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OPERATOR'S MANUAL

ABC-DM SERIES

SWITCHING POWER SUPPLY

VOLTAGE/CURRENT-STABILIZED DC SOURCE

KEPCO INC.

MODEL
ABC-DM 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.

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THE POWER SUPPLIER™

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GETTING STARTED
SIMPLIFIED OPERATING INSTRUCTIONS

These instructions are a quick reference for getting started with Kepco's ABC power supply. For more detailed information you are encouraged to read the accompanying Operator's Manual.

CONNECT THE LOAD. ***The Sense terminals must be connected for the power supply to work. For local sensing use the links supplied on the barrier strip at the rear.*** For remote sensing, remove the links and make the 4-wire connections at your load. (See the Operator's manual for more information.)

CONNECT SOURCE POWER. The power supply accepts a wide range of source power: 85-264V a-c, 47-63 Hz or 400Hz. The POWER switch turns the unit on and off. The power supply is equipped with a grounded North American 2-blade plug. Overseas users may substitute their national plug; the chassis end is a standard 15A IEC connector.

LOCAL OPERATION

THE ALPHANUMERIC DISPLAY (LCD). Operations are done from the keypad and observed on the LCD. Optimize LCD contrast by pressing MENU until LCD reads **CONTRAST**, then press numbers until viewing is optimum. The LCD displays the actual output voltage and current and the operating mode: Local or Remote and constant voltage (CV) or current (CC). and a blinking colon (:), or a blinking equal sign (=). Enter a command when you see a blinking colon (:), enter numbers when you see a blinking equal sign (=). Six keys have a dual function (command/number): the blinking colon (:) or equal sign (=) tells you which key function is effective.

USING THE KEYPAD. Use ENTER to accept numbers entered or execute a command. Use CLEAR if you make a mistake and don't want to change the status quo. Valid entries are accompanied by a short beep; invalid entries by a longer buzz. (The speaker can be disabled by pressing MENU until LCD display SPEAKER and entering 0.)

OUTPUT SETTINGS. V SET sets output voltage; I SET sets output current. Depending on the mode (CV or CC), one setting acts as a limit. (For example, in CC mode, V SET is the voltage limit and I SET is the output current setting.) The operating mode (CC or CV) is determined by the load combined with the V SET and I SET settings. The ➔ and ← keys can be used to increase or decrease output voltage (CV mode) or current (CC mode) by the least amount possible (approximately the maximum rating divided by 4000).

OUTPUT ON/OFF. (ON) enables programmed output settings to appear at the output (OFF) sets output voltage and current to zero and the LCD reads "**Output is OFF**"

RESET. Use RESET to restore the power-on defaults (output on, V SET and I SET at zero, OV SET and OC SET at approximately 10% above rated output).

PROTECTION. OV SET and OC SET establish protection for overvoltage and overcurrent conditions. If the output attempts to exceed programmed OV SET or OC SET values, the LCD indicates which condition occurred, and the output goes to zero. RESET or cycle the power supply off and on to recover.

CALIBRATION. CALIB leads you through a digital calibration procedure (password protected). The initial password is the voltage rating plus current rating (e.g., 1010 for ABC 10-10DM). You can change it using the MENU. The previous calibration is saved and can be restored. The original factory calibration can also be restored. (See Section 4 of the Operator's Manual.)

STORAGE LOCATIONS. Forty locations are available to either save active settings or to establish a local program that can be sequenced (EDIT PROG). STORE lets you save the active programmed settings (V SET, I SET, OV SET and OC SET). Just select a location (from 1 to 40). RECALL applies the V SET and I SET values previously stored.

LOCAL PROGRAMMING. The same forty locations are also available for local programming. Each location stores values for six parameters: output voltage, output current, overcurrent protection, overvoltage protection, time duration (between 0.01 and 300 seconds) for the programmed parameters, and the address of the next memory location in the program. Local programs are set up using EDIT PROG; a MEMORY LOCATION WORKSHEET table included in the Operator's Manual helps you to program Kepco's ABC.

Select the starting location and enter the desired values for each parameter. Use → or ← key to scroll forward or backward to view the next parameter or memory location. Set the last address to 0 for the program to run once and stop. If you want the program to cycle indefinitely, set the last address to the starting address. After all parameters have been entered, use CLEAR or ENTER to exit EDIT PROG mode. To run the program one step at a time, press STEP, select a starting location, then press STEP to execute the next step. To run the program, press RUN and select the starting location. If the program is designed to cycle, press CLEAR or RESET to stop it. The TIME key offers a quick and easy way to change the time for any memory location without entering EDIT PROG mode.

MENU FEATURES. Press MENU to scroll through the MENU functions. Press CLEAR to exit, enter number(s) and press ENTER to change a feature. The following features are included:

- ***Set LCD contrast:*** set from 1 to 9 for optimum viewing.
- ***Set GPIB address:*** Set from1 to 30
- ***Set RS 232 Baud Rate:*** Set to 19200, 9600, 4800 or 2400.
- ***Loop Back Test:*** Aids isolating RS 232 problems
- ***DCL Control:*** Allows DCL (Device Clear) to either set output to 0V or have no effect on output voltage
- ***Power up output on/off:*** Allows the output to be either on or off when unit is first turned on.
- ***Set speaker on/off:*** 0 to disable beeps and buzzes, 1 to enable.
- ***Change password (required for calibration):***. Enter old password, then the new password.
- ***Restore previous or factory calibration values:*** (See Section 4 of Operator's Manual.)
- ***View Model number, Serial number and firmware version*** (not changeable)
- ***Set maximum values for V SET and I SET:*** To prevent damage to a sensitive load the maximum output voltage and current can be reduced from the rated value to a user-selected maximum.
- ***Delay protection:*** To allow for large initial transients (e.g., from inductive loads), overvoltage and overcurrent protection can be delayed about 8 seconds by entering a count (count of 30 is about one second, maximum count is 255). If an overvoltage or overcurrent condition is still present at the end of the delay, protection trips the power supply off.

Declaration of Conformity

Application of Council directives:	**73/23/EEC (LVD)** **89/336/EEC(EMC)** **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)
EN61326-1:1997	(Electrical equipment for measurement, control and laboratory use - EMC requirements)
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:	**Power Supply**
Model No.:	*(ABC SERIES MODEL NUMBER*]
Year of Manufacture:	

I, the undersigned, declare that the product specified above, when used in accordance with the product instruction manual, complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/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)

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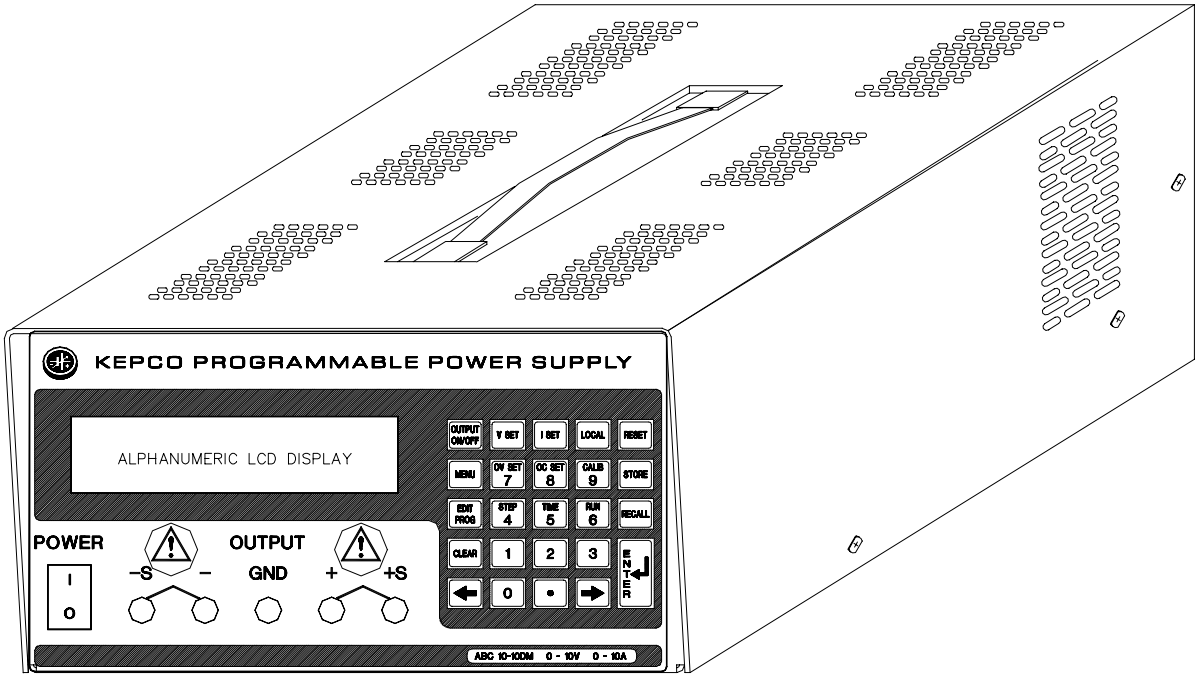
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FIGURE 1-1. ABC SERIES POWER SUPPLY

SECTION 1 - INTRODUCTION

1.1 SCOPE OF MANUAL

This manual contains instructions for the installation and operation of the ABC series of 100 Watt bench-top, voltage and current stabilized d-c power supplies manufactured by Kepco, Inc., Flushing, New York, U.S.A.

1.2 GENERAL DESCRIPTION

The Kepco ABC Power Supply Series (Figure 1-1) consists of six single-output models as listed in Table 1-1. ABC Series Power Supplies can be operated from a wide range of a-c input power sources (85-265V a-c, 47 - 63Hz). Although ABC is a stand-alone, bench top design, rack mounting can also be accommodated by rack adapters available for standard 19-inch wide racks (see Figures 1-2 and 1-3). Load connections may be made either at front panel terminals, or at a barrier terminal strip located at the rear.

ABC Series Power Supplies employ high frequency switch-mode conversion and power factor correction. ABC Power Supplies are full-range, automatic-crossover voltage/current stabilizers with a full rectangular output characteristic. The ABC is controlled digitally over the entire voltage/current range. Voltage and current are displayed on a two-line alphanumeric LCD display. Control of the ABC can either be local (via the front panel keypad) or remote (via either the IEEE 488.2 GPIB communication bus or RS 232 serial bus) using SCPI commands.

1.3 SPECIFICATIONS

Table 1-1 below indicates parameters that vary for different ABC models; Table 1-2 lists the Overcurrent and Overvoltage Range for each model. Table 1-3 lists general specifications that apply to all ABC models.

TABLE 1-1. MODEL PARAMETERS

MODEL NUMBER	d-c OUTPUT			RIPPLE AND NOISE (mv) (See PAR. 1.10)						EFFICIENCY
	RANGE		POWER	2x SOURCE FREQUENCY		SWITCHING FREQUENCY		SPIKE (50MHz)		100% LOAD 85-264V a-c
	VOLTS	AMPS	WATTS	TYP	MAX	TYP	MAX	TYP	MAX	% MIN
ABC 10-10DM	0-10	0-10	100	2	4	2	5	3	20	65%
ABC 15-7DM	0-15	0-7	105	3	7	3	8	4	20	66%
ABC 25-4DM	0-25	0-4	100	5	10	5	10	5	20	66%
ABC 36-3DM	0-36	0-3	108	7	15	7	15	7	20	67%
ABC 60-2DM	0-60	0-2	120	12	24	12	24	12	24	68%
ABC 125-1DM	0-125	0-1	125	25	50	25	50	25	50	70%

TABLE 1-2. MAXIMUM OVERVOLTAGE AND OVERCURRENT SETTINGS

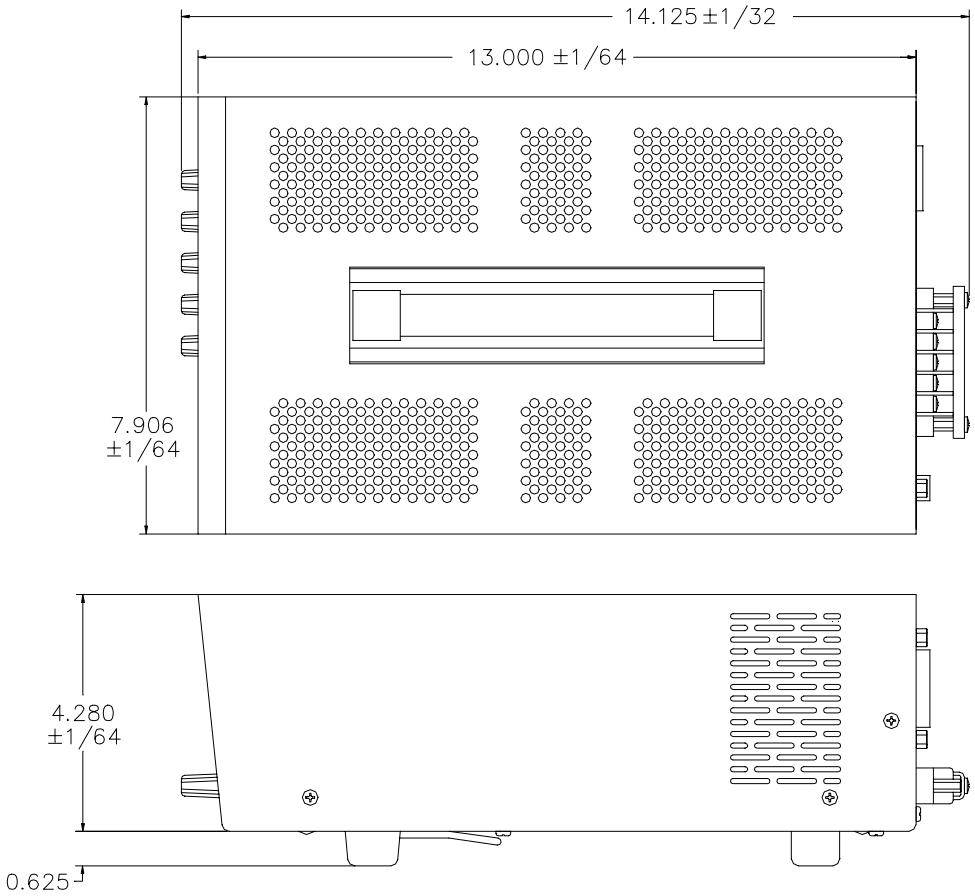
MODEL NUMBER	ABC 10-10DM	ABC 15-7DM	ABC 25-4DM	ABC 36-3DM	ABC 60-2DM	ABC 125-1DM
MAXIMUM OVERVOLTAGE SETTING	11V	17	27	39	65	137
MAXIMUM OVERCURRENT SETTING	11	7.7	4.4	3.3	2.2	1.1

TABLE 1-3. ABC SPECIFICATIONS

SPECIFICATION		RATING/DESCRIPTION	CONDITION
INPUT CHARACTERISTICS			
a-c Voltage	nominal	100/120/220/240V a-c	Single phase
	range	85-264V a-c	Wide range
Frequency	nominal	50-60Hz	>63Hz Input leakage current exceeds specifications
	range	47-63Hz (400Hz)	
Current	85V a-c	1.8A	Maximum at 100W output
	120V a-c	1.3A	
	240V a-c	0.65A	
	264V a-c	0.60A	
Initial turn-on surge		5A peak for <150 usec	85-264V a-c, 0-100% load
Power Factor (min)	120V	0.99	100% load
	240V	0.97	
EMC immunity to:	Radiated RF	EN 61000-4-3	level 3
	Magnetic Field	EN 61000-4-8	level 4
	Electrostatic discharge	EN 61000-4-2	level 2: contact, level 3: 8KV air discharge
	Conducted RF	EN 61000-4-6	level 3
	Electrical fast transient	EN 61000-4-4	level 3
	Surges	EN 61000-4-5	level 4
EMC Emissions	Conducted	EN 55022 Class B	0.15-30 MHz
	Radiated	EN 55022 Class B	30-1000 MHz
Harmonics	Conducted	EN 61000-3-2	0-2 KHz
Leakage current	120V a-c	<0.25mA	Source frequency in 47-63Hz range
	240V a-c	<0.5mA	
Circuit type		PFC	Flyback converter
		Output	Forward converter
Switching Frequency		100KHz	
OUTPUT CHARACTERISTICS			
Type of Stabilizer		Automatic crossover	Voltage/Current
Adjustment range		0 to 100% of rating	Voltage/Current
Source effect	Voltage	<0.01% E_O max	Nominal ±15% of input voltage
	Current	<0.01% I_O max	
Load effect	Voltage	<0.01% E_O max	0 to 100% load change
	Current	<0.02% I_O max	
Temperature effect	Voltage	<0.01% E_O max	Per degree C (0 to 50° C)
	Current	<0.01% I_O max	
Time effect	Voltage	<0.01% E_O max	0.5-8.5 hours
	Current	<0.01% I_O max	
Error sense		0.5V per wire	Voltage allowance
Isolation voltage		500V d-c or peak	Output to ground

TABLE 1-3. ABC SPECIFICATIONS (Continued)

SPECIFICATION		RATING/DESCRIPTION	CONDITION
OUTPUT CHARACTERISTICS (Continued)			
Programming time		2ms max	0-100%
Programming accuracy	Voltage	<0.025% E_O max	
	Current	0.1% I_O max	ABC 10-10DM ABC 15-7DM
		0.05% I_O max	ABC 25-4DM
		0.025% I_O max	ABC 36-3DM ABC 60-2DM ABC 125-1DM
Readback/Display accuracy	Voltage	<0.05% E_O max	
	Current	<0.1% I_O max	
Transient recovery to load change	Excursion	<5% E_O max	50-100% load change return to 1% E_O max
	Recovery	<200 usec	
Overshoot		None	Turn ON/OFF
Data entry	Local	24 keypads	Front panel
	Remote	GPIB	SCPI commands
GENERAL (ENVIRONMENTAL) CHARACTERISTICS			
Temperature	Operating	0° to +50° C	No derating, 100% P_O max
	Operating	+50° to +70° C	Linear derating to 40% P_O max
	Storage	-20° to +70° C	
Humidity		0 to 95% RH	Non condensing operating & storage
Shock		20g, 11msec ±50% half sine	3-axes 3 shocks each axis
Vibration		5-10Hz 10mm double amplitude	Non operating 1 hour each axis
Altitude		Sea level to 10,000 feet	
Cooling		Natural convection	
PHYSICAL CHARACTERISTICS			
Dimensions	English	7.9” x 4.9” x 14” ±1/32”	See Outline Drawing, Figure 1-1. For rack mounting see Figures 1-2 and 1-3.
	Metric	200.8 x 124.6 x 355.6 mm ±0.8 mm	
Weight	English	11 lbs.	Unpacked
	Metric	5 Kg	
A-C input connections	Front	Panel ON/OFF switch	
	Rear	Detachable IEC 320 type connector	3 wire fused
Output connections	Front	5 binding posts	±Output, ±Sense, Ground
	Rear	5 terminal barrier strips	
Remote control programming		One standard GPIB connector	Rear, SCPI & IEEE 488.2 Commands
Digital display front panel		Voltage, current, mode, status, menu, program, etc.	2 x 16 character alphanumeric LCD with LED backlight



NOTES:
1–MATERIAL: A–COVER & CHASSIS 16 GAUGE C.R.S
B–FRONT PANEL 16 GAUGE C.R.S WITH 0.010" THK. CLEAR HARD COATED POLYCARBONATE OVERLAY
2–FINISH: A–COVER: CHARCOAL GRAY , VINYL TEXTURE
B–CHASSIS: CADMIUM PLATE , CHROMATE WASH (IRIDESCENT YELLOW) BF00008–1
C–FRONT PANEL LIGHT GRAY PER FEDERAL STD 595–26496
3–RACK ADAPTER MOUNTING:
FOR EITHER RACK ADAPTER 168–0131 (RA 72) OR 168–0132 (RA 71)
A–REMOVE BAIL , AND FEET (4 PCS.) FROM POWER SUPPLY
B–INSERT (3) 6–32 X 1/4 SCREW [(4) SCREWS FOR SINGLE UNIT MTG.] KEPCO P/N 101–0212 THROUGH BOTTOM OF RACK ADAPTER AND ALIGN WITH PEMNUTS IN PWR. SUPPLY CHASSIS , THEN TIGHTEN THEM PROPERLY.
C–FOR RACK ADAPTER 168–0131 (RA 72) WITH TWO POWER SUPPLIES, MOUNT SUPPORT BRACKET 128–2071 TO CHASSIS OF BOTH ABC POWER SUPPLIES USING (2) 6–32 X 1/4 SCREW (KEPCO P/N 101–0212) AND (2) #6 INT. TOOTH LOCK WASHER (KEPCO P/N 103–0015).

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FIGURE 1-1. ABC SERIES POWER SUPPLY, MECHANICAL OUTLINE DRAWING

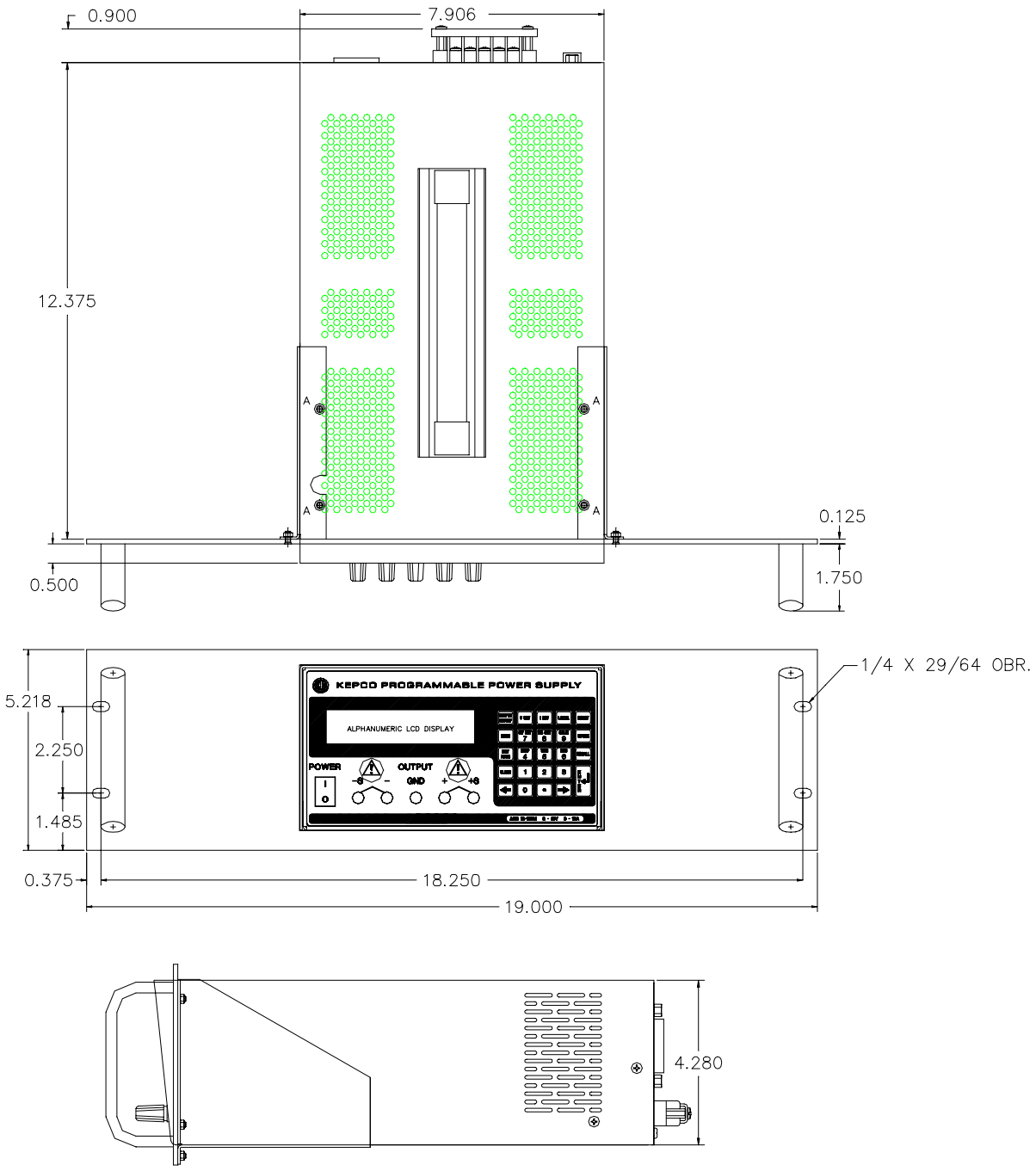
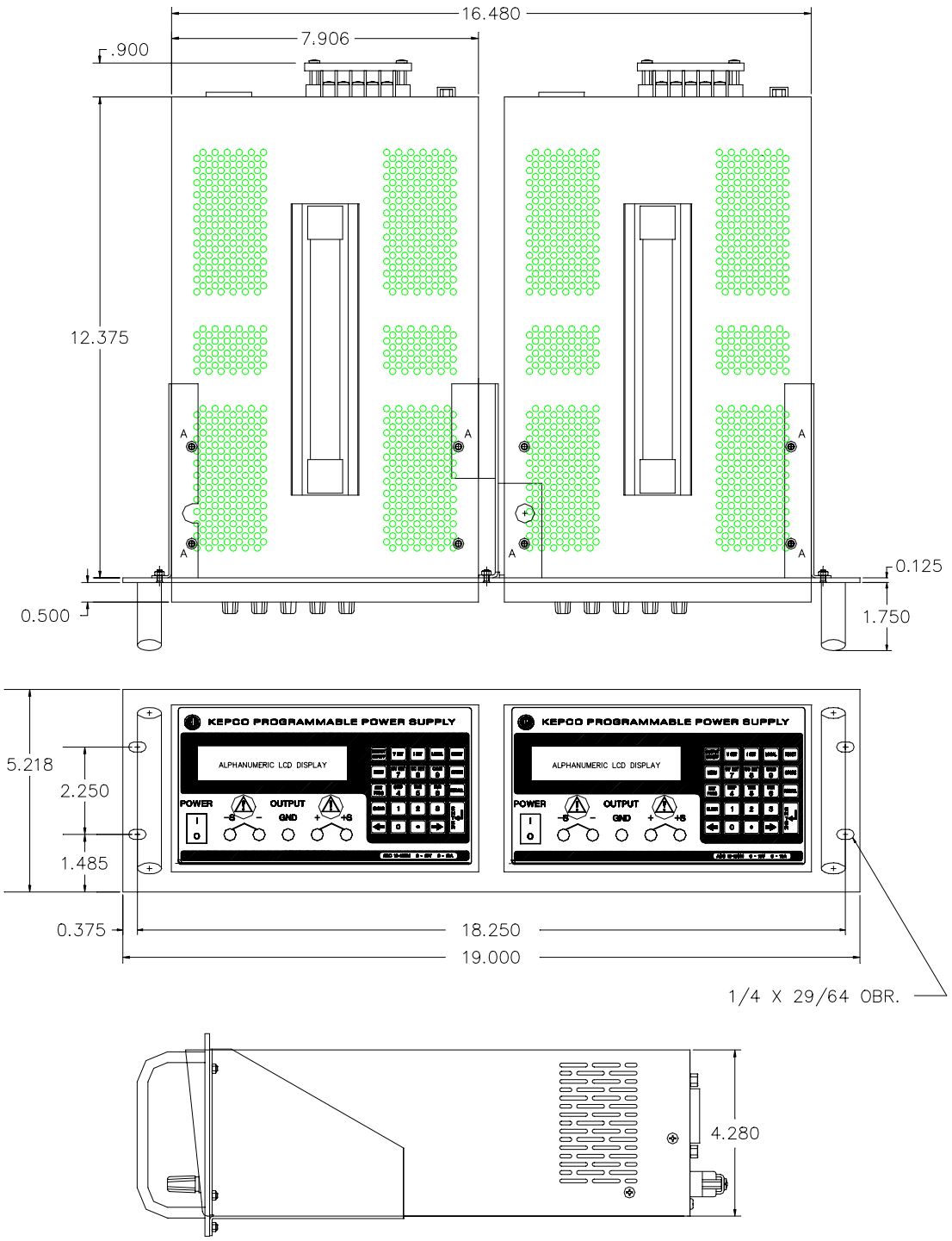


FIGURE 1-2. ABC POWER SUPPLY AND RA 71 RACK ADAPTER, OUTLINE DRAWING



NOTES:

TO MOUNT ABC UNITS IN RACK ADAPTER P/N 168-0131 (RA 72)

1: REMOVE BAIL AND (4) FEET FROM EACH POWER SUPPLY.

2: USE (6) SCREWS , 6-32 X 1/4 (KEPCO P/N 101-0212) AND (6) INT. LOCK WASHER FOR #6 SCREW (KEPCO P/N 103-0015) MARKED"A" FROM BOTTOM OF THE RA 72 TO SECURE EACH POWER SUPPLY.

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FIGURE 1-3. TWO ABC POWER SUPPLIES AND RA 72 RACK ADAPTER, OUTLINE DRAWING

1.4 LOCAL CONTROL

Front panel keypad entries are utilized for setting and adjusting output voltage and current under local control. The keypad's keys are organized to either directly execute commands, or to introduce a program that can either be run once or cycled. Calibration of the unit is facilitated by a password -protected, menu-driven procedure from the front panel.

1.5 REMOTE CONTROL

The ABC Power Supply can be remotely controlled directly via either the IEEE 488.2 (GPIB) bus or RS 232 serial bus using SCPI commands. All features available in local mode can also be accessed remotely. The unit is shipped with a VISA (Virtual Instrumentation Software Architecture) driver to facilitate remote programming of the ABC Power Supply. The VISA translates function calls made in standard C language to SCPI commands.

1.6 FEATURES

1.6.1 DIGITAL CALIBRATION

The ABC Power Supply contains no internal adjustments. Calibration is done entirely via the keypad using digital entries and a calibrated DVM and precision shunt resistor. Calibration instructions appear on the front panel after a password is entered; previous calibration values are saved and can be restored if desired. The original factory calibration values can also be restored. (Refer to Section 4.)

1.6.2 OVERVOLTAGE/OVERCURRENT PROTECTION

Overvoltage and Overcurrent protection values can be individually programmed. The maximum values are listed in Table 1-2. Refer to PAR. 3.3.9.

1.6.3 PROGRAMMABLE OVERVOLTAGE/OVERCURRENT DELAY

Changing the output settings may cause large output transients (common with reactive loads) that can trip the overvoltage/overcurrent protection. The ABC can be programmed to delay tripping of overvoltage/overcurrent protection when output settings are changed to avoid inadvertent tripping. After the delay, the programmed overcurrent/overvoltage setting is effective. Protection can be delayed up to approximately 8 seconds after the output settings are changed. Refer to PAR. 3.3.10.

1.6.4 NON-VOLATILE STORAGE OF PROGRAMMED SEQUENCES OR ACTIVE SETTINGS

The ABC Power Supply contains 40 memory locations that can be used either to preprogram a sequence of output values or to store the active settings. For programming sequences each memory location accommodates six parameters: output voltage, output current, Overvoltage, Overcurrent, Time (how long the parameters are in effect) and the next address in the sequence. Values are stored in the non-volatile memory, and are retained when the unit is turned off. Refer to PAR. 3.3.12.

The same 40 memory locations are also available to save the active programmed settings (V SET, I SET, OV SET and OC SET). The saved setting can be recalled by specifying the memory location.

1.6.5 USER-DEFINED VOLTAGE/CURRENT LIMITS

The ABC output can be programmed not to exceed user-defined values. For example, the ABC 10-10DM, which has a maximum capacity of 10V, 10A, can be limited to 5.5V, 1A for working with circuitry that might be damaged by higher levels. Once the limits are set, the power supply becomes, in effect a 5.5V,1A supply and values exceeding the limit values will not be accepted. Refer to PAR. 3.3.11.

1.6.6 EXTERNAL TRIGGER/REMOTE ON-OFF PORT

The external trigger/Remote on off port provides two functions: One pin allows the unit to be triggered to return to previously stored settings using SCPI commands (see PAR. B.101). Another pin allows the output to be set to zero Volts, zero Amperes from a remote location using a single dedicated line (see PAR. 3.2).

1.7 EQUIPMENT SUPPLIED

The unit is shipped with a standard Power Cord, IEC to 115 VAC (USA),

1.8 ACCESSORIES

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

TABLE 1-4. ACCESSORIES

ITEM	FUNCTION	PART NUMBER
Rack Adapter	Accepts a single ABC power supply for installation in a 19-inch wide rack (see Figure 1-2).	RA 71
Rack Adapter	Accepts a two ABC power supplies for side by sided installation in a 19-inch wide rack (see Figure 1-3).	RA 72
IEEE 488 Cable, (1 meter long)	Connects ABC power supply to GPIB bus	SNC 488-1
IEEE 488 Cable, (2 meter long)	Connects ABC power supply to GPIB bus	SNC 488-2
IEEE 488 Cable, (4 meter long)	Connects ABC power supply to GPIB bus	SNC 488-4
Fuse	Circuit Protection (Replacement of Fuse A2FS1 is authorized by service personnel only.)	IEC TYPE T, 3.15A, 250V a-c
External Trigger mating connector (9mm 3-pin earphone jack)	Allows access to remote trigger and remote output on/off functions	142-0486 (Power Dynamics MDP-023)
RS 232 Cable Kit	Contains RJ 45 Patch cord, two RS 232 adapters, one with male pins to connect to DTE equipment and one with female pins to connect to a PC (personal computer,.and an RS 232 Loop Back test Connected to test RS 232 communication and aid in isolating RS 232 communication problems.	KIT 219-0436

1.9 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
	WARNING: 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.

1.10 RIPPLE/NOISE MEASUREMENT

To accurately verify that ABC Power Supply ripple and noise parameters are within the specification limits listed in Table 1-1, specialized test cables are required (not supplied). Figure 1-4 illustrates the requirements for two cables, one for ripple measurement and one for spike measurement.

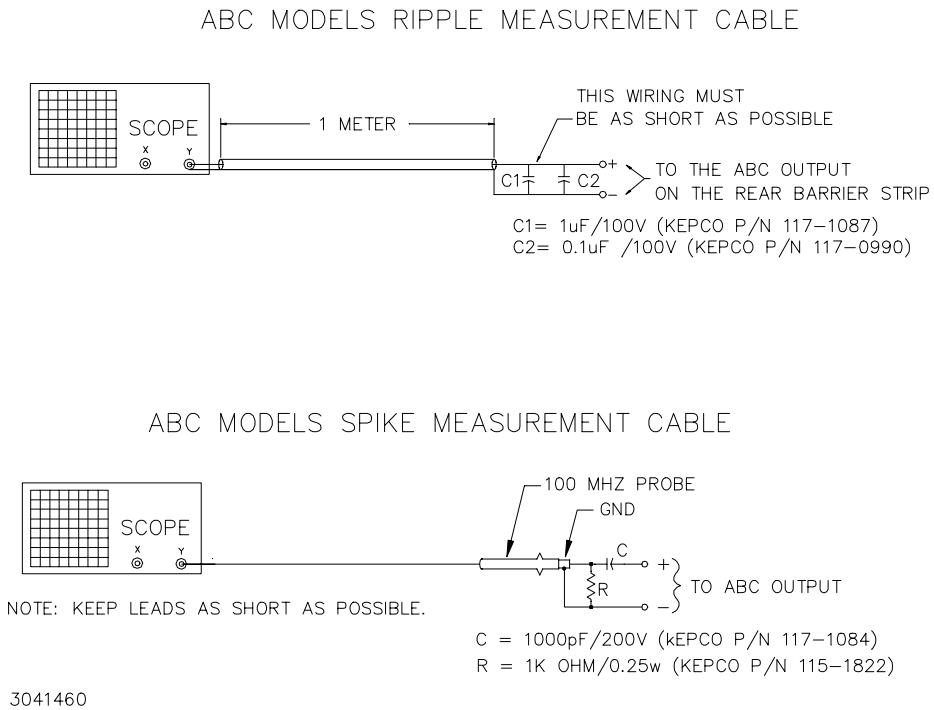


FIGURE 1-4. RIPPLE AND SPIKE MEASUREMENT CABLES

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

a) Front Panel: Refer to Figure 2-1 and Table 3-1.

b) Rear Panel: Refer to Figure 2-2 and Table 2-1.

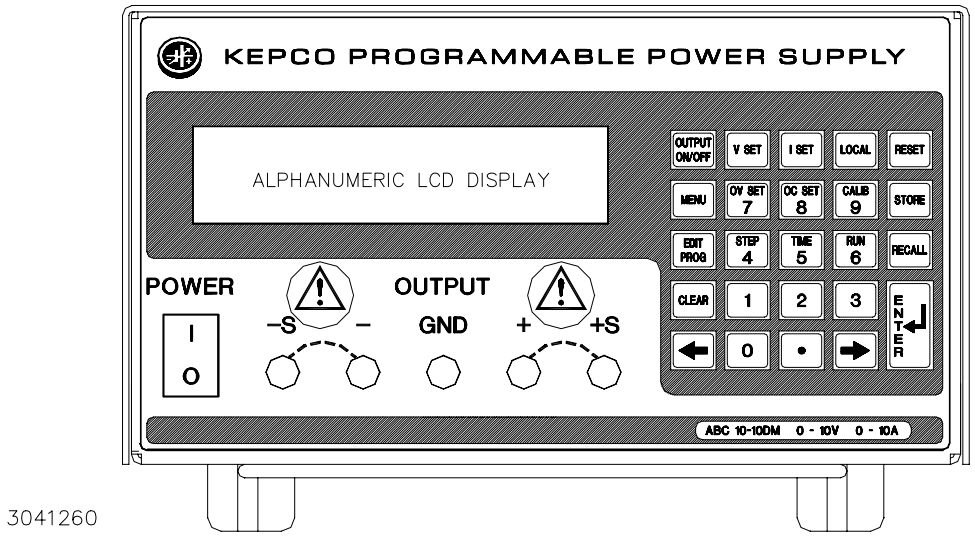


FIGURE 2-1. ABC SERIES FRONT PANEL

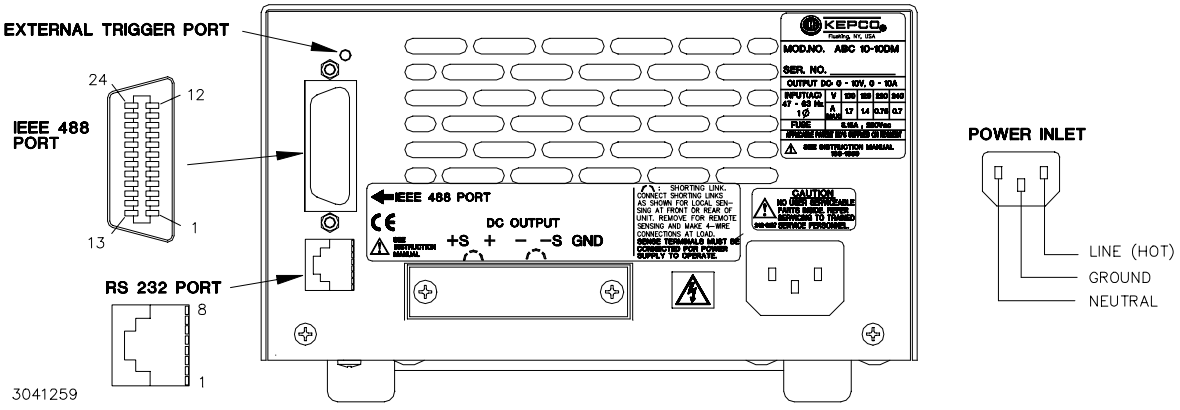


FIGURE 2-2. ABC SERIES REAR PANEL

TABLE 2-1. INPUT/OUTPUT PIN ASSIGNMENTS FOR IEEE 488 (GPIB) PORT

CONNECTOR	PIN	SIGNAL NAME	FUNCTION
IEEE 488 PORT (connector A1J1)	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 2-2. TRIGGER PORT PIN ASSIGNMENTS

CONNECTOR	PIN	SIGNAL NAME	FUNCTION
TRIGGER PORT (connector A1J2)	1	TRIGGER	Logic 0 triggers ABC to previously stored setting (see PAR. B.101.).
	2	EXT_OFF	Logic 0 causes ABC output to go to 0 Volts, 0 Amps (the same as pressing the OUTPUT ON/OFF key).
	3	Trigger- Shutdown RTN	Return for TRIGGER and SHUTDOWN signals.

TABLE 2-3. RS232C PORT INPUT/OUTPUT PIN ASSIGNMENTS

CONNECTOR	PIN	SIGNAL NAME	FUNCTION	Adapter Cable (P/N KIT 219-0436)	
				PIN	FUNCTION
RS 232 PORT (connector A1J5)	1	RTN	Return	1	Signal Ground
	2	Not Used	Not Used	2	Receive Data
	3	TXD	Transmit Data	3	Transmit Data
	4	RXD	Receive Data	4	Data Terminal Ready (protocol not used)
	5	RTN	Return	5	Signal Ground
	6	Not Used	Not Used	6	Data Set Ready (protocol not used)
	7	RTN	Return	7	Request To Send (protocol not used)
	8	RTN	Return	8	Clear To Send (protocol not used)
				9	Signal Ground

2.3 SOURCE POWER REQUIREMENTS

This power supply operates from single phase a-c mains power over the specified voltage and frequency ranges (Table 1-3) without any need for range selection.

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 convection. Periodic cleaning of the power supply interior is recommended. If the power supply is located 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 1-3).

2.5 PRELIMINARY OPERATIONAL CHECK

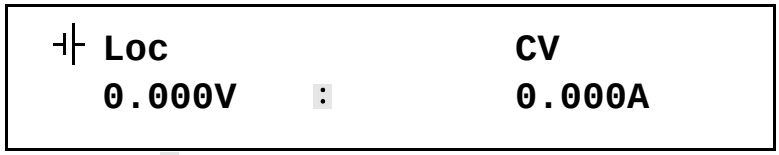
A simple operational check after unpacking and before equipment installation is advisable to ascertain whether the power supply has suffered damage resulting from shipping.

Refer to Figures 2-1 and 2-3 for location of operating controls and electrical connections. Tables 3-1 and 3-2 explain the functions of operating controls/indicators and keypad keys, respectively.

1. With POWER switch set to off position, connect the power supply to source power.

2. With no load connected, set POWER switch to the ON position. Each time the unit is turned on an internal self-test is performed. If the test is successful the indications of step 3 are visible.

3. The alphanumeric display (LCD) indicates the model and GPIB address. After approximately 2 seconds, the display changes to the power on default values: Local mode, Constant Voltage (CV) mode, 0.000V, 0.000A, output enabled, command entry status (see Figure 2-3). Overcurrent and Overvoltage protection are set to the maximum values (Table 1-2), but are not displayed.



NOTE: : indicates blinking colon (:), Command Entry status
= indicates blinking equal sign (=), Data Entry status

FIGURE 2-3. LCD POWER ON DEFAULTS

NOTE: Six keys with dual functions are labeled with both a command and a number. The command label is referred to when the unit is in : command entry status; the number is referred to when the unit is in = data entry status.

4. Press VSET key. Verify bottom line of LCD reads Vset = nn (where nn = voltage setting).

5. Connect a digital voltmeter (DVM) to the (+) and (–) terminals at either the front or rear panel.

6. Use number keys to enter rated maximum voltage (e.g. for ABC 25-4DM, 25V is the rated maximum voltage) and press ENTER. Output voltage will be displayed at bottom left of LCD.

7. Use → and ← keys as necessary to adjust output precisely to rated maximum voltage. Verify DVM voltage reading agrees with displayed voltage on LCD within 0.01% of rated maximum (see Table 1-3). If the LCD reads VsetMAX= (value), you are entering a value higher than the maximum voltage setting; see PAR. 3.3.11.

2.6 INSTALLATION

A bail located on the bottom of the unit can be utilized to raise the front of the unit about two inches for ease of accessing the front panel keypad and LCD display. For rack mounting, refer to Figures 1-2 and 1-3.

2.7 WIRING INSTRUCTIONS

Interconnections between an a-c power source and a 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. The ground terminal of the source power connector (Figure 2-2) is connected to the ABC chassis and 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 power input cable supplied. See Table 1-3 for source power specifications.

2.7.3 D-C OUTPUT GROUNDING

Connections between the power supply and the load and sensing connections may, despite all precautions such as shielding, twisting of wire pairs, etc., be influenced by radiated noise, or “noise 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, 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 output binding posts of ABC 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. Grounding a single point in the output circuit can be of great importance. 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 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 constantly modulated or step-programmed; has primarily reactive characteristics; or where the dynamic output response of the power supply is critical to load performance.

2.7.5 LOAD CONNECTION - GENERAL

Load connections to the ABC power supply are achieved via the (+) and (–) binding posts located on the front panel. A barrier strip is provided at the rear panel for connection to the load (system applications).

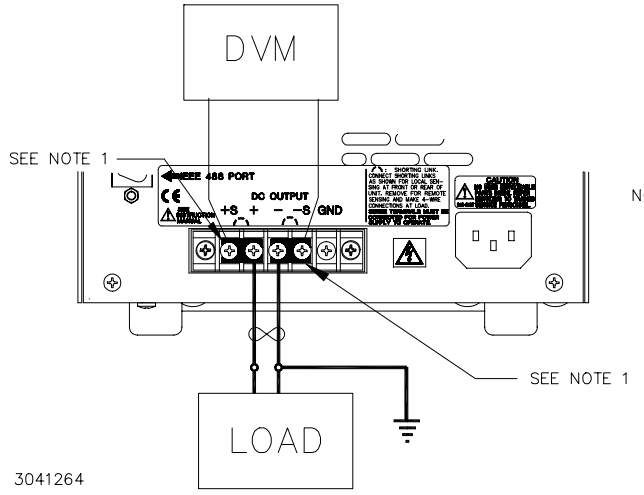
NOTE REGARDLESS OF OUTPUT CONFIGURATION, OUTPUT SENSE LINES MUST BE CONNECTED FOR OPERATION.

1. OBSERVE POLARITIES: The **OUTPUT +S** sensing wire must be connected to the **OUTPUT +** load wire, and the **OUTPUT –S** sensing wire must be connected to the **OUTPUT –** load wire.

2. IF LOCAL SENSING IS USED, INSTALL LINKS (see Figures 2-4 and 2-5). Links may be installed at either the front or rear terminals, but not both (installing links at both the front and rear will degrade power supply performance).

2.7.6 LOAD CONNECTION USING LOCAL SENSING

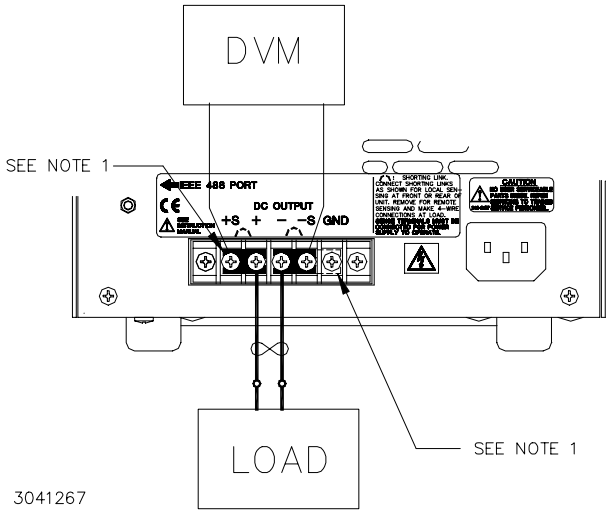
Figure 2-4 shows a typical configuration using local sensing and a grounded load; Figure 2-5 shows a typical configuration using local sensing with an isolated (“floating”) load.



NOTES: 1. USE LINKS (SUPPLIED) FOR CONNECTIONS BETWEEN (+S) AND (+) AND BETWEEN (–S) AND (–) FOR LOCAL SENSING.

2. CONNECTIONS MAY BE MADE AT EITHER FRONT OR REAR PANEL (SHOWN).

FIGURE 2-4. GROUNDED LOAD CONNECTIONS, LOCAL SENSING



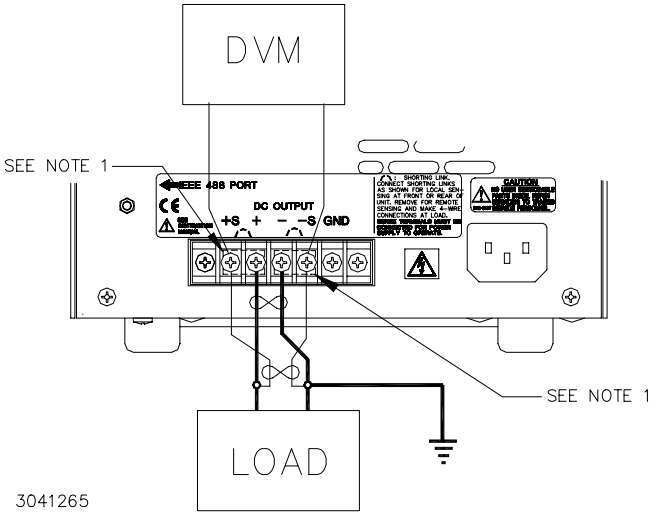
NOTES: 1. USE LINKS (SUPPLIED) FOR CONNECTIONS BETWEEN (+S) AND (+) AND BETWEEN (–S) AND (–) FOR LOCAL SENSING.

2. CONNECTIONS MAY BE MADE AT EITHER FRONT OR REAR PANEL (SHOWN).

FIGURE 2-5. ISOLATED LOAD CONNECTIONS, LOCAL SENSING

2.7.7 LOAD CONNECTION USING REMOTE SENSING

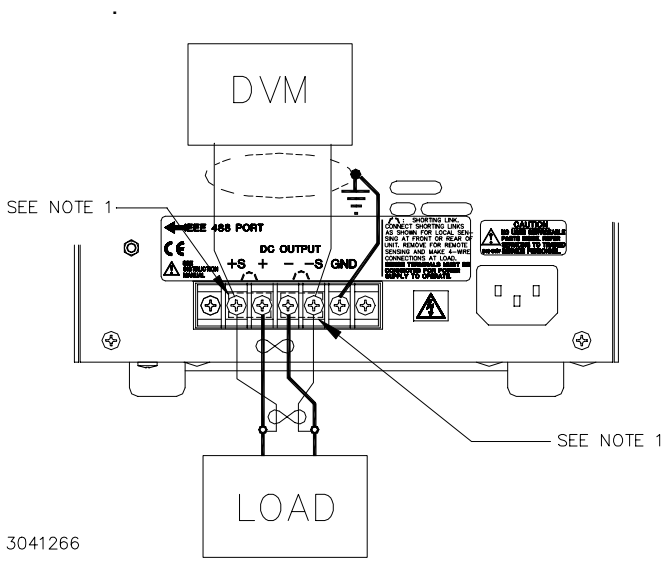
Figure 2-6 shows a typical configuration using remote sensing and a grounded load; Figure 2-7 shows a typical configuration using remote sensing with an isolated (“floating”) load.



NOTES: 1. LINK CONNECTIONS BETWEEN (+S) AND (+) AND BETWEEN (–S) AND (–) MUST BE REMOVED.

2. CONNECTIONS MAY BE MADE AT EITHER FRONT OR REAR PANEL (SHOWN).

FIGURE 2-6. GROUNDED LOAD CONNECTIONS, REMOTE SENSING



NOTES: 1. LINK CONNECTIONS BETWEEN (+S) AND (+) AND BETWEEN (–S) AND (–) MUST BE REMOVED.

2. CONNECTIONS MAY BE MADE AT EITHER FRONT OR REAR PANEL (SHOWN).

FIGURE 2-7. ISOLATED LOAD CONNECTIONS, REMOTE SENSING

2.8 OPERATING CONFIGURATION

The operating configuration can be determined by pressing MENU (with the unit in : command entry status) until the LCD reads ABC-XXXX yymmdd-nnn, Vz.z (XXXX indicates the model, e.g., for the ABC 125-1DM, top line reads 1251).The calibration date (yy = year, mm = month, dd = day) is followed by a 3-digit number (nnn), followed by the firmware version number (Vz.z).

SECTION 3 - OPERATION

3.1 GENERAL

This section explains how to operate the ABC Power Supply. The power supply can be operated either in Local mode using the front panel keypad and LCD, or in Remote mode using SCPI commands via the GPIB or RS 232 bus. Operation in remote mode can be simplified by the use of the VISA driver available for download at http://www.kepcopower.com/drivers.htm.

Local mode operation includes a description of the interaction between the LCD and the front panel keypad. Each key of the front panel is described, with a reference to a paragraph detailing the use of that key.

3.2 REMOTE ON/OFF

Regardless of whether the unit is in local or remote mode, the output can be set to off (0V, 0A) from a remote location by applying a logic 0 to pin 2 (0V0ASET signal) of the External Trigger port (see to Table 2-2).

3.3 LOCAL MODE OPERATION

Local operation of the ABC Power Supply is accomplished via the 24 key keypad on the front panel. All indications are provided by the 2-line LCD.

3.3.1 FRONT PANEL KEYPAD AND LCD (SEE FIGURE 2-1)

The front panel keypad is comprised of 24 key, 13 dedicated to command functions, 5 dedicated to data functions, and 6 keys that have both command and data functions When the power supply is in command entry status the command functions are effective; when the power supply is in data entry status the data functions are effective.

3.3.1.1 COMMAND ENTRY STATUS

Indicated by blinking colon (:) on bottom line of LCD; the power supply is waiting for a command to be entered; data will not be accepted (accompanied by brief audible buzz). The LCD indicates the actual voltage and current at the output terminals. When the output is disabled (LCD bottom line reads Output OFF), the power supply is in Command entry status even though the blinking colon is not visible.

NOTE: The blinking colon is indicated by : in this manual.

3.3.1.2 DATA ENTRY STATUS

Indicated by blinking equal sign (=) on bottom line of LCD; the power supply is waiting for data to be entered. A command will not be accepted (accompanied by brief audible buzz). Enter new value (the ← key erases data entered). Press ENTER to accept new setting, or CLEAR to exit without changing setting.

NOTE: The blinking equal sign is indicated by = in this manual.

3.3.1.3 DISPLAY (LCD)

The LCD is a 2-line display with a capacity of 16 characters per line. The information is generally arranged as follows (information that does not follow this format is self-explanatory).

- Top left: Loc/Rem/Rwl — Local/Remote/Keypad locked Status (See PAR. 3.3.3)
- Top right: CV/CC — Constant voltage mode/constant current mode
- Bottom left:
  - In command entry: n.nnnV — Output voltage
  - In data entry: (parameter) — e.g. OVset if OV SET key was pressed.
- Bottom middle: : — Command entry status
  = — Data entry status
- Bottom right:
  - In command entry: n.nnnA — Output current
  - In data entry: n.nnn — Present value of parameter, replaced by data entered

3.3.1.4 KEYPAD FUNCTIONS

Keypad functions are listed in Table 3-1. Six keys have dual functions, depending on whether the power supply is in command entry status (waiting for a command to be entered), or data entry status (waiting for a number to be entered). Command entry status is indicted by a blinking colon : and data entry status is indicated by a blinking equal sign =.

NOTE: Keys with dual functions are labeled with both a command and a number. The command label is referred to when the unit is in : command entry status; the number is referred to when the unit is in = data entry status.

TABLE 3-1. KEY FUNCTIONS

KEY	POWER SUPPLY STATUS ACTIVE	DESCRIPTION	REFERENCE PARAGRAPH
OUTPUT ON/OFF	**Command Entry**	If bottom line of LCD reads Output OFF, press to enable the output. If output is on (voltage and current measurements displayed on bottom line of LCD), press to disable the output.	3.3.6
V SET	**Command Entry**	Press to set output voltage. After V SET is pressed, previous setting is displayed. Data entry required to enter new value of output voltage; press ENTER to accept displayed value.	3.3.8
I SET	**Command Entry**	Press to set output current. After I SET is pressed, previous setting is displayed. Data entry required to enter new value of output current; press ENTER to accept displayed value.	3.3.8
LOCAL	**Command Entry**	If the power supply is in remote mode, keypad is disabled except for LOCAL key. Press to enable keypad. If LCD reads KEYPAD LOCKED, The LOCAL key is disabled and can only be unlocked by remote operation.	3.3.3

TABLE 3-1. KEY FUNCTIONS (CONTINUED)

KEY	POWER SUPPLY STATUS ACTIVE	DESCRIPTION	REFERENCE PARAGRAPH
RESET	**Command Entry**	Press to restore the power on default values: CV mode, output voltage = 0, output current = minimum (1-2% of I_{Omax}), output enabled, overvoltage and overcurrent values per Table 1-2. Also resets overvoltage or overcurrent condition.	3.3.7
MENU	**Command Entry**	Press to enter Menu commands: press repeatedly to scroll through Menu functions: (1) set LCD contrast, (2) GPIB address, (3) Baud rate, (4) Loop back test, (5) DCL Control, (6) Power-Up Digital DC Output on/off, (7) Speaker on/off, (8) Calibration password, (9) previous calibration values, (10) factory calibration values, (11) view firmware serial number, (12) set maximum voltage, (13) set maximum current, (14) protection delay. Press ENTER or RESET to exit Menu.	(1) 3.3.4, (2) 3.5.2, (3) 3.6.1, (4) 3.6.4, (5) 3.4.1, (6) 3.3.6.1 (7) 3.3.5, (8) 4.4, (9) 4.5, (10) 4.6 (11) 2.8, (12, 13) 3.3.11 (14) 3.3.10,
OV SET 7	**Command Entry**	Press to set overvoltage protection value. Data entry required to enter the overvoltage protection value; press ENTER to accept displayed value.	3.3.9
	Data Entry	Press to enter number 7.	3.3.1.2
OC SET 8	**Command Entry**	Press to set overcurrent protection value. Data entry required to enter new overcurrent protection value; press ENTER to accept displayed value.	3.3.9
	Data Entry	Press to enter number 8.	3.3.1.2
CALIB 9	**Command Entry**	Press to enter Calibration status. Requires password entry; instructions appear on LCD.	4.3
	Data Entry	Press to enter number 9.	3.3.1.2
STORE	**Command Entry**	Press to store present values of output voltage and current and overvoltage and overcurrent protection. Data entry required to select memory location where values are to be stored	3.3.12
EDIT PROG	**Command Entry**	Press to select the starting memory location to be edited. Then use ← or → to view or modify the parameters of a specific memory location or to create a new program.	3.3.14.1
STEP 4	**Command Entry**	Press to select starting address of program to be executed one step at a time.	3.3.14.3
	Data Entry	Press to enter number 4.	3.3.1.2
TIME 5	**Command Entry**	Press to edit time value for specific memory location. Select memory location (data entry), then enter time value, 0.01 to 300 seconds (data entry).	3.3.14.1
	Data Entry	Press to enter number 5.	3.3.1.2
RUN 6	**Command Entry**	Press to run a program. Requires data entry to select starting location. Press ENTER to accept displayed value.	3.3.14.2
	Data Entry	Press to enter number 6.	3.3.1.2
RECALL	**Command Entry**	Press to recall previously stored values of output voltage and current, and overvoltage and overcurrent protection. Data entry required to select memory location containing values to be recalled; press ENTER to accept displayed value.	3.3.13
CLEAR	**Data Entry**	Press to exit Data Entry status; any numbers entered are lost. Restores Command Entry status	3.3.8
1	**Data Entry**	Press to enter number 1.	3.3.1.2

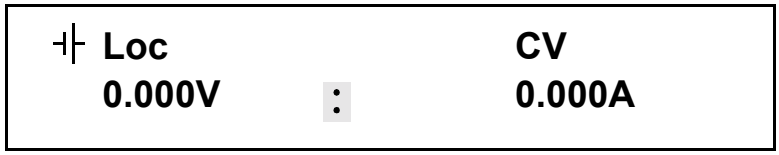
TABLE 3-1. KEY FUNCTIONS (CONTINUED)

KEY	POWER SUPPLY STATUS ACTIVE	DESCRIPTION	REFERENCE PARAGRAPH
2	**Data Entry**	Press to enter number 2.	3.3.1.2
3	**Data Entry**	Press to enter number 3.	3.3.1.2
ENTER	**Data Entry**	Press to accept data entered and return to Command Entry status.	3.3.8
←	**Command Entry**	— In CV (constant voltage), press to decrease output voltage by increment equal to voltage resolution (≤.0.025% of $E_O$max). — In CC (constant current), press to decrease output current by increment equal to current resolution (≤.0.025% of $I_O$max). — In EDIT PROG status, changes the parameter displayed on LCD for a specific memory location and decrements memory location displayed on LCD.	3.3.8, 3.3.14.1
	Data Entry	Erases number to left, or decreases value shown (e.g. Display Contrast setting).	3.3.8
0	**Data Entry**	Press to enter number 0.	3.3.1.2
(.)	**Data Entry**	Press to enter decimal point	3.3.1.2
→	**Command Entry**	— In CV (constant voltage), press to increase output voltage by increment equal to voltage resolution (≤.0.025% of $E_O$max). — In CC (constant current), press to increase output current by increment equal to current resolution (≤.0.025% of $I_O$max). — In EDIT PROG status, changes the parameter displayed on LCD for a specific memory location and increments memory location displayed on LCD	3.3.8, 3.3.14.1
	Data Entry	Not used.	—

3.3.2 TURNING THE POWER SUPPLY ON

When the power supply is turned on, it performs a self-test and displays the status in the LCD. After completing the self-test the LCD first shows the power supply type, e.g., Kepco **ABC10-10 GPIB addr. = nn**, where nn is the GPIB address (factory default GPIB address = 6).The LCD then shows the power on defaults (see Figure 3-1). The defaults are: output enabled, voltage mode, output voltage set to zero, output current set to a minimum value (1-2% of I_O max). Power on defaults also include setting maximum values for overcurrent and overvoltage protection indicated in Table 1-2.

NOTE: The power supply can be programmed to power up with output set to OFF. See PAR. 3.3.6.1.



NOTE: : indicates blinking colon (:), Command Entry status
= indicates blinking equal sign (=), Data Entry status

FIGURE 3-1. LCD POWER ON DEFAULTS

Depressing any key on the keypad during the power up sequence will cause the power supply to enter the keypad test. To return to normal operation, follow the prompts, depressing keypad keys as indicated on the LCD.

3.3.3 SETTING LOCAL MODE

When the power supply is turned on, it is automatically set to Local mode. If remote commands are accepted over the GPIB bus, the power supply will automatically go into Remote mode (**Rem** at the upper left of the LCD). Pressing the **LOCAL** key will restore Local mode. When in Remote mode, all keys except **LOCAL** are disabled.

The ABC incorporates a "keypad lockout" command which allows the **LOCAL** key to be disabled during remote operation, preventing inadvertent setting of the power supply to Local mode. When the keypad is locked, the LCD displays **Rwl** in place of **LOC**. If the keypad is locked, it must be unlocked either by a remote command (see Appendix B, PAR. B.91), or cycling the power supply off then on.

3.3.4 ADJUSTING LCD CONTRAST

With the power supply in command entry status **:**, press **MENU** key until LCD displays **CONTRAST**. Press → or ← key to increase or decrease contrast for optimum viewing. The contrast can also be set directly by entering a number from **1** to **9**. Press **ENTER** or **CLEAR** to exit menu.

3.3.5 ENABLING/DISABLING AUDIBLE BEEPS

With the power supply in command entry status **:**, press **MENU** until LCD displays **SPEAKER**. The top line indicates if the speaker is on or off (the factory default setting is speaker on). Enter **1** to enable the speaker, or **0** to disable the speaker. Press **ENTER** or **CLEAR** to exit menu.

3.3.6 ENABLING/DISABLING DC OUTPUT POWER

When the power supply is turned on, the output is automatically enabled, and the bottom line of the LCD gives voltage and current measurements at the output. To disable the output, press the red **OUTPUT ON/OFF** key; the lower line of the LCD reads: **Output OFF**. When the output is disabled, voltage and current are programmed to zero; the power supply remains in Command Entry status. Pressing the **OUTPUT ON/OFF** key again enables the output: the previously programmed values of voltage and current are restored and the LCD displays the mode (CV or CC) and actual values of output voltage and current.

3.3.6.1 POWER UP DIGITAL DC OUTPUT CONTROL

The output of the power supply can be programmed to be either enabled or disabled upon power-up. With the power supply in command entry status **(:_:_:)**, press the **MENU** key until LCD displays **Dig Off @Pwr-Up**. The top line indicates whether the Digital DC Output will be on (enabled) or off (disabled) upon power-up. Press 1 to enable the Digital DC Output upon power up. This sets the output to zero volt and current to the Power-up value. Press 0 to disable the output upon power up. Press **CLEAR** or **RESET** to exit menu and return to command entry status.

3.3.7 RESET

RESET overrides all other local commands to reset the power supply to the power on defaults: output enabled, voltage mode, output voltage set to zero, output current set to a minimum value

(1-2% of I_O max), overcurrent and overvoltage protection set to the maximum values per Table 1-2. The power supply remains in command entry status.

3.3.8 SETTING OUTPUT VOLTAGE OR CURRENT

V SET and **I SET** set output voltage and current limit, respectively, when the unit is in constant voltage (CV) mode and set 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 or equal to the **I SET** value, the unit operates in CV mode (voltage programmed to **V SET** value, current limited by **I SET** value). If the load changes to the point that current through the load reaches the **I SET** value, the unit automatically enters CC mode (current programmed to **I SET** value, voltage limited by **V SET** value).

With the power supply in command entry status :, press **V SET** (voltage) or **I SET** (current) key to put the power supply in data entry status =. The lower right side of the LCD shows the programmed setting in effect when the key is pressed. Press **ENTER** or **CLEAR** to exit without changing setting. Enter new value (the ← key erases data just entered) and press ENTER to accept new setting or CLEAR to exit without changing setting.

With the power supply in command entry status :, an alternative is to use → (increase) or ← key (decrease) to change the output by the minimum increment (≤0.025% of $E_O$max for voltage, ≤0.025% of $I_O$max for current). In CC mode, these keys control output current; in CV mode they control output voltage. The → and ← keys have no effect after the maximum (or programmed limit) has been reached.

If the value entered exceeds the maximum setting, the LCD bottom line flashes **VsetMAX=nn V** or **IsetMAX=n.n A** where n.n is the maximum setting (see PAR.3.3.11). The unit returns to = waiting for a value that does not exceed the maximum.

3.3.8.1 PROGRAMMING TECHNIQUES TO OPTIMIZE POWER SUPPLY PERFORMANCE

Kepco's auto-crossover digital supplies can operate in either voltage mode with current limit, or current mode with voltage limit. The operating mode is determined by the voltage and current commands received, as well as the load.

Proper programming techniques can offer significant response time improvement and reduce undesirable transients at the power supply output. The key to performance optimization is to minimize mode changes (voltage mode/current limit to current mode/voltage limit or vice versa). Mode changes should be limited to changes in load conditions (to which the power supply will respond automatically), or by programming the limit parameter when required by the user application.

Each time voltage and current commands are received, the unit must evaluate the commands and the load conditions to determine the proper operating mode. Reducing the number of times this evaluation must be made is desirable because Kepco's digital auto-crossover supplies employ two separate feedback loops. Each time there is a potential mode change, there is always an uncontrolled period of a few milliseconds while the two feedback loops compete for control of the output. In addition to increasing the time before the output reflects the programmed command, undesirable transients may also be present at the output during this period. By sending only the operating command, there is no doubt as to what the operating mode will be, so the unit is never uncontrolled, response is quick, and no transients are possible.

The proper way to program the power supply is to initially program the operating parameter to zero and the complementary limit parameter to the desired maximum value. Subsequent commands should change only the operating parameter. (The operating parameter is the parameter that controls the output, e.g., voltage controls the output in voltage mode, current in current mode.) The complementary limit parameter should be programmed only when there is a need to change it.

3.3.9 SETTING OVERVOLTAGE OR OVERCURRENT PROTECTION

With the power supply in command entry status **:**, press **OV SET** (overvoltage) or **OC SET** (overcurrent) to put the power supply in data entry status **=**. The lower right side of the LCD shows the programmed setting in effect when the key is pressed. Press **ENTER** or **CLEAR** to exit without changing setting. Enter new value and press **ENTER** to accept new setting (the ← key erases data just entered), or **CLEAR** to exit without changing setting. To recover from overvoltage or overcurrent condition, press **RESET**; this restores the power on defaults (see PAR. 3.3.7).

3.3.10 CHANGING PROTECTION DELAY

The overvoltage and overcurrent protection normally trips immediately upon detection of an overvoltage/overcurrent condition. However, changing output settings (particularly with reactive loads) large transients can cause inadvertent tripping of the protection. For this reason, tripping of the overvoltage/overcurrent protection can be delayed approximately 8 seconds after the output is changed.

With the power supply in command entry status **:**, press **MENU** until LCD displays **`Prot. Delay Count = nn`** where nn is the active setting. A count of 0 means no delay, a count of 255 (highest value) means approximately 8 seconds delay (a count of 30 provides a delay of 1 second).

3.3.11 CHANGING MAXIMUM VOLTAGE OR CURRENT VALUE

The maximum values of voltage and current are determined by the model, e.g., 25V and 4A for the ABC 25-4DM. These values can be lowered by the user, e.g., to prevent inadvertent damage to a specific circuit under test. Changing the maximum values of the ABC 25-4DM to 10V and 1A, effectively makes the unit a 10V 1A power supply.

With the power supply in command entry status **:**, press **MENU** key until LCD reads **`New MAXIMUM Vset`** (or **`Iset) = nn`** where nn is the maximum value setting to be changed. Press **ENTER** or **CLEAR** to exit menu without changing setting. Press number keys to enter new value and press **ENTER**. Press **ENTER** again to exit the menu and return to command status **:**.

If a value is entered that is higher than the rated maximum for the power supply, the bottom line of the LCD flashes **`Vset`** or **`Iset MAX = nn`** where nn is the rated maximum of the power supply. The unit remains in data entry status **=** waiting for a value equal to or less than the rated maximum. Press **CLEAR** to exit without changing the value.

Once the maximum value has been changed, if a value higher than the new maximum is attempted to be programmed, the LCD flashes **`Vset`** (or **`Iset`**) **`MAX = nn`** where nn is the programmed maximum.

NOTE: If the programmed output value is higher than the new maximum value established with the **MENU** key, the output will be limited to the new maximum value.

3.3.12 STORING POWER SUPPLY OUTPUT SETTINGS

The programmed settings of voltage, current, overvoltage protection and overcurrent protection can be stored in one of the 40 memory locations available for local programming (see PAR. 3.3.14).

With the power supply in command entry status **:**, press **STORE** key. The LCD reads **STORE mem = nn** where nn is the memory location where the settings are to be stored. Press **ENTER** or **CLEAR** to exit without changing setting. Enter memory location (from 1 to 40) and press **ENTER**. The programmed voltage, current, overvoltage protection and overcurrent protection settings in effect when **ENTER** is pressed are stored in the selected memory location. To recall stored settings, see PAR. 3.3.13

3.3.13 RECALLING STORED OUTPUT SETTINGS

With the power supply in command entry status **:**, press **RECALL**. The LCD reads **RECALL mem = nn** where nn is the memory location holding the settings to be retrieved. Press **ENTER** or **CLEAR** to exit without changing setting. Enter memory location (from 1 to 40) and press **ENTER**. The stored settings for voltage, current, overvoltage protection and overcurrent protection replace the **current** values, and the unit returns to **:** command entry status.

3.3.14 LOCAL MODE PROGRAMMING OF THE POWER SUPPLY.

Local mode programming offers the user 40 memory locations that can be used to program the power supply. Each location defines values for output voltage, output current, overcurrent protection, overvoltage protection, time duration (between 0.1 and 300 seconds) for the programmed settings, and the address of the next memory location in the program.

NOTE: 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.

3.3.14.1 CREATING OR MODIFYING A PROGRAM (PROGRAM EDIT MODE)

Creating a program and modifying an existing program are identical except that a program modification requires only selected parameters to be changed rather than all new parameter values. With the power supply in command entry status **:**, press **EDIT PROG** key. The top line indicates the **STARTaddr.= nn**, where nn is one of 40 memory location. To select a different address, enter new value and press **ENTER.**

The top line of the LCD indicates the active memory location, e.g. **ViewVAL Mem <n>** where n is the memory location previously chosen. The bottom line of the LCD indicates the parameter on the left (**Iset**, **Vset**, **OVset**, **OCset**, **TIMEval**, **NEXT STEP**), the parameter's value on the right, and data entry status **=** in the middle. To modify time values see PAR.3.3.14.1.1.

Press ENTER to accept displayed value, or enter new value and press **ENTER** to accept new setting (the LCD displays the next parameter). Press **CLEAR** to exit Program Edit mode without changing value. Use → or ← key to scroll forward (or backward) to view next (or previous) parameter or memory location. For a program to run once, then stop, see PAR. 3.3.14.6; to cycle a program continuously, see 3.3.14.4. After all program values have been set, press **CLEAR** or **ENTER** to exit Program Edit mode. Setting up a program can be made easier by copying the Memory Location Worksheet (Table 3-3) and filling in the values before programming the power supply.

3.3.14.1.1 MODIFYING PROGRAMMED TIME INTERVAL

The **TIME** key offers a quick and easy way to change the time for any memory location. With the power supply in command entry status :, press **TIME** key. The unit displays **TIME @ mem = 01** indicating the current step to be changed. To change a different step, enter the step number using the numeric keys. To proceed, depress ENTER. The LCD displays **TIMEval = nn** where nn is the time value set for the selected location. Press ENTER to accept displayed value, or enter new value (between 0.01 and 300 seconds) and press **ENTER to accept new value or press CLEAR to exit without changing value**. The unit returns to command entry status :. The accuracy of the time interval is +5% (specified time interval may be exceeded by a maximum of 5%).

3.3.14.2 RUNNING A PROGRAM

With the power supply in command entry status :, press **RUN** key. The LCD bottom line indicates the start address of the program. Press ENTER key to run the program starting with that address. To change the starting address, enter new value and press **ENTER** to run the program. Press **CLEAR** to exit without running the program

3.3.14.3 STEPPING THROUGH A PROGRAM

The STEP function is useful for examining a program that has just been created or edited before running in real-time. With the power supply in command entry status :, press **STEP** key. The LCD bottom line indicates the start address of the program; press ENTER to begin stepping at that address. To change the starting address, enter new value and press **ENTER** to begin stepping at the new address, press **CLEAR** to exit without stepping through the program.

The LCD top line shows **LOC** to indicate local mode, **aa→bb** where aa is the memory location just executed, bb is the NEXT STEP location, and shows **CV** (constant voltage) or **CC** (constant current) to indicate the actual operating mode. The LCD bottom line shows the output voltage and current measurements for the location just executed, and : indicates command status. Press **STEP** to execute location bb. The LCD will again display the location just executed, voltage and current measurements, and the NEXT STEP location. Continue to press **STEP** to execute the program one step at a time, or press **CLEAR** to exit Step function.

3.3.14.4 CYCLING A PROGRAM

To cycle a program, modify the program (see PAR. 3.3.14.1) and go to the last memory location to be executed and set the NEXT STEP address to the Starting address, causing the program to loop and repeat indefinitely. For example, if the last location is 14, and the starting location is 05, press **EDIT PROG**, enter **14**, then press **ENTER**. Press → until LCD reads **ViewVAL Mem14 NEXT STEP =**. Enter **5** and press **ENTER**. When the program runs, it will start at location 05, continue to 14, then loop back to the location 05, and repeat indefinitely.

3.3.14.5 RUNNING A PROGRAM ONCE

To set up a program to stop after running once, modify the program (see PAR. 3.3.14.1) and go to the last memory location to be executed and set the NEXT STEP address to 0. For example, with the power supply in command entry status :, press **EDIT PROG**. Enter the last memory location you want executed (e.g. 14), then press **ENTER**. Press → key until LCD reads **ViewVAL Mem14 NEXT STEP =**. Enter 0 and press **ENTER**. The program will now stop after memory location 14 is executed. When the program stops, the power supply will continue to provide the output specified by the last location (in the above example, location 14).

TABLE 3-2. MEMORY LOCATION WORKSHEET

MEMORY LOCATION	I SET (Current) (A)	V SET (Voltage) (V)	OCset (Overcurrent Protection) (A)	OV set (Overvoltage Protection) (V)	TIMEval (0. to 300 Sec) (Sec)	NEXT STEP (Next location to execute)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						

3.3.14.6 STOPPING A PROGRAM

To set up a program to stop after running once, set the NEXT STEP address of the last memory location to be executed to 0. For example, with the power supply in command entry status :, press **EDIT PROG**. Enter the last memory location you want executed (e.g. 14), then press **ENTER**. Press → key until LCD reads **ViewVAL Mem14 NEXT STEP =**. Enter 0 and press **ENTER**. The program will now stop after memory location 14 is executed.

3.3.14.7 STOPPING A RUNNING PROGRAM

There are three ways to stop a program that is running:

- Press CLEAR key: the program immediately stops at the step (location) that was being executed when the key was pressed. The power supply output remains at the values specified by that step.

- Press RESET key: The program stops and power on defaults are restored (see PAR. 3.3.7).

- Press OUTPUT ON/OFF key: the output is disabled (programmed to zero) and the program immediately stops at the step (location) that was being executed when the key was pressed. Pressing the OUTPUT ON/OFF key again restores the output to the values specified by the step in effect when the program was stopped.

3.3.14.8 SAMPLE PROGRAM

Table 3-3 shows a sample program designed to cycle continuously; if the NEXT STEP value for location 3 is set to 00, the program will run once and stop.

TABLE 3-3. SAMPLE PROGRAM (MODEL ABC 10-10DM)

MEMORY LOCATION	I SET (Current) (A)	V SET (Voltage) (V)	OCset (Overcurrent Protection) (A)	OV set (Overvoltage Protection) (V)	TIMEval (0. to 300) (Sec)	NEXT STEP (Next location to execute)
1	**2.1**	**4.3**	**11**	**11**	**1.5**	**02**
2	**1.2**	**5.0**	**1.3**	**6.4**	**1.8**	**03**
3	**4.5**	**6.2**	**4.8**	**6.4**	**1.0**	**01**

3.3.15 CALIBRATION

See Section 4.

3.4 REMOTE MODE PROGRAMMING

ABC 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; refer to Table 2-1 for input/output signal allocations and PAR. 3.5 for a description of GPIB Operation) or the RS 232 serial bus (refer to Table 2-3 for input/output signal allocations and PAR. 3.6 for a description of RS 232 operation). Most power supply functions available from the keypad can be programmed via remote commands, in addition to some that are not available from the keypad (e.g. trigger-

ing, and local lockout). Refer to PAR. 3.7 for a detailed explanation of SCPI programming, and to Appendix A and B for detailed explanations of IEEE 488 and SCPI commands, respectively.

3.4.1 DCL CONTROL

The device clear and selected device clear can be set to operate in two modes. In the “output = 0V” mode, when the device clear (DCL) is received, the output of the power supply is set to zero volts. In the “output unchanged” mode sending DCL or selected DCL has no effect on output voltage and current as required by IEEE specification 488.2; it only clears the GPIB programming registers. The factory default value is “output unchanged” mode. NOTE: When set to “output = 0V” mode, the power supply will power up with OUTPUT set to OFF.

To change the DCL mode the unit must be in command entry mode **:**, then depress the **MENU** key until the LCD shows the current setting: either **DCL sets OUTP=0V** or **DCL = OUTP UNCHNG**. The bottom line of the display reads **depress 1 to toggle**. Depressing 1 toggles the DCL mode and updates the displayed message. Depressing the **RESET** key leaves the mode unchanged. Depressing **0**, **ENTER**, or **MENU** updates the DCL mode and displays the next selection.

3.5 IEEE 488 (GPIB) BUS OPERATION

This section includes a discussion of GPIB bus protocols (PAR. 3.5.1), instructions for changing the GPIB address (PAR. 3.5.2), and a discussion of the VISA (Virtual Instrumentation Software Architecture) driver (PAR. 3.5.3). Refer to PAR 3.3.8.1 for programming techniques to optimize power supply performance. Refer to PAR. 3.7 for a detailed explanation of SCPI programming, and to Appendix A and B for detailed explanations of IEEE 488 and SCPI commands, respectively

3.5.1 IEEE 488 (GPIB) BUS PROTOCOL

Table 3-4 defines the interface capabilities of the ABC 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 3-5 and 3-6 define the messages sent to the ABC, or received by the ABC, 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 ABC power supply operating as either a Talker or a Listener.

3.5.2 CHANGING THE GPIB ADDRESS

When the power supply is in local mode, command entry status **:**, press **MENU** until the LCD displays **GPIB addr. = nn** where nn indicates the current GPIB address. Enter new value and press **ENTER** to accept new setting, or **CLEAR** to exit without changing setting.

TABLE 3-4. 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 ABC 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.91) so that only the controller or a power on condition can restore Local mode.
Parallel Poll	PP0	No Capability
Device Clear	DC1	Complete Capability. ABC accepts DCL (Device Clear) and SDC (Selected Device Clear).
Device Trigger	DT1	Respond to *TRG and <GET> trigger functions.
Controller	C0	No Capability

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

MNEMONIC	MESSAGE DESCRIPTION	COMMENTS
ATN	Attention	Received
DAC	Data accepted	Received or Sent
DAV	Data Valid	Received or Sent
DCL	Device Clear	Received (see PAR. 3.4.1)
IFC	Interface Clear	Received
MLA	My Listen Address	Received
MTA	My Talk Address	Received
OTA	Other Talk Address	Received
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 3-6. 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

3.5.3 ABC 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, 2) a complete programming reference manual and 3) a sample application of the VISA functions (written in C) which can be used to program one or more ABC 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 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).

3.6 RS232-C OPERATION

The ABC 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
- Parity: None
- Data Bits 8
- Stop Bits 1
- Echo ON
- XON OFF

Baud rate may be changed from the front panel (see PAR. 3.6.1); changing other RS 232 parameters is accomplished using SCPI commands (see Appendix B). To change baud rate refer to PAR's. B.80 and B.81. To select prompt refer to PAR's. B.86 and B.87. To select echo refer to PAR's. B.82 and B.83. To select XON/XOFF, refer to PAR's. B.84 and B.85.

3.6.1 SETTING RS 232 BAUD RATE

When the power supply is in local mode, command entry status :, press **MENU** key until LCD displays **BAUD RATE =**. The top line of the LCD indicates the current RS 232 baud rate (default = 19200). Use → and ← keys to scroll through the available baud rate settings (19200, 9600, 4800 or 2400). Press **ENTER** to accept new setting (new baud rate is effective immediately), or **CLEAR** to exit without changing setting.

3.6.2 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 ABC 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 ABC.
Line Feed ($0A_H$)	Causes the input buffer to be parsed by the ABC.
> 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.

3.6.3 RS 232 IMPLEMENTATION

The following paragraphs are provided to help the user understand how the RS 232 serial interface is implemented in the ABC. 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 ABC power supply, thus avoiding a more complex “handshake” protocol.

When the ABC is in the RS 232 echo mode it returns all data sent to the host controller. The ABC 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 ABC. As shown in Figure 3-2, there are times when the ABC 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 3-2 illustrates the default echo mode, the prompt method and the XON XOFF method described in the following paragraphs.

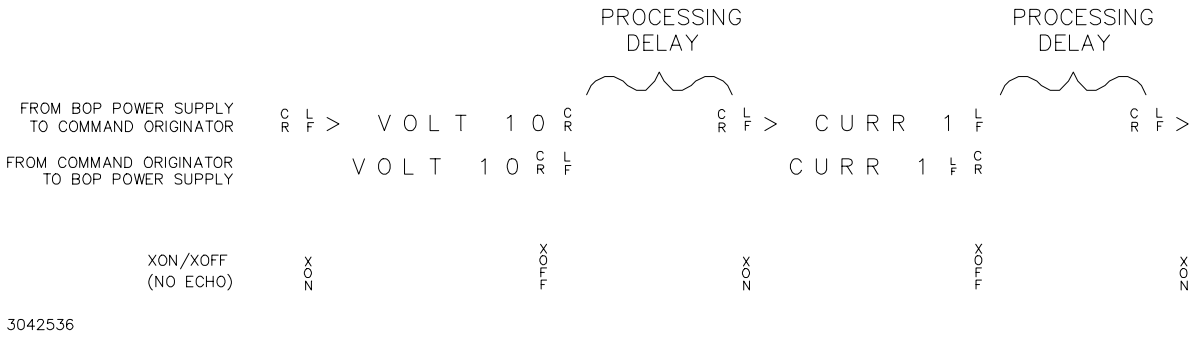


FIGURE 3-2. RS 232 IMPLEMENTATION

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 ABC by the command originator. When the line is parsed and the commands are sent to the analog processor, the ABC sends the line terminator sequence CR LF to the command originator.

The ESC character is used for synchronization, causing the ABC 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 3-2).

3.6.3.1 ECHO MODE

In echo mode each byte (character) is echoed back to the sender where it is verified as the same character that was just sent.

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 3-2).

3.6.3.2 PROMPT METHOD

The command originator sends a message line (command) to the ABC and waits until the prompt sequence CR LF > ($3E_H$, 62_{10}) is received. The ABC 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.

3.6.3.3 XON XOFF METHOD

The XON XOFF method allows the ABC 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.

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 ABC returns the normal sequence of CR LF (if echo mode is enabled).

3.6.4 ISOLATING RS 232 COMMUNICATION PROBLEMS

A Loop Back test can be run from the front panel to aid in isolating RS 232 communication problems. The unit is designed to pass the test only with the Loop Back test connector (part of Kit 219-0436, see Table 1-4) installed.

1. With the power supply in local mode, command entry status **:**, press **MENU** key until LCD reads **LOOP BACK TEST UNTESTED 1=RUN**.

2. Press the **1** key to run the test with the Loop Back Test connector NOT installed and very the LCD reads **FAILED**. If the LCD reads **PASSED**, the power supply is defective and requires repair.

3. Install the loop back test connector into RS 232 port and press the **1** key to rerun the test. If the LCD reads **PASSED**, the power supply is operating properly. If the LCD reads **FAILED**, the unit 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 from the power supply RS 232 port and connect the cable in its place. With the DB9 adapter installed on the opposite end of the cable, connect a short jumper wire between pins 2 and 3 of the adapter connector and repeat the test of (3) above. If the LCD display reads **FAILED**, the cord is either the improper type (not null modem) or is defective. If the LCD display reads **PASSED**, the cable is correct; remove the jumper and reconnect the cable to the computer.

   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.

3.7 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 ABC 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 RS 232 or IEEE 488 (GPIB) 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.3.5.2 to establish the ABC Power Supply GPIB address.)

3.7.1 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.

3.7.2 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 (see Table A-1). Refer also to syntax considerations (PARs 3.7.3 through 3.7.6).

3.7.3 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 ABC 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.

3.7.3.1 ABORT SUBSYSTEM

This subsystem allows pending trigger levels to be cancelled.

3.7.3.2 DISPLAY SUBSYSTEM

This subsystem controls the second line of the LCD. The first line will always display the LOCal or REMote operation status and the constant Voltage (CV) or constant Current functioning mode (CC).

3.7.3.3 INITIATE SUBSYSTEM

This subsystem enables the trigger system. When a trigger is enabled, the triggering action will occur upon receipt of a GPIB <GET>, *TRG or TRIGger command. If a trigger circuit is not enabled, all trigger commands are ignored.

3.7.3.4 LIST SUBSYSTEM

The LIST subsystem is represented by the 40 memory locations (groups of settings) which are stored in the nonvolatile memory. Each setting contains values for: Current, Voltage, Overcurrent, Overvoltage, Next memory location, and Time. The range for the first four values is the maximum available range for the specific power supply. The Next memory location is the address of the next group of settings and is between 1 and 40. A value of 0 means end of chain. The Time setting is between 0.01 and 300 seconds. In order to access one of the 40 memory locations an index value must be provided. The 40 memory locations can be very useful in remote mode using the *RCL command (see Appendix A, PAR. A.10.)

3.7.3.5 MEASURE SUBSYSTEM

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

3.7.3.6 OUTPUT SUBSYSTEM

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

3.7.3.7 PROTECTION SUBSYSTEM

This subsystem allows overvoltage/overcurrent protection tripping to be delayed to prevent brief transients (caused by application of power to a reactive load) from tripping overvoltage/overcurrent protection.

3.7.3.8 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.

3.7.3.9 TRIGGER SUBSYSTEM

This subsystem controls the remote triggering of the power supply.

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

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

3.7.3.11 CALIBRATE SUBSYSTEM

The ABC series of power supplies support software calibration. 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.

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 following equipment is required for calibration: Digital Voltmeter (DVM) with 6 digits Dc accuracy. Shunt 0.1 Ohm, 0.04%, minimum 15A, power > 50W (100W recommended)

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.

3.7.3.12 INSTRUMENT SUBSYSTEM

This subsystem controls the power supply's voltage and current outputs and allows compatibility with other vendor’s products

3.7.3.13 SYSTEM SUBSYSTEM

This subsystem controls the RS 232 port, as well as system errors, passwords, security, language, beep, version and keyboard lockout

3.7.4 PROGRAM MESSAGE STRUCTURE

SCPI program messages (commands from controller to power supply) consist of one or more ***message units*** ending in a ***message terminator***. 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). Sending a character with EOL line asserted is another way of sending a message terminator. 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 3-4 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.

3.7.4.1 KEYWORD

Keywords are instructions recognized by a decoder within the ABC, referred to as a “parser.” Each keyword describes a command function; all keywords used by the ABC 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 3-7.

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).

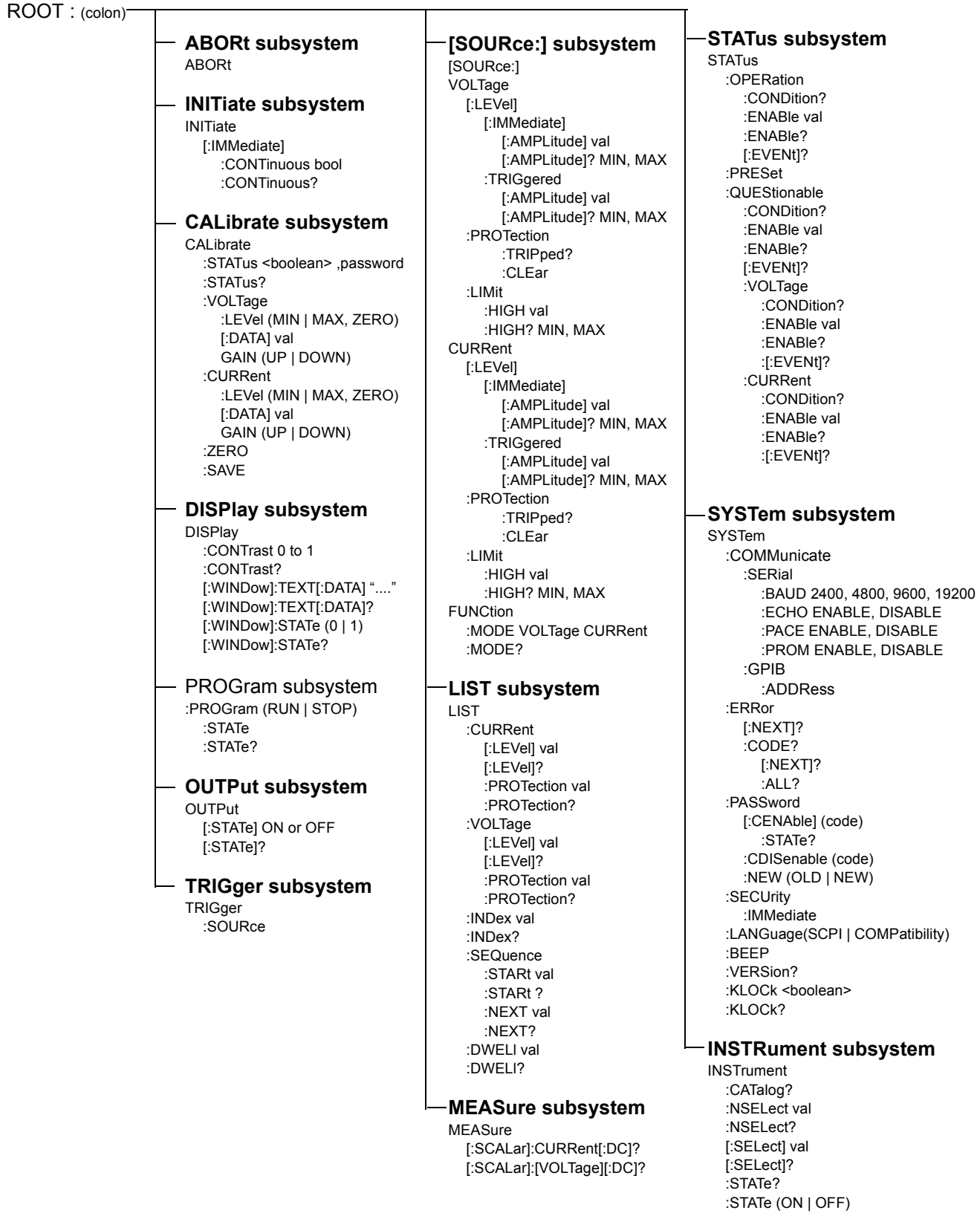


FIGURE 3-3. TREE DIAGRAM OF SCPI COMMANDS USED WITH ABC POWER SUPPLY

TABLE 3-7. 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

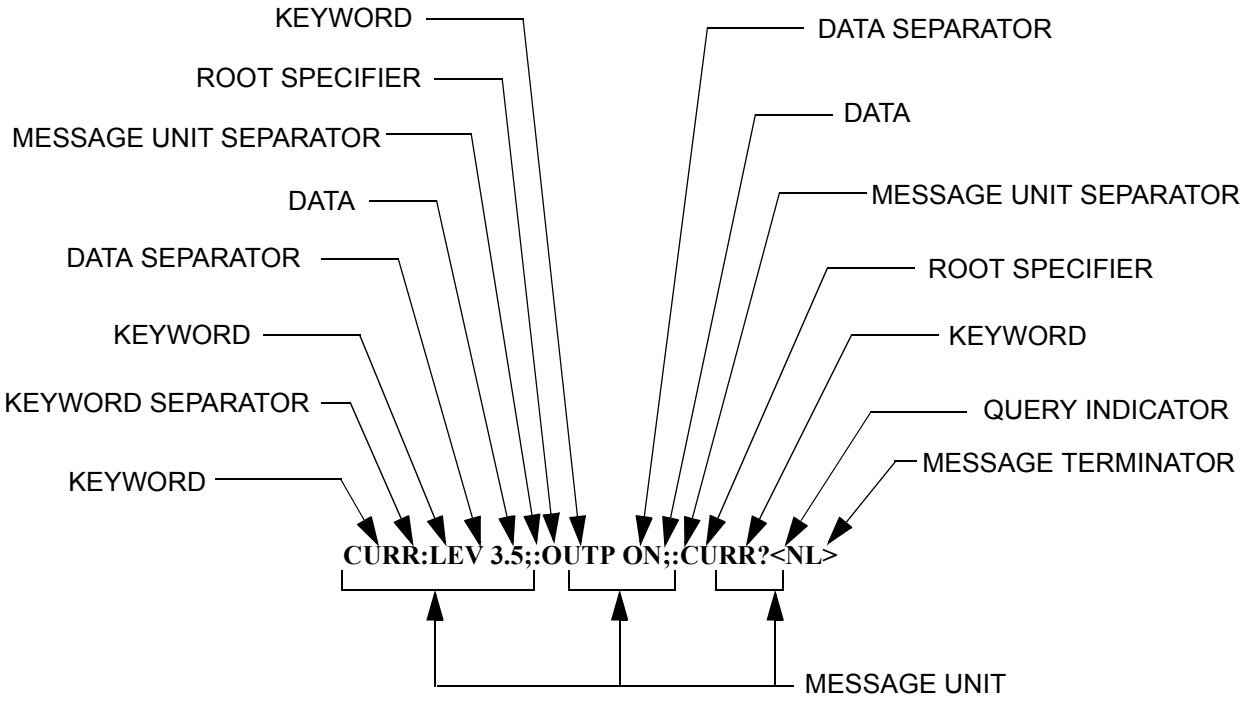


FIGURE 3-4. MESSAGE STRUCTURE

3.7.4.2 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 3.7.4.7).

3.7.4.3 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?).

3.7.4.4 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

3.7.4.5 DATA SEPARATOR

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

3.7.4.6 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).

3.7.4.7 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.

3.7.4.8 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.

3.7.5 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 ABC 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.

3.7.6 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

3.7.7 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 ABC 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.

3.8 OPERATOR MAINTENANCE

1. Twice a year, clean exterior surfaces using a dry lint-free cloth to wipe all exterior surfaces of the power supply to remove dust and other contaminants.

2. Once a year, clean the front panel as follows:

   - Disconnect the unit from mains power
   - Using a damp, lint-free cloth, wipe the front panel to remove any accumulated dirt.
   - Reconnect a-c power to the unit.

```
/************************************************************************/
/*    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 ABC POWER SUPPLY PROGRAM USING SCPI COMMANDS

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.3.3) 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.

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.

4.2 EQUIPMENT REQUIRED

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

- Digital Voltmeter (DVM) with 6 digits d-c accuracy.
- Shunt Resistor: During the calibration procedure the LCD displays the minimum requirements for the shunt resistor. However, to avoid problems due to drift caused by heat dissipation at higher power levels, Kepco recommends the following:
  - ABC 10-10DM: 0.1 Ohm, 0.04%, 15A, 50W minimum (100W recommended)
  - ABC 15-7DM: 0.1 Ohm, 0.04%, 15A, 50W minimum (100W recommended)
  - ABC 25-4DM: 0.25 Ohm, 0.04%, 15A, 50W minimum (100W recommended)
  - ABC 36-3DM: 0.25 Ohm, 0.04%, 15A, 50W minimum (100W recommended)
  - ABC 60-2DM: 1.0 Ohm, 0.04%, 15A, 50W minimum (100W recommended)
  - ABC 125-1DM: 1.0 Ohm, 0.04%, 15A, 50W minimum (100W recommended)

NOTE: Because the voltage measured will be used as reference for calibration, the DVM used must be accurately calibrated prior to calibrating the ABC power supply.

4.3 CALIBRATION PROCEDURES

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 either voltage or current calibration, BOTH zero AND full scale calibrations must be performed.

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.

NOTES: Keys with dual functions are labeled with both a command and a number. The command label is referred to when the unit is in : command entry status; the number is referred to when the unit is in = data entry status.

1. With the power supply in command entry status :, press **CALIB** key. power supply enters Calibration mode, data entry status =.

2. Enter password (4 digits) and press **ENTER**. If password is incorrect, ****WRONG PASSWORD**** flashes, then LCD returns to command status. (See PAR. 4.4 to change the password).

3. If password is correct, LCD reads **VOLTAGE CALIB**. Enter **1** for voltage calibration (see PAR. 4.3.1), enter **0** to proceed to current calibration.

4. LCD reads **CURRENT CALIB**. Enter **1** for current calibration (see PAR. 4.3.2), enter **0** to exit Calibration mode.

4.3.1 VOLTAGE CALIBRATION

1. With LCD reading **VOLTAGE CALIB. Connect Instr.**, connect DVM to output (+) and (–) terminals of power supply. then press ENTER.

2. With LCD reading **Vout ZERO adj.**, monitor DVM and use → or ← keys to increase or decrease output voltage as necessary to get DVM reading as close to zero as possible (without going to negative value). Press **ENTER** when complete.

NOTE: During calibration the → (increase) or ← (decrease) keys are used for fine adjustments. If necessary, use the **1** (decrease) and **3** (increase) keys for coarse adjustment, then use the → or ← keys.

3. LCD will flash **Vout F.S.adj. **WAIT**** then **Vout F.S. adj < >**. Monitor DVM and use → or ← keys to increase or decrease output voltage as necessary to get DVM reading as close as possible to full scale value (without exceeding full scale value). E.g., for ABC 25-4DM, adjust for DVM reading as close to 25.000V as possible. Press **ENTER** when complete. If the → and ← keys do not provide the required adjustment range, press the **1** (increase) or **3** (decrease) key for additional range.

4.3.2 CURRENT CALIBRATION

1. LCD reads **CONNECT SHUNT <n OHM >zz A** (n and zz values are determined by ABC model being calibrated.; e.g., for ABC 10-10DM LCD reads <1 OHM, >50 W). Refer to PAR. 4.2 for shunt requirements. Press **ENTER**.

2. LCD reads **CONNECT DVM TO SHUNT**. Connect Precision Shunt across output (+) and (–) terminals of power supply and connect DVM to sense terminals of shunt. Press **ENTER** when connections are complete.

NOTE: During calibration the → (increase) or ← (decrease) keys are used for fine adjustments. If necessary, use the **1** (decrease) and **3** (increase) keys for coarse adjustment, then use the → or ← keys.

3. With LCD reading **Iout ZERO adj.**, monitor DVM and use → or ← keys to increase or decrease output current as necessary to get DVM reading as close to zero as possible (without going to negative value). Press **ENTER** when complete.

4. LCD will flash **`Iout F.S.adj. **WAIT**`** then **`Iout F.S. adj < >`**. Monitor DVM and use → or ← keys to increase or decrease output voltage as necessary to get DVM reading as close as possible to value listed below (without exceeding value listed). If the → and ← keys do not provide the required adjustment range, press the **1** (increase) or **3** (decrease) key for additional range.

   – ABC 10-10DM: 1.000V
   – ABC 15-7DM: 0.700V
   – ABC 25-4DM: 1.000V
   – ABC 36-3DM: 0.750V
   – ABC 60-2DM: 2.000V
   – ABC 125-1DM: 1.000V

5. Press ENTER when complete.

4.4 CHANGING THE CALIBRATION PASSWORD

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

TABLE 4-1. FACTORY DEFAULT CALIBRATION PASSWORDS

MODEL	PASSWORD
ABC 10-10DM	1010
ABC 15-7DM	1507
ABC 25-4DM	2504
ABC 36-3DM	3603
ABC 60-2DM	6002
ABC 125-1DM	1251

1. If the unit is not in command entry status **:**, press **CLEAR** or **RESET** to put the unit in command entry status.

2. Press **MENU** key until LCD reads **`Change Passw. OldPass =`**.

3. Enter the old password and press **ENTER**. Then enter the new 4-digit Password and press **ENTER**.

4. The new password is accepted and the LCD shows the next Menu screen **`GoTo Previous CALIB? 1=Yes`**.

5. Press **CLEAR** to exit the Menu, press **1** to restore the previous calibration values (see PAR. 4.5), or **MENU** for additional menu screens.

4.5 RESTORING PREVIOUS CALIBRATION VALUES

Each time the unit is calibrated, the previous calibration values are retained in non-volatile memory. If it is determined that a new calibration is erroneous, the previous calibration values can be restored.

1. If the unit is not in command entry status **:**, press **CLEAR** or **RESET** to put the unit in command entry status.

2. Press **MENU** until LCD reads **GoTo Previous CALIB? 1=**.

3. Press **1**, then **ENTER**. LCD reads **Calibration ! PassWord=**.

4. Enter 4-digit password and press **ENTER**. Previous calibration values are restored.

4.6 RESTORING FACTORY CALIBRATION VALUES

The original factory calibration values can be restored.

1. If the unit is not in command entry status **:**, press **CLEAR** or **RESET** to put the unit in command entry status.

2. Press **MENU** until LCD reads **GoTo Factory CALIB? 1 =**.

3. Press 1, then **ENTER**. LCD reads **Calibration ! PassWord =**.

4. Enter 4-digit password and press **ENTER**. Factory calibration values are restored.

4.7 SETTING FACTORY CALIBRATION VALUES

After a unit has been repaired, is operating correctly, and has been calibrated, the new calibration values should be saved as the new factory calibration values. This can only be accomplished via the GPIB interface.

To save the current calibration values to the non-volatile RAM as factory default values, send the following strings via the GPIB interface:

```
SYSTEM:PASS:CENABLE xxxx
DIAG:NEW_FACTORY_CAL
```

where xxxx = the current password of the power supply.

4.8 CALIBRATION STORAGE

The ABC maintains the calibration tables in Flash Memory until a PACK is executed. There are six calibration areas maintained in Flash Memory: Working, Prior, Oldest, Factory, Master, and First.

The calibration can be copied to another area using the CAL:COPY command. The syntax is as follows: CAL:COPY (source) (destination) where (source) and (destination) refer to the areas of Flash memory where calibration data is stored, designated as: WORKing, PRIor, OLDest, FACTory, MASTer, FIRst. Source refers to the calibration area that is to be copied, destination to the area that the calibration will be copied into.

The Master calibration should never be overwritten. Factory, Master, and First are set to the same values when at the factory. The Working calibration is the active calibration. Each time a CAL:SAV is executed, the values are saved in the Working (active) area. At the same time, the values previously stored in Working are moved to Prior, and the values previously stored in Prior are moved to Oldest. The values previously stored in Oldest are no longer available. Table 4-2 illustrates calibration storage and the use of the CAL:COPY command.

TABLE 4-2. CALIBRATION STORAGE

COMMAND	WORKing	PRIor	OLDest	FACTory	MASTer	FIRst
1. CAL:SAVE	Cal 1 values			factory cal.	Master cal.	First cal.
2. CAL:SAVE	Cal 2 values	Cal 1 values		No Change	No Change	No Change
3. CAL:SAVE	Cal 3 values	Cal 2 values	Cal 1 values	No Change	No Change	No Change
4. CAL:SAVE	Cal 4 values	Cal 3 values	Cal 2 values	No Change	No Change	No Change
5. CAL:COPY FACTory WORKing	factory cal.	Cal 4 values	Cal 3 values	No Change	No Change	No Change
6. CAL:COPY PRIor WORKing	Cal 4 values	factory cal.	Cal 4 values	No Change	No Change	No Change

APPENDIX A - IEEE 488.2 COMMAND/QUERY DEFINITIONS

A.1 INTRODUCTION

This appendix defines the IEEE 488.2 commands and queries used with the ABC 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 ABC Power Supply.

TABLE A-1. IEEE 488.2 COMMAND/QUERY INDEX

COMMAND	PAR.	COMMAND	PAR.
*CLS	A.2	*RST	A.11
*ESE, ?	A.3, A.4	*SAV	A.12
*ESR?	A.5	*SRE, ?	A.13, A.14
*IDN?	A.6	*STB?	A.15
*OPC, ?	A.7, A.8	*TRG	A.16
*OPT	A.9	*TST?	A.17
*RCL	A.10		

A.2 *CLS — CLEAR STATUS COMMAND *CLS

Syntax: *CLS

Description: **Clears status data.** Clears the error queue of the instrument. It also 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). 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
OPC Operation Complete

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.89) (See example, Figure A-1.)

- Any 1xx type error sets the Command error bit (5).
- Any 2xx type error sets the Execution error bit (4).
- Any 3xx type error sets the Device error bit (3).
- Any 4xx type error sets the Query error bit (2).

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>, <Serial Number>, <Firmware revision> where: <Manufacturer> = KEPCO, <Model> = ABC-VVAA (VV is Vmax, AA is Imax, e.g. 1010), <Serial Number> = MM,DD,YY-SSS (MM - month, DD - day, YY - year, SSS - serial number in that day) <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 *OPC?

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.)

A.9 *OPT? — OPTIONS QUERY *OPT?

Syntax**:** *OPT?
Returns string determined by power supply model.

Description: Causes the power supply to return an ASCII string which defines the functionality of the power supply. The functionality is defined as follows:

STRING DATA	MEANING
CAL	Support for CALibrate is present.
RL3	Hardware switch controlling remote/local is functional. Unit can be used to take measurements in local mode, but all other functions require the unit to be in remote mode (REN must be asserted).
M40	Indicates the number of memory steps supported.
D16	Indicates the number of characters supported for user messages on LCD.

A.10 *RCL — RECALL COMMAND *RCL

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

Description: **Restores power supply to previously defined levels of output voltage, output current, overvoltage protection, and overcurrent protection.**This command selects one of the 40 power supply memory locations, each of which stores values for output current, output voltage, overvoltage protection, and overcurrent protection. The following parameters are affected by *RCL: CURR[:LEV][:IMM] VOLT[:LEV][:IMM] CURR:PROT[:LEV] VOLT:PROT[:LEV]. The recall function also sets the unit to operating parameters to SCPI compatible mode, or device clear operation and output on or off. If the recall value was not initialized by the *SAV command, but from an edit save or front panel save, the output condition will remain unchanged along with the language preferences. (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, ABC-1010, 082495-001, 1.0.
LIST:IND 21	Selects memory location 21.
LIST:CURR 2.35E-1	Sets output current value of memory location 21 to 0.235A.
LIST:VOLT 14	Sets output voltage value of memory location 21 to 14V.
*OPC	Allows status bit 0 to be set when pending operations complete
VOLT 21;CURR 3	Sets output voltage to 21V, output current to 3A
*SAV 33	The present state of the power supply is stored in memory location 33.
*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 15;CURR 5;*OPC?	Sets output voltage to 15V, output current to 5A, puts “1” on output bus when command operations are complete.
*RCL 21	Values in memory location 21 recalled (21V, 3A).
*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 12	Programs power supply voltage to 12V when *TRG received.
INIT	Trigger event is initialized.
*TRG	Power supply reverts to commanded output voltage of 12V.
*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.11 *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] = OFF. If the power supply is in either an overvoltage or overcurrent state, this condition is reset by *RST. (See example, Figure A-1.)

A.12 * SAV — SAVE COMMAND *SAV

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

Description: **Saves the present state of output voltage, output current, overvoltage and overcurrent to the specified memory location.** This command stores the present state of the power supply to one of 40 memory locations. The following parameters are stored by *SAV: CURR[:LEV][:IMM], VOLT[:LEV][:IMM], CURR:PROT[:LEV], and VOLT:PROT[:LEV]. The *SAV command also saves the language status and output on/off state. The stored values can be restored by the *RCL command. (See example, Figure A-1.)

A.13 *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.88)
NU	(Not Used)

A.14 *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.15 *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.16 *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.17 *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 ABC Power Supply. Subsystem commands are defined in PAR. B.2 through B.100, arranged 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.2	[SOUR:]CURR:PROT:CLE	B.54
CAL:VOLT:GAIN	B.3	[SOUR:]CURR:PROT:TRIP	B.55
CAL:CURR[:DATA]	B.4	[SOUR:]CURR:LIM:HIGH, ?	B.56, B.57
CAL:PASS, ?	B.5	[SOUR:]VOLT[:LEV][:IMM][:AMP], ?	B.58, B.59
CAL:CURR:GAIN	B.6	[SOUR:]VOLT[:LEV]:TRIG[:AMP]?	B.60, B.61
CAL:STAT, ?	B.7, B.8	[SOUR:]VOLT:LIM:HIGH, ?	B.62, B.63
CAL:VOLT:LEV	B.9	[SOUR:]VOLT:PROT:LEV, ?	B.64, B.65
CAL:VOLT[:DATA]	B.10	[SOUR:]VOLT:PROT:CLE	B.66
CAL:ZERO	B.11	[SOUR:]VOLT:PROT:TRIP?	B.67
DISP:CONT, ?	B.12, B.13	[SOUR:]FUNC:MODE?	B.68
DISP:MODE, ?	B.14 ,B.15	STAT:OPER:COND?	B.69
DISP:TEXT, ?	B.16, B.17	STAT:OPER:ENAB, ?	B.70, B.71
INIT[:IMM]	B.18	STAT:OPER[:EVENT]?	B.72
INIT:CONT, ?	B.19, B.20	STAT:PRES	B.73
INST:STAT	B.21	STAT:QUES[:EVENT]?	B.74
[SOUR:]LIST:CURR, ?	B.22, B.23	STAT:QUES:COND?	B.75
[SOUR:]LIST:CURR:PROT, ?	B.24, B.25	STAT:QUES:ENAB, ?	B.76, B.77
[SOUR:]LIST:DWELL, ?	B.26, B.27	SYST:COMM:GPIB:ADDR, ?	B.78, B.79
[SOUR:]LIST:IND, ?	B.28, B.29	SYST:COMM:SER:BAUD, ?	B.80, B.81
[SOUR:]LIST:SEQ:NEXT, ?	B.30, B.31	SYST:COMM:SERECHO, ?	B.82, B.83
[SOUR:]LIST:SEQ:START, ?	B.32, B.33	SYST:COMM:SER:PACE, ?	B.84, B.85
[SOUR:]LIST:VOLT, ?	B.34, B.35	SYST:COMM:SER:PROM, ?	B.86, B.87
[SOUR:]LIST:VOLT:PROT, ?	B.36, B.37	SYST:ERR?	B.88
MEAS:CURR?	B.38	SYST:ERR:CODE?	B.89, B.90
MEAS:VOLT?	B.39	SYST:KLOCK, ?	B.91, B.92
OUTP[:STAT], ?	B.40, B.41	SYST:LANG, ?	B.93, B.94
OUTP:PROT:DEL, ?	B.42, B.43	SYST:PASS CEN, DIS	B.95, B.96
PROG:STAT, ?	B.44, B.45	SYST:PASS:STAT	B.97
READ:CURR?	B.46	SYST:SEC	B.98
READ:VOLT?	B.47	SYST:SET	B.99
[SOUR:]CURR[:LEV][:IMM][:AMP], ?	B.48, B.49	SYST:VERS?	B.100
[SOUR:]CURR[:LEV]:TRIG[:AMP], ?	B.50, B.51	TRIG:SOUR	B.101
[SOUR:]CURR:PROT[:LEV], ?	B.52, B.53		

B.2 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 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: INIT, *RST, *TRG. (See example, Figure B-1.)

NOTES: 1. The power supply is assumed to be operating in constant voltage (CV) mode.
2 Examples below are intended only to illustrate command functions. Refer to PAR. 3.3.8.1 for programming techniques to optimize performance.

OUTP ON	Output enabled.
OUTP?	Power supply returns “1” (output enabled).
VOLT 21; CURR 1.5	Power supply output programmed to go to 21V, current limit 1.5A
INIT:CONT ON	Continuous triggers enabled.
INIT:CONT?	Power supply returns “1.”
VOLT:TRIG 15;CURR:TRIG 3	Power supply output programmed to return to 15V, current limit 3A upon receipt of trigger.
*TRG	Power supply output returns to 15V,current limit 3A.
VOLT 21; CURR 5E-2	Power supply output programmed to go to 21V, current limit 0.05A
MEAS:VOLT?	If actual value of output voltage is 20.9V, power supply returns 2.09E+1.
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 3 (current value established by CURR:TRIG.
VOLT:TRIG?	Returns 15 (voltage value established by VOLT:TRIG.
ABOR	Pending trigger levels changed to 21V, 0.05A (immediate values) VOLT 17; CURR 2 Power supply output programmed to go to 17V, 2A
*TRG	Power supply output returns to 21V, current limit 0.05A.
INIT:CONT 0	Triggers disabled.
INIT:CONT?	Power supply returns “0.”
OUTP OFF	Output disabled.
OUTP?	Returns 0 (output disabled).
MEAS:VOLT?	Returns 0. (measured output voltage).
VOLT?	Returns 17.(programmed output voltage)/
CURR?	Returns 1.5 (programmed current)
CURR? MAX	Returns 4 (assuming maximum allowable current for power supply being addressed is 4A, i.e. ABC 25-4DM).
CURR? MIN	Returns 0 (minimum allowable current).
CURR:PROT 2.6	Current protection set to 2.6A.
CURR?	Returns 1.5, indicating programmed current value = 1.5A.
CURR:PROT?	Returns 2.6 , indicating programmed overcurrent protection current value = 2.6A.
CURR:PROT?MAX	For ABC 25-4DM, returns 4.4A (see Table 1-2).
SYST:VERS?	Returns 1997.0.

FIGURE B-1. PROGRAMMING THE OUTPUT

B.3 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:PASS, CAL:VOLT, CAL:CURR, CAL:ZERO, CAL:SAVE. (See example, Figure B-2.)

B.4 CALibrate:CURRent[:DATA] COMMAND — CAL:CURR

Syntax: Short Form: CAL:CURR[:DATA] {0 | 1 | 2 | 3} Long Form: CALibrate:CURRent[:DATA] {0 | 1 | 2 | 3}

Description: **Increases or decreases output current during calibration only.** CAL:CURR[:DATA] 0 decreases output current by small increment. CAL:CURR[:DATA] 1 increases output current by small increment. CAL:CURR[:DATA] 2 decreases output current by large increment. CAL:CURR[:DATA] 3 increases output current by large increment. This command is used during current calibration to adjust the output current for current zero calibration as well as full scale current calibration. 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 Current Zero or Current Full Scale calibration are active. This command is equivalent to the on the front panel left and right arrow keys for fine adjustment and the 1 and 3 keys for coarse adjustment. Related Commands: CAL:STAT, CAL:PASS, CAL:VOLT, CAL:CURR, CAL:ZERO, CAL:SAVE. (See example, Figure B-2.)

CAL:STAT ON,1234	Power supply enters Calibrate status.
CAL:STAT?	Returns 1 indicating power supply in Calibrate status.
CAL:VOLT:LEV MIN	Voltage Zero Calibration selected.
CAL:VOLT 1	Output voltage increased
CAL:VOLT:LEV MAX	Voltage Full Scale Calibration selected, voltage zero values stored in volatile memory
CAL:VOLT 0	Output voltage decreased.
CAL:ZERO	Output voltage and current set to zero. Voltage maximum and values established analog to digital conversion values read calculations performed. Voltage and current output set to zero.
---	* User disconnects shunt and connects DVM to output.
CAL:CURR:LEV MIN	Current Zero Calibration selected.
CAL:CURR 1	Output current increased
CAL:CURR:LEV MAX	Current Full Scale Calibration selected, current zero values stored in volatile memory
CAL:CURR 0	Output current decreased.
CAL:SAVE	Calibration values saved. current maximum values calculated based on power supply settings an measurements. The non-volatile current calibration constants are moved to area of non-volatility memory reserved for previous calibration data. New volatile constants are stored in memory.
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.5 CALibrate:PASSword COMMAND — CAL:PASS

Syntax: Short Form: CAL:PASS new_password (new_password is 4 digits)
Long Form: CALibrate:PASSword new_password (new_password is 4 digits)

Description: **Changes the password used to put the power supply in Calibrate status.** To execute this command, the power supply must be in Calibrate status (see CAL:STAT).
password = 4 digits, required to enter Calibrate status. Related Commands: CAL:PASS, CAL:VOLT, CAL:CURR, CAL:ZERO, CAL:SAVE. (See example, Figure B-2.)

B.6 CALibrate:SAVE COMMAND — CAL:SAVE

Syntax: Short Form: CAL:SAVE Long Form: CALibrate:SAVE

Description: **Saves computed calibration values in non-volatile memory.** The Analog to Digital (A/D) converter is read to establish the final values of the calibration state. For example, if VOLT:MAX was the last calibration state, the voltage A/D converter is read and the volts per step multiplier is calculated. The voltage per step for the voltage Digital to Analog (D/A) converter is also calculated and the non-volatile memory is updated from the volatile calibration constants. Previous values are not lost, and can be restored using Local mode (see PAR. 4.5). This command should be the last command before exiting Calibrate status. CAL:STAT, CAL:PASS, CAL:VOLT, CAL:CURR, CAL:ZERO, CAL:SAVE. (See example, Figure B-2.)

B.7 CALibrate:STATus COMMAND — CAL:STAT

Syntax: Short Form: CAL:STAT <boolean>[,password]
Long Form: CALibrate:STATus <boolean>[,password]
where boolean = 0 or OFF, 1 or ON, password = 4 digits, required if<boolean = 1 or ON>

Description: **Sets the power supply to Calibrate status.** <boolean> 1 or ON causes power supply to enter Calibrate status. <boolean> 0 or OFF causes power supply to exit Calibrate status. Upon entering Calibrate status the current calibration constants are stored in the volatile memory. If the state is 0, the non-volatile calibration constants are supplied to the ASC working calibration.
password = 4 digits, required to enter Calibrate status. If the wrong password is entered, error message -224 is posted to the queue. Related Commands: CAL:PASS, CAL:VOLT, CAL:CURR, CAL:ZERO, CAL:SAVE. (See example, Figure B-2.)

B.8 CALibrate:STATus? QUERY — CAL:STAT?

Syntax: Short Form: CAL:STAT? Long Form: CALibrate:STATus?
Return Value: <boolean> (boolean = 0 or OFF, 1 or ON)

Description: **Identifies whether the power supply is in Calibrate status.** 1 indicates power supply is in Calibrate status. 0 indicates power supply is not in Calibrate status. (See example, Figure B-2.)

B.9 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. CAL:VOLT:MAX causes the maximum value to be read and saved in calibration xx. The power supply then raises the output level to maximum and waits for CAL:VOLT[:DATA] commands. Related Commands: CAL:STAT, CAL:PASS, CAL:VOLT, CAL:CURR, CAL:ZERO, CAL:SAVE. (See example, Figure B-2.)

B.10 CALibrate:VOLTage[:DATA] COMMAND — CAL:VOLT

Syntax: Short Form: CAL:VOLT[:DATA] {0 | 1 | 2 | 3} Long Form: CALibrate:VOLTage[:DATA] {0 | 1 | 2 | 3}

Description: **Increases or decreases output voltage during calibration only.**
CAL:VOLT[:DATA] 0 decreases output voltage by small increment. CAL:VOLT[:DATA] 1 increases output voltage by small increment. CAL:VOLT[:DATA] 2 decreases output voltage by large increment.

CAL:VOLT[:DATA] 3 increases output voltage by large increment. This command is used during voltage calibration to adjust the output voltage for voltage zero calibration as well as full scale voltage calibration. Output voltage is monitored on a calibrated digital multimeter and increased or decreased as required using this command. This command is only effective if Calibration status and either Voltage Zero or Voltage Full Scale calibration are active. This command is equivalent to the front panel left and right arrow keys for fine adjustment and the 1 and 3 keys for coarse adjustment. Related Commands: CAL:STAT, CAL:PASS, CAL:VOLT, CAL:CURR, CAL:ZERO, CAL:SAVE. (See example, Figure B-2.)

B.11 `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.12 `DISPlay:CONTrast` COMMAND — DISP:CONT

Syntax: Short Form: DISP:CONT <num_value> (0 to 1)
Long Form: DISPlay:CONTrast <num_value> (0.0 to 1.0)

Description: **Sets the contrast of the front panel LCD.** The contrast value from (0.1 to 0.9) is stored in the nonvolatile memory and is retained when the power supply is turned off. A contrast value of 0 is best when looking up at the display, 1 is best when looking down at the display. Values in between provide adjustment for optimum viewing. Setting the values to 0.1 or 0.9 are not reported back and are rounded to 0 or 1 respectively. Related Commands: DISP:CONT?. (See example, Figure B-3.)

DISP:CONT 0.9	Sets LCD contrast value to 0.9.
DISP:CONT?	Returns 0.9.
DISP:MODE NORM	Changes LCD to Normal metering mode.
DISP:MODE?	Returns NORMAL.
DISP:MODE TEXT	Changes LCD to Text mode.
DISP:TEXT “**ABC IS IN USE”	Second line of display reads **ABC IS IN USE.
DISP:MODE?	Returns “TEXT”
DISP:TEXT?	Returns “**ABC IS IN USE”

FIGURE B-3. USING DISPLAY COMMANDS

B.13 `DISPlay:CONTrast?` QUERY — DISP:CONT?

Syntax: Short Form: DISP:CONT? Long Form: DISPlay:CONTrast?
Return Value: Numerical value from 0 to 1 indicating contrast setting.

Description: **Identifies LCD contrast setting.** Returns 0 if LCD is at minimum setting, 1 if at maximum setting. and returns values between 0.2 through 0.8 for other contrast settings. Related Commands: DISP:CONT. (See example, Figure B-3.)

B.14 `DISPlay:MODE` COMMAND — DISP:MODE

Syntax: Short Form: DISP:MODE NORM or DISP:MODE TEXT
Long Form: DISPlay:MODE NORMal or DISPlay:MODE TEXT

Description: **Switches the LCD display between Normal and Text mode.** Switches the display between its normal metering mode and a mode in which it displays text sent by the user on the second line. The default status at power up or after *RST is NORMal. In order to display text on the second line the display mode has to be changed to TEXT. Related Commands: DISP:MODE?, DISP:TEXT, DISP:TEXT?, *RST. (See example, Figure B-3.)

B.15 DISPlay:MODE? QUERY — DISP:MODE?

Syntax: Short Form: DISP:MODE? Long Form: DISPlay:MODE?
Return Value: NORMAL or TEXT.

Description: **Identifies the LCD mode.** Returns NORMAL when the display is in normal mode, TEXT when the display is in text mode. Related Commands: DISP:MODE, DISP:TEXT, *RST. (See example, Figure B-3.)

B.16 DISPlay:TEXT COMMAND — DISP:TEXT

Syntax: Short Form: DISP:TEXT[:DATA] <char_string> Long Form: DISPlay:TEXT [:DATA] <char_string>

Description: **Allows entry of character string to be viewed when LCD display is set to Text mode.** Allows for character strings of maximum 16 characters to be displayed (on the second line of the LCD) when the display mode is TEXT, e.g., DO NOT TOUCH or ABC IS IN USE, etc. The LCD has the following character set: A to Z, 0 to 9 and special characters as < > + - / = : ... If the message exceeds the display capacity only the first 16 characters will be displayed and no error message will be generated. Upon executing *RST, character string set to 16 spaces:" ". Related Commands: DISP:TEXT?, DISP:MODE, DISP:MODE?, *RST. (See example, Figure B-3.)

B.17 DISPlay:TEXT? QUERY — DISP:TEXT?

Syntax: Short Form: DISP:TEXT? Long Form: DISPlay:TEXT]?
Return Value: Character string displayed on second line of LCD display.

Description: **Returns the text displayed on second line of LCD in TEXT mode.** When the display set to TEXT mode, returns the character string entered by DISP:TEXT. If the display set to NORMAL mode, returns information displayed on second line of display. (This can be used to see the monitored values presently being displayed on the second line of the LCD.) Related Commands: DISP:MODE, DISP:TEXT, *RST. (See example, Figure B-3.)

B.18 INITiate[:IMMediate] COMMAND — INIT[:IMM]

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

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

B.19 INITiate:CONTinuous COMMAND — INIT:CONT

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

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

B.20 INITiate:CONTinuous QUERY — INIT:CONT?

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

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

B.21 INSTrument:STATe COMMAND — INST:STAT

Syntax: Short Form :INST:STAT <val> Long Form: INSTrument:STATe <val>

Description: Operation is identical to OUTPut:STATe command (PAR. B.40) and is provided for compatibility with other vendors products.

B.22 LIST:CURRent COMMAND — LIST:CURR

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

Description: **Sets the current (Amps) value for the memory location selected by LIST:IND.** If the value is out of the acceptable current range for the power supply model, an error message: -222,"Data out of range" is posted in the output queue. The current value is stored in non-volatile memory and is retained when the power supply is turned off. Related Commands: LIST:IND. LIST:IND?, LIST:CURR?. (See example, Figure B-4.)

B.23 [SOUR:]LIST:CURRent? QUERY — LIST:CURR?

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

Description: **Returns current value (Amps) stored in indexed memory location selected by LIST:IND.** Related Commands: LIST:IND. LIST:IND?, LIST:CURR. (See example, Figure B-4.)

B.24 [SOUR:]LIST:CURRent:PROTect COMMAND — LIST:CURR:PROT

Syntax: Short Form: LIST:CURR:PROT<num_value> Long Form: LIST:CURRent:PROTect <num_value>
<num_value> = digits with decimal point and Exponent

Description: **Sets the current protection (Amps) value for the memory location selected by LIST:IND.** If the value is out of the acceptable current range for the power supply model, an error message: -222,"Data out of range" is posted in the output queue. The current value is stored in non-volatile memory and is retained when the power supply is turned off. Related Commands: LIST:IND. LIST:IND?, LIST:CURR:PROT?. (See example, Figure B-4.)

LIST:IND 21	Selects memory location 21.
LIST:IND?	Returns 21.
LIST:CURR 2.35E-1	Sets output current value of memory location 21 to 0.235A.
LIST:CURR?	Returns 2.35E-1.
LIST:CURR:PROT 1.67E+1	Sets output current value of memory location 21 to 16.7A.
LIST:CURR:PROT?	Returns 1.67E+1.
LIST:VOLT:PROT 2.77E+1	Sets voltage protection value of memory location 21 to 27.7V.
LIST:VOLT:PROT?	Returns 2.77E+1.
LIST:DWEL 0.6	Sets memory location 21 time value to 0.6 second. During program execution, after parameters specified by memory location 21 have been applied for 0.6 second, power supply will switch to parameters specified by memory location 21 sequence number.
LIST:SEQ:NEXT 39	Sets memory location sequence number to 39. During program execution, when memory location 21 is complete, the next location to be executed will be 39.
LIST:SEQ:NEXT?	Returns 39.
LIST:IND 22	Selects memory location 22 .
LIST:IND?	Returns 22.
LIST:VOLT 1.256E+2	Sets output voltage value of memory location 22 to 125.6V.
LIST:VOLT?	Returns 1.256E+2.
LIST:SEQ:STAR 21	Sets memory location 21 as the starting location for executing a program.
LIST:SEQ:STAR?	Returns 21.
PROG:SEL:STAT RUN	Sequence starting at location 21 and ending at location 22 will be run continuously
PROG:SEL:STAT STOP	Programmed sequence stops running.

FIGURE B-4. USING LIST COMMANDS AND QUERIES

B.25 [SOUR:]LIST:CURRent:PROTect? QUERY — LIST:CURR:PROT?

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

Description: **Returns current protection value (Amps) stored in indexed memory location selected by LIST:IND.** Related Commands: LIST:IND. LIST:IND?, LIST:CURR. (See example, Figure B-4.)

B.26 [SOUR:]LIST:DWELl COMMAND — LIST:DWEL

Syntax: Short Form: LIST:DWEL <value> (0.01 to 300) Long Form: LIST:DWELl <value> (0.01 to 300)

Description: **Determines the execution time duration during a programmed sequence for the memory location selected by LIST:IND.** Sets time value (from 0.01 to 300) in seconds for memory location selected by LIST:IND. A value of 0 means that this memory location will be skipped during the RUN command (LOCal mode). The time value is stored in non-volatile memory and is retained when the power supply is turned off. Related Commands: LIST:IND. LIST:IND?, LIST:DWEL?, LIST:SEQ. (See example, Figure B-4.)

B.27 [SOUR:]LIST:DWELl? QUERY — LIST:DWEL?

Syntax: Short Form: LIST:DWEL? Long Form: LIST:DWELl?
Return Value: <value> (0.01 to 300)

B.28 [SOUR:]LIST:INDex COMMAND — LIST:IND

Syntax: Short Form: LIST:IND <int_value> (from 1 to 40) Long Form: LIST:INDex <int_value> (from 1 to 40)

Description: **Selects one 40 memory locations for viewing or modification of parameter selected by subsequent LIST:CURR, LIST:CURR:PROT, LIST:VOLT, LIST:VOLT:PROT commands or queries.** The index value (the selected memory location) is stored in non-volatile memory and is retained when the power supply is turned off. Related Commands: LIST:IND?. (See example, Figure B-4.)

B.29 [SOUR:]LIST:INDex? QUERY — LIST:IND?

Syntax: Short Form: LIST:IND? Long Form: LIST:INDex?
Return Value: <int_value> 1 to 40

Description: **Returns index value.** Identifies which one 40 memory locations has been selected for viewing or modification by subsequent LIST:CURR, LIST:CURR:PROT, LIST:VOLT, LIST:VOLT:PROT commands or queries. Related Commands: LIST:IND?. (See example, Figure B-4.)

B.30 [SOUR:]LIST:SEQuence:NEXT COMMAND — LIST:SEQ:NEXT

Syntax: Short Form: LIST:SEQ:NEXT <int_value> (0 to 40)
Long Form: LIST:SEQuence:NEXT <int_value> (0 to 40)

Description: **Determines the next memory location to be addressed during a programmed sequence.**Sets sequence number (from 1 to 40) of next memory location to be addressed. Sequence number is set for memory location selected by LIST:IND. Setting sequence number to 0 indicates the end of the program chain, and the programmed sequence will stop. The sequence number is stored in non-volatile memory and is retained when the power supply is turned off. Related Commands: LIST:IND. LIST:IND?, LIST:SEQ?. (See example, Figure B-4.)

B.31 [SOUR:]LIST:SEQuence:NEXT? QUERY — LIST:SEQ:NEXT?

Syntax: Short Form: LIST:SEQ:NEXT? Long Form: LIST:SEQuence:NEXT?
Return Value: <int_value> (0 to 40)

Description: **Returns sequence number stored in memory location selected by LIST:IND.** Related Commands: LIST:IND. LIST:IND?, LIST:SEQ. (See example, Figure B-4.)

B.32 [SOUR:]LIST:SEQuence:STARt COMMAND — LIST:SEQ:STAR

Syntax: Short Form: LIST:SEQ:STAR <int_value> (1 to 40)
Long Form: LIST:SEQuence:STARt <int_value> (1 to 40)

Description: **Determines the first memory location (start of sequence) to be addressed during a programmed sequence.** Sets memory location (from 1 to 40) of first memory location to be addressed when a program (chain of memory locations) is executed. This is the start address for the STEP and RUN commands (LOCal mode). The starting sequence number is stored in non-volatile memory and is retained when the power supply is turned off. Related Commands: LIST:SEQ:STAR?. (See example, Figure B-4.)

B.33 [SOUR:]LIST:SEQuence:STARt? QUERY — LIST:SEQ:STAR?

Syntax: Short Form: LIST:SEQ:STAR? Long Form: LIST:SEQuence:STARt?
Return Value: <int_value) between 1 and 40

Description: **Identifies the starting address for program execution.** Returns the starting sequence location set by LIST:SEQ:STAR command. Related Commands: LIST:SEQ:STAR. (See example, Figure B-4.)

B.34 [SOUR:]LIST:VOLTage COMMAND — LIST:VOLT

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

Description: **Sets the voltage value for the memory location selected by LIST:IND.** If the value is out of the acceptable voltage range for the power supply model, an error message: -222,"Data out of range" is posted in the output queue. The voltage value is stored in non-volatile memory and is retained when the power supply is turned off. Related Commands: LIST:IND. LIST:IND?, LIST:VOLT? (See example, Figure B-4.)

B.35 [SOUR:]LIST:VOLTage? QUERY — LIST:VOLT?

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

Description: **Returns voltage value stored in indexed memory location selected by LIST:IND.** Related Commands: LIST:IND. LIST:IND?, LIST:VOLT. (See example, Figure B-4.)

B.36 [SOUR:]LIST:VOLTage:PROTect COMMAND — LIST:VOLT:PROT

Syntax: Short Form: LIST:VOLT:PROT<exp_value> Long Form: LIST:VOLTage:PROTect <exp_value>
<exp_value> = digits with decimal point and Exponent, e.g., 2.71E+1 for 27.1

Description: **Sets the voltage protection value for the indexed memory location selected by LIST:IND.**If the value is out of the acceptable voltage range for the power supply model, an error message: -222,"Data out of range" is posted in the output queue. The voltage value is stored in non-volatile memory and is retained when the power supply is turned off. Related Commands: LIST:IND. LIST:IND?, LIST:VOLT:PROT?. (See example, Figure B-4.)

NOTE: 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.

B.37 [SOUR:]LIST:VOLTage:PROTect QUERY — LIST:VOLT:PROT?

Syntax: Short Form: LIST:VOLT[:LEV]? Long Form: LIST:VOLTage[:LEVel]?
Return Value: <num_value> (digits with decimal point and Exponent)

Description: **Returns voltage protection value stored in indexed memory location selected by LIST:IND.** Related Commands: LIST:IND. LIST:IND?, LIST:VOLT. (See example, Figure B-4.)

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. 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 power supply accepts this format but sets the command warning bit (13) in the status questionable register and ignores the extra characters. (See example, Figure B-1.)

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. 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 power supply accepts this format but sets the command warning bit (13) in the status questionable register and ignores the extra characters. (See example, Figure B-1.)

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.** Upon power up the output is enabled (OUTP ON). When OUTP OFF is executed, the programmed values of voltage and current are saved, then voltage and current are programmed to 0. 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 OUTPut:PROTection:DELay COMMAND — OUTP:PROT:DEL

Syntax: Short Form: OUTP:PROT:DEL <n.n> Long Form: OUTPut:PROTection:DELay <n.n>
where n.n = seconds

Description: **Delays tripping of overvoltage/overcurrent protection.** The overvoltage and overcurrent protection can be programmed to trip immediately upon detection of an overvoltage/overcurrent condition, or can be delayed approximately 8 seconds. This delay is set in increments of 0.033 milliseconds If delay is programmed, overcurrent/overvoltage protection trips only if condition still present at end of delay. A count of 0 means no delay, the maximum delay possible is 8.50 seconds.

B.43 OUTPut:PROTection:DELay QUERY — OUTP:PROT:DEL?

Syntax: Short Form: OUTP:PROT:DEL? Long Form: OUTPut:PROTection:DELay?
Return Value: <integer 1 to 8.5>

Description: **Returns value of overvoltage/overcurrent delay.** A count of 0 means no delay, The maximum value is 8.5. The delay constants are set in -.033 milliseconds per internal value. Related Commands: OUTP:PROT:DEL. (See example, Figure B-5.)

B.44 PROGram:SELect:STATe COMMAND — PROG:SEL:STAT

Syntax: Short Form: PROG:SEL:STAT {RUN | STOP}
Long Form: PROGram:SELect:STATe {RUN | STOP}

Description: **Starts or stops user programmed sequence.** Program sequence is preprogrammed using LIST commands, starting address is established by LIST:SEQ:STAR. When PROG:SEL:STAT command is executed the keyboard is locked until the program stops running. *RST command aborts a program that is running. Related commands: PROG:SEL:STAT?, LIST:CURR, LIST:CURR:PROT, LIST:VOLT, LIST:VOLT:PROT, LIST:DWEL, LIST:SEQ:NEXT, LIST:SEQ:STAR

B.45 PROGram:SELect:STATe? QUERY — PROG:SEL:STAT?

Syntax: Short Form: PROG:SEL:STAT? Long Form: PROGram:SELect:STATe?
Return value: <boolean> (0 = stopped, 1 = running)

Description: **Indicates status of user progammed sequence.** 1 returned when program is running. 0 returned when program is stopped. Related commands: PROG:STAT

B.46 READ[:SCALar]:CURRent[:DC]? QUERY — READ:CURR?

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

Description: **Measures actual current.** Same as MEAS:CURR? (see PAR. B.38)

B.47 READ[:VOLTage][:SCALar][:DC]? QUERY — READ:VOLT?

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

Description: **Measures actual voltage.** Same as MEAS:VOLT? (see PAR. B.39)

B.48 [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: *RCL, *SAV, CURR:LIM:HIGH. (See example, Figure B-1.)

B.49 [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.50 [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.51 [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

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

B.52 [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. An overcurrent condition can be cleared with the CURR:PROT:CLE command. The current protection level can be programmed independently of the output current level. Setting current protection to a value lower than the output current causes the current protection mechanism to trigger after the delay established by OUTP:PROT:DEL command. (See example, Figure B-5.)

NOTES: 1. The power supply is assumed to be operating in constant voltage (CV) mode.
2 Examples below are intended only to illustrate command functions. Refer to PAR. 3.3.8.1 for programming techniques to optimize performance

VOLT 21; CURR 1.1	Power supply programmed to voltage limit 21V, 1.1A.
CURR?	Returns 1.1.
CURR:LIM:HIGH 3.3	Current limit set to 3.3A.
CURR:LIM:HIGH?	Returns 3.3.
CURR 4.2	Power supply output current programmed to 3.3A.
SYST:ERR?	Error message -301 “Value bigger than limit.”
CURR?	Returns 3.3.
OUTP:PROT:DEL 0	Protection will trip immediately upon detection of overvoltage or overcurrent condition.
OUTP:PROT:DEL?	Returns 0.
CURR:PROT:TRIP?	0 indicating overcurrent protection not tripped.
--- OVERCURRENT CONDITION (1 SECOND) OCCURS.	
CURR:PROT:TRIP?	1 indicating overcurrent protection tripped.
CURR:PROT:CLE	Overcurrent condition cleared.
CURR:PROT:TRIP?	0 indicating overcurrent condition not tripped.
CURR?	Returns small value (approx. 1% of full scale current rating).
OUTP:PROT:DEL 7.47	Protection will trip if overvoltage or overcurrent condition still present approx. 0.575 seconds after detection.
OUTP:PROT:DEL?	Returns 7.50.
CURR 2.5	Power supply output current programmed to 2.5A
--- OVERCURRENT CONDITION (1 SECOND) OCCURS.	
(After 10 seconds)	
CURR:PROT:TRIP?	0 indicating overcurrent condition not tripped.
CURR?	Returns 2.5.

FIGURE B-5. PROGRAMMING CURRENT

B.53 [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-5.)

B.54 [SOURce:]CURRent:PROTection:CLEar COMMAND CURR:PROT:CLE

Syntax: Short Form: [SOUR:]CURR:PROT:CLE Long Form: [SOURce:]CURRent:PROTection:CLEar

Description: **Clears overcurrent condition.**Output programmed to 0V; current limit programmed to small value (approximately 1% of full scale current rating). Overcurrent Protection Tripped is reset so that CURR:PROT:TRIP? returns 0. Related Commands: CURR:PROT, CURR:PROT:TRIP?. (See example, Figure B-5.)

B.55 [SOURce:]CURRent:PROTection:TRIPped? QUERY CURR:PROT:TRIP?

Syntax: Short Form: [SOUR:]CURR:PROT:TRIP? Long Form: [SOURce:]CURRent:PROTection:TRIPped?
Return Value: 0 or 1.

Description: **Identifies whether overcurrent condition was detected.** 0 if overcurrent protection tripped. 1 if overcurrent protection not tripped. Related Commands: CURR:PROT, CURR:PROT:CLE. (See example, Figure B-5.)

B.56 [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 limit for maximum power supply output current.** 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. NOTE: If the current limit is changed, any previously established trigger levels higher than the new limit must be reprogrammed to be lower than the new limit; otherwise triggers will cause the output to exceed the new limit. Once the limit is established, the unit will not accept trigger values higher than the programmed limit. Related Commands: CURR. (See example, Figure B-5.)

B.57 [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 current limit set by CURR:LIM:HIGH command.** Related Commands: CURR:LIM:HIGH, CURR. (See example, Figure B-5.)

B.58 [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: *RCL, *SAV, VOLT:LIM:HIGH. (See example, Figure B-1.

B.59 [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-6

B.60 [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.61 [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.)

B.62 [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 voltage limit for power supply output.** If the value is out of the acceptable voltage 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 level 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 voltage limit is changed, any previously established trigger levels higher than the new limit must be reprogrammed to be lower than the new limit; otherwise triggers will cause the output to exceed the new limit. Once the limit is established, the unit will not accept trigger values higher than the programmed limit. Related Commands: VOLT. (See example, Figure B-6.)

B.63 [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 voltage limit set by VOLT:LIM:HIGH command.** Related Commands: VOLT:LIM:HIGH, VOLT. (See example, Figure B-6.)

B.64 [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-6.)

B.65 [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-6.)

NOTES: 1. The power supply is assumed to be operating in constant voltage (CV) mode.
2 Examples below are intended only to illustrate command functions. Refer to PAR. 3.3.8.1 for programming techniques to optimize performance

VOLT 21; CURR 1.1	Power supply programmed to 21V, 1.1A.
VOLT 2.157E1	Power supply programmed to go to 21.57V.
VOLT?	Returns 2.157E1, indicating programmed voltage = 2.157V.
VOLT? MAX	For ABC 135-1DM, returns 135 (135V).
VOLT? MIN	Returns 0 (minimum allowable voltage).
VOLT:PROT 2.365E+1	Voltage protection set to 23.65V.
VOLT?	Returns 21.57, indicating programmed voltage value = 21.57V.
VOLT:PROT?	Returns 2.365+E1, (programmed overvoltage protection = 23.65V
VOLT:PROT?MAX	For ABC 10-10DM, returns 11.
VOLT:PROT:TRIP?	0 indicating overvoltage protection not tripped.
--- OVERVOLTAGE CONDITION OCCURS.	
VOLT:PROT:TRIP?	1 indicating overvoltage protection tripped.
VOLT:PROT:CLE	Overvoltage condition cleared.
VOLT:PROT:TRIP?	0 indicating overvoltage condition not tripped.
VOLT?	Returns 0, programmed voltage value = 0V.
VOLT 21; CURR 1.1	Power supply programmed to go to 21V, 1.1A.
VOLT?	Returns 21.
VOLT:LIM:HIGH 5	Voltage limit set to 5V.
VOLT:LIM:HIGH?	Returns 5.
VOLT 33	Power supply programmed to 5V.
SYST:ERR?	Error message -301 “Value bigger than limit.”
VOLT?	Returns 5.

FIGURE B-6. PROGRAMMING VOLTAGE

B.66 [SOURce:]VOLTage:PROTection:CLEar COMMAND VOLT:PROT:CLE

Syntax: Short Form: [SOUR:]VOLT:PROT:CLE Long Form: [SOURce:]VOLTage:PROTection:CLEar

Description: **Clears overvoltage condition.** Output programmed to 0V; current limit programmed to small value (approximately 1% of full scale current rating). Overvoltage Protection Tripped is reset so that VOLT:PROT:TRIP? returns 0. Related Commands: VOLT:PROT, VOLT:PROT:TRIP?. (See example, Figure B-6.)

B.67 [SOURce:]VOLTage:PROTection:TRIPped? QUERY VOLT:PROT:TRIP?

Syntax: Short Form: [SOUR:]VOLT:PROT:TRIP? Long Form: [SOURce:]VOLTage:PROTection:TRIPped?
Return Value: 0 or 1

Description: **Identifies whether overvoltage condition was detected.** Returns 0 if overvoltage protection tripped; 1 if overvoltage protection not tripped. Related Commands: VOLT:PROT, VOLT:PROT:CLE. (See example, Figure B-6.)

B.68 [SOURce:]FUNCtion:MODE? QUERY FUNC:MODE?

Syntax: Short Form: FUNC:MODE? Long Form: [SOURce:]FUNCtion:MODE?
Return Value: VOLT or CURR

Description: **Identifies the operating mode of the power supply.** VOLT = Constant Voltage mode (CV). CURR = Constant Current mode (CC). (See example, Figure B-1.)

B.69 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-7.)

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 INIT SUBSYSTEM)

B.70 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-7.)

B.71 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-7.)

B.72 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-7.)

B.73 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-7.)

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.
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
---	OVERCURRENT CONDITION OCCURS
STAT:QUES?	Returns 2 (overcurrent protection tripped since the last STAT:QUES? query).
STAT:QUES:COND?	Returns 2, (Power supply still in overcurrent protection state).
STAT:QUES?	Returns 0, (Register cleared by previous STAT:QUES?).
STAT:QUES:COND?	Returns 2, (Power supply still in overcurrent protection state).
CURR:PROT:CLE	Overcurrent condition cleared.
STAT:QUES:COND?	Returns 0, (register cleared by CURR:PROT:CLE).
SYST:ERR?	Power supply returns 0,“No error” message.

FIGURE B-7. USING STATUS COMMANDS AND QUERIES

B.74 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-7.)

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

CONDITION	NU	OC	OV
BIT	15 - 2	1	0
VALUE	32,768 - 4	2	1

OC - OVERCURRENT PROTECTION TRIPPED
OV - OVERVOLTAGE PROTECTION TRIPPED
NU - NOT USED

B.75 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-7.)

B.76 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-7.)

B.77 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-7.)

B.78 SYSTem:COMMunication:GPIB:ADDRess COMMAND — SYST:COMM:GPIB:ADDR

Syntax: Short Form: SYST:COMM:GPIB:ADDR<INT VAL> 0 to 30
Long Form: SYSTem:COMMunication:GPIB:ADDRess<INT VAL> 0 to 30

Description: **Sets selected power supply GPIB address.**

B.79 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> 0 to 30

Description: **Identifies selected power supply GPIB address.**

B.80 SYSTem:COMMunication:SERial:BAUDrate COMMAND SYST:COMM:SER:BAUD

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

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

B.81 SYSTem:COMMunication:SERial:BAUD? QUERY SYST:COMM:SER:BAUD?

Syntax: Short Form: SYST:COMM:SER:BAUD?
Long Form: SYSTem:COMMunication:SERial:BAUD?
Return Value: <int_value> {19200 | 9600 | 4800 | 2400}

Description: **Returns operating baud rate.**

B.82 SYSTem:COMMunication:SERial:ECHO COMMAND SYST:COMM:SER:ECHO

Syntax: Short Form: SYST:COMM:SER:ECHO {ON | OFF}
Long Form: SYSTem:COMMunication:SERial:ECHO {ON | OFF}

Description: **Enables (ON) or disables (OFF) echo mode** (see PAR. 3.6.3.1) Sending ON causes all subsequent characters to be echoed back. Sending OFF turns off the character echo after the nest line terminator character. The *RST command has no effect on echo status

B.83 SYSTem:COMMunication:SERial:ECHO? QUERY SYST:COMM:SER:ECHO?

Syntax: Short Form: SYST:COMM:SER:ECHO?
Long Form: SYSTem:COMMunication:SERial:ECHO?
Return Value: {ON | OFF}

Description: **Identifies whether echo mode is active (ON) or disabled (OFF)** (see PAR. 3.6.3.1).

B.84 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. 3.6.3.3)

B.85 SYSTem:COMMunication:SERial:PACE? QUERY SYST:COMM:SER:PACE?

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

Description: **Identifies whether data flow control via the serial interface is enabled (XON) or disabled (NONE)** (see PAR. 3.6.3.3).

B.86 SYSTem:COMMunication:SERial:PROMpt COMMAND SYST:COMM:SER:PROM

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

Description: **Enables (ON) or disables (OFF) prompt** (see PAR. 3.6.3.2). Sending ON causes the unit to return > character after the command is parsed.

B.87 SYSTem:COMMunication:SERial:PROMpt? QUERY SYST:COMM:SER:PROM?

Syntax: Short Form: SYST:COMM:SER:PROM {ON | OFF}
Long Form: SYSTem:COMMunication:SERial:PROMpt {ON | OFF}
Return Value: {ON | OFF}

Description: **Identifies whether prompt is enabled (ON) or disabled (OFF) prompt** (see PAR. 3.6.3.2).

B.88 SYSTem:ERRor[:NEXT]? QUERY SYST:ERR?

Syntax: Short Form: SYST:ERR[:NEXT]? Long Form: SYSTem:ERRor[:NEXT]?
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.89 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.) The error bits defined in PAR A.3 through A.5 are related to these error codes produced during parsing of messages and also to errors in the power supply as indicated in Table B-4.

B.90 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.91 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 keypad.** With the keypad unlocked the power supply enters Remote mode as soon as a command or query is received. Once in Remote mode (with keypad unlocked) the front panel keys are disabled with the exception of the LOCAL key, which is used to return to Local mode.

After sending a SYST:KLOC ON (keypad lock) command, all front panel keys, including LOCAL, are disabled. The power supply is now in the “local lockout” state and the LCD changes from Loc to 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. Related Commands: SYST:KLOCK?. (See example, Figure B-8.)

B.92 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-8.)

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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
-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	Command only valid in password Cenable state
-221,"Settings conflict"	Execution error bit 4	Invalid password from syst:pass:cen command
-222,"Data out of range"	Execution error bit 4	Value exceeds power supply rating
-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
-241,"Hardware missing"	Execution error bit 4	Requesting device 2 status (INST:NSEL 2)
-282,"Illegal program name"	Execution error bit 4	Executing prog:run without LIST:SEQ command
-301,"Value bigger than limit"	Device Error bit 3	Requesting a time of 301 which is bigger than limit
-311,"Memory error"	Device Error bit 3	Power-up NV RAM error
-314,"Save/recall memory error"	Device Error bit 3	Using cell other than 1 - 41 for SAV and RCL
-341,"Non Volatile Mem. CRC error"	Device Error bit 3	Power supply constants may be corrupted; recalibration may be necessary.
-350, "Queue overflow"	Query Error bit 2	More than 15 errors are in queue.
-410,"Query interrupted"	Query Error bit 2	New command sent before data from previous query read. Previous query data lost.
-430, "Query Deadlocked"	Query Error bit 2	Over 255 characters received in single input string"

B.93 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 ABC power supplies up to Revision 1.

B.94 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 ABC power supplies up to Revision 1. 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.95 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 *SAV 41 to operate.

B.96 SYSTem:PASSword:CDISable COMMAND — SYST:PASS:CDIS

Syntax: Short Form: SYST:PASS:CDIS <val> Long Form: SYSTem:PASSword:CDISable <val>

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

B.97 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.98 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.).It also initializes the power -up state to have DC Output Control off (see PAR 3.4.1). The calibration password is reset per Table 4-1 Use master password (see below) If password has been lost. Related Commands: SYST:PASS:CEN must be sent prior to this command

TABLE B-5. MASTER PASSWORDS

MODEL	PASSWORD	MODEL	PASSWORD	MODEL	PASSWORD
ABC 10-10	..10	ABC 25-4	..20	ABC 60-2	..40
ABC 15-7	..60	ABC 36-3	..30	ABC 125-1	..50

B.99 SYSTem:SET COMMAND — SYST:SET

Syntax: Short Form: SYST:SET {CM0 | CM1 | DC0 | DC1 | LF0 | LF1 | STR | RLX)
Long Form: SYSTem:SET {CM0 | CM1 | DC0 | DC1 | LF0 | LF1 | STR | RLX)

Description: Sending SYST:SET CM1 sets the unit to operate in compatible mode and have all GPIB functions compatible with software version 1.2 and lower units. Sending SYST:SET CM0 sets the unit to be fully SCPI 1997 compliant.

Sending SYST:SET DC1 causes Device Clear to be identical to *RST command. Sending SYST:SET DC0 causes Device Clear to have no effect on output voltage, output current or output on/off state.

Sending SYST:SET LF1 causes the power supply to respond with line feed if read occurs with output buffer empty. Sending LF0 causes the power **not** to send a line feed if read occurs with output buffer empty (SCPI 1997 compliant).

Sending SYST:SET RLX allows the power supply to accept special debug and troubleshooting commands (for KEPCO use only - e.g., after sending SYST:SET RLX the power supply will respond to the $vda? command by returning the value of the internal D/A converter for voltage). Sending SYST:SET STR disables the special debug and troubleshooting commands.

Related Commands:
SYST:PASS:CEN - the password must be enabled prior to saving the SYST:SET configuration using the *SAV41 command.
*SAV41 - this command saves the configuration established by SYST:SET and OUTP commands and restores it upon power up.

B.100 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-8.)

SYST:VERS?	Returns 2003.0.
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:KLOC?	Returns 0 indicating keypad unlocked.

FIGURE B-8. USING SYSTEM COMMANDS AND QUERIES

B.101 TRIGger:SOURce COMMAND — TRIG:SOUR

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

Description: Sending TRIG:SOUR activates the external 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 INIT:CONT 1 was sent prior to sending TRIG:SOUR EXT, continuous mode is disabled and unit will wait for INIT:IMM. Related Commands: VOLT:TRIG and CURR:TRIG.

You must register your product to comply with the terms of the warranty. Either fill out the form below and mail or fax to Kepco, or for rapid on-line registration go to:

http://www.kepcopower.com/warranty.htm

PRODUCT PURCHASED:

Model Number)_____

Serial Number_____

PURCHASE INFORMATION:

Date Purchased:_____

Date Received:_____

REQUEST ADDITIONAL INFORMATION

❑ Send complete Catalog

❑ Have Sales Engineer Call

Contact via: ❑ E-Mail ❑ Telephone ❑ Fax ❑ S-mail

REGISTER TO:

Registered by:_____

Company Name:_____

Street: _____

City:_____

State:_____

Country:_____

Zip:_____

E-mail: _____

FAX:_____

Phone: _____

WHAT INFLUENCED YOUR CHOICE OF THIS POWER SUPPLY?

❑ Previous Experience (which Kepco Models do you have?)

_____

_____

_____

❑ Magazines (which ones?)_____

_____

❑ Trade Shows (which ones?)_____

❑ Directory?_____

❑ Kepco Catalog or Brochure?_____

❑ Sales Representative?

❑ Web Site

❑ Other (please explain):_____

What products would you like to see Kepco make?

_____

_____

_____

CUT HERE

Kepco 5 Year Warranty

This is to certify that we, KEPCO, INC., (hereinafter called "Company"), Flushing, NY 11352 USA, warrants for a period of FIVE YEARS, this instrument known as:

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The Company's products are warranted for a period of five years from date of delivery to be free from defects in materials and workmanship and to conform to the specifications furnished or approved by the Company. Liability under this warranty shall be limited to the repair or replacement of any defective product at Company's option.

If any defect within this warranty appears within the warranty period, the Purchaser shall promptly notify the Company in writing. No material will be accepted for repair or replacement without written authorization of the Company.

Upon such authorization, and in accordance with instructions of the Company, parts or materials for which replacement is requested shall be returned to the Company for examination, with shipping charges prepaid by the Purchaser. Final determination as to whether a product is actually defective rests with the Company.

This warranty does not extend to any product which has been subjected to misuse, neglect, accident, improper installation, or use in violation of instructions furnished by the Company. The warranty does not extend to, or apply to, any unit which has been repaired or altered outside of the Company's factory by persons not expressly approved by the Company.

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