OPERATOR'S MANUAL

TLD 488-16

INTERACTIVE DIGITAL PROGRAMMER

KEPCO INC.
An ISO 9001 Company.

MODEL
TLD 488-16
DIGITAL PROGRAMMER

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 Operator's 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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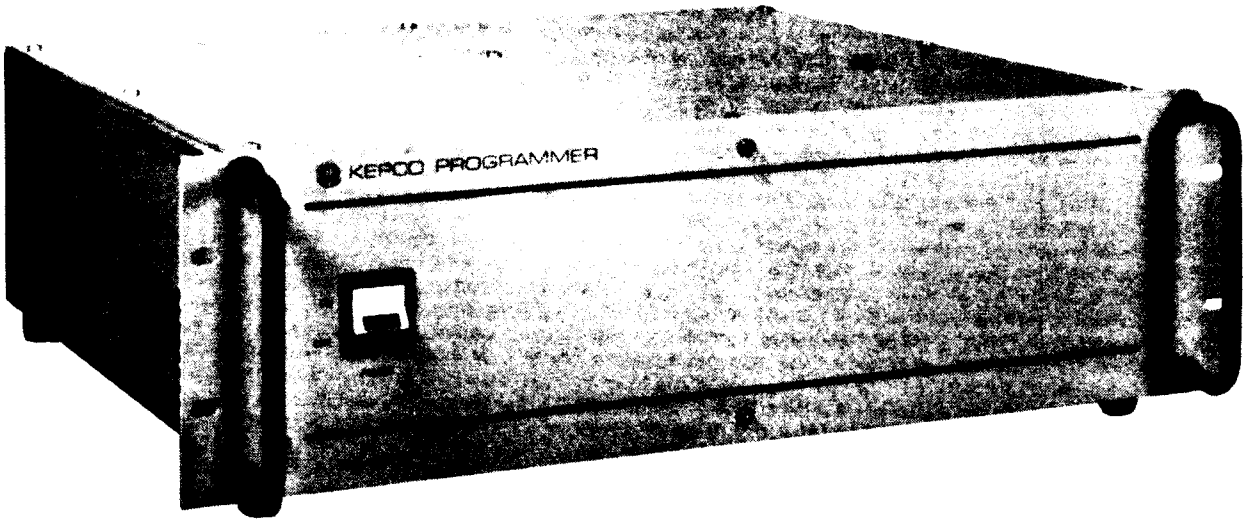


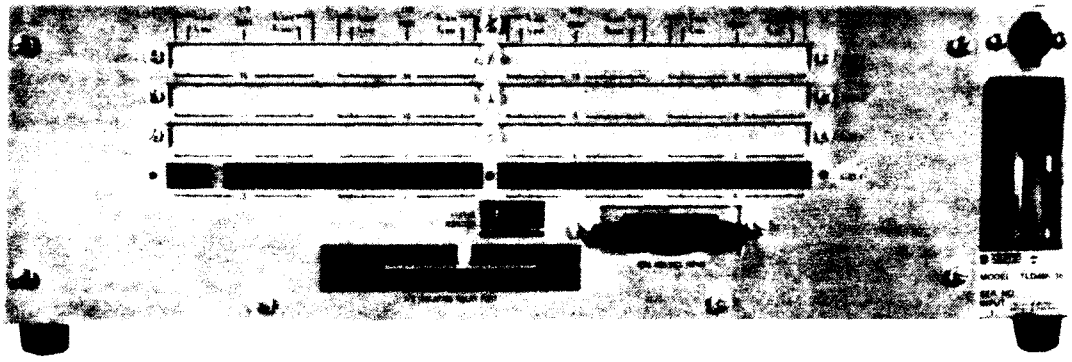


FIG. 1-1 KEPCO MODEL TLD 488-16 INTERACTING DIGITAL PROGRAMMER, FRONT AND REAR VIEW.

SECTION I—INTRODUCTION

1-1 SCOPE OF MANUAL

1-2 This operator's manual contains the specifications and instructions for the installation and operation of the Model TLD 488-16 Digital Programmer, manufactured by Kepco Inc., Flushing, N.Y., U.S.A. For extended technical information see the Kepco TLD 488-16 Hardware Reference Manual.

1-3 GENERAL DESCRIPTION (See Fig. 1-1)

1-4 The Kepco Model TLD 488-16, was designed as an interactive digital to analog interface between a system controller and the Kepco Series ATE and BOP power supplies. The TLD 488-16 communicates with its controller via the IEEE 488 (GPIB) bus and is designated as a LISTENER or a TALKER according to the GPIB protocol. The TLD 488-16 recognizes and responds to the mnemonics and syntax of the Control Interface Intermediate Languague (CIIL). It uses a built-in microprocessor to drive up to four plug-in cards which in turn can control up to four power supplies each, so that a single TLD 488-16 can control up to sixteen power supplies. The TLD 488-16 recognizes ten commands: FUNCTION, SET, SET MAXIMUM, SET MINIMUM, CLOSE, OPEN, RESET, INTERNAL SELF TEST, CONFIDENCE TEST and STATUS. It also recognizes five nouns and noun modifiers: DIRECT CURRENT SOURCE, VOLTAGE, VOLTAGE LIMIT, CURRENT and CURRENT LIMIT. When the TLD 488-16 is "talk addressed" by the controller over the IEEE 488 bus, it will respond with an error message if it can not comply with the instruction. Some possible error messages are: CROWBARRED, OVERLOAD, VOLTAGE COMPARISON ERROR, CURRENT COMPARISON ERROR, DEVICE NOT PRESENT and INVALID COMMAND.

1-5 The interface functions implemented by Kepco's TLD 488-16 on the GENERAL PURPOSE INTERFACE BUS (GPIB), as defined by the IEEE-488 Standard, are listed in Table 1-1.

GPIB FUNCTION	SUBSET SYMBOL	COMMENTS
Source Handshake	SH1	—
Acceptor Handshake	AH1	—
Talker	T6	Basic talker, serial poll, unaddress if MLA.
Listener	L4	Basic listener, unaddress if MTA.
Service Request	SR1	—
Device Clear	DC1	—

TABLE 1-1 TLD 488-16 INTERFACE FUNCTIONS

OUTPUT VOLTAGE RATING	ATE ¼ RACK 50W & 100W SIZES A & B	ATE ½, ¾ & FULL RACK 250W, 500W & 1000W SIZES C, D & E
6V	PCA 6-1	PCA 6-2
15V	PCA 15-1	PCA 15-2
25V	PCA 25-1	PCA 25-2
36V	PCA 36-1	PCA 36-2
55V	PCA 55-1	PCA 55-2
75V	PCA 75-1	PCA 75-2
100V	PCA 100-1	PCA 100-2
150V	PCA 150-1	PCA 150-2
325V	N.A.	PCA 325-2

TABLE 1-2 SERIES PCA CONNECTOR ASSEMBLIES FOR ATE UNIPOLAR POWER SUPPLIES

1-6 In order to interconnect the TLD 488-16 with ATE power supplies, a Kepco Series PCA interface connector must be selected for each power supply from Table 1-2. For BOP power supplies, a single interface is used, Model PCA X-3, which is mounted inside the BOP. The interconnection from the TLD 488-16 to the GPIB is made with an IEEE 488 standard bus cable. The TLD 488-16 has a separate input/output port to close, open and verify the status of external relays which may be connected between the power supplies and the load. In addition, a status monitor port is available which provides a two-wire status monitor line to the controller to report catastrophic failures in the TLD 488-16 or in the power supplies. Connectors for the STATUS MONITOR INTERFACE and the ISOLATION RELAY INTERFACE are provided.

1-7 The TLD 488-16 consists of a "full-rack" (19 inch) standard card cage. It contains a single-board microcomputer and accomodates up to four (4) plug-in cards. These cards may either be Model TL 488-4A (for ATE power supplies), **or** Model TL 488-4B (for BOP power supplies), or a mixture of the two. Each plug-in card can control the voltage and current function of up to four (4) power supplies. With a full complement of four (4) TL 488-4A or TL 488-4B cards, the system will control 16 individual, isolated, power supplies.

1-8 SPECIFICATIONS, GENERAL: Refer to Table 1-3

A-C Input requirements:	105 to 125V a-c or 210 to 250V a-c Approximately 90W maximum
Ambient operating temperature range:	0 °C to + 55 °C
Storage temp. range:	– 20 °C to + 75 °C
Dimensions:	$5\frac{7}{32}$"H, x 19"W, x $16\frac{3}{16}$"D
Weight:	Approximately 8 lbs.
Color:	Gray, Fed. Std. 26440
Mounting:	19" rack (Provisions for chassis slides.)

TABLE 1-3 GENERAL SPECIFICATIONS MODEL TLD 488-16

1-9 SPECIFICATIONS, PLUG-IN CARDS: Refer to Table 1-4

MODEL	TL 488-4A	TL 488-4B
Number of isolated input/output ports	Four (4) ports.	
Analog outputs per port	Two (2) channels.	
Mode of operation for the Analog Output Channels	Voltage and Current Limit or Current and Voltage Limit. Determined by noun modifiers within SET command.	
Analog output voltage level	0 to + 10V for Voltage or Voltage Limit Channel 0 to + 1V for Current or Current Limit Channel.	0 to ± 10V Main Channel 0 to + 10V Limit Channel
Analog output current level	0 to + 2mA per channel.	0 to ± 2mA Main Channel 0 to + 2mA Limit Channel
Output impedance	< 0.05 ohms.	
Output resolution	12 bit.	
Linearity error (0 to + 55°C)	< ± ½ LSB. (Least Significant Bit)	
Adjustments	Full Scale calibration. Zero adjustment. Both channels	Main Channel only
Temp. coefficient (per degree C)	± 0.002% at full scale. ± 20μV at zero.	
Isolation between ports	500V d-c.	
Power supply identification codes	Set with DIP switches for each port.	
Input signals accepted from the power supply	Supply Absent flag. Voltage/Current Mode flag. Crowbar flag. Voltage out of limit (0.1% of full scale). Current out of limit (1.0% of full scale).	Supply Absent flag. Overload flag. Turn-off flag. Voltage out of limit (0.1% of full scale). Current out of limit (0.1% of full scale).
Input digital commands	Via Multibus™ from TLD 488-16. All signals TTL compatible.	
Power requirements	+ 5V at 2A, via Multibus™ from TLD 488-16.	
Card, physical characteristics	Width: 12". Length 6.75". Height: 0.5". Weight: 20 ounces.	

TABLE 1-4 SPECIFICATIONS FOR MODEL TL 488-4A and TL 488-B PLUG-IN CARDS.

1-10 BLOCK DIAGRAM DESCRIPTION (Refer to FIG. 1-2)

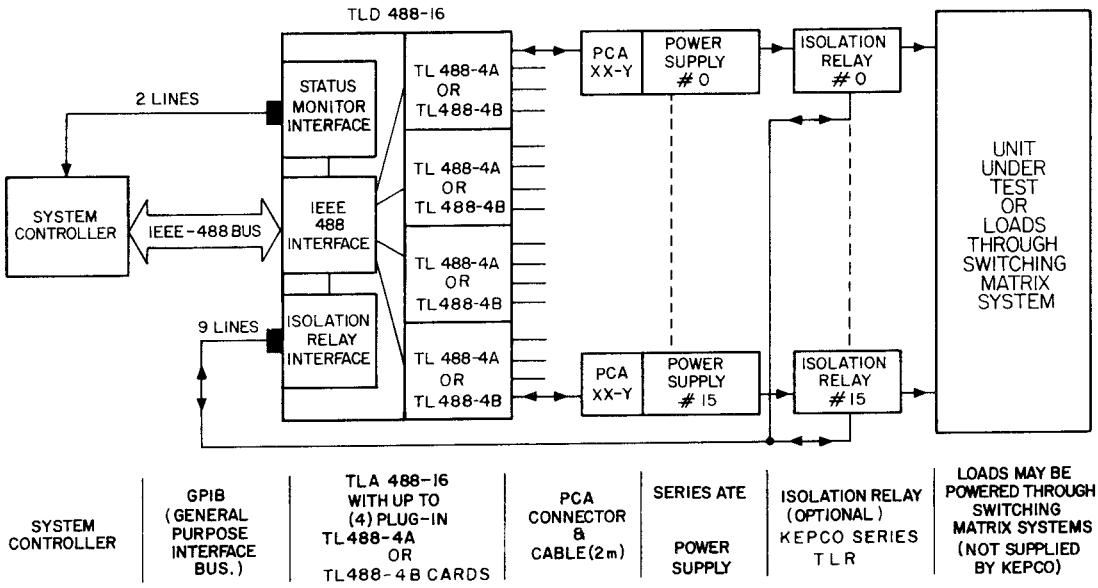
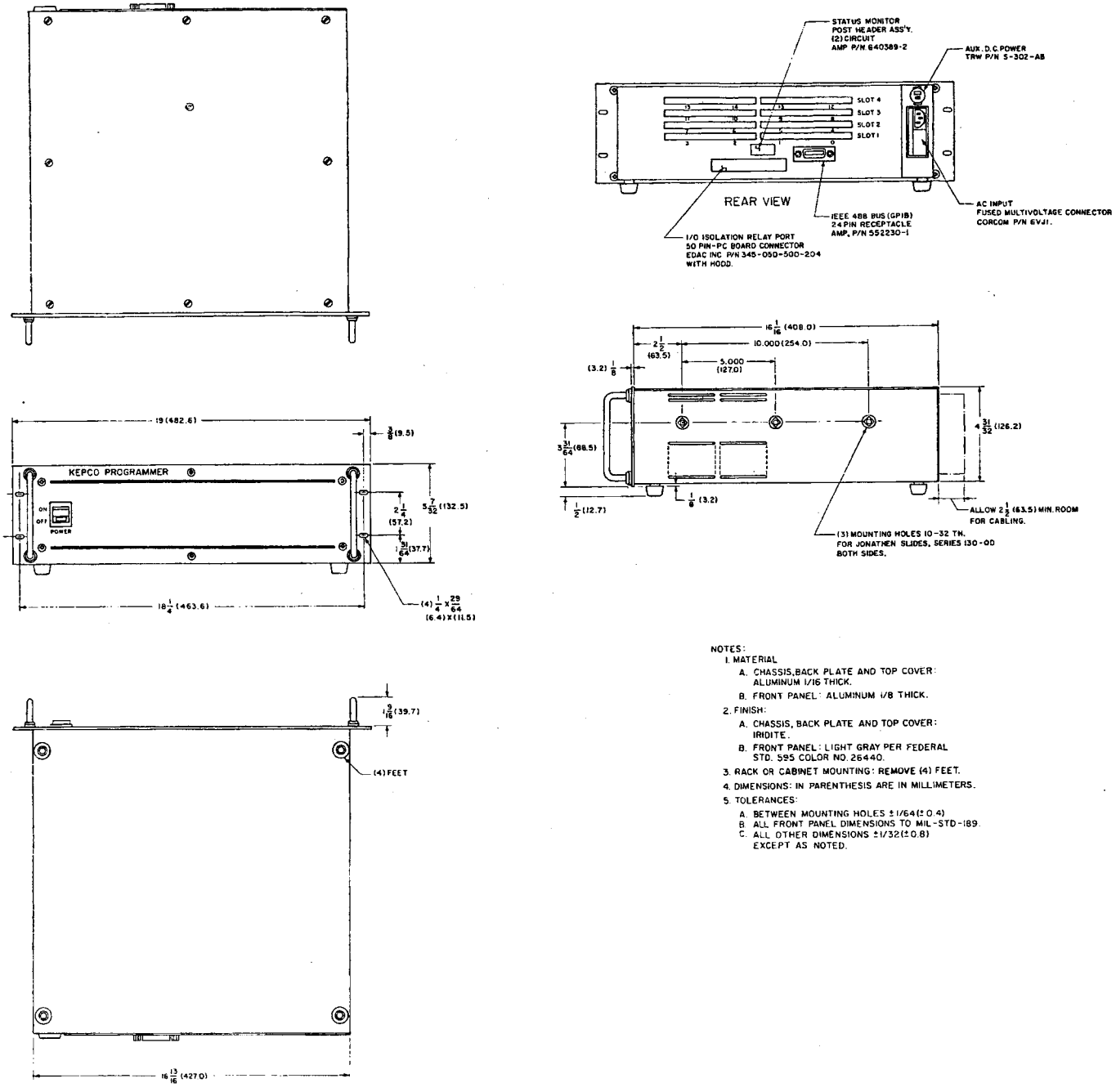


FIG. 1-2 BLOCK DIAGRAM OF A TYPICAL TEST SET-UP, SHOWING THE INTERFACE CONNECTIONS BETWEEN A SYSTEM CONTROLLER, THE KEPCO MODEL TLD 488-16 AND KEPCO SERIES ATE or BOP POWER SUPPLIES.

1-11 The BLOCK DIAGRAM (FIG. 1-2) shows a typical test set up under the direction of a SYSTEM CONTROLLER. All communications between the TLD 488-16 and the SYSTEM CONTROLLER take place on the IEEE 488 bus. The additional two lines to the SYSTEM CONTROLLER transmit a contact closure in case of a serious malfunction in one of the power supplies. The nine (9) relay lines may be used to operate optional relays (Kepco Series TLR, for example) which isolate the load from the power supplies if required.

1-12 The SYSTEM CONTROLLER can set the output voltage with current limit, or the output current with voltage limit for ATE power supplies or the Main Channel and Limit Channel values for BOP power supplies on each of the power supplies connected to the TLD 488-16. The commands to and the response from the power supplies are transmitted via the TLD 488-16 and the IEEE 488 bus, using the mnemonics and syntax of the Control Interface Intermediate Language (CIIL). All data transmissions over the bus are ASCII encoded. The values for the command parameters can be written in integer, decimal or scientific notation. The response from the power supplies via the TLD 488-16 include CONDITIONS NORMAL, INVALID COMMAND and other various ERROR MESSAGES, detailed in Section III of this manual.



NOTES:

1. MATERIAL
   - A. CHASSIS, BACK PLATE AND TOP COVER: ALUMINUM 1/16 THICK.
   - B. FRONT PANEL: ALUMINUM 1/8 THICK.
2. FINISH:
   - A. CHASSIS, BACK PLATE AND TOP COVER: IRIDITE.
   - B. FRONT PANEL: LIGHT GRAY PER FEDERAL STD. 595 COLOR NO. 26440.
3. RACK OR CABINET MOUNTING: REMOVE (4) FEET.
4. DIMENSIONS: IN PARENTHESIS ARE IN MILLIMETERS.
5. TOLERANCES:
   - A. BETWEEN MOUNTING HOLES ±1/64 (±0.4)
   - B. ALL FRONT PANEL DIMENSIONS TO MIL-STD-189.
   - C. ALL OTHER DIMENSIONS ±1/32 (±0.8) EXCEPT AS NOTED.

FIG. 1-3 TLD 488-16 CARD CAGE, MECHANICAL OUTLINE DRAWING.

SECTION II—PREPARATION FOR USE

2-1 UNPACKING AND INSPECTION

2-2 The Model TLD 488-16 and its accompanying programming card(s) have been carefully inspected and tested prior to packing. Inspect the shipping carton(s) immediately upon receipt for evidence of damage during transit. Save the original packing material. If any indication of damage is found file a claim immediately with the responsible transport service.

2-3 For repairs of a product damaged in shipment, contact the Kepco Factory Representative nearest you, or contact the Kepco Sales Department directly for further instruction.

2-4 INSTALLATION

2-5 The installation and set-up procedure for the TLD 488-16 consists of the following steps:

1) ON THE COMPUTER BOARD:	2) ON THE PROGRAMMING CARD(S):	3) ON THE CARD CAGE:
Set Device Address.	Set TL 488-4A or TL 488-4B Board Address.	Set a-c line voltage.
Set Reset Function.	Set Power Supply Identification Switches.	Set PCA Connector Switches.
Set Shield Ground Selector.	Install Programming Card into TLD 488-16.	(For ATE power supplies only).

These steps are detailed in the following paragraphs. Refer to the fold-out Installation Drawing, FIG. 2-1 at the end of this section.

WARNING

Do not connect TLD 488-16 to a-c line until installation procedure is completed.

2-6 SET DEVICE ADDRESS, RESET FUNCTION AND SHIELD GROUND SELECTOR

2-7 The DEVICE ADDRESS for the TLD 488-16 is initially set by means of DIP switches on the COMPUTER BOARD, which occupies the bottom slot in the TLD 488-16 card cage. The DEVICE ADDRESS is the permanent LISTENER or TALKER address of the TLD 488-16 on the GPIB. It is factory pre-set to decimal "6". If a different DEVICE ADDRESS is required in your system, proceed as follow, if not go to STEP 3. There are 31 (0-30) possible choices (See Table 2-1).

STEP 1: Place the TLD 488-16 on a bench top, its rear panel facing forward. Take off the rear panel by removing the holding screws.

STEP 2: Carefully remove the COMPUTER BOARD from the lowest slot in the TLD 488-16, using the BOARD EJECTORS. Note that the COMPUTER board actually occupies the two bottom slots, due to its "piggy-back" construction. The four progressively higher slots are designated SLOT 1, 2, 3 and 4, with SLOT 4 being the highest in the TLD 488-16 card cage. Locate the IEEE 488 INTERFACE board with the DEVICE ADDRESS SELECTOR. This subassembly is the larger of the two "piggy-back" boards on the COMPUTER BOARD. The selector is a DIP switch, as indicated in FIG. 2-1 and detailed in FIG 2-2. The factory set device address is 6. For other choices select and set the device address according to Table 2-1.

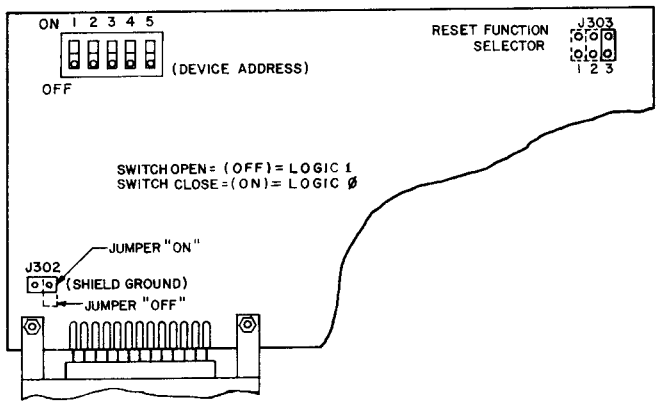


FIG. 2-2 IEEE 488 INTERFACE BOARD ON THE COMPUTER BOARD OF THE TLD 488-16, DEVICE ADDRESS SELECTOR DETAILS.

DECIMAL ADDRESS	S1-1	S1-2	S1-3	S1-4	S1-5
0	0	0	0	0	0
1	1	0	0	0	0
2	0	1	0	0	0
3	1	1	0	0	0
4	0	0	1	0	0
5	1	0	1	0	0
6	0	1	1	0	0
7	1	1	1	0	0
8	0	0	0	1	0
9	1	0	0	1	0
10	0	1	0	1	0
11	1	1	0	1	0
12	0	0	1	1	0
13	1	0	1	1	0
14	0	1	1	1	0
15	1	1	1	1	0
16	0	0	0	0	1
17	1	0	0	0	1
18	0	1	0	0	1
19	1	1	0	0	1
20	0	0	1	0	1
21	1	0	1	0	1
22	0	1	1	0	1
23	1	1	1	0	1
24	0	0	0	1	1
25	1	0	0	1	1
26	0	1	0	1	1
27	1	1	0	1	1
28	0	0	1	1	1
29	1	0	1	1	1
30	0	1	1	1	1

SWITCH OFF (OPEN) = LOGIC 1
SWITCH ON (CLOSED) = LOGIC 0

TABLE 2-1 DEVICE ADDRESS SELECTION ON THE KEPCO MODEL TLD 488-16 IEEE 488 INTERFACE BOARD

STEP 3: Locate the RESET FUNCTION SELECTOR in FIG. 2-2 and place jumper into the position desired: (RESET FUNCTION should not be confused with "CIIL" op-code RST (Reset) as defined in Section III of this manual).

POS. 1 = AUTORESET — Automatically resets the system if microprocessor hangs up.
POS. 2 = HARDWARE RESET — Is activated by the IFC (Interface Clear) command (original "MATE" requirement).
POS. 3 = Reset is activated by DCL (Device Clear) command. The factory set position is POS. 3.

STEP 4: Locate the SHIELD GROUND SELECTOR in Fig.2-2 and place jumper in position "ON" (shields on the IEEE 488 connector connected to common) or in position "off" (shields not grounded). The factory set position is "ON".

STEP 5: Carefully, re-insert the COMPUTER BOARD into the lowest slot (A) in the TLD 488-16, closing the BOARD EJECTORS. ***NOTE:*** *The DEVICE ADDRESS of the TLD 488-16 serves as the LISTENER as well as the TALKER address on the IEEE bus.*

2-8 SET TL 488-4A or TL 488-4B BOARD ADDRESS AND POWER SUPPLY IDENTIFICATION SWITCHES.

2-9 The TL 488-4A or TL 488-4B Board Addresses are set by means of jumpers on the P.C. board. The board addresses permit the Controller to address from one to sixteen individual power supplies (CHANNELS 0 to 15). All TL 488 boards are shipped separate from the TLD 488-16 card cage. Before installing the board(s) into the cage, proceed as follows:

STEP 1: Place board on a clean, cushioned surface, component side up, power supply connectors facing forward. Locate the BOARD ADDRESS SELECTOR. This selector is a jumper-type device, as indicated in FIG. 2-1 and detailed in FIG. 2-3.

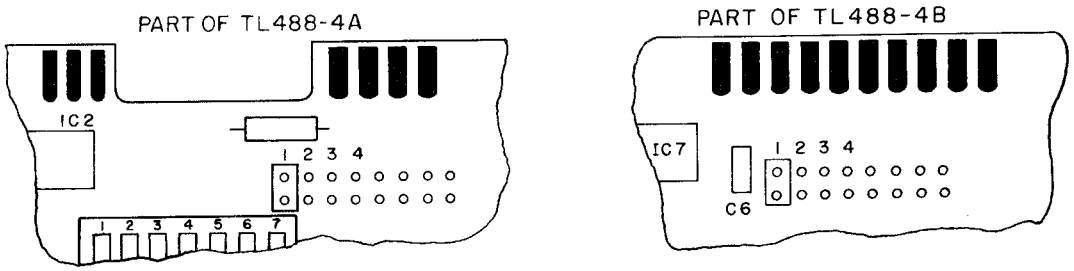


FIG. 2-3 VIEW OF TL 488-4A, (LEFT) AND TL 488-4B (RIGHT)
WITH BOARD ADDRESS SELECTOR DETAIL, JUMPER IN POS. 1.

STEP 2: Place the jumper in the position equivalent to the SLOT NUMBER the board occupies in the TLD 488-16: If a single board is used (one to four power supplies are to be controlled), the board will occupy SLOT 1. Set the jumper to position 1. If several boards are used (more than four power supplies are to be controlled), the second board will occupy SLOT 2. Set the jumper to position 2 on the second board. Continue with board 3, SLOT 3, jumper to position 3 and board 4, SLOT 4, jumper to position 4.

STEP 3: Locate the POWER SUPPLY IDENTIFICATION SWITCHES as indicated in FIG. 2-1 and detailed in FIG. 2-4.

FIG. 2-4 ONE OF FOUR POWER SUPPLY IDENTIFICATION SWITCHES
ON THE TL 488-4A BOARD (LEFT) AND ON THE TL 488-4B BOARD (RIGHT).

STEP 4: Find the power supply model to be controlled at CHANNEL 0 in the Table 2-2 or Table 2-3 and set the switch positions as indicated in the table. Continue with the power supply occupying CHANNEL 1 and so on, until all power supply identification switches are set. Set switches for unoccupied channels as directed in Table 2-2 or Table 2-3.

NOTE: *There are seven (7) switch positions for ATE power supplies as shown in Table 2-2. Switch position 7 (S1-7) serves to select SLOW or FAST operating modes. For BOP power supplies only five (5) positions are provided as shown in Table 2-3.*

STEP 5: Install the TL 488-4A or TL 488-4B board(s) into the appropriate slot in the TLD 488-16 card cage. Replace the rear panel of the TLD 488-16 and fasten with the panel holding screws.

MODEL	SWITCHES SW #1	SW #2	SW #3	SW #4	SW #5	SW #6	(SWITCH # 7 CLOSED)	MONITOR TIME OUT[1]	(SWITCH #7 OPEN)	MONITOR TIME OUT[1]
ATE 6-5M	0	0	0	0	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 15-3M	1	0	0	0	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 25-2M	0	1	0	0	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 36-1.5M	1	1	0	0	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 55-1M	0	0	1	0	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 75-0.7M	1	0	1	0	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 100-0.5M	0	1	1	0	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 150-0.3M	1	1	1	0	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 6-10M	0	0	0	1	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 15-6M	1	0	0	1	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 25-4M	0	1	0	1	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 36-3M	1	1	0	1	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 55-2M	0	0	1	1	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 75-1.5M	1	0	1	1	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 100-1M	0	1	1	1	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 150-0.7M	1	1	1	1	0	0	SLOW MODE	2.5 sec	FAST MODE	50 millisec
ATE 6-25M	0	0	0	0	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 15-15M	1	0	0	0	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 25-10M	0	1	0	0	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 36-8M	1	1	0	0	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 55-5M	0	0	1	0	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 75-3M	1	0	1	0	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 100-2.5M	0	1	1	0	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 150-1.5M	1	1	1	0	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 325-0.8M	1	0	0	1	0	1	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 6-50M	0	0	0	1	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 15-25M	1	0	0	1	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 25-20M	0	1	0	1	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 36-15M	1	1	0	1	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 55-10M	0	0	1	1	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 75-8M	1	0	1	1	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 100-5M	0	1	1	1	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 150-3.5M	1	1	1	1	1	0	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 6-100M	0	0	0	0	0	1	SLOW MODE	10 sec	FAST MODE	50 millisec
21333	0	0	0	1	0	1	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 15-50M	1	0	0	0	0	1	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 25-40M	0	1	0	0	0	1	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 36-30M	1	1	0	0	0	1	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 55-20M	0	0	1	0	0	1	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 75-15M	1	0	1	0	0	1	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 100-10M	0	1	1	0	0	1	SLOW MODE	10 sec	FAST MODE	50 millisec
ATE 150-7M	1	1	1	0	0	1	SLOW MODE	10 sec	FAST MODE	50 millisec
NO SUPPLY	1	1	1	1	1	1	X	N.A.	X	N.A.

TABLE 2-2 MODEL TABLE FOR SETTING THE POWER SUPPLY IDENTIFICATION SWITCHES ON TL 488-4A
NOTE: 0 = CLOSED (ON), 1 = OPEN (OFF), X = DON'T CARE, N.A. = NOT APPLICABLE

[1] Monitor time outs are time delays, imposed by the TLD 488-16 to allow the power supply output to settle after a change in output value has been commanded.

MODEL	SWITCHES SW #1	SW #2	SW #3	SW #4	SW #5	MONITOR TIME OUT[1]
BOP 50-2M	0	0	0	0	0	50 millisec.
BOP 100-1M	1	0	0	0	0	50 millisec.
BOP 20-10M	0	1	0	0	0	50 millisec.
BOP 36-6M	1	1	0	0	0	50 millisec.
BOP 50-4M	0	0	1	0	0	50 millisec.
BOP 72-3M	1	0	1	0	0	50 millisec.
BOP 100-2M	0	1	1	0	0	50 millisec.
BOP 20-20M	1	1	1	0	0	50 millisec.
BOP 36-12M	0	0	0	1	0	50 millisec.
BOP 50-8M	1	0	0	1	0	50 millisec.
BOP 72-6M	0	1	0	1	0	50 millisec.
BOP 100-4M	1	1	0	1	0	50 millisec.
BOP 200-0.5M	0	0	1	1	0	50 millisec.
BOP 200-1M	1	0	1	1	0	50 millisec.
NO SUPPLY	1	1	1	1	1	N.A.

TABLE 2-3 MODEL TABLE FOR SETTING THE POWER SUPPLY IDENTIFICATION SWITCHES ON TL 488-4B
NOTE: 0 = ON (CLOSED), 1 = OFF (OPEN).

[1] Monitor time outs are time delays, imposed by the TLD 488-16 to allow the power supply output to settle after a change in output value has been commanded.

2-10 SET A-C LINE VOLTAGE

NOTE: *The TLD 488-16 is normally connected for operation on 105-125V a-c lines. If operation on 210-250V a-c lines is desired, proceed as follows:*

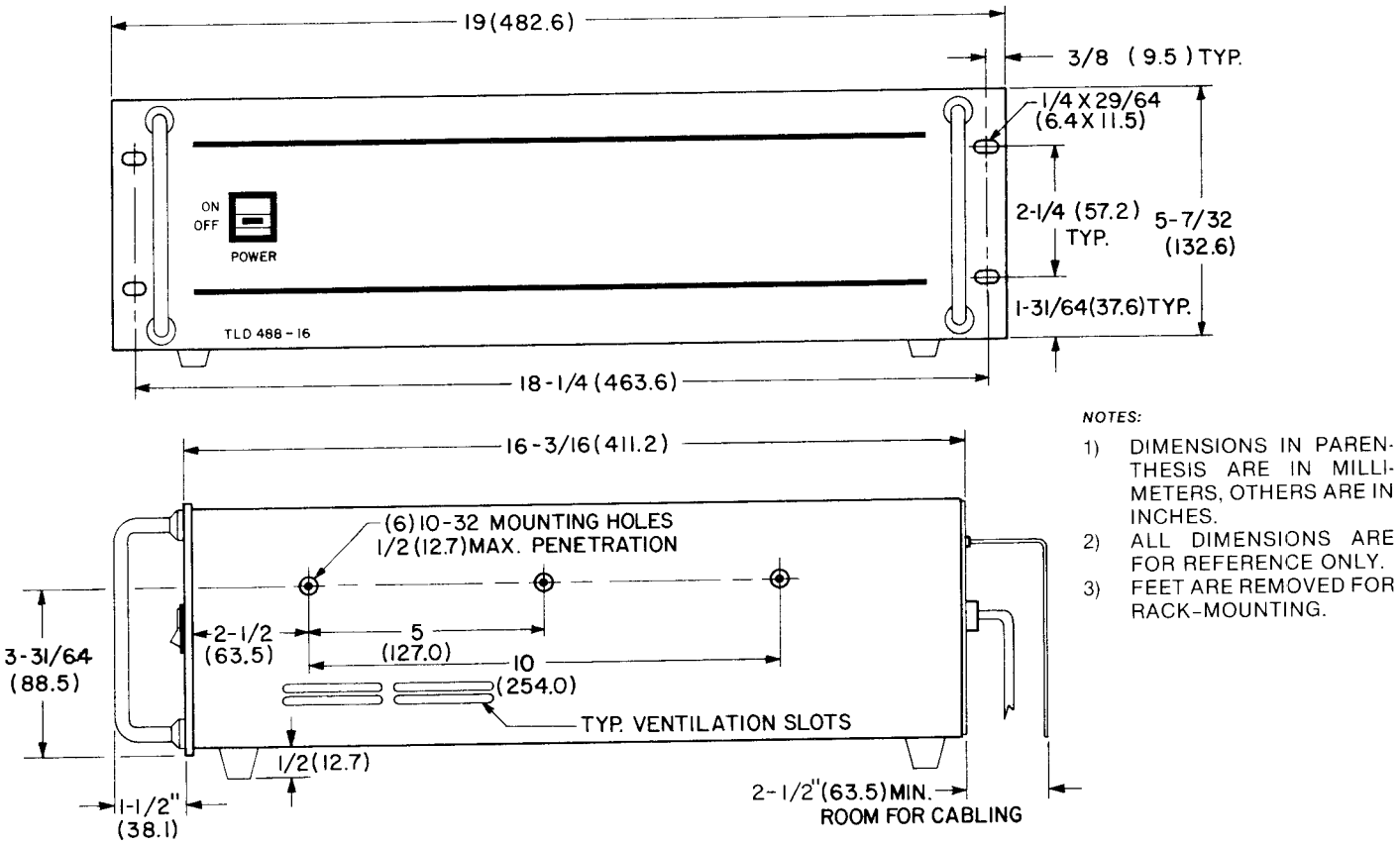
STEP 1: With the a-c power cord removed from the FUSED MULTIVOLTAGE CONNECTOR, lift-up the transparent cover and lift the FUSE-PULL lever up. Remove fuse and put aside.

STEP 2: Remove the miniature SELECTOR CARD, turn so that the desired a-c input voltage is visible and replace card, pushing it firmly into the slot.

STEP 3: Reinstall fuse. ***NOTE:*** *The same value fuse is used (5A-250V, KEPCO P/N 141-0056 or BUSS MDA-5) for operation on 115V a-c or on 230V a-c.* Close cover and insert the a-c power cord into the connector.

2-11 INSTALLATION OF THE MODEL TLD 488-16 (Refer to FIG. 2-5)

2-12 The TLD 488-16 may be operated on the bench or it can be installed into a standard 19 inch equipment rack. The sides of the unit have inserts for chassis slide mounting. *Chassis slides must be drilled according to the mounting hole pattern in FIG. 2-5 and must not obstruct the ventilation slots.* A suitable slide is Jonathan Series 130-QD or equivalent.



NOTES:

1) DIMENSIONS IN PARENTHESIS ARE IN MILLIMETERS, OTHERS ARE IN INCHES.
2) ALL DIMENSIONS ARE FOR REFERENCE ONLY.
3) FEET ARE REMOVED FOR RACK-MOUNTING.

FIG. 2-5 INSTALLATION DRAWING, MODEL TLD 488-16.

2-13 PREPARATION AND INSTALLATION OF THE KEPCO SERIES PCA CABLE ASSEMBLIES. (ATE POWER SUPPLIES WITH TL 488-4A CARDS ONLY).

2-14 The PCA cable assembly connects each ATE power supply to its pre-selected output channel on the TLD 488-16. Each PCA cable assembly is selected for the particular power supply (Refer to Section I, paragraph 1-6) and in addition must be set for selection of the operating mode (Slow or Fast) and for overvoltage protection (Tracking or Non-Tracking). Proceed as follows:

STEP 1: Remove the flat cable from the connector assembly by opening the EJECTOR LATCH at the large connector end. Take the large connector, remove the two (2) 4-40 holding screws and take out the connector insert. Refer to FIG. 2-6.

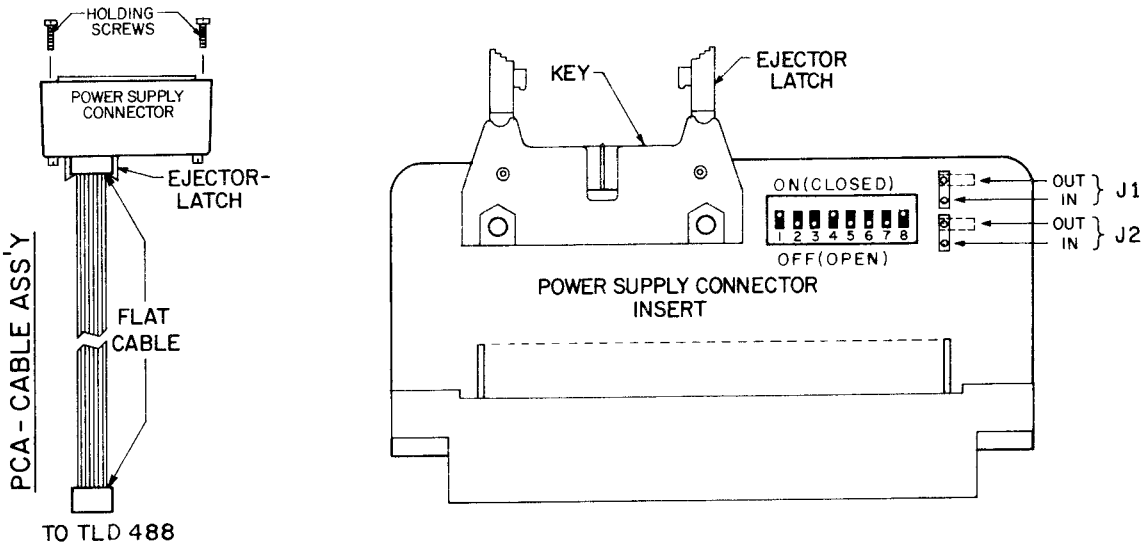


FIG. 2-6 PCA CABLE ASSEMBLY AND POWER SUPPLY CONNECTOR INSERT DETAIL, TOP VIEW.

NOTE: *PCA-2 Series Connectors have a single jumper only (J1).*

STEP 2: Determine the design group of the power supplies to be programmed. For power supplies in the ATE ¼ RACK SERIES enter Table 2-4. For models in the ATE ½, ¾ and FULL RACK SERIES enter Table 2-5. Place the jumper(s) and set the switches as directed in the tables.

STEP 3: Re-install the connector insert into the connector shell, re-attach the cable (note key-way) and mount the PCA connector assembly onto the power supply. Connect the other end of the PCA to the designated output channel on the TLD 488-16.

SWITCH #	SLOW		FAST	
	OVERVOLTAGE			
	NON TRACKING	TRACKING	NON TRACKING	TRACKING
S1	ON[1]	ON	OFF	OFF
S2	OFF[2]	OFF	ON	ON
S3	OFF	OFF	ON	ON
S4	ON	OFF	ON	OFF
S5	OFF	ON	OFF	OFF
S6	OFF	OFF	OFF	ON
S7	OFF	ON	OFF	OFF
S8	ON	OFF	ON	ON

[1] ON = CLOSED

[2] OFF = OPEN

JUMPER #	SLOW	FAST
J1	IN	OUT
J2	IN	OUT

TABLE 2-4 SWITCH AND JUMPER SELECTION ON THE PCA-1 CONNECTOR ASSEMBLY FOR QUARTER RACK ATE POWER SUPPLIES.

SWITCH #	SLOW		FAST	
	OVERVOLTAGE			
	NON TRACKING	TRACKING	NON TRACKING	TRACKING
S1	Not Used	Not Used	Not Used	Not Used
S2	OFF[1]	OFF	ON	ON
S3	OFF[2]	OFF	ON	ON
S4	ON	OFF	ON	OFF
S5	OFF	ON	OFF	OFF
S6	OFF	OFF	OFF	ON
S7	OFF	ON	OFF	OFF
S8	ON	OFF	ON	ON

[1] ON = CLOSED

[2] OFF = OPEN

JUMPER #	SLOW	FAST
J1	IN	OUT

TABLE 2-5 SWITCH AND JUMPER SELECTION ON THE PCA-2 CONNECTOR ASSEMBLY FOR ½, ¾ AND FULL RACK ATE POWER SUPPLIES.

2-15 INSTALLATION OF PCA X-3 AND CABLE (BOP POWER SUPPLIES) WITH TL 488-4B CARDS.

2-16 For BOP power supplies, the interface between the BOP and the TLD 488-16 programmer consists of the Model PCA X-3 interface card and a set of three (3) cables with connectors. The Model PCA X-3 interface card is installed inside the BOP as shown in FIG. 2-7. Detailed installation instructions are provided with the PCA X-3 Instruction Manual.

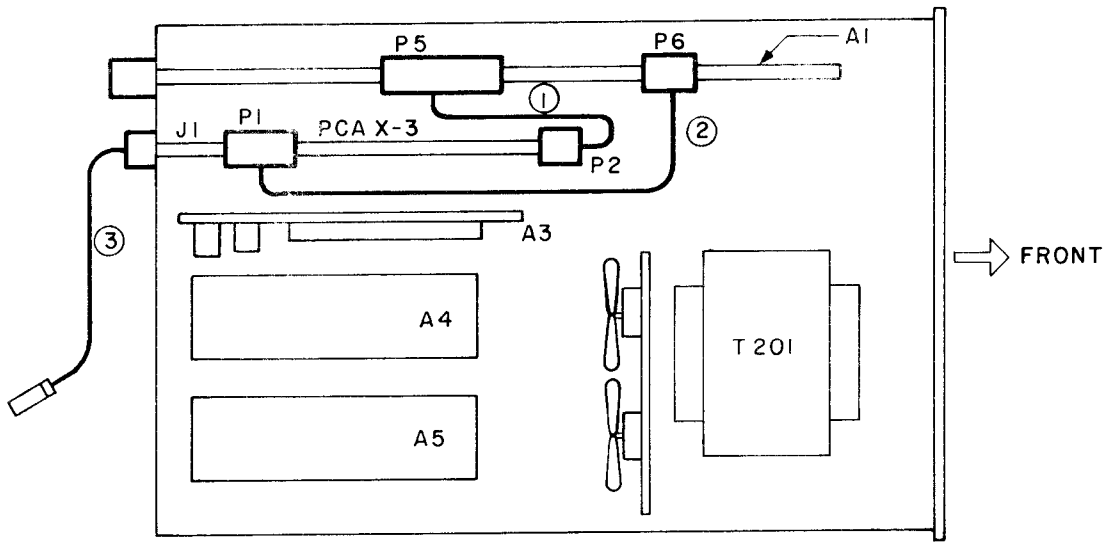


FIG. 2-7 BOP TOP VIEW (SIMPLIFIED) WITH
PCA X-3 INTERFACE INSTALLED.

2-17 Once the PCA X-3 is installed in the predetermined space on the BOP chassis, the cables may be connected as follows:

1) CABLE (1), 15 wires, from PCA X-3, P2 to BOP-A1-P5
2) CABLE (2), 5 wires, from PCA X-3, P1 to BOP-A1-P6
3) (3), 20 wires, from PCA X-3, J1 to TL 488-4B board installed in the TLD 488-16 Programmer, SLOT number and CHANNEL number depending on position of board in the TLD.

2-18 FINAL SYSTEM INTERCONNECTIONS.

2-19 Connect the TLD 488-16 to the GPIB, connect the STATUS MONITOR INTERFACE to the SYSTEM CONTROLLER and make the remaining connections from the power supply outputs to the loads, either directly, or via the ISOLATION RELAYS. Mating connectors for the relay interface, as well as for the status monitor interface are provided with the TLD 488-16. The installation of the TLD 488-16 system is now complete. System Calibration is described in Section III, paragraphs 3-51 through 3-56.

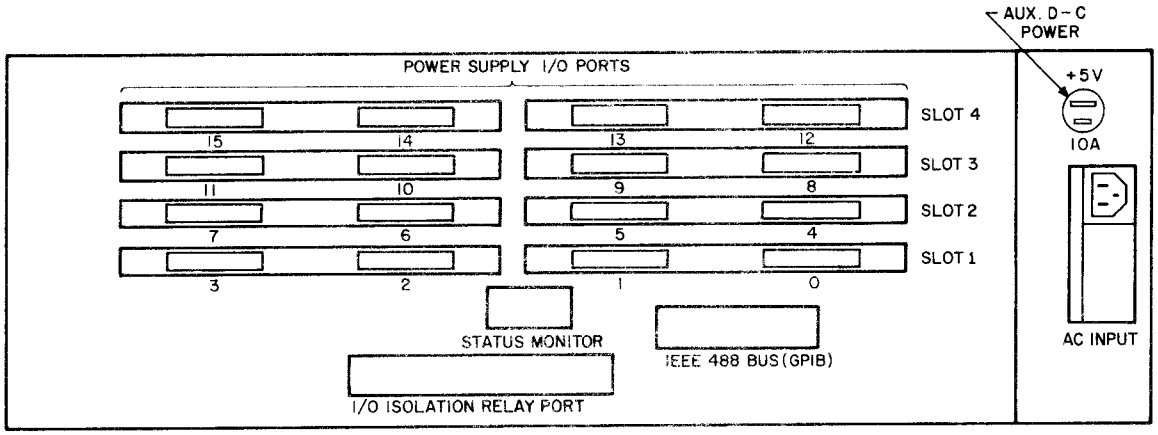


FIG. 2-8 MODEL TLD 488-16, REAR TERMINATIONS.

2-20 REAR TERMINATIONS ON THE TLD 488-16.

A) A-C input. The power line connection is made via a removable a-c power cord, KEPCO P/N 118-0552 (supplied). TLD 488-16 is delivered for operation on a nominal 115V a-c, single phase line. For operation on 230V a-c, see paragraph 2-10.

B) POWER SUPPLY I/O PORTS. These ports are terminated with connectors each of which accept a Kepco Series PCA cable assembly for ATE power supplies (see FIG. 2-6) or a 20-wire flat cable for BOP power supplies (see FIG. 2-7).

ATE I/O PORT TERMINATIONS (14-WIRE CABLE)		BOP I/O PORT TERMINATIONS (20-WIRE CABLE)	
PIN 1	MODE FLAG	PIN 1	OVERLOAD FLAG
PIN 2	CROWBAR FLAG	PIN 2	TURN-OFF FLAG
PIN 3	DEVICE PRESENT FLAG	PIN 3	DEVICE PRESENT FLAG
PIN 4,5	COMMON (INPUT)	PIN 4,5	COMMON (INPUT)
PIN 6,7,8,9	NO CONNECTION	PIN 6,7,8,9	NO CONNECTION
PIN 10	VOLTAGE OUTPUT (0-10V d-c)	PIN 10	MAIN CHANNEL OUTPUT (0 to ± 10V d-c)
PIN 11	P.S. VOLTAGE MONITOR (0-10V d-c)	PIN 11	P.S. VOLTAGE MONITOR (0 to ± 10V d-c)
PIN 12	COMMON (OUTPUT)	PIN 12	COMMON (OUTPUT)
PIN 13	P.S. CURRENT MONITOR (0-1V d-c)	PIN 13	P.S. CURRENT MONITOR (0 to ± 10V d-c)
PIN 14	CURRENT OUTPUT (0-1V d-c)	PIN 14	LIMIT CHANNEL OUTPUT (0 to + 10V d-c)
		PIN 15	MODE (V/$\overline{I}$)
		PIN 16.17	COMMON (OV), $\overline{\text{REMOTE}}$
		PIN 18	+ 5V d-c
		PIN 19	+ 15V d-c
		PIN 20	– 15V d-c

NOTES:

1) The INPUT COMMON and the OUTPUT COMMON are optically isolated from each other for 500V d-c.

2) SIGNALS at pins 1,2 and 3 are with reference to COMMON (Input), Pin 4. All other signals are with reference to COMMON (Output) pin 12.

C) STATUS MONITOR PORT. This port is terminated with a miniature, 2 pin locking-type connector, KEPCO P/N 143-0313 (supplied). The function of the status monitor lines is described in Section III, paragraph 3-34.

D) IEEE 488 BUS (GPIB) I/O PORT. This port is terminated with a 24 pin IEEE 488 connector and conforms mechanically and electrically to the IEEE 488 standard. Note that the TLD 488-16 has a Shield Ground selector on the IEEE 488 Interface board, providing the option of either grounding the shields externally or internally. Refer to Section II, FIG. 2-2 and paragraph 2-7, Step 4.

E) AUXILIARY D-C POWER. A stabilized auxiliary d-c voltage source (+5V at 10A) is available at the rear panel. It is terminated with a two-terminal outlet, with the mating connector (Kepco P/N 142-0245) supplied.

F) I/O ISOLATION RELAY PORT. This port is terminated with a 50-pin standard PC board connector (0.100 spacing, for 1/16 thick board, KEPCO P/N 143-0321).

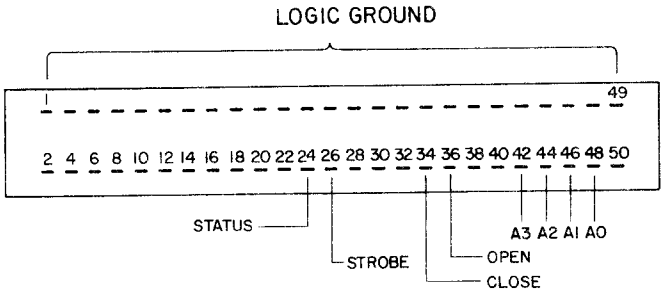


FIG. 2-9 RELAY PORT, PIN-OUTS

The line designations are as follows:

A_0 J1-48 Address lines, logic high = true
A_1 J1-46
A_2 J1-44
A_3 J1-42

Strobe (Strobe) J1-26, logic low = true
Open J1-36, logic high = true
Close J1-34, logic high = true
Status (open) J1-24 logic low = relay open

NOTE:

For applications where the optional external ISOLATION RELAYS are not used, a jumper connection between Pin 24 (RELAY STATUS) and Pin 23 (LOGIC GROUND) at the I/O ISOLATION PORT CONNECTOR will eliminate unnecessary initial error messages related to the ISOLATION RELAYS. In the absence of the jumper (Status Line HIGH — means Relay Closed) and with the default state R1 at POWER ON (ENABLE STATUS ERROR MESSAGES) a number of error messages such as "RELAY NOT OPEN" will be generated equal to the number of power supplies connected to TLD 488-16.

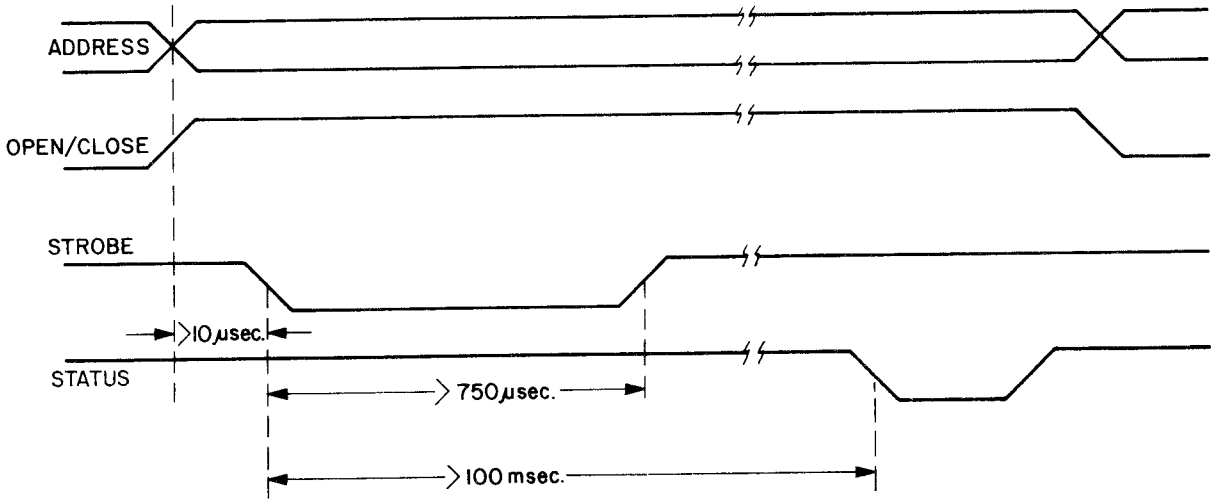


FIG. 2-10 TIMING DIAGRAM, I/O ISOLATION RELAY PORT

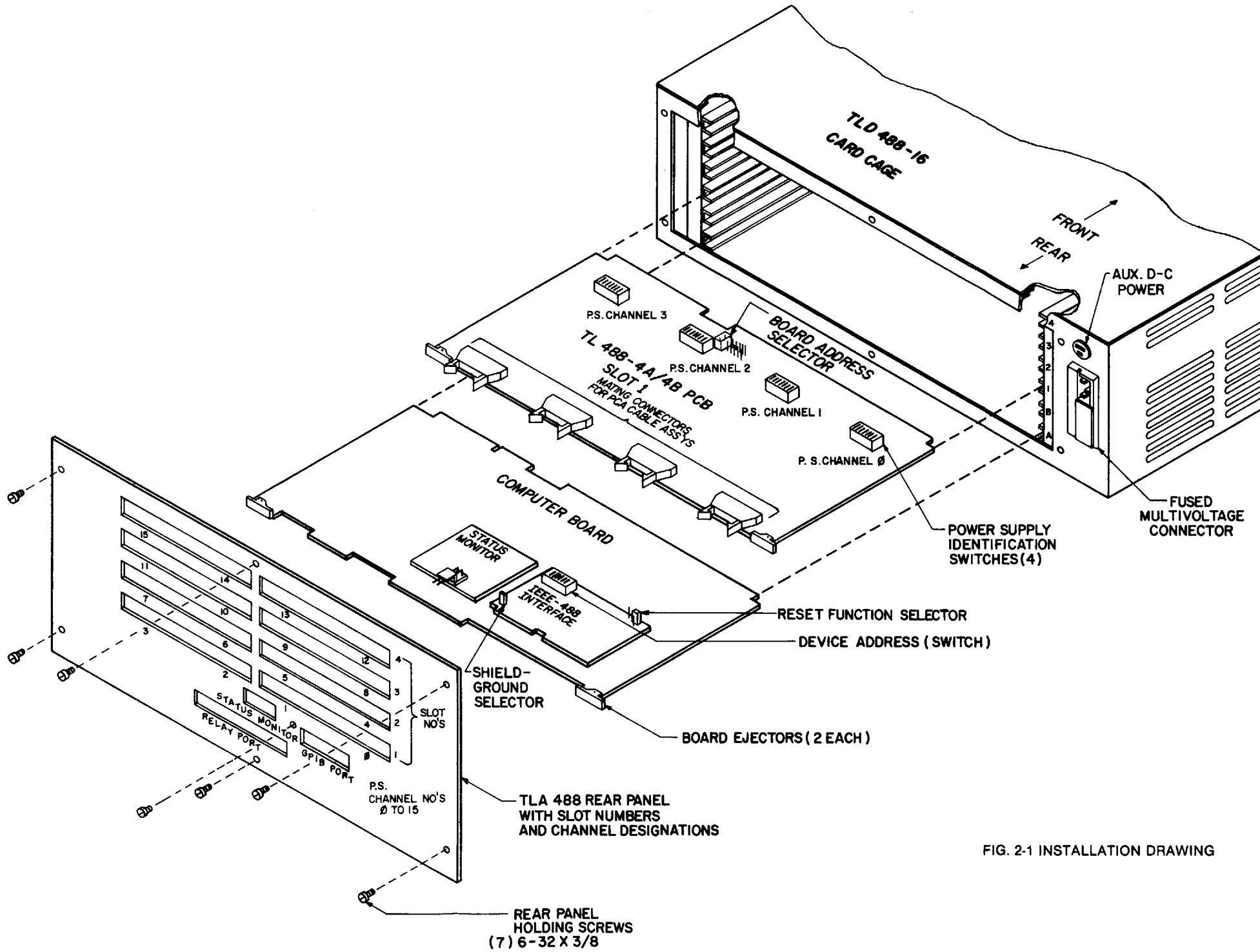


FIG. 2-1 INSTALLATION DRAWING

SECTION III—OPERATION

3-1 GENERAL

3-2 Once the TLD 488-16 INTERACTIVE PROGRAMMER (TLD) has been prepared and interconnected as described in Section II of this manual, operation can proceed. The TLD functions as a TALKER/LISTENER on the GENERAL PURPOSE INTERFACE BUS (GPIB, defined by IEEE Standard 488 and IEC625-1). The GPIB CONTROLLER will communicate with the TLD via the GPIB, using the specified IEEE 488 protocol as well as elements of the CONTROL INTERFACE INTERMEDIATE LANGUAGE (CIIL). Since the TLD can accommodate from one (1) to sixteen (16) programmable power supplies, up to sixteen power supplies may be digitally programmed via the GPIB. The CONTROLLER may be programmed to implement the MODULAR AUTOMATIC TEST EQUIPMENT (MATE) protocol[1], or it may be programmed for non-MATE applications. For non-MATE applications, the CONTROLLER should have the capability to implement the SERVICE REQUEST and SERIAL-POLL functions.

3-3 COMMUNICATIONS

3-4 INTERNAL. All internal communications within the TLD 488-16 take place via the Intel Multibus™, directed by a program residing in PROM memory.

3-5 EXTERNAL. Communications between the TLD 488-16 TALKER/LISTENER and the computer, functioning as a CONTROLLER/TALKER/LISTENER take place according to the IEEE 488 protocol. The TLD 488-16 implements the interface functions listed in Table 3-1.

[1] Refer to PROPOSED MATE SYSTEM CONTROL INTERFACE STANDARD, No. 2806763, Rev. B, 25 September 1983 or later.

GPIB FUNCTION	SUBSET SYMBOL	COMMENTS
Source Handshake	SH1	Complete Capability
Acceptor Handshake	AH1	Complete Capability
Talker	T6	Basic talker, serial poll, unaddress if MLA
Listener	L4	Basic listener, unaddress if MTA
Service Request	SR1	Complete Capability
Remote Local	RL0	No Capability
Parallel Poll	PP0	No Capability
Device Clear	DC1	Complete Capability
Device Trigger	DT0	No Capability
Controller	C0	No Capability

TABLE 3-1 INTERFACE FUNCTIONS IMPLEMENTED BY TLD 488-16

A) In COMMAND MODE, the TLD 488-16 will send or receive remote messages per IEEE 488 protocol as listed in Table 3-2.

MNEMONIC	MESSAGE DESCRIPTION	COMMENTS
ATN	Attention	Received
DAC	Data Accepted	Received or Sent
DAV	Data Valid	Received or Sent
DCL	Device Clear	Received
IFC	Interface Clear	Received
MLA	My Listen Address	Received
MTA	My Talk Address	Received
OTA	Other Talk Address	Received
RFD	Ready for Data	Received or Sent
SDC	Selected Device Clear	Received
SPD	Serial Poll Disable	Received
SPE	Serial Poll Enable	Received
SRQ	Service Request	Sent
UNL	Unlisten	Received
UNT	Untalk	Received

TABLE 3-2 MESSAGES SENT OR RECEIVED BY THE TLD 488-16 IN COMMAND MODE.

B) In DATA MODE, the TLD 488-16 will send or receive remote messages per IEEE 488 protocol as listed in Table 3-3. These messages are enabled during the "handshake" cycle, with the TLD 488-16 operating as a TALKER or as a LISTENER.

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

TABLE 3-3 MESSAGES SENT OR RECEIVED BY THE TLD 488-16 IN DATA MODE.

3-6 CIIL CODES

3-7 All other communication on the GPIB bus in DATA MODE are not defined by the IEEE 488 Standard. Instead, the syntax and mnemonics of the Control Interface Intermediate Language (CIIL)[1] are used to program the power supplies, test and report their status and send error messages. The CIIL elements used for these purposes are the OPERATION CODES, NOUNS and NOUN MODIFIERS listed below and discussed in detail in the following paragraphs.

[1] CIIL is a subset of ATLAS. For special or non-MATE requirements some non-CIIL commands are accepted. Refer to paragraphs 3-38 and 3-39.

A) CIIL OPERATION CODES (OP CODES):

FNC.....Function
SET.....Setup
SRX.....Set Maximum
SRN.....Set Minimum
CLS.....Close
OPN.....Open
RST.....Reset
CNF.....Confidence Test
IST.....Internal Self-Test
STA.....Status

B) NOUNS:

DCS.....Direct Current Source

C) NOUN MODIFIERS:

VOLT.....Voltage
VLTL.....Voltage Limit
CURR.....Current
CURL.....Current Limit

D) DELIMITERS: All OP CODES and OPERANDS must be separated by the ASCII "space" code (SP)

E) TERMINATORS: The MATE (Modular Automatic Test Equipment) protocol requires that all command strings are terminated by a "carriage return"and a "line feed" (cr) (lf). Alternately, for non-MATE applications, the END message (See Table 3-3) may be utilized as a terminator. The TLD 488-16 sends both, a "line feed" (lf) and the END command when messages are sent. It accepts both, "line feed" (lf) and the END command as terminators when receiving messages.

F) TIME-OUTS: (To obtain a valid status indication):

1) The required delay times following a SET command string are listed in Section II, Tables 2-2 and 2-3.
2) The required delay time following an "open" (OPN) or a "close" (CLS) command is 100 milliseconds.
3) The required delay time following the Confidence Test (CNF) or Internal Self Test (IST) command is 15 seconds.

3-8 THE FUNCTION COMMAND.

3-9 FNC — Function Op Code. This operator is uniquely associated with the start of a set-up sequence for the device. There are two (2) operand fields associated with this op code.

	OP CODE		OPERAND 1		OPERAND 2
SYNTAX:	FNC	SP	DCS	SP	:CHnn

NOTE: *Incomplete command. Complete Commands are followed by SET command and terminated with the ASCII characters "cr" (carriage return) and "lf" (line feed).*

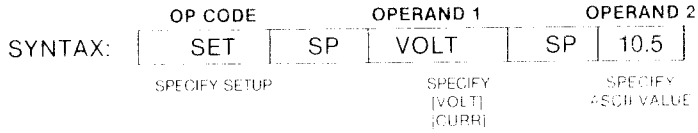
A) The Function Command is always the first command in the set-up sequence.

B) The first operand field of the command contains the three (3) letter mnemonic pertaining to the device on the GPIB bus. For the Kepco Model TLD 488-16 it is "DCS" (Direct Current Source). ***NOTE:*** *An ASCII "space" (SP), ASCII 32 is used as a delimiter between OP CODE and OPERAND and between OPERANDS.*

C) The second operand field of the command is used to select the specific input "Port" of the device being programmed. Since the Kepco Model TLD 488-16 has sixteen possible power supplies connected to it, the "nn" in Operand 2 is a one to two digit ASCII integer (0 to 15), designating the power supply being programmed at this time.

3-10 THE SET, SRX and SRN COMMANDS.

3-11 SET — Setup Op Code. This operator is used to specify the output mode of the power supply being programmed. The NOUN MODIFIER as the first operand specifies the chosen output mode and the second operand specifies the value in ASCII characters.



NOTE: *Incomplete command. Complete Commands are preceded by FNC command and terminated with the ASCII characters "cr" (carriage return) and "lf" (line feed).*

A) 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 Operation
CURR — Current Mode Operation
CURL — Current Limit Mode Operation

B) The second operand field of the command contains the value assigned to the chosen output mode. This value may be specified as accurate as the resolution of the TLD 488-16 allows (12 bits, or VALUE = 4095). It can be specified directly in ASCII integer, decimal, or in scientific notation.

NOTE: *There are two (2) SET commands, separated by the ASCII "space" delimiter, for each power supply being programmed. The following combinations of NOUN MODIFIERS can* ***not*** *be used together in the SET sequence for a single power supply:*

VOLT with CURR
VLTL with CURL
VOLT with VLTL
CURR with CURL

The only correct combinations are: VOLT with CURL **or** CURR with VLTL

C) For unipolar power supplies (Kepco Series ATE), polarity signs (+ or −) preceding the voltage or current values in OPERAND 2 are optional. For bipolar power supplies (Kepco Series BOP), polarity signs must be used with OPERAND 2 to determine the polarity of their output terminal with reference to their common terminal.

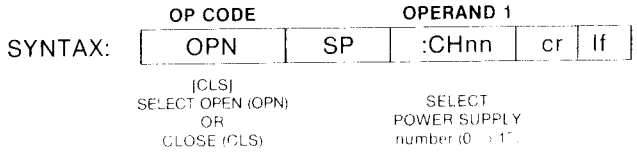
D) In addition to the SET Command, two (2) related Op Codes may be used to specifiy the maximum and minimum values for the four (4) NOUN MODIFIERS VOLT, CURR, CURL and VLTL:

1) SRX — Set Maximum
2) SRN — Set Minimum

The format of the command sequence is identical to that used for the SET Command, with SRX and SRN replacing SET in the syntax. SRX and SRN may be used previous to SET in the complete command sequence sent to a single power supply channel, (refer to paragraph 3-24) to establish the desired operating range of each of the four (4) Noun Modifiers. If the subsequent SET Command exceeds the limits established by SRX and SRN, an error message will result (see paragraph 3-32).

3-12 THE OPEN/CLOSE RELAY COMMANDS

3-13 An external (optional) relay is interposed between the output terminals of each of the power supplies and the associated load or the (optional) switching systems. The relay is under the control of the Kepco Model TLD 488-16 via a separate, discrete interface and responds as follows:



NOTE: *All complete Commands are terminated with the ASCII characters "cr" (carriage return) and "lf" (line feed).*

A) OPN—Open Op Code. This operator is used to open the external relay associated with the power supply specified by the operand. Only a single operand is used with this op code. It is identical in format and meaning to the port identification field of the FNC command.

B) CLS—Close Op Code. This operator is analogous to the OPN op code, except that the TLD 488-16 closes the external relay associated with the power supply specified by the operand.

3-14 THE RST (RESET) COMMAND

3-15 RST — Reset Op Code. This operator is used to program the addressed power supply output to zero and open the external relay.

The RST command has the same operand fields as the FNC command.

3-16 THE CONFIDENCE TEST COMMAND

3-17 CNF — Confidence Test Op-Code. This operator commands the TLD 488-16 to execute the confidence test procedure defined for the power supplies controlled by it. As a result of the CNF (Confidence Test) Command, all isolation relays are opened and an internal, localized test is performed. This test ascertains if all the function blocks of the control section (microcomputer) are working properly. Also, the CNF command programs all the power supplies connected at the I/O ports to their maximum ratings and then checks for the error flags. Upon completion of the test, all ports of the TLD 488-16 remain isolated (Relays Open), while the power supply outputs are programmed to zero.

SYNTAX:

CNF	cr	lf

No operators are associated with this op-code. The result of the confidence test is reported in response to the status (STA) command. The "STA" command should be issued only after the required delay time (15 sec.) is observed.

3-18 INTERNAL SELF-TEST COMMAND

3-19 IST — Internal Self-Test Op Code. This operator evokes the identical response as the CNF command, since TLD 488-16 is not designed to support an internal self-test (BIT).

3-20 STATUS COMMAND

3-21 STA — Status Request Op Code. This operator commands the TLD 488-16 to report its current operating status.

SYNTAX:

OP CODE		
STA	cr	lf

There are no operands associated with this operator. The response for the status request is in accordance with the Response Message Syntax described in paragraph 3-27. It is important to impose the proper time delays (See paragraph 3-27) before the status command (STA) is given. The TLD 488-16 responds to the status request as soon as it is talk-addressed by the controller. If conditions are normal, only one response message is sent (see paragraph 3-27). If conditions are abnormal, the controller (Test Executive) should send multiple status commands and talk addresses to the TLD 488-16 until all error messages are collected and transmitted.

3-22 ERROR HANDLING COMMANDS

3-23 T0 — Erase Error Message Op Code. This operator commands the TLD 488-16 to erase previously recorded, unreported non-catastrophic error messages from the error buffer as soon as a new valid command is received or a catasthrophic error occurs. This is the default state after power-on.

T1 — Do Not Erase Error Message Op Code. This operator commands the TLD 488-16 **not** to erase previously recorded, unreported error messages from the error buffer. Error messages may be retrieved from the error buffer one by one for each STA command received. In order to gather all error messages, multiple STA commands and TALK ADDRESSES should be sent by the controller. The error buffer is clear of error messages if the response for the STA command is a "normal" response message (space, cr, lf).

SYNTAX:

	OP CODE		
SYNTAX:	T0	cr	lf
or	T1	cr	lf

3-24 BUS TRANSMISSION FORMAT.

3-25 The CIIL transmission format for a single power supply channel are given here as an example. The example given will address the power supply, set the output voltage and the current limit, check the status and subsequently reset all parameters to zero:

NOTE: *Each complete command is terminated with the ASCII carriage return (cf) and the ASCII line feed (lf) character.*

SET:

FNC	SP	DCS	SP	:CH0	SP
SET	SP	VOLT	SP	10	SP
SET	SP	CURL	SP	2.5	cr	lf

STATUS CHECK:

STA	cr	lf

RESET:

RST	SP	DCS	SP	:CH0	cr	lf

3-26 Note that the individual CIIL statements for the SET command are shown on three separate lines for readability only. In actuality, they must be concatenated into a single ASCII string, with blank delimiters separating the statements.

3-27 RESPONSE MESSAGE SYNTAX

3-28 The Controller (Test Executive) requests the present operating Status (via the STA command and the TALKER ADDRESS) of the TLD 488-16. In order to obtain a meaningful response, the controller should use the STA (Status) command only after waiting the proper delay time, defined in Section II, Table 2-2 and 2-3 or 100 milliseconds, if the preceding command affected the isolation relays, or 15 seconds if the preceding command was a confidence test (See paragraph 3-16).

The response of the TLD 488-16 to a STA (Status) command is sent to the controller (Test Executive) in the form described below. The status is either reported as "normal" or as "abnormal". If conditions are normal, only one response message is sent. If conditions are abnormal, the controller (Test Executive) should send multiple status commands and talk addresses to the TLD 488-16 until all error messages are collected and transmitted.

3-29 CONDITION NORMAL. All "normal" response messages begin with an ASCII blank (space), followed by a carriage return and a line feed:

	BLANK	MESSAGE	
SYNTAX:	SP	cr	lf

3-30 CONDITION ABNORMAL. All "abnormal" response messages begin with an ASCII "F", followed by a 2 digit ASCII integer code, followed by a text string describing the error condition. The 2 digit code used for TLD 488-16 is 07 (HALT) and is used by the controller (Test Executive) to take corrective action.

	ASCII "F"		ERROR MESSAGE						
SYNTAX:	F	07	DCSnn	SP	(bbb):	SP	Text	cr	lf

3-31 The next 3-digit code is the mnemonic abbreviation of the generic **type** device being controlled by the TLD 488-16 (DCS) followed by a two-digit numerical code to distinguish between multiple **units** controlled by the TLD 488-16 (0 to 15).

"bbb" indicates the origin of the message. There are two possibilities:

A) bbb = DEV Device related error conditions as detected by the monitoring system of the power supply flags.

B) bbb = MOD error conditions detected by TLD 488-16, such as invalid syntax.

3-32 Following is the list of error messages transmitted over the GPIB bus, in response to the STA command, when an error condition is detected and the TLD is "talk addressed". The error conditions marked with * also activate the "status monitor" discrete line. The "status monitor" (contact closure) is also activated by a power failure or by the "watch-dog timer" monostable.

A) POWER SUPPLY RELATED ERROR MESSAGES:

1) "F07DCSnn (DEV): CROWBARRED"* (ATE)
2) "F07DCSnn (DEV): DEVICE TURNED OFF"* (BOP)
3) "F07DCSnn (DEV): OVERLOAD"*
4) "F07DCSnn (DEV): VOLTAGE COMPARISON ERROR"*
5) "F07DCSnn (DEV): CURRENT COMPARISON ERROR"*
6) "F07DCSnn (DEV): RELAY NOT OPEN"*
7) "F07DCSnn (DEV): RELAY NOT CLOSED"*
8) "F07DCSnn (DEV): DEVICE NOT PRESENT"
9) "F07DCSnn (DEV): INVALID DEVICE ID"
10) "F07DCSnn (DEV): DEVICE DISCONNECTED"
11) "F07DCSnn (DEV): VOLTAGE OUT OF RANGE"
12) "F07DCSnn (DEV): CURRENT OUT OF RANGE"
13) "F07DCSnn (DEV): TWO CHANNELS SELECTED"
14) "F07DCSnn (DEV): SET MODIFIER ERROR"

B) SYSTEM RELATED ERROR MESSAGES:

1) "F07DCSnn (MOD): INVALID COMMAND" (See Note 4)
2) "F07DCSnn (MOD): RCVD INCOMPLETE MESSAGE"

NOTES:

1) nn = Channel number
2) Error conditions 1) through 5) initiate "SRQ" on IEEE bus.
3) All error messages are terminated with a "(cr) (lf)".
4) "INVALID COMMAND" error message is transmitted when one of the following error conditions are detected:
   a) unrecognizable op code
   b) unrecognizable noun
   c) unrecognizable noun modifier
   d) incomplete command (string)

3-33 The abnormal reponse syntax is used by TLD 488-16 whenever a detected error condition has not yet been reported to the controller. Such errors are reported whenever TLD 488-16 is "talk addressed" per CPIB protocol. Once a particular condition has been reported to the controller, it will not be reported again, unless a re-occurrence of the condition is detected after the initial report. Multiple occurrences of the same failure condition are reported as a single event.

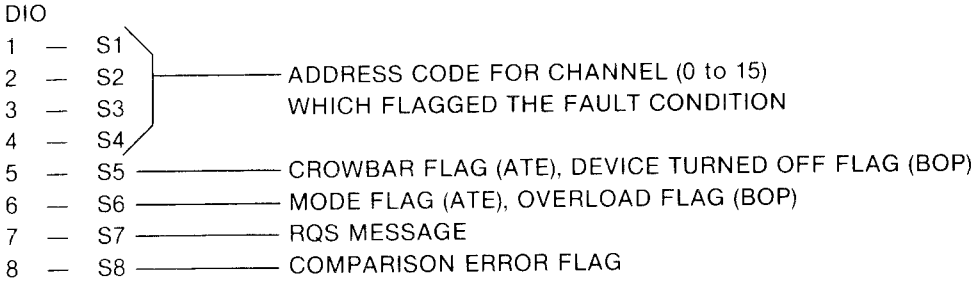
3-34 CATASTROPHIC ERROR HANDLING

3-35 The response protocol defined above is primarily intended for the reporting of non-critical error conditions which, although they may invalidate certain test results, will not cause a condition which is hazardous to either the station operator, station instrumentation or the unit under test (UUT). Those error conditions which might prove hazardous, are additionally flagged by the STATUS MONITOR.

3-36 The status monitor output consists of a contact pair, terminated at the rear of the TLD 488-16. A two wire connection may be returned to the controller. Any error condition, as listed in the Power Supply Error Message Table and marked with an asterisk (*) will produce a contact closure on the status monitor line. Under normal conditions, the status monitor lines are open.

3-37 MATE SYSTEM APPLICATIONS. Once the status monitor line is activated, indicating the report of a "catasthropic" failure, the controller responds by sending IFC (Interface Clear) and DCL (Device Clear) commands to the TLD 488-16, which place all power supplies connected to it into an "idle" state (Similar to Power On). Then, the controller sends the STA command and TALK ADDRESS to the TLD 488-16 interrogating the error buffer, to find out which power supply generated the fault condition, and what the nature of the fault is, so that appropriate action can be taken. The Status monitor lines will not be released until the TLD 488-16 error buffer has been cleared of all catastrophic error messages. To that end, the controller must send repeated STA commands, accompanied by the TALKER ADDRESS, until the CONDITION NORMAL message is received.

3-38 NON-MATE SYSTEM APPLICATIONS. An identical scenario as that described for MATE systems may be used for error handling. In place of the Status Monitor line, the SERVICE REQUEST and SERIAL POLL functions of the IEEE 488 bus may be used for NON-MATE applications. Once the SRQ line is activated, the subsequent SERIAL POLL command places all devices into the serial poll mode. The status byte register on all devices on the GPIB bus is serially interrogated for the status of bit 7. If the request service status (RQS) on the TLD 488-16 is true, bits one to four are querried for the channel address (0-15) and bits 5,6 and 8 for the nature of the error. The contents of the status byte in the TLD 488-16 is as follows:



3-39 The following commands are accepted in addition to all CIIL commands:

S0 — Disable SERVICE REQUEST and SERIAL POLL (Default State At Power-On)
S1 — Enable SERVICE REQUEST and SERIAL POLL
S2 — Clear SERIAL Poll "request for service" bit (See IEEE 488 Standard, SR state diagram)
R0 — Disable Relay Status Error Messages
R1 — Enable Relay Status Error Messages (Default State At Power-On)
T0 — Erase Error Message Op Code (Default State at Power-On)
T1 — Do Not Erase Error Message Op Code

Their syntax is similar to that of the STA command. The END message may be utilized as message terminator for non-MATE applications.

NOTE: If the SERIAL POLL reveals the existence of errors the STA command and the TALK ADDRESS should be sent to extract the error message from the TLD 488-16 status byte register until a "normal" response is received. If this is not done, later STA commands may result in erroneous error messages.

3-40 GENERAL PROGRAMMING COMMENTS.

3-41 In a power supply programming system consisting of a controller, the TLD 488-16 Interactive Programmer and a number of power supplies to be digitally programmed, successful system operation is based on the principle of intercommunication between the system components. Intercommunication, in the context of the programming system under discussion, consists of the command sequence and the verification request issued by the controller and the response from the TLD as to the status of each power supply to be programmed. In practical terms, any command sent by the controller to the TLD 488-16 to affect the connected power supplies or the (optional) relays, should be followed by an inquiry (status) request. The command and the status inquiry from the controller must be separated by the proper delays, as pointed out previously (See paragraph 3-7F, for example) and as detailed once more below.

3-42 In order to establish successful intercommunications between the controller and the TLD 488-16 the following "ground rules" should be observed:

Following any command from the controller via the TLD 488-16 to the connected power supplies or (optional) relays, the status command (STA) and the TALK address must be sent by the controller to verify the previous command(s). The TLD 488-16 will respond to the controller either with a Condition Normal, or a Condition Abnormal message. The syntax of the response messages is defined in paragraph 3-27.

3-43 To insure the validity of the operating status messages, the following time delays are recommended **before** issuing the STA command:

1) Following a command to change voltage or current level of a given power supply, the listed MONITOR TIME OUT delays, shown in Section II, Tables 2-2 and 2-3 should be imposed in order to permit the power supply to reach its final value (equilibrium).

2) Following a command to open or close one of the (optional) external relays between the power supply and it's load, a delay of at least 100 milliseconds should be imposed to permit the electromechanical relays to settle.

3) Following a confidence test command (CNF) or an internal self-test command (IST) a delay of 15 seconds should be imposed if all (sixteen) slots of the TLD 488-16 Programmer are occupied. This delay is required to provide sufficient time to interrogate the status of all power supplies connected to the TLD 488-16. If less than 16 power supplies are used, the delay time may be correspondingly shorter.

3-44 If the recommended time delays are not respected and the status command (STA) is given too soon, the received response may not represent the true operating status of the connected power supplies, since they have not yet reached the commanded level (See FIG. 3-1).

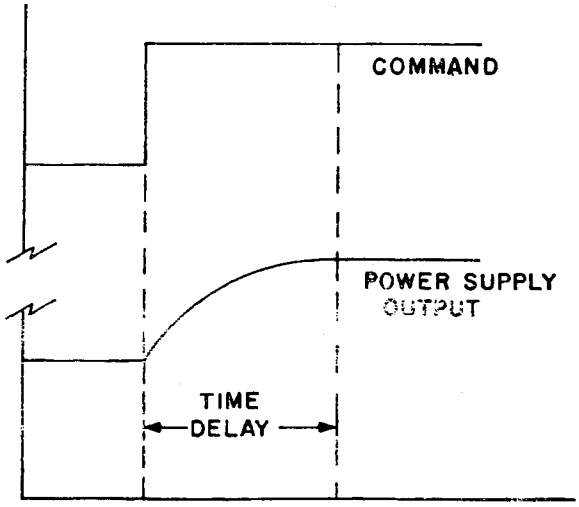


FIG. 3-1 RELATIONSHIP OF INPUT COMMAND AND POWER SUPPLY OUTPUT.

3-45 All connected power supplies are continuously interrogated by the TLD 488-16 and their status is deposited into an error buffer. During the prescribed time delays, the error flag of the power supplies are blanked, so that the error buffer may not contain the true status if interrogated prematurely.

3-46 If multiple errors occur on a connected power supply as a result of a fault condition, only the error message with the highest priority is recorded and transmitted. The priority of error flags is as follows:

1) CROWBAR FLAG or TURN-OFF FLAG (HIGHEST)
2) OVERLOAD FLAG
3) COMPARISON ERROR FLAG (LOWEST).

3-47 A PROGRAMMING EXAMPLE IN COMMODORE BASIC

3-48 The syntax and mnemonics of CIIL, as specified and described in previous paragraphs, can be used within a high level computer language to control and supervise Kepco ATE or BOP Series power supplies connected to the GPIB via the Kepco TLD 488-16 Interface. The example described below utilizes a COMMODORE PET 2001 computer with COMMODORE BASIC 4.0 as the operating system. The example program has been kept as simple as possible, so that other computers and versions of the BASIC language may be used as well.

The BASIC commands unique to COMMODORE BASIC are:

OPEN a, b	Open a logic file (communication channel)
CLOSE a, b	a = 0-255, b = device address. Close channel.
PRINT # a	Output Operation, instrument identification via associated logic file number.
GET # a	Input Operation, instrument identification via associated logic file number.

3-49 Note that the INPUT command of COMMODORE BASIC can not be utilized, since CIIL contains a colon which is interpreted as a delimiter by the PET. Note also in the program (See FIG. 3-2), the delay loops interposed following each SET command. These delays are imposed by the TLD 488-16 to give the power supply time to settle to the new command value. The necessary delay for ATE supplies operating in the SLOW mode, is approximately 2.5 seconds for ¼ rack models, and 10 seconds for ½ rack, ¾ rack and full rack ATE supplies. Since the FOR/NEXT loop in the PET requires about 1 millisecond per loop and since a "quarter-rack" ATE is used in the example program, lines 140, 190 and 240 contain 2500 as the loop value. The loop value may, of course change if another controller or another power supply is used.

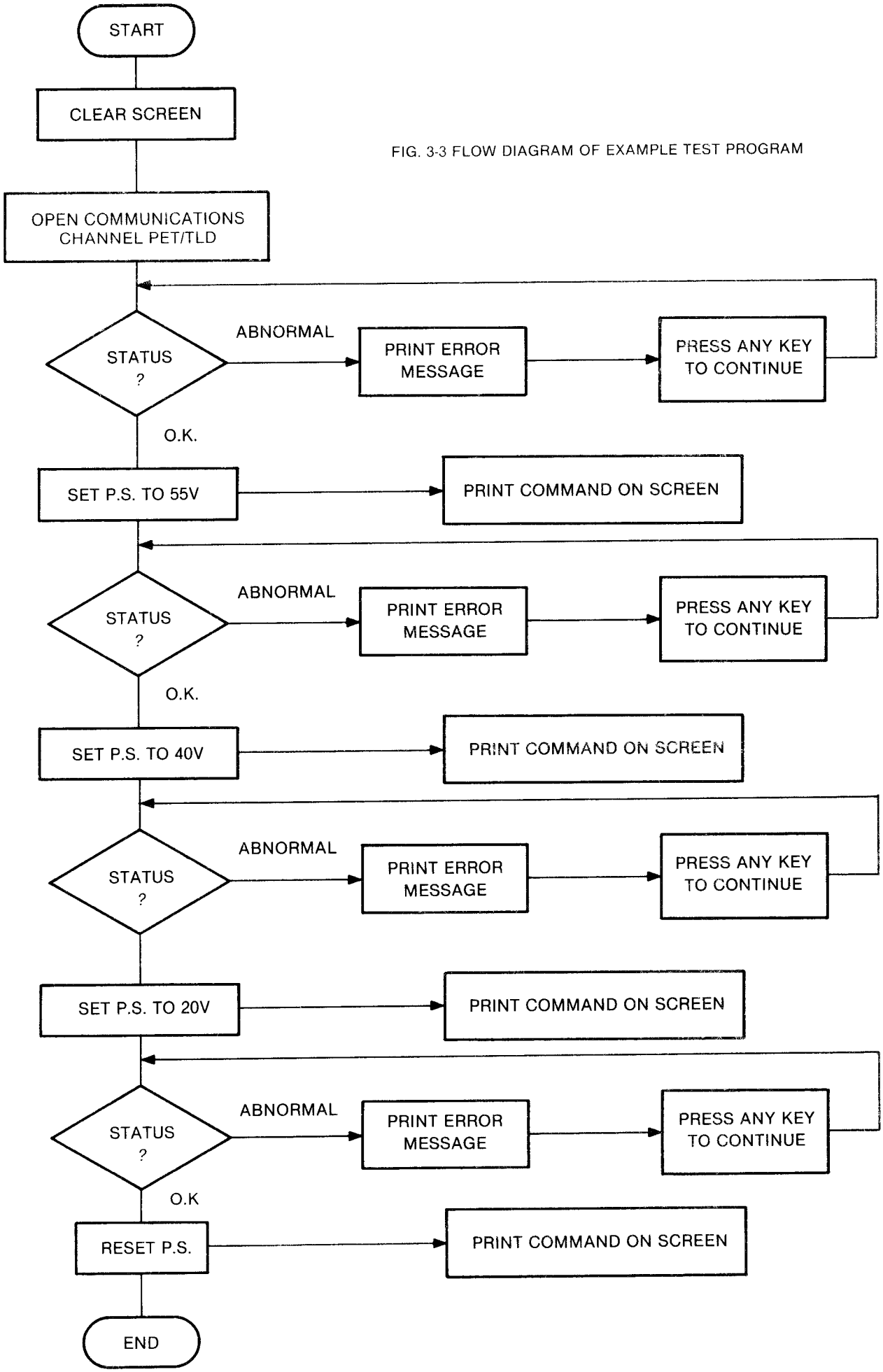
3-50 The example program controls and monitors a single Kepco Model ATE 55-1M power supply, operating in the voltage mode. It is connected to channel 2 of the TLD 488-16. The TLD 488-16 address is set to be "6". The program first checks the STATUS of the power supply on the bus and indicates any error messages on the screen of the PET CRT. If there are errors, the PET stands by until the space bar is depressed to continue. The program then sets the power supply output voltage to 55 volts and the current limit to 1 ampere. It checks the STATUS again, before changing the output voltage to 40 volts, then to 20 volts and finally to zero by means of the RST command. All TLD commands given over the bus are indicated on the PET CRT and the STATUS is checked every time before a new command is issued. FIG. 3-3 shows a flow diagram while FIG. 3-2 shows a listing of the example program.

```
READY.

 5   REM***INTIAL STATUS***
 10  PRINT CHR$(147):REM CLEAR SCREEN
 20  OPEN 6,6:GOSUB 30:GOTO 100
 30  REM STATUS SUBROUTINE
 40  PRINT#6,"STA":IS=0
 50  GET#6,S$:IF S$<>CHR$(13)THEN PRINT S$;
 60  IS=IS+1:IF S$<>CHR$(10)THEN 50
 70  IF IS>4 THEN ER=ER+1:PRINT:GOTO 40
 80  IF ER>0 THEN GET X$:IF X$="" THEN 80
 85  IF ER>0 THEN ER=0 :PRINT CHR$(147)
 95  RETURN
100 REM*** SET-UP ***
110 A$="FNC DCS :CH2 ":B$="SET VOLT 55 ":C$="SET CURL 1 ":PRINT:PRINT
120 PRINT"TLD COMMAND IS: ":PRINT A$;B$;C$:PRINT:PRINT
130 PRINT#6,A$;B$;C$
140 FOR I=1TO 2500:NEXT:GOSUB 30
160 B$="SET VOLT 40 "
170 PRINT"TLD COMMAND IS: ":PRINT A$;B$:PRINT:PRINT
180 PRINT#6,A$;B$
190 FOR I=1TO 2500:NEXT:GOSUB 30
210 B$="SET VOLT 20 "
220 PRINT"TLD COMMAND IS: ":PRINT A$;B$:PRINT:PRINT
230 PRINT#6,A$;B$
240 FOR I=1TO 2500:NEXT:GOSUB 30
250 A$="RST DCS :CH2":PRINT#6,A$
255 PRINT"TLD COMMAND IS :"
256 PRINT A$
260 END
```

FIG. 3-2 LISTING OF EXAMPLE TEST PROGRAM

FIG. 3-3 FLOW DIAGRAM OF EXAMPLE TEST PROGRAM



3-51 SYSTEM CALIBRATION

3-52 GENERAL. After the final system interconnections are completed (refer to Section II, PREPARATION FOR USE) and before actual operation, a final system calibration check should be performed to assure system operation within the specifications, see Section I, paragraph 1-9.

3-53 The System Calibration Set-Up drawings (refer to Fig's 3-4 through 3-7) illustrate the interconnections between the system components. The output of all power supplies in the set-up drawings is an OPEN CIRCUIT when operating in the Voltage Mode and a SHORT CIRCUIT when operating in the Current Mode.

3-54 The Control Location drawings (refer to Fig's 3-8 through 3-11) illustrate the location and function of the controls needed for system calibration for all applicable power supplies and for the TLD 488-16.

3-55 Four calibration procedures, in the form of flow-charts, are provided (refer to Fig's 3-12 through 3-15). Two are for BOP power supplies with PCA X-3 Interface and TLD 488-16 with TL 488-4B Programming Card. The other two are for ATE power supplies with PCA Cable Adapter and TLD 488-16 with TL 488-4A Programming Cards.

3-56 PRECAUTIONS. The ATE and BOP power supplies as well as the Programming Cards, TL 488-4A and TL 488-4B contained in the TLD 488-16 Programmer are pre-calibrated at the factory. The Systems Calibration procedures described here are given to compensate for different systems interconnections and do not involve the full complement of internal controls in the power supplies or on the programming boards. DO NOT TURN ANY CONTROLS WHICH ARE NOT EXPRESSLY MENTIONED IN THE SYSTEM CALIBRATION PROCEDURES.

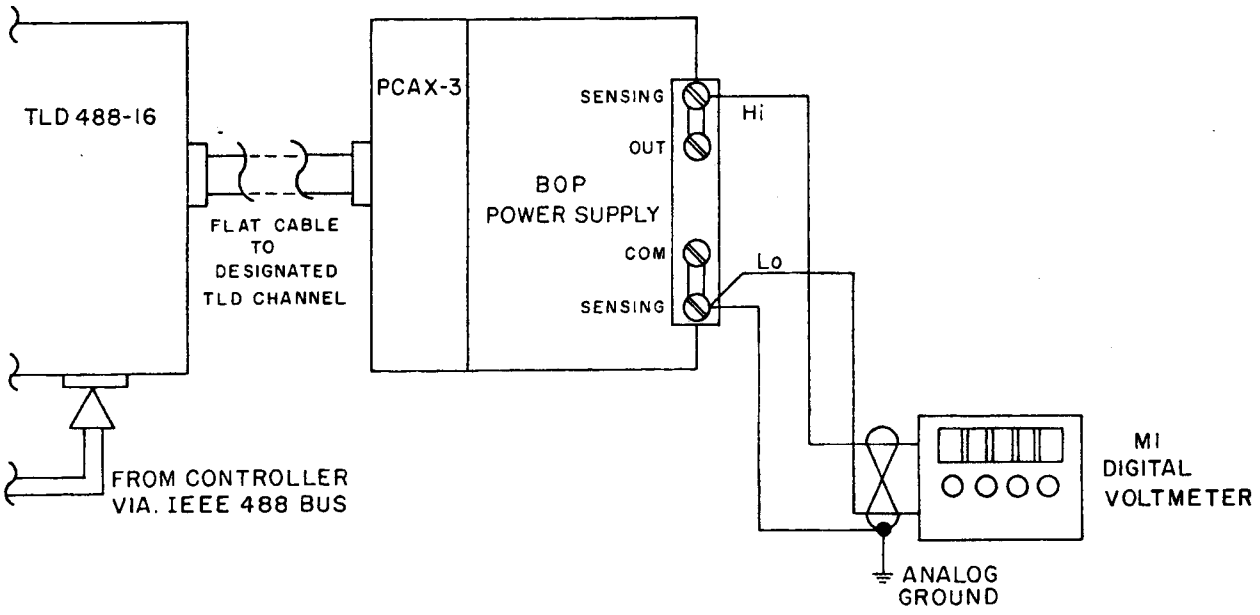


FIG. 3-4 SYSTEM CALIBRATION FOR BOP WITH PCA X-3 INTERFACE
AND TLD 488-16 PROGRAMMER WITH TL 488-4B PROGRAMMING CARD, VOLTAGE MODE.

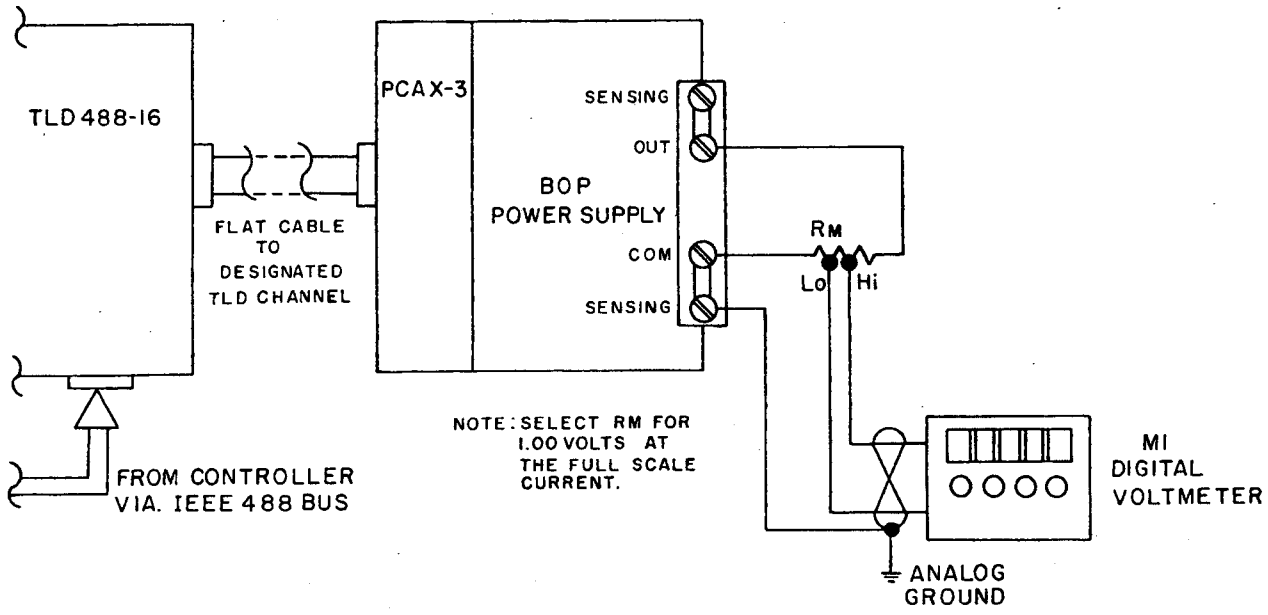


FIG. 3-5 SYSTEM CALIBRATION SET-UP WITH PCA X-3 INTERFACE
AND TLD 488-16 PROGRAMMER WITH TL 488-4B PROGRAMING CARD, CURRENT MODE.

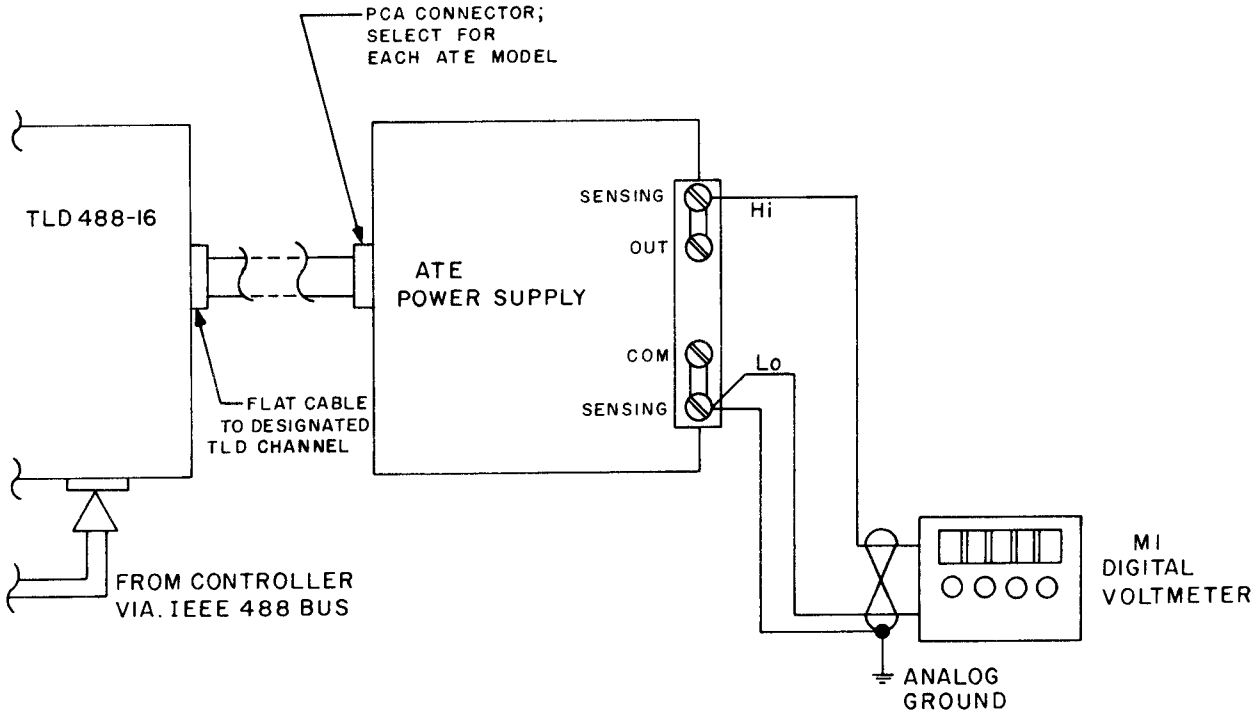


FIG. 3-6 SYSTEM CALIBRATION SET-UP FOR ATE POWER SUPPLIES WITH PCA CABLE ASSEMBLY AND TLD 488-16 PROGRAMMER WITH TL 488-4A PROGRAMMING CARD, VOLTAGE MODE.

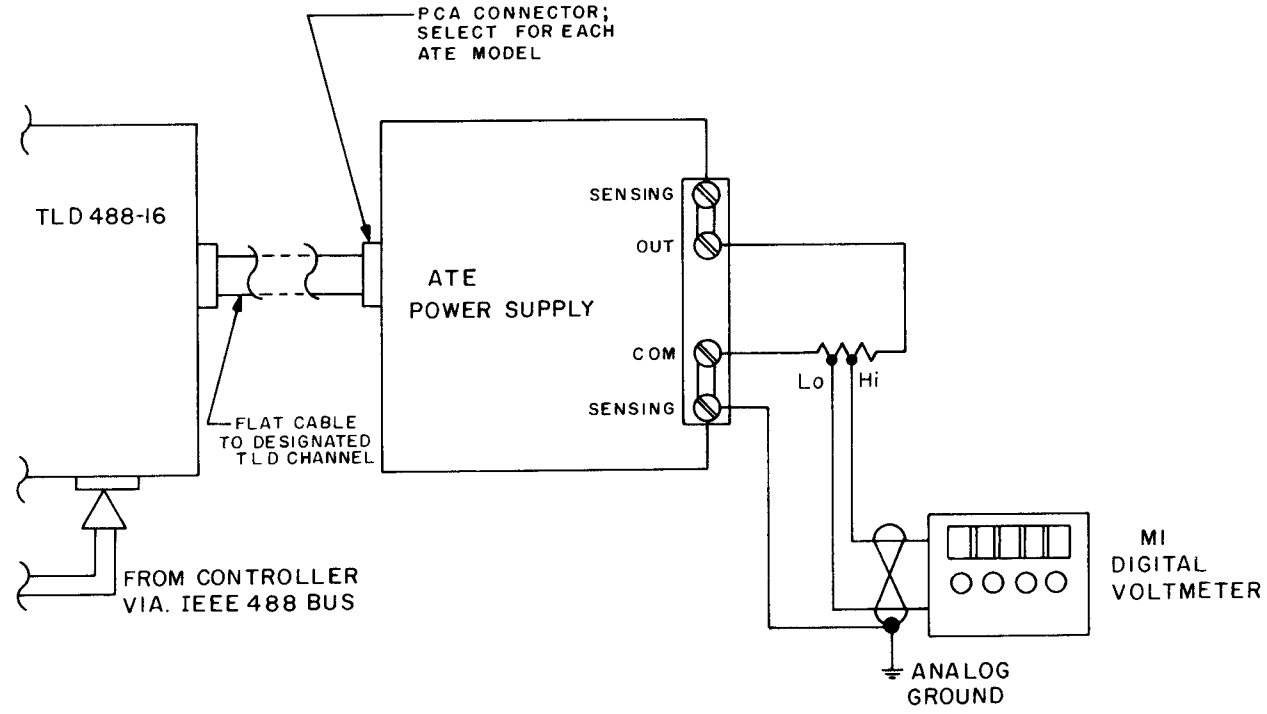


FIG. 3-7 SYSTEM CALIBRATION SET-UP FOR ATE POWER SUPPLIES WITH PCA CABLE ASSEMBLY AND TLD 488-16 PROGRAMMER WITH TL 488-4A PROGRAMMING CARD, CURRENT MODE.

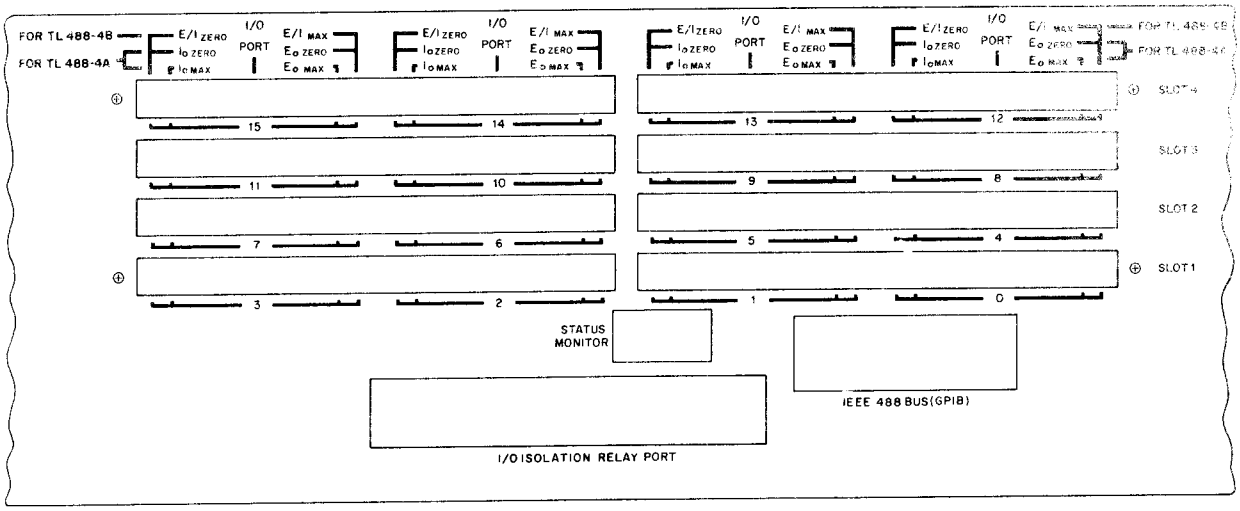


FIG. 3-8 TLD 488-16 PROGRAMMER, REAR PANEL WITH CALIBRATION CONTROLS FOR TL 488-4A AND TL 488-4B PROGRAMMING BOARDS.

NOTE: *There are two (2) sets of controls indicated for each of the sixteen (16) I/O PORTS, since any of the four (4) SLOTS may contain either a TL 488-4A Programming Card (for ATE power supplies) or a TL 488-4B Programming Card (for BOP power supplies).*

In case the slot contains a TL 488-4A card, the controls $I_{O\ ZERO}$, $I_{O\ MAX}$ and $E_{o\ ZERO}$, $E_{O\ MAX}$ (4 controls)are applicable, while with a TL 488-4B card the E/I ZERO and E/I MAX controls (2 controls) are used. Since only the MAIN CHANNEL which can be dedicated to either voltage or current control, is calibrated, only two controls are used with the TL 488-4B card.

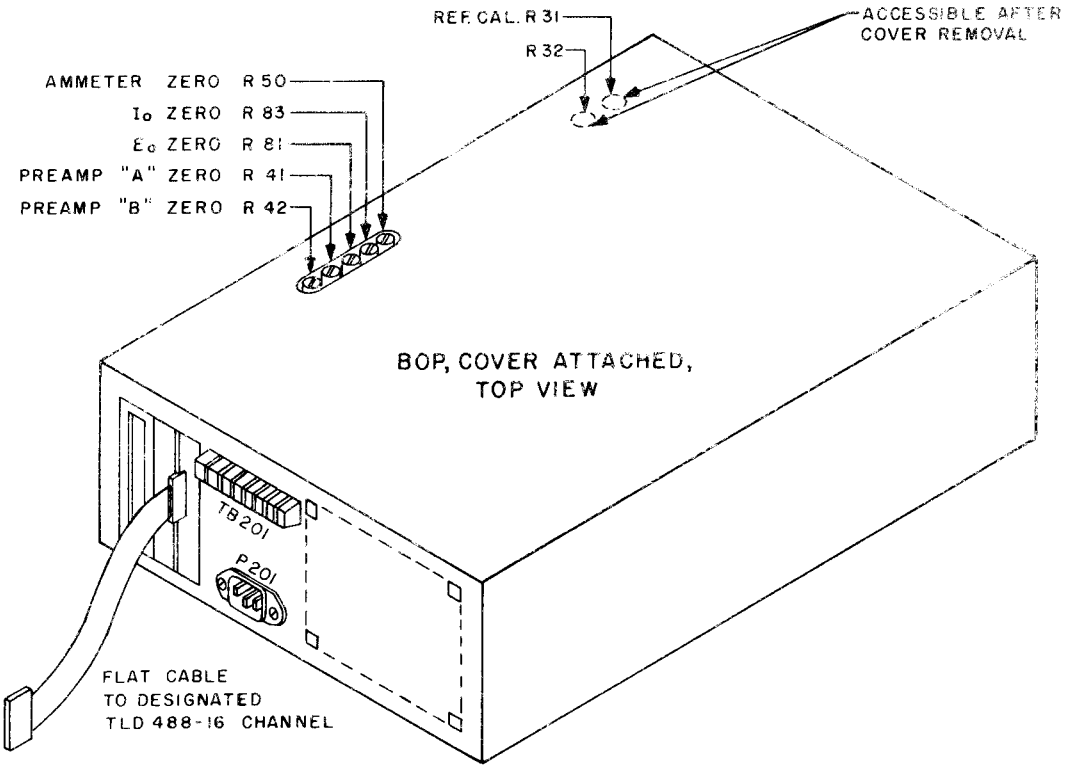


FIG. 3-9 BOP POWER SUPPLY WITH PCA X-3 INTERFACE AND CABLE, LOCATION OF INTERNAL CONTROLS

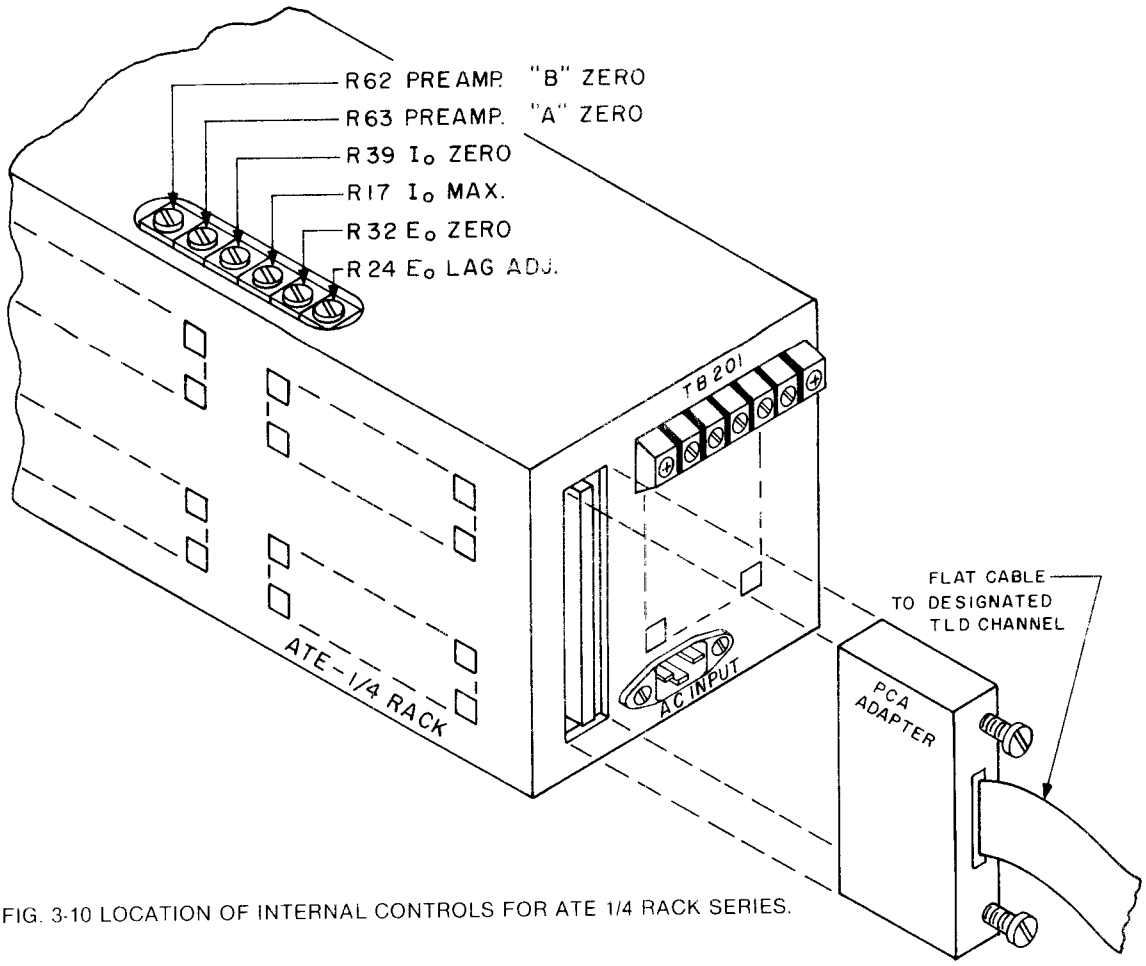
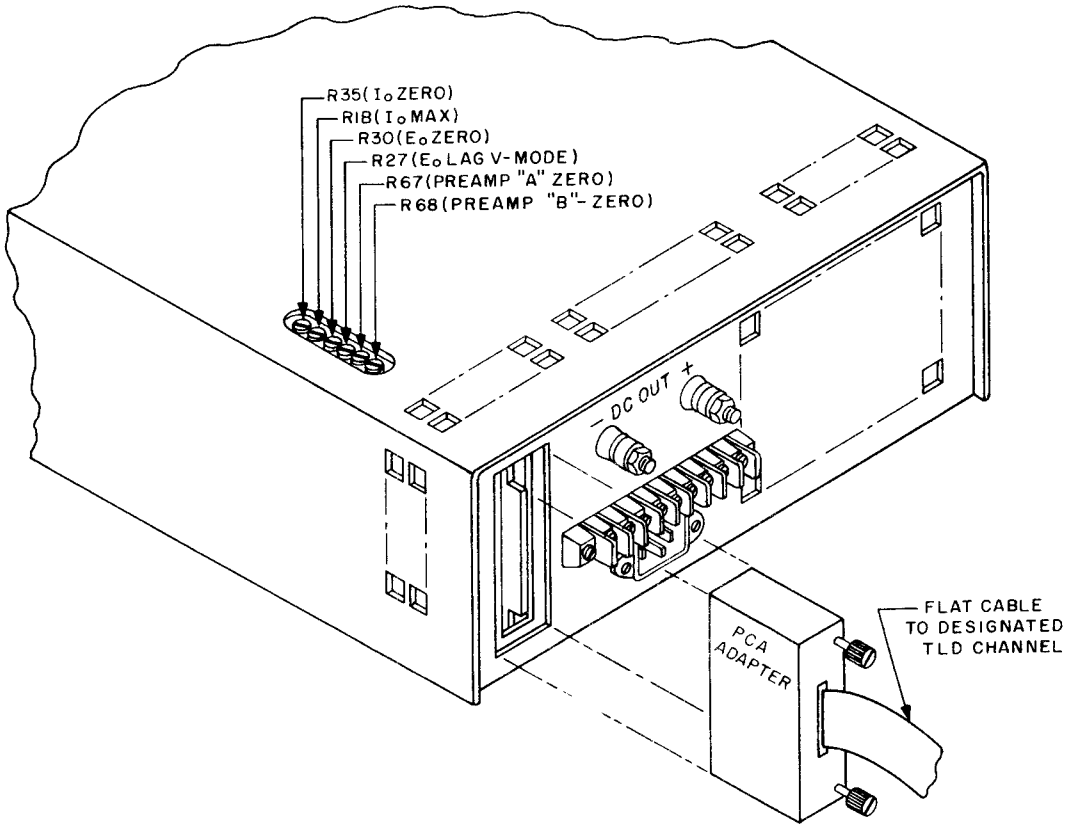


FIG. 3-10 LOCATION OF INTERNAL CONTROLS FOR ATE 1/4 RACK SERIES.



TLD 488—06-0186

FIG. 3-11 LOCATION OF INTERNAL CONTROLS FOR ATE 1/2 RACK AND FULL RACK SERIES.

APPENDIX A
E-PROM CHANGES

The Kepco Model TLD 488-16 Interactive Digital Programmer contains the Intel iSBC88/25 Microcomputer board which is driven by an operating system residing in two (2) proprietary E-PROM devices. These E-PROMS have undergone periodic functional upgrading but are upward or downward compatible.

The TLD 488-16 is always delivered with the latest version E-PROM. Should the user own a TLD 488-16 with the older E-PROMS, they may be replaced by the latest version, which is available from Kepco. On the other hand, if the user should require the older E-PROMS with a new TLD 488-16 (in cases where programs exist which were written for the older TLD 488-16), the old E-PROMS are available from Kepco.

The E-PROM versions are as follows:
V1.00: Kepco P/N 250-0136 and 250-0137
V1.07: Kepco P/N 250-0150 and 250-0151
V2.11: Kepco P/N 250-0155 and 250-0156
V2.17: Kepco P/N 250-0159 and 250-0160
V2.20: Kepco P/N 250-0161 and 250-0162
V2.30: Kepco P/N 250-0186 and 250-0187
V3.00: Kepco P/N 250-0189 and 250-0190

The E-PROMS are identified by their Kepco Part Number and are located on the TLD 488-16 computer board as shown in FIG. 1.

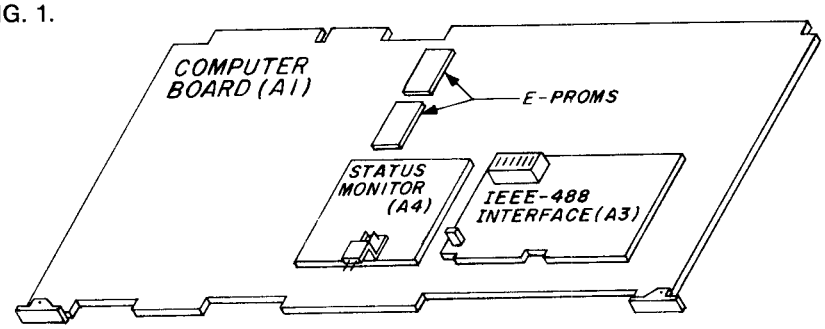


FIG. 1. TLD 488-16 COMPUTER BOARD, LOCATION OF E-PROMS.

The principal differences of the E-PROMS are:

V1.07 differs from V1.00 as follows:

1) Two additional power supply models were added to the model table: Model ATE 325-0.8M and Model 21333.
2) Allowable lenght for the value string in the SET Command has been increased.
3) Leading zeroes are now permitted in the exponent field.
4) Polarity sign, if programmed, is now ignored for ATE power supply models.
5) Interrupt-handling has been modified to accommodate HP computers.
6) Partial command strings are no longer accepted.

V2.11 includes all modifications listed for V1.07 and has these additional features:

1) Includes the ability to program Kepco BOP power supplies if TLD 488-16 has the TL 488-4B card installed.
2) The ABNORMAL RESPONSE syntax has been changed to the following form:

F07DCSnn sp (bbb): sp Text cr lf

Where nn = channel number, now decimal bbb = error origin
sp = ASCII space character Text = ASCII error description.

3) SRQ may now be asserted when TLD 488-16 is in the TALKER state.

4) Two commands (T0, T1) have been added. The TLD will "power on" in the T0 state. In this state, the TLD will erase all previously collected unreported non-catastrophic error messages from the error buffer as soon as a new valid command is received or a catastrophic error occurs. The T1 op code, issued after power on, will preserve all error messages (this was the default condition with E-PROM V1.07).

5) Independently of the T0 or T1 state, the DCL (Device Clear) or SDC (Selected Device Clear) commands will clear the TLD 488-16 error buffer of any non-catastrophic error messages.

6) Issuance of DCL (Device Clear) or SDC (Selected Device Clear) will no longer release the STATUS MONITOR line.

V2.17 includes all the modifications listed for V2.11 and implements an RFD holdoff under the following conditions:

1) In response to overly-anxious controllers.
2) In response to a relay command.
3) In response to a DCL (Device Clear) or SDC (Selected Device Clear) command.
4) In response to an RST command.

V2.20 includes all the modifications listed for V2.17. The SRX (Set Maximum) and SRN (Set Minimum) commands are now functionally identical to the SET command.

V2.30 includes all the modifications of V2.20 and extends the timeout for the TLR 200 relay box.

V3.00 includes all the modifications of V2.30 as well as the following:

1) A bug which under certain conditions, caused premature release of the NRFD line, was removed.

2) NRFD holdoff times for relay commands and set commands were reduced in order to optimize programming speed.

3) The operation of the "STA" command was modified in order to compensate for the speeding up of other commands. In addition to loading the status buffer, all flags will first be checked for approximately 60 msecs. This will ensure that premature requests for status, following set commands and relay commands does not yield misleading status information.

4) Execution time for confidence test (CNF,IST) was reduced from 10 seconds to 1.8 seconds.