuing VOLT:MODe FIX while the list is running will stop the execution of the list and return power supply to settings in effect prior to running the list. If the list runs to completion, the settings of the last step of the list will be in effect.

VOLT:MODe TRANs nn causes the next VOLT: command to produce a transient pulse of nn seconds duration, after which the voltage reverts back to the previous setting. E.g., VOLT:25 sets the output to 25 volts, and VOLT:MODe TRAN .02 primes the unit for a transient of 0.02 seconds. When VOLT:10 is issued, the power supply output goes to 10V for 0.02 seconds, then reverts to 25V. Similarly, sending VOLT:TRIG 14, VOLT:MODe TRAN .05 and *TRG causes the output to go to 14V for 0.05 seconds, then revert to 25V. **Related Commands:** LIST commands. (See example, Figure B-3.)

B.55 [SOURce:]VOLTage:MODe? QUERY VOLT:MOD?

Syntax: Short Form: [SOUR:]VOLT[:LEV]:MOD?
Long Form: [SOURce:]VOLTage[:LEVel]:MODe?
Return value: FIXED or LIST or TRANS

Description: **Identifies active voltage mode.** Returns LIST while list is being executed. Returns TRANSIENT after VOLT:MODE TRAN nn command has been issued, but before VOLT: or *TRG command executes the transient. Returns FIXED while in fixed (default) mode of operation. **Related Commands:** LIST commands. (See example, Figure B-3.)

B.56 [SOURce:]VOLTage:PROTection[:LEVel] COMMAND VOLT:PROT

Syntax: Short Form: [SOUR:]VOLT:PROT[:LEV] <exp_value>
Long Form: [SOURce:]VOLTage:PROTection[:LEVel] <exp_value>
<exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Sets overvoltage protection level for power supply.**If the value is out of the acceptable overvoltage range for the power supply model, error message -222,"Data out of range" is posted in the output queue. If the power supply output exceeds the voltage protection level programmed, then the power supply output is disabled (programmed to 0) and the OV bit in the Questionable Condition status register is set. An overvoltage condition can be cleared with the VOLT:PROT:CLE command. The voltage protection level can be programmed independently of the output voltage level. Setting voltage protection to a value lower than the output voltage causes the voltage protection mechanism to trigger immediately. (See example, Figure B-5.)

B.57 [SOURce:]VOLTage:PROTection[:LEVel]? QUERY VOLT:PROT?

Syntax: Short Form: [SOUR:]VOLT:PROT[:LEV] MIN, MAX
Long Form: [SOURce:]VOLTage:PROTection[:LEVel] MIN, MAX
Return Value: <exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Identifies overvoltage protection setting, maximum allowable overvoltage protection, or minimum overvoltage protection.** VOLT:PROT? returns value set by VOLT:PROT. VOLT:PROT? MAX returns maximum voltage protection value (see Table 1-2); this value is determined at the factory and cannot be changed by the user. VOLT:PROT? MIN returns the minimum voltage protection value (always 0). (See example, Figure B-5.)

B.58 [SOURce:]VOLTage:[:LEVel]TRIGgered[:AMPlitude] COMMAND **VOLT:TRIG**

Syntax: Short Form: [SOUR:]VOLT[:LEV]:TRIG[:AMP] <exp_value>
Long Form: [SOURce:]VOLTage[:LEVel]:TRIGgered[:AMPlitude] <exp_value>
<exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Programs voltage value to be transferred to output by *TRG commands.** Actual output voltage will depend on load conditions. If the value exceeds the maximum for the model being programmed, error message -222,"Data out of range" is posted in output queue. If value exceeds VOLT:LIM:HIGH value, a value corresponding to the voltage limit will be programmed. (See example, Figure B-1.)

B.59 [SOURce:]VOLTage:[:LEVel]TRIGgered[:AMPlitude]? QUERY **VOLT:TRIG?**

Syntax: Short Form: [SOUR:]VOLT[:LEV]:TRIG[:AMP]?
Long Form: [SOURce:]VOLTage[:LEVel]:TRIGgered[:AMPlitude]?
Return Value: <exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Returns value representing voltage value to be programmed by *TRG command established by VOLT:TRIG command).** (See example, Figure B-1.)

NOTE: The power supply is assumed to be operating in constant voltage (cV) mode.

VOLT 218; CURR 1.1e-1	Power supply programmed to 218V, 0.11A.
VOLT 2.157E3	Power supply programmed to go to 215.7V.
VOLT?	Returns 2.157E3, indicating programmed voltage = 215.7V.
VOLT? MAX	For BHK 500-0.4MG, returns 500 (500V).
VOLT? MIN	Returns 0 (minimum allowable voltage).
VOLT:PROT 2.365E+3	Voltage protection set to 236.5V.
VOLT?	Returns 2.157E+3, indicating programmed voltage value = 215.7V.
VOLT:PROT?	Returns 2.365E+3, (programmed overvoltage protection = 236.5V
VOLT:PROT?MAX	For BHK 500-0.4MG, returns 5.5e+3 (550V).
VOLT 221; CURR 1.1E-1	Power supply programmed to go to 221V, 0.1A.
VOLT?	Returns 221.
VOLT:LIM:HIGH 300	Voltage limit set to 300V.
VOLT:LIM:HIGH?	Returns 300.
VOLT 333	Power supply programmed to 333V., error message -301 posted.
VOLT?	Returns 300.

FIGURE B-5. PROGRAMMING VOLTAGE

B.60 STATus:OPERation:CONDition QUERY **STAT:OPER:COND?**

Syntax**:** Short Form: STAT:OPER:COND? Long Form: STATus:OPERation:CONDition?
Return Value: <int_value> 0 to 1313 (1 + 32 + 256 + 1024).

Description: **Returns the value of the Operation Condition Register (see Table B-2).** The Operation Condition Register contains unlatched real-time information about the operating conditions of the power supply. Bit set to 1 = function enabled (active, true); bit reset to 0 = function disabled (inactive, false). (See example, Figure B-6.)

TABLE B-2. OPERATION CONDITION REGISTER, OPERATION ENABLE REGISTER, AND OPERATION EVENT REGISTER BITS

CONDITION	NU	CC	NU	CV	NU	WTG	NU	CAL
BIT	15-11	10	9	8	7 - 6	5	4 - 1	0
VALUE	32,768 - 2048	1024	512	256	128 - 64	32	16 -2	1

CAL - INTERFACE COMPUTING NEW CALIBRATION CONSTANTS
CC - POWER SUPPLY IN CONSTANT CURRENT MODE
CV - POWER SUPPLY IN CONSTANT VOLTAGE MODE
NU - NOT USED
WTG WAIT FOR TRIGGER (SET BY TRIG SUBSYSTEM)

B.61 STATus:OPERation:ENABle COMMAND — STAT:OPER:ENAB

Syntax: Short Form: STAT:OPER:ENAB <int_value> 0 to 1313 (1 + 32 + 256 + 1024)
Long Form: STATus:OPERation:ENABle <int_value> 0 to 1313 (1 + 32 + 256 + 1024)

Description: **Sets Operation Enable Register.** The Operation Enable Register is a mask for enabling specific bits in the Operation Event Register which will cause the operation summary bit (bit 7) of the Status Byte register to be set Bit set to 1 = function enabled (active, true); bit reset to 0 = function disabled (inactive, false). The operation summary bit is the logical OR of all the enabled bits in the Operation Event register. (See example, Figure B-6.)

NOTE:The power supply is assumed to be operating in cV (constant voltage) mode.

STAT:OPER:ENAB 1056	Mask enabled for CC, WTG and bits.
STAT:OPER:ENAB?	Returns 1056 (32 + 1024) (CC, WTG bits set).
STAT:QUES:ENAB 3	Mask enabled for OV and OC bits (1 + 2).
STAT:QUES:ENAB?	Returns 3 (1 + 2) indicating OV and OC bits are enabled.
STAT:PRES	Operation Condition and Questionable Condition registers are reset.
TRIG:INIT:CONT ON	Continuous triggers enabled.
STAT:OPER:COND?	Power supply returns 288 (256 + 32) to indicate that power supply is constant voltage mode and Wait For Trigger is true.
STAT:OPER?	Returns 1057, e.g., indicating that since the last reading of the Operation Event Register the power supply has entered Constant Current mode, the Wait Trigger was set.
STAT:OPER?	Returns 0 indicating no changes since previous reading of the Operation Event register.
STAT:QUES?	Returns 0 (no questionable conditions occurred since previous reading
--- OVERTEMPERATURE CONDITION OCCURS	
STAT:QUES?	Returns 8 (overtemperature condition tripped since the last STAT:QUES? query).
STAT:QUES:COND?	Returns 8, (Power supply still in overtemperature condition).
STAT:QUES?	Returns 0, (Power supply no longer in overtemperature condition).
STAT:QUES:COND?	Returns 2, (Power supply still in overcurrent protection state).
SYST:ERR?	Power supply returns 0,“No error” message.

FIGURE B-6. USING STATUS COMMANDS AND QUERIES

B.62 STATus:OPERation:ENABle? QUERY — STAT:OPER:ENAB?

Syntax: Short Form: STAT:OPER:ENAB? Long Form: STATus:OPERation:ENABle?
Return Value: <int_value> 0 to 1313 (1 + 32 + 256 + 1024).

Description: **Reads Operation Enable Register (see Table B-2).** Returns value of Operation Enable Register bits. Bit set to 1 = function enabled (active, true); bit reset to 0 = function disabled (inactive, false). (See example, Figure B-6.)

B.63 STATus:OPERation[:EVENt] QUERY **STAT:OPER?**

Syntax: Short Form: STAT:OPER[:EVEN]? Long Form: STATus:OPERation[:EVENt]?
Return Value: <int_value> 0 to 1313 (1 + 32 + 256 + 1024).

Description: **Indicates changes in conditions monitored by Operational Event Register.** Returns the value of the Operation Event register. The Operation Event register is a read-only register which holds (latches) all events that occur. Reading the Operation Event register clears it. (See example, Figure B-6.)

B.64 STATus:PRESet COMMAND **STAT:PRES**

Syntax: Short Form: STAT:PRES Long Form: STATus:PRESet

Description: **Disables reporting of all status events.** This command sets all bits of the Operation Condition (Table B-2) and Questionable Condition Registers to 0, preventing all status events from being reported. (See example, Figure B-6.)

B.65 STATus:QUEStionable[:EVENt]? QUERY **STAT:QUES?**

Syntax: Short Form: STAT:QUES[EVEN]? Long Form: STATus:QUEStionable[EVENT]?
Return Value: <int_value> actual register value

Description: **Indicates questionable events that occurred since previous STAT:QUES? query.** Returns the value of the Questionable Event register (see Table B-3). The Questionable Event register is a read-only register which holds (latches) all events. Reading the Questionable Event register clears it. (See example, Figure B-6.)

NOTE: Removing source power from the unit (e.g., setting POWER ON/OFF dircuit breaker to OFF) causes the unit to generate and store the PWR bit. Therefore the first query of the Questionable Event Register after the unit is turned on will always show a PWR fault - this is normal.

TABLE B-3. QUESTIONABLE EVENT REGISTER, QUESTIONABLE CONDITION REGISTER AND QUESTIONABLE CONDITION ENABLE REGISTER BITS

CONDITION	NU	FAN	PWR	OTP	OLF	OCP	OVP
BIT	15 - 6	3					2 - 0
VALUE	32,768 - 64	8	16	8	4	2	1

FAN - INTERNAL FAN FAILURE
PWR - LOSS OF SOURCE POWER
OTP - OVERTEMPERATURE
OLF - OUTPUT LEAD FAULT
OCP - OVERCURRENT
OVP - OVERVOLTAGE
NU - NOT USED

B.66 STATus:QUEStionable:CONDition? QUERY **STAT:QUES:COND?**

Syntax: Short Form: STAT:QUES:COND? Long Form: STATus:QUEStionable:CONDition?
Return Value: <int_value> actual register value

Description: **Returns the value of the Questionable Condition Register (see Table B-3).** The Questionable Condition Register contains unlatched real-time information about questionable conditions of the power supply. Bit set to 1 = condition (active, true); bit reset to 0 = condition (inactive, false). (See example, Figure B-6.)

B.67 STATus:QUEStionable:ENABle Command **STAT:QUES:ENAB**

Syntax: Short Form: STAT:QUES:ENAB <int_value> Long Form: STATus:QUESionable:ENABle <int_value>

Function: **Programs Questionable Condition Enable Register.**

Description: **Programs Questionable Condition Enable Register (see Table B-3).**The Questionable Condition Enable Register determines which conditions are allowed to set the Questionable Condition Register; it is a mask for enabling specific bits in the Questionable Event register that can cause the questionable summary bit (bit 3) of the Status Byte register to be set. The questionable summary bit is the logical OR of all the enabled bits in the Questionable Event register. Bit set to 1 = function enabled (active, true); bit reset to 0 = function disabled (inactive, false). (See example, Figure B-6.)

B.68 STATus:QUEStionable:ENABle? QUERY **STAT:QUES:ENAB?**

Syntax: Short Form: STAT:QUES:ENAB? Long Form: STATus:QUESionable:ENABle?
Return Value: <int_value> actual register value

Description: **Reads Questionable Condition Enable Register (see Table B-3).** Power supply returns value of Questionable Condition Enable Register, indicating which conditions are being monitored. Bit set to 1 = function enabled (active, true); bit reset to 0 = function disabled (inactive, false). Related Commands: STAT:QUES?. (See example, Figure B-6.)

B.69 SYSTem:COMMunication:GPIB:ADDRess COMMAND **SYST:COMM:GPIB:ADDR**

Syntax: Short Form: SYST:COMM:GPIB:ADDR<INT VAL> 01 to 30
Long Form: SYSTem:COMMunication:GPIB:ADDRess<INT VAL> 01 to 30

Description: **Sets selected power supply GPIB address.** Two-digit address required

B.70 SYSTem:COMMunication:GPIB:ADDRess? QUERY **SYST:COMM:GPIB:ADDR?**

Syntax: Short Form: SYST:COMM:GPIB:ADDR?
Long Form: SYSTem:COMMunication:GPIB:ADDRess?
Return Value: <int_value> GPIB address

Description: **Returns GPIB address.**

B.71 SYSTem:COMMunication:SERial:BAUD COMMAND **SYST:COMM:SER:BAUD**

Syntax: Short Form: SYST:COMM:SER:BAUD {19200 | 9600 | 4800 | 2400}
Long Form: SYSTem:COMMunication:SERial:BAUD {19200 | 9600 | 4800 | 2400}

Description: **Sets the unit to operate at the specified baud rate.**

B.72 SYSTem:COMMunication:SERial:ECHO COMMAND **SYST:COMM:SER:ECHO**

Syntax: Short Form: SYST:COMM:SER:ECHO {1 | 0}
Long Form: SYSTem:COMMunication:SERial:ECHO {1 | 0}

Description: **Enables (1 = ON) or disables (0 = OFF) echo mode** (see PAR. 3.4.2.3). When echo mode is ON causes all subsequent characters to be echoed back. When echo mode is OFF turns, off the character echo after the nest line terminator character. The *RST command has no effect on echo status

B.73 SYSTem:COMMunication:SERial:ECHO? QUERY **SYST:COMM:SER:ECHO?**

Syntax: Short Form: SYST:COMM:SER:ECHO?
Long Form: SYSTem:COMMunication:SERial:ECHO?
Return Value: <int_value> (1 or 0)

Description: **Indicates whether echo mode is on (1) or off (0).** (See PAR. 3.4.2.3.)

B.74 SYSTem:COMMunication:SERial:ENABle COMMAND **SYST:COMM:SER:ENAB**

Syntax: Short Form: SYST:COMM:SER:ECHO {1 | 0}
Long Form: SYSTem:COMMunication:SERial:ECHO {1 | 0}

Description: **Enables (1 = ON) or disables (0 = OFF) transmission of data via the RS 232 port** (see PAR. 3.4.2) Once RS 232 transmission has been disabled, it can be enabled again by either turning the unit off, then on, or by sending SYST:COMM:SER:ECHO 1 via the GPIB port.

B.75 SYSTem:COMMunication:SERial:ECHO? QUERY **SYST:COMM:SER:ENAB?**

Syntax: Short Form: SYST:COMM:SER:ECHO?
Long Form: SYSTem:COMMunication:SERial:ECHO?
Return Value: <int_value> (1 or 0)

Description: **Indicates whether RS 232 transmission mode is enabled (1 = ON) or disabled (0 = OFF).** (See PAR. 3.4.2.)

B.76 SYSTem:COMMunication:SERial:PACE COMMAND SYST:COMM:SER:PACE

Syntax: Short Form: SYST:COMM:SER:PACE {NONE | XON}
Long Form: SYSTem:COMMunication:SERial:PACE {NONE | XON}

Description: **Enables (XON) or disables (NONE) data flow control via the serial interface** (see PAR. 3.4.2.3)

B.77 SYSTem:COMMunication:SERial:PROMpt COMMAND SYST:COMM:SER:PROM

Syntax: Short Form: SYST:COMM:SER:PROM {1 | 0}
Long Form: SYSTem:COMMunication:SERial:PROMpt {1 | 0}

Description: **Enables (1 = ON) or disables (0 = OFF) prompt** (see PAR. 3.4.2.3). When prompt is ON, causes the unit to return > character after the command is parsed.

B.78 SYSTem:COMMunication:SERial:PROMpt? QUERY SYST:COMM:SER:PROM?

Syntax: Short Form: SYST:COMM:SER:PROM {1 | 0}
Long Form: SYSTem:COMMunication:SERial:PROMpt {1 | 0}
Return Value: <int_value> (1 or 0)

Description: **Indicates whether prompt is enabled (1 = ON) or disabled (0 = OFF)** (see PAR. 3.4.2.3).

B.79 SYSTem:ERRor? QUERY SYST:ERR?

Syntax: Short Form: SYST:ERR? Long Form: SYSTem:ERRor?
Return Value: <int_value,string>

Description: **Posts error messages to the output queue.** Returns the next error number followed by its corresponding error message string from the instrument error queue. The error queue is a FIFO (first in first out) buffer that stores errors as they occur. As it is read, each error is removed from the queue and the next error message is made available. When all errors have been read, the query returns 0,"No error". If more than 15 errors are accumulated, it will overflow. The oldest errors stay in the queue but the most recent errors are discarded. The last error in the queue will be -350,"Too many errors." Error messages are defined in Table B-4.

B.80 SYSTem:ERRor:CODE? QUERY SYST:ERR:CODE?

Syntax: Short Form: SYST:ERR:CODE?] Long Form: SYSTem:ERRor:CODE?

Description: Returns the three character error code without the ASCII definition string. The error codes are defined in table B-4 (See example, Figure B-1.)

B.81 SYSTem:ERRor:CODE:ALL? QUERY SYST:ERR:CODE:ALL?

Syntax: Short Form: SYST:ERR:CODE:ALL?] Long Form: SYSTem:ERRor:CODE:ALL?
Return Value:

Description: Returns a comma-separated list of all error codes. A maximum of 15 codes will be returned; if the queue is empty, the power supply returns 0.

B.82 SYSTem:KLOCk COMMAND SYST:KLOC

Syntax: Short Form: SYST:KLOC <boolean> Long Form: SYSTem:KLOCk <boolean>
<boolean> (0 or OFF, 1 or ON)

Description: **Locks (ON or 1) or unlocks (OFF or 0) the front panel controls.** When set to OFF, local lockout is disabled and the power supply enters Remote mode as soon as a command or query is received. Once in Remote mode (with local lockout disabled) the front panel controls are disabled with the exception that local mode can be restored by pressing the VOLTAGE and CURRENT adjustment knobs at the same time.

After sending a SYST:KLOC ON (local lockout enabled) command, all front panel controls (including pressing VOLTAGE and CURRENT adjustment knobs at the same time to return to local mode) are disabled. The power supply is now in the "local lockout" state and the status display reads Rwl. Local lockout can also be entered by sending the GPIB <LLO> code (hex 11) to the power supply. The power supply remains in "local lockout" until a SYST:KLOC OFF command is received or the power supply is turned off, ANALOG I/O DIP switch position 5 is set to OFF, and then the power supply is turned on again. Related Commands: SYST:KLOCK?. (See example, Figure B-7.)

B.83 SYSTem:KLOCk? QUERY **SYST:KLOC?**

Syntax: Short Form: SYST:KLOC? Long Form: SYSTem:KLOCk?
Return Value: <int_value> 0 or 1

Description: **Identifies whether keypad is locked or unlocked.** 0 = keypad unlocked, local operation possible by pressing LOCAL key. 1 = keypad locked, LOCAL key disabled, only remote operation possible. Related Commands: SYST:KLOCK. (See example, Figure B-7.)

SYST:VERS	Returns 1997.0.
SYT:SET	Unit returns DC0, STR, KL0, LF0, L100, M40, SCP
SYST:KLOC ON	keypad locked, only remote control possible.
SYST:KLOC?	Returns 1 indicating keypad locked.
SYST:KLOC OFF	keypad unlocked, pressing LOCAL key allows Local mode operation.
SYST:PASS:CEN 5678	Password enabled, commands are accepted.
SYST:KLOC?	Returns 0 indicating keypad unlocked.

FIGURE B-7. USING SYSTEM COMMANDS AND QUERIES

B.84 SYSTem:LANGuage COMMAND **SYST:LANG**

Syntax: Short Form: SYST:LANG {COMP | SCPI} Long Form: SYSTem:LANGuage {COMP | SCPI}

Description:**Determines whether unit responds to older command formats.** Sending SYST:LANG COMP causes the unit to respond to older formats such as LIST:TIME for compatible operation with software written for KLP power supplies up to Revision 2.9. SYST:LANG COMP has been selected at the factory to permit the VISA demonstration program (which uses older command formats) to operate. SYST:LANG SCPI disables responses to older command formats.

B.85 SYSTem:LANGuage? QUERY **SYST:LANG?**

Syntax: Short Form: SYST:LANG? Long Form: SYSTem:LANGuage?
Return Value: <string> SCPI or COMP

Description: **Identifies whether unit responds to older command formats.** SCPI means the unit will not respond to older formats such as LIST:TIME. COMP means the unit will respond to older formats such as LIST:TIME for compatible operation with software written for KLP power supplies. up to Revision 1

B.86 SYSTem:PASSword:CENable COMMAND **SYST:PASS:CEN**

Syntax: Short Form: SYST:PASS:CEN <val> Long Form: SYSTem:PASSword:CENable <val>

Description: Sets the password enable state if the value matches the current password. This command allows other commands such as the CAL commands to operate.

B.87 SYSTem:PASSword:DISable COMMAND **SYST:PASS:DIS**

Syntax: Short Form: SYST:PASS:DIS <val> Long Form: SYSTem:PASSword:DISable <val>

Description: Clears the password enable state if the value matches the current password.

B.88 SYSTem:PASSword:NEW COMMAND **SYST:PASS:NEW**

Syntax: Short Form: SYST:PASS:NEW <old password>,<new password>
Long Form: SYSTem:PASSword:NEW <old password>,<new password>

Description: **Establishes new password.** The old (current) password is checked, then replaced by the new password.

B.89 SYSTem:PASSword:STATe? QUERY

SYST:PASS:STAT?

Syntax: Short Form: SYST:PASS:STAT? Long Form: SYSTem:PASSword:STATe?
Return Value: <int_value> 0 or 1

Description: Returns a 1 if the password state is enabled or a 0 if it is disabled.

B.90 SYSTem:SECurity:IMMediate COMMAND

SYST:SEC:IMM

Syntax: Short Form: SYST:SEC:IMM Long Form: SYSTem:SECurity:IMMediate

Description: Initializes all NVRAM variable to factory defaults. This includes all memory steps to be set to 0 volts, 1.28% of full scale current, overvoltage and overcurrent to be set to Iomax+10%, time value to be set to 0, and next step equal to 0. The calibration password is reset per Table 4-1.

B.91 SYSTem:SET COMMAND

SYST:SET

Syntax: Short Form: SYSTem:SET {CM0 | DC0 | DC1 | LF0 | LF1 | KL0 | KL1 | L100 | M40 |}
Long Form: SYSTem:SET {CM0 | DC0 | DC1 | LF0 | LF1 | KL0 | KL1 | L100 | M40 |}

Description: **Establishes Device Clear, Line Feed, and Reset functions. Sending SYST:SEC:IMM sets LF1, DC0, and RO0 (as if CM0 was sent).** Sending SYST:SET CM1 sets the KLP to operate in compatible mode and have all GPIB functions compatible with software version 2.9 and lower units. Sending SYST:SET CM0 sets the unit to be fully SCPI 1997 compliant.

- CM0 Establishes DC0, LF0, conditions described below. (SCPI 1997 Standard compliance)
- DC0 Device Clear functions per IEEE 488.2 Standard. (No effect on the device (power supply), only clears internal status registers.)
- LF0 Line Feed not provided upon empty buffer condition
- DC1 Device Clear functions identical to *RST (Output set to 0V, voltage mode and output set to OFF except if RO1 (see below) is set.)
- LF1 Line Feed provided if buffer is empty and a read is performed.
- KL0 Enables front panel controls
- KL1 Disables front panel controls.
- L100 Number (100) of locations programmable using LIST commands.
- M40 Number (40) of locations programmable using *SAV and *RCL commands.

B.92 SYSTem:VERSion QUERY

SYST:VERS?

Syntax: Short Form: SYST:VERS? Long Form: SYSTem:VERSion?
Return Value: <int_value>.<int_value> (YYYY.V)

Description: **Identifies SCPI Version implemented.** Returns SCPI Version number:
YYYY = year, V = Revision number for specified year. (See example, Figure B-7.)

TABLE B-4. ERROR MESSAGES

ERROR MESSAGE	ESR ERROR BIT SET (SEE PAR. A.5)	EXPLANATION
0,“No error”	None	No error
-100,“Command error”	Command Error bit 5	Command and data understood, but more information included which is not recognized.
-102,”Syntax error”	Command Error bit 5	First 4 characters recognized, subsequent characters not recognized.
-103,”Invalid separator”	Command Error bit 5	For example, VOLT.PROT received instead of VOLT:PROT.
-108,”Parameter Not Allowed Error”	Command Error bit 5	Volt12 sequence, channel number is invalid.
-109,”Missing parameter”	Command Error bit 5	For example, VOLT instead of VOLT 21.
-111,”Header separator error”	Command Error bit 5	Missing space between volt and value or ; missing.
-113,”Undefined header”	Command Error bit 5	First 4 characters could not be identified as legal command.For example, command VLT instead of VOLT.

TABLE B-4. ERROR MESSAGES (CONTINUED)

ERROR MESSAGE	ESR ERROR BIT SET (SEE PAR. A.5)	EXPLANATION
-120,"Numeric data error"	Command Error bit 5	Expected number but other characters were detected.
-121,"Invalid character in number"	Command Error bit 5	Volt 1,500 (comma not allowed).
-123,"Exponent too large"	Command Error bit 5	Exponent E+3 or greater is invalid.
-141,"Invalid character data"	Command Error bit 5	For example OUTP OFD or OUTP STOP instead of OUTP OFF.
-150,"String data error"	Command Error bit 5	Invalid characters were detected in numeric entry.For example E.1 instead of E+1 or 4d3 instead of 4.3.
-203,"Command protected"	Execution error bit 4	Password must be CENabled.
-213,"INIT ignaoed"	Execution error bit 4	Request for measurement ignored because another measurement already in progress.
-221,"Settings conflict"	Execution error bit 4	E.g. , Invalid password from syst:pass:cen command. or Calibration state not enabled but CALibrate command received.
-222,"Current, Voltage or Data out of range"	Execution error bit 4	Value (current or voltage) exceeds power supply rating or (data) exceeds acceptable command parameters.
-223,"Data format error"	Execution error bit 4	Multiple decimals in digit, Multiple E, etc.
-224,"Illegal parameter value"	Execution error bit 4	For example, OUTP 2 instead of OUTP 1.
-226,"Lists not same length"	Execution error bit 4	During a LIST command, number of DWEL list entries was not equal to 1 and did not match number of LIST:VOLT or LIST:CURR entries.
-240,"Hardware error"	Execution error bit 4	Power supply did not respond to command.
-241,"Hardware missing"	Execution error bit 4	Requesting device 2 status (INST:NSEL 2).
-280, "Program Error"	Execution error bit 4	LIST execution error, e.g., program already running.
-282,"Illegal program name"	Execution error bit 4	Executing prog:run without LIST:SEQ command.
-301,"Value bigger than limit"	Device Error bit 3	E.g., requesting a voltage or current exceeds the limit.
-310,"System Failure"	Device Error bit 3	Program checksum incorrect.
-311,"Memory Error"	Device Error bit 3	E.g., power-up NV RAM error, or CALibrate:STORe error.
-313,"Calibration Memory Lost"	Device Error bit 3	No valid calibration found.
-314,"Save/recall memory error"	Device Error bit 3	Using cell other than 1 - 41 for SAV and RCL.
-315,"Configuration Memory Error"	Device Error bit 3	Configuration Memory Error.
-330,"Self Test Failed"	Device Error bit 3	Self test failed.
-340,"Calibration Failure"	Device Error bit 3	Unable to perform auto calibration.
-341,"Non Volatile Mem. CRC error"	Device Error bit 3	Power supply constants may be corrupted; recalibration may be necessary.
-350,"Queue Overflow"	Device Error bit 3	More than 15 errors are in queue. Error queue was full, error events have been lost.
-400,"QueryError"	Query Error bit 2	Data requested was lost due to 253 character limit or KLP output buffer.
-410,"Query interrupted	Query Error bit 2	New command sent before data from previous query read. Previous query data lost.
-420,"Query Unterminated"	Query Error bit 2	Controller sent query but did not accept data from power supply. See VOLT? (PAR. B.51), CAL:SAVE (PAR. B.9) commands.
-430,Query Deadlocked	Query Error bit 2	Over 255 characters received in single input string.

B.93 TRIGer:INITiate[:IMMediate] COMMAND **TRIG:INIT[:IMM]**

Syntax: Short Form: TRIG:INIT:[IMM] Long Form: TRIGger:INITiate[:IMMediate]

Description: **Enables a single trigger.** If TRIG:INIT:CONT is OFF, then TRIG:INIT[:IMM] arms the trigger system for a single trigger. If TRIG:INIT:CONT is ON, then the trigger system is continuously armed and TRIG:INIT[:IMM] is redundant. This command enables a single trigger. A GPIB <GET>, *TRG command completes the sequence. Upon receipt of the <GET>, *TRG command, the power supply will return to the programmed values of voltage and current established by the VOLT:TRIG and CURR:TRIG commands. After a GPIB <GET>, *TRG command has been received, subsequent GPIB <GET>, *TRG commands have no effect unless preceded by TRIG:INIT or TRIG:INIT:CONT ON. Related Commands: <GET>, *RST, *TRG. (See example, Figure B-1.)

B.94 TRIGger:INITiate:CONTinuous COMMAND **TRIG:INIT:CONT**

Syntax: Short Form: TRIG:INIT:CONT {ON | OFF} or {1 | 0} (1 = on, 0 = off)
Long Form: TRIGger:INITiate:CONTinuous {ON | OFF} or {1 | 0} (1 = on, 0 = off)

Description: **TRIG:INIT:CONT ON enables continuous triggers.; TRIG:INIT:CONT OFF disables continuous triggers.** If TRIG:INIT:CONT is OFF, then TRIG:INIT[:IMM] arms the trigger system for a single trigger. If TRIG:INIT:CONT is ON, then the trigger system is continuously armed and TRIG:INIT[:IMM] is redundant. Executing *RST command sets TRIG:INIT:CONT to OFF. (See example, Figure B-1.)

B.95 TRIGger:INITiate:CONTinuous QUERY **TRIG:INIT:CONT?**

Syntax: Short Form: TRIG:INIT:CONT?Long Form: TRIGger:INITiate:CONTinuous?
Return Value: 1 or 0

Description: **Determines whether continuous triggers are enabled or disabled.** Power supply returns value of TRIG:INIT:CONT flag: “1” = continuous triggers are enabled (TRIG:INIT:CONT ON); “0” = continuous triggers disabled (TRIG:INIT:CONT OFF). (See example, Figure B-1.)

B.96 TRIGger:SOURce COMMAND **TRIG:SOUR**

Syntax: Short Form: TRIG:SOUR {EXT | BUS} Long Form: TRIGger:SOURce {EXT | BUS}

Description: Sending TRIG:SOUR activates either internal (BUS) or external (EXT) trigger. When the external trigger (ground) is applied to J2 pin 3, output voltage and current are set to previously stored values for VOLT:TRIG and CURR:TRIG.
NOTE: If TRIG:INIT:CONT 1 was sent prior to sending TRIG:SOUR EXT, continuous mode is disabled and unit will wait for TRIG:INIT:IMM