OPERATOR'S MANUAL

BIT 232, BIT 232-F
DIGITAL INTERFACE CARD

KEPCO INC.

MODEL
BIT 232, BIT 232-F
INTERFACE CARD

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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KEPCO®
THE POWER SUPPLIER™

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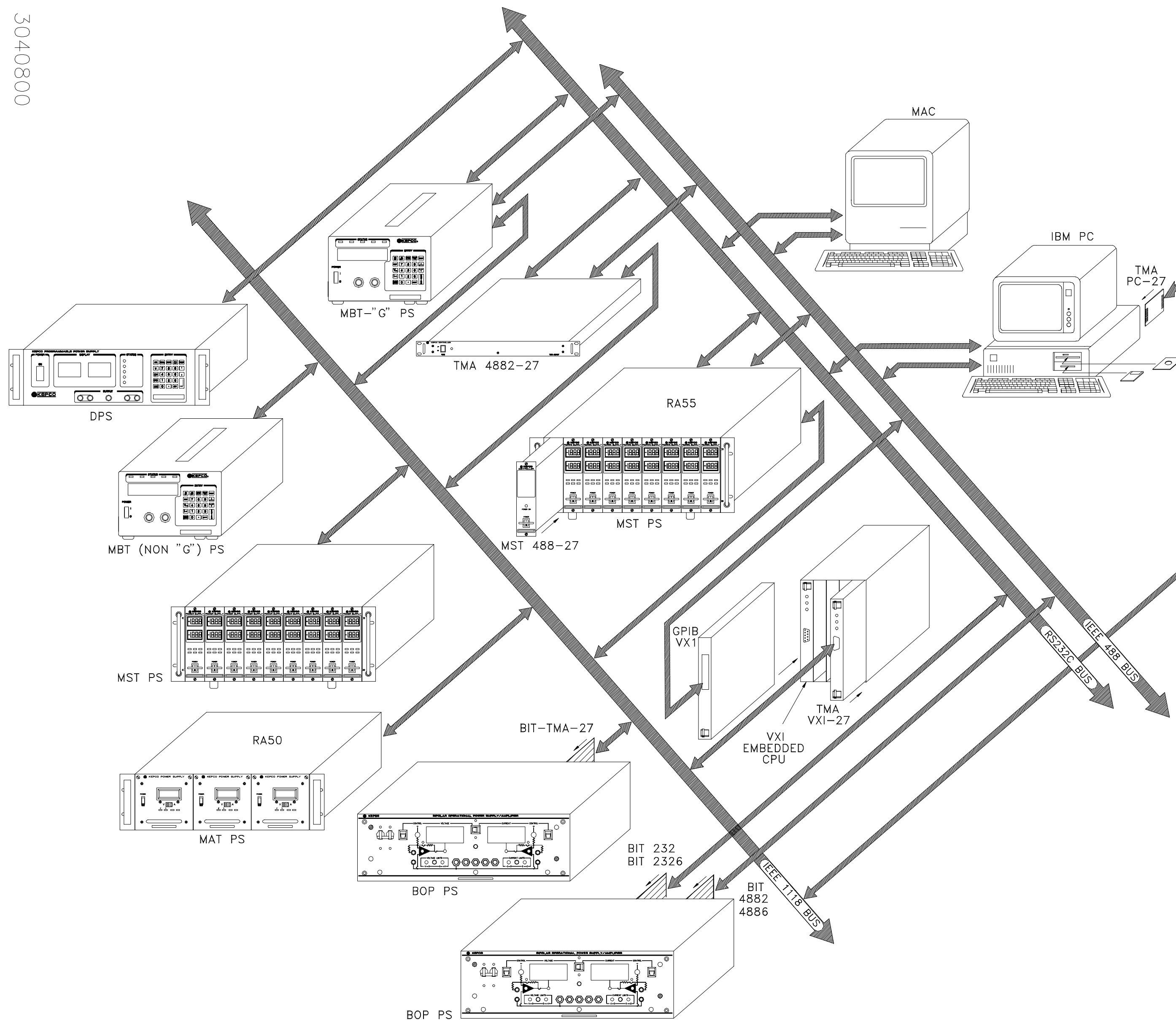


FIGURE 1-1. REMOTELY CONTROLLED POWER SUPPLY CONFIGURATIONS USING KEPCO PRODUCTS

SECTION 1 - INTRODUCTION

1.1 SCOPE OF MANUAL

This manual contains instructions for the installation, operation and maintenance of the BIT 232 and BIT 232-F Interface Cards manufactured by Kepco, Inc., Flushing, NY, U.S.A. References to “BIT Card” refer to both models.

1.2 GENERAL DESCRIPTION

The Kepco BIT Card Series were designed as an accessory for the Kepco BOP series bipolar power supplies. The BIT cards make it possible to control the BOP output by means of digital input signals (see Figure 1-1). The BIT card acts as an interface between the digital data bus and the BOP, accepting the digital input data and converting it to an analog signal, which in turn, controls the BOP output. The BIT 232 provides RS232 communication capability. It is fully compliant with SCPI and CIIL high level programming languages.

The BIT design group consists of five models. Field installable interface cards carry the prefix “BIT”. BOP bipolar power supplies with an installed BIT card carry the suffixes shown in Table 1-1.

TABLE 1-1. KEPCO BIT 232, 488 AND 4882 DIGITAL PROGRAMMING CARDS

FIELD INSTALLABLE PROGRAMMING CARD MODEL	FACTORY INSTALLED PROGRAMMING CARD BOP SUFFIX	INPUT CODING	RESOLUTION		REMARKS
			MAIN CHANNEL	LIMIT CHANNEL	
BIT 232 (See Table 1-2) BIT 232-F (See Table 1-2)	-232	SERIAL: 8 DATA BITS, NO PARITY BIT 1 STOP BIT	–	–	FOR THE RS 232-C BUS
BIT 488-B	-488-B	BYTE-SERIAL	12 BITS (BINARY)	8 BITS (BINARY)	FOR THE IEEE-488 OR GPIB BUS
BIT 488-D	-488-D	BYTE-SERIAL	3-DIGIT (BCD)	2-DIGIT (BCD)	
BIT 4882 (See Table 1-2) BIT 4882-F (See Table 1-2)	-4882	BYTE-SERIAL	12 BITS (BINARY)	12 BITS (BINARY)	
BIT TMA-27	-TMA	2-WIRE-SERIAL	12 BITS (BINARY)	12 BITS (BINARY)	KEPCO CONTROL BUS

Except for the installation procedures, the BIT 232 and 232-F cards are identical. The BIT 232F includes a replacement transformer needed to modify earlier BOP Models indicated in Table 1-2.

1.3 SPECIFICATIONS, BIT 232/BIT 232-F (SEE TABLE 1-3)

Refer to Table 1-3 for BIT 232/BIT 232-F specifications.

1.4 ACCESSORIES

The sample programs illustrated in Appendices E through G are available on 3.5 in. diskette, Kepco P/N 254-0019.

TABLE 1-2. APPLICABILITY OF BIT INTERFACE CARDS TO SPECIFIC BOP MODELS

BOP TO BE MODIFIED		APPLICABLE CARD	BOP TO BE MODIFIED		APPLICABLE CARD
MODEL	REVISION NO.		MODEL	REVISION NO.	
20-5M	1	BIT 232-F, BIT 4882-F	50-8M	4 TO 9	BIT 232-F, BIT 4882-F
	2 AND LATER	BIT 232, BIT 4882		10 AND LATER	BIT 232, BIT 4882
20-10M	12 TO 16	BIT 232-F, BIT 4882-F	72-3M	5 TO 9	BIT 232-F, BIT 4882-F
	17 AND LATER	BIT 232, BIT 4882		10 AND LATER	BIT 232, BIT 4882
20-20M	8 TO 14	BIT 232-F, BIT 4882-F	72-6M	7 TO 13	BIT 232-F, BIT 4882-F
	15 AND LATER	BIT 232, BIT 4882		14 AND LATER	BIT 232, BIT 4882
36-6M	12 TO 18	BIT 232-F, BIT 4882-F	100-1M	17 TO 23	BIT 232-F, BIT 4882-F
	19 AND LATER	BIT 232, BIT 4882		24 AND LATER	BIT 232, BIT 4882
36-12M	7 TO 12	BIT 232-F, BIT 4882-F	100-2M	10 TO 14	BIT 232-F, BIT 4882-F
	13 AND LATER	BIT 232, BIT 4882		15 AND LATER	BIT 232, BIT 4882
50-2M	16 TO 20	BIT 232-F, BIT 4882-F	100-4M	6 TO 13	BIT 232-F, BIT 4882-F
	21 AND LATER	BIT 232, BIT 4882		14 AND LATER	BIT 232, BIT 4882
50-4M	6 TO 12	BIT 232-F, BIT 4882-F	200-1M	6 AND EARLIER	BIT 232-F, BIT 4882-F
	13 AND LATER	BIT 232, BIT 4882		7 AND LATER	BIT 232, BIT 4882
NOTE: For modification of BOP Models with revision numbers that do not appear in this table, contact Kepco for assistance.					

TABLE 1-3. SPECIFICATIONS, BIT 232 AND BIT 232-F

SPECIFICATION		DESCRIPTION	
OUTPUT VOLTAGE (MAIN CHANNEL)		0 ± 10V	
OUTPUT VOLTAGE (LIMIT CHANNEL)		0 to +10V	
OUTPUT CURRENT (EACH CHANNEL)		0 to ± 2 mA max.	
OUTPUT IMPEDANCE		<0.05 ohms	
TEMPERATURE COEFFICIENT		Full scale: ± 35 ppm/°C max Zero: ± 20µV/°C max	
OPTICAL ISOLATION		Digital and Analog grounds can be separated by a maximum of 500 Volts.	
DIGITAL INPUT FORMAT		Serial, 8 data bits, no parity, 1 stop	
POWER REQUIREMENT		Supplied by BOP	
		RATING/DESCRIPTION	CONDITION
PRGRAMMING RESOLUTION	VOLTAGE	0.024%	12 Bits
	CURRENT		
DATA READBACK ACCURACY	VOLTAGE	0.2%	of Max. Voltage
	CURRENT		of Max. Current

SECTION 2 - INSTALLATION

2.1 UNPACKING AND INSPECTION

The BIT Card has been thoroughly inspected and tested prior to packing and is ready for operation following installation. Unpack, saving original packing material. If any indication of damage is found, file a claim immediately with the responsible transport service.

2.2 SET START-UP DEFAULTS (SEE FIGURE 2-2)

Start-up defaults, consisting of Start-up Language and Power Supply Identification are initially set by means of DIP switches as described in the following paragraphs.

2.2.1 START-UP LANGUAGE DEFAULT (SEE FIGURE 2-2)

DIP switch S1 position 6 sets the Start-up Language Default:

- OFF (0) = SCPI (factory default)
- ON (1) = CIIL

2.2.2 SET POWER SUPPLY IDENTIFICATION SWITCH (SEE FIGURE 2-2)

Power Supply Identification switch S2 (Figure 2-2) identifies the BOP model to be controlled by the BIT Card. Set Switch S2 positions 1 through 6 in accordance with Table 2-1.

2.3 INSTALLATION OF BIT CARD INTO THE BOP

Refer to Figure 2-1 to install the BIT 232-F BIT Card.

NOTE: Step numbers coincide with encircled numbers on Figure 2-1, sheet 2.

Step 1. Disconnect a-c power from BOP by removing line cord.

Step 2. Remove BOP cover (see Section 5, Figure 5-1 of your BOP Instruction Manual).

Step 3. Remove and discard Rear Cover Plate (PN 128-1434) and associated hardware.

Step 4. Remove J204 Connector Assembly (PN 241-0680) from Location #1, save for Step 11.

Step 5. Locate Transformer T202 and note part number (stamped on top):
if PN 100-2167, remove from unit and discard (applicable to BIT 232-F only).
if PN 100-2354, unplug connector from Location #4 only.

Step 6. Locate Rear Bracket and note part number (stamped on outside left edge)
if PN 128-1566, remove and discard, replace with Bracket noted in Step 9.

Step 7. Unpack the BIT Card Installation Components

BIT 232-F: (Transformer, PCB Assembly, Cables #1 and #2, Connector Assembly, three (3) Knurled Nuts, five (5) washers, Spacer and Bracket).

BIT 232: PCB Assembly, Cables #1 and #2, Connector Assembly, three (3) Knurled Nuts, five (5) washers, Spacer and Bracket).

Step 8. BIT 232-F only: Mount Transformer T202 (PN 100-2354) if required (ref. Step 5, above).

Step 9. Mount Rear Bracket (PN 128-1810) if required, (ref. Step 6, above).

Step 10. Install PCB Assembly (PN 235-1166) into the guides, slide into position so that mounting holes in PCB Assembly line up with the three mounting posts on the BOP mounting bracket.

Step 11. Secure the BIT Card to the Mounting Posts using the Knurled Nuts and Lockwashers. Mount Connector J204 (Ref. Step 4, above) into Location #3 using the Lockwashers, Hex Spacer and Knurled Nut.

Step 12. Install Cable #1 (18-position connectors) to the BIT Card; mate the other end of the cable with Location #1 on BOP A1 Assembly.

Step 13. Step 7AInstall Cable #2 (5-position connectors) to the BIT Card; mate the other end of the cable with Location #2 on BOP A1 Assembly.

Step 14. Plug in 3 and 9 pin Connectors and Primary Leads from Transformer 100-2354 as shown.

Step 15. Mark "-232" after Model No. on Nameplate (see Detail A).

Step 16. Remove “Control Identification” label (PN 188-1107) and “Address Label” (PN 188-1012). Affix revised “Control Identification” label (PN 188-1826) and “Address Label” (PN 188-1726) in vacated positions (with part numbers facing front panel).

Step 17. Affix “Connector Identification” label (PN 188-1912) to rear bracket (PN 188-1810) between rear programming connector and Interface Card (see Detail C).

Step 18. Reinstall BOP cover.

Step 19. Perform calibration procedure detailed in Section 3 of this manual.

FIGURE 2-1. INSTALLATION OF BIT CARD INTO BOP (SHEET 1 OF 2)

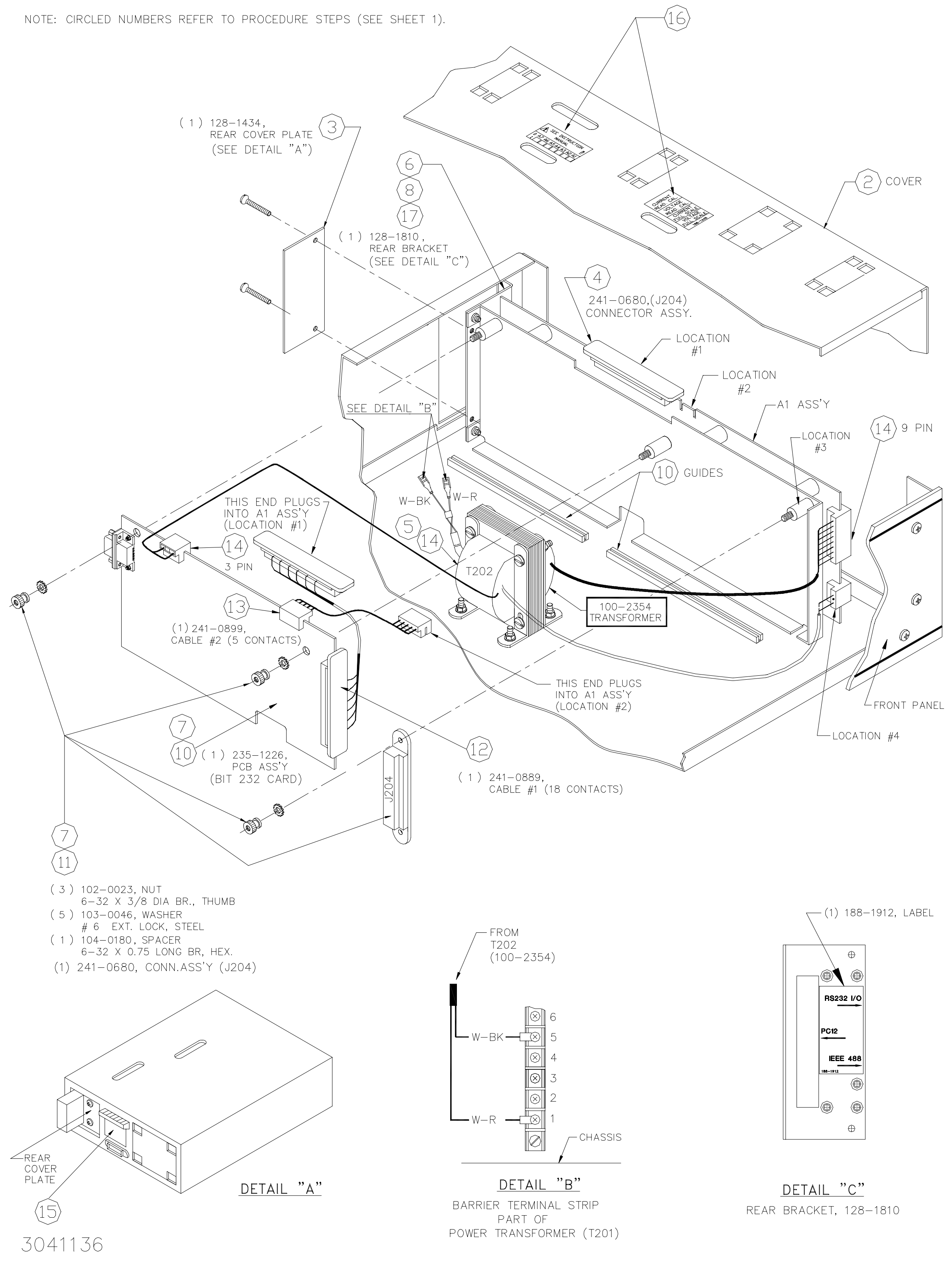

NOTE: CIRCLED NUMBERS REFER TO PROCEDURE STEPS (SEE SHEET 1).
16
2 COVER
(1) 128-1434, REAR COVER PLATE (SEE DETAIL "A")
3
6
8
17
(1) 128-1810, REAR BRACKET (SEE DETAIL "C")
4
241-0680,(J204) CONNECTOR ASSY.
LOCATION #1
LOCATION #2
A1 ASS'Y
SEE DETAIL "B"
LOCATION #3
14 9 PIN
10 GUIDES
W-BK
W-R
THIS END PLUGS INTO A1 ASS'Y (LOCATION #1)
14
3 PIN
5
14
T202
100-2354 TRANSFORMER
13
(1) 241-0899, CABLE #2 (5 CONTACTS)
THIS END PLUGS INTO A1 ASS'Y (LOCATION #2)
FRONT PANEL
LOCATION #4
7
10
(1) 235-1226, PCB ASS'Y (BIT 232 CARD)
12
(1) 241-0889, CABLE #1 (18 CONTACTS)
J204
7
11
(3) 102-0023, NUT 6-32 X 3/8 DIA BR., THUMB
(5) 103-0046, WASHER # 6 EXT. LOCK, STEEL
(1) 104-0180, SPACER 6-32 X 0.75 LONG BR, HEX.
(1) 241-0680, CONN.ASS'Y (J204)
REAR COVER PLATE
15
DETAIL "A"
FROM T202 (100-2354)
W-BK
W-R
6
5
4
3
2
1
CHASSIS
DETAIL "B"
BARRIER TERMINAL STRIP PART OF POWER TRANSFORMER (T201)
(1) 188-1912, LABEL
RS232 I/O
PC12
IEEE 488
188-1912
DETAIL "C"
REAR BRACKET, 128-1810
3041136

FIGURE 2-1. INSTALLATION OF BIT CARD INTO BOP (SHEET 2 OF 2).

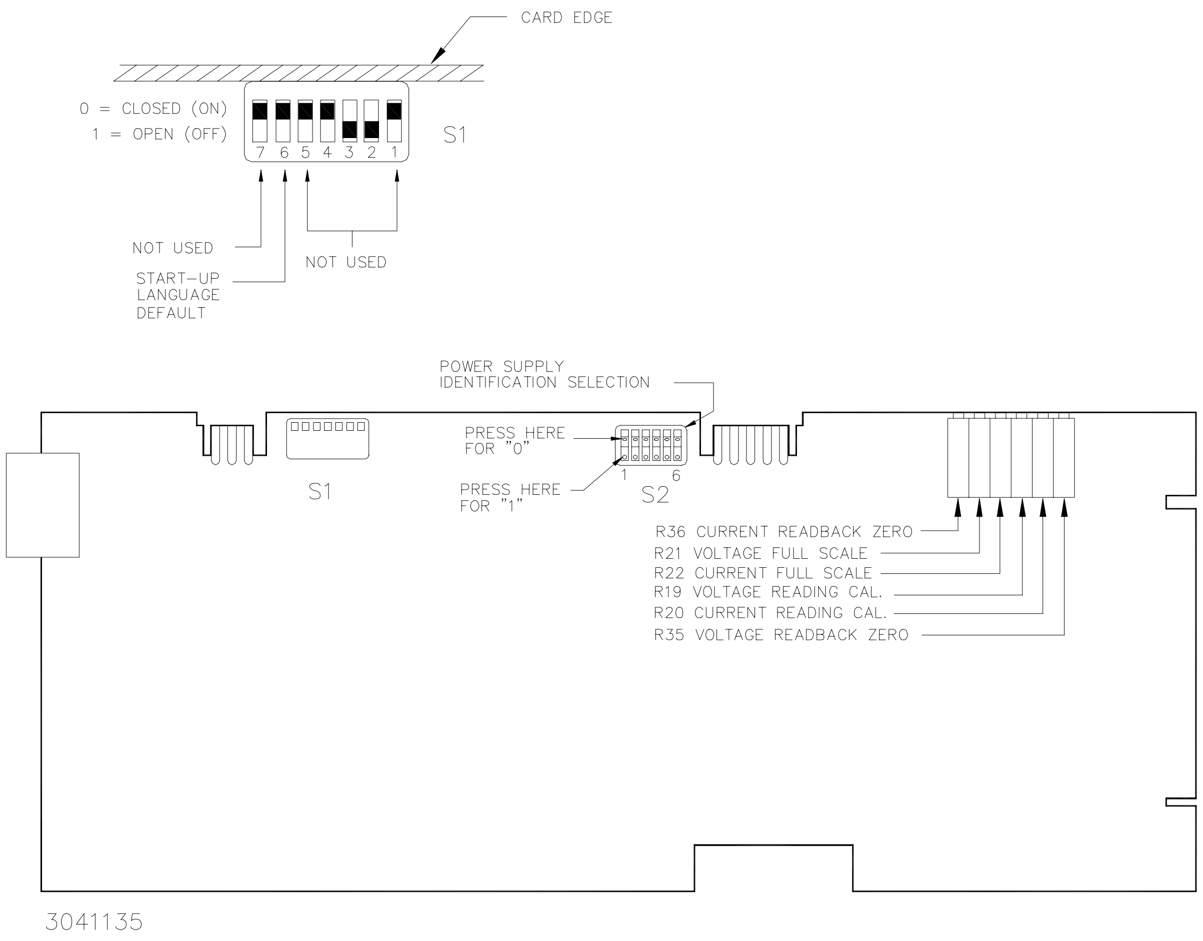


FIGURE 2-2. BIT 232/BIT 232-F SWITCH AND ADJUSTMENT LOCATIONS

TABLE 2-1. POWER SUPPLY IDENTIFICATION SWITCH S2 SETTING

MODEL	SELECTOR SWITCH S2 SECTION						HEX VALUE
	SW#1	SW#2	SW#3	SW#4	SW#5	SW#6	
BOP 50-2M	0	0	0	0	0	0	00
100-1M	1	0	0	0	0	0	01
20-10M	0	1	0	0	0	0	02
36-6M	1	1	0	0	0	0	03
50-4M	0	0	1	0	0	0	04
72-3M	1	0	1	0	0	0	05
100-2M	0	1	1	0	0	0	05
20-20M	1	1	1	0	0	0	07
36-12M	0	0	0	1	0	0	08
50-8M	1	0	0	1	0	0	09
72-6M	0	1	0	1	0	0	0A
100-4M	1	1	0	1	0	0	0B
200-1M	1	0	1	1	0	0	0C
20-5M	0	1	1	1	0	0	0D
BOP 50-2M	0	0	0	0	0	0	00

2.4 INPUT/OUTPUT SIGNALS

The RS232 port is a standard 9 pin connector (Figure 2-4) conforming to the IBM AT 9-Pin RS 232 Serial Interface. Refer to Table 2-3 for pin assignments.

TABLE 2-2. INPUT/OUTPUT PIN ASSIGNMENTS

PIN	SIGNAL NAME	FUNCTION
1	SGND	Signal Ground
2	RXD	Receive Data
3	TXD	Transmit Data
4	DTR	Data Terminal Ready
5	SGND	Signal Ground
6	DSR	Data Set Ready
7	RTS	Request To Send
8	CTS	Clear To Send
9	SGND	Signal Ground

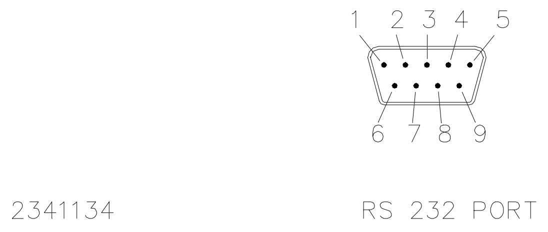


FIGURE 2-3. RS 232C CONNECTOR

2.5 RS 232 CONNECTIONS

Since the BIT Card uses a 9-pin male connector, it is classified as a Data Terminal Equipment (DTE) in accordance with the RS 232 Standard (equipment using a female connector is classified as Data Communication Equipment, DCE).

Either a DTE to DTE or a null modem cable is required to connect the BIT Card to an IBM-PC compatible computer. This cable connects RXD at one end to TXD at the other end, DTR at one end to DSR at the other end, and CTS at one end with RTS at the other end

SECTION 3 - CALIBRATION

NOTE: The calibration procedures below are for the purpose of recalibration and for the case where the BIT card is installed by the user. Unless otherwise noted, syntax is in SCPI.

3.1 EQUIPMENT REQUIRED

The following is a listing of equipment required for calibration of the BIT Card installed in a Kepco “BOP” Series Power Supply:

A. Precision digital voltmeter (DVM), 5 digit minimum resolution (suggested).

B. An RS232 compatible Controller, (with appropriate software) connected to BOP Power Supply with an RS232 cable.

C. Precision four-terminal current shunt (with suitable power rating and tolerance for the currents to be measured).

3.2 ADJUSTMENT OF THE BOP ±10 VOLT CALIBRATION CONTROLS (R31, R32)

NOTE: BOP cover removal required for this procedure.

1. Connect a DVM to the REAR PROGRAMMING CONNECTOR (PC-12); between common and pin 28 (+10Vdc REFERENCE).

2. Turn the BOP Power Supply “ON” and locate the calibration controls (see Figure 3-1, refer to Table 3-1). Adjust R31 for +10.000Vdc.

3. Turn the BOP Power Supply “OFF” and connect DVM between common and pin 22 (–10Vdc REFERENCE).

4. Turn the BOP Power Supply “ON”. Adjust R32 for –10.000Vdc.

5. Turn the BOP Power Supply “OFF”.

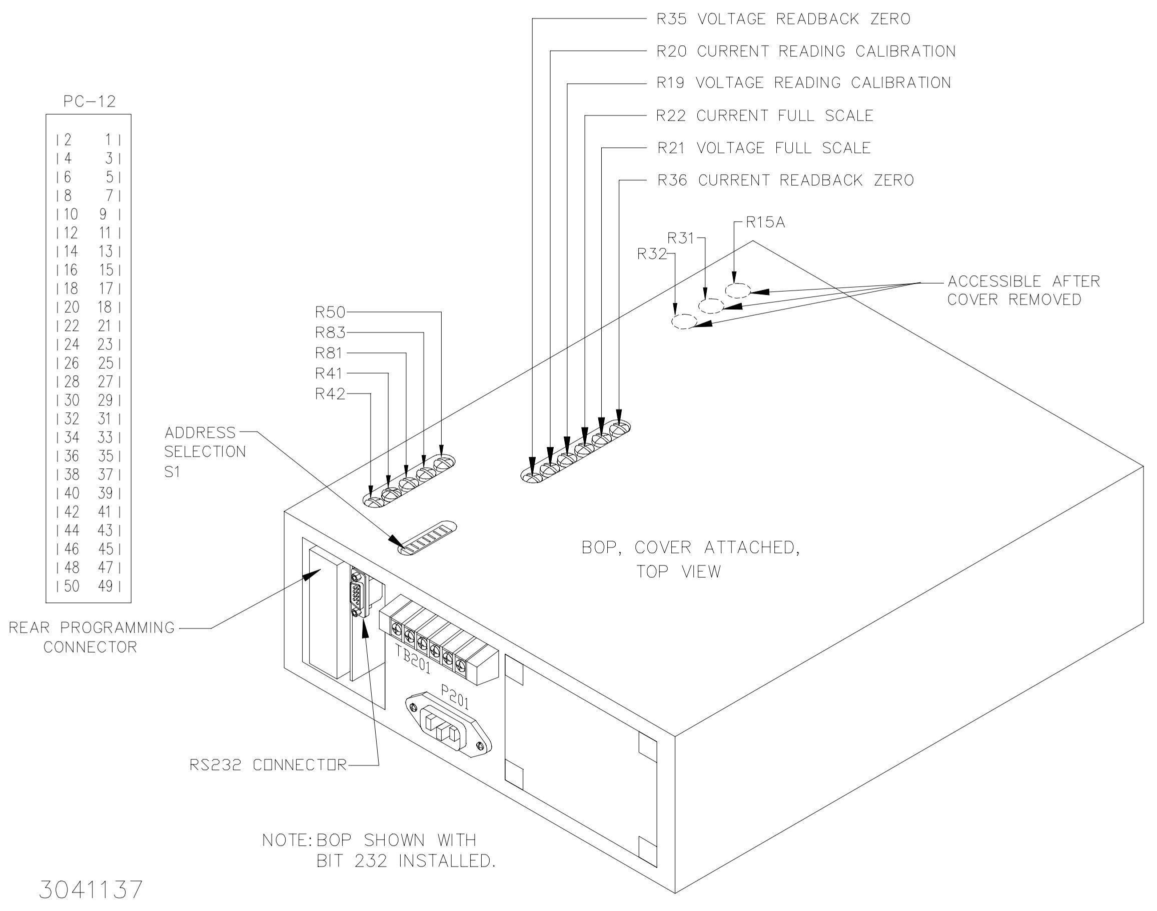
3.3 ADJUSTMENT OF THE AMMETER ZERO (R50)

1. Without a load connected to the BOP output, connect the DVM to the REAR PROGRAMMING CONNECTOR (PC-12); between COMMON and pin 10.

2. Turn the BOP Power Supply “ON” and locate AMMETER ZERO control R50 (see Figure 3-1, refer to Table 3-1).

3. Adjust the control for zero, ±100 microvolts.

4. Turn the BOP Power Supply “OFF”.



R35 VOLTAGE READBACK ZERO
R20 CURRENT READING CALIBRATION
R19 VOLTAGE READING CALIBRATION
R22 CURRENT FULL SCALE
R21 VOLTAGE FULL SCALE
R36 CURRENT READBACK ZERO
PC-12
R15A
R31
R32
ACCESSIBLE AFTER COVER REMOVED
R50
R83
R81
R41
R42
ADDRESS SELECTION S1
BOP, COVER ATTACHED, TOP VIEW
REAR PROGRAMMING CONNECTOR
TB201
P201
RS232 CONNECTOR
NOTE: BOP SHOWN WITH BIT 232 INSTALLED.
3041137

FIGURE 3-1. BOP POWER SUPPLY, INTERNAL CALIBRATION CONTROL LOCATIONS

3.4 ADJUSTMENT OF THE OUTPUT VOLTAGE ZERO (R81)

1. Without a load connected to the BOP output, connect a DVM between the FRONT PANEL SENSING TERMINALS of the BOP Power Supply.
2. Turn the BOP Power Supply “ON”, program the BOP Power Supply to ZERO VOLTAGE AND MAXIMUM CURRENT LIMIT.
3. Locate Eo COMP AMP ZERO control R81 (see Figure 3-1, refer to Table 3-1).
4. Adjust control R81 for zero, ±100 microvolts.

3.5 ADJUSTMENT OF THE FULL SCALE OUTPUT VOLTAGE (R21)

1. Program the BOP Power Supply for PLUS FULL SCALE VOLTAGE.
2. Locate VOLTAGE FULL SCALE control R21 (see Figures 2-1 and 3-1, refer to Table 3-1).
3. Adjust control R21 for FULL SCALE VOLTAGE, ±1 millivolt.
4. Program the BOP Power Supply for MINUS FULL SCALE. The output should be NEGATIVE FULL SCALE ±0.024% (±1 LSB).

TABLE 3-1. BOP POWER SUPPLY, INTERNAL CALIBRATION CONTROLS

REFERENCE DESIGNATION	CONTROL NAME	PURPOSE	ADJUSTMENT PROCEDURE (PAR.)
R19	**VOLTAGE READING**	'MEASURE'd voltage reading adjustment	3.7
R20	**CURRENT READING**	'MEASURE'd current reading adjustment	3.11
R21	**VOLTAGE FULL SCALE**	Full scale output voltage adjustment	3.5
R22	**CURRENT FULL SCALE**	Full scale output current adjustment	3.9
R31, R32	**(±) 10V CAL.**	Reference voltage calibration	3.2
R35	**VOLTAGE READBACK ZERO**	Aero output voltage adjustment	3.6
R36	**CURRENT READBACK ZERO**	Zero output current adjustment	3.10
R50	**AMMETER ZERO**	Sensing amplifier offset adjustment	3.3
R81	**E_O COMP AMP ZERO**	Voltage channel zero adjustment	3.4
R83	**I_O COMP AMP ZERO**	Current channel zero adjustment	3.8

3.6 VOLTAGE READING ZERO CALIBRATION (R35)

1. Program the BOP power supply for ZERO VOLTAGE and MAXIMUM CURRENT LIMIT.
2. 'MEASURE' ('FETCH' in CIIL syntax) the OUTPUT VOLTAGE of the BOP.
3. Locate VOLTAGE READBACK ZERO control R35 (see Figures 2-1 and 3-1, refer to Table 3-1).
4. Continue to 'MEASURE' ('FETCH' in CIIL syntax) the VOLTAGE READING while adjusting control R35 until the 'MEASUREd' ('FETCHed' in CIIL syntax) value is not 0.0.
5. Continue to 'MEASURE' ('FETCH' in CIIL syntax) the VOLTAGE READING while adjusting control R35 until the 'MEASUREd' ('FETCHed' in CIIL syntax) value is 0.0. Once a stable value of 0.0 is reached, continue rotating R35 four full (360°) turns in the same direction. Verify VOLTAGE READING is 0.0.

3.7 VOLTAGE READING CALIBRATION (R19)

1. Program the BOP Power Supply for PLUS FULL SCALE VOLTAGE, less one percent (verify by reading external DVM).

NOTE: If the unit is calibrated using CIIL syntax, send the 'GAL' command followed by the 'FØ' switch command.

2. 'MEASURE' ('FETCH' in CIIL syntax) the OUTPUT VOLTAGE of the BOP Power Supply.
3. Locate VOLTAGE READ. CAL. control R19 (see Figures 2-1 and 3-1, refer to Table 3-1).

4. Continue to ‘MEASURE’ (‘FETCH’ in CIIL syntax) the VOLTAGE READING while adjusting control R19, until the ‘MEASUREd’ (‘FETCHed’ in CIIL syntax) value matches the programmed value.

5. Turn the BOP Power Supply “OFF”.

3.8 ADJUSTMENT OF THE OUTPUT CURRENT ZERO (R83)

1. With the BOP Power Supply “OFF”, connect a precision current shunt between the FRONT PANEL OUTPUT TERMINALS.

2. Connect the DVM to the REAR PROGRAMMING CONNECTOR (PC 12); between COMMON and pin 10.

3. Turn the BOP “ON” and program the BOP Power Supply to ZERO CURRENT and MAXIMUM VOLTAGE LIMIT.

4. Locate Io COMP AMP ZERO control R83 (see Figure 3-1, refer to Table 3-1).

5. Adjust control R83 for zero, ±0.5 millivolts.

6. Turn the BOP Power Supply “OFF”.

3.9 ADJUSTMENT OF THE FULL SCALE OUTPUT CURRENT (R22)

1. With the BOP Power Supply “OFF”, connect the DVM to the PRECISION 4-TERMINAL SHUNT (see Figure 3-2)

2. Turn the BOP Power Supply “ON” and program the BOP Power Supply for PLUS FULL SCALE CURRENT and MAXIMUM VOLTAGE LIMIT.

3. Locate CURRENT FULL SCALE control R22 (see Figures 2-1 and 3-1, refer to Table 3-1).

4. Adjust control R22 for exactly FULL SCALE CURRENT.

5. Program the BOP Power Supply for MINUS FULL SCALE CURRENT. The output should be NEGATIVE FULL SCALE within ±0.024% (±1 LSB or ±1 mA [which ever is greater]) of the POSITIVE VALUE.

3.10 CURRENT READING ZERO CALIBRATION (R36)

1. Program the BOP Power Supply for ZERO CURRENT and MAXIMUM VOLTAGE LIMIT.

2. ‘MEASURE’ (‘FETCH’ in CIIL syntax) the OUTPUT CURRENT of the BOP Power Supply.

3. Locate CURRENT READBACK ZERO control R36 (see Figures 2-1 and 3-1, refer to Table 3-1).

4. Continue to ‘MEASURE’ (‘FETCH’ in CIIL syntax) the CURRENT, while adjusting control R36, until the ‘MEASUREd’ (‘FETCHed’ in CIIL syntax) value is not 0.0.

5. Continue to ‘MEASURE’ (‘FETCH’ in CIIL syntax) the OUTPUT CURRENT while adjusting control R36 until the ‘MEASUREd’ (‘FETCHed’ in CIIL syntax) value is 0.0. Once a stable value of 0.0 is reached, continue rotating R36 four full (360°) turns in the same direction. Verify OUTPUT CURRRENT is 0.0.

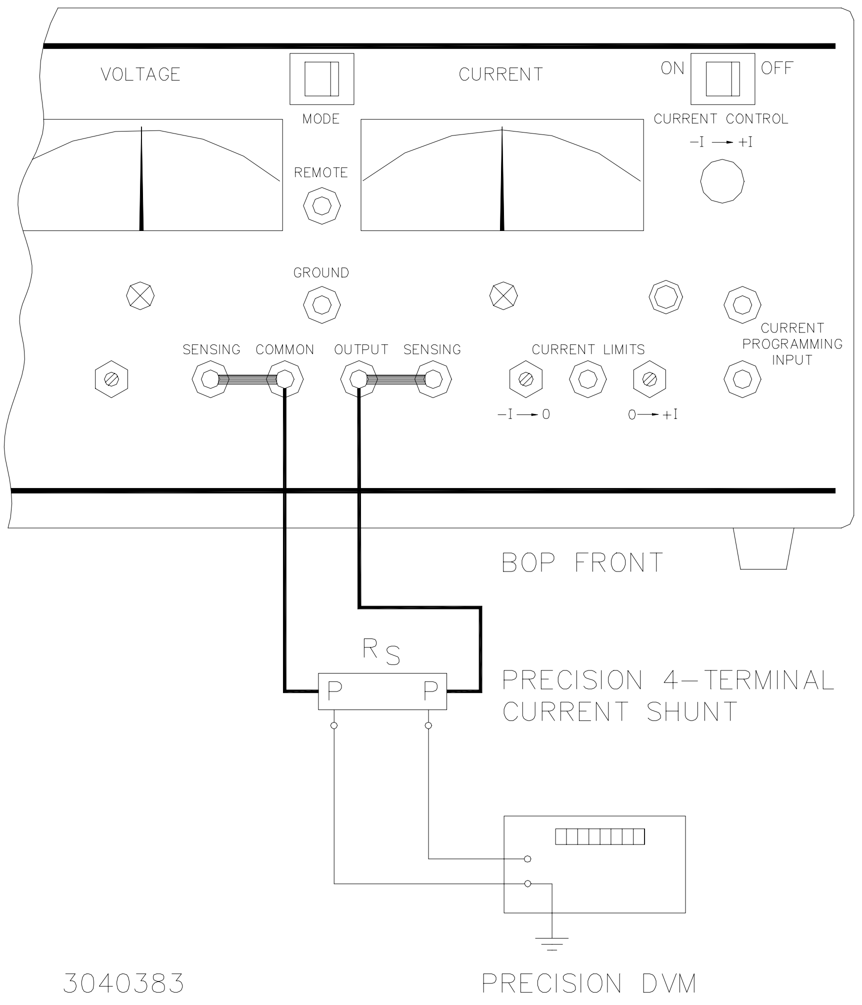


FIGURE 3-2. CURRENT SHUNT CONNECTIONS

3.11 CURRENT READING CALIBRATION (R20)

1. Program the BOP Power Supply for PLUS FULL SCALE CURRENT, less one percent (verify by reading external DVM).

NOTE: If the unit is calibrated using CIIL syntax, send the 'GAL' command followed by the 'FØ' switch command.

2. 'MEASURE' ('FETCH' in CIIL syntax) the OUTPUT CURRENT of the BOP Power Supply.

3. Locate CURRENT READ. CAL. control R20 (see Figures 2-1 and 3-1, refer to Table 3-1).

4. Continue to 'MEASURE' ('FETCH' in CIIL syntax) the CURRENT while adjusting control R20, until the 'MEASUREd' ('FETCHed' in CIIL syntax) value matches the programmed value.

SECTION 4 - OPERATION

4.1 GENERAL

The Kepco BOP Power Supply, with an installed BIT 232/BIT 232-F Interface Card, may be programmed over the RS232C bus using either SCPI (Standard Commands for Programmable Instruments) or CIIL (Control Interface Intermediate Language) commands. SCPI and CIIL provide a common language used in an automatic test system. (Refer to Table 2-3 for input/output signal allocations.)

4.2 RS232-C BUS PROTOCOL

The BIT Card may be operated via an RS232-C terminal, or from a PC using a terminal emulation program. The following settings must be observed:

• Baud rate:	9600
• Parity:	None
• Data Bits	8
• Stop Bits	1

The above settings are established by the firmware and cannot be changed by the user although firmware with alternate settings can be ordered. It is recommended that the user program the computer's serial interface to match the above setting. Refer to PAR. 2.5 for RS232 connections.

4.3 RS232 IMPLEMENTATION

The following paragraphs are provided to help the user understand how the RS232 interface is implemented in the BIT 232 and BIT 232-F Interface Cards. Since the RS232 protocol does not use a parity bit, the echo method is used to ensure reliable communication between the command originator (computer) and the BIT Card, thus avoiding a more complex "handshake" protocol.

When a character is received through the RS232 Interface, the software checks for the backspace character, hex value 08 (08_H). If the backspace character is not detected, the received character is put in a buffer, the buffer pointer is incremented, and it is sent (echoed) back to the originator. If the backspace character is detected, the buffer pointer is decremented, and three characters are sent to the originator: Backspace (08_H), Blank (20_H), and Backspace (08_H). These three characters permit a direct interface with a terminal emulation program, effectively erasing the last character.

When either a Carriage Return, CR, ($0D_H$ decimal value 13, 13_{10}) or Line Feed, LF, ($0A_H$, 10_{10}) is received by the BIT Card, the buffer contents are transferred to the SCPI (PAR.4.4) or CIIL (PAR. 4.5) parser for analysis and execution of command(s). If the command requires the power supply to respond, the response message is immediately returned to the command originator via the RS232 interface.

To inform the command originator that the parsing and execution phases are complete, the BIT Card returns the following three characters: CR, LF, and > ($3E_H$, 62_{10}). These characters create the "prompt" effect if a terminal emulation program is the command(s) originator.

Sample programs provided in Appendices D through G guide the user in setting up a program to communicate with the BOP via the BIT 232/BIT 232-F Interface Card.

4.4 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 BIT Card as output strings within the selected programming language (PASCAL, BASIC, etc.) in accordance with the manufacturer's requirements for the particular interface card used.

Different programming languages (e.g., BASIC, C, PASCAL, etc.) have different ways of representing data that is to be put on the RS232C bus. It is up to the programmer to determine how to output the character sequence required for the programming language used. Address information must be included before the command sequence.

4.4.1 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.

4.4.2 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 4-4). Refer also to syntax considerations (PARs 4.4.3 through 4.4.6).

4.4.3 SCPI SUBSYSTEM COMMAND/QUERY STRUCTURE

Subsystem commands/queries are related to specific power supply functions (such as setting output voltage, current limit, etc.) Figure 4-1 is a tree diagram illustrating the structure of SCPI subsystem commands used in the BIT Card with the "root" at the left side, and specific commands forming the branches. The subsystem commands are defined and explained in Appendix B (see Table 4-4).

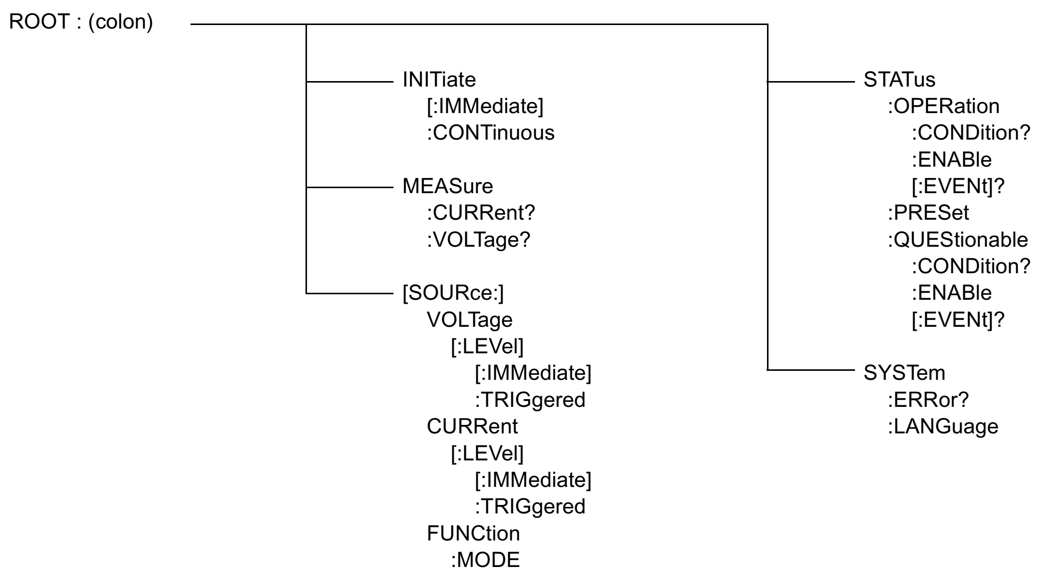


FIGURE 4-1. TREE DIAGRAM OF SCPI COMMANDS USED WITH BIT 232/BIT 232-F INTERFACE CARD

4.4.4 PROGRAM MESSAGE STRUCTURE

SCPI program messages (commands from controller to power supply) consist of one or more ***message units*** ending in a ***message terminator*** (required by Kepco power modules). The message terminator is not part of the syntax; it is defined by the way your programming language indicates the end of a line (such as a “newline” or “end-of-line” character). The message unit is a keyword consisting of a single command or query word followed by a message terminator (e.g., CURR?<newline> or TRIG<end-of-line>). The message unit may include a data parameter after the keyword separated by a space; the parameter is usually numeric (e.g., CURR 5<newline>), but may also be a string (e.g., OUTP ON<newline>). Figure 4-2 illustrates the message structure, showing how message units are combined. The following subparagraphs explain each component of the message structure.

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

4.4.4.1 KEYWORD

Keywords are instructions recognized by a decoder within the BIT Card, referred to as a “parser.” Each keyword describes a command function; all keywords used by the BIT Card are listed in Figure 4-1.

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 4-5.

TABLE 4-1. SCPI COMMAND INDEX

COMMAND	PAGE	COMMAND	PAGE
*CLS	A-1	[SOUR]:CURR?	B-5
*ESE	A-2	[SOUR]:CURR:TRIG	B-6
*ESE?	A-2	[SOUR]:CURR:TRIG?	B-6
*ESR?	A-3	[SOUR]:VOLT	B-7
*IDN?	A-3	[SOUR]:VOLT?	B-7
*OPC	A-4	[SOUR]:VOLT:TRIG	B-8
OPC?	A-4	[SOUR]:VOLT:TRIG?	B-8
*RST	A-5	[SOUR]:FUNC:MODE	B-9
*SRE	A-6	STAT:OPER:COND?	B-9
*SRE?	A-6	STAT:OPER:ENAB	B-10
*STB?	A-7	STAT:OPER:ENAB?	B-10
*TRG	A-7	STAT:OPER?	B-11
*TST	A-8	STAT:PRES	B-11
*WAI	A-8	STAT:QUES?	B-12
INIT[:IMM]	B-1	STAT:QUES:COND?	B-12
INIT:CONT	B-1	STAT:QUES:ENAB	B-13
INIT:CONT?	B-2	STAT:QUES:ENAB?	B-13
MEAS:CURR?	B-3	SYST:ERR?	B-14
MEAS:VOLT?	B-3	SYST:LANG	B-14
[SOUR]:CURR	B-4		

TABLE 4-2. 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

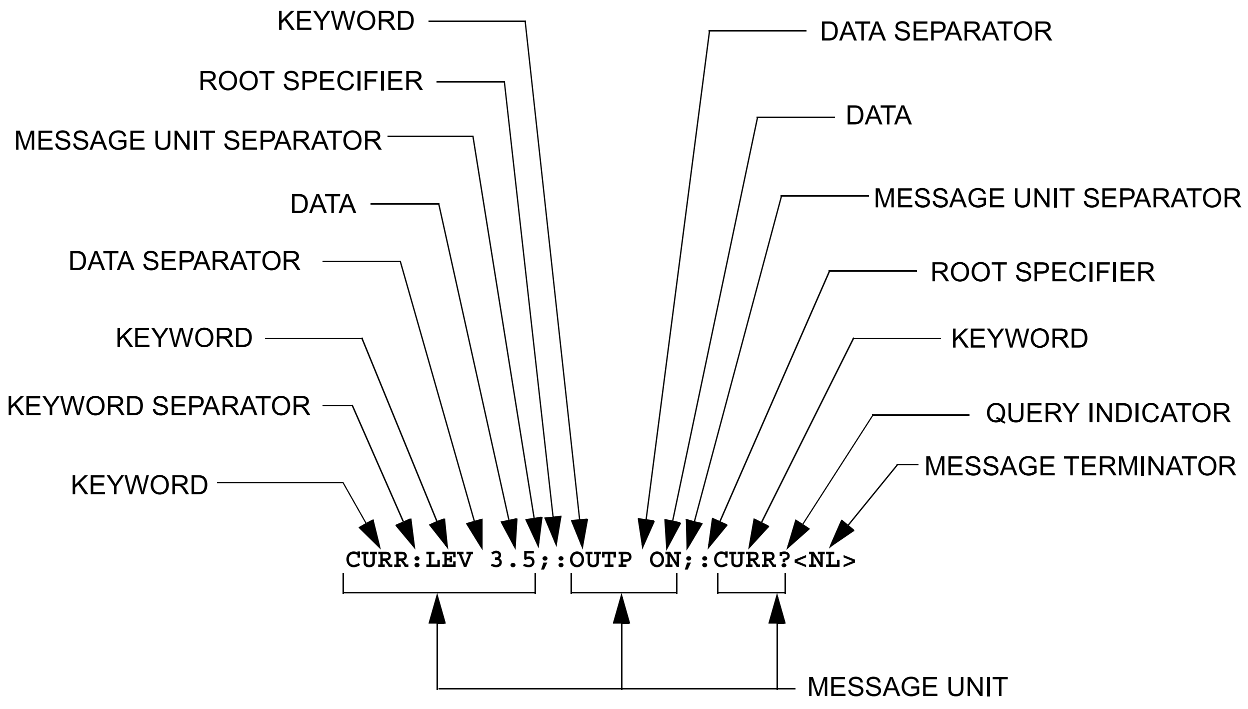


FIGURE 4-2. MESSAGE STRUCTURE

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).

4.4.4.2 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 4.4.4.7).

4.4.4.3 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?).

4.4.4.4 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

4.4.4.5 DATA SEPARATOR

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

4.4.4.6 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).

4.4.4.7 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 4-3) 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.

4.4.4.8 MESSAGE TERMINATOR

The message terminator defines the end of a message. Three message terminators are permitted:

- new line (<NL>), ASCII 10 (decimal) or 0A (hex)
- (<CR>), ASCII 13 (decimal) or 0D (hex)
- both of the above (<CR> <NL>)

NOTE: Kepco power modules ***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.

4.4.5 UNDERSTANDING THE COMMAND STRUCTURE

Understanding the command structure requires an understanding of the subsystem command tree illustrated in Figure 4-3. 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 BIT Card are :INITiate, :MEASure, :OUTPut, [:SOURce], :STATus, and :SYSTem. 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.

4.4.6 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**

4.5 CIIL PROGRAMMING

The CIIL command language is used on early models of Kepco power supplies and controllers. The command functions are included here for compatibility with other equipment programmed with CIIL commands. The CIIL command set for the BIT Card is defined and explained in Appendix C.

4.6 PROGRAMMING EXAMPLES

Appendices D through G provide sample programs which can be altered and adapted by the user for specific applications, or used exactly as shown. All programs shown use SCPI commands; these can be adapted to use CIIL commands by changing the command strings to CIIL.

Appendix D is a C language program used with an IBM compatible computer running a terminal emulation program.

Appendix E is a C language program which automatically programs a series of commands

Appendix F is comprised of C language function prototypes used as building blocks for the programs in Appendices D and E. These function prototypes can also aid the user in creating new programs for unique applications.

Appendix G is a QuickBasic language program which executes some commands and also implements terminal emulation .

APPENDIX A - SCPI COMMON COMMAND/QUERY DEFINITIONS

A.1 INTRODUCTION

This appendix defines the SCPI common commands and queries used with the BIT 232/BIT 232-F Interface Card. Common 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 SCPI common commands and queries used in the BIT Card.

TABLE A-1. SCPI COMMON COMMAND/QUERY INDEX

COMMAND	PAGE	COMMAND	PAGE
*CLS	A-1	*RST	A-5
*ESE	A-2	*SRE	A-6
*ESE?	A-2	*SRE?	A-6
*ESR?	A-3	*STB?	A-7
*IDN?	A-3	*TRG	A-7
*OPC	A-4	*TST	A-8
*OPC?	A-4	*WAI	A-8

*CLS

Syntax: *CLS

Function: Clear status data

Response: Not Applicable

Description: Forces power supply to “operation complete idle” and “operation complete query” state. Clears all Event Registers summarized in Status Byte Register.

Clears Standard Event Status, Operation Status Event, Questionable Status Event, and Status Byte Registers. Clears the error queue.

Example: *CLS Power supply clears status data.

FIGURE A-1. *CLS — CLEAR STATUS COMMAND

*ESE

Syntax: *ESE <integer>
<integer> = positive whole number: 0 to 255 per **STANDARD EVENT STATUS ENABLE REGISTER BITS** table below.

Function: Sets ESE (standard Event Status Enable) register bits to enable the Standard events to be summarized in the Status Byte register (1 = set = enable function, 0 = reset = disable function).

Response: Not applicable

Description: 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.

STANDARD EVENT STATUS ENABLE REGISTER BITS

CONDITION	NU	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

NU	(Not Used)
CME	Command Error
EXE	Execution Error
DDE	Device Dependent Error
QUE	Query Error
OPC	Operation Complete

Example: *ESE 49 Power supply enables bits 0, 4 and 5) allowing command error, execution error and operation complete conditions to be recorded in the Event Status Register.

FIGURE A-2. *ESE — STANDARD EVENT STATUS ENABLE COMMAND

*ESE?

Syntax: *ESE?

Response: <integer> value per **STANDARD EVENT STATUS ENABLE REGISTER BITS** table below.

Function: Returns the status of the Standard Event Status Enable Register

Description: 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).

STANDARD EVENT STATUS ENABLE REGISTER BITS

CONDITION	NU	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

NU	(Not Used)
CME	Command Error
EXE	Execution Error
DDE	Device Dependent Error
QUE	Query Error
OPC	Operation Complete

Example:

*ESE 49	Power Supply enables bits 0, 4 and 5
*ESE?	Controller reads <value> 49, verifying that bits 0, 4 and 5 have been enabled.

FIGURE A-3. *ESE? — STANDARD EVENT STATUS ENABLE QUERY

*ESR?

Syntax: *ESR?

Response: <integer> value per **STANDARD EVENT STATUS REGISTER BITS** table below.

Function: This query reads the Standard Event Status Event register, clearing the register at the same time.

Description: The Standard Event Status Event register bit configuration is shown below (1 = set = enable function, 0 = reset = disable function):

STANDARD EVENT STATUS REGISTER BITS

CONDITION	NU	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

NU	(Not Used)
CME	Command Error
EXE	Execution Error
DDE	Device Dependent Error
QUE	Query Error
OPC	Operation Complete

Example: *ESE 49 Power supply enables bits 0, 4 and 5
*ESR? Controller reads <value> 48 (bits 4 and 5 set), indicating Command Error and Execution error have occurred since the last time the register was read.

FIGURE A-4. *ESR? — EVENT STATUS REGISTER QUERY

*IDN?

Syntax: *IDN?

Function: Identifies the instrument.

Response: Character string.

Description: Power Supply responds with model and version.

Example: *IDN? Controller reads character string: “KEPCO BOP BIT 232 REV ***n***”
where ***n*** = applicable revision number.

FIGURE A-5. *IDN? — IDENTIFICATION QUERY

*OPC

Syntax: *OPC

Function: Causes power supply to set status bit 0 (Operation Complete) when pending operations are complete

Description: This command sets Standard Event Status Register bit 0 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)

STANDARD EVENT STATUS REGISTER BITS

CONDITION	NU	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

NU	(Not Used)
CME	Command Error
EXE	Execution Error
DDE	Device Dependent Error
QUE	Query Error
OPC	Operation Complete

Example: 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).

FIGURE A-6. *OPC — OPERATION COMPLETE COMMAND

*OPC?

Syntax: *OPC?

Function: Indicates when pending operations have been completed.

Response: <1>

Description: 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.

Example: Controller sends command(s), then sends *OPC?
Controller waits until power supply responds with “1” on bus, indicating previous commands are complete, then proceeds to execute subsequent commands.

FIGURE A-7. *OPC? — OPERATION COMPLETE QUERY

*RST

Syntax: *RST

Function: Resets power supply as defined below:

Response: None

Description: Establishes the following power supply parameters:

CURR[:LEV][:IMM]	0
VOLT[:LEV][:IMM]	0
FUNC:MODE	VOLT

Example: *RST Power supply responds by establishing default states defined above.

FIGURE A-8. *RST — RESET COMMAND

*SRE

Syntax: *SRE<integer>
<integer> = value from 0 - 255 per **SERVICE REQUEST ENABLE REGISTER** table below, except bit 6 cannot be programmed.

Function: Programs the Service Enable Register to determine which events of the Status Byte Register will cause the power supply to generate a service request

Description: When a Service Request Enable Register bit is set (“1”), the corresponding Status Byte Register bit (set to “1”) causes the RQS and MSS bits to be set (1 = set = enable function, 0 = reset = disable function). All enabled Service Request Enable Register bits are logically ORed to set bit 6 (MSS/RQS) of the Status byte register. Bit 6 is also set by the power supply to request service (RQS). (See also Figure 3-12, *STB?)

SERVICE REQUEST ENABLE REGISTER BITS

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

MSS	Master Status Summary
RQS	Request for Service
ESB	Event Status Byte summary
MAV	Message available
NU	(Not Used)

Example: *SRE112 Power supply will set bit 6 (MSS/RQS) if any event status register bit is set (ESB = 1), or any message is available (MAV = 1)

FIGURE A-9. *SRE — SERVICE REQUEST ENABLE COMMAND

*SRE?

Syntax: *SRE?

Response: <integer> = value from 0 - 255 per **SERVICE REQUEST ENABLE REGISTER** table below,.

Function: Reads the Service Enable Register to determine which events of the Status Byte Register are programmed to cause the power supply to generate a a service request (1 = set = function enabled, 0 = reset = function disables).

Description: See *SRE command (Figure 3-11) and *STB? command (Figure 3-13).

SERVICE REQUEST ENABLE REGISTER BITS

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

MSS	Master Status Summary
RQS	Request for Service
ESB	Event Status Byte summary
MAV	Message available
NU	(Not Used)

Example: *SRE? Power supply responds with 32 to indicate that the power supply will request service if the Event Status Byte summary bit is set.

FIGURE A-10. *SRE? — SERVICE REQUEST ENABLE QUERY

*STB?

Syntax: *STB?

Response: <integer> value from 0 to 255 per table below

Function: Read Status Byte Register without clearing it

Description: 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; ands RQS will be reset.)

STATUS BYTE REGISTER BITS

CONDITION	N#HI	MSS RQS	ESB	MAV	NODE NUMBERS (ADDRESS)			
BIT	7	6	5	4	3	2	1	0
VALUE	128	64	32	16	8	4	2	1

N#HI	Node number high
MSS	Master Status Summary
RQS	Request for Service
ESB	Event Status Byte summary
MAV	Message available

Example: *STB? Power supply responds with 96 (64 + 32) to indicate MSS and the Event Status Byte summary bit have been set.

FIGURE A-11. *STB? — STATUS BYTE REGISTER QUERY

*TRG

Syntax: *TRG

Function: Triggers the power supply to be commanded to preprogrammed value of output current and voltage.

Description: This command causes the power supply to be commanded to the output voltage and current levels specified by VOLT:TRIG and CURR:TRIG commands, respectively (see Figures B-13 and B-9).

Example 1:

VOLT 25	Power supply voltage commanded to 25V.
VOLT:TRIG 15	Programs power supply voltage to 15V when *TRG received.
INIT	Trigger event is initialized.
*TRG	Power supply reverts to commanded output voltage of 15V.

FIGURE A-12. *TRG — TRIGGER COMMAND

*TST?

Syntax: *TST?

Response:

0	= pass test
1	= fail test

Function: Power Supply test

Description: This query causes the power supply to do a self-test and provide the controller with pass/fail results.

CAUTION: TO AVOID DAMAGE TO THE LOAD, DISCONNECT THE LOAD BEFORE ISSUING THIS COMMAND. (DURING THE SELF-TEST, THE BOP IS PROGRAMMED TO FULL SCALE POSITIVE AND FULL SCALE NEGATIVE OUTPUT.)

Example:

*TST?	Power supply executes self test and responds with 0 if test completed successfully, with 1 if test failed.

FIGURE A-13. *TST? — SELF TEST QUERY

*WAI

Syntax: *WAI

Function: Causes the power supply to wait until all previously issued commands and queries are complete before executing subsequent commands or queries.

Description: This command can be used to guarantee sequential execution of commands and queries. When all pending operations are complete (all previous commands have been executed, changes in output level have been completed), the WAI command is completed and execution of subsequent commands can continue.

Example:

Controller sends Command 1	Power supply begins execution of command 1.
Controller sends *WAI	Power supply waits for command 1 to be completed before executing command 2.
Controller sends Command 2	Command 2 executed after command 1 is completed.

FIGURE A-14. *WAI — WAIT-TO-CONTINUE COMMAND

APPENDIX B - SCPI COMMAND/QUERY DEFINITIONS

B.1 INTRODUCTION

This appendix defines the SCPI subsystem commands and queries used with the BIT 232/BIT 232-F Interface Card. Subsystem commands are defined in Figures B-1 through B-26, 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 BIT Card.

TABLE B-1. SCPI SUBSYSTEM COMMAND/QUERY INDEX

COMMAND	PAGE	COMMAND	PAGE
INIT[:IMM]	B-1	[SOUR]:FUNC:MODE	B-9
INIT:CONT	B-2	STAT:OPER:COND?	B-9
INIT:CONT?	B-2	STAT:OPER:ENAB	B-10
MEAS:CURR?	B-3	STAT:OPER:ENAB?	B-10
MEAS:VOLT?	B-3	STAT:OPER[EVENT]?	B-11
[SOUR]:CURR	B-5	STAT:PRES	B-11
[SOUR]:CURR?	B-5	STAT:QUES[EVENT]?	B-12
[SOUR]:CURR:TRIG	B-6	STAT:QUES:COND?	B-12
[SOUR]:CURR:TRIG?	B-6	STAT:QUES:ENAB	B-13
[SOUR]:VOLT	B-7	STAT:QUES:ENAB?	B-13
[SOUR]:VOLT?	B-7	SYST:ERR?	B-14
[SOUR]:VOLT:TRIG	B-8	SYST:LANG	B-14
[SOUR]:VOLT:TRIG?	B-8		

INIT[:IMM]

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

Function: Enables a single trigger.

Description: This command enables a single trigger. A *TRG command completes the sequence. Upon receipt of the *TRG command, the power supply will return to the commanded values of voltage and current established by the VOLT:TRIG and CURR:TRIG commands. After a *TRG command has been received, subsequent *TRG commands have no effect unless preceded by INIT or INIT:CONT ON.

Example:

VOLT 21; CURR 5	Power supply output commanded to go to 21V, 5A
VOLT:TRIG 15;CURR:TRIG 3	Power supply output programmed to return to 15V, 3A upon receipt of *TRG trigger.
INIT;*TRG	Upon receipt of *TRG command power supply is commanded to 15V, 3A.

NOTE: Commanded voltage and current parameters will either be output or limit parameters, depending on whether output is enabled, load and mode

FIGURE B-1. INITiate[:IMMediate] COMMAND

INIT:CONT

Syntax:	Short Form:	INIT:CONT <value>
	Long Form:	:INITiate:CONTinuous <value>

Function:	INIT:CONT ON	Enables continuous triggers.
	INIT:CONT OFF	Disables continuous triggers.

Description: This command enables/disables triggers. *TRG commands complete the sequence. Once INIT:CONT ON enables continuous triggers, subsequent *TRG commands return the power supply output to the commanded values of voltage and current established by the VOLT:TRIG and CURR:TRIG commands until INIT:CONT OFF is received.

Example:	VOLT 21; CURR 5	Power supply output commanded to go to 21V, 5A
	INIT:CONT ON	Continuous triggers enabled.
	VOLT:TRIG 15;CURR:TRIG 3	Power supply output programmed to return to 15V, 3A upon receipt of trigger.
	*TRG	Upon receipt of *TRG command power supply output returns to 15V, 3A.
	VOLT 17; CURR 2	Power supply output commanded to go to 17V, 2A
	*TRG	Upon receipt of *TRG command power supply output returns to 15V, 3A.
	INIT:CONT OFF	Triggers disabled.

FIGURE B-2. INITiate:CONTinuous COMMAND

INIT:CONT?

Syntax:	Short Form:	INIT:CONT?
	Long Form:	:INITiate:CONTinuous?

Function: Determines whether continuous triggers are enabled or disabled.

Response: "1" = continuous triggers are enabled (INIT:CONT ON)
"0" = continuous triggers disabled (INIT:CONT OFF)

Description: Power supply returns value of INIT:CONT flag to controller

Example:	VOLT 21; CURR 5	Power supply output commanded to go to 21V, 5A
	INIT:CONT ON	Continuous triggers enabled.
	VOLT:TRIG 15;CURR:TRIG 3	Power supply programmed to return to 15V, 3A upon receipt of *TRG trigger.
	*TRG	Power supply returns to 15V, 3A.
	INIT:CONT?	Controller reads "1" to indicate that continuous triggers are enabled.

FIGURE B-3. INITiate:CONTinuous QUERY

MEAS:CURR?
MEAS:VOLT?

Syntax:	Short Form:	MEAS:CURR?
	:	MEAS:VOLT?
	Long Form:	MEASure:CURRent[:DC]?
		MEASure:VOLTage[:DC]?

Function: Measures actual current or voltage

Description: This query returns the actual value of output current or voltage (measured at the sense terminals) as determined by the commanded value of voltage and current and load conditions.

Example:

VOLT 21; CURR 5	Power supply output commanded to go to 21V, 5A
MEAS:CURR?	Controller reads actual value of output current, e.g., 4.83A.
MEAS:VOLT?	Controller reads actual value of output voltage, e.g., 20.9.

FIGURE B-4. MEASure:CURRent? and MEASure:VOLTage? QUERIES

CURR

Syntax: Short Form: CURR <value>
Long Form: [SOURce]:CURRent[:LEVel][:IMMediate] <value>

Function: Sets commanded current or current limit to specified level.

Description: This command programs output current (Current mode) or current limit (Voltage mode) to a specific value. Actual output current will depend on load conditions.

Example: VOLT 21; CURR 5 Power supply output commanded to go to 21V, 5A

FIGURE B-5. CURRent COMMAND

CURR?

Syntax: Short Form: CURR?
Long Form: [SOURce]:CURRent?

Function:

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).

Description: The CURR? query returns the programmed current (Current mode) or current limit (Voltage mode) of the power supply. Actual output current will depend on load conditions. The CURR?MAX query returns the maximum current allowed for a particular model.

Example:

VOLT 21; CURR 1.1	Power supply commanded to go to 21V, 1.1A
CURR?	Controller reads 1.1, indicating programmed current value = 1.1A
CURR? MAX	Controller reads 3.6 (assuming maximum allowable current for power supply being addressed is 3.6 A).

FIGURE B-6. CURRent QUERY

CURR:TRIG

Syntax:	Short Form:	CURR:TRIG <value>
	Long Form:	[SOURce]:CURRent:TRIGgered <value>

Function: Programs current value to be implemented by *TRG command. Actual output current will depend on load conditions.

Description: This command can be used to reset many power supplies to preselected parameters by issuing a single *TRG command.

Example:

VOLT 21; CURR 1.1	Power supply commanded to go to 21V, 1.1A
CURR:TRIG 2.3	Power supply current programmed to 2.3A upon receipt of *TRG
CURR?	Controller reads 1.1, indicating programmed current value = 1.1A
*TRG	Power supply commanded to current value established by CURR:TRIG command (2.3) and voltage value established by VOLT:TRIG
CURR?	Controller reads 2.3, indicating programmed current value = 2.3A

FIGURE B-7. CURRent:TRIGgered COMMAND

CURR:TRIG?

Syntax:	Short Form:	CURR:TRIG?
	Long Form:	[SOURce]:CURRent:TRIGgered?

Function: Returns value to controller which represents current value to be programmed by *TRG command.

Description: This command returns the current value established by CURR:TRIG command.

Example:

VOLT 21; CURR 1.1	Power supply commanded to go to 21V, 1.1A
CURR:TRIG 2.3	Power supply current programmed to 2.3 upon receipt of *TRG
CURR?	Controller reads 1.1, indicating programmed current value = 1.1A
CURR:TRIG?	Controller reads 2.3 (current value established by CURR:TRIG command

FIGURE B-8. CURRent:TRIGgered QUERY

VOLT

Syntax:	Short Form:	VOLT <value>
	Long Form:	[SOURce]:VOLTage[:LEVel][:IMMediate] <value>

Function: Sets commanded voltage or voltage limit to specified level.

Description: This command programs commanded output voltage (Voltage mode) or voltage limit (Current mode) to a specific value. Actual output voltage will depend on load conditions.

Example:	VOLT 21; CURR 5	Power supply commanded to go to 21V, 5A

FIGURE B-9. VOLTage COMMAND

VOLT?

Syntax:	Short Form:	VOLT?
	Long Form:	[SOURce]:VOLTage?

Function:	VOLT?	Returns programmed voltage value.
	VOLT? MAX	Returns maximum voltage allowed for power supply.
	VOLT? MIN	Returns minimum voltage allowed for power supply (always 0).

Description: The VOLT? query returns the programmed voltage (Voltage mode) or voltage limit (Current mode) of the power supply to the controller. Actual output voltage will depend on load conditions. The VOLT?MAX query returns the maximum voltage allowed for a particular model.

Example:	VOLT 21; CURR 1.1	Power supply commanded to go to 21V, 1.1A
	VOLT?	Controller reads 21, indicating programmed voltage value = 21V
	VOLT? MAX	Controller reads 100 (assuming maximum allowable voltage for power supply being addressed is 100V).

FIGURE B-10. VOLTage QUERY

VOLT:TRIG

Syntax:	Short Form:	VOLT:TRIG <value>
	Long Form:	[SOURce]:VOLTage:TRIGgered <value>

Function: Programs voltage value to be implemented by *TRG command. Actual output voltage will depend on load conditions.

Description: This command can be used to reset many power supplies to preselected parameters by issuing a single *TRG command.

Example:

VOLT 21; CURR 1.1	Power supply commanded to go to 21V, 1.1A
VOLT:TRIG 29.3	Power supply current programmed to 29.3 upon receipt of *TRG
VOLT?	Controller reads 21, indicating programmed current value = 21V
*TRG	Power supply commanded to voltage value established by VOLT:TRIG command (29.3) and current value established by CURR:TRIG
VOLT?	Controller reads 29.3, indicating programmed current value = 2.3A

FIGURE B-11. VOLTage:TRIGgered COMMAND

VOLT:TRIG?

Syntax:	Short Form:	VOLT:TRIG?
	Long Form:	[SOURce]:VOLTage:TRIGgered?

Function: Returns value to controller representing voltage value to be programmed by *TRG command.

Description: This command returns the voltage value established by VOLT:TRIG command.

Example:

VOLT 21; CURR 1.1	Power supply commanded to go to 21V, 1.1A
VOLT:TRIG 29.3	Power supply voltage programmed to 29.3 upon receipt of *TRG
VOLT?	Controller reads 21, indicating programmed voltage value = 21V
VOLT:TRIG?	Controller reads 29.3 (voltage value established by VOLT:TRIG command

FIGURE B-12. VOLTage:TRIGgered QUERY

FUNC:MODE

Syntax: Short Form: FUNC:MODE
Long Form: [SOURce]:FUNCtion:MODE

Function:

FUNC:MODE VOLT	Commands power supply to Voltage mode
FUNC:MODE CURR	Commands power supply to Current mode

Description: Commanded mode establishes parameters (voltage or current) monitored for error conditions. Actual mode depends upon load conditions. When commanded to Voltage mode, if load conditions cause the power supply to try to exceed the current limit, the unit will automatically switch to Current mode and flag an error condition. When commanded to Current mode, if load conditions cause the power supply to try to exceed the voltage limit, the unit will automatically switch to Voltage mode and flag an error condition.

Example:

FUNC:MODE VOLT	Power supply commanded to Voltage mode.
VOLT 21; CURR 1.1	Power supply commanded to output 21V, current limit set to 1.1A.
FUNC:MODE CURR	Power supply commanded to Current mode.
CURR 1.1; VOLT 21	Power supply commanded to output 1.1A, voltage limit set to 21V.

FIGURE B-13. FUNCtion:MODE COMMAND

STAT:OPER:COND?

Syntax: Short Form: STAT:OPER:COND?
Long Form: STATus:OPERation:CONDition?

Function: Returns the value of the Operation Condition Register to controller (1 = set = function enabled, 0 = reset = function disabled).

Description: The Operation Condition Register contains unlatched real-time information about the operating conditions of the power supply.

OPERATION CONDITION REGISTER BITS

CONDITION	CURRENT MODE	RELAY CLOSED	VOLTAGE MODE	NOT USED							
BIT	10	9	8	7	6	5	4	3	2	1	0
VALUE	1024	512	256	128	64	32	16	8	4	2	1

Example: STAT:OPER:COND? Power supply returns <value> 1536 (1024 + 512) to indicate that power supply is operating in Current mode with relay closed.

FIGURE B-14. STATus:OPERation:CONDition QUERY

STAT:OPER:ENAB

Syntax: Short Form: STAT:OPER:ENAB <value>
Long Form: STATus:OPERation:ENABle <value>

Function: Programs Operational Condition Enable Register)

Description: The Operation Condition Enable Register determines which conditions are allowed to set the Operation Condition Register. The value sent by the controller sets the corresponding bits of the Operation Condition Enable Register in the power supply (1 = set = function enabled, 0 = reset = function disabled).

OPERATION CONDITION ENABLE REGISTER BITS

CONDITION	CURRENT MODE	RELAY CLOSED	VOLTAGE MODE	NOT USED							
BIT	10	9	8	7	6	5	4	3	2	1	0
VALUE	1024	512	256	128	64	32	16	8	4	2	1

Example: STAT:OPER:ENAB 1280 Bits 8 and 10 of Operation Condition Enable Register are set, allowing the Operation Condition Register to monitor Voltage and Current mode conditions, but not report the status of the relay.

FIGURE B-15. STATus:OPEReration:ENABle COMMAND

STAT:OPER:ENAB?

Syntax: Short Form: STAT:OPER:ENAB?
Long Form: STATus:OPERation:ENABle?

Function: Reads Operational Condition Enable Register)

Description: Power supply returns value of Operation Condition Enable Register to controller, indicating which conditions are being monitored. (1 = set = function enabled, 0 = reset = function disabled)

OPERATION CONDITION ENABLE REGISTER BITS

CONDITION	CURRENT MODE	RELAY CLOSED	VOLTAGE MODE	NOT USED							
BIT	10	9	8	7	6	5	4	3	2	1	0
VALUE	1024	512	256	128	64	32	16	8	4	2	1

Example: STAT:OPER:ENAB? Controller reads <value> 1792 (1024 + 512 + 256) to indicate that bits 8, 9, and 10 of the Operation Condition Register are set, allowing Voltage mode, relay closed, and Current mode conditions to be monitored.

FIGURE B-16. STATus:OPEReration:ENABle QUERY

STAT:OPER?

Syntax: Short Form: STAT:OPER[EVEN]?
Long Form: STATus:OPERation[EVENT]?

Function: Indicates changes in conditions monitored by Operational Event Register)

Description: Power supply returns value to controller indicating conditions of Operation Event Register which have changed since the last STAT:OPER? query. This value is cleared once reported...

OPERATION EVENT REGISTER BITS

CONDITION	CURRENT MODE	RELAY CLOSED	VOLTAGE MODE	NOT USED							
BIT	10	9	8	7	6	5	4	3	2	1	0
VALUE	1024	512	256	128	64	32	16	8	4	2	1

Example: STAT:OPER? Controller reads <value> 768 (512 + 256) to indicate that bits 8 and 9 are set, indicating that the power supply has changed to Voltage mode and the relay has closed since the last STAT:OPER? query.

FIGURE B-17. STATus:OPERation QUERY

STAT:PRES

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

Function: Disables reporting of all status events.

Description: This command sets all bits of the Operation Condition and Questionable Condition Registers to 0, preventing all status events from being reported...

Example: STAT:PRES Operation Condition and Questionable Condition registers can no longer be set.

FIGURE B-18. STATus:PRESet COMMAND

STAT:QUES?

Syntax: Short Form: STAT:QUES[EVEN]?
Long Form: STATus:QUEStionable[EVENT]?

Function: Indicates changes in conditions monitored by Questionable Event Register)

Description: Power supply returns value to controller indicating conditions of Questionable Event Register which have changed since the last STAT:OPER? query. This value is cleared once reported.

QUESTIONABLE EVENT REGISTER BITS

CONDITION	PL	OL	RE	NU	NU	NU	NU	NU	OT	NU	CE	VE
BIT	11	10	9	8	7	6	5	4	3	2	1	0
VALUE	2048	1024	512	256	128	64	32	16	8	4	2	1

PL	POWER LOSS
OL	OVERLOAD
RE	RELAY ERROR
OT	OVERTEMPERATURE
CE	CURRENT ERROR
VE	VOLTAGE ERROR
NU	NOT USED

Example: STAT:OPER? Controller reads <value> 1026 (1024 + 2) to indicate that bits 1 and 10 are set, indicating that the power supply has detected overload and current error conditions since the last STAT:QUES? query.

FIGURE B-19. STATus:QUEStionable? QUERY

STAT:QUES:COND?

Syntax: Short Form: STAT:QUES:COND?
Long Form: STATus:QUEStionable:CONDition?

Function: Returns the value of the Questionable Condition Register to controller. (1 = set = function enabled, 0 = reset = function disabled)

Description: The Questionable Condition Register contains unlatched real-time information about questionable conditions of the power supply.

QUESTIONABLE CONDITION REGISTER BITS

CONDITION	PL	OL	RE	NU	NU	NU	NU	NU	OT	NU	CE	VE
BIT	11	10	9	8	7	6	5	4	3	2	1	0
VALUE	2048	1024	512	256	128	64	32	16	8	4	2	1

PL	POWER LOSS
OL	OVERLOAD
RE	RELAY ERROR
OT	OVERTEMPERATURE
CE	CURRENT ERROR
VE	VOLTAGE ERROR
NU	NOT USED

Example: STAT:QUES:COND? Power supply returns <value> 1545 (1024 + 512 + 8 + 1) to indicate that overload, relay, overtemperature and voltage errors were detected.

FIGURE B-20. STATus:QUEStionable:CONDition? QUERY

STAT:QUES:ENAB

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

Function: Programs Questionable Condition Enable Register)

Description: The Questionable Condition Enable Register determines which conditions are allowed to set the Questionable Condition Register. The value sent by the controller sets the corresponding bits of the Questionable Condition Enable Register in the power supply (1 = set = function enabled, 0 = reset = function disabled**.**

QUESTIONABLE CONDITION ENABLE REGISTER BITS

CONDITION	PL	OL	RE	NU	NU	NU	NU	NU	OT	NU	CE	VE
BIT	11	10	9	8	7	6	5	4	3	2	1	0
VALUE	2048	1024	512	256	128	64	32	16	8	4	2	1

PL	POWER LOSS
OL	OVERLOAD
RE	RELAY ERROR
OT	OVERTEMPERATURE
CE	CURRENT ERROR
VE	VOLTAGE ERROR
NU	NOT USED

Example: STAT:QUES:ENAB 3595 Bits 0, 1, 3, 9, 10, and 11 of the Questionable Condition Enable Register are set, causing the power supply to monitor voltage error, current error, overtemperature, relay error, overload and power loss conditions.

FIGURE B-21. STATus:QUEStionable:ENABle COMMAND

STAT:QUES:ENAB?

Syntax: Short Form: STAT:QUES:ENAB?
Long Form: STATus:QUESionable:ENABle?

Function: Reads Questionable Condition Enable Register)

Description: Power supply returns value of Questionable Condition Enable Register to controller, indicating which conditions are being monitored**.**

QUESTIONABLE CONDITION ENABLE REGISTER BITS

CONDITION	PL	OL	RE	NU	NU	NU	NU	NU	OT	NU	CE	VE
BIT	11	10	9	8	7	6	5	4	3	2	1	0
VALUE	2048	1024	512	256	128	64	32	16	8	4	2	1

PL	POWER LOSS
OL	OVERLOAD
RE	RELAY ERROR
OT	OVERTEMPERATURE
CE	CURRENT ERROR
VE	VOLTAGE ERROR
NU	NOT USED

Example: STAT:QUES:ENAB? Controller reads <value> 3595 (2048 + 1024 + 512 + 8 + 2 + 1) to indicate that voltage error, current error, overtemperature, relay error, overload and power loss conditions are being monitored.

FIGURE B-22. STATus:QUEStionable:ENABle? QUERY

SYST:ERR?

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

Function: Provides error messages to controller.

Description: Returns error number and character string containing error message. Error messages are defined as follows**:**

ERROR MESSAGES

ERROR MESSAGE	EXPLANATION
`0 “No error”`	No error
`-100 “Command error”`	Wrong syntax; command not understood.
`-222 “Voltage out of range”`	Value Exceeds Power Supply Rating
`-222 “Current out of range”`	Value exceeds power supply rating
`-240 “Hardware error”`	Power supply did not respond to command

Example: SYST:ERR? Controller reads: 0, “No error”

FIGURE B-23. SYSTem:ERRor? QUERY

SYST:LANG

Syntax: Short Form: SYST:LANG CIIL
Long Form: SYSTem:LANGuage

Function: Selects the CIIL language command set (See Appendix C.)

Description: This command allows the CIIL command language to be used to program the power supply. (CIIL is included to provide compatibility with earlier Kepco equipment.) Once CIIL is selected, the CIIL command ‘GAL’ followed by the command ‘SCPI’ must be sent for the power supply to respond to SCPI commands.

Example: SYST:LANG CIIL Power supply responds to CIIL command set.

FIGURE B-24. SYSTem:LANGuage COMMAND

APPENDIX C - CIIL COMMAND DEFINITIONS

C.1 INTRODUCTION

This appendix defines the CIIL commands used with the BIT 232/BIT 232-F Interface Card. Table C-1 provides a quick reference of all CIIL commands used in the BIT Card.

TABLE C-1. CIIL SUBSYSTEM COMMAND/QUERY INDEX

COMMAND	PAGE	COMMAND	PAGE
CNF	C-4	RST	C-4
FNC	C-1	SET	C-3
FTH	C-2	SRN	C-3
GAL	C-6	SRX	C-3
INX	C-2	STA	C-5
IST	C-4		

FNC

Syntax: Stimulus mode: FNC DCS :CH1 <SET Command>
Sensor mode: FNC DCS <VOLT or CURR command> :CH1

Function: This operator is used with either the SET command to program a power supply's output (stimulus mode), or with the VOLT and CURR commands to read its output settings (sensor mode).

Description: The first operand contains the three (3) letter mnemonic pertaining to the device on the control bus, in this case DCS (Direct Current Source). If a reading is being set up, the modifier VOLT or CURR follows. The next operand is used to select the specific channel of the device being programmed or read from.

Example:

FNC DCS :CH1 SET VOLT 15	Power supply commanded to 15V
FNC DCS :CH1 SET CURR 3	Power supply commanded to 3A
FNC DCS VOLT :CH1	Power supply returns value which represents actual output voltage
FNC DCS CURR :CH1	Power supply returns value which represents actual output current

NOTE: Actual output voltage and current depends on load conditions

FIGURE C-1. FNC — FUNCTION COMMAND

INX

Syntax:	INX VOLT (initiate voltage reading) INX CURR (initiate current reading)
Function:	Commences a data acquisition process in accordance with the preceding FNC command.
Description:	The response to the INX command is a dynamic time-out value, unless a catastrophic error condition exists, in which case an error message will be returned. If the time-out value returned is not zero, this indicates the power supply's output voltage or current has not yet settled. A time delay should be observed before proceeding with the FTH command, or the command may be repeated until a zero value is returned, but the preceding FTH command must also be repeated.

Example:	INX VOLT	Power supply initiates voltage reading)
	FTH VOLT	Power supply sends voltage reading to controller)

FIGURE C-2. INX — INITIATE OP CODE COMMAND

FTH

Syntax:	FTH VOLT (fetch voltage reading) FTH CURR (fetch current reading)
Function:	Commands the previously designated power supply to return the requested data reading.
Description:	This command must immediately follow an INX command. The value returned is the value of the output voltage or current, whichever was requested, unless a catastrophic error condition exists, in which case an error message will be returned. The value observed will be in scientific notation.

Example:	INX VOLT	Power supply initiates voltage reading)
	FTH VOLT	Power supply sends voltage reading to controller)

FIGURE C-3. FTH — FETCH COMMAND

SET, SRX, SRN

Syntax:

```
FNC DCS :CH1 SET VOLT <value> CURL <value>
FNC DCS :CH1 SET CURR <value> VLTL <value>
SRX          Set Range Maximum
SRN          Set Range Minimum
```

Function: This operator is used in conjunction with FNC (in stimulus mode) to specify the output mode of the power supply being programmed.

Description: The first operand is the noun modifier and the second operand specifies the value. The first operand field of the command contains the four(4) letter mnemonic for the output mode of the power supply. The choices are:

VOLT	VOLTAGE MODE OPERATION
VLTL	VOLTAGE LIMIT
CURR	CURRENT MODE OPERATION
CURL	CURRENT LIMIT

The second operand field of the command contains the value assigned to the chosen output mode. This value may be specified as accurately as the resolution of the power supply allows. It can be directly specified in ASCII integer, decimal, or in scientific notation.

There may be two (2) set commands, separated by a space (ASCII 32), for each power supply being programmed. The following are the only allowable combinations:

VOLT with CURL
CURR with VLTL

The limit parameter (CURL or VLTL) may not be set without the main parameter. A polarity sign may precede the VOLT or CURR value so that the power supply's polarity may be selected.

In the case of Kepco's BOP power supplies, the two related Op Codes, SRX and SRN are functionally identical to the SET command, since there is only one range, 0 - maximum. The commands are included only for compatibility.

Example:

FNC DCS :CH1 SET VOLT 5 CURL 3	Power supply commanded to 5V (Voltage mode) with current limit of 3A.
FNC DCS :CH1 SET CURR 2 VLTL 17	Power supply commanded to 2A Current mode) with voltage limit of 17V

FIGURE C-4. SET COMMAND

RST

Syntax:	RST DCS :CH1	
Function:	This operator is used to return a power supply to its power-on state. The output voltage and current are programmed to zero.	
Example:	RST DCS :CH1	The power supply is reset.

FIGURE C-5. RST — RESET COMMAND

CNF, IST

Syntax:	CNF or IST	
Function:	Causes power supply to execute confidence test.	
Description:	The CNF operator commands the BOP to execute the confidence test procedure defined for the BOP power supplies (IST is functionally identical to CNF for BOP power supplies). The procedure consists of programming voltage and current to their maximum values, checking for error flags, then programming voltage and current to zero. The results of CNF are obtained through the STA command.	
Example:	CNF	Power supply executes confidence test.
	IST	Power supply executes self test.

FIGURE C-6. CNF, IST — CONFIDENCE TEST, INTERNAL SELF TEST COMMANDS

STA

Syntax: STA

Function: Causes power supply to return operating status to controller.

Description: This operator commands the power supply to report its present operating status. Status is reported in the form of a message (character string) as defined below. Any catastrophic error conditions (indicated by * in the table below) which exist will be reported, until the error condition is corrected. As required by CIIL, all error messages begin with an ASCII "F" (Fault) followed by a 2 digit code, "07" (Halt). The code that follows (DCSnn) indicates the type of device and the channel number. The next 3 digit code describes the nature of the fault: "DEV" for device related errors or "MOD" for non-device errors, such as syntax.

TABLE C-2. CIIL ERROR MESSAGES

ERROR MESSAGE	EXPLANATION
F07 DCSnn DEV Power Loss	The power supply has lost its input power. *
F07 DCSnn DEV Device Turned Off (BOP)	A shutdown occurred due to overvoltage or overcurrent. *
F07 DCSnn DEV Over Temperature	A shutdown occurred due to thermal causes. *
F07 DCSnn DEV Overload	The voltage or current limit point was exceeded. *
F07 DCSnn DEV Voltage Fault	The output voltage is not within limits (voltage mode). *
F07 DCSnn DEV Current Fault	The output current is not within limits (current mode). *
F07 DCSnn DEV Load Path Fault	Open or miswired load or error sense leads detected. *
F07 DCSnn MOD Invalid Command	Improper syntax was used. **
F07 DCSnn DEV Not Ready	The output voltage or current has not settled. **
F07 DCSnn DEV Device Not Present	The specified power supply was not present during power up or during the last DCL. **
F07 DCSnn DEV Device Not Responding	The power supply has failed to communicate to the controller. **
F07 DCSnn DEV Invalid Voltage Range	The programmed voltage is outside the power supply's range. **
F07 DCSnn DEV Invalid Current Range	The programmed current is outside the power supply's range. **
F07 DCSnn DEV Set Modifier Error	An improper SET command was sent. **
F07 DCSnn DEV Invalid Device ID	The selected channel was not between 1-31. **
* Catastrophic error ** Non-Catastrophic error	

FIGURE C-7. STA — STATUS COMMAND

GAL

Syntax: GAL

Function: Enables utility commands which change error handling defaults.

Description: This command enables the utility commands listed below. If no GAL command is issued, the default conditions are T0, F1, and P1. Once the GAL command is issued, the appropriate utility command may be sent to change the default condition.

TABLE C-3. CIIL ERROR HANDLING UTILITY COMMANDS

UTILITY COMMAND	DESCRIPTION
T0	Instructs non-catastrophic error messages to be erased from memory if any command is sent prior to STA command.
T1	Instructs non-catastrophic error messages to be stacked in memory until STA command is sent.
F0	Fetch Mode 0. Ignores error conditions when performing FTH command.
F1	Fetch Mode 1. Reports any error conditions which are present during FTH command.
P0	Power Loss Mode 0. Reports a power loss message only once until power is restored to the power module.
P1	Power Loss Mode 1. Continuously reports a power loss message until power is restored to the power module.
Note: The defaults are T0, F1 and P1	

Example:

GAL	Enables utility commands.
F0	Causes controller to ignore error conditions during FTH command.

FIGURE C-8. GAL — GO TO ALTERNATE LANGUAGE COMMAND

APPENDIX D - TERMINAL EMULATION PROGRAM

D.1 INTRODUCTION

Appendix D is a C language program used with an IBM-PC-compatible computer as a terminal emulator, allowing the BOP to be controlled directly from a keyboard. Refer to Appendix F for all functions. (See PAR. 1.4 to order Sample Programs diskette.)

To modify this program for computers other than IBM-PC-compatible (e.g., Macintosh), four ROM BIOS routines must be replaced with their equivalent (see Table D-1).

TABLE D-1. ROM BIOS ROUTINES TO BE REPLACED WITH EQUIVALENT FOR NON-IBM-PC-COMPATIBLE PC'S

ROM BIOS ROUTINE	FUNCTION
`open_port(n) n=0 for COM1 or n=1 for COM 2`	Initialize the serial port.
`put_serc(n,c)`	Write the character c to COM 1 or COM 2 serial port.
`get_serc(n)`	Read a character from the serial port.
`in_ready(n)`	Fetch the current status of the serial port.

The Terminal Emulation program is a loop in which typed characters from the computer keyboard are sent to the BIT Card using the SendWecho function (see Appendix F). This allows the BOP to be exercised by typing the appropriate commands (SCPI or CIIL) directly from the keyboard. Responses to the typed commands are received from the BIT Card and displayed on the computer monitor. Typing ALT+Q ends the program.

The Terminal Emulation program can be set to run on either COM 1 or COM 2. For convenience it is recommended that two separate programs be created, one for COM 1, one for COM 2.

If this program is started before power is applied to the BOP, the sign on message will be displayed on the computer monitor when the BOP is powered up:

```
KEPCO BOP BIT232 REV. 1.0
POWER SUPPLY Type = XX (BOP YY-Y)
```

where XX = hex value representing setting of Power Supply Identifications switch S2 (see PAR. 2.2.2)

YY-Y = BOP Model No. (e.g., 20-5)

NOTE: If switch S2 is set to an illegal setting, the message will read:
UNDEFINED BOP TYPE

```
/*********************************************************************
*  RS232 interactive driver for BIT232
*     use ROM BIOS  INT 14 function calls
*********************************************************************/
#include <stdio.h>
#include <stdlib.h>
#include <dos.h>

#define TRUE 1
#define FALSE 0

#define PORT 2     /* serial port */

/* function prototypes */
void open_port(int n);
void put_serc(int n, int c);
int get_serc(int n);
int in_ready(int n);
int SendWecho(int n,int c);
void SendCommand(char *send_cmmd);
void SendCmmdWready(char *send_cmmd);

void main(void)
{
       int c;
       clrscr();
       printf("  **  BIT232 Interactive Driver Program  -  Press ALT + Q to exit \n");

       /* open the serial port */
       open_port(PORT);

       /* main program loop */
       while (TRUE) {
              /* process keyboard presses */
              if (kbhit()) {
                     c = getch();
                     switch (c) {
                            case 0:                                     /* exit on Alt-X */
                                   /* if ALT + Q */
                                   if (getch() == 16)
                                          exit(0);
                                   break;
                            default:
                                   {
                                   SendWecho(PORT,c);
                                   /* display it if one was available */
                                   if (c != EOF)
                                          putch(c);
                                   if (c == '\r')
                                          putch('\n');
                            }
                     }
              }
              /* process remote characters */
              if (in_ready(PORT)) {
                     /* get character from serial port*/
                     c = get_serc(PORT);
                     /* display it if one was available */
                     if (c != EOF)
                            putch(c);
              }
       }
}
```

APPENDIX E - RS232 COMMAND LOOP PROGRAM

E.1 INTRODUCTION

This appendix is a C language program used with an IBM-PC-compatible computer running a terminal emulation program to set up a command loop. Refer to Appendix F for all function prototypes. (See PAR. 1.4 to order Sample Programs diskette.)

To modify this program for computers other that IBM-PC-compatible (e.g., Macintosh), four ROM BIOS routines must be replaced with their equivalent (see Table E-1).

TABLE E-1. ROM BIOS ROUTINES TO BE REPLACED WITH EQUIVALENT FOR NON-IBM-PC-COMPATIBLE PC'S

ROM BIOS ROUTINE	FUNCTION
`open_port(n) n=0 for COM1 or n=1 for COM 2`	Initialize the serial port.
`put_serc(n,c)`	Write the character c to COM 1 or COM 2 serial port.
`get_serc(n)`	Read a character from the serial port.
`in_ready(n)`	Fetch the current status of the serial port.

The Command Loop program performs the following functions

1. Interrogates the power supply (SCPI command VOLT?MAX) to determine the maximum voltage of the BOP (XXX).
2. Sets the voltage to full scale, current to 0.5A (VOLT XXX;CURR 0.5).
3. Reads the voltage and current (MEAS:VOLT?CURR?) and displays it on the computer monitor.
4. Sets voltage to minus full scale, current to 0.5A (VOLT –XXX;CURR 0.5).
5. Reads the voltage and current (MEAS:VOLT?CURR?) and displays it on the monitor.
6. Sends a reset command (*RST).
7. Reads the voltage and current (MEAS:VOLT?CURR?) and displays it on the monitor.
8. Sends a test command (*TST?).
9. Reads the voltage and current (MEAS:VOLT?CURR?) and displays it on the monitor.
10. Checks for errors (SYST:ERR?); the message: 0. “No Error” is displayed on the monitor.
11. The program continuously cycles through steps 1 through 10 above; to exit the program press ALT+Q.

This program can be set to run on either COM 1 or COM 2; for convenience it is recommended that the user create two separate programs, one for COM1, one for COM 2.

```
/*********************************************************************
* RS232 command loop program for BIT232
*     use ROM BIOS  INT 14 function calls
*********************************************************************/
#include <stdio.h>
#include <stdlib.h>
#include <dos.h>

#define TRUE 1
#define FALSE 0

#define PORT 2     /* serial port */

/* function prototypes */
void open_port(int n);
void put_serc(int n, int c);
int get_serc(int n);
int in_ready(int n);
int SendWecho(int n,int c);
void SendCommand(char *send_cmmd);
void SendCmmdWready(char *send_cmmd);

void main(void)
{
        char string[80], stringm[80], wstr[80];
        char volt[4], *curr = ";curr 0.5";
        char *test = "*tst?";
        char *reset = "*rst";
        char *msvolt = "meas:volt?;curr?";
        char *sterror = "syst:err?";
        char *id = "*idn?";
        int j,k,c,vl;
         int on_line;
        double max;

        clrscr();
        printf("  **  BIT232 Command Loop Program  -  Press ALT + Q to exit \n");

        /* open the serial port */
        open_port(PORT);

        /* get power supply id */
        strcpy(string, id);
        SendCommand(string);

        on_line = FALSE;
        for (k=0; k < 10000; k++)
                {
                if (in_ready(PORT)) {
                        /* get character from serial port*/
                        c = get_serc(PORT);
                        /* display it if one was available */
                        if (c != EOF)
                                {
                                putch(c);
                                on_line = TRUE;
                        }
                }
        }

        if (on_line == FALSE)
         exit(0);

        /* change the first \r in end of string */
        for (j = 0; j < strlen(string); j++)
        {
        if (string[j] == '\r')
            string[j] = '\0';
}


/* get maximum voltage */
strcpy(string, "volt?max");
SendCmmdWready(string);
/* change the first \r in end of string */
for (j = 0; j < strlen(string); j++)
        {
        if (string[j] == '\r')
            string[j] = '\0';
}
max = atof(string);
        if (max <= 10.0)
           vl=1;
        else
                {
                if (max <= 100.0)
                        vl=2;
                else
                        vl=3;
        }
j=0;
volt[0]=string[j];
volt[1]='\0';
j ++;
if (vl > 1)
        if( string[j] == '.')
                {
                j ++;
                volt[1]=string[j];
                volt[2]='\0';
        }
        else
                {
                volt[1]=string[j];
                volt[2]='\0';
        }
if (vl > 2)
        if( string[j] == '.')
                {
                j ++;
                volt[2]=string[j];
                volt[3]='\0';
        }
        else
                {
                volt[2]=string[j];
                volt[3]='\0';
        }
strcpy(string, "volt ");
strcat(string, volt);
strcat(string, curr);

strcpy(stringm, "volt -");
strcat(stringm, volt);
strcat(stringm, curr);

/* main program loop */
while (TRUE) {
        /* process keyboard presses */
        if (kbhit()) {
                c = getch();
                if (c == 0)
                        /* exit on Alt-Q */
                        if (getch() == 16)
                                exit(0);
        }
        strcpy(wstr,string);
        /* set voltage to full scale, current 0.5A */
        SendCmmdWready(wstr);
        for (j = 0; j < 10000; j++)
                for (k = 0; k < 100; k++);

        strcpy(wstr,msvolt);
        /* read voltage and current */
        SendCmmdWready(wstr);
        for (j = 0; j < 10000; j++);


        strcpy(wstr,stringm);
        /* set voltage to minus full scale, current 0.5A */
        SendCmmdWready(wstr);
        for (j = 0; j < 10000; j++)
                for (k = 0; k < 100; k++);

        strcpy(wstr,msvolt);
        /* read voltage and current */
        SendCmmdWready(wstr);
        for (j = 0; j < 10000; j++);

        strcpy(wstr,reset);
        /* send reset command  -  *rst */
        SendCmmdWready(wstr);
        for (j = 0; j < 10000; j++)
                for (k = 0; k < 100; k++);

        strcpy(wstr,msvolt);
        /* read voltage and current */
        SendCmmdWready(wstr);
        for (j = 0; j < 10000; j++);

        strcpy(wstr,test);
        /* send test command  -  *tst? */
        SendCmmdWready(wstr);
        for (j = 0; j < 10000; j++)
                for (k = 0; k < 100; k++);

        strcpy(wstr,msvolt);
        /* read voltage and current */
        SendCmmdWready(wstr);
        for (j = 0; j < 10000; j++);

        strcpy(wstr,sterror);
        /* read error output queue */
        SendCmmdWready(wstr);
        for (j = 0; j < 10000; j++);
    }
}
```

APPENDIX F - C LANGUAGE FUNCTIONS

F.1 INTRODUCTION

This appendix contains examples of C language functions which can be used as the building blocks for unique programs to interface the BIT Card and associated power supply with an IBM-PC-compatible computer. These functions are used in the sample programs shown in Appendices D and E.

F.2 OPEN SERIAL PORT USING ROM BIOS ROUTINE

This function opens the serial port selected by n, using the ROM BIOS routine; if the computer is not IBM-PC-compatible the ROM BIOS routine must be replaced by an equivalent.

```
/* open serial port using ROM BIOS routine */
void open_port(int n)
{
       union REGS regs;

       /* AH has the function code */
       regs.h.ah = 0x00;
       /* AL has the baud rate for 8 bits No parity 1 Stop bit  */
       regs.h.al = 0xe3;
       /* DX has the port number */
       if (n == 1)
             regs.x.dx = 0;
       else
             regs.x.dx = 1;
       /* call the ROM BIOS routine */
       int86(0x14, &regs, &regs);
}
```

F.3 PUT CHARACTER TO SERIAL PORT

This function sends a character (c) to the serial port specified by (n) using the ROM BIOS routine; if the computer is not IBM-PC-compatible the ROM BIOS routine must be replaced by an equivalent.

```
/* put character to serial port */
void put_serc(int n, int c)
{
       union REGS regs;

       /* AH has the function code */
       regs.h.ah = 0x01;
       /* AL has the character */
       regs.h.al = c;
       /* DX has the port number */
       if (n == 1)
             regs.x.dx = 0;
       else
             regs.x.dx = 1;
       /* call the ROM BIOS routine */
       int86(0x14, &regs, &regs);
}
```

F.4 SEND, WAIT FOR ECHO

This function sends a character to the serial port specified by (n), allows a small delay (about 50 msec) for the character to be received by the BIT card, analyzed, put in a buffer and echoed back. If the BIT Card did not receive the character, or if the time-out expires, the BIT card returns the EOF character.

This command could be modified so that if the time-out expires, the last character is sent to the BIT Card again.

```
int SendWecho(int n, int c)
{
int j;
       /* send to the serial port */
       put_serc(n, c);

       /* timeout delay = 1000  -  biger for faster computers */
       for(j=1;j<1000;j++)
         if (in_ready(PORT)) {
              /* get character from serial port*/
              c = get_serc(PORT);
              return c;
         }
       /* if timeout  -  no character returned */
       c = EOF;
       return c;
}
```

F.5 GET CHARACTER FROM SERIAL PORT

This function accepts a character from the serial port specified by n using the ROM BIOS routine; if the computer is not IBM-PC-compatible the ROM BIOS routine must be replaced by an equivalent.

```
/* get character from serial port */
int get_serc(int n)
{
       union REGS regs;

       /* AH has the function code */
       regs.h.ah = 0x02;
       /* DX has the port number */
       if (n == 1)
              regs.x.dx = 0;
       else
              regs.x.dx = 1;
       /* call the ROM BIOS routine */
       int86(0x14, &regs, &regs);

       /* return EOF if timed out */
       if (regs.h.ah & 0x80)
              return EOF;
       return regs.h.al;
}
```

F.6 CHECK TO SEE IF A CHARACTER WAS RECEIVED

This function checks to see if a character was received using the ROM BIOS routine; if the computer is not IBM-PC-compatible the ROM BIOS routine must be replaced by an equivalent.

```
/* check to see if a character was received */
int in_ready(int n)
{
	union REGS regs;

	/* AH has the function code */
	regs.h.ah = 0x03;
	/* DX has the port number */
	if (n == 1)
		regs.x.dx = 0;
	else
		regs.x.dx = 1;
	/* call the ROM BIOS routine */
	int86(0x14, &regs, &regs);

	/* check for received data ready */
	if (regs.h.ah & 1)
		return TRUE;
	return FALSE;
}
```

F.7 SEND COMMAND

This function sends a character string to the BIT Card and sends the echoed characters to the monitor screen. The SendWecho function is used to send the command, byte by byte, to the BIT Card. After the last byte of the command is sent, the Carriage Return (CR) character is sent to the BIT Card to cause the parser to execute the command, and CR and Line Feed (LF) characters are sent to the monitor screen.

This function could be modified by comparing the character sent with the echoed character, then if they do not match, send the last character again.

```
void SendCommand(char *send_cmmd)
{
int chr;
	while( *send_cmmd != '\0') {
		/* output character here */
		chr = *send_cmmd ++;
		SendWecho(PORT,chr);
		/* display returned byte if available */
		if (chr != EOF)
			putch(chr);
	}

	/* output end command */
	chr = '\r';
	SendWecho(PORT,chr);
	/* display returned byte if available */
	if (chr != EOF)
		putch(chr);
	if (chr == '\r')
		putch('\n');
}
```

F.8 SEND COMMAND AND WAIT UNTIL READY

This function uses the SendCommand function to send commands to the BIT Card and display echoed characters and response messages on the screen until the > character is received, indicating that parsing and execution of the command has been completed.

```
void SendCmmdWready(char *send_cmmd)
{
int not_endcmd;
char recv, *st_buff;

not_endcmd = TRUE;
st_buff = send_cmmd;
SendCommand(send_cmmd);
send_cmmd =st_buff;
while(not_endcmd)
       {
       if (in_ready(PORT)) {
              /* get character from serial port*/
              recv = get_serc(PORT);
              /* display it if one was available */
              if (recv != EOF)
                     {
                     putch(recv);
                     *send_cmmd = recv;
                     send_cmmd ++;
                     if (recv == '>')
                            not_endcmd = FALSE;
              }
       }
}
       *send_cmmd = '\0';

}
```

APPENDIX G - BASIC LANGUAGE TERMINAL EMULATION

G.1 INTRODUCTION

This appendix presents a program written in BASIC language intended to aid the user in building BASIC language test programs using the BIT Card. (See PAR. 1.4 to order Sample Programs diskette.)

The BASIC Language Terminal Emulation program performs a series of commands, then allows the user to type commands and control a BOP via the BIT Card from a keyboard. The keyboard commands are displayed on the screen while the commands are executed and response messages are displayed on the screen.

SCPI commands are used, however the program may easily be modified to use CIIL commands by changing the applicable character strings.

The program is written to use COM port 2; to use COM port 1 change the following line:

```
OPEN "COM2:9600,N,8,1,RS,CS,DS" FOR RANDOM AS #1 LEN = 256
```

to:

```
OPEN "COM1:9600,N,8,1,RS,CS,DS" FOR RANDOM AS #1 LEN = 256
```

With the program loaded under a BASIC interpreter, press ALT+R to run the program or ALT+Q to exit.

The program performs the following functions

1. Request power supply identification (*IDN?).
2. Reset the power supply (*RST).
3. Test the power supply (*TST).
4. Check for errors (SYST:ERR)
5. Wait for keyboard commands. When keyboard commands are entered, the echoed commands and response messages are displayed.

```
DEFINT A-Z

DECLARE SUB SendWecho (SendChar$)
DECLARE SUB SendCommand (SendCmmd$)
DECLARE SUB SendCmmdWready (SendCmd$)
DECLARE SUB Filter (InString$)
CONST FALSE = 0, TRUE = NOT FALSE

COLOR 7, 1                      ' Set screen color.
CLS

Quit$ = CHR$(0) + CHR$(16)      ' Value returned by INKEY$
                              ' when ALT+q is pressed.

' Set up prompt on bottom line of screen and turn cursor on:
LOCATE 24, 1, 1
PRINT STRING$(80, "_");
LOCATE 25, 1
PRINT TAB(30); "Press ALT+q to quit";
```

```
VIEW PRINT 1 TO 23              ‘ Print between lines 1 & 23.

‘ Open communications (9600 baud, no parity, 8-bit data,
‘ 1 stop bit, 256-byte input buffer):
OPEN “COM2:9600,N,8,1,RS,CS,DS” FOR RANDOM AS #1 LEN = 256


   ‘ Check the RS 232 interface  if characters are waiting (EOF(1) is
   ‘ true) and get them
   IF NOT EOF(1) THEN

      ‘ LOC(1) gives the number of characters waiting:
      SendChar$ = INPUT$(LOC(1), #1)
   END IF

  ComString$ = “*idn?”
  SendCmmdWready ComString$

  ComString$ = “*rst”
  SendCmmdWready ComString$

  ComString$ = “*tst?”
  SendCmmdWready ComString$

  ComString$ = “syst:err?”
  SendCmmdWready ComString$

DO                              ‘ Main communications loop.

   KeyInput$ = INKEY$           ‘ Check the keyboard.

   IF KeyInput$ = Quit$ THEN    ‘ Exit the loop if the user
      EXIT DO                   ‘ pressed ALT+q.

   ELSEIF KeyInput$ <> ““ THEN  ‘ Otherwise, if the user has pressed a key
   SendWecho KeyInput$
   END IF                       ‘ character typed to the modem.

    PRINT KeyInput$;        ‘ then print.

   ‘ Check the modem. If characters are waiting (EOF(1) is
   ‘ true), get them and print them to the screen:
   IF NOT EOF(1) THEN

      ‘ LOC(1) gives the number of characters waiting:
      CharInput$ = INPUT$(LOC(1), #1)

      Filter CharInput$        ‘ Filter out line feeds and
      PRINT CharInput$;        ‘ backspaces, then print.
   END IF

LOOP

CLOSE                           ‘ End communications.
CLS
END

‘
```

```
' ======================== FILTER ==========================
'     Filters characters in an input string.
' ============================================================
'
SUB Filter (InString$) STATIC

   ' Look for backspace characters and recode them to
   ' CHR$(29) (the LEFT cursor key):
   DO
      BackSpace = INSTR(InString$, CHR$(8))
      IF BackSpace THEN
         MID$(InString$, BackSpace) = CHR$(29)
      END IF
   LOOP WHILE BackSpace

   ' Look for line-feed characters and remove any found:
   DO
      LineFeed = INSTR(InString$, CHR$(10))
      IF LineFeed THEN
         InString$ = LEFT$(InString$, LineFeed - 1) + MID$(InString$, LineFeed + 1)
      END IF
   LOOP WHILE LineFeed

END SUB

'
' ======================== Send Command =====================
' Send command line and wait for the command to be completed
' ============================================================
'
SUB SendCmmdWready (SendCmd$) STATIC

  SendCommand SendCmd$

   Notendcm = TRUE

   WHILE Notendcm
     ' Check the modem. If characters are waiting (EOF(1) is
     ' true), get them and print them to the screen:
     IF NOT EOF(1) THEN

        ' LOC(1) gives the number of characters waiting:
        CharInput$ = INPUT$(LOC(1), #1)
        IF CharInput$ = CHR$(62) THEN
          Notendcm = FALSE
        END IF
        Filter CharInput$
        PRINT CharInput$;        ' backspaces, then print.
     END IF
   WEND
END SUB

'
```

```
' ========================= Send Command =====================
' Send command line using SendWecho
' ==============================================================
'
SUB SendCommand (SendCmmd$) STATIC
   FOR K = 1 TO LEN(SendCmmd$)
     Istr$ = MID$(SendCmmd$, K, 1)
     SendWecho Istr$
     PRINT Istr$;        ' then print.
   NEXT K

   Istr$ = CHR$(13)
   SendWecho Istr$
   PRINT Istr$
END SUB

'
' ========================= Send with Echo ===================
' Send character and wait for the character to be echoed back
' ==============================================================
'
SUB SendWecho (SendChar$) STATIC
      PRINT #1, SendChar$;      ' send the pressed key

   FOR J = 1 TO 100

     ' Check the RS 232 interface  if characters are waiting (EOF(1) is
     ' true), get them and print them to the screen:
     IF NOT EOF(1) THEN

        SendChar$ = INPUT$(1, #1)
        Filter SendChar$        ' Filter out backspace
        EXIT FOR
     END IF
   ' If timeout expire return empty string
   SendChar$ = ""
   NEXT J

END SUB
```