INSTRUCTION MANUAL

SNR 588-4, 488-8

PROGRAMMING CARD CAGE

KEPCO INC.
An ISO 9001 Company.

MODEL
SNR 488-8
PROGRAMMING CARD CAGE
INSTRUCTION MANUAL

ORDER NO.	REV. NO.

NOTE: This on-line version of the Technical Manual includes only installation and operating instructions. For the complete manual, please contact Kepco.

KEPCO®
THE POWER SUPPLIER™

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

TABLE OF CONTENTS

SECTION I—INTRODUCTION

SECTION II—INSTALLATION

SECTION III--OPERATION

SECTION IV—THEORY OF OPERATION

SECTION V--ELECTRICAL PARTS LISTS AND DIAGRAMS

LIST OF ILLUSTRATIONS

List of Illustrations (cont'd.)

LIST OF TABLES

SECTION I–INTRODUCTION

1-1 SCOPE OF MANUAL

1-2 This manual contains a general description, as well as instructions for the installation, operation and calibration of the KEPCO SN 488 PROGRAMMING SYSTEM, manufactured by KEPCO INC., Flushing, N.Y. U.S.A. The KEPCO SN 488 PROGRAMMING SYSTEM consists of the following components:

1) MODEL SNR 488-4, RACK HOUSING WITH INTERFACE
2) MODEL SNR488-8, RACK HOUSING WITH INTERFACE
3) MODEL SN 488-B/SN 488-D, PLUG-IN PROGRAMMING CARDS
4) MODEL SN 488-K, KEYBOARD
5) MODEL SNC 488-1,-2,-4, BUS INTERCONNECTING CABLES, 1,2 and 4 meters long
6) MODEL SNP 488-1,-2,-4, KEYBOARD CABLES, 1,2 and 4 meters long

1-3 This manual provides complete documentation (Parts Lists, Component Locations, Schematic Diagrams) for the Model SNR 488-4 and SNR 488-8 RACK HOUSING, while all other systems components are, although included in the description here, fully documented within their own Instruction Manuals.

1-4 INTRODUCTION

1-5 The KEPCO SN 488 PROGRAMMING SYSTEM is designed to interface Kepco's programmable power supplies with the GENERAL PURPOSE INTERFACE BUS (GPIB), per IEEE STD. 488-1975. A typical Kepco SN 488 PROGRAMMING SYSTEM is shown in the form of a block diagram in FIG. 1-1. The system as shown, consists of the Model SNR 488-4 Rack Housing with interface card, four (4) plug-in Model SN 488-B or SN 488-D Programming Cards, a Model SN 488-K Keyboard with Model SNP 488 Cable, the bus connecting cable Model SNC 488 plus the programmable Kepco power supplies. Since each Model SN 488-B or SN 488-D Programming Card has two independent control channels, the system shown in FIG. 1-1 can program four (4) power supplies , providing independent control of each supply's voltage and current channel for example.

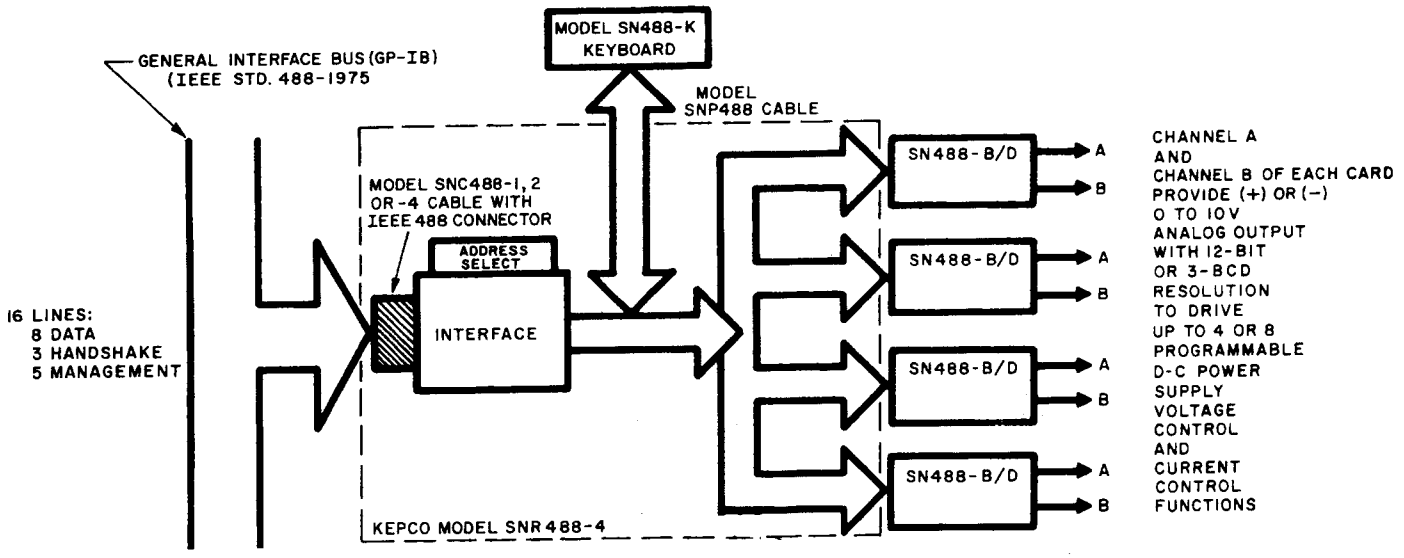


FIG. 1-1 BLOCK-DIAGRAM, KEPCO 488 PROGRAMMING SYSTEM (EXAMPLE)

1-6 While a minimum SN 488 system, consisting of a Model SNR 488-4 Rack Housing and one Model SN 488-B or SN 488-D Programming Card provides two (2) independent outputs, the maximum capacity is provided with Model SNR 488-8 Rack Housing and eight (8) Model SN 488-B or SN 488-D Progamming Cards, providing sixteen (16) independent outputs. The Kepco SNR 488 system is thereby capable of programming multi-power supply installations via a single standard bus connector.

1-7 By means of the Kepco SN 488 Programming Sytem, and " controller" or " talker " on the GPIB bus can communicate with any system power supply. The SN 488 implements the LISTENER (LI) and the ACCEPTOR HANDSHAKE (AHI) functions per GPIB protocol.

1-8 GENERAL DESCRIPTION OF THE KEPCO 488 SYSTEM

1-9 **Kepco Model SNR 488-4,** with built-in interface card, is a 19" rack housing with slots for four (4) programming cards and with room for either two (2) "quarter rack" or one (1) "half-rack" Kepco power supply (see FIG. 1-2).

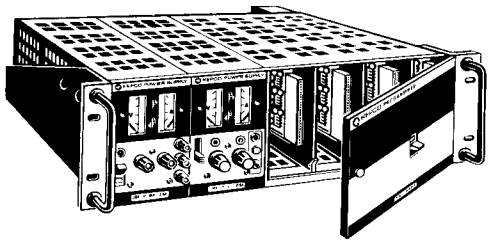


FIG. 1-2 KEPCO MODEL SN 488-4 RACK HOUSING.

1-10 **Kepco Model SNR 488-8** with built-in interface card, is a 19" rack housing slots for eight (8) programming cards (see FIG. 1-3).

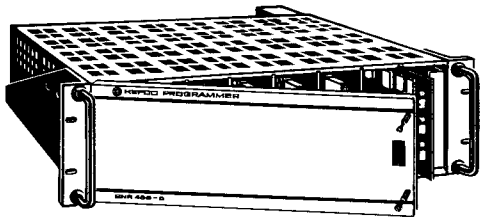


FIG. 1-3 KEPCO MODEL SNR 488-8 RACK HOUSING.

1-11 ACCESSORIESS SUPPLIED

a) Each SNR rack housing is provided with a removable a-c power cord, Kepco P/N 118-0552.

b) Each analog output connector, provided on the SNR housings is provided with a mating connector, Kepco P/N 143-0293.

1-12 ACCESSORIES OPTIONAL

a) **Kepco Model SN 488-B and SN 488-D** are the programming plug-in cards for use in the rack housings described above. Each card provides ***two channels*** of optically isolated, digital to analog conversion. The Model SN 488-B is binary coded with 12-bit resolution. The Model SN 488-D has BCD coding with 3-decade resolution.

A Model SN 488-B or SN 488-D, mounted in either the Model SNR 488-4 or SNR 488-8 and connected to the GPIB and to a suitable Kepco power supply or other analog programmable device, forms a complete digital programming system. This programming system may also be manually controlled by means of the Kepco Model SN 488-K Keyboard, described in PAR. 1-12 b "Accessories, Optional".

Both channels of the Models SN 488-B and SN 488-D may be programmed for ***magnitude, range and polarity.***

b) **Kepco Model SN 488-K Keyboard**, hand-held keyboard capable of addressing the internal bus in the Kepco Model SNR 488-4 or SNR 488-8. The keyboard is intended primarily for off-line testing and calibrating the Kepco 488 System.

c) **Kepco Models SNC 488-1, -2, -4 Bus Interconnecting Cables** with respective lengths of 1, 2, and 4 meters, for connecting SNR rack housing to the IEEE 488 or GPIB bus.

d) **Kepco Models SNP 488-1, -2, -4, Interconnecting Cables** with respective lengths of 1, 2 and 4 meters for connecting the Model SN 488-K Keyboard to the SNR rack housings and thereby to the Kepco internal bus.

1-13 SPECIFICATIONS OF THE KEPCO 488 PROGRAMMING SYSTEM (1)

1-14 GENERAL

a) A-C POWER INPUT (MODEL SNR 488-4 and SNR 488-8): 105 to 125V a-c or 210 to 250V a-c (selectable by built-in switch), 50 to 440 Hz, single phase, approximately 6VA with interface card, plus 7VA for each programming card.

b) OPERATING TEMPERATURE RANGE: 0° to 70°C.

c) STORAGE TEMPERATURE: -25°C to 85°C.

d) INPUT: The Kepco 488 Programming System is connected to the GPIB bus by means of an interconnecting cable (Kepco Model SNC-1, -2 or -4), terminated at both ends with two standard 24-pin connectors.

Once connected to the GPIB, the Kepco 488 programming System must be addressed by the bus controller, transmitting the listener address byte followed by 9 (nine) data bytes see FIG. 1-4. All data bytes are ASCII (American Standard Code for Information Interchange) characters, sent on the bus according to the GPIB protocol.

(1) **The "Kepco 488 Programming System", as described in this manual, consist of either a Kepco Model SNR 488-4 or SNR 488-8 RACK HOUSING and at least one (optional) Kepco Model SN 488-B or SN 488-D Programming Card.**

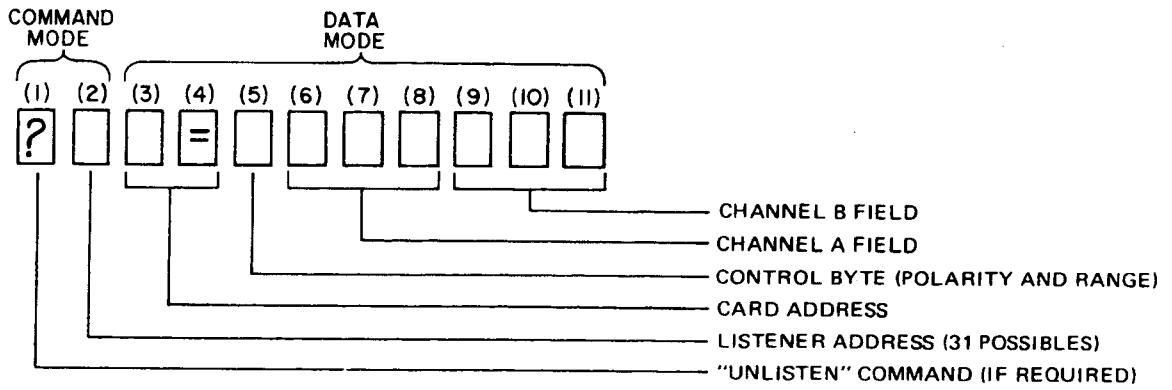


FIG. 1-4 INPUT DATA FORMAT AND SEQUENCE FOR KEPCO 488 PROGRAMMING SYSTEM.

Note: A data byte description is provided in Section III of this manual.

e) OUTPUT:
   1) HIGH RANGE: 0 to ± 10V d-c, 2mA max.
   2) LOW RANGE: 0 to ± 1V d-c, 2mA max.

f) ISOLATION: 1000V d-c isolation between digital input and analog output.

1-15 PERFORMANCE: Refer to Table 1-1.

SPECIFICATION	WITH MODEL SN 488-B PROGRAMMING CARD	WITH MODEL SN 488-D PROGRAMMING CARD
RESOLUTION	12 BIT (BINARY)	3 DIGIT (BCD)
LINEARITY	± 1/2 LSB	± 1/4 LSB
GAIN DRIFT	± 35 PPM/°C	± 35 PPM/°C
OFFSET DRIFT (High Range)	± 20 μV/°C	± 20 μV/°C
OFFSET DRIFT (Low Range)	± 10 μV/°C	± 10 μV/°C
OUTPUT CURRENT	2 MA MAX.	2 MA MAX.
OUTPUT IMPEDANCE	< 0.05 Ω	< 0.05 Ω

TABLE 1-1 PERFORMANCE SPECIFICATIONS, KEPCO 488 PROGRAMMING SYSTEM.

SECTION II—INSTALLATION

2-1 UNPACKING AND INSPECTION

2-2 All systems components have been thoroughly inspected and tested prior to packing and are ready for operation. After careful unpacking, inspect for shipping damage before attemting to operate. An off-line check-out may be performed by following the instructions provided in Section III (paragraph 3-16). If any indication of damage is found, file an immediate claim with the responsible transport service.

2-3 TERMINATIONS, MODEL SNR 488-4 (See FIG.'s 2-1, 2-2 and Table 2-1).

2-4 TERMINATIONS, MODEL SNR 488-8 (See FIG.'s 2-3, 2-4 and Table 2-1).

2-5 A-C SOURCE INPUT CONVERSION (See FIG.'s 2-2, 2-4 and Table 2-1).

2-6 The Kepco SNR 488 Programming System is normally delivered for operation on a nominal 115V a-c source. Conversion for operation on 230V a-c sources requires the performance of the following steps:

1) Remove Line Cord (Item 6) and Fuse Holder (Item 5). Now go to Item 7 in Table 2-1.
2) Change MAIN FUSE (see FIG.'s 2-2, 2-4, Item 5), to one-half its former value (see Parts List for F201-230).
3) Change INTERFACE FUSE (see FIG.'s 2-2, 2-4 Item 8) to one-half its former value (see Parts List for F1-230).
4) Change FUSE on **each** of the Programming Boards to one-half their former value (see Programming Board Instruction Manual for location).
5) Set SOURCE VOLTAGE SELECTOR (see FIG.'s 2-2, 2-4, Item 8) to the "230" position.
6) Set SOURCE VOLTAGE SELECTOR on **each** of the Programming Boards (see Programming Board Instruction Manual for location) to the "230" position.
7) Replace Line Cord (Item 6) and Fuse Holder (Item 5). Replace and fasten screws (Item 7).

2-7 COOLING

2-8 Power dissipating components in the Kepco SNR 488 Programming System are cooled by convection. Rear panel and cover openings must be kept clear from obstructions to ensure proper air circulation.

2-9 Periodic cleaning of the cabinet's inside is recommended. if the cabinet is mounted into confined spaces (rack installations, etc.), care must be taken that the temperature, two (2) inches below the cabinet, does not exceed 70°C.

2-10 INSTALLATION (Refer to FIG. 5-1 and 5-2 "MECHANICAL OUTLINE DRAWING").

2-11 MODEL SNR 488-4 or SNR 488-8 RACK HOUSING: All SNR rack housings can be directly mounted into a standard (19-inch) instrument rack.

NOTE: *CARE MUST BE TAKEN THAT THE TEMPERATURE SURROUNDING THE INSTALLED INSTRUMENT DOES NOT EXCEED 70°C.*

2-12 MODEL SN 488-B or SN 488-D PROGRAMMING CARD: Loosen LOCKING SCREWS (ITEM 2 on FIG.'s 2-1 or 2-3) on SNR RACK HOUSING. Swing open hinged FRONT PANEL and slide Programming Card into designated slot in the RACK HOUSING, using the board-mounted thumb lever. Close FRONT PANEL on the RACK HOUSING and refasten the LOCKING SCREWS.

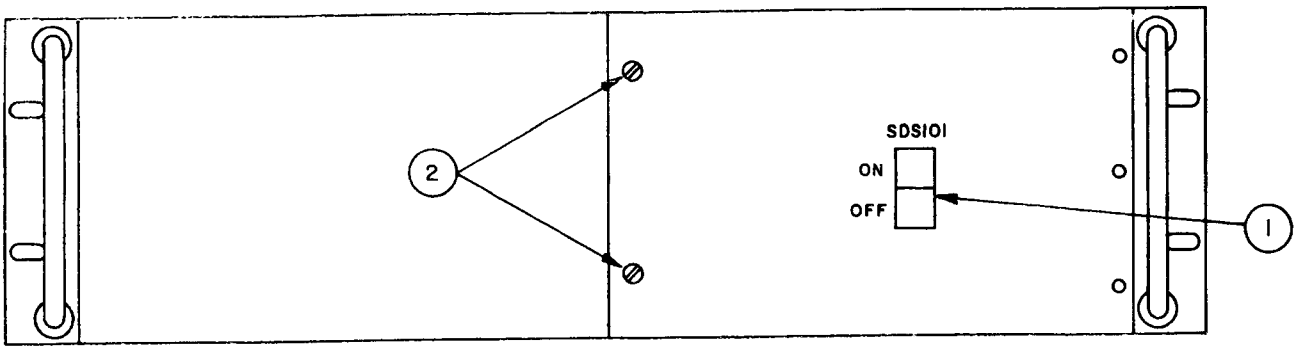


FIG. 2-1 FRONT PANEL, MODEL SNR 488-4 (See Table 2-1).

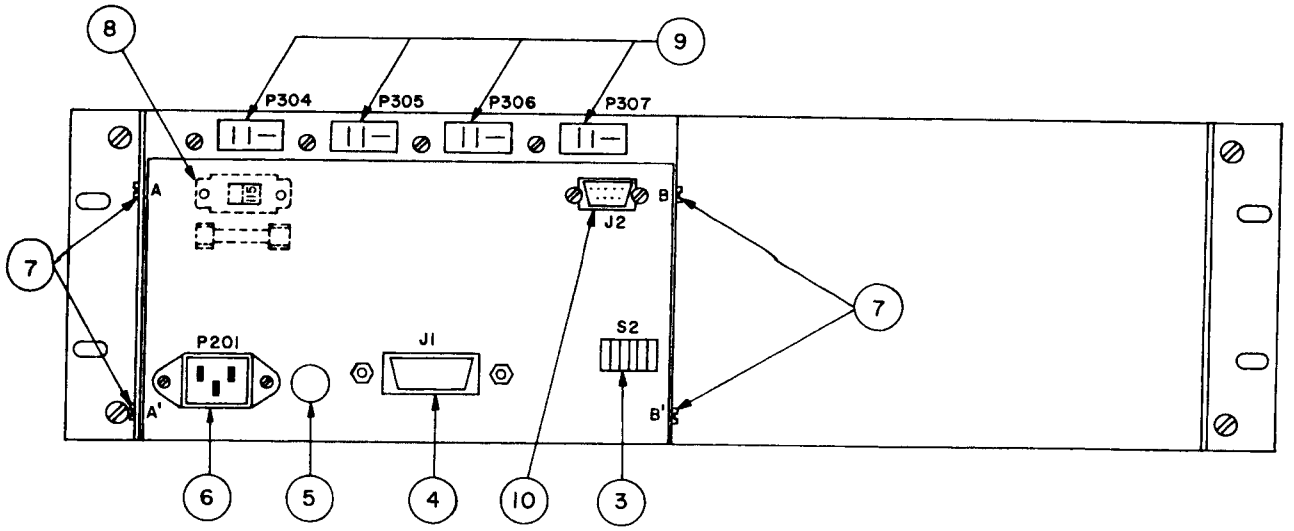


FIG. 2-2 REAR PANEL, MODEL SNR 488-4 (See Table 2-1).

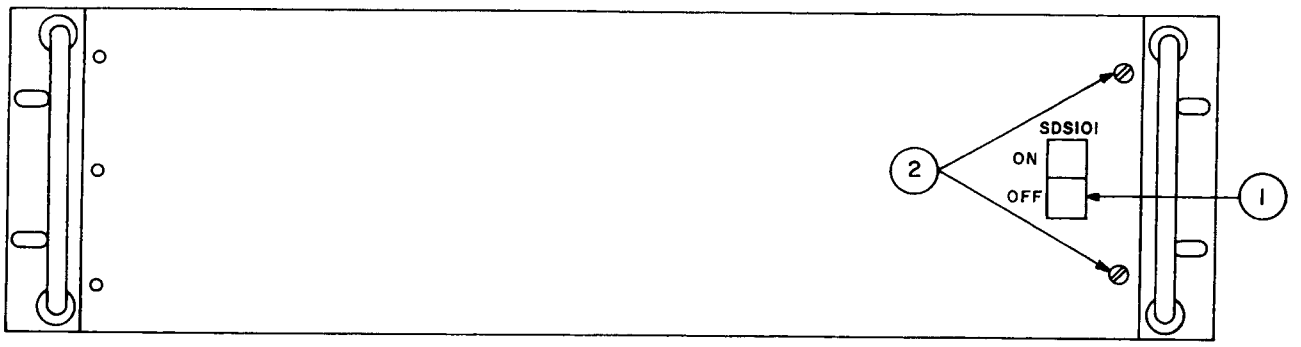


FIG. 2-3 FRONT PANEL, MODEL SNR 488-8 (See Table 2-1).

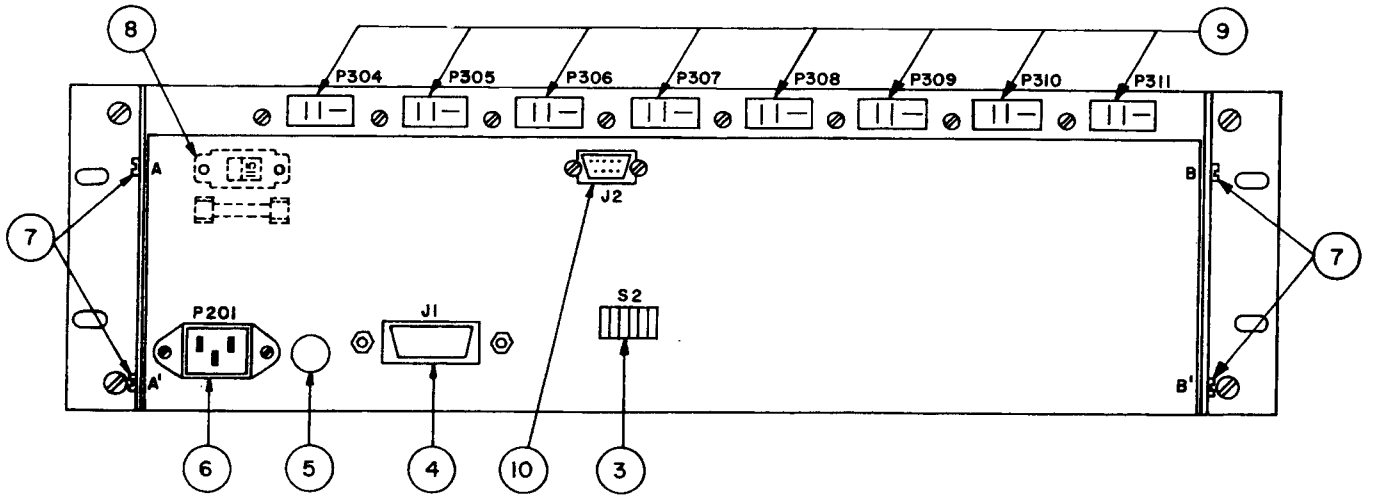


FIG. 2-4 REAR PANEL, MODEL SNR 488-8 (See Table 2-1).

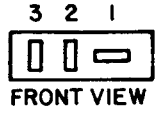
NO.	CONTROL OR TERMINATION	FUNCTION
1	A-C POWER SWITCH	A-C POWER LINE ON-OFF SWITCH, WITH "ON" LIGHT. APPLIES SOURCE POWER TO INTERFACE AND ALL PLUG-IN PROGRAMMING CARDS.
2	LOCKING SCREWS	WHEN LOOSENED, HINGED FRONT PANEL MAY BE OPENED FOR ACCESS TO PROGRAMMING CARD SLOTS.
3	ADDRESS SELECTOR	MULTIPLE ROCKER SWITCH, TO SET INTERFACE TO EITHER THE "LISTEN ONLY" MODE OR THE "ADDRESSABLE" MODE AND TO PRESET INTERFACE ADDRESS. SEE SECTION III FOR DETAILED INSTRUCTIONS.
4	EXT-BUS CONNECTOR	TO CONNECT INTERFACE TO GPIB BUS BY MEANS OF KEPCO MODEL SNC 488-1, -2 or -4 CABLE.
5	FUSE HOLDER	MAIN FUSE, PROTECTS A-C INPUT CIRCUITRY TO ALL PROGRAMMING CARDS.
6	A-C LINE CORD	TO CONNECT INSTRUMENT TO A-C INPUT SOURCE.
7	REAR PANEL HOLDING-SCREWS	REMOVE SCREWS A, B AND LOOSEN SCREWS A'B' IF REQUIRED, TO PIVOT REAR PANEL OUTWARDS FOR ACCESS TO INTERFACE BOARD, INTERFACE FUSE AND SOURCE VOLTAGE SELECTOR SWITCH.
8	INTERFACE FUSE AND SOURCE-VOLTAGE SELECTOR	SEPARATE FUSE FOR INTERFACE A-C INPUT CIRCUIT AND SWITCH TO SELECT EITHER "115V A-C" OR "230V A-C" NOMINAL SOURCE INPUT (INTERFACE ONLY, PROGRAMMING CARDS HAVE THEIR OWN FUSE AND SOURCE SELECTOR).
9	OUTPUT CONNECTORS 1) Output Channel A 2) Output Channel B 3) Common  FRONT VIEW	ANALOG OUTPUTS FOR EACH PROGRAMMING CARD. MATING CONNECTORS SUPPLIED.
10	INT-BUS CONNECTOR	INTERNAL BUS ACCESS CONNECTOR. FOR INTERCONNECTING MODEL SN 488-K KEYBOARD BY MEANS OF KEPCO MODEL SNP 488-1, -2 OR -4 CABLE.

TABLE 2-1 TERMINATIONS, KEPCO SNR 488-4 AND SNR 488-8 RACK HOUSINGS.

SECTION III--OPERATION

3-1 GENERAL

3-2 Operation of the Kepco 488 Programming System on the GPIB bus requires four basic steps as follows:

1) Set Kepco 488 interface address
2) Set all programming card addresses
3) Establish Kepco 488 to power supply connections
4) System operation

These steps are described in detail in the following paragraphs.

3-3 SETTING THE KEPCO 488 INTERFACE ADDRESS

3-4 The GPIB bus address for the Kepco 488 Programming System is intially set by means of the ADDRESS SELECTOR switch as shown in FIG. 3-1.

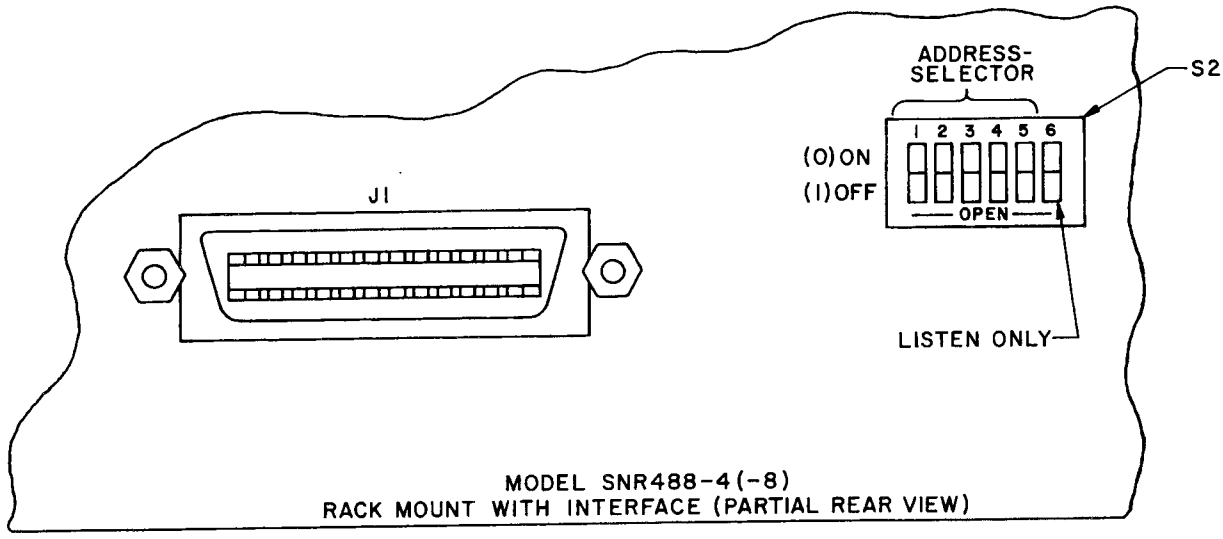


FIG. 3-1 LOCATION OF REAR PANEL BUS-ADDRESS SELECTOR SWITCHES.

3-5 The Kepco 488 address may be selected from thirty-one (31) ASCII characters as shown in Table 3-1.

ASCII CHARACTER	DECIMAL ADDRESS	ADDRESS SELECTOR SWITCH POSITIONS S1	S2	S3	S4	S5	LISTEN ONLY (S6)
NOT APPLICABLE		X	X	X	X	X	0
SP	0	0	0	0	0	0	1
!	1	1	0	0	0	0	1
"	2	0	1	0	0	0	1
#	3	1	1	0	0	0	1
$	4	0	0	1	0	0	1
%	5	1	0	1	0	0	1
&	6	0	1	1	0	0	1
'	7	1	1	1	0	0	1
(	8	0	0	0	1	0	1
)	9	1	0	0	1	0	1
*	10	0	1	0	1	0	1
+	11	1	1	0	1	0	1
,	12	0	0	1	1	0	1
-	13	1	0	1	1	0	1
.	14	0	1	1	1	0	1
/	15	1	1	1	1	0	1
0	16	0	0	0	0	1	1
1	17	1	0	0	0	1	1
2	18	0	1	0	0	1	1
3	19	1	1	0	0	1	1
4	20	0	0	1	0	1	1
5	21	1	0	1	0	1	1
6	22	0	1	1	0	1	1
7	23	1	1	1	0	1	1
8	24	0	0	0	1	1	1
9	25	1	0	0	1	1	1
:	26	0	1	0	1	1	1
;	27	1	1	0	1	1	1
<	28	0	0	1	1	1	1
=	29	1	0	1	1	1	1
>	30	0	1	1	1	1	1

X = DON'T CARE
0 = ON (SWITCH CLOSED)
1 = OFF (SWITCH OPEN)

PROGRAMMING NOTE:
The *complete* ASCII character (7-bits) must be programmed.

TABLE 3-1 LISTENING ADDRESS SELECTION ON THE KEPCO 488 PROGRAMMING SYSTEM.

3-6 SETTING THE PROGRAMMING CARD ADDRESS

3-7 The address for each programming card contained in the Kepco 488 system is initially set by means of an address switch (S1) located on each card as shown in FIG. 3-2.

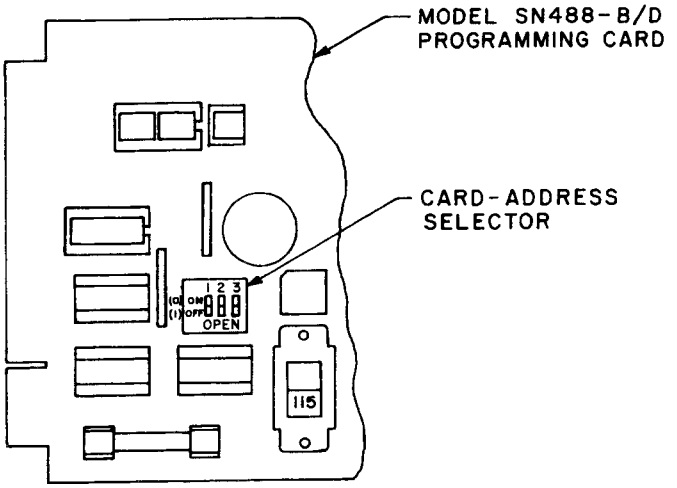


FIG. 3-2 LOCATION OF CARD ADDRESS SELECTOR SWITCH.

3-8 The card address may be selected from eight (8) ASCII characters as shown in Table 3-2.

ASCII CHARACTER	SWITCH POSITIONS S1	S2	S3
0	0	0	0
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1
5	1	0	1
6	0	1	1
7	1	1	1

Programming Note:
The *complete* ASCII character (7 bits) must be programmed.
0 = On (Switch closed)
1 = Off (Switch open)

TABLE 3-2 CARD ADDRESS SELECTION ON THE KEPCO 488 PROGRAMMING SYSTEM.

3-9 MAKING THE CONNECTIONS BETWEEN THE KEPCO 488 SYSTEM AND THE POWER SUPPLY TO BE PROGRAMMED.

3-10 The Kepco 488 Programming System can control a wide variety of Kepco programmable power supplies. On some models, the output voltage and the current limit function can be controlled by means of a simple resistor connection, while others can be connected without any additional components. On many of the newer design groups, marked with superscript "(1)" , the output voltage and the output current can be controlled simultaneously, while on older design groups only single channel control can be exercised (current ***or*** voltage). Several basic interconnections are described in the following paragraphs. These circuits are chosen to deliver from zero to maximum rated output voltage and current, in response to the two analog output signals (0–10V and 0–1V), from a single programming card in the Kepco 488 system. The circuits may, however, be scaled to any desired ratio. Detailed information on each Kepco power supply model is contained in the individual power supply instruction manual.

NOTE: EITHER SIDE OF THE POWER SUPPLY OUTPUT MAY BE GROUNDED.

3-11 The table below (see Table 3-3) lists the major groups of Kepco programmable power supplies, suitable for operation with the Kepco 488 Programming System. From the table, the connection requirements can be quickly determined. For special requirements, please consult your Kepco Representative, or the Kepco Application Engineering Department, Flushing, New York.

KEPCO MODEL GROUP	PROGRAMMING SIGNAL FOR FULL OUTPUT		CONNECTIONS REQUIRED	
	VOLTAGE CONTROL	CURRENT CONTROL	VOLTAGE CONTROL	CURRENT CONTROL
* APH(1)	0-10V	0-1V	DIRECT CONNECTIONS	
ATE(1)	0-10V	0-1V	DIRECT CONNECTIONS	
* BHK(1)	0-1 mA	0-1V	See FIG. 3-3	See FIG. 3-5
* BOP-H.V.(1)	0-10V	0-1V	DIRECT CONNECTIONS	
BOP-NEW(1)	0-10V	0-1V	DIRECT CONNECTIONS	
BOP-OLD	0-1 mA	0-1V/0-0.5V(2)	See FIG. 3-3	See FIG. 3-4
CC	N.A.	0-1 mA	N.A.	See FIG. 3-4
CCP	0-1 mA	0-1 mA	See FIG. 3-3	See Fig. 3-4
JQE	0-1 mA	0-1V/0-0.5V(2)	See FIG. 3-3	See FIG. 3-4
JQE-Y(1)	0-1 mA	0-1V/0-0.5V(2)	See FIG. 3-3	See FIG. 3-5
JMK(1)	0-1 mA	0-1V/0-0.5V(2)	See FIG. 3-3	See FIG. 3-5
OPS-I, II	0-1 mA	0-1V	See FIG. 3-3	See FIG. 3-4
OPS-III to VIII(1)	0-1 mA	0-1V/0-0.5V(2)	See FIG. 3-3	See FIG. 3-5
* OPS-X(1)	0-1 mA	0-1V/0-0.5V(2)	See FIG. 3-3	See FIG. 3-5
* OPS-IX-B(1)	0-1 mA	0-1V	See FIG. 3-3	See FIG. 3-5
PAT	0-1 mA	0-1V	See FIG. 3-3	See FIG. 3-4
PCX	0-1 mA	0-1V	See FIG. 3-3	See FIG. 3-4
PTR(1)	0-1 mA	0-1V	See FIG. 3-3	See FIG. 3-5

N.A. -Not Applicable.
(1) -Simultaneous Voltage/Current Control possible.
(2) -Models with output current to 5 amperes: 1V. Models with output current 5A and greater: 0.5V.
* -For all units over 1000 Volts, the positive output Terminal must be grounded.

TABLE 3-3 KEPCO PROGRAMMABLE POWER SUPPLIES AND THEIR PROGRAMMING SIGNAL AND CONNECTION REQUIREMENTS.

3-12 OUTPUT VOLTAGE CONTROL. Many Kepco power supplies require a d-c control current of 0 to 1 mA for zero to maximum output in the voltage mode. This requirement is readily satisfied by connecting a series resistance of 10K ohm as shown in FIG. 3-3.

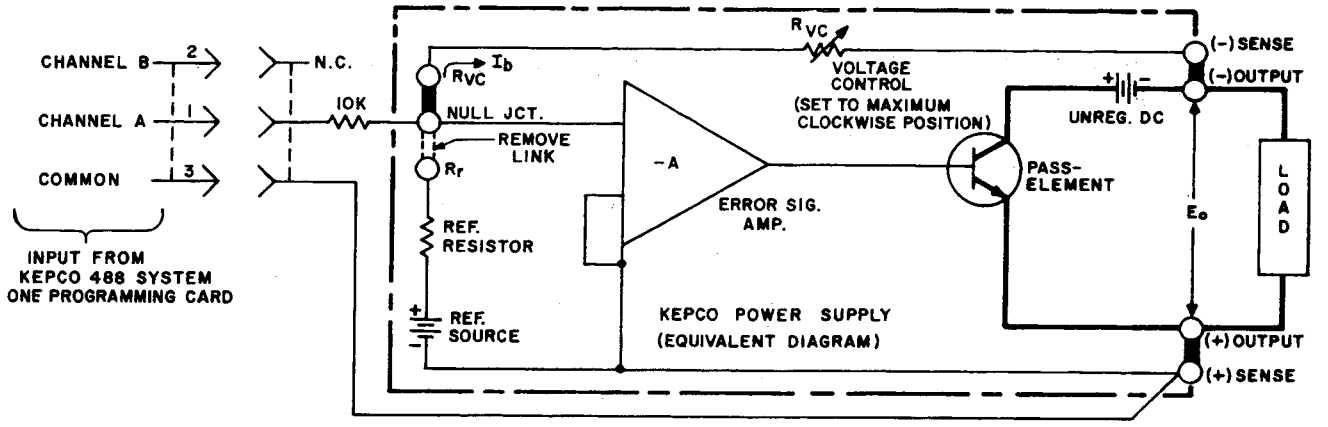


FIG. 3-3 OUTPUT VOLTAGE CONTROL WITH TYPICAL KEPCO POWER SUPPLY AND THE KEPCO 488 SYSTEM.

3-13 Certain precautions should be observed when making the interconnection between the KEPCO 488 SYSTEM and the power supply:

1) The input leads to the power supply should be tightly twisted and shielded to protect against static and magnetic "pick-up".

2) The input leads should be as short as possible if the series resistor (R_i = 10 K ohm) is used as shown. If the input leads must be longer than a few inches, the input resistor should be placed close to the power supply's "Null Junction" terminal. Since the output from the KEPCO 488 SYSTEM is (without the resistor) a low impedance line, noise "pick-up" is greatly reduced in this manner.

3-14 OUTPUT CURRENT CONTROL. Kepco power supplies designed as current stabilizers (CC and CCP groups for example) as well as many Kepco voltage stabilizers connected for external current sensing and control may be controlled by the method shown previously for output voltage control (see PAR. 3-15). The illustration below (see FIG. 3-4) shows both cases. The component shown with dashed lines are added for current control with a voltage stabilized power supply. The previous remarks on interconnecting precautions (see PAR. 3-13). are equally valid in this case.

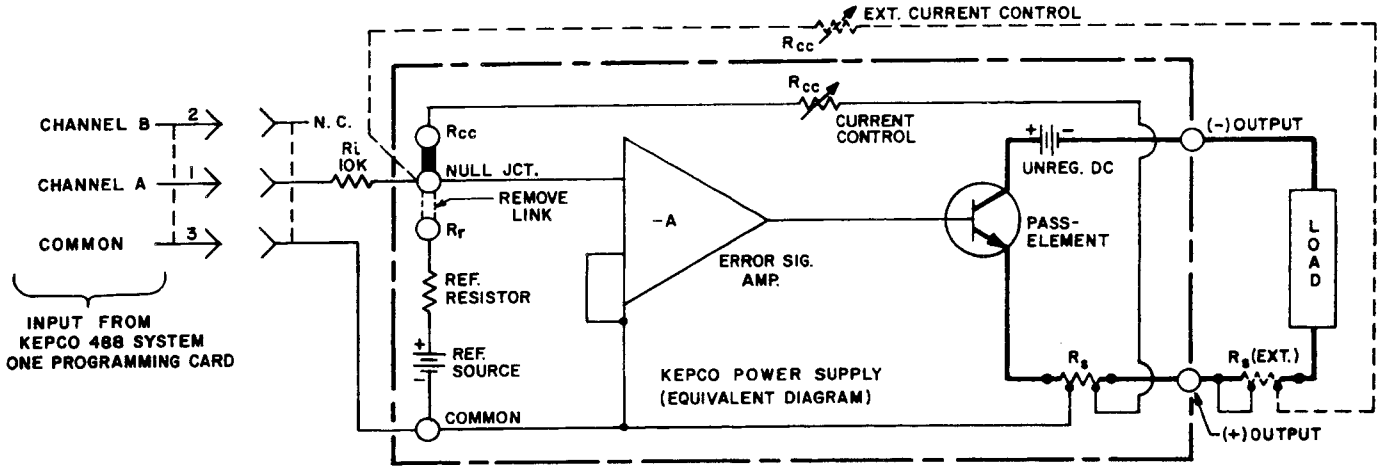


FIG. 3-4 OUTPUT CURRENT CONTROL USING A KEPCO CURRENT STABILIZED POWER SUPPLY OR A KEPCO VOLTAGE STABILIZED SUPPLY WITH EXTERNAL SENSING AND CONTROL RESISTOR (EXT. COMPONENTS, SHOWN WITH DASHED LINES).

3-15 COMBINED OUTPUT VOLTAGE/OUTPUT CURRENT CONTROL. For Kepco power supplies so identified in Table 3-3, the two channels (A,B) from a programming card in the Kepco 488 System may be used to control voltage and current output together, as shown in FIG. 3-5.

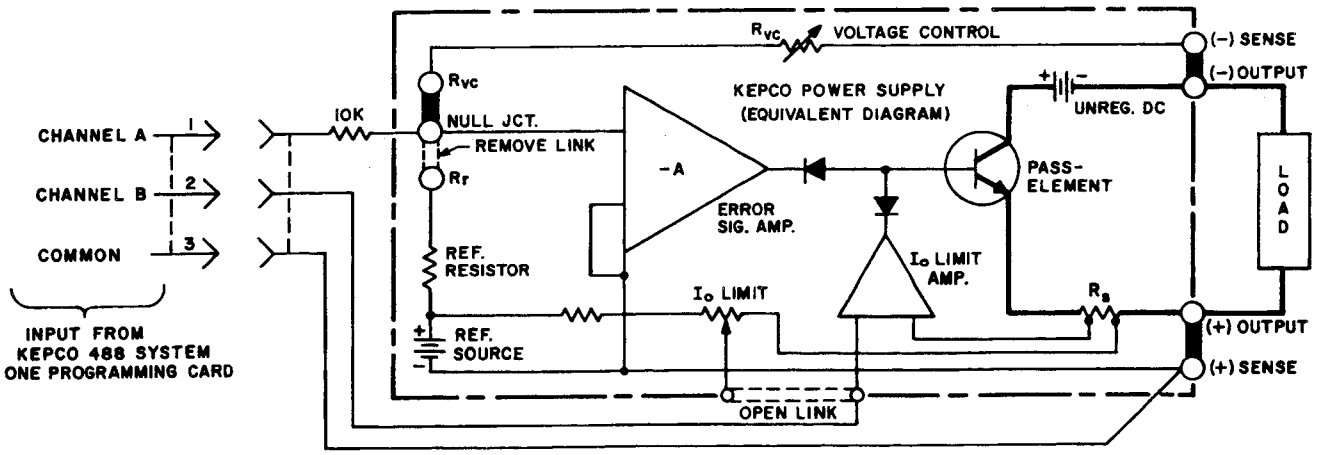
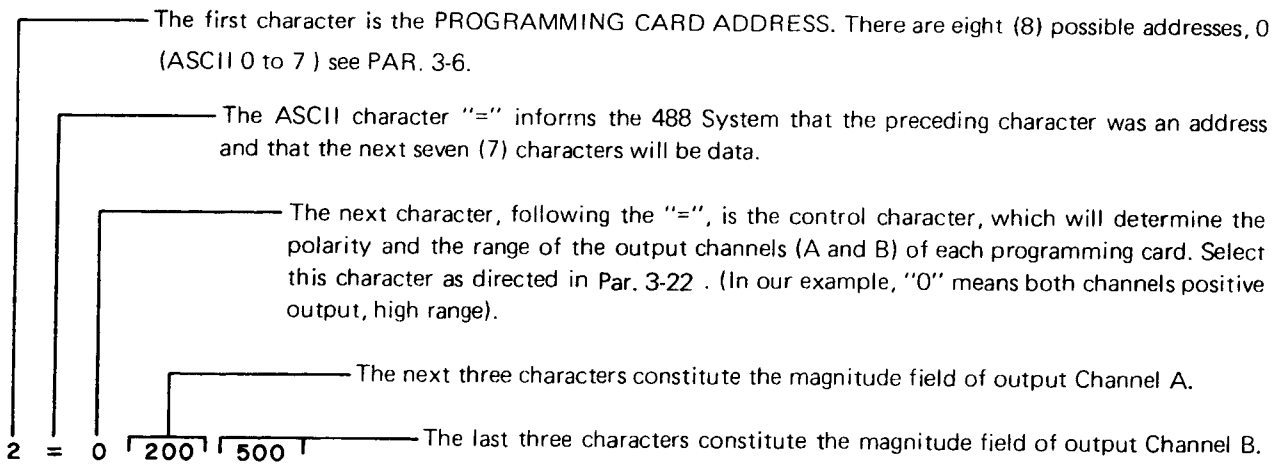


FIG. 3-5 COMBINED OUTPUT VOLTAGE/OUTPUT CURRENT CONTROL WITH A TYPICAL KEPCO POWER SUPPLY AND KEPCO 488 SYSTEM.

NOTE: On models requiring 0.5 volt current control voltage, a voltage divider, consisting of the two 500 ohm resistors, may be installed. System will yield 0 to full current output for 0–1 volt input from the programming card.

3-16 SYSTEM OPERATION

3-17 INSTRUCTION FORM. The Kepco SN 488 PROGRAMMING SYSTEM responds to an instruction of the form:



3-18 The magnitude field characters for both output channels must be numerals 0 to 9 for the Model SN 488D (BCD) Programming Card. These characters represent an output voltage of (magnitude field ÷ 99.9)volts .

3-19 For the Model SN 488-B (binary) Programming Card, the magnitude field characters must be 0 to 9 or A to F. They form a 12-bit magnitude field represented as three hexadecimal characters. These characters represent an output voltage of (magnitude field ÷ 409.5) volts.

3-20 BLANKS. Blanks between instruction characters are permissible. They will be closed up by the SN-488 interface card circuit.

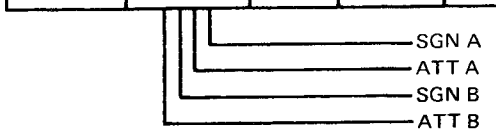
NOTE: AN INSTRUCTION MUST BE COMPLETE. INSTRUCTIONS OF FEWER THAN NINE (9) CHARACTERS WILL NOT BE EXECUTED BY THE PROGRAMMING CARD.

3-21 MULTIPLE CARD PROGRAM. Instructions for several cards may be strung together. The ASCII character "=" will serve as a delimiter, identifying each card address and its accompanying instruction fields. An example of a multiple card program is shown below:

0 = 03104001 = 05551002 = 0300200

3-22 CODING THE CONTROL CHARACTER. The character following "=" is the control character and determines the range and the polarity of the output channels. This character is converted by the SN 488 system into a 4-bit hexadecimal character resulting in the control possibilities shown in Table 3-4.

ASCII Character	Hex Data Byte	CHANNEL B Range	CHANNEL B Polarity	CHANNEL A Range	CHANNEL A Polarity
0	0000	H	+	H	+
1	0001	H	+	H	–
2	0010	H	+	L	+
3	0011	H	+	L	–
4	0100	H	–	H	+
5	0101	H	–	H	–
6	0110	H	–	L	+
7	0111	H	–	L	–
8	1000	L	+	H	+
9	1001	L	+	H	–
A	1010	L	+	L	+
B	1011	L	+	L	–
C	1100	L	–	H	+
D	1101	L	–	H	–
E	1110	L	–	L	+
F	1111	L	–	L	–



H = High Range, 0–10 Volts.
L = Low Range, 0–1 Volt.
\+ = Positive with respect to analog common.
– = Negative with respect to analog common.

TABLE 3-4 CODING THE CONTROL CHARACTER.

3-23 INSTRUCTION EXAMPLES. The following examples illustrate typical instructions, executed by the programming cards.

3-24 EXAMPLE 1: SN-488 System with two Model SN 488D (BCD) programming cards with addresses 0 and 1.

a) To set Channel A of the card with address 0 to +5V and Channel B to -7.5V, the following instruction must be transmitted:

0 = 4499749

b) To set Channel A of the card with address 1 to -8.75V and Channel B to +0.5V, the following instruction is required:

1 = 1874050

Note: For increased resolution, Channel B of the card with address 1 may be switched to the LOW range by transmitting:

1 = 9874499

3-25 EXAMPLE 2: SN-488 System with two Model SN 488B (binary) programming card with addresses 0 and 1.

a) To set Channel A of the card with address 0 to +5V and Channel B to -7.5V, the following instruction must be transmitted:

0 = 47FFBFF

b) To set Channel A of the card with address 1 to -8.75V and Channel B to +0.5V, the following instruction is required:

1=1EØØØCD

Note: For increased resolution, Channel B of the card with address 1 may be switched to the LOW range by transmitting:

1=9E007FF

3-26 POWER SUPPLY CONTROL. When the Kepco SN-488 is used to control one or more system power supplies, we must know the instructions required to produce the correct output voltage and/or output current from the power supplies, rather than the output levels from the programming cards as in the previous examples.

3-27 All Kepco power supplies suitable for use with the SN-488 System and listed in Table 3-3 may be linearly controlled over their full output range by a 0 to 10 volt signal (voltage output) and by a 0 to 1V or 0 to 0.5V signal (current output). In most systems, therefore, a single programming card can be used per power supply, with one channel controlling the output voltage and the other the output current or current limit of the power supply.

3-28 To calculate the voltage field of the instruction sequence, the following quantities must be known:

a) Maximum power supply output voltage (V_1)
b) Control voltage required to produce the maximum output voltage (V_2)
c) Required power supply output voltage (V)

The voltage field (BCD) is then equal to:

$$\text{INTEGER} \quad \frac{99.9\ VV_2}{V_1}$$

or, to illustrate use of the basic language:

V$ = STR (INT (999*V*V_2/V_1))

3-29 When calculating the voltage field, the computer must always generate a three character field. Leading zeros must be included in the instruction when the output is small, so as to retain all three characters of the voltage field.

3-30 The current field may be programmed in a similar manner. The following quantities must be known:

a) Maximum power supply output current (I_1)
b) Control voltage required for maximum output current (I_2)
c) Required power supply output current (I)

The current field (BCD) is then equal to:

$$\text{INTEGER} \quad \frac{99.9\ I\ I_2}{I_1}$$

or, in basic:

I$ = STR (INT (999*I*I_2/I_1))

3-31 As in the case of the voltage field, the current field must contain three characters.

WARNING

BEFORE MAKING MEASUREMENTS AND/OR PERFORMING CALIBRATION ON THE KEPCO 488 SYSTEM, DISCONNECT THE POWER SUPPLY FROM THE ANALOG OUTPUT OF THE 488 SYSTEM.

IF MEASUREMENTS AND/OR CALIBRATIONS ARE PERFORMED WITH THE POWER SUPPLY CONNECTED, STANDARD HIGH-VOLTAGE PRECAUTIONS SHOULD BE EXERCISED, IF THE ANALOG "COMMON" OF THE 488 SYSTEM IS OPERATED "FLOATING".

3-32 SYSTEM CALIBRATION

3-33 POWER SUPPLY CALIBRATION. Before connecting the power supply to the SN-488 system, it should be carefully calibrated as described in the power supply instruction manual.

3-34 PROGRAMMING CARD CALIBRATION. Kepco Model SN 488-B/D Programming Cards are factory-calibrated and system tested before delivery to the customer. If re-calibration should be required, the following procedure should be used.

a) EQUIPMENT REQUIRED:

1) System Controller, or Kepco Model SN 488-K Keyboard

2) D-C Voltmeter, 0 to 10 volts, minimum accuracy ±.01%, minimum impedance 1000 ohms per volt (M1)

b) NOTE: FOR OPTIMUM ACCURACY, ALLOW A SYSTEM WARM-UP TIME OF AT LEAST 15 MINUTES.

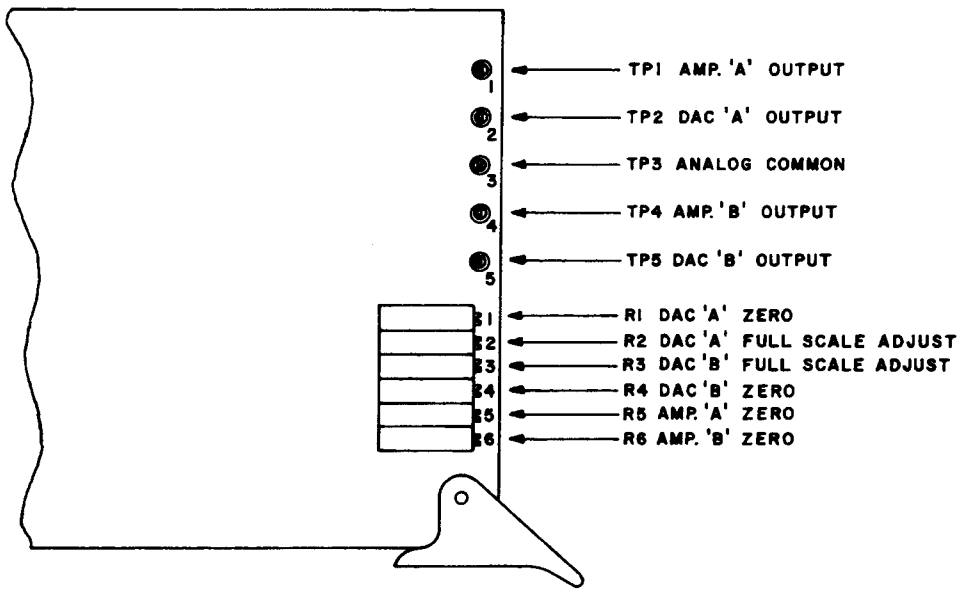


FIG. 3-6 LOCATION OF CALIBRATING CONTROLS AND TEST POINTS, KEPCO MODEL SN 488-B/D PROGRAMMING CARDS.

c) PROCEED AS FOLLOWS: (Refer to FIG. 3-6 for the location of test points and calibration controls)

STEP 1: Connect M1 (+) to TP2. Connect M1 (-) to TP3.

STEP 2: TRANSMIT: X = 0 000 000, where X is the card address, set as described in PAR. 3-6. This command will set both channels to zero volts. Check zero reading on M1 and correct, if necessary by adjusting R1.

STEP 3: Move M1 (+) to TP1. Check zero reading on M1 and correct by adjusting R5 if required.

STEP 4: Move M1 (+) to TP5. Check zero reading on M1 and correct by adjusting R4 if required.

STEP 5: Move M1 (+) to TP4. Check zero reading on M1 and correct by adjusting R6 if required.

STEP 6: TRANSMIT: X = 0 FFF FFF if Model SN 488-B Programming Card is used.

TRANSMIT: X = 0 999 999 if Model SN 488-D Programming Card is used.

Note: Substitute your selected card address for "X". Leave M1 connected as previously in Step 5.

STEP 7: Adjust R3 for 10V reading.

STEP 8: Move M1 (+) to TP1. Adjust R2 for 10V reading.

This concludes the calibration of the programming card.

3-35 FINAL CALIBRATION CHECK. Once the SN-488 system components are interconnected, the power supply output, following an instruction, should be checked for accuracy. Discrepancies between instructions and power supply output may be corrected by re-inserting the actual measured output values into the voltage and current field calculations (see PAR. 3-26 "Power Supply Control").