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A.D.DATA SYSTEMS, INC.

DATA ACQUISITION AND SWITCHING SYSTEMS

SERIES 56E SWITCHING MATRIX

Operators Manual



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Section 1

INTRODUCTION

1.0 Introduction

The series 56E is a modular system that can be configured for matrix or switching applications. Up to 10,000 single or two-wire closures can be provided. Each closure may be latched or unlatched by remote access, or optionally, by front panel manual control.

The basic system configuration is a 200 latchpoint, 10 switch module, STANDARD CONTROL CHASSIS with expansion interface. EXPANSION CHASSIS may be configured for 400 (maximum) latchpoints, 20 switch modules, per each unit. Both are modular in construction, featuring a mother board backplane to minimize servicing, enhance reliability, and improve system signal characteristics. Typically, a system with a requirement for 1000 latchpoints maximum is composed of a STANDARD CONTROL CHASSIS and TWO EXPANSION CHASSIS.

Standard DC Power is supplied to latch 120 crosspoints simultaneously; optionally, 400 crosspoint power may be provided in the CONTROL CHASSIS (not available with Option K). All chassis accomodate switch module expansion through plug-in circuit boards, providing 20 latchpoints each (except for special modules; VHF High Isolation/Low Leakage and High Power).

The type and characteristics of each module are listed under the system Options Listing and the Signaling-Switching section of this manual.

1.1 Options

The Model 56E matrix can be equipped at the factory with the following system options:

Option A - 16 Bit unbuffered BCD input for up to 10,000 crosspoints
Option B - IEEE-488 Listen Only for up to 1,000 crosspoints
Option C - IEEE-488 Listen Only for up to 10,000 crosspoints
Option D - Manual Control for up to 1,000 crosspoints
Option E - Manual Control for up to 10,000 crosspoints
Option F - Power supply for latching 400 simultaneous crosspoints (NOT available with Option K)
Option G - Buffered 16 bit BCD Input for up to 10,000 crosspoints
Option H - Additional power supply for high voltage isolation
Option J1- IEEE-488 Talk/Listen, RS232-C Full Duplex-w/0.5K user RAM expandable in 2K increments up to 8K user RAM
J2- IEEE-488 Talk/Listen (user RAM - see J1)
J3- RS232-C Full Duplex (user RAM - see J1)
Option K - Front loading Control/Expansion Chassis

The Model 56E matrix system can be supplied with the following reed module configurations. These are listed in Table A.

TABLE A

SWITCH MODULE CONFIGURATIONS

REED MODULE MODEL NO.		DESCRIPTION		USER JX MATING CONNECTOR
230038-11	2x10x1	Standard	Single Wire	12 Pin
-12	"	Mercury 1 amp	"	"
-13	"	Mercury 2 amp	"	"
-14	"	Mercury 3 amp	"	"
230038-21	2x10x2	Standard	Two Wire	12 Pin
-22	"	Low Thermal	"	"
-23	"	Mercury 1 amp	"	"
-24	"	Mercury 2 amp	"	"
-25	"	Mercury 3 amp	"	"
230040-01	20(1x1)	Standard	Single Wire	44 Pin
-02	"	Mercury 1 amp	"	"
-03	"	Mercury 2 amp	"	"
-04	"	Power Relay	"	"
230041-11	10X2x1	Standard	Single Wire	44 Pin
-12	"	Mercury 1 amp	"	"
-13	"	Mercury 2 amp	"	"
-14	"	Mercury 3 amp	"	"
230041-21	10x2x2	Standard	Two Wire	44 Pin
-22	"	Low Thermal	"	"
-23	"	Mercury 1 amp	"	"
-24	"	Mercury 2 amp	"	"
-25	"	Mercury 3 amp	"	"
230042-11	2(10x1x1)	Standard	Single Wire	44 Pin
-12	"	Mercury 1 amp	"	"
-13	"	Mercury 2 amp	"	"
-14	"	Mercury 3 amp	"	"
230042-21	2(10x1x2)	Standard	Two Wire	44 Pin
-22	"	Low Thermal	"	"
-23	"	Mercury 1 amp	"	"
-24	"	Mercury 2 amp	"	"
-25	"	Mercury 3 amp	"	"
230043-01	20(1x1)	Standard Form C	Single Wire	44 Pin
-02	"	Mercury 1 amp Form C	"	"
-03	"	Power Relay Form C	"	"
029765	I/O Extender-	1 Required w/each 230043		"

TABLE A (continued)

REED MODULE MODEL NO.	DESCRIPTION	USER JX MATING CONNECTOR
230043-011	20(1x1) Standard Form A Single Wire	44 Pin
-021	" Mercury 1 Amp, Form A Single Wire	"
029765	I/O Extender - 1 Req w/each 230043	44 Pin
230044-01	10(1x1) High Power Relay, 20 Amp Form C Single Wire	22 Pin Terminal Block
030766	I/O Extender - 1 Req w/each 230044	22 Pin Terminal Block
230052-01	1x6x1 VHF Module, Common Shield, Unterminated	BNC
-02	" " 50 Ohm terminated	"
-03	" " 75 Ohm terminated	"
230068-11	10(2x1x1) Standard Single Wire	44 Pin
-12	" Mercury 1 Amp "	"
-13	" Mercury 2 Amp "	"
230068-21	10(2x1x2) Standard Two Wire	44 Pin
-22	" Low Thermal "	"
-23	" Mercury 1 Amp "	"
-24	" Mercury 2 Amp "	"
230069-01	1x6x2 VHF Module, Switched Shield, Unterminated	BNC
-02	" " 50 Ohm terminated	"
-03	" " 75 Ohm terminated	"
230071	1x10x2 High Isolation/Low Leakage	Triaxial & Poststrip
030776	Triaxial I/O	Triaxial & Poststrip
030777	Flexible Circuit Module Interconnect	
230076-01	10(1x1) Heavy Duty Contactor, 60 Amp	Terminal Block
030773	Programmable, User-Defined Module	44 Pin

1.2 56E Accessories

TABLE B

56E ACCESSORIES

Accessory Model No.	Description
030771	LED Programming Aide/Diagnostic Module
212908	44 Pin Connector/Cable Restrainer
212916	44 Pin Connector/Hood and Cable Restrainer
4540003	44 Pin Connector, w/solder eyelet
4540014	12 Pin Connector, w/solder eyelet
130360-2	Test Card Extender, Sw. Module (56M-56F)
030209	Test Card Extender, Control Card (44M-44F)
130340	Large System Rack/Address Buffer
4540007	IEEE 488 Cable Assembly (1 meter)
4540008	IEEE 488 Cable Assembly (2 meter)
4540038	IEEE 488 Cable Assembly (4 meter)
4512039	Card Extractor
CABINETS	19" NEMA Rack Mount
4512041	Single 5.25" Panel Height (7"Hx20.25"Wx21"D)
4512049	Dual 10.5" Panel Height (12.25"Hx20.25"Wx21"D)
4512050	4 Level 21" Panel Height (22.75"Hx20.25"Wx21"D)

Section 2

SPECIFICATIONS

2.0 56 E Specifications

2.0.1 Standard Control Chassis

Dimensions	5 1/4"Hx19"Wx17 5/8"D (19 5/8"D w/Option F)
Mechanical	NEMA 19" rack mount (See Figure 1)
Weight(approx.)	15 lbs. - Without reed modules
Power	115V/230VAC + or - 10% 47-63 Hz, 50 Watts (Derate current output 10% for 50 Hz operation)
Control Logic	LSTTL, CMOS, TTL
Configuration	200 crosspoint maximum

2.0.2 Expansion Chassis

Dimensions	5 1/4"Hx19"Wx15"D
Mechanical	NEMA 19" rack mount (See Figure 2)
Weight	22.5 lbs. fully loaded
Power	120 Watts all channels latched
Configuration	400 crosspoints maximum

2.0.3 Extended Control Chassis

Dimensions	5 1/4"Hx19"Wx17 5/8"D (19 5/8"D w/Option F)
Mechanical	NEMA 19" rack mount (See Figure 1)
Weight	15 lbs. - Without reed modules
Power	115/230VAC + or - 10%, 47-63 Hz, 50W (Derate current output 10% for 50 Hz operation)
Control Logic	LSTTL, CMOS, TTL
Configuration	360 Crosspoints Maximum

2.0.4 Standard/Extended Control Chassis (Front Loading)

Dimensions	5 1/4"Hx19"Wx21"D
Mechanical	NEMA 19" rack mount (See Figure 3)
Weight(approx.)	15 lbs. - Without reed modules
Power	115V/230VAC + or - 10% 47-63 Hz, 50 Watts (Derate current output 10% for 50 Hz operation)
Control Logic	LSTTL, CMOS, TTL
Configuration	200 crosspoint maximum Std., 360 Extended

2.0.5 Expansion Chassis (Front Loading)

Dimensions	5 1/4"Hx19"Wx17"D
Mechanical	NEMA 19" rack mount (See Figure 4)
Weight	22.5 lbs. fully loaded
Power	120 Watts all channels latched
Configuration	400 crosspoints maximum

2.0.6 Matrix Unit Characteristics

Insertion Loss	< .2db per termination at 1MHz, 50 OHM, 1 volt source
Crosstalk, Std. reeds	> 60db at 1Mhz, 50 OHM, 1 volt source
Crosstalk, Mercury reeds	> 40 db at 1MHz, 50 OHM, 1 volt source
H.V. Leakage Limits (channel to channel)	Not > .01 microamps at 500 volts DC and 80% humidity without condensation
Latchpoint Select	< 5 microseconds
Switching Time	Typically 2.0 milliseconds for full contact force

Note: For further system characteristics on signaling, consult A. D. Data Systems.

2.0.7 Switching Relay Characteristics

A = Form A S = Standard Dry M = Mercury
C = Form C T = Low Thermal Z = Power Relay (Encapsulated)
P = High Power Relay PC= High Power Contactor

TABLE C SWITCHING RELAY MODULE APPLICATIONS

SWITCH PART NO.	TYPE	MODULE USED ON	CONTACT RATING WATTS DC	SW VOLTS DC	SW AMPS DC	INITIAL CONTACT RES. Ω	BREAK DOWN VOLTS	OPERATE TIME MS	
4560010	AS	230038-11,21 230040-01 230041-11,21 230042-11,21 230043-011 230068-11,21	10	200	0.50	.060	400 DC	1.4	(4)
4560001	AM1	230038-12,23 230040-02 230041-12,23 230042-12,23 230043-021 230068-12,23	50	1000	1.0 (1)	.050	1500 RMS	1.8	(4)
4560011	AM4	230038-13,24 230040-03 230041-13,24 230042-13,24 230068-13,24	50	500	2.0 (2)	.050	1000 DC	1.5	(4)
4560008	AM3	230038-14,25 230041-14,25 230042-14,25	60	500	3.0 (3)	.060	1000 RMS	2.2	(4)
4560003	CS	230043-01 (5)	3	28	0.250	.150	250 DC	1.5	(4)
4560007	CM	230043-02 (5)	50	1000	1.0 (1)	.050	1500 RMS	1.8	(4)
4560002	AT	230038-22 230041-22 230042-22 230068-22	0.3	28	.010	.100	250 DC	1.0	(4)
4560012	CP	230044-01 (5)	1500	12 VDC 26 VDC 115 VDC	20.0 16.0 16.0	.020	750 RMS	20	(4)
4560005	AZ CZ	230040-04 230043-03 (5)	125	26 VDC 115 VDC 220 VAC	5.0 3.0 2.0	.050	1000 RMS	5.0	(4)

TABLE C (continued)

SWITCH PART NO.	TYPE	MODULE USED ON	CONTACT RATING WATTS DC	SW VOLTS DC	SW AMPS DC	INITIAL CONTACT RES. Ω	BREAK DOWN VOLTS	OPERATE TIME MS
4560014	CS	230052-1,2,3	3	200 VDC	.25	.150	225 DC	2.0 (4)
4560017	CS	230069-1,2,3	3	200 VDC	.26	.200	200 DC	2.0 (4)
4560045	PC	230076-01	1650	28 VDC	60	.050	500 RMS	25 (4)

Note 1 Derate to .002 amps at 1000 VDC

Note 2 Derate to .010 amps at 500 VDC

Note 3 Derate to .050 amps at 500 VDC

Note 4 Not a system specification

Note 5 Individual I/O only

Operating Life: All reed relays, greater than 10^7 operations.

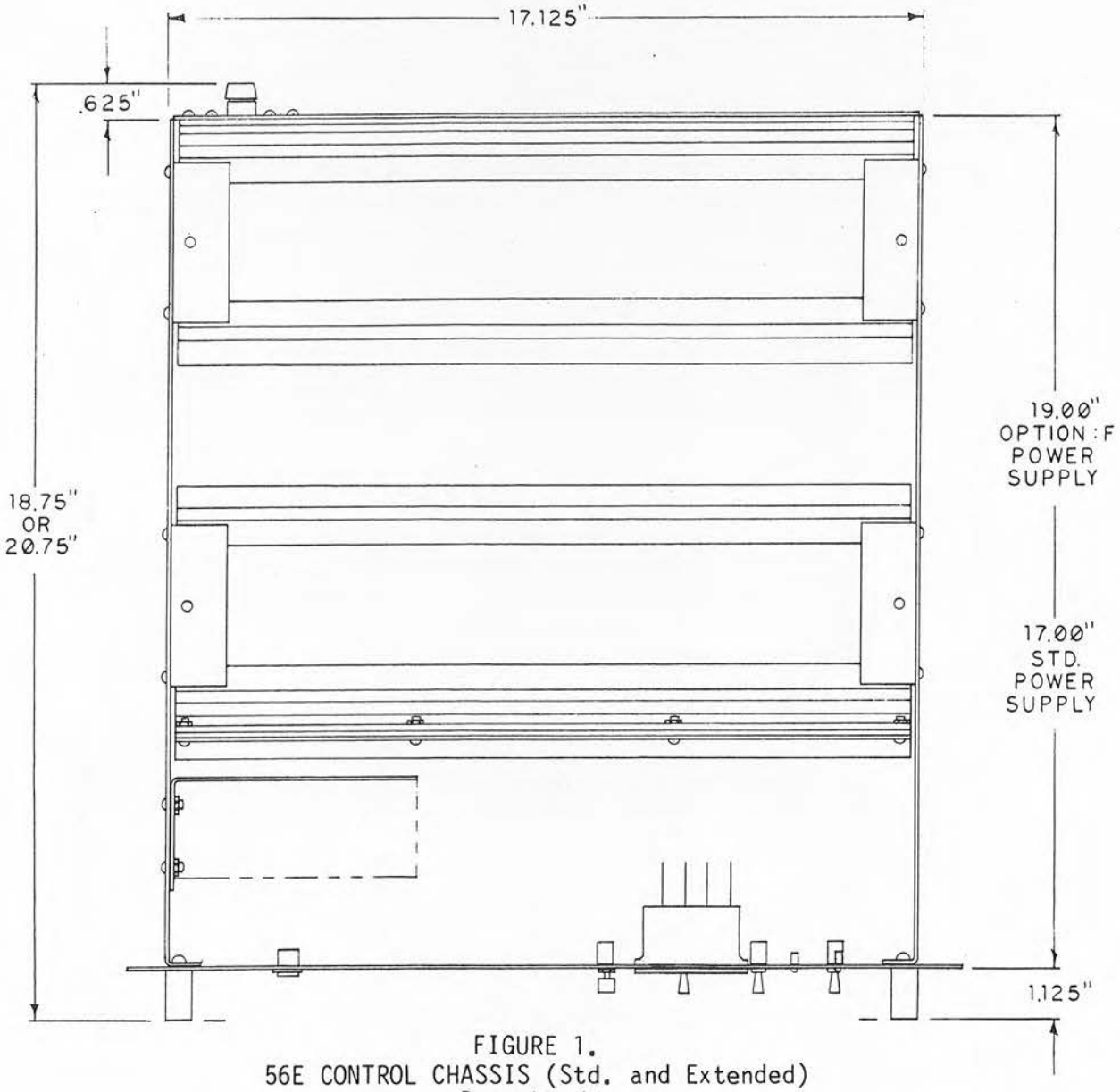
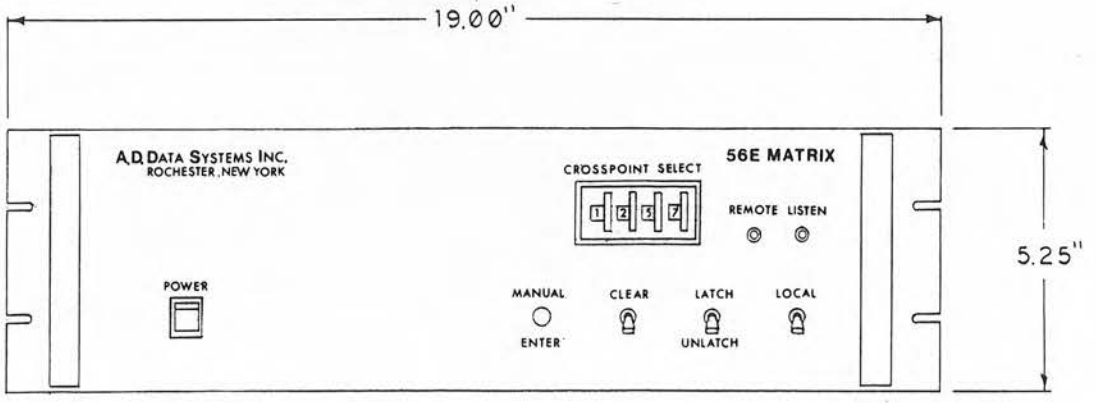


FIGURE 1.
56E CONTROL CHASSIS (Std. and Extended)
Rear Loading



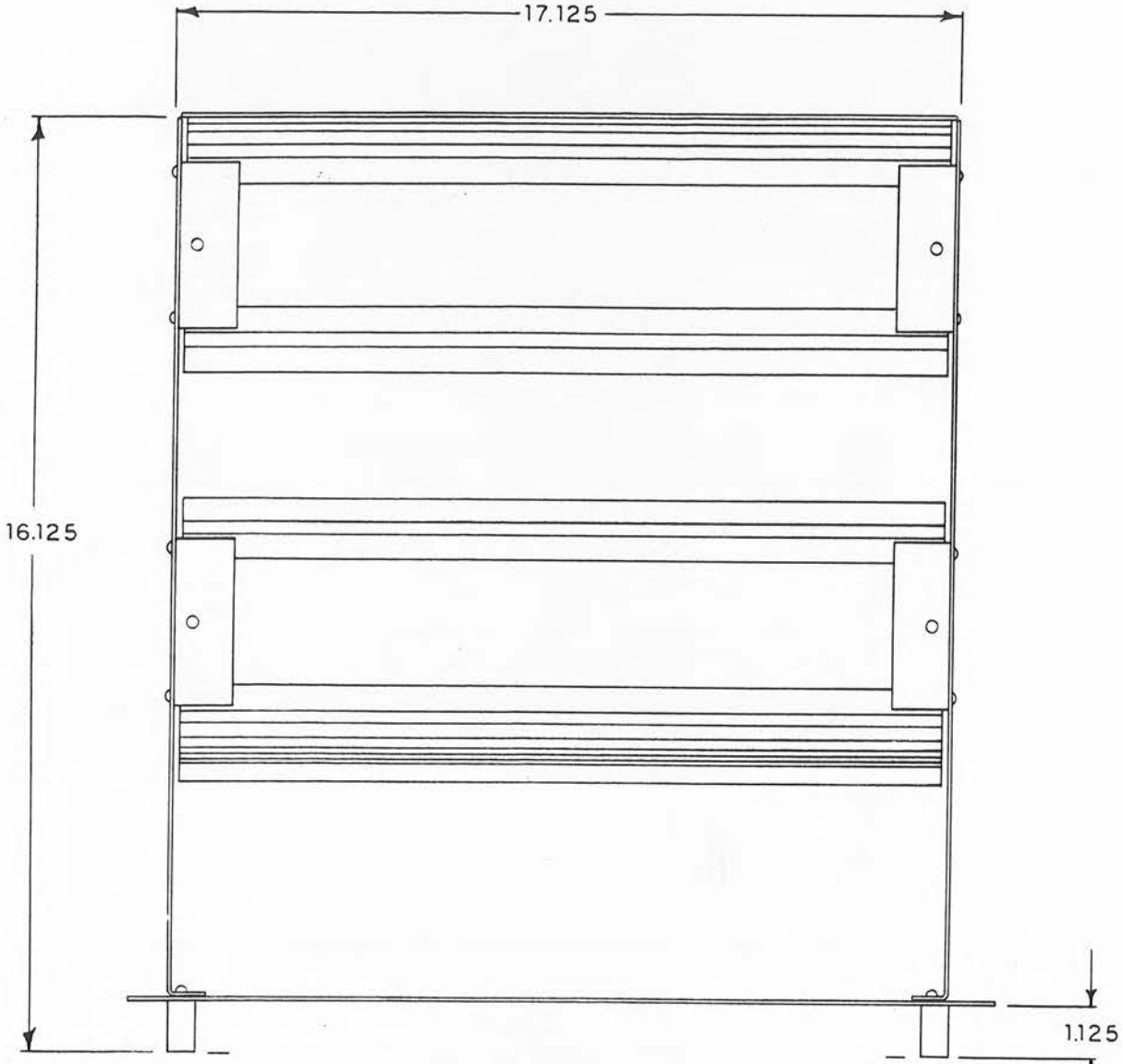
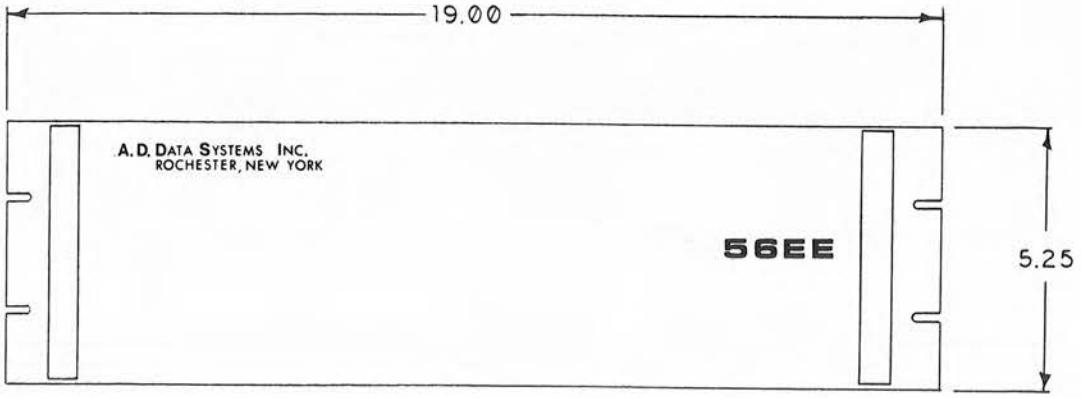


FIGURE 2.
56E EXPANSION CHASSIS
Rear Loading



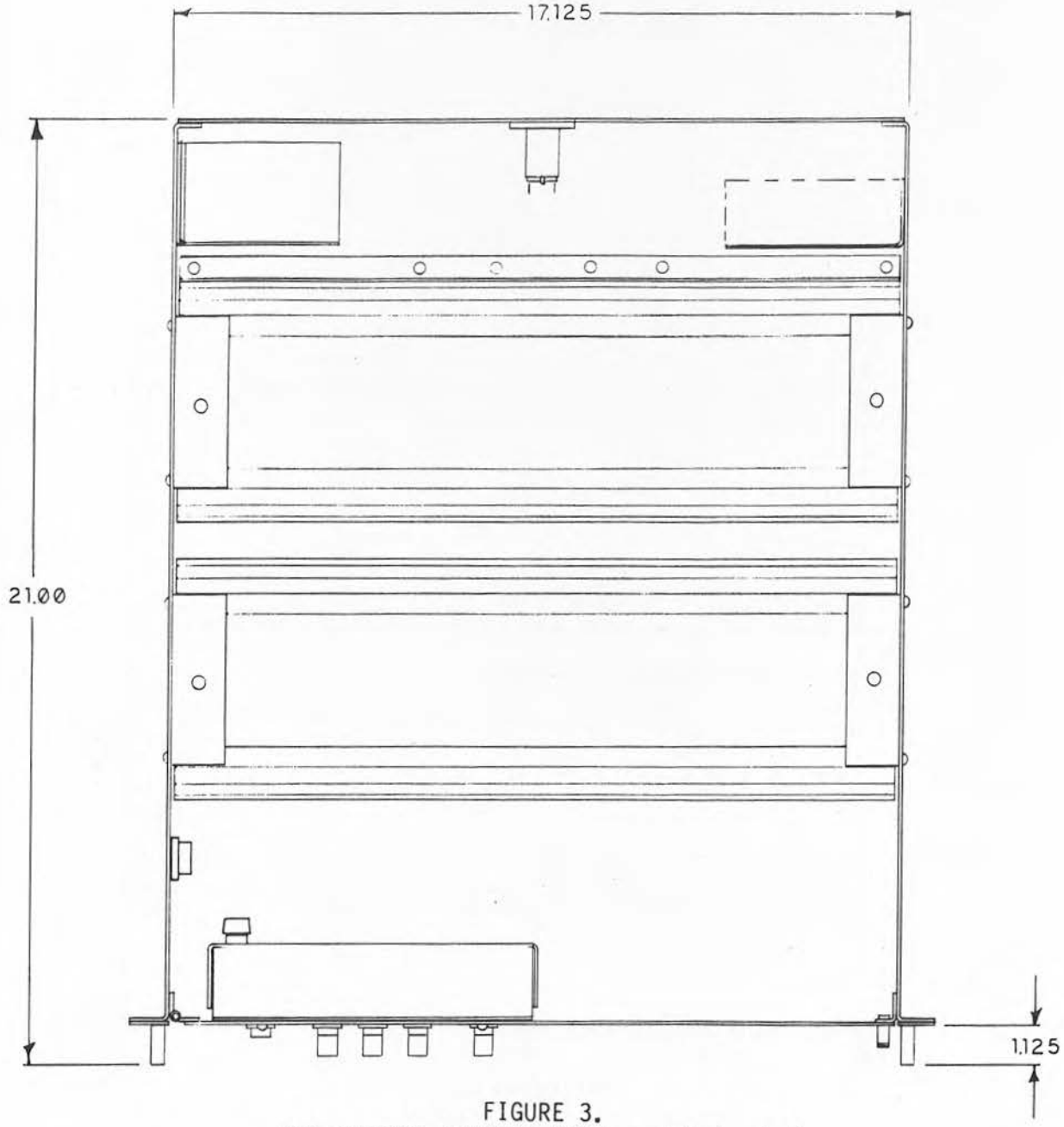
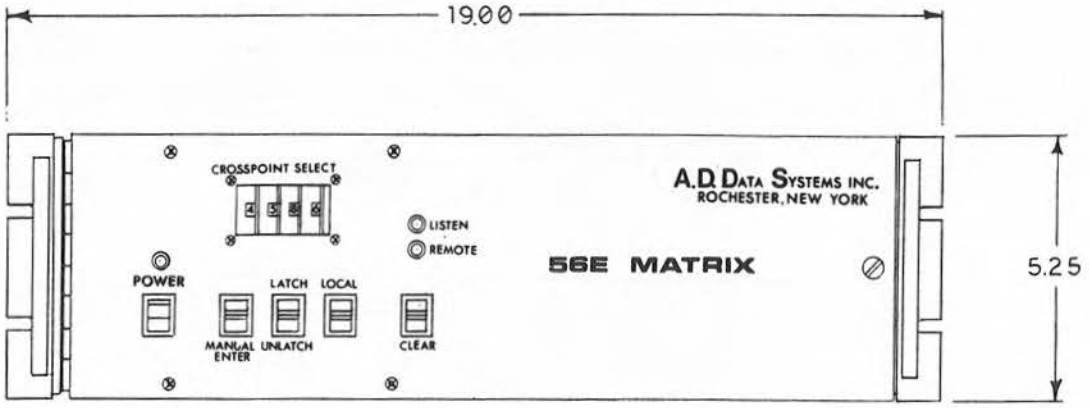


FIGURE 3.
56E CONTROL CHASSIS (Std. and Extended)
Front Loading



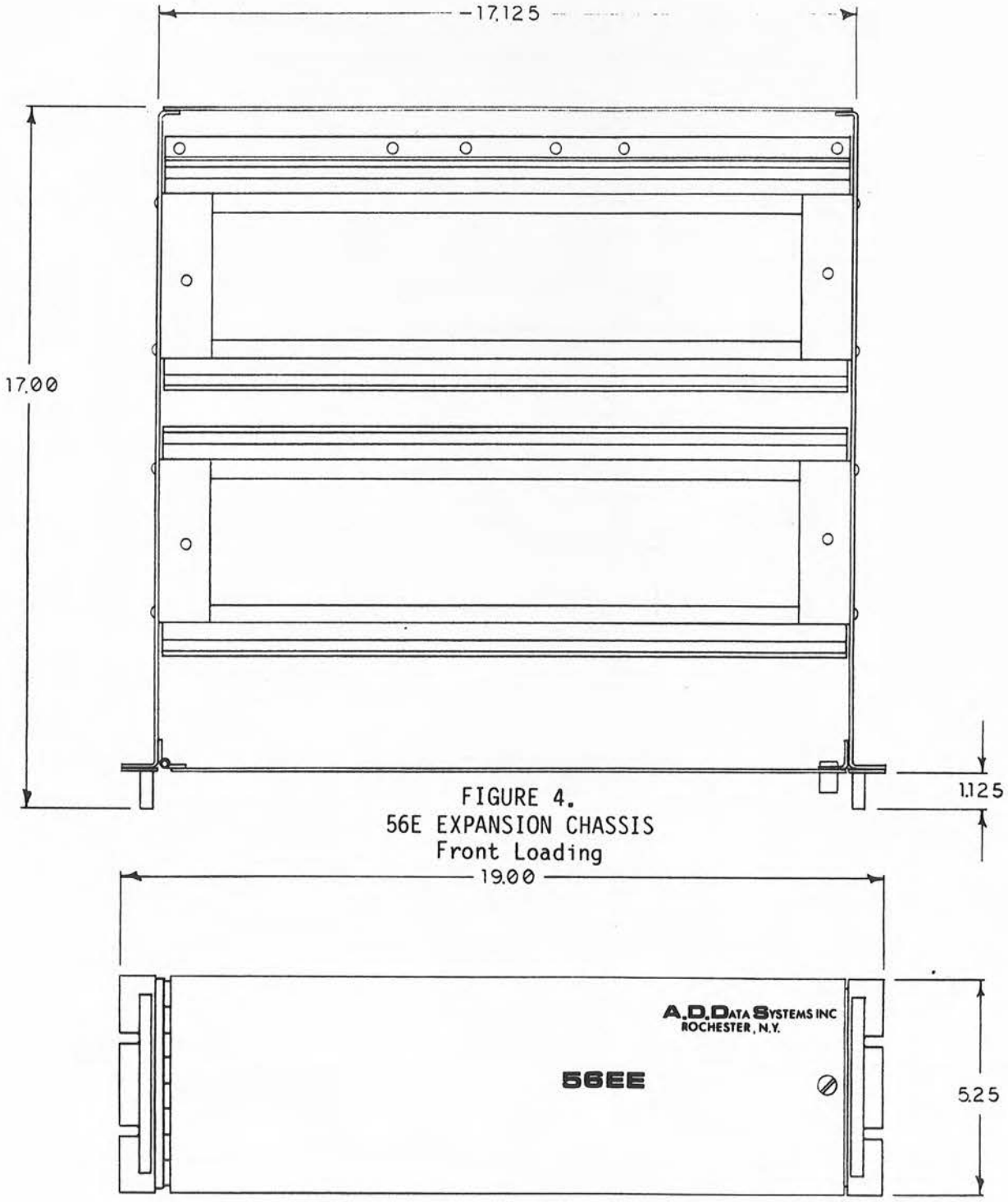


FIGURE 4.
56E EXPANSION CHASSIS
Front Loading

NOTES

SECTION 3
OPERATING INSTRUCTIONS

3.0 Introduction

This section contains information regarding the installation and operation of the Model 56E switching matrix. The contents of this section should be read and understood, before operating the matrix. Should any difficulties be encountered during operation, contact your nearest A. D. Data Systems Sales Representative or A. D. Data Systems, Inc., 200 Commerce Drive, Rochester, New York 14623, Telephone: (716) 334-9649.

3.1 Shipping Information

The Model 56E was packaged and shipped according to the system size and configuration. After unpacking the unit, a thorough inspection should be made to note any damage that may have occurred in transit.

If damage to the unit has occurred, save the original shipping container and contact the carrier for claim purposes.

3.2 Input Power

**********WARNING**********

DANGEROUS VOLTAGES ARE PRESENT AT THE LINE POWER INPUT CONNECTOR WHEN THE 56E IS CONNECTED TO LINE POWER.

The Model 56E may be equipped from the factory for input line power of 115 or 230 volts at the desired line frequency. The input power cord is a three-prong polarized connector which permits connection to 115 or 230 volts. Insure that the ground pin on the power cord is connected to a good earth ground.

3.3 Rack Installation

The Model 56E is designed for mounting in a standard NEMA 19 inch equipment rack. The CONTROL CHASSIS and EXPANSION CHASSIS are each 5 1/4 inch panel height.

IMPORTANT

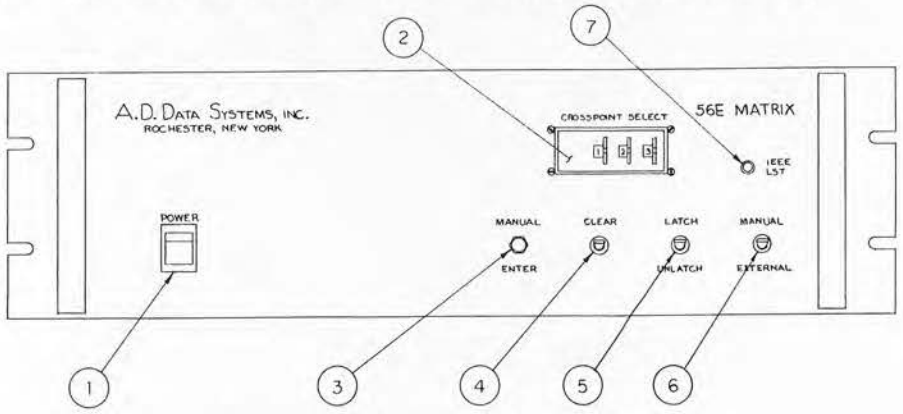
WETTED MERCURY REED MODULES

IF YOUR 56E MATRIX IS EQUIPPED WITH MERCURY WETTED REED MODULES, IT IS NECESSARY TO RE-POOL THE MERCURY WHICH BECOMES DISORIENTED DURING SHIPMENT. PRIOR TO RACK MOUNTING, REMOVE EACH MERCURY MODULE AND GENTLY TAP ITS LOWER CARD EDGE A FEW TIMES ON A FLAT SURFACE AND RE-INSERT INTO THE CARD CAGE.

3.4 Controls and Indicators

The function and location of the Model 56E controls and indicators are provided in the FIGURES that follow.

3.4.1 Standard and Extended Control Chassis (option B or C)



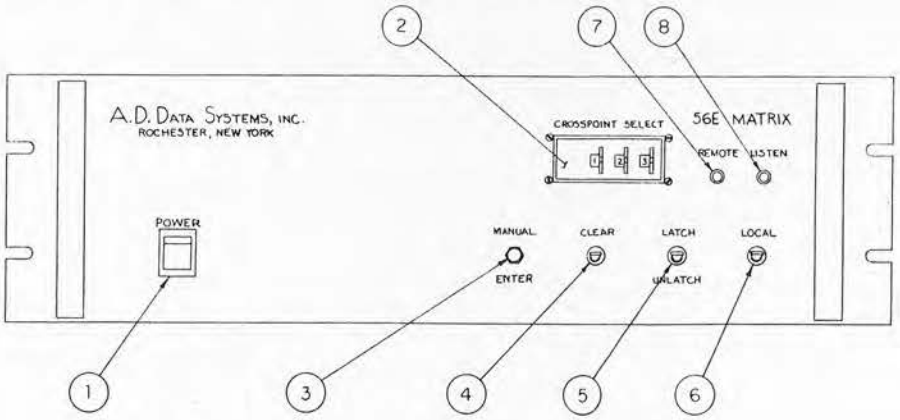
* Manual Control Option D Shown

Fig. 5

Item No.	Name	Description
1	POWER (rocker)	Turns system On or Off
2	* CROSSPOINT SELECT (thumbwheel)	Allows selection of any system relay for latch or unlatch when in the manual mode of operation.
3	* MANUAL ENTER (momentary pushbutton)	Enters the selected crosspoint for latch or unlatch when in the manual mode of operation.
4	* CLEAR (momentary toggle)	Unlatches simultaneously all of previously entered latched crosspoints when in the manual mode of operation.
5	* LATCH-UNLATCH (toggle)	Provides latch or unlatch function of the individually selected crosspoint when in the manual mode of operation.
6	* MANUAL-EXTERNAL (toggle)	Activates front panel controls in the manual position, remote access program entry in the external position.
7	IEEE LST (LED)	Illuminates when unit is in the IEEE "LISTEN" mode (does not function with other Remote Access Options)

FIGURE 5. Standard and Extended Control Chassis (front panel)

3.4.2 Standard and Extended Control Chassis (Option J)

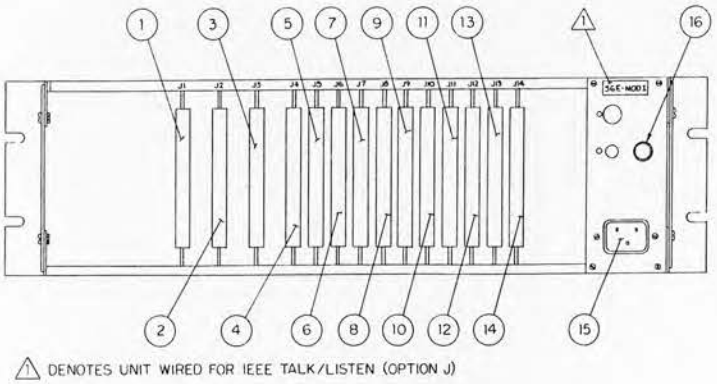


* Manual Control Option D Shown

Fig. 6 Item No.	Name	Description
1	POWER (rocker)	Turns System On or Off.
2	* CROSSPOINT SELECT (thumbwheel)	Allows selection of any system relay for latch or unlatch when in the manual mode of operation.
3	* MANUAL ENTER (momentary pushbutton)	Enters the selected crosspoint for latch or unlatch when in the manual mode of operation.
4	* CLEAR (momentary toggle)	Unlatches simultaneously all of previously entered, latched crosspoints when in the manual mode of operation.
5	* LATCH/UNLATCH (toggle)	Provides latch or unlatch function of the individual selected crosspoint when in the manual mode of operation.
6	* LOCAL (momentary toggle)	Enables local front panel control. Remote access has priority over return to local control.
7	REMOTE (LED)	Illuminates when the unit is in the REMOTE mode of operation. LED off indicates Local mode.
8	LISTEN (LED)	Illuminates when unit is in the IEEE LISTEN mode. (Does not function with other Remote access options)

Figure 6. Standard and Extended Control Chassis w/Option J (Front Panel)

3.4.3 Standard Control Chassis (Module Locations)



⚠ DENOTES UNIT WIRED FOR IEEE TALK/LISTEN (OPTION J)

Fig. 7

Item No.	Name	Description
1	J1 (44 Pin)	Card cage location for control card Model 130343 matrix control with BCD, IEEE Listen Only & manual input. (Model 130373 for IEEE T/L, RS232-C)
2	J2 (44 Pin)	Card cage location for control card Model 130355 IEEE-488 Listen Only or Model 130344 parallel input buffer. (330024 IEEE T/L, RS232-C for Option J)
3	J3 (56 Pin)	Card cage location for control card Model 130339 matrix decoder driver.
4	J4 (44 Pin)	Card cage location for I/O card Model 029209 signal I/O.
5-14	J5-J14 (56 Pin)	Card cage locations for all types of switching modules.
15	POWER (receptacle)	3 prong polarized male receptacle.
16	FUSE	3AG: 1 1/2 amp, 250 volts.

Note: ALL CONTROL CARDS AND SWITCHING MODULES (ITEM NO'S 1-14) ARE TO BE INSERTED INTO THE CARD CAGE, WITH CARD EDGE CONNECTOR J1 INWARD AND WITH ALL COMPONENTS FACING TO THE RIGHT AS SEEN FROM REAR OF THE CHASSIS.

FIGURE 7. Standard Control Chassis (Module Locations)

3.4.4 Extended Control Chassis (Module Locations)

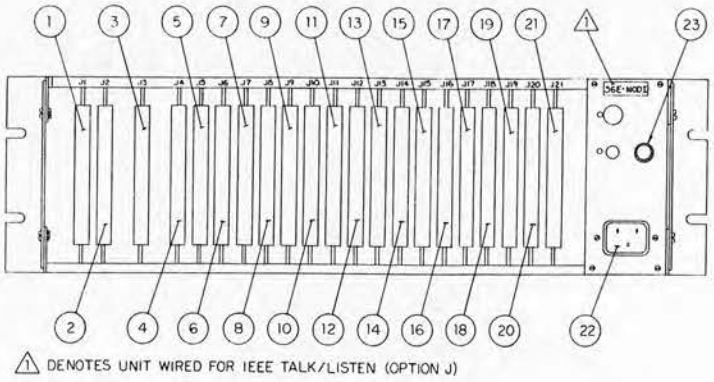


Fig. 8 Item No.	Name	Description
1	J1 (44 Pin)	Card cage location for control card Model 130343 matrix control with BCD, IEEE-488 Listen Only and manual input. (Model 130373 for IEEE T/L, RS232-C)
2	J2 (44 Pin)	Card cage location for control card Model 130355 IEEE-488 Listen Only or Model 130344 parallel input buffer. (Model 330024 IEEE T/L, RS232-C for Option J)
3	J3 (56 Pin)	Card cage location for control card Model 130339 matrix decoder driver.
4 - 21	J4-J21 (56 Pin)	Card cage location for all types of switching modules. User selected card cage location for I/O card Model 029765 signal I/O.
22	Power (Receptacle)	3 prong polarized male receptacle.
23	Fuse	3 AG: 1 1/2 amp, 250 volts

Note: ALL CONTROL CARDS AND SWITCHING MODULES (ITEM NO'S 1-21) ARE TO BE INSERTED INTO THE CARD CAGE, WITH CARD EDGE CONNECTOR J1 INWARD AND WITH ALL COMPONENTS FACING TO THE RIGHT AS SEEN FROM REAR OF THE CHASSIS.

Figure 8. Extended Control Chassis (Module Locations)

3.4.5 Expansion Chassis (Front/Rear Panel, Module Locations)

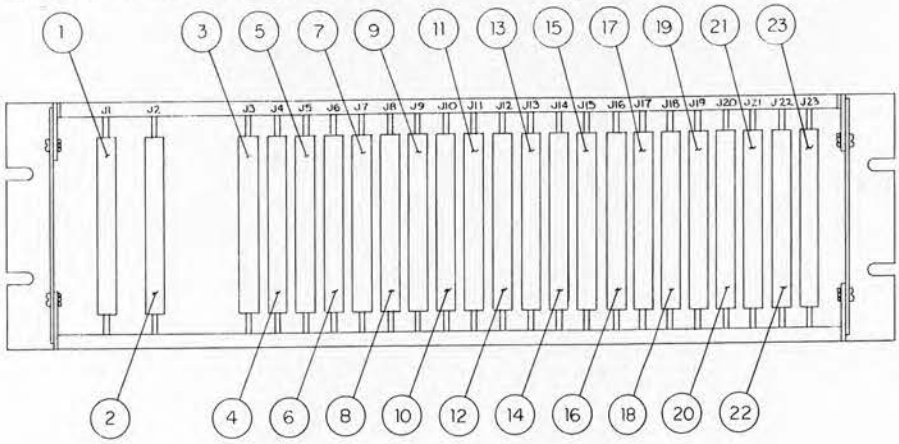


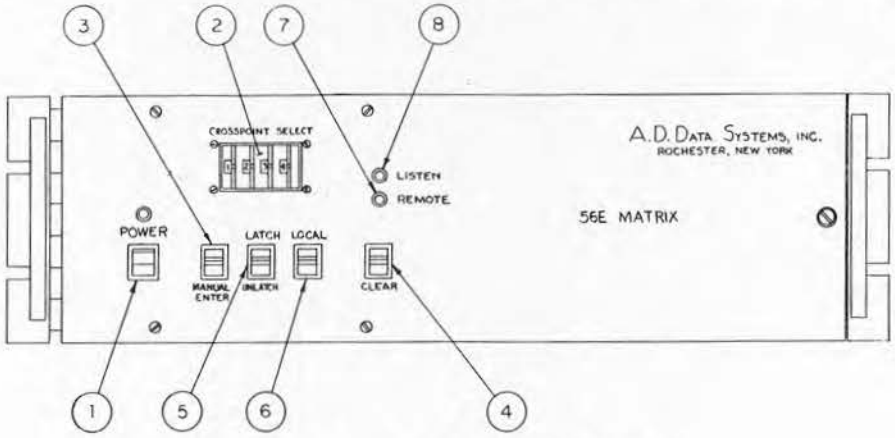
Fig. 9.

Item No.	Name	Description
1	J1 (44 Pin)	Card cage location for address extender card Model 029209
2	J2 (44 Pin)	Card cage location for address extender card Model 029209
3	J3 (44 Pin)	Card cage location for I/O card Model 029209 Signal I/O
4 - 23	J4-J23 (56 Pin)	Card cage location for all types of switching modules
4 - 22	J4-J22 (56 Pin) even	Card cage location for individual I/O Model 029765 or Model 030766. (Special segmented mother board required).
5 - 23	J5-J23 (56 Pin) odd	Card cage location for individual Form C modules Model 230043 or 230044. (Special segmented mother board required).

Note: ALL CONTROL CARDS AND SWITCHING MODULES (ITEM NO'S 1-23) ARE TO BE INSERTED INTO THE CARD CAGE, WITH CARD EDGE CONNECTOR J1 INWARD AND WITH ALL COMPONENTS FACING TO THE RIGHT AS SEEN FROM THE FRONT OR REAR OF THE CHASSIS.

Figure 9. Expansion Chassis (Front/Rear Panel, Module Locations)

3.4.6 Standard and Extended Control Chassis w/Option K (front panel)



* Manual Control Option E Shown

Fig. 10

Item No.	Name	Description
1	POWER (rocker)	Turns System On or Off.
2	* CROSSPOINT SELECT (thumbwheel)	Allows selection of any system relay for latch or unlatch when in the manual
3	* MANUAL ENTER (momentary toggle)	Enters the selected crosspoint for latch or unlatch when in the manual mode of operation.
4	* CLEAR (momentary toggle)	Unlatches simultaneously all of previously entered, latched crosspoints when in the manual mode of operation.
5	* LATCH/UNLATCH (toggle)	Provides latch or unlatch function of the individual selected crosspoint when in the manual mode of operation.
6	* LOCAL (momentary toggle)	Enables local front panel control. Remote access has priority over return to local control.
7	REMOTE (LED)	Illuminates when the unit is in the REMOTE mode of operation. LED off indicates Local mode.
8	LISTEN (LED)	Illuminates when unit is in the IEEE LISTEN mode. (Does not function with other Remote access options)

Figure 10. Standard and Extended Control Chassis with Option K (Front Panel)

3.4.7 Standard Control Chassis (Option K) Module Locations

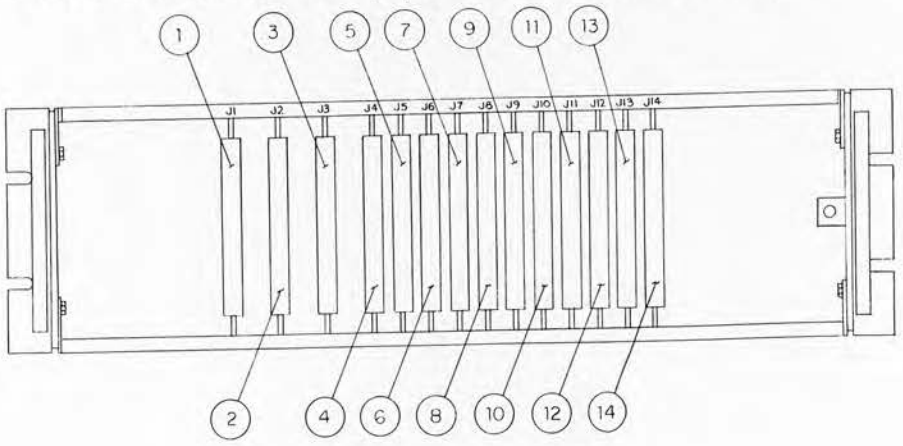


Fig. 11 Item No.	Name	Description
1	J1 (44 Pin)	Card cage location for control card Model 130373 matrix control with BCD, IEEE-488 Listen Only, IEEE-488 T/L, RS232-C and manual input
2	J2 (44 Pin)	Card cage location for control card Model 130355 IEEE-488, Listen Only or Model 130344 parallel input buffer. (Model 330024 IEEE T/L, RS232-C Option J)
3	J3 (56 Pin)	Card cage location for control card Model 130339 matrix decoder driver.
4	J4 (44 Pin)	Card cage location for I/O card Model 029209 signal I/O.
5 - 14	J5-J14 (56 Pin)	Card cage location for all types of switching modules.
	Power (Receptacle)	3 prong polarized male receptacle. (located on rear of control chassis)
	Fuse	3 AG: 1 1/2 amp, 250 volts (located inside of hinged front panel)

Note: ALL CONTROL CARDS AND SWITCHING MODULES (ITEM NO'S 1-14) ARE TO BE INSERTED INTO THE CARD CAGE, WITH CARD EDGE CONNECTOR J1 INWARD AND WITH ALL COMPONENTS FACING TO THE RIGHT AS SEEN FROM FRONT OF THE CHASSIS.

Figure 11. Standard Control Chassis w/Option K (Module Locations)

3.4.8 Extended Control Chassis (Module Locations)

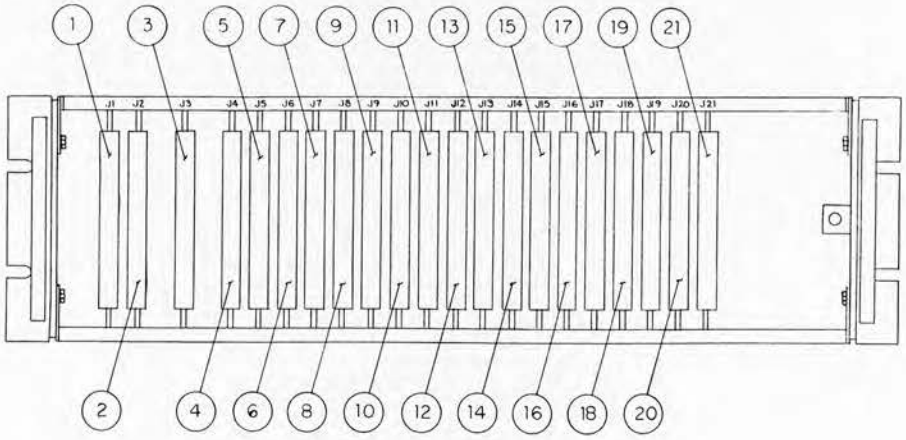


Fig. 12

Item No.	Name	Description
1	J1 (44 Pin)	Card cage location for control card Model 130373 matrix control with BCD, IEEE-488, IEEE-488 T/L, RS232-C and manual input.
2	J2 (44 Pin)	Card cage location for control card Model 130355 IEEE-488 or Model 130344 parallel input buffer. (Model 330024 IEEE T/L, RS232-C Option J)
3	J3 (56 Pin)	Card cage location for control card Model 130339 matrix decoder driver.
4 - 21	J4-J21 (56 Pin)	Card cage location for all types of switching modules. User selected card cage location for I/O card Model 029765 signal I/O.
	Power (Receptacle)	3 prong polarized male receptacle. (located on rear of control chassis)
	Fuse	3 AG: 1 1/2 amp, 250 volts (located inside of hinged front panel)

Note: ALL CONTROL CARDS AND SWITCHING MODULES (ITEM NO'S 1-21) ARE TO BE INSERTED INTO THE CARD CAGE, WITH CARD EDGE CONNECTOR J1 INWARD AND WITH ALL COMPONENTS FACING TO THE RIGHT AS SEEN FROM FRONT OF THE CHASSIS.

Figure 12. Extended Control Chassis w/Option K (Module Locations)

3.5 Signaling and Switching

SIGNALING - Refers to an A.D. DATA SYSTEMS, INC. unit or system equipped with reed modules characterized as matrix modules. Matrix modules are switch configurations where the number of inputs and outputs are not equal, such as (2x10), (10x2) configurations.

SWITCHING - Refers to an A.D. DATA SYSTEMS, INC. unit or system equipped with reed modules characterized as switching modules. Switching modules are switch configurations where the number of inputs is equal to the number of outputs, such as 20(1x1) configuration.

3.5.1 SIGNALING CONFIGURATIONS

A.D. DATA SYSTEMS, INC. accomodates a variety of signaling configurations by providing a printed circuit board backplane in both the CONTROL and optional EXPANSION CHASSIS. The matrix unit backplane features ten (2 wire) parallel buses which pin-out on a 44 pin common I/O bus connector used on 029209 and 029765 I/O printed circuit cards.

TABLE D

MOTHERBOARD SIGNALING - I/O INTERFACE

Motherboard Signal	Signal I/O Interface Connector	Matrix System Unit & Card Cage Slot	Signal I/O Connector 44 Pin
Pair Channel	Pin No. Hi Lo		
0A,0B	B,2 C,3		
1A,1B	D,4 E,5		
2A,2B	F,6 H,7	Control Chassis Std.	Model 212916 or
3A,3B	J,8 K,9	(J4)	Model 212908 or
4A,4B	L,10 M,11	Expansion Chassis (J3)	Model 4540003
5A,5B	N,12 P,13		
6A,6B	R,14 S,15	Control Chassis (Extended)	
7A,7B	T,16 U,17	J4-J21	
8A,8B	V,18 W,19		
9A,9B	X,20 Y,21		

3.6 Matrix Relay Modules

3.6.1 Model 230038

Size Matrix - 2x10x2 2 wire (-21,22,23,24,25)
2x10x1 1 wire (-11,12,13,14)

Reed Options (See TABLES A & C)

Figure 13. Model 230038 Module

Configures a STANDARD CONTROL CHASSIS for a 20 input, 10 output, (20x10x1) or (20x10x2)matrix.

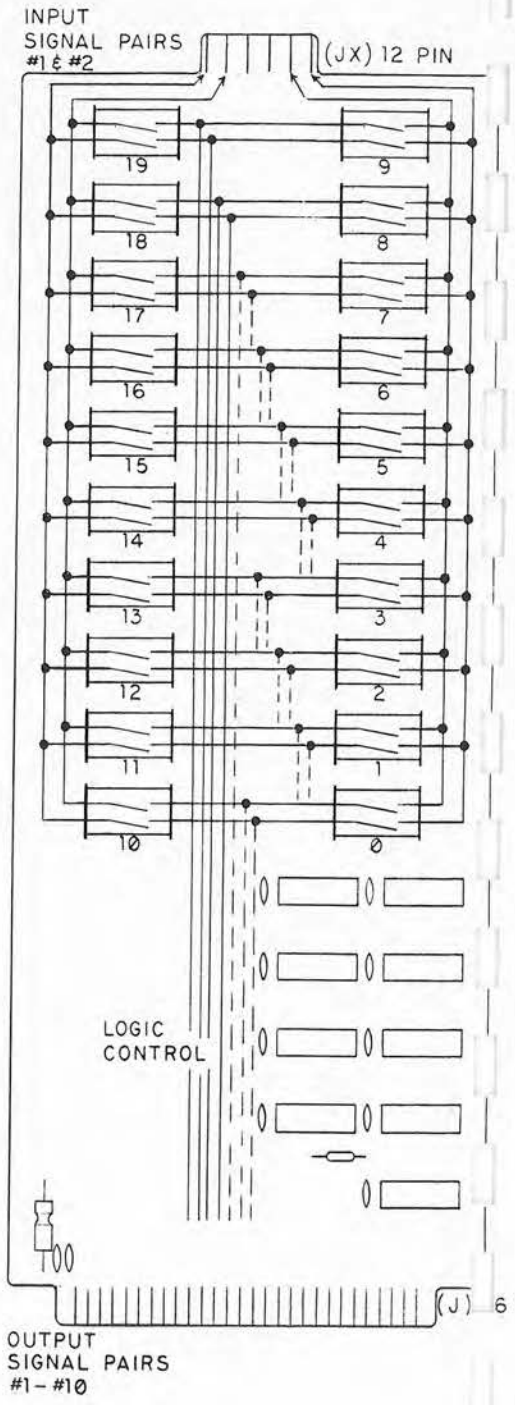
Configures an EXTENDED CONTROL CHASSIS for a 34 input, 10 output, (34x10x1) or (34x10x2) matrix.

Configures an EXPANSION CHASSIS for a 40 input, 10 output, (40x10x1) or (40x10x2)matrix.

TABLE E
MODEL 230038 PIN ASSIGNMENTS

(J) Signal Pin Out		(JX) Signal Pin No.	
Mother Board Channel	Module Cross Point	Hi	Lo
0A, 0B	00		
1A, 1B	01		
2A, 2B	02		
3A, 3B	03		
4A, 4B	04	1,A	2,B
5A, 5B	05		
6A, 6B	06		
7A, 7B	07		
8A, 8B	08		
9A, 9B	09		

(J) Signal Pin Out		(JX) Signal Pin No.	
Mother Board Channel	Module Cross Point	Hi	Lo
0A, 0B	10		
1A, 1B	11		
2A, 2B	12		
3A, 3B	13		
4A, 4B	14	5,E	6,F
5A, 5B	15		
6A, 6B	16		
7A, 7B	17		
8A, 8B	18		
9A, 9B	19		

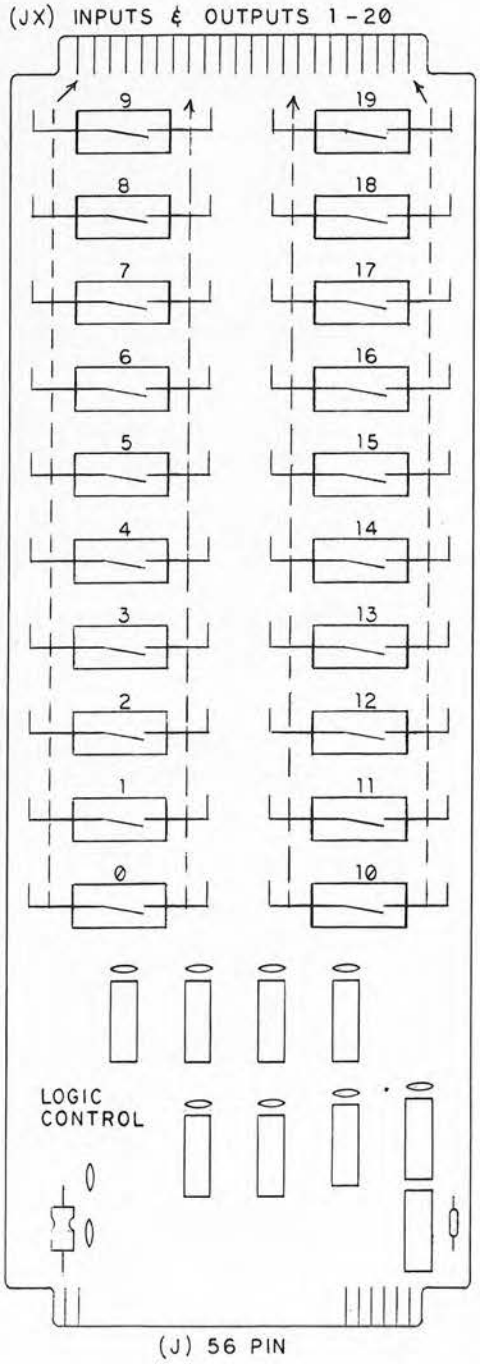


3.6.2 Model 230040

Size Switch - 20(1x1) 1 wire (-01,02,03,04)

Reed Options - (See TABLES A & C)

Figure 14. Model 230040 Module



Configures a STANDARD CONTROL CHASSIS for 200 inputs, 200 outputs of single wire switching.

Configures an EXTENDED CONTROL CHASSIS for 360 inputs, 360 inputs of single wire switching.

Configures a system EXPANSION CHASSIS for 400 inputs, 400 outputs of single wire switching.

TABLE F
MODEL 230040 PIN ASSIGNMENTS

SWITCHES 0-9

Module Switch	(JX) Signal Pin No.	
	Input	Output
0	21	22
1	19	20
2	17	18
3	15	16
4	Y	Z
5	10	9
6	12	11
7	13	14
8	R	S
9	W	X

SWITCHES 10-19

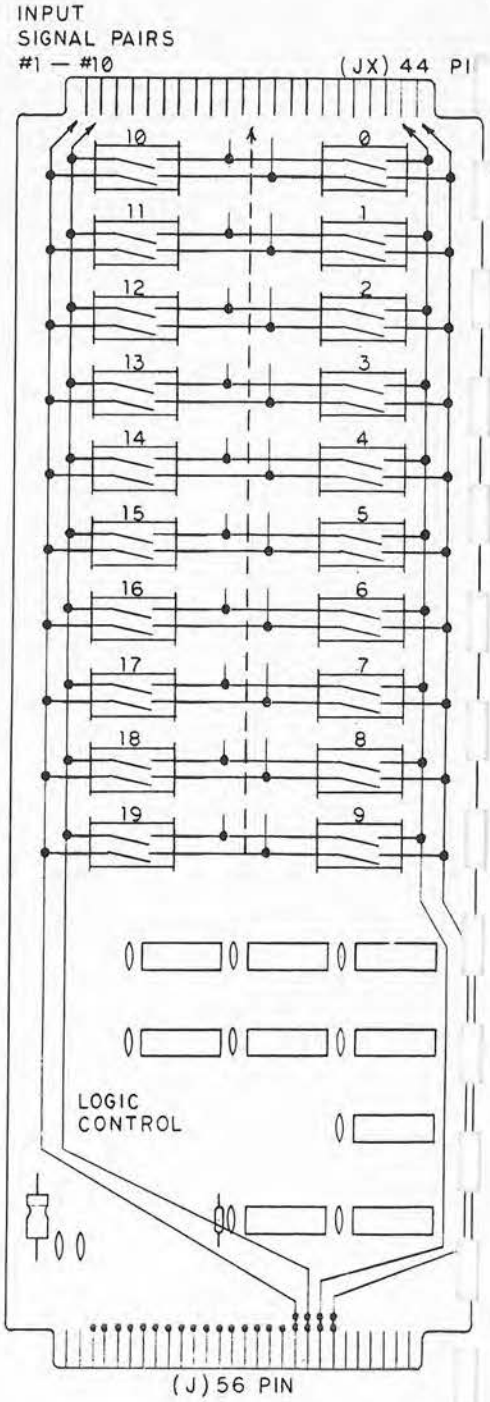
Module Switch	(JX) Signal Pin No.	
	Input	Output
10	1	2
11	N	P
12	L	M
13	J	K
14	7	8
15	5	6
16	3	4
17	E	F
18	C	D
19	A	B

3.6.3 Model 230041

Size Matrix - 10x2x2 2 wire (-21,22,23,24,25)
10x2x1 1 wire (-11,12,13,14)

Reed Options - (See TABLES A & C)

Figure. 15 Model 230041 Module



Option #0 - (J) edge signal routing (none)

Option #1 - (J) edge signal routing to internal mother boad channels 0A,0B and 1A,1B

Option #2 - (J) edge signal routing to internal mother board channels 2A,2B & 3A,3B

Option #3 - (J) edge signal routing to internal mother board channels 4A,4B & 5A,5B

Option #0:

Configures a standard CONTROL CHASSIS for 100 input, 2 output, (100x2x1) or (100x2x2) matrix.

Configures an EXTENDED CONTROL CHASSIS for 180 input, 2 output, (180x2x1) or (180x2x2) matrix.

Configures a system EXPANSION CHASSIS for 200 input, 2 output, (200x2x1) or (200x2x2) matrix.

A variety of matrix sizes may be configured by grouping modules and employing #1/#2/#3 etc.

TABLE G
MODEL 230041 PIN ASSIGNMENTS

Signal Pair 1

(J) Signal Pin Out		(JX) Signal Pin No.		
Mother Board Channel	Module Cross Point	Hi	Lo	Pair #1
	00	2,B	3,C	
	01	4,D	5,E	
	02	6,F	7,H	
	03	8,J	9,K	
0A, 0B	04	10,L	11,M	1,A
	05	12,N	13,P	
	06	14,R	15,S	
	07	16,T	17,U	
	08	18,V	19,W	
	09	20,X	21,Y	

(Continued on Next Page)

Signal Pair 2

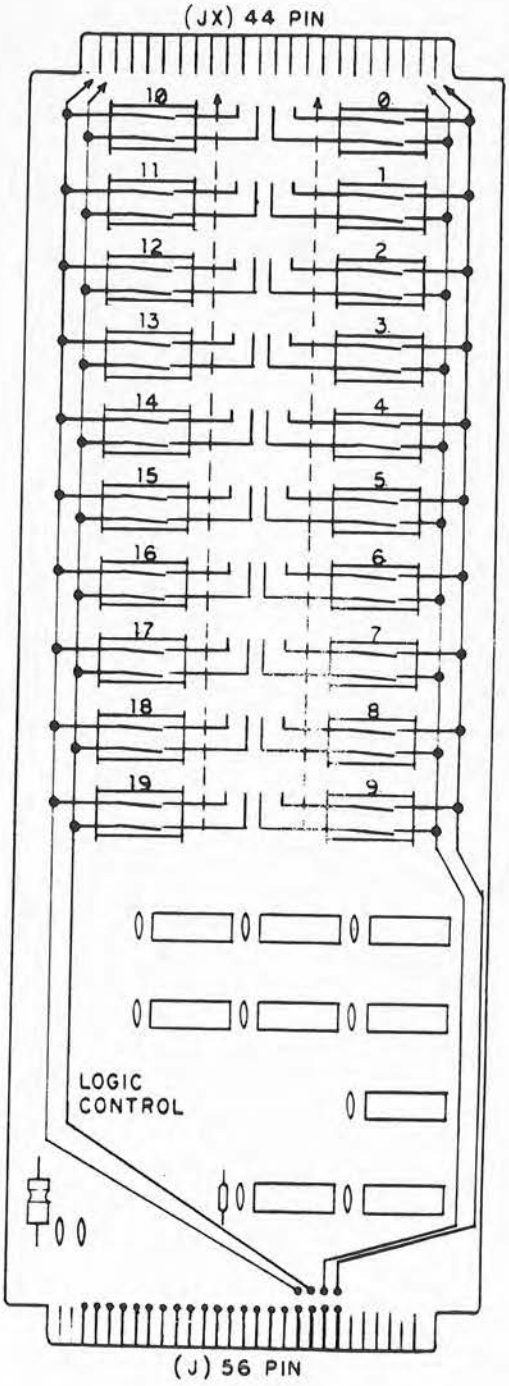
(J) Signal Pin Out		(JX) Signal Pin No.		
Mother Board Channel	Module Cross Point	Hi	Lo	Pair #2
	10	B,2	C,3	
	11	D,4	E,5	
	12	F,6	H,7	
	13	J,8	K,9	
1A, 1B	14	L,10	M,11	22,Z
	15	N,12	P,13	
	16	R,14	S,15	
	17	T,16	U,17	
	18	V,18	W,19	
	19	X,20	Y,21	

3.6.4 Model 230042

Size Matrix - 2(10x1x2) 2 wire (-21,22,23,24,25)
2(10x1x1) 1 wire (-11,12,13,14)

Reed Options - (See TABLES A & C)

Figure 16. Model 230042 Module



Configures a STANDARD CONTROL CHASSIS for a 200 input, 1 output, (200x1x1) or (200x1x2) matrix.

Configures an EXTENDED CONTROL CHASSIS for a 360 input, 1 output, (360x1x1) or (360x1x2) matrix.

Configures a system EXPANSION CHASSIS for a 400 input, 1 output, (400x1x1) or (400x1x2) matrix.

TABLE H
MODEL 230042 PIN ASSIGNMENTS

(10x1) #1

Pair #1	(JX) Signal Pin No. Module Cross Point	Hi	Lo	(J) Signal Pin out (Opt.) Mother Board Channel
	00	2	3	
	01	4	5	
	02	6	7	
	03	8	9	
1,A	04	10	11	0A, 0B
	05	12	13	
	06	14	15	
	07	16	17	
	08	18	19	
	09	20	21	

(Continued on Next Page)

(10x1) #2

Pair #2	(JX) Signal Pin No. Module Cross Point	Hi	Lo	(J) Signal Pin out (Opt.) Mother Board Channel
	10	B	C	
	11	D	E	
	12	F	H	
	13	J	K	
22,Z	14	L	M	1A, 1B
	15	N	P	
	16	R	S	
	17	T	U	
	18	V	W	
	19	X	Y	

NOTE: This module is similar to the 230041 and could be configured as 10x2x1 or 10x2x2, however; twice the interconnect wiring would be required and is only recommended under unique circumstance for this configuration.

3.6.5 Model 230043

Size Switch - 20(1x1) 1 wire (Form C) (-01,02,03)
20(1x1) 1 wire (Form A) (-011,021)

Reed Options - (See TABLES A & C)

*I/O Extender - Model 029765

Configures an individual I/O segmented EXPANSION CHASSIS for 200 inputs, 200 outputs of single wire Form C or Form A switching.

Figure 17. Model 230043 Module

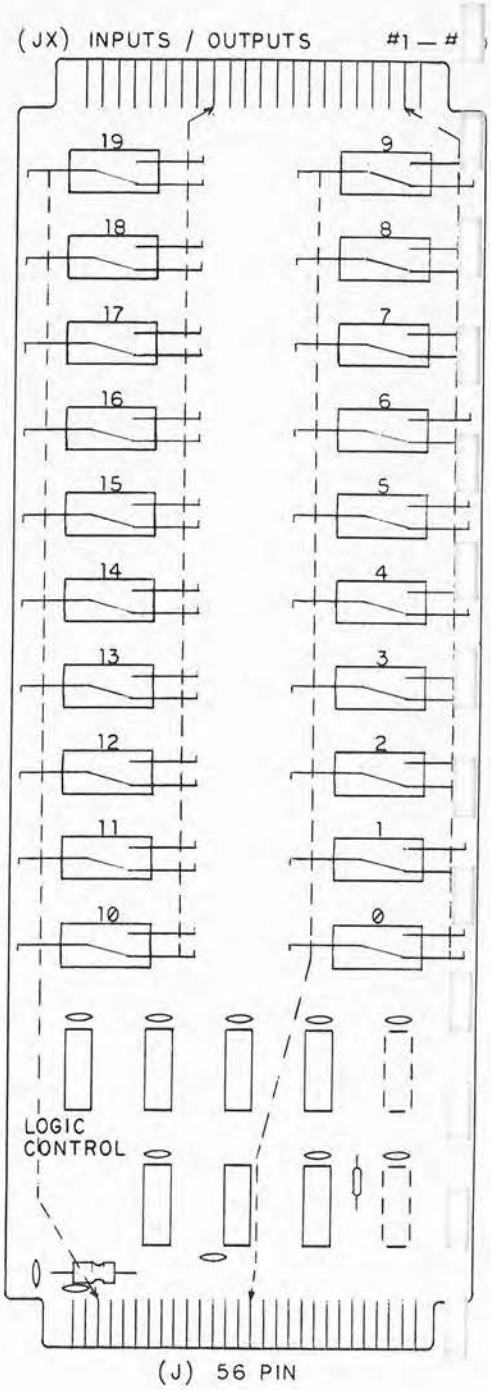


Table I
MODEL 230043 PIN ASSIGNMENTS

Switches 0-9

Module Switch	(J) Pin No.	(JX) Signal Pin No.		Mother Board	(JX) I/O* Extender
	Armature	N.O. Pole	N.C. Pole	Channel I.D.	Pin No.
0	7,H	2	B	0A	2,B
1	8,J	3	C	0B	3,C
2	9,K	4	D	1A	4,D
3	10,L	5	E	1B	5,E
4	11,M	6	F	2A	6,F
5	12,N	7	H	2B	7,H
6	13,P	8	J	3A	8,J
7	14,R	9	K	3B	9,K
8	15,S	10	L	4A	10,L
9	16,T	11	M	4B	11,M

Switches 10-19

Module Switch	(J) Pin No.	(JX) Signal Pin No.		Mother Board	(JX) I/O* Extender
	Armature	N.O. Pole	N.C. Pole	Channel I.D.	Pin No.
10	17,U	12	N	5A	12,N
11	18,V	13	P	5B	13,P
12	19,W	14	R	6A	14,R
13	20,X	15	S	6B	15,S
14	21,Y	16	T	7A	16,T
15	22,Z	17	U	7B	17,U
16	23,a	18	V	8A	18,V
17	24,b	19	W	8B	19,W
18	25,c	20	X	9A	20,X
19	26,d	21	Y	9B	21,Y

NOTE: Form A configurations use Armature & N.O. Pole Pin numbers.

3.6.6 Model 230044

Size Switch - 10(1x1) 1 wire (Form C)

*I/O Extender - Model 030766

Configures a system individual I/O EXPANSION CHASSIS for 50 inputs, 50 outputs of single wire Form C switching. Each 230044 and its I/O Extender (030766) require 4 card slots.

Figure 18. Model 230044 Module

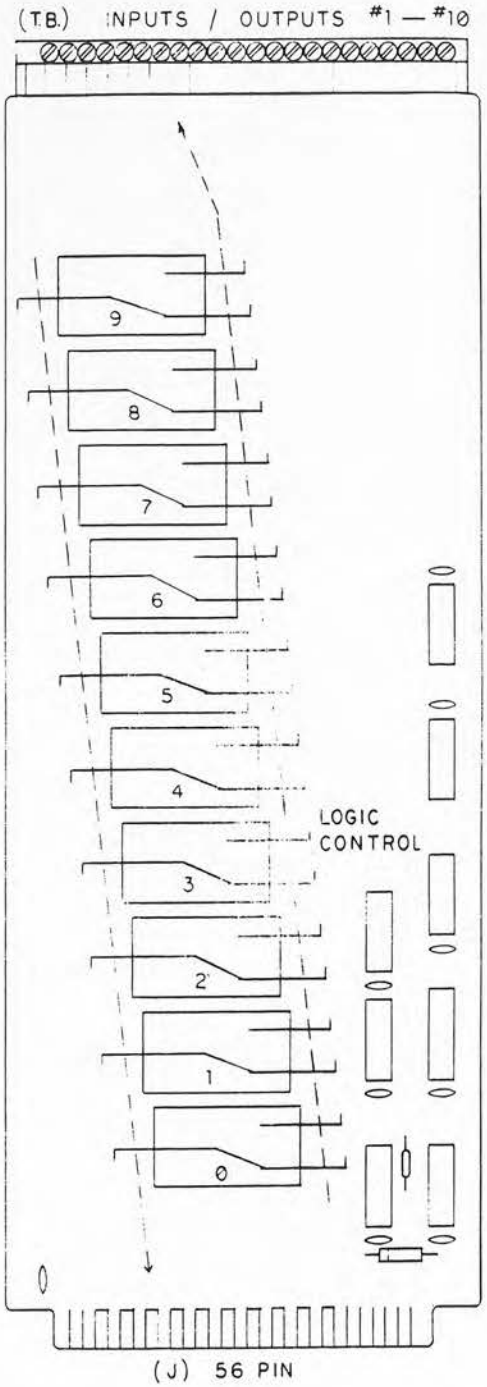


Table J
MODEL 230044 PIN ASSIGNMENTS

Module Switch	(J) Pin No. Armature	(T.B.) Term No. N.O. Pole	N.C. Pole	Signal Mother Board Channel I.D.	(T.B.) I/O* Extender Term No.
	Switches 0-9				
0	7,H&8,J	2	3	0A , 0B	2,3
1	9,K&10,L	4	5	1A , 1B	4,5
2	11,M&12,N	6	7	2A , 2B	6,7
3	13,P&14,R	8	9	3A , 3B	8,9
4	15,S&16,T	10	11	4A , 4B	10,11
5	17,U&18,V	12	13	5A , 5B	12,13
6	19,W&20,X	14	15	6A , 6B	14,15
7	21,Y&22,Z	16	17	7A , 7B	16,17
8	23,a&24,b	18	19	8A , 8B	18,19
9	25,c&26,d	20	21	9A , 9B	20,21

3.6.7 Model 230052 VHF Switch

Size Switch - 1x6x1

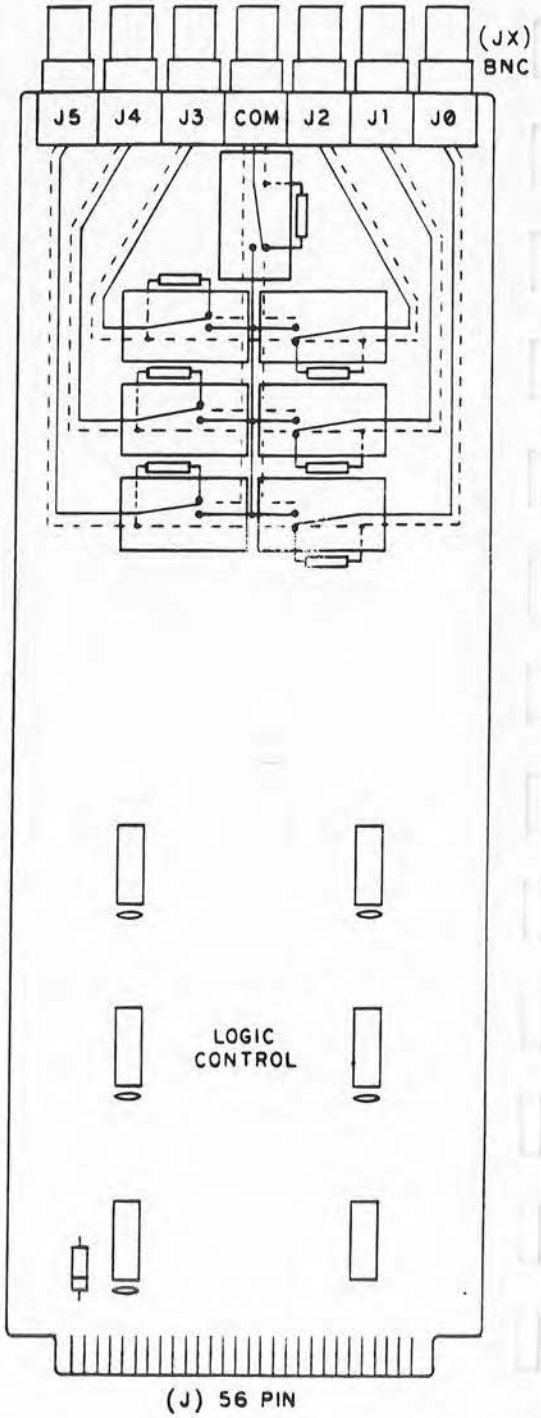
230052-1 - unterminated
230052-2 - 50 Ohm terminated
230052-3 - 75 Ohm terminated

1. Standard Control Chassis houses a maximum of five VHF modules.
2. Switched center conductor.
3. Common shield throughout.
4. RFI shielding.
5. BNC connectorization.

Table K
VHF Module Specifications

Bandwidth (BW)	DC-200 MHz at 3 db point
Rise Time (RT)	≤3.0 Nsec.
Impedance	50 Ohm w/wo open port termination
VSWR	1.1:1 at 100 MHz
Isolation	≥55 db Open to Open Port ≥35 db Open to Closed Port
Insertion Loss	
100 MHz, 50 Ohms	≤0.75 db Input to Output
200 MHz, 50 Ohms	≤3.0 db Input to Output
Switching Time	≤1.5 Msec. for full contact force
Stand off Voltage	
Term. port, 50 Ohm	7 Volts DC (Max)
Unterm. port	300 Volts (Max)
Switch Contact Rating	3 Watts
Addressing	
Common - J0	1st Address in Resident Slot
Common - J1	2nd Address in Resident Slot
Common - J2	3rd Address in Resident Slot
Common - J3	4th Address in Resident Slot
Common - J4	5th Address in Resident Slot
Common - J5	6th Address in Resident Slot

Figure 19. Model 230052 Module



NOTES

3.6.8 Model 230068

Size Switch - 10(2x1x2) 2 wire
10(2x1x1) 1 wire

Reed Options - (See TABLES A & C)

*I/O Extender - Model 029209
- Model 029765

Configures a system Control Chassis for a 10 (20x1x1) or 10 (20x1x2) matrix.

Configures a system Extended Control Chassis for a 10 (34x1x1) or 10 (34x1x2) matrix.

Configures a system Expansion Chassis for a 10 (40x1x1) or 10 (40x1x2) matrix.

Figure 20. Model 230068 Module

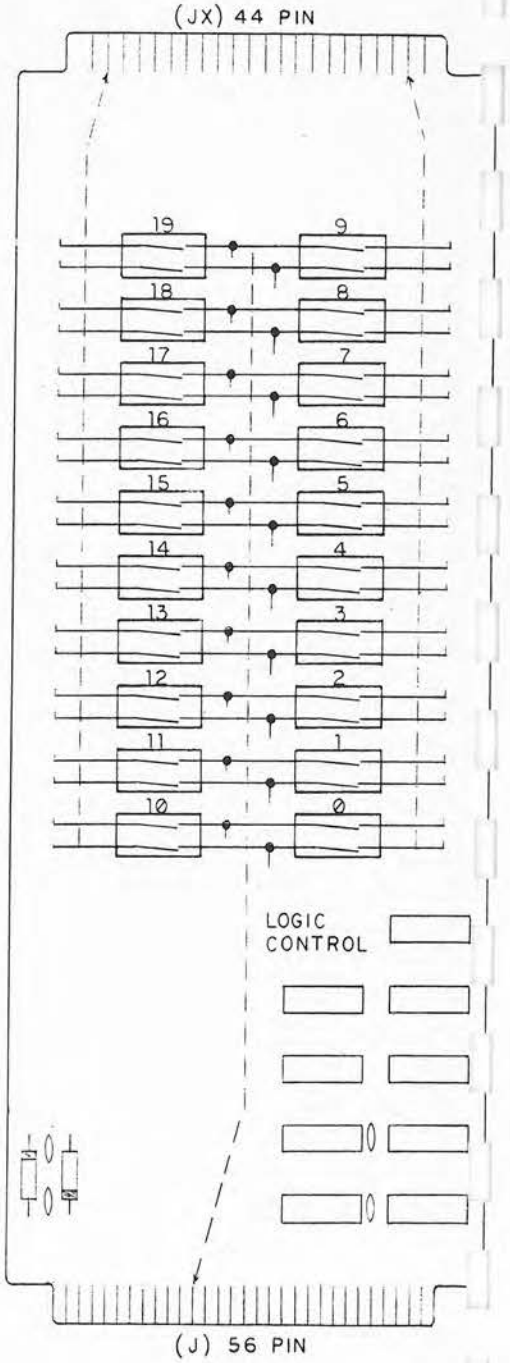


Table L
MODEL 230068 PIN ASSIGNMENTS

Switches 0-9

Module Switch	(J) Pin No. Armature	(JX) Signal Mother Board N.O. Pole	Channel I.D.	(JX) I/O* Extender Pin No.
0	7,H	2	0A	2,B
	8,J	B	0B	3,C
1	9,K	3	1A	4,D
	10,L	C	1B	5,E
2	11,M	4	2A	6,F
	12,N	D	2B	7,H
3	13,P	5	3A	8,J
	14,R	E	3B	9,K
4	15,S	6	4A	10,L
	16,T	F	4B	11,M
5	17,U	7	5A	12,N
	18,V	H	5B	13,P
6	19,W	8	6A	14,R
	20,X	J	6B	15,S

(Continued on Next Page)

Module Switch	(J) Pin No.	(JX) Signal Pin No.	Mother Board	(JX) I/O* Extender
7	21,Y	9	7A	16,T
	22,Z	K	7B	17,U
8	23,a	10	8A	18,V
	24,b	L	8B	19,W
9	25,c	11	9A	20,X
	26,d	M	9B	21,Y

Switches 10-19

Module Switch	(J) Pin No.	(JX) Signal Pin No.	Mother Board	(JX) I/O* Extend
	Armature	N.O. Pole	Channel I.D.	Pin No.
10	7,H	21	0A	2,B
	8,J	Y	0B	3,C
11	9,K	20	1A	4,D
	10,L	X	1B	5,E
12	11,M	19	2A	6,F
	12,N	W	2B	7,H
13	13,P	18	3A	8,J
	14,R	V	3B	9,K
14	15,S	17	4A	10,L
	16,T	U	4B	11,M
15	17,U	16	5A	12,N
	18,V	T	5B	13,P
16	19,W	15	6A	14,R
	20,X	S	6B	15,S
17	21,Y	14	7A	16,T
	22,Z	R	7B	17,U
18	23,a	13	8A	18,V
	24,b	P	8B	19,W
19	25,c	12	9A	20,X
	26,d	N	9B	21,Y

3.6.9 Model 230069 VHF Switch

Size Switch - 1x6x2

230069-1 - unterminated
230069-2 - 50 Ohm terminated
230069-3 - 75 Ohm terminated

1. Standard Control Chassis houses a maximum of five VHF modules.
2. Switched center conductor + shield.
3. RFI shielding.
4. BNC connectorization.

Figure 21. Model 230069 Module

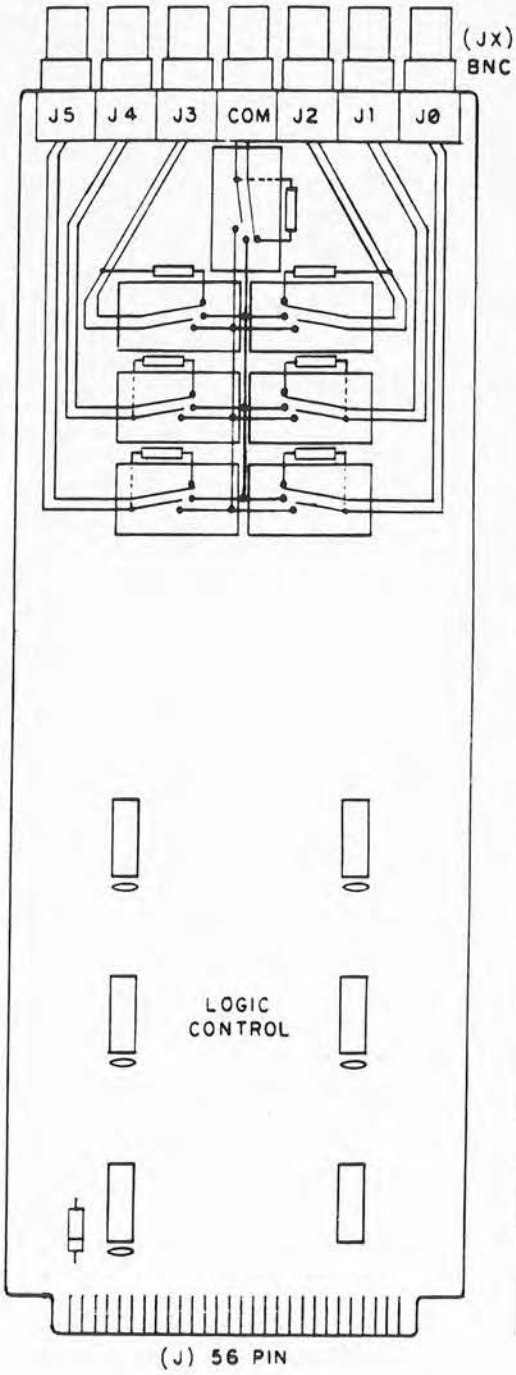


Table M
VHF Module Specifications

Bandwidth (BW)	DC-200 MHz at 3 db point
Rise Time (RT)	≤ 3.0 Nsec.
Impedance	50 Ohm w/wo open port termination
VSWR	1.2:1 at 100 MHz
Isolation	≥ 30 db Open to Open Port ≥ 30 db Open to Closed Port
Insertion Loss	
100 MHz, 50 Ohms	≤ 0.75 db Input to Output
200 MHz, 50 Ohms	≤ 3.0 db Input to Output
Switching Time	≤ 1.5 Msec. for full contact force
Stand off Voltage	
Term. port, 50 Ohm	7 Volts DC (Max)
Unterm. port	300 Volts (Max)
Switch Contact Rating	3 Watts
Addressing	
Common - J0	1st Address in Resident Slot
Common - J1	2nd Address in Resident Slot
Common - J2	3rd Address in Resident Slot
Common - J3	4th Address in Resident Slot
Common - J4	5th Address in Resident Slot
Common - J5	6th Address in Resident Slot

3.6.10 Model 230071

Size Switch - 1x10x2 2 wire
w/unswitched guard

Configures a STANDARD CONTROL CHASSIS for a 5 input, 10 output, (2 wire) matrix (5x10x2).

Configures a system EXTENDED CONTROL CHASSIS for an 9 input, 10 output (2 wire) matrix (9x10x2).

Configures a system EXPANSION CHASSIS for a 10 input, 10 output, (2 wire) matrix (10x10x2).

Figure 22. Model 230071 Module

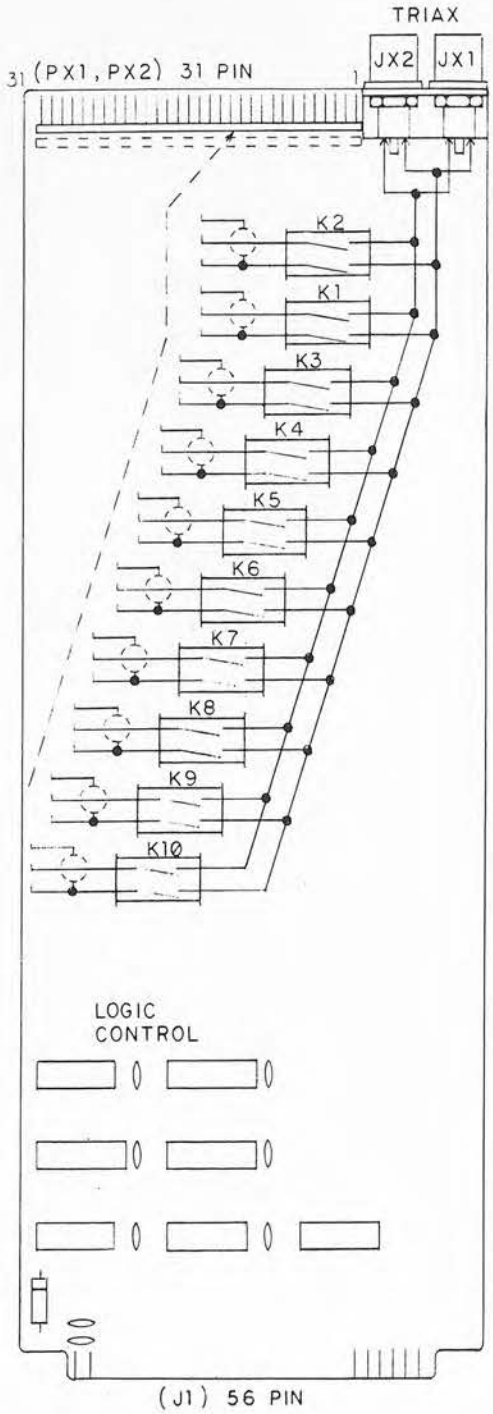


Table N
MODEL 230071 PIN ASSIGNMENTS

Module Switch	Input JX1, JX2 (connection)	Output PX1, PX2 (Pin No.)
	GUARD	1
K1	Shield	2
	Center	3
	Shield	4
K2	Shield	5
	Center	6
	Shield	7
K3	Shield	8
	Center	9
	Shield	10
K4	Shield	11
	Center	12
	Shield	13
K5	Shield	14
	Center	15
	Shield	16
K6	Shield	17
	Center	18
	Shield	19
K7	Shield	20
	Center	21
	Shield	22
K8	Shield	23
	Center	24
	Shield	25
K9	Shield	26
	Center	27
	Shield	28
K10	Shield	29
	Center	30
	Shield	31

3.6.11 Model 230076

Size Switch - 10(1x1) 1 wire (Form A)

Configures a STANDARD CONTROL CHASSIS for a 30 input, 30 output, (1 wire) matrix.

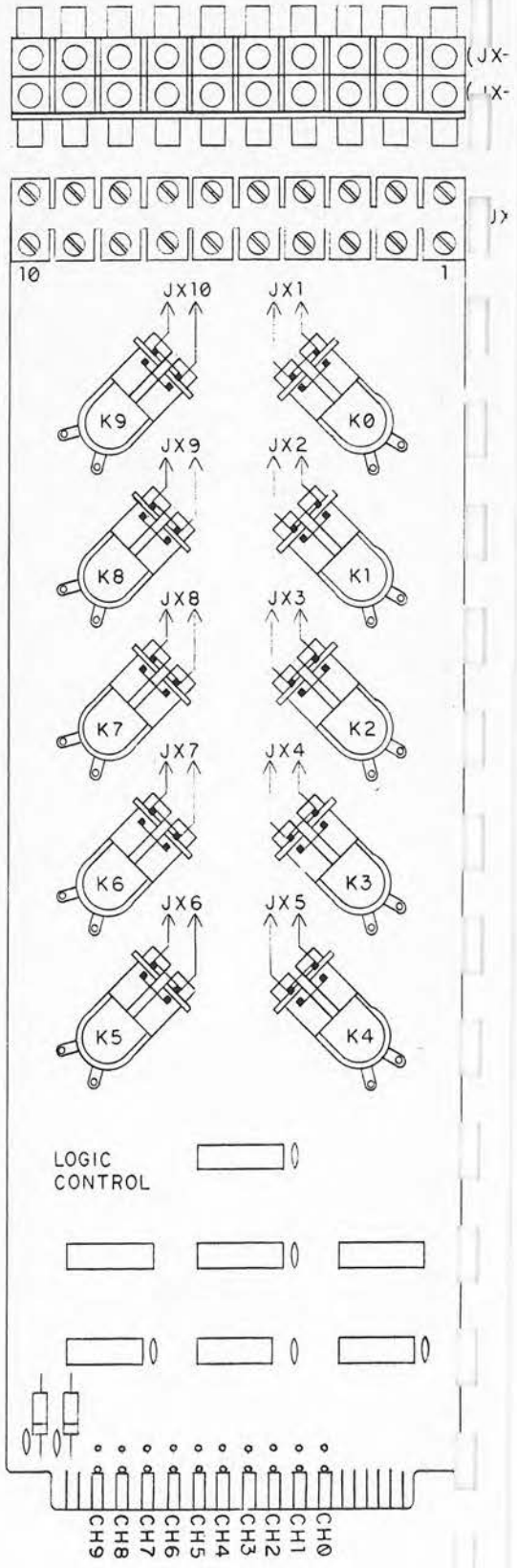
Configures a system EXTENDED CONTROL CHASSIS for an 40 input, 40 output (1 wire) matrix.

Configures a system EXPANSION CHASSIS for a 50 input, 50 output, (1 wire) matrix.

Table 0
MODEL 230076 PIN ASSIGNMENTS

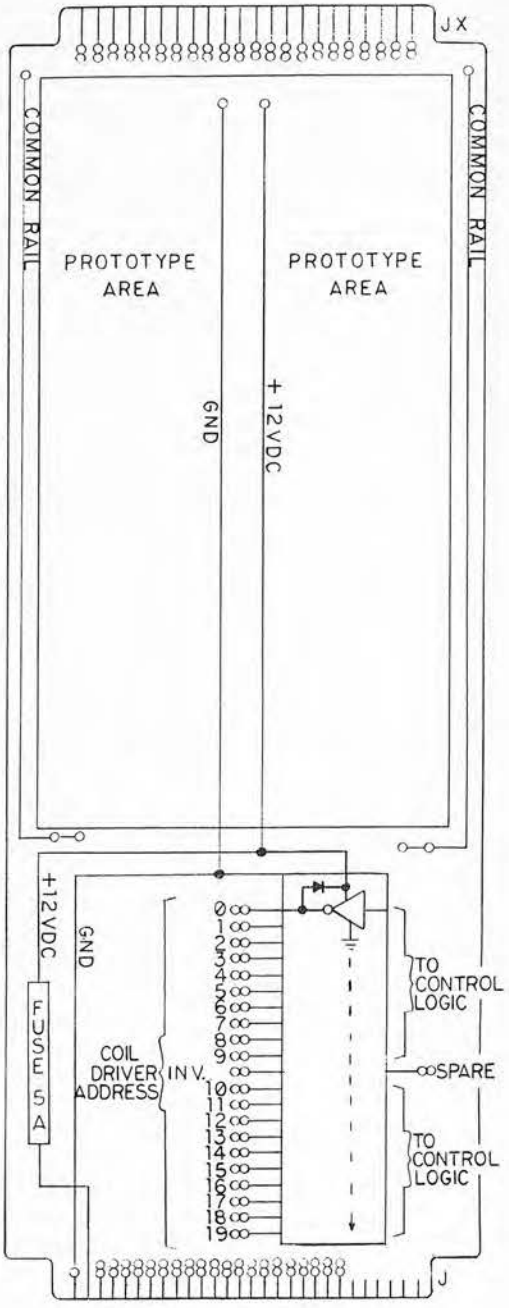
Module Switch	JX Signal Pin No. Input	Output
0	1A	1B
1	2A	2B
2	3A	3B
3	4A	4B
4	5A	5B
5	6A	6B
6	7A	7B
7	8A	8B
8	9A	9B
9	10A	10B

Figure 23. Model 230076 Module



3.6.12 Model 030773 (Programmable User-Defined Module)

Figure 24. Model 030773 Module



NOTES:

1. 20 hole patterns, common rails power rails and access are supplied to facilitate user requirements.

2. 20 decoded diode suppressed Darlington drivers are provided and protected by a 5 Amp fuse. If higher current is required, strict attention to systems power requirements is warranted.

3. External power up to 50V may be implemented by removing the 5 Amp fuse and wiring to user's DC Voltage source, OBSERVING CORRECT POLARITY.

4. One driver/inverter is also available for user's application.

5. ULN 2004 Limitations:

Vce (supplied)	+12 Volts DC
Vce (Max.)	+50 Volts DC
Ic (Max.)	500 MA
Temp. Range	0 C to 70 C
Max. Power Dissipation	125W at 70 C

6. Max. Power on internal 56 E motherboard Signal Bus 5 Amps.

7. Available A.D. Data Systems Switches & Coils:
   - Model 45600xx Switches (See Table C)
   - Model 4560020 Coil (Single) A12
   - Model 4560022 Coil (Dual) 011582
   - Model 4560024 Coil (Dual) for 4560008 Switch only
   - Model 5350193 Micron Post

3.7 Description of Operation

A.D. DATA SYSTEMS, INC. 56E is a remote access, addressable latchpoint, switching matrix. Front panel MANUAL control is an option in addition to remote IEEE-488, RS232-C or BCD remote access.

3.7.1 Remote Access (R/A)

The user provides address and control input data at the remote access 24 (IEEE-488), 25 (RS232-C), or 44 (BCD) pin connector on the control card located in slot J2 of the CONTROL CHASSIS (See FIGURE 7). Latching and un-latching of crosspoints or switches occurs based on the input data. The R/A options description in the manual details control and address data input requirements.

3.7.2 Manual Control (Optional)

Manual Control is provided by means of front panel switches. Decade thumbwheel switches allow user-selectable addresses to be entered with latch or unlatch command to the matrix logic. A front panel local/remote switch selects R/A or front panel manual mode of operation.

3.7.3 Latchpoint

Address recognition and latching is accomplished on the matrix module boards. Decoder logic and switch drive diode suppression is also part of the on-board matrix module circuitry. Contact closure is made upon command and switch settling time is per the module's switch specification. (See Table C)

3.7.4 User Signal Interface

A.D. DATA SYSTEMS signaling and switching modules are listed in TABLE A. The bus I/O connectors for the CONTROL and EXPANSION CHASSIS are 44 pin card edge connectors. (See TABLE D).

3.7.5 Channel Identification

Channel Identification refers to the hardware location of a crosspoint or switch for the purpose of input and output wiring interface as well as remote access addressing. In a particular equipped system, the user may position a reed module in any available location; however, it is accepted practice to fill card cage positions in an ascending order starting from left to right as viewed from the point of module access into the chassis. This practice will usually simplify programming requirements.

(Continued on Next Page)

3.7.5 Channel Identification (Continued)

The standard CONTROL CHASSIS'S first relay module positon, J5, is addressed as 000 thru 019 and the second position, J6, is 020 thru 039 for a 1,000 crosspoint configured system, 0000 thru 0019 and 0020 thru 0039 respectively for a 10,000 crosspoint configured system. This sequential addressing pattern continues thru the CONTROL CHASSIS and each EXPANSION CHASSIS switching module location starting from left to right (viewed from the point of module access into the chassis).

Input-output wiring is different for each of the optional matrix relay modules and can be identified in Section 3.

3.7.6 Control Chassis (Extended)

The extended CONTROL CHASSIS offers a maximum capability of 18 switching modules. The CONTROL CHASSIS'S (EXTENDED) first relay module position, J4, is addressed 000 thru 019 and the second position, J5, is 020 thru 039 and so on up to 340 thru 359 at J21. The first expansion chassis address is 400, followed by sequential addresses (addressing, described above, is based on a 1,000 crosspoint system).

A signal I/O card may be employed in any unused switching module slot (J4-J21) to provide access to the signal traces of the internal mother board merely by skipping the card cage slot addresses in which the I/O card resides.

3.8 IEEE-488 Remote Access

3.8.1 GENERAL DESCRIPTION (IEEE-488 Listen Only Options B or C)

Ref: Control Card Model 130355 (See Figure 6, Item 2).

A.D. DATA SYSTEMS' IEEE-488 LISTEN ONLY interface has 31 addresses available for PRIMARY addressing. The IEEE 488 "Listen Only" remote communication module operates per device specification subset AH1 and L1. For IEEE-488 operation, the 130355 module requires that it be hardware programmed for a My Listen Address (MLA) unique to the system or CONTROL CHASSIS being controlled by the users Central Processing Unit (CPU).

MLA Address selection is accomplished by positioning DIP switches on the 130355 module. SETTING THE DUAL IN LINE SWICHES (DIP) TO THE OFF POSITION SELECTS THE ADDRESS BITS REQUIRED. When the MANUAL CONTROL options D or E have not been factory installed with the IEEE option, remote enable for CONTROL CHASSIS will have been pre-set during the A.D. DATA SYSTEMS final test, and will operate upon receiving the proper command codes over the IEEE Buss. If the unit is equipped with the manual control option, the MANUAL-EXTERNAL front panel switch must be set to its EXTERNAL position to enable remote communication.

NOTE: EXTERNAL select disables all front panel controls except the power ON-OFF switch.

3.8.2 MLA - My Listen Address

Transmission of the 56E Control Unit's "My Listen Address" places the IEEE interface into the listening mode. Attention (ATN) must be set true, and handshake is required. My Listen Address Switches (MLA) on-board the 130355 module, positions 1 thru 5 correspond to IEEE Buss bits DIO1 thru DIO5 respectfully. Switches 1 thru 4 select addresses 0-15 and switch 5 selects the higher order bits for addresses 16-31.

EXAMPLE: Binary coded bits 1, 2, 4, 8, 16
MLA 7: Switch Positions 1,2, and 3 OFF, 4 and 5 ON

3.8.3 UNL - Unlisten

Command to remove all listening devices from the listening mode. Attention Bit must be set true and handshake is required. The unlisten command character is ASCII character ? which is binary coded bits DIO8 thru DIO1 (X011-1111).

EXAMPLE: ASCII Hex code 3F.

Table P

ADDRESS AND CONTROL FORMAT

IEEE-488 LISTEN ONLY

PROGRAM EXAMPLE: Latch Crosspoint #3254

Byte	ATN Bit	ASCII Character		Binary DI08-DI01 16 8421	Function
1	1	0		x011-0000	Listen Address 16
2	0	1		x011-0001	Latch Command
"	"	0	or	x011-0000	Unlatch Command
"	"	2	or	x011-0010	Matrix Clear (all unlatch)
3	0	3		x011-0011	Thousands Address
4	0	2		x011-0010	Hundreds "
5	0	5		x011-0101	Tens "
6	0	4		x011-0100	Units "
7	1	?		x011-1111	UNL-Unlisten

Upon accepting Byte 6, the 56E matrix will latch crosspoint 3,254. If Byte 7 has not been sent, the 56E matrix is in the LISTENING mode and additional crosspoints may be addressed by sending strings of data.

Example: Send bytes (2 thru 6), (2 thru 6), (2 thru 6), UNL.

The string is terminated with the UNLISTEN command. A crosspoint may be unlatched by sending the ASCII character 0 for byte 2. A matrix CLEAR may be accomplished by sending the ASCII Character 2 for byte 2.

- Programming the HP9825 for use with the 56E with Option B or C. (Shown for 1000 crosspoint system)

```
Latch Crosspoints 000,025,040

wtb 707,"100010251040"
```

- Programming the HP9836/46 and 85 for use with the 56E Option B or C.

```
Latch Crosspoints  000,025,040

output 707 using "K"; "100010251040"
```

3.8.4 General Description (IEEE-488 TALK/LISTEN Option J1 or J2)

Ref: control card model 330024.

The J1 or J2 Option provides the 56E System with IEEE-488 Talk/Listen capability. This capability is controlled by the user's Central Processing Unit (CPU).

The IEEE-488 (Std. 1978) allowable subsets are:

SH1 - Source Handshake

AH1 - Acceptor Handshake

T6 - Talker-Serial Polling, Unaddress if MLA

L4 - Listener Unaddress if MTA

SR1 - Service Request

RL1 - Remote w/Local Lockout

PP1 - Local Configuration

DC1 - Device Clear (DCL, SDC)

3.8.4 (Continued)

The on-board, in-line switches SW1, SW2, and SW3 (See Fig. 25) allow the user to initialize the 56E System. The following describes the switch positions and how they are used.

Switch 1 (SW1)

Positions 1-5 - set the device address; 0 through 30 are legal. Position 1 is the least significant bit (worth 1) and position 5 is the most significant bit (worth 16).

To set 56E device address to 21, press positions 1, 3, and 5 (1,4,16) to "ON". Positions 2 and 4 (2,8) should be "OFF".

Position 7 - enables or inhibits the prompt (#,RETURN,LINE FEED). When switched "ON" the 56E Control Unit returns prompts (#,RETURN,LINE FEED) to the users CPU. This indicates that an input operational or status command has been completed and the system is "READY" for another command. The user may inhibit prompts, to reduce bus traffic, by pressing Position 7 to the "OFF" setting.

Position 8 - allows the user to assert End or Identify (EOI) after each line. To enable this feature press Position 8 to "ON".

NOTE: Some CPU's lack the capability to handle Carriage Return/Line Feed properly. When these control codes are read into a buffer, EOI is required by each line feed. Faster operation can be achieved by setting Position 8 to "OFF". This asserts EOI only after each message, regardless of the number of lines sent.

Switch 2 (SW2)

Position 1-3 - allows the user to set the Parallel Poll Bit. Position 1 is the least significant bit (worth 1), Position 2 (worth 2), and Position 3 (worth 4). For example, to set bit 5 as the Parallel Poll Bit, press positions 1 and 3 (worth 1+4) to "ON" and press position 2 to "OFF".

Position 7 - allows selection of either Lower Case or Upper Case alpha characters to enable compatibility with the CPU. Press position 7 to "ON" to enable Lower Case (↓), "OFF" to enable Upper Case (↑).

Position 8 - selects the Execution Character. The Execution Character starts execution of a command, entered from the user's CPU. This character may be a Carriage Return <CR>, position 8 "ON" or a Line Feed (LF), position 8 "OFF".

Switch 3 (SW3)

Position 1 - selects between IEEE-488 (when set to "ON") or RS232-C (when set to "OFF").

Position 2 - selects between a 1000 Crosspoint system (when set to "OFF") or a 10,000 Crosspoint system (when set to "ON").

Position 8 - selects between 120 simultaneous latched crosspoints maximum (when set to "ON") with a standard power supply or 400 (when set to "OFF") with a heavy-duty power supply (option F).

3.8.5 Remote with Local Lockout (RWLS)

The 56 E system can be placed in the Local Lockout state from the user's CPU as follows:

- o Sending UNL (Unlisten; decimal 63)
- o Asserting REN (Remote Enable)
- o Sending the 56 E Control Chassis My Listen Address
- o Issuing LLO (Local Lockout; decimal 17)

The 56E will then not respond to operation of its front panel controls (except AC power switch) when in the Local Lockout state. De-asserting REN causes all devices on the bus to exit the Remote with Local Lockout state and enter the Local state (LOCS).

3.8.6 Device Clear Active State (DCAS)

The Device Clear Active state may be achieved on the 56E by the user's CPU as follows:

- o Issuing Device Clear (DCL; decimal 20) or UNL (Unlisten; decimal 63)

and

- o Sending MLA's (My Listen Address) to listeners to be cleared, then sending SDC (Selected Device Clear; decimal 4)

The 56E will re-initialize completely, to include, unlatching all latched crosspoints and issuing a SRQ (Service Request) to generate a prompt.

3.8.7 Programming the IEEE-488 Talk/Listen Interface

A typical program written in HPL for the HP9825A desk-top computer is shown below. The program makes the computer transparent so that the various devices on the bus can be operated by entering commands on the computer keyboard.

Sample Program

Listing	Comments
0: fmt 1,z,b	Format #1, no CR or LF, transmit binary data
1: dim A$[80], B$[80],C$[1]	Dimension three string buffers
2: ""→C$	Clear string buffer C$
3: oni 7,"ISR"	"ISR" is GPIB SRQ service routine
4: on key "kbd"	"kbd" is keyboard service routine
5: ent "Select device:",F;F+700→F	Get device address from operator (legal addresses: 0-30)
6: rem F;""→A$	Put selected device in REMS; clear A$
7: eir 7	Enable GPIB interrupt
8: if C$#char(25);gto 8	Wait until CONTINUE key is pressed
9: ""→C$	Clear C$
10: if A$="E"; end	Stop processing if "E" <CONTINUE> is typed
11: if A$="A"; ""→A$;gto 5	Clear keyboard buffer and request new address if "A" <CONTINUE> is typed
12: if A$="CC"; char(3)→A$;gto 16	Force CONTROL-C into keyboard buffer and branch if "CC"<CONTINUE> is typed
13: if A$="REM"; ""→A$;gto 6	Clear keyboard buffer and branch if "REM"<CONTINUE> is typed
14: wrt F,A$	Output contents of keyboard buffer to device
15: gto 17	
16: wrt F+.1,A$	Output buffer using format #1
17: ""→A$	Clear keyboard buffer
18: gto 8	End of main loop
19: "ISR":	GPIB interrupt service routine
20: time 1	Set bus time-out at 1 millisecond
21: for G=700 to 730	Poll all 31 possible devices
22: on err "nodev"	Enable bus time out
23: rds(G)→H	Store serial poll response byte
24: if H=0;gto 27	Branch if byte is null

(Continued on Next Page)

Listing	Comments
25: G→I;gto 28	Device active; save its address
26: "nodev":	Time-out target
27: next G	End of poll loop
28: time 0	Cancel bus time out
29: red I,B$	Receive device's response
30: rds(7,A,B, C)→D	Store register 4 (EOI bit) in D
31: dsp B$	Display response
32: wait len(B$) *25+300	Time display according to the number of characters in the buffer
33: if bit(0,D)= 1;gto 35	Get ready to exit interrupt service routine if EOI set
34: gto 29	EOI not set; receive another line
35: eir 7	Re-enable GPIB interrupt
36: iret	Exit interrupt service routine
37: "kbd":	Keyboard service routine
38: cap(char(asc key))→C$	Keyed character to C$ (null if no character has been typed); convert lc to caps
39: if num(C$[1, 1])<32;gto 42	Exclude non-graphic characters
40: A$&C$→A$	Append keyboard character to display buffer
41: dsp A$	Update display
42: kret	Exit keyboard service routine

The above program makes it possible to communicate with a bus full of devices. The device is selected by typing the device address when requested by the program. The computer keyboard is then used to transmit ASCII commands to the device on the bus. The program has four commands:

1. "E"- exit the program
2. "A"- enter a new device address
3. "CC"- transmit a CONTROL-C to the device
4. "REM"- put the device in REMS

An SRQ from any device causes the program to determine which one it is, and receive its response. The response is displayed by the 9825's LED display.

This program works with all 56E commands, except EF (Execute File). If a file that loops is executed, there may be no way to stop it because the SRQ interrupt service routine appears to lock out the keyboard.

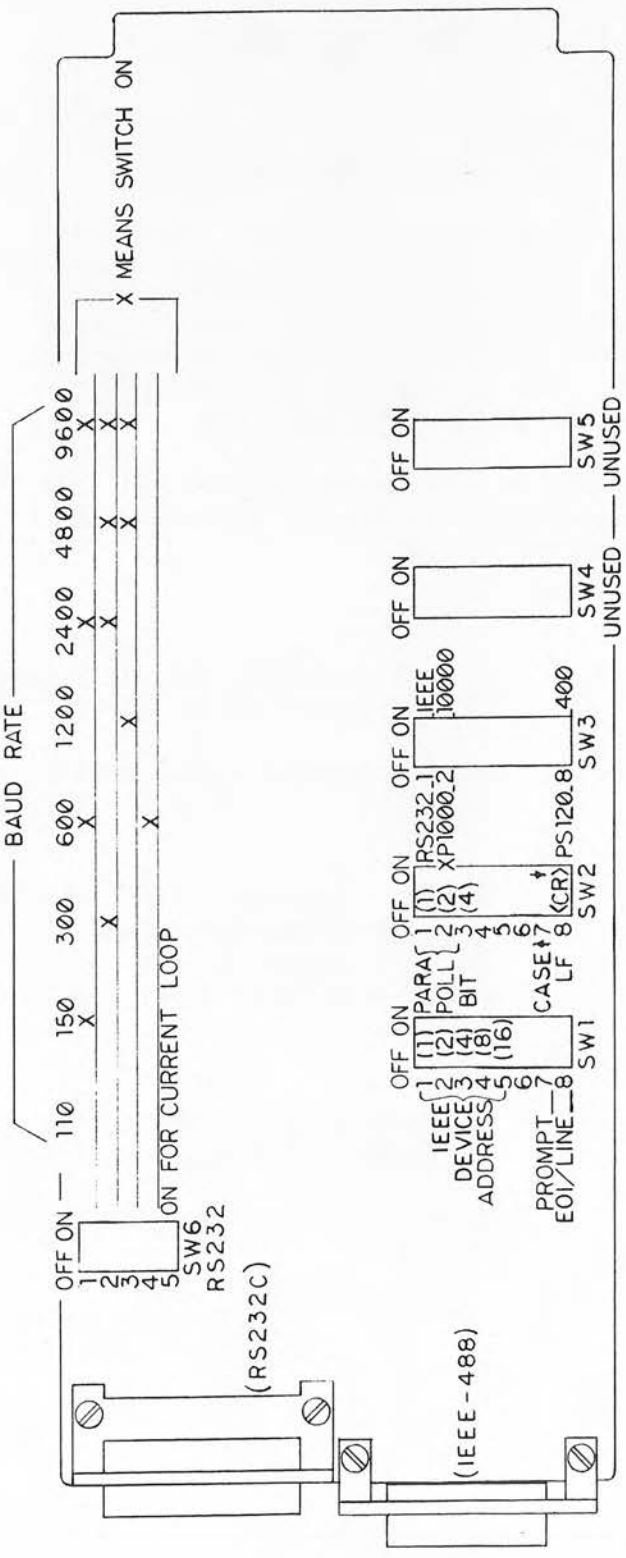


Figure 25. IEEE-488/RS232-C Interface
Model 330024

3.9 RS232-C REMOTE ACCESS (Option J1 or J3)

3.9.1 General Description

Ref: Remote Interface 330024

The J1 or J3 option provides the 56E System with full duplex RS232-C capability. This is achieved by using an on-board, Universal Synchronous/Asynchronous Receiver/Transmitter (USART).

The USART is a 40-pin IC that facilitates programming of the communications link data format. The 56E RS232-C Interface uses ASCII format with one pre-programmed stop bit. EIA standards are met by using interface drivers that operate link at +12 and -10 Volts. This interface module also supports 20ma current loop (ILP) and can be active or passive by virtue of the on-board, optically isolated receiver/drivers.

The on-board, in-line switches, SW3 and SW6 (see Fig. 25) allow the user to initialize the 56E system. A description of each switch position follows.

Switch 3 (SW3)

Position 1 - selects between IEEE-488 (when set to "ON") or RS232-C (when set to "OFF").

Position 2 - selects between a 1000 Crosspoint system (when set to "OFF") or a 10,000 Crosspoint system (when set to "ON").

Position 8 - selects between 120 simultaneous latched crosspoints maximum (when set to "ON") with a standard power supply or 400 (when set to "OFF" with a heavy-duty power supply (option F).

Switch 6 (SW6)

Positions 1-4 - are used to select the system interface baud rate. For example: 150 Baud; Position 1 "ON", 2-4 "OFF".

Position 5 - selects current loop operation in the "ON" setting.

3.10 IEEE-488 Talk/Listen/RS232-C Command Format

3.10.1 Input Operational Commands

SYMBOL		DEFINITION
CLR	CLEAR:	Unlatch all crosspoints.
L(sp)nnnn	LATCH:	Performs a status check of crosspoint nnnn, and if unlatched, executes command. Will also report number(s) and status of crosspoint(s) not executed with response symbol indicating reason. Example: L(sp)0000,0200,0010. *0000
U(sp)nnnn	UNLATCH:	Performs a status check of crosspoint nnnn, and if latched, executes command. Will also report number(s) and status of crosspoint(s) not executed with symbol indicating reason. Example: U(sp)0000,0200,0010. *0000
H1	HELP:	Displays menu comprising all operational, status, and programming commands with explanations.
H2	HELP:	Displays menu comprising all output responses with explanations.
TL(sp)nnnn	TEST LATCH LOOP:	Start loop routine which repeatedly stimulates the matrix for diagnostic purposes. Control-C causes return to command level.
TU(sp)nnnn	TEST UNLATCH LOOP:	Start loop routine which repeatedly stimulates the matrix for diagnostic purposes. Control-C causes return to command level.

nnn = Crosspoint address (1000 crosspoint system)
nnnn = Crosspoint address (10000 crosspoint system)
(sp) = Space

3.10.2 Input Status Commands

SYMBOL	DEFINITION	
IXS(sp)nnnn	INTERROGATE CROSSPOINT STATUS:	Display status (L or U) of requested crosspoint nnnn.
ILX	INTERROGATE LATCHED CROSSPOINTS:	Display numbers of all latched crosspoints.

3.10.3 Programming Commands

SYMBOL		DEFINITION
WF(sp)X	WRITE FILE:	Write command(s) which follow in the file named in the single-character argument(X). Use CONTROL-C to close file and exit from this mode.
EF(sp)X	EXECUTE FILE:	Execute command(s) stored in the file designated by the single-character argument (X).
SF(sp)X	SHOW FILE:	List command string stored in the file designated by the single-character argument (X).
SBD	SHOW BUFFER DIRECTORY:	Display command buffer directory including the number of characters stored in each file and the number of bytes (available character spaces) remaining in the buffer.
DF(sp)X	DELETE FILE:	Delete the command buffer file designated by the single-character argument (X).
<CTRL>C	EXIT:	Exit programming command mode; return to input operational command mode.

(sp) = Space
X = Any single ASCII character

3.10.4 Output Responses to Input Commands

SYMBOL		DEFINITION
#	DONE (PROMPT):	Indicates that the last line of commands has been executed and that the device is waiting for another input command.
-	LOCAL FLAG:	Flag to the remote control device indicating that the device has been switched to the LOCAL mode. The 56E ignores any commands sent over the communication channel until another prompt (#) is sent.
|	COMMAND BUFFER PROMPT:	Indicates that a file is open in the command buffer and command lines may be stored therein. A CONTROL-C is required to close the file and exit the command buffer storage mode.
?	SYNTAX ERROR:	The last input was not understood and was not executed.
*	STATE IN FORCE:	Indicates that the state requested for the crosspoint displayed is already in force, either due to a previous request or as a result of initialization.
!	RESET STATE:	Indicates that no switch closure is made to the interrogated crosspoint.
<	BUFFER OVERFLOW:	Input command string has overflowed the buffer capacity. Complete commands inserted before the overflow are accepted.
=	POWER SUPPLY CAPACITY WARNING:	The power supply current required by the number of crosspoints latched has reached 85 percent of the maximum allowable level. Additional crosspoints will be latched and continued violations will be displayed.
^	POWER SUPPLY CAPACITY REACHED:	The power supply current required by the number of crosspoints latched has reached the maximum allowable level. No additional crosspoints will be latched. Continued violations will be displayed.

3.11 BCD Remote Access

3.11.1 GENERAL DESCRIPTION (BCD OPTIONS A and G))

The A.D. DATA SYSTEMS' BCD interface is a DIRECT ACCESS control for addressing the matrix or switch modules. A factory installed Front Panel Control is available as well as BCD input. A PARALLEL INPUT BUFFER is required and must be factory installed as an additional option: Control Card Model 130344 located in CONTROL CHASSIS card cage position (J2). An un-buffered BCD control is also available without Front Panel Control and requires factory installed bus extender card, Model 029209, in card cage position (J2).

The user accesses a crosspoint or switch position by presenting at the BCD input a 16 bit address (10,000 crosspoint configuration) and a 4-bit control byte. Tables Q and R outline BCD input pin numbers and their Most Significant Digit (MSD) to Least Significant Digit (LSD) position in the data word. Internal timing is provided for the data word translation; however, the control character should be presented at the same time as, or not to precede the address bits.

3.11.2 BCD Parallel Control (Buffered Option G)

Ref: Control Chassis Schematic 930005 (J2)
Control Chassis Figure 7 (Item 2)
Parallel Input Buffer Schematic 130344

TABLE Q
BCD PARALLEL INPUT PROGRAMMING
VIA INPUT BUFFER CARD (130344)

JX Connector Pin No.	Function	Description	BCD
A	Bit 0	Units Address	1
1	Bit 1	Units Address	2
B	Bit 2	Units Address	4
2	Bit 3	Units Address	8
C	Bit 4	Tens Address	10
D	Bit 5	Tens Address	20
E	Bit 6	Tens Address	40
H	Bit 7	Tens Address	80
8	Bit 8	Hundreds Address	100
K	Bit 9	Hundreds Address	200
L	Bit 10	Hundreds Address	400
N	Bit 11	Hundreds Address	800
13	Bit 12	Thousands Address	1000
R	Bit 13	Thousands Address	2000
14	Bit 14	Thousands Address	4000
S	Bit 15	Thousands Address	8000

(Continued on Next Page)

15	Bit 16	Latch (L) = High or Unlatch (UNL) = Low
T	Bit 17	Clear Sync (CLRS) = High (Normally Low) + Control Trigger (CTTR)
U	Bit 18	Control Trigger (CTTR), Strobe = High (Norm Low)
17	Bit 19*	Select Device Clear (SDC), Async = High

*Bit 19 - MUST be held low, until used

3.11.3 BCD Remote Control (Unbuffered Option A)

Ref: Control Chassis Figure 7 (Item 2)

TABLE R
BCD PARALLEL INPUT PROGRAMMING
VIA EXTENDER CARD (029209)

JX Connector Pin No.	Function	Description	BCD
X	Bit 0	Units Address	1
W	Bit 1	Units Address	2
V	Bit 2	Units Address	4
18	Bit 3	Units Address	8
S	Bit 4	Tens Address	10
T	Bit 5	Tens Address	20
14	Bit 6	Tens Address	40
N	Bit 7	Tens Address	80
J	Bit 8	Hundreds Address	100
K	Bit 9	Hundreds Address	200
8	Bit 10	Hundreds Address	400
H	Bit 11	Hundreds Address	800
9	Bit 12	Thousands Address	1000
10	Bit 13	Thousands Address	2000
11	Bit 14	Thousands Address	4000
13	Bit 15	Thousands Address	8000
R	Bit 16	Latch (L) = High or Unlatch (UNL) = Low	
P	Bit 17	Clear Sync (CLRS) = High (Normally Low)+ Control Trigger (CTTR)	
17	Bit 18	Control Trigger (CTTR), Strobe = High (Norm Low)	
12	Bit 19*	Select Device Clear (SDC), Async = High	

*Bit 19 - MUST be held low, until used.

Section 4

THEORY OF OPERATION

4.0 Introduction

The 56E matrix system is a CMOS-LSTTL logic design which is composed of three major design blocks. They are INPUT CONTROL, DECODER DRIVER and SIGNALING and SWITCHING modules.

4.1 Input Control: (See Figure 26)

Input Control is performed by the REMOTE ACCESS (R/A) input module which resides in the 56E CONTROL CHASSIS, card cage position (J2). The data output register of this module is buffered by tri-state drivers to form a tri-state bus shared by the front panel thumbwheel address switches. Control outputs for the R/A module and the CONTROL CHASSIS front panel controls are selectively decoded by the matrix control module which resides in the (J1) position of the CONTROL CHASSIS. The matrix control outputs logic signals for latch/unlatch, strobe and matrix clear.

4.2 Decoder Driver: (See Figure 26)

The decoder driver, for the matrix signaling and switching modules, is positioned in the matrix CONTROL CHASSIS (J3) cardslot. The decoder accepts a BCD parallel dataword from the R/A module output register or front panel thumbwheel switches. Level conversion (TTL - CMOS) is provided at the decoder driver front end. BCD to decimal translation is then performed and outputted to the reed relay modules via on-board CMOS buffer driver circuits. Units drive translation is forwarded as a BCD number. Thousands, Hundreds, and Tens digit addressing is forwarded to the reed modules as a decimal number 0-9. All buffer drive circuitry is 4000 "B" series CMOS to accomodate equal high and low mother board rail drive current.

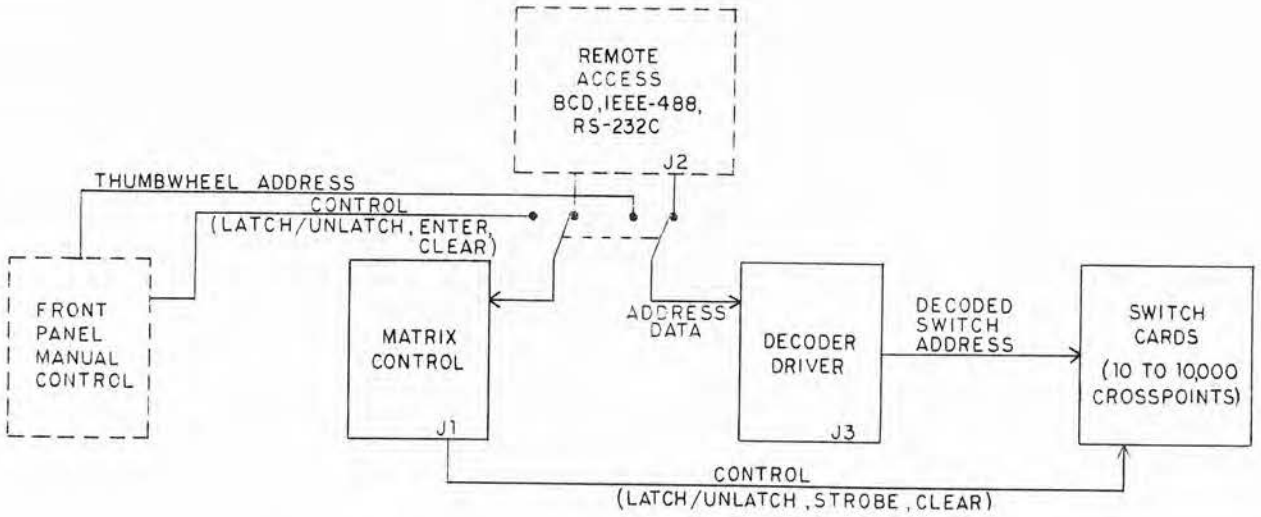


Figure 26. 56E Block Diagram

4.3 Signaling and Switching Modules (See Figure 26)

Matrix modules are positioned in the 56E STANDARD CONTROL CHASSIS from position J5 thru J14, J4 thru J21 in the EXTENDED CONTROL CHASSIS and in the 56E EXPANSION CHASSIS from J4 thru J23. The modules accept BCD and decimal addressing data from the decoder driver. (See matrix model 230038 schematic as typical). The Units digit data extends across the chassis backplane as a BCD data bus, where as, decimal selects for Thousands, Hundreds, and Tens are distributed uniquely to module groups which form the most significant digit translation. (See the Control and Expansion Chassis schematics supplied with each system.)

Module on-board logic decoders translate the input address and store the resultant translation in memory as LATCH or UNLATCH crosspoint or switch command. Addressable latch outputs are buffered by Darlington Switch Drivers with internal diode suppression for each switch.

4.4 Reed Switch

The reed switch is a unique electromechanical device - the contacts are heremetically sealed in an inert gas atmosphere, protected from dust, moisture, fumes, spray, and pressure changes, and are acutated by an external magnetic field produced by a magnet brought into proximity to the contact reeds.

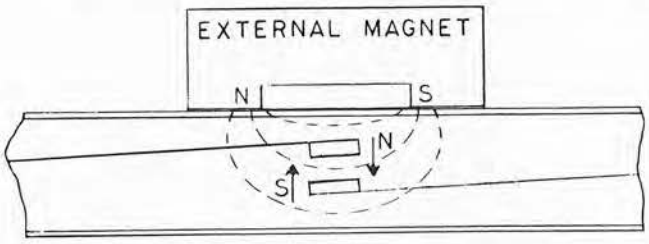


Figure 27. Form A Reed Relay Magnetic Closure.

The external magnetic field produces magnetic poles of opposite polarity at the adjacent ends of the reeds. The attraction of the poles brings them together, producing contact closure. Removal of the external field causes the contacts to open due to the natural spring tension of the reeds.

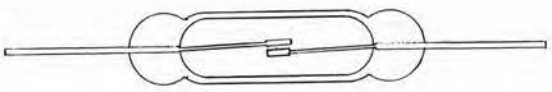


Figure 28. Form A - Reed Relay

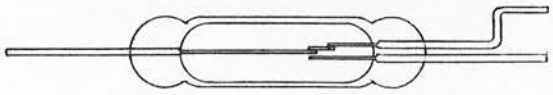
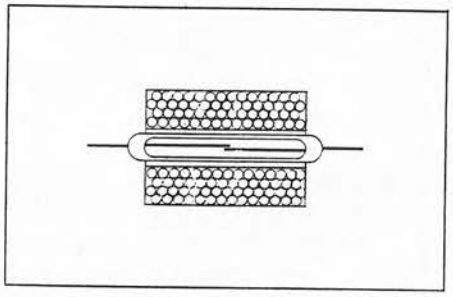
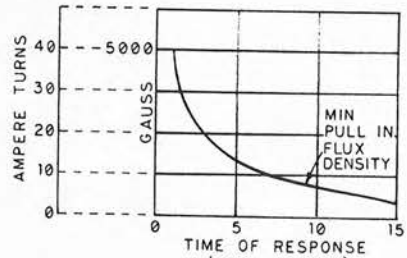


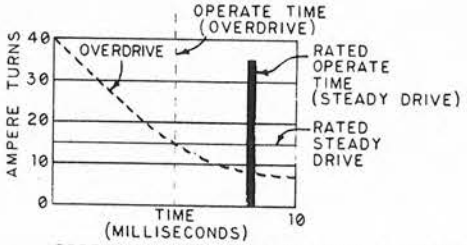
Figure 29. Form C - Reed Relay

TYPICAL RESPONSE CHARACTERISTICS





PULL-IN TIME -VS- INDUCED FLUX DENSITY (GAUSS) AND APPLIED FIELD (AMPERE TURNS FOR A GIVEN COIL).



EFFECT OF OVERDRIVE ON TIME OF RESPONSE OF A REED SWITCH.

Figure 30. Reed Relay Characteristics

Section 5

MAINTENANCE

5.0 Introduction

The motherboard and modular design of the 56E matrix system provide the utmost in reliability and serviceability. The user can realize many millions of trouble-free switching operations by simply employing good engineering practices in both the areas of signal transmission and software programming. Close attention should be paid to the switching relay characteristics, as shown in TABLE C of this manual, especially the parameters of breakdown voltage, switched current and contact wattage ratings noting the applicable derating values. If doubt does arise regarding a switching or signaling capability, a call to A.D. DATA Systems is welcomed.

In the event a reed relay requires replacement, due to wear or other circumstances, it is suggested that the faulty module be returned to A.D. DATA SYSTEMS for repair, test and a speedy return to the sender. The following section is presented for those who feel their in-house capability is of the caliber to handle this delicate repair.

5.1 Reed Relay Replacement

REMOVAL

1. Using a soldering iron, heat the junction* of one end of the reed lead and its micron (post).

2. Using a de-solder tool remove the solder completely. Repeat the same procedure at the other end. Before removing the reed from the magnetic coil, mercury reed only, note the location of the flat on one of its leads.

*****CAUTION*****

MERCURY REED RELAYS ARE POLARIZED AND MUST BE ORIENTED CORRECTLY IN THE COIL SUCH THAT THE MERCURY POOL WILL SETTLE IN THE NON-CONTACT AREA OF THE GLASS ENVELOPE. INCORRECT INSTALLATION WILL CAUSE THE CONTACTS TO BE MERCURY-POOL-CLOSED UPON RE-INSERTION OF THE MODULE INTO ITS CHASSIS CARD CAGE. THIS CONDITION COULD CAUSE SERIOUS DAMAGE TO THE MATRIX OR WORST YET THE DEVICE UNDER TEST.

(Also see Para. 3.3)

3. Remove the reed from the coil.

REPLACEMENT

1. Select the proper reed (identical to the type removed). It is recommended that only reed relays under A.D. DATA SYSTEMS specification control be used as replacement in order to insure the same system performance. See TABLE C for the various switch part numbers.

2. Place the reed into the coil carefully as not to bend or place any stress on the axial leads. This is a delicate device and the glass envelop may shatter or crack under stress.

3. Make sure the micron posts are perpendicular to the circuit board and are free of solder. Position the reeds leads into the micron slots.

4. Gently *heat each junction of the reed lead and the micron slot and solder into place. (Make sure mercury reed is oriented properly).

* NOTE - DO NOT OVERHEAT THE MICRON IN REMOVING OR REPLACING THE REED RELAY AS IT WILL FLOAT CAUSING A RELOCATION OF HEIGHT AND STRAIGHTNESS. ALSO EXCESSIVE HEAT MAY PRODUCE EXCESSIVE STRESS ON THE GLASS ENVELOPE CAUSING IT TO SHATTER.

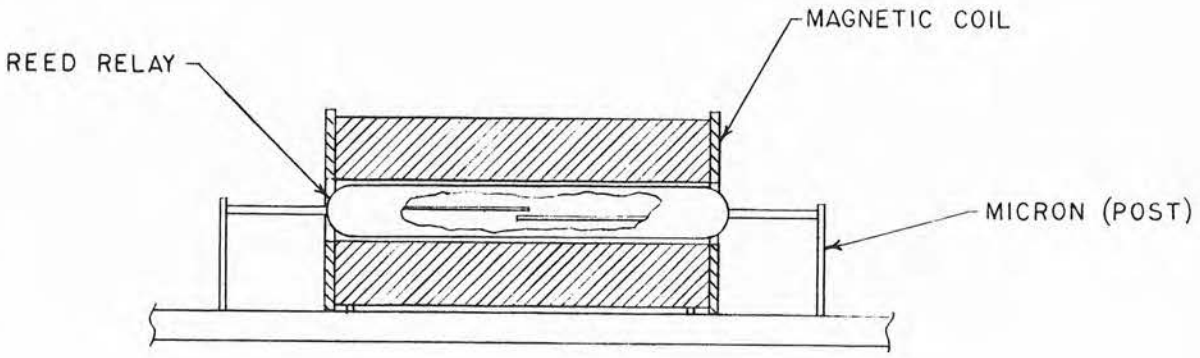


Figure. 31 Reed Relay Installation.

5.2 Spare Parts List

TABLE S

SPARE PARTS LIST

Model 2300xx-xx Switch Modules (See Table A)

Model 4560Oxx Reed and Power Relays (See Table C)

Model 130343 Matrix Control Card

Model 130373 Matrix Control Card

Model 130355-1 IEEE-488 Listen Only - 1,000 Crosspoint
-2 IEEE-488 Listen Only - 10,000 Crosspoint

Model 330024-1 IEEE-488 Talk Listen
-2 RS232-C
-3 IEEE-488 Talk Listen & RS232-C

Model 130344 BCD Parallel Input Buffer Card

Model 130339-1 Decoder Driver Card - 10,000 Crosspoint
-2 Decoder Driver Card - 1,000 Crosspoint

Model 4550020 Standard Power Supply - 120 Crosspoint

Model 4550021 Option H Power Supply

Model 4550022 Option F Power Supply - 400 Crosspoint

NOTES

APPENDIXES

ADDENDA

SCHEMATIC DIAGRAMS

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