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INSTRUCTION MANUAL
MXT10 INTERFACE MODULE
AND
959XPT

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MXT10 INTERFACE MODULE

AND

959XPT

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SECTION 1 GENERAL DESCRIPTION

1.1 INTRODUCTION

This instruction manual contains information relative to the installation, operation and calibration of the California Instruments Model 959XPT and the MXT10 Interface Module. Information is provided to completely calibrate a power system with any California Instruments power source.

1.2 GENERAL DESCRIPTION

The 959XPT is a plug-in oscillator for a California Instruments 3-phase XP-Series AC Power Source or MXT10 Interface Module.

It obtains its primary operating power from the device in which it is installed. The 959XPT provides the AC signal for the AC power source. The AC signal from the 959XPT may be programmed for frequency, amplitude, phase angle, and distortion. An option for the 959XPT allows it to program the type of waveform. The 959XPT also provides the means to measure the output voltage, current, frequency, phase angle, true power, apparent power and power factor. In addition, the 959XPT can be programmed for an output current limit value in amps. The 959XPT will synchronize the output frequency and phase angle to an external sync input at the rear panel of the device in which the 959XPT is installed.

When the 959XPT is used with an MXT10 Interface Module it can be used as a component of a power system that has California Instruments T-Series power sources. It can also be used with other power sources that are not mechanically or electrically compatible with the 959XPT. The MXT10 Interface Module supplies the DC supplies for the 959XPT, the current transformers for current and power measurement and a current limit assembly. The MXT10 Interface Module also has all of the connections for interface to the power sources.

1.3 ACCESSORY EQUIPMENT

An Extender Assembly, California Instruments Part Number 4930-705, is available. It permits test and adjustment of the 959XPT external to the power source in which it is installed. An Extender Cable, Part Number 4849-203-1, is also available. It connects the circuit boards of the 959XPT to the mother board during test and servicing.

1.4 SPECIFICATIONS

Specifications for the Model 959XPT AC Power Controller are listed in Table 1-1. Note that these specifications apply when the 959XPT is used with a power source.

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TABLE 1-1

MODEL 959XPT AC POWER CONTROLLER SPECIFICATIONS

AMPLITUDE PROGRAM (All specifications apply from 45 Hz to 70 Hz. Specifications of the power source apply above 70 Hz.)

VOLTAGE RANGES	156/312 are standard.
VOLTAGE ACCURACY: (25 degrees C ±1 degree C) (Based on TRMS)	±0.5 volts
TEMPERATURE COEFFICIENT:	±0.05 volts per degree C average from 25 degrees C.
LOAD REGULATION:	AC Source Specification
LINE REGULATION:	AC Source Specification
DISTORTION: (THD=0 Programmed)	(AC Source Specification +.5)%
DEFAULT VOLTAGE:	0.0 Volts.
DEFAULT RANGE:	Either range of specified range pair. 156 volt range is standard.

DISTORTION PROGRAM (Sine wave only. All phases may be independently programmed.)

RANGE:	0 to 20% THD
RESOLUTION:	1%

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FREQUENCY PROGRAM

FREQUENCY RANGE:	45.00 (or other low limit) to 500 Hz (or other high limit).
FREQUENCY RESOLUTION:	0.01 Hz from 45.00 to 99.99 Hz 0.1 Hz from 100.0 to 500.0 Hz
FREQUENCY ACCURACY: (25 degrees C ±1 degree C)	±0.001% of programmed value
TEMPERATURE COEFFICIENT:	±5ppm/degrees C from 25 degrees C
LONG TERM STABILITY: (25 degrees C ±1 degree C)	±15 PPM of Programmed Value per year.
DEFAULT FREQUENCY: (Initial Value)	ANY (60 Hz is standard)

PHASE ANGLE PROGRAM

PHASE ANGLE RANGE: (Phase B and C relative to A and Phase A relative to an optional external sync input)	0 to ±999.9 degrees in .1 increments.
DEFAULT (Phase C):	ANY, but 0 defines Single Phase. Any value except 1000 and 120 defines Two-Phase. 120 defines Three-Phase.
PHASE ACCURACY	
PHASE B AND C:	±1 degree; add 0.5 degrees per KHz above 2 KHz.
PHASE A:	±6 degrees to 500 Hz.

CURRENT LIMIT (Independent or simultaneous control of each phase)

RANGE:	0 to maximum current of power source (example 8.00 amps)
RESOLUTION:	1 part in 256 (example 0.04 amps for 8 amps Full Scale)
DEFAULT ACTION	will operate at programmed current limit for 0.1 seconds before defaulting to 0.0 volts.

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MEASUREMENT SPECIFICATIONS

VOLTS	
RANGE:	0.0 to 312.0 volts.
RESOLUTION:	0.1 Volt
ACCURACY:	±(0.2% RDG + 3 digits)
TEMPERATURE COEFFICIENT:	±0.05 volts per degree C
CURRENT (Crest Factor of 3 at 10 or 100 Amps increasing to 15 at 20% of range)	
RANGE:	10.00 or 100.0 Amps
RESOLUTION:	0.01 Amp or 0.1 Amp
ACCURACY:	±(0.3% RDG + 3 digits)
TEMPERATURE COEFFICIENT:	±0.016% of Full Scale current per degree C
POWER	
RANGE:	0.0 to 4000 watts or 40.00 KW.
RESOLUTION:	1 watt or 0.01 KW
ACCURACY:	±(0.4% RDG + 3 digits) to 500 Hz
TEMPERATURE COEFFICIENT:	~~±0.06% of Full Scale per degree C.~~
POWER FACTOR	
RANGE:	0.000 TO 1.000
PHASE (at Full Scale voltage)	
RANGE:	0 to 360 degrees
RESOLUTION:	0.1 degree
ACCURACY:	±1 degree to 500 Hz
FREQUENCY	
RANGE:	45 to 500 Hz
RESOLUTION:	Four decades
ACCURACY:	±0.02 Hz to 99.99 ±0.2 Hz to 500.0

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MEASUREMENT SPECIFICATIONS (continued)

VA

RANGE:	0.0 to 4000 VA or 40.00 KVA
RESULTION:	1 VA or 0.01 KVA
ACCURACY:	±(.5% RDG +6 digits) to 500 Hz

SQUARE WAVE OPERATION (Option)

RISE & FALL TIME:	Dependent on power source. Typically less that 40 usec.
DROOP:	Less than 2% at 50 Hz
OVERSHOOT:	Dependent on power source. Typically less than 10%.

SPECIFICATIONS (GENERAL)

INPUT POWER (MXT10/959XPT Combination)

NOMINAL	RANGE
115	104 to 132
100	87 to 110
208	191 to 229
220	198 to 242
230	207 to 253
240	216 to 265

NOTE

The input line voltage can be changed at the rear panel of the MXT10 with the range-change card inside the input power receptical.

FREQUENCY:	48 to 65 Hz
EXTERNAL SYNC INPUT:	45 Hz to 500 Hz.
REGISTERS:	16 Nonvolatile

DISPLAY

DATA:	Two lines, 16 characters long, of alphanumeric information.

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SPECIFICATIONS (GENERAL) [continued]

LOCAL CONTROL:	20-key keyboard.
REMOTE PROGRAMMING	
IEEE-488-1978 SUBSETS:	SH1, AH1, T6, L3, SR1, RL2, DC1, DT1
IEEE-728-1982 OPERATING CODES AND FORMATS:	NUMERIC REPRESENTATION; NR1, NR2 OR NR3. HEADERS; HR1 OR HR2 (UPPER OR LOWER CASE) MESSAGE SEPARATORS; SR1
DATA TRANSFER RATE:	200K bytes/second using DMA methods
END OF STRING:	(CR) & (LF) or (END), (LF) or (END)
DATA FORMAT:	Scientific notation or explicit point
DIMENSIONS:	
MXT10/959XPT:	Height 3.5" (89mm) Width 19.0" (483mm) Depth 18.0" (431mm)
NET WEIGHT:	
MXT10/959XPT:	12 pounds (6 kg)

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SECTION 2 INSTALLATION

2.1 GENERAL

This section of the manual describes the connections to the 959XPT and the power source or MXT10 Interface Module in which the 959XPT is installed. Connection of the power system is also described. Removal and installation instructions for the 959XPT are also provided.

2.2 UNPACKING

The 959XPT is shipped installed into its parent device. If damage has occured during transit, conduct a detailed inspection to determine if the 959XPT has been damaged. If damage is evident, notify the carrier's agent immediately. Retain the equipment and shipping carton in the same condition as received until it has been examined by the carrier's representative.

If the unit has been damaged in transit, DO NOT return it to California Instruments until authorized by the carrier's agent and return authorization has been issued by California Instruments. Refer to "PROCEDURE FOR SERVICE" on the warranty page of this manual for instructions on obtaining a return authorization.

2.3 POWER REQUIREMENTS

The 959XPT obtains its primary power from the device in which it is mounted.

CAUTION

Potentials up to 312 volts rms are present inside the 959XPT.

DEATH

On contact may result if safety precautions are not observed. Do not touch any of the internal circuits when power is applied.

2.4 FUSE REQUIREMENTS

There are three fuses, F1, F2 and F3, in the 959XPT. They are mounted on the CPU/GPIB Board (A3). They protect against overload and application of reverse polarity. The fuses are fabricated from strands of No. 24 stranded copper wire. If any fuse is blown for any reason, it should be replaced only with a piece of copper wire of the same size and length.

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2.5 REMOVAL/INSTALLATION

The 959XPT is mounted in its parent device at the factory. In the event it becomes necessary to remove the 959XPT from the parent device, the following removal and installation instructions should be followed.

CAUTION

REMOVE POWER FROM THE POWER SOURCE BEFORE REMOVING OR INSTALLING THE 959XPT.

To remove the 959XPT, first loosen the thumb screws in the display front panel. Remove the 959XPT module by pulling on the thumb screws.

The 959XPT consists of several circuit boards, fastened together into an assembly. To replace it in its parent device engage the bottom board of the circuit board assembly in the card guides of the power source. Push the assembly all the way into the power source to engage the connectors at its rear with those in the power source.

2.6 IEEE-488 CONNECTIONS

The 959XPT may be operated remotely by an IEEE-488 bus controller. Connections to the IEEE-488 bus are made at the rear of the MXT10 or 3-phase AC power source. Refer to the associated power source manual for instructions on connecting the IEEE-488 bus. Up to 15 instruments may be connected to the bus.

2.7 POWER SYSTEM INTERCONNECTIONS

The 959XPT may be directly inserted into some XP model power sources. Alternately, it may be installed into an MXT10 Interface Module to operate other power sources not mechanically compatible with the 959XPT.

The Remote Sense connections must be connected at the rear panel of the device containing the 959XPT. Refer to Figure 2-1 or Figure 2-2 for the proper connections.

2.7.1 959XPT WITH POWER SOURCE

2.7.1.1 POWER SYSTEM

The power system configuration of the 959XPT with a three-phase XP-Series power source is described in Figure 2-1. All XP power sources are non-inverting.

2.7.1.2 AUXILIARY INPUTS AND OUTPUTS

The auxiliary inputs and outputs available when a 959XPT is installed into an XP-Series power source is shown in Table 2-1.

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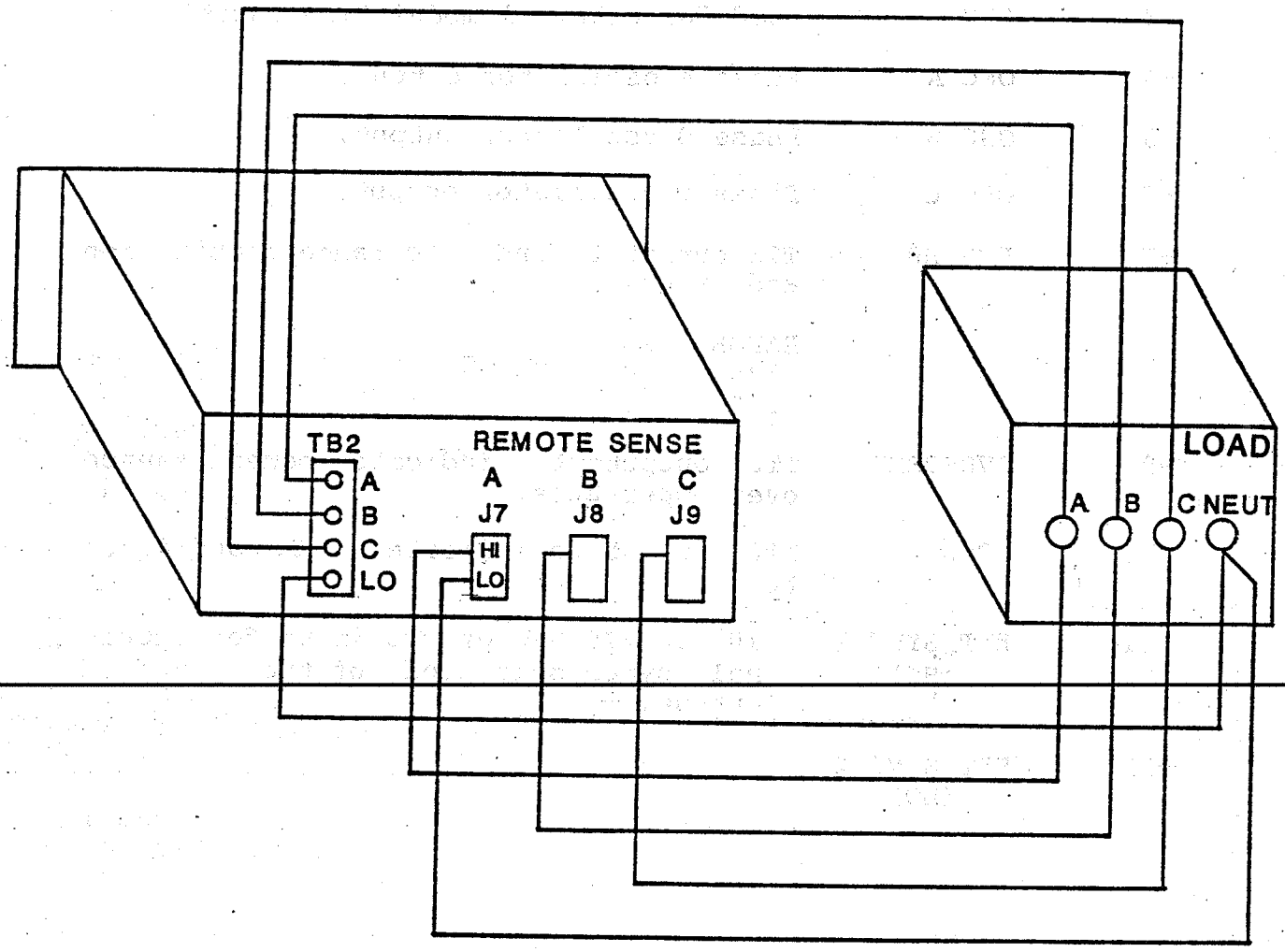


FIGURE 2-1
THREE PHASE XP POWER SOURCE CONFIGURATION

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XP POWER SOURCE REAR PANEL CONNECTOR	SYMBOL	FUNCTION
J1-1	CHASSIS	Connects to chassis of power source.
-2	COM	Common for all inputs and outputs to J1 and J2 except EXT SYNC.
-3	RPV	Used for external modulation input.
-4	OSC A	Phase A oscillator output.
-5	OSC B	Phase B oscillator output.
-6	OSC C	Phase C oscillator output.
-7	RNG R0	TTL output to indicate range combination and range. RANGE R0 135 H 270 L
-9	OVERTEMP	TTL output to indicate power source overtemperature.
-10	CNF	TTL output to indicate MATE Confidence test.
-11	EXT SYNC 1 (HI)	10 to 270 VAC or TTL input for external synchronization of the phase A output.
-12	EXT SYNC 2 (LO)	

TABLE 2-1

AUXILIARY CONNECTIONS TO XP POWER SOURCE

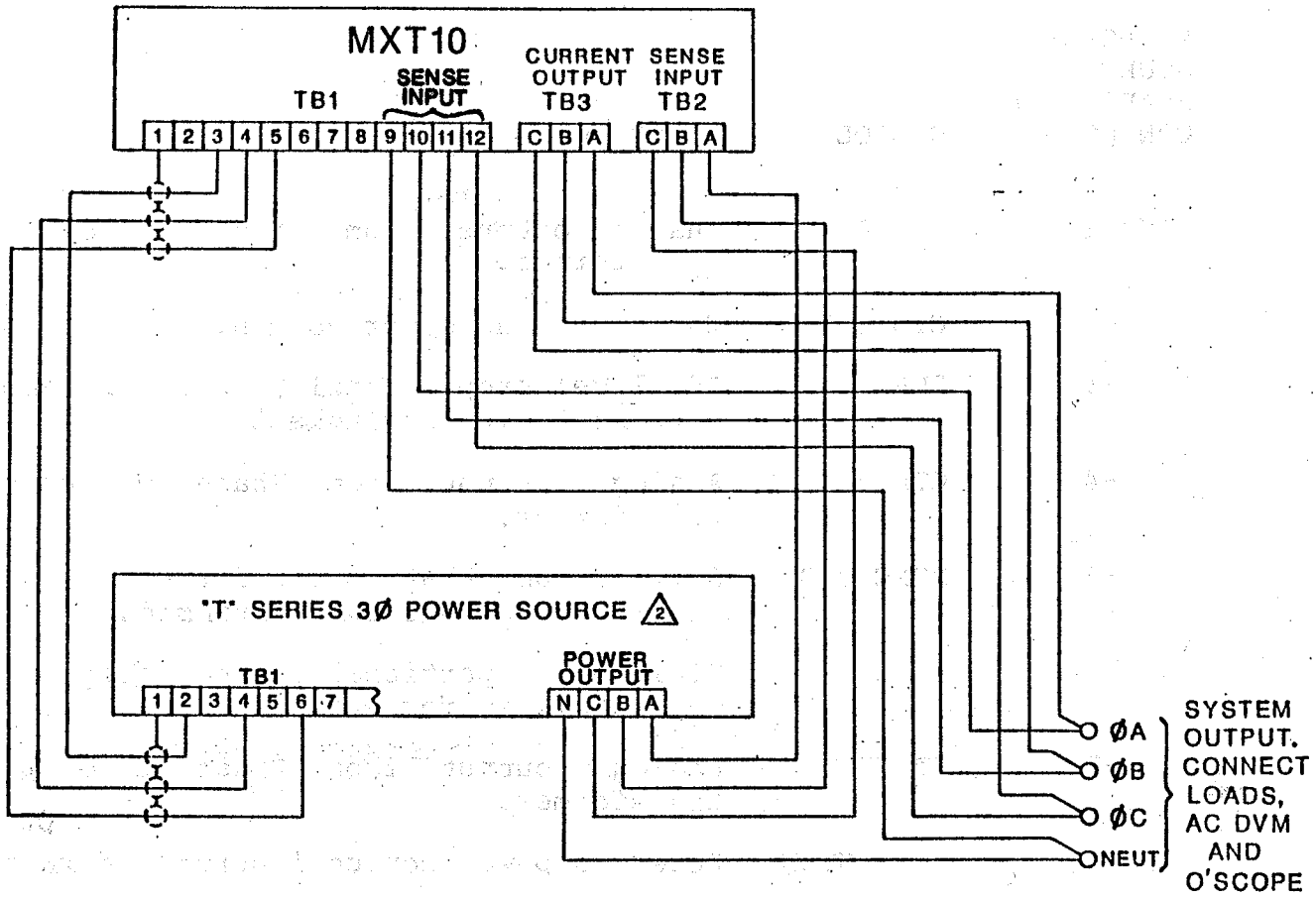
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XP POWER SOURCE REAR PANEL CONNECTOR	SYMBOL	FUNCTION
J2-1	CTH A	Analog output from Phase A current transformer.
-2	CTL COM	Current transformer common.
-3	CLA	DC level proportional to the prgrammed current limit for Phase A.
-4	CTH B	Analog output from Phase B current transformer.
-5	FUNC STB	A TTL strobe that is low for 0.6 ms when any output change is programmed.
-6	CLB	DC level proportional to the programmed current limit for Phase B.
-7	CTH C	Analog output from Phase C current transformer.
-8	REM SHTDN	Refer to power source instruction manual.
-9	CLC	DC level proportional to the programmed current limit for Phase C.
-11	SYS SHTDN	Refer to power source instruction manual.
J3	CLOCK	(Option) TTL output or input with frequency 1024 times the output frequency.
J4	LOCK	(Option) TTL output or input 180 degrees relative to the Phase A output.
J5	GPIB	IEEE-488 interface connection.
J6	DFI	(Option) A contact closure to indicate a catastropic failure. MATE system.

TABLE 2-1 (continued)

AUXILIARY CONNECTION TO POWER SOURCE

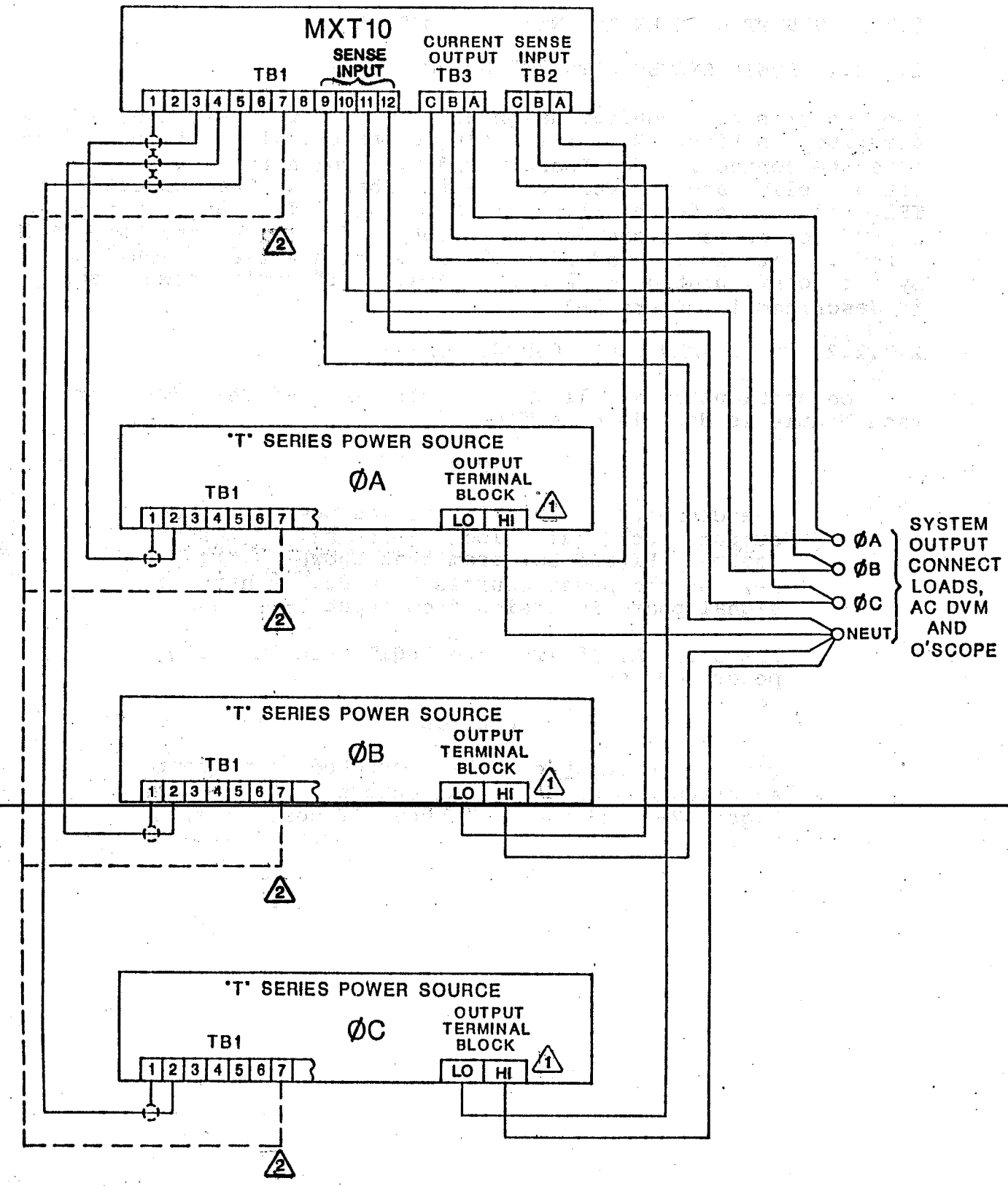
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(2) 153T, 503T, 1503TC, 2253TC

FIGURE 2-3
MXT10 POWER SYSTEM INTERCONNECT
WITH 3 PHASE T SERIES POWER SOURCE

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1. CONNECTIONS SHOWN AT OUTPUT TERMINAL BLOCK FOR INVERTING POWER SOURCE; 1001TC, 1501TPM, 3001TCA. REVERSE CONNECTIONS FOR NON-INVERTING POWER SOURCE.
2. CONNECTION SHOWN FOR RANGE CHANGE. CONNECTION SHOULD BE TO TB11 PIN 1 FOR THE 3001TCA INSTEAD OF TB1 PIN 7.

FIGURE 2-2 A

MXT10 WITH SINGLE PHASE T-SERIES POWER SOURCE

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2.7.2 959XPT WITH MXT10 INTERFACE MODULE

2.7.2.1 POWER SYSTEM WITH "T" SOURCES

The power system configuration with "T" series power sources is described in Figure 2.2 For a single-phase configuration, eliminate the connection for Phase B and C. For a two-phase configuration, eliminate the connections for Phase B. The connection to TB1, pin 7, is for a voltage range change. The range change for a "T" series power sources is an option for all except the TPM series. It is a standard feature for this series. The power system configuration with a three-phase "T" series power source is described in Figure 2-3.

2.7.2.2 MXT10 REAR PANEL CONNECTIONS

The connections available at the rear panel of the MXT10 Interface Module is described in Table 2-2.

NOTE

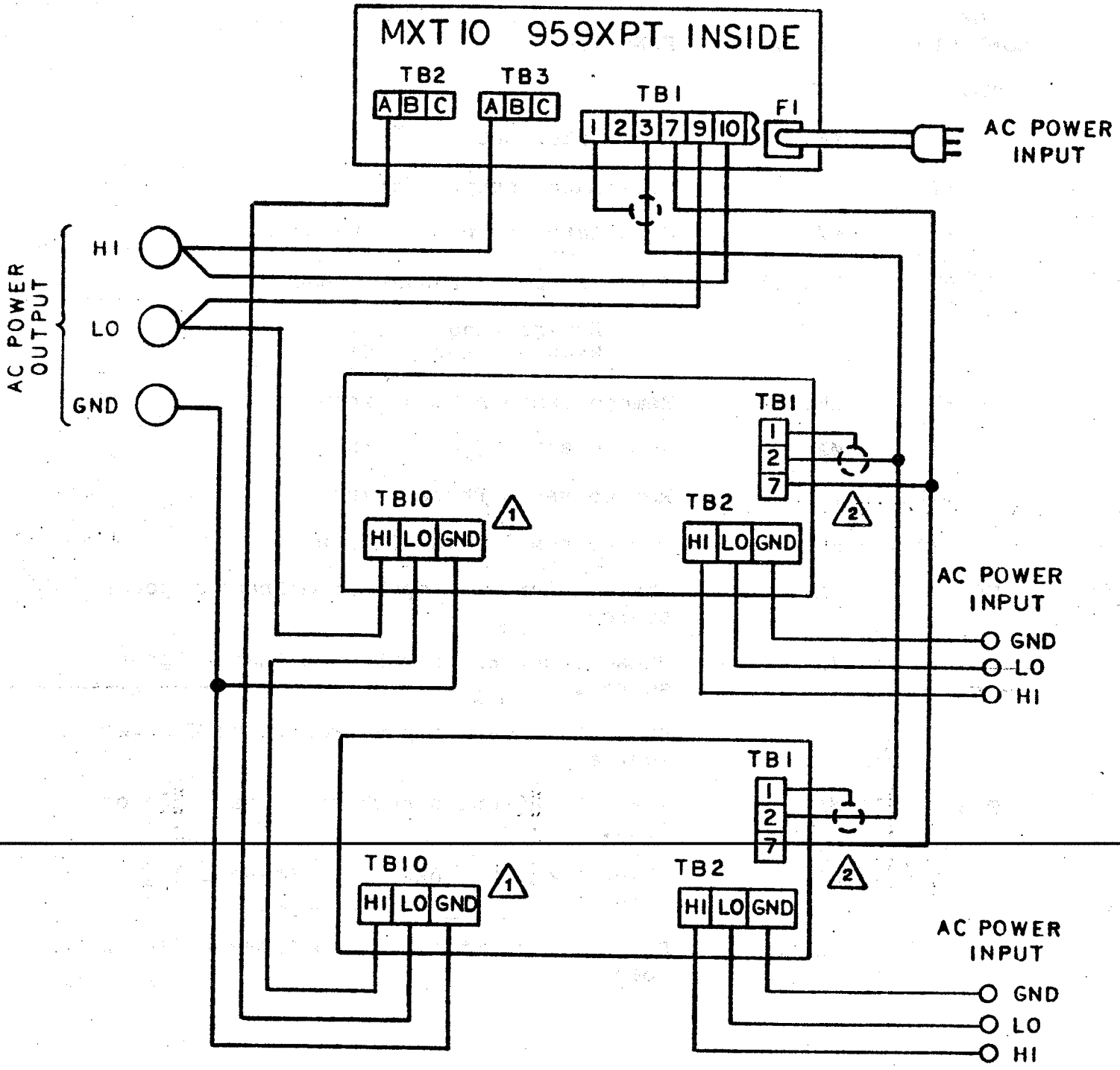
The connections to the T-Series power source output terminal block must be reversed (output HI and LO) from that shown in Figure 2-2 for the power sources that do not have a signal phase inversion from input to output.

The 3001TCA, 1501TPM and 1001TC are inverting power sources.

CAUTION

The sense input must be connected to prevent an erroneous or dangerous output. Refer to Figure 2-2 and the note above if necessary.

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1. CONNECTIONS SHOWN AT OUTPUT TERMINAL BLOCK ARE FOR INVERTING POWER SOURCE; 1001TC, 1501TPM, 3001TCA. REVERSE CONNECTIONS FOR NON-INVERTING POWER SOURCE.

2. CONNECTIONS SHOWN FOR RANGE CHANGE. CONNECT TO TB11 PIN 1 INSTEAD OF TB1 PIN 7 FOR 3001TCA.

FIGURE 2-2B

MXT10 WITH SERIES SINGLE PHASE T-SERIES POWER SOURCES

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MXT CONNECTOR	SYMBOL	FUNCTION
TB1-1	COM	
-3	øA	Oscillator output for Phase A
-4	øB	Oscillator output for Phase B
-5	øC	Oscillator output for Phase C
-7	RNG R0	TTL output for range-change Lowest range = Low Highest range = Hi
-9	NEUT	Remote sense neutral input
-10	øA	Remote sense Phase A input
-11	øB	Remote sense Phase B input
-12	øC	Remote sense Phase C input
TB2	øA	Phase A current input from Phase A power source.
	øB	Phase B current input from Phase B power source.
	øC	Phase C current input from Phase C power source
TB3	øA	Phase A current output to Phase A leg of load.
	øB	Phase B current output to Phase B leg of load.
	øC	Phase C current output to Phase C leg of load.

TABLE 2-2

MXT10 REAR PANEL CONNECTIONS

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MXT CONNECTOR	SYMBOL	FUNCTION
J1	CLOCK	(Option) TTL output or input with frequency 1024 times the output frequency.
J2	LOCK	(Option) TTL output or input 180 degrees relative to the Phase A output.
J3	DFI	(Option) A contact closure to indicate a catastrophic failure. MATE system.
J5-2	CNF	TTL output to drive Application relay.
-3	FAULT	
-8	FUNC STB E	Emitter of opto coupler
-9	FUNC STB C	Collector of opto coupler The Function Strobe (FNC STB) opto coupler is open circuit for .001 seconds when any output parameter is programmed. The opto coupler should have a .5 milliamp pull-up.
-10	RPV	External modulation input.

TABLE 2-2 (continued)

MXT10 REAR PANEL CONNECTIONS

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SECTION 3

LOCAL OPERATION

3.1 GENERAL

The following section describes the control of the 959XPT from the front panel keyboard as well as from the remote interface, IEEE-488.

The front panel keyboard will be enabled whenever the REMOTE light is extinguished.

The CONTRAST control on the front panel of the 959XPT may be adjusted to optimize the viewing angle of the 959XPT display.

The 959XPT may be manually programmed by using the front panel keyboard and observing the front panel display.

3.2 KEYPAD

Figure 3-1 shows the front panel keypad. Table 3-1 lists the key and a brief description. While viewing any Ouput Parameter screen (Ref. Table 3-2), the screens may be viewed in increasing order by depressing the MON key and in decreasing order by depressing the PRG key. While viewing the Measurement Screens, the MON and PRG keys work in a similar fashion.

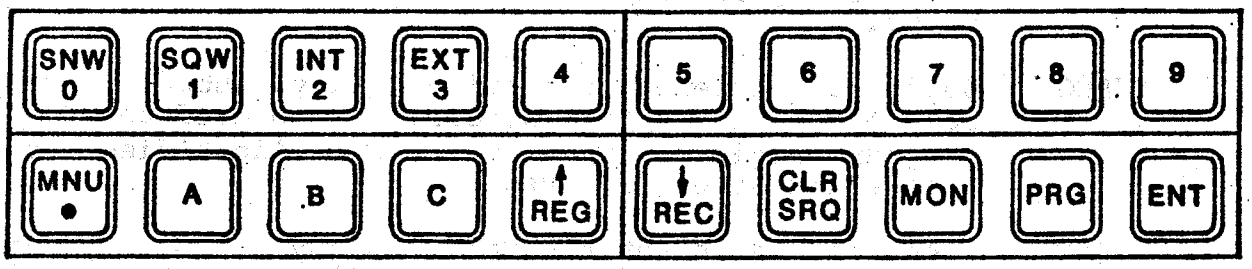


FIGURE 3-1

FRONT PANEL KEYPAD

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KEY	DESCRIPTION
SNW/0	Inputs the value "0" for all output parameters or to select screen "0" when followed by the ENT key. Also used to select the sine wave waveform.
SQW/1	Inputs the value "1" for all output parameters or to select screen "1" when followed by the ENT key. Also used to select the square wave waveform.
INT/2	Inputs the value "2" for all output parameters or to select screen "2" when followed by the ENT key. Also used to select the Internal Synchronize or Internal Clock modes of operation.
EXT/3	Inputs the value "3" for all output parameters or to select screen "3" when followed by the ENT key. Also used to select the External Synchronize or External Clock modes of operation.
4 through 9	Inputs the indicated numeric value for all output parameters or to select the corresponding screen when followed by the ENT KEY.
MNU/.	Selects the Menu screens that show all display screens and the corresponding numeric value. The decimal point function of this key is enabled after any numeric key is depressed.
A	Used to direct any parameter change to phase A. Also used to update any quantity in the display identified as A=.
B	Used to direct any parameter change to phase B. Also used to update any quantity in the display identified as B=.
C	Used to direct any parameter change to phase C. Also used to update any quantity in the display identified as C=.
↑/REG	Used to increment the value in any output parameter screen or calibration screen. Also used to load the program register into any register identified by the preceeding numeric value.
↓/REC	Used to decrement the value in any output parameter screen or calibration screen. Also used to recall the program register identified by the preceeding numeric value.

TABLE 3-1

KEYPAD KEY DESCRIPTION

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KEY	DESCRIPTION
CLR/SRQ	Used to clear the numerical inputs for the display screen.
MON	Used to display programmed output parameter values. Used repeatedly, it will cause the display screens of increasing numeric numbers to be displayed.
PRG	Used to program setup values in the Program Register. Used repeatedly, it will cause the display screens of decreasing numeric numbers to be displayed.
ENT	Used to transfer the contents of the program register to the actual output parameters.

TABLE 3-1 (continued)

KEYPAD KEY DESCRIPTION

3.3 DISPLAY SCREENS

A display of data on the 959XPT front panel display is called a screen. The 959XPT displays five types of screens: menu, output parameter, measurement, configuration screens and error screens. Refer to Figure 3-2 for the various error screen messages.

3.3.1 MENU SCREENS

Menu screens display the screen abbreviation with its equivalent number. After power-on, the 959XPT will show the following menu screen after the MNU key is depressed:

```
RNG = 04        AMP = 05
FRQ = 06        PHZ = 07
```

The numeric value for each item in a menu screen is the code that may be used to select the screen. Tables 3-2 through 3-4 show the numeric values for all screens. Without the aid of the tables the MNU key may be used.

The menu screens will display only the programmable features that are enabled and their associated screen number.

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3.3.2 OUTPUT PARAMETER SCREENS

Table 3-2 shows all of the available Output Parameter screens. The 959XPT may not display all of the screens since some program parameters are optional. While viewing any of the screens, the associated output parameter may be changed from the keyboard.

3.3.3 MEASUREMENT SCREENS

Table 3-3 shows all of the Measurement screens. When accessing some Measurement screens up to three seconds may be required to display the screen.

3.3.4 CALIBRATION SCREENS

Table 3-4 shows all of the screens for calibrating the output and measurement functions. A special code is required to access these screens. Refer to Section 5, Calibration.

3.3.5 CONFIGURATION SCREENS

Table 3-5 shows all of the Configuration screens. The only value that is user programmable is the IEEE-488 (GPIB) Listen Address.

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NO.	SCREEN NAME	EXTENSIONS	ARGUMENT	ACTION TAKEN
The following are for changing the output:				
0	THD	A, B, C	0-20	Sets the output distortion from 0 to 20%.
1	SNC		INT, EXT	Selects phase A to be synchronized to an external input.
*2	CLK		INT, EXT	Selects the external clock mode of operation.
*3	WVF		SNW, SQW	Sets the output waveform.
4	RNG		Range limit	Selects the output voltage range. Range limit values of 156 and 312 are standard.
5	AMP		0-RNG limit	Sets the output voltage amplitude.
6	FRQ		45-FRQ limit	Sets the output frequency. The FRQ limit is typically 500 Hz.
7	PHZ	A, B, C,	0-±999.9	Sets the output phase angle.
*8	CRL	A, B, C	0-X	Sets the output current limit. X is the maximum rated current per phase.

*Optional screen.

TABLE 3-2

OUTPUT PARAMETER SCREENS

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NO.	SCREEN NAME	EXTENSIONS	ARGUMENT	ACTION TAKEN
9	RMP A	DLY	0.001-9999	Sets the Delay between ramp steps in seconds. Four decade resolution from 0.001 to 9999 seconds.
		STP		Sets the step size of ramp parameter.
		VAL		Sets the final value of the parameter ramped.
	RMP B	STP		Same as RMPA
		VAL		Same as RMPA

NOTE: RMPA and RMPB screens are not accessible until AMP, FRQ, CRL or PHZ are programmed (PRG) but not yet entered (ENT).

TABLE 3-2 (continued)

OUTPUT PARAMETER SCREENS

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NO.	SCREEN NAME	EXTENSIONS	ARGUMENT	ACTION TAKEN
The following are for measured values.				
11	ELT	H, M, S	Hrs,Min,Sec	Reports the total accumulated run time up to 99,999 hours.
21	VLT	A, B, C	0-312.0	Measures the TRMS output voltage.
22	CUR	A, B, C	0-X	Measures the TRMS output current in Amps. X is either 20.00 or 100.0.
23	PWR	A, B, C	0-X	Measures the True output power. X is either 4000 watts or 40.00 kilowatts.
24	PWF	A, B, C	0-1.000	Measures the power factor of the load.
25	APW	A, B, C	0-X	Measures the apparent output power. X is either 4000 VA or 40.00 KVA.
26	FQM		45-500	Measures the output frequency in hertz.
27	PZM	A, B, C	0-359.9	Measures the phase angle of the output voltage relative to phase A and phase A relative to an external input.

TABLE 3-3

MEASUREMENT SCREENS

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NO.	SCREEN NAME	EXTENSIONS	ARGUMENT	ACTION TAKEN
13	CAL VLT	A, B, C	0-255	Calibrates the measured voltage.
14	CAL CUR	A, B, C	0-255	Calibrates the measured current.
15	CAL PWR	A, B, C	0-255	Calibrates the measured power.
20	POF	A, B, C	0-±359.9	Calibrates the programmed output phase angle.

TABLE 3-4

CALIBRATION SCREEN

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NO.	SCREEN NAME	EXTENSIONS	ARGUMENT	ACTION TAKEN
16	CFG	A(LSN)	0-30	Sets the IEEE-488 (GPIB) Listen Address.
		B(CFG)	*0-4095	Defines the features enabled for Power Source compatibility.
		C(PHZ)	*0-359	Defines the phase C initial value for power system configuration.
17	ALM	A(RNG)	*0-16	Code that defines the default voltage range.
		B(LLM)	*0-40.00 or 400.0	Defines the upper limit of the lower voltage range.
		C(HLM)	*0-40.00 or 400.0	Defines the upper limit of the higher voltage range.
18	FLM	A(FRQ)	*LLM-HLM	Defines the default frequency.
		B(LLM)	*45-9999	Defines the low frequency limit.
		C(HLM)	*45-9999	Defines the high frequency limit.
19	CLM	A(RNG)	*Any value	Defines the maximum current limit value.
		B(PRS)	*0-3	Defines the decimal point location for measured power.
		C(CRS)	*0-3	Defines the decimal point location for measured current.

*NOT USER PROGRAMMABLE

TABLE 3-5

CONFIGURATION SCREENS

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3.4 TO PROGRAM THE OUTPUT

NOTE

When the 959XPT is used with a California Instruments MXT10 Drawer, it requires the external sense wiring to be connected as shown in Figures 2-2 or 2-3. If they are not properly connected, an erroneous output will appear from the power sources.

3.4.1 AMPLITUDE

Select the Amplitude (AMP) screen by entering keystrokes:

5 ENT

The display now shows the AMP parameter screen:

```
AMP  MON     A = 0.0
B = 0.0      C = 0.0
```

NOTE: The B and C values are only displayed with either a two or three-phase configuration.

Program all outputs to 115.5 volts with the keystrokes:

115.5 PRG ENT

NOTE: The 959XPT does not allow independent control of the output voltage for phase A, B or C.

To slowly increase the output amplitude:

↑ (Hold until desired value is obtained.)

3.4.2 FREQUENCY

Select the Frequency (FRQ) screen by entering the keystrokes:

6 ENT

Program the output to 60.23 hertz:

60.23 PRG ENT

To incrementally increase the output frequency to adesired value:

↑ (Hold until desired frequency is reached.)

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3.4.3 PHASE ANGLE

Select the Phase (PHZ) screen by entering

7 ENT

Program phase C to .5 degree relative the phase A:

0.5 C PRG ENT

The up (↑) and down (↓) keys may be used to increment or decrement any or all output phases.

To slowly increment the phase angle of phase B leading phase A, depress the following keys:

B PRG ↑(Hold until desired value is obtained.)

3.4.4 CURRENT LIMIT (CRL = 8)

Current Limit programming is usually enabled for the 959XPT. If the screen cannot be selected, the option is not enabled.

The Current Limit can be programmed independently or simultaneously for each phase of the 959XPT.

A CRL value of 0 will inhibit the response of the 959XPT to a current limit fault. With other CRL values, the 959PXT will respond within .1 seconds to a fault.

NOTE

The MXT10 programs in rms amps. The 3-phase XP-sources program in peak amps.

1. Select the Current Limit screen by entering:

   8 ENT

2. Program all phases to 5 amps:

   5 PRG ENT

3.4.5 VOLTAGE RANGE (RNG=04)

The RNG screen has two purposes; to select a range defined by the range pair selected in the Amplitude Limit (ALM) screen and to select an upper voltage limit less than that specified by the ALM screen, LLM or HLM values. If the range pair 135/270 has been selected in the ALM screen with LLM=135 and HLM=270, the 135 range of the power source will be programmed by the RNG screen for any value of 135 or less. The value programmed will then be the maximum value allowed to be programmed in the Amplitude (AMP) screen.

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To select the 270 range and set a program amplitude limit of 250 volts, perform the key sequence below:

4 ENT 250 PRG ENT

NOTE

If the LLM values is the same as the HLM value, the 959XPT will not attempt to range-change the power source.

3.4.6 RAMP OR STEP FUNCTIONS (RMP=9)

The Ramp (RMP) function allows any programmable parameter (AMP, FRQ, PHZ, CAL or CRL) to be Stepped (STP) with a Delay (DLY) for each step to a final value (VAL).

There are three types of programs that may be specified by the RMP screen; a ramp and two types of step programs.

The step function will program the output parameter value specified by a previous screen for the time specified for the DLY value in seconds. The parameter will then return to a final value specified by the VAL value.

The ramp function will step the output parameter value specified by a previous screen with the STP value, the DLY time per step and the final VAL setup in the RMP screen. The ramp will increment if the VAL value is larger than the parameter value. It will decrement if it is less than the parameter value.

NOTE

The DLY, STP or VAL parameters must be specified (A, B or C key depressed) before the number value for the parameter is entered.

When ramping frequency, an error message will result with an attempt to step the frequency with greater resolution than that possible by the initial or final values. The frequency resolution is four decades.

The step program may also be used to generate a dropout to zero volts on phase A at any point on the waveform. This type of program is selected by setting the AMP value to zero before setting the DLY and VAL parameters. The point on the waveform at which the dropout occurs is specified by the A value in the (PHZ) screen.

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The following key sequence will program 130V for 2.5 seconds and then return to a final value of 115V.

1. Select the AMP screen and enable 130 volts to be programmed:

   5 ENT 130 PRG (*)

2. Select the RMP screen, program a DLY of 2.5, a final VAL of 115 volts and run the program:

   9 ENT A 2.5 PRG C 115 PRG ENT

The next example will illustrate a ramp program. The following sequence will ramp the frequency from 60 hertz to 400 hertz in .1 hertz steps with a delay (DLY) for each step of .003 seconds. The total time for this ramp will be = [(VAL-FRQ)/STP]DLY or 10.2 seconds.

1. Select the FRQ screen and set the starting frequency of 60 Hz:

   6 ENT 60 PRG

2. Select the RMP screen, set a DLY of .003, set the STP of .1, set the final VAL of 400 and run the program:

   9 ENT A 0.003 PRG B 0.1 PRG C 400 PRG ENT

The following program will illustrate a dropout to zero volts. The program will drop the amplitude to zero volts at 90 degrees for .002 seconds and return to 115 volts.

1. Select the AMP screen and program to 115 volts:

   5 ENT 115 PRG ENT

2. Select the PHZ screen and program A to 90:

   7 ENT 90 A PRG ENT

3. Select the AMP screen and program the dropout voltage to zero volts:

   5 ENT 0 PRG

4. Select the RMP screen. Set a delay of .002 seconds and a return value of 115 volts:

   9 ENT A 0.002 PRG C 115 PRG

5. Execute the program by depressing the ENT key.

(*)If the ENT key is depressed at this point, the AMP would be programmed to and remain at 130 volts.

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NOTE

Any ramp may be terminated at any time by depressing the ENT key.

3.4.7 WAVEFORM (WVF = 3)

The waveform selection is an option for the 959XPT. If the screen cannot be selected the option is not enabled.

The WVF screen displays the type of waveform selected, sine wave (SNW) or square wave (SQW), for the output. To program a square wave, depress the SQW or any odd number key followed by the PRG key and ENT key. The new waveform will be simultaneously programmed for all outputs.

To program the output to square wave:

SQW PRG ENT

To select the sine wave waveform depress the SNW or any even number key followed by the key sequence described above.

NOTE

Depressing key 4 while viewing the WVF screen will select an auxiliary waveform to be programmed. If no waveform was specified when the 959XPT was ordered, a square wave will be programmed equal to the peak value of the equivalent sine wave.

3.4.8 SYNCHRONIZATION (SNC = 1) AND ERROR MESSAGES

The SNC screen displays whether the external or internal SNC mode of operation has been selected. While viewing this screen to select the external SNC mode depress the EXT key followed by the PRG and ENT key:

Example: EXT PRG ENT

While operating in the EXT SNC mode, the FRQ screen will display the frequency of the External Sync signal. The signal must be between the Low Frequency Limit and the High Frequency Limit.

NOTE

When viewing the SNC, CLK or WVF screens the MON or PRG keys must be used to sequence to the desired screen. The MNU key can also be used to return to the menu then followed by any screen selection.

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To return to the internal SNC mode of operation, depress the INT key or any even numeric key followed by the PRG and ENT key while viewing the SNC screen.

Example: INT PRG ENT

If the External Sync signal is not between the Low Frequency Limit and the High Frequency Limit, an error message will be displayed. See Figure 3-2. In addition, the 959XPT will return to the INT mode of operation.

In the EXT SNC mode the A value on the PHZ screen represents the angle of the A output leading the External Sync input. If the zero degree point of the power source does not match the zero degree point of the External Sync input, the POF screen may be used for calibration. Select the POF screen and enter a value for calibration.

CRL FAULT
TEMP FAULT
CPU MEMORY FAULT
DMA OVERFLOW
DIV ERROR
OVERFLOW ERROR
EXT SYNC ERROR
BUS LOCAL ERROR
SYNTAX ERROR
AMP RANGE ERROR
FRQ " "
PHZ " "
CRL " "
RMP " "
RNG " "

FIGURE 3-2

ERROR MESSAGES

3.4.9 CLOCK (CLK = 2)

The clock selection is an option for the 959XPT. The CLK screen displays whether the 959XPT is operating in the external (EXT) or internal (INT) CLK mode of operation. While viewing this screen to select the EXT CLK mode, depress the EXT key followed by the PRG and ENT key:

Example: EXT PRG ENT

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NOTE

Before selecting the External Clock mode, ensure that the power source containing the the 959XPT has the proper clock and lock signals applied to the BNC connectors at the rear panel. Failure to have the proper clock and lock signals when the EXT CLK mode of operation is selected may result in damage to the power source.

To return to the internal (INT) CLK mode of operation, depress the INT or any even numeric key followed by the PRG and ENT key while viewing the CLK screen.

Example: INT PRG ENT

3.4.10 REGISTERS AND RAMPS

The 959XPT has 16 registers that can be used to store setups. All of the data stored in the registers will be retained during power-down. Each 959XPT register operation may be chained to another register by adding the REC and register number to any setup sequence.
The REC and REG keys are used for register operations. Any of the previous examples may be stored in a register by adding the extra step of entering the register number followed by depressing the REG key. This extra step must be entered before the last ENT keystroke.

The following program will program 135 volts and 60 hertz on all outputs for 10 seconds before reducing the output to 115 volts and store the test in register 0.

1. Select the FRQ screen and program 60 hertz:

   6 ENT 60 PRG

2. Select the AMP screen and program 135 volts:

   5 ENT 135 PRG

3. Select the RMP screen and program DLY = 10 and VAL = 115:

   9 ENT A 10 PRG C 115 PRG

4. Store the program in register 0:

   0 REG

To recall and perform the register operation, simply enter the register number followed by depressing the REC and ENT keys.

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3.4.10.1 REGISTER LINKING

Any number of registers may be linked together by using the REC key prior to loading the register operation.

The following program will ramp the voltage from 115 volts and 60 hertz to 135 volts with .1 volts per 10 millisecond steps, remain at 135 volts for 10 seconds, return to 115 volts at the same rate but at 62 Hz. Store the program in Registers 1 and 2.

1. Select the FRQ screen and program 60 Hz:

   6 ENT 60 PRG

2. Select the AMP screen and program 115 volts:

   5 ENT 115 PRG

3. Select the RMP screen and program DLY = 0.01, STP = 0.1 and VAL = 135:

   9 ENT A 0.01 PRG B 0.1 PRG C 135 PRG

4. Link this program to Register 2:

   2 REC

5. Store this program in Register 1:

   1 REG ENT

The second portion of the program will be stored in Register 2.

6. Select the FRQ screen and program 62 Hz:

   6 ENT 62 PRG

7. Select the AMP screen and program 135 volts:

   5 ENT 135 PRG

8. Select the RMP screen and program DLY = 0.01, STP = 0.1 and VAL = 115:

   9 ENT A 0.01 PRG B 0.1 PRG C 115 PRG

9. Store this program in Register 2:

   2 REG ENT

To initiate the program:

1 REC ENT

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3.4.10.2 SIMULTANEOUS RAMPS

Two outputs may be simultaneously ramped or stepped by enabling two parameter screens. The screen first selected will be the dependent parameter. The last parameter screen selected before entering the ramp (RMP) screen is the independent parameter. The independent parameter is used to specify the number of steps in a ramp. Since the dependent parameter has as many steps as the independent parameter, the step (STP) size must be calculated so the dependent parameter will not exceed its maximum value. The following example will specify frequency as the independent parameter and phase as the dependent parameter.

The following example will ramp frequency from 360 to 440 Hz at a rate of .2 Hz per .2 second, while each .2 Hz step causes the amplitude to go from 10 volts to 210 volts in .5 volt steps.

1. Select the AMP screen and specify the starting voltage of 10 volts:

   5 ENT 10 PRG

2. Select the FRQ screen and specify the starting frequency of 360 Hz.

   6 ENT 360 PRG

3. Select the RMP A screen and specify the ramp parameters of the independent parameter, FRQ, of DLY = .2 seconds, STP = .2 Hz and VAL = 440 Hz:

   9 ENT A 0.2 PRG B 0.2 PRG C 440 PRG

4. Select the RMP B screen and speciffy the ramp parameter of the dependent parameter, AMP, of STP = .5 volts:

5. At this point the program may be executed by depressing the ENT key or stored in a register.

The final value of the dependent parameter, AMP, will be determined by the number of steps of the independent parameter and the STP value, .5V specified in RMP B.

FINAL VALUE = INITIAL VALUE + (RMP B STP) (NO. STEPS)
NO. STEPS = (DEP. PAR.) (FINAL VALUE - INITIAL VALUE)/STEP SIZE

In this example:

NO. STEPS = (440 - 360)/.2 = 400

FINAL AMP VALUE = 10 + .5 X 400 = 210 Volts

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3.4.11 TOTAL HARMONIC DISTORTION (THD)

The Total Harmonic Distortion screen is used to program independently or simultaneously the distortion for phase A, B and C. The program range is from 0 to 20% with 1% program resolution.

The following example will program the output voltage to 115 volts. Phase B will have 10% distortion for 1 second.

1. Select THD screen

   0 ENT

2. Enable phase B to be programmed to 10% distortion

   10 B PRG

3. Select the AMP screen and enable all outputs to be set to 115.0 volts.

   5 ENT 115 PRG

4. Select the RMP A screen and specify the output distortion and voltage time of 1 second and a final value of 115 volts:

   9 ENT A 1 PRG C 115 PRG

5. Recall a register where the undistorted waveform will be specified. Register 1 will be used in the example. Store the operation in register 0:

   1 REC 0 REG ENT

6. Enable the waveform to be undistorted and remain at 115.0 volts for 10 seconds before dropping to 0.0 volts.

   0 ENT 0 PRG 5 ENT 115 PRG 9 ENT A 10 PRG C 0 PRG 1 REG ENT

At this point the program may be performed by depressing:

0 REC ENT

3.5 TO MEASURE THE OUTPUT

Six of the measurement screens display the phase A, B and C outputs simultaneously. These six screens are for voltage, current, power, apparent power, power factor and phase. The measurement screen for frequency displays only a single value.

While viewing any measurement screen, any other measurement screen may be displayed by repeatedly depressing either the MON or PRG keys.

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The screen may also be displayed by entering its equivalent screen number followed by depressing the ENT key. Refer to Table 3-3 for all measurement screen numbers.

3.5.1 VOLTAGE (VLT = 21)

The voltage screen displays the actual TRMS output voltage with 0.1 volt resolution. This voltage is the voltage at the Remote Sense connector of the XP-power source or MXT10.

To access the voltage screen, depress the keys:

21 ENT

3.5.2 CURRENT (CUR = 22)

The current screen displays the actual TRMS load current. The resolution depends on the available current from the power source. It is 0.01 amp for a 10 amp range or 0.1 amp for a 100 amp range. Refer to Table 3-6 for the expected current resolution. If the power source has two ranges, the current resolution will be for the highest maximum current for the lowest voltage range.

3.5.3 POWER (PWR = 23)

The power screen displays the actual true power delivered to the load. The resolution depends on the output voltage range and the available current and power from the power source. Refer to Table 3-6 for the expected power resolution.

3.5.4 POWER FACTOR (PWF = 24)

This screen displays the power factor to 1.000 with 0.001 resolution. ~~The PWF screen will read unity for loads less than 10~~ digits on the Watt (PWR) screen (10 watts or .01 KW). When this screen is displayed after another screen, it takes approximately two seconds to update the screen.

3.5.5 APPARENT POWER (APW = 25)

This screen is accessed by its screen number, 25. It displays either VA or KVA with a resolution of either 1 VA or .01 KVA. The resolution is equal to the resolution of the power screen.

3.5.6 FREQUENCY (FQM = 26)

This screen is accessed by its screen number, 26. It displays the measured output frequency with a resolution of 0.01 Hz, 0.1 Hz or 1 Hz up to 99.99 Hz or 500.0 Hz, respectively.

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3.5.7 PHASE ANGLE (PZM = 27)

This screen is accessed by its screen number, 27. It displays phase A relative to an external synchronizing input and phase B and C relative to phase A. The resolution is 0.1 degree.

3.5.8 ELAPSED TIME (ELT = 11)

This screen displays the total run time accumulated on the 959XPT up to 99,999 hours.

H = Hours

M = Minutes

S = Seconds

TABLE 3-6

CURRENT MEASUREMENT AND POWER RESOLUTION

POWER SOURCE VOLTAGE RANGE	MAXIMUM POWER SYSTEM CURRENT (Amps)	CURRENT RESOLUTION (Amps)	POWER ABSOLUTION
156	10	.01	1 watt
156	100	.1	.01 kilowatt
312	10	.01	1 watt
312	100	.1	.01 kilowatt

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SECTION 4 REMOTE PROGRAMMING WITH ABBREVIATED PLAIN ENGLISH (APE)

4.1 GENERAL

Remote programming for the 959XPT IEEE-488 GPIB interface consists of sending the unit address and the proper ASCII alphanumeric characters to identify the parameter and the numerical value or other argument. The description of the abbreviations for GPIB messages used in this section are listed in Table 4-1.

These abbreviations must not be confused with the device dependent abbreviations used to describe the 959XPT operating parameters (ex. FRQ=Frequency, etc.).

4.2 UNIT ADDRESS

This is the A value (LSN) set in the CFG screen. The Unit Address 0 through 30 corresponds to the HEX value 20 through 3E. Refer to Table 4-2 for the equivalent HEX, Binary, ASCII and Decimal equivalents. The Unit Address is set at the factory to 1.

To select the CFG screen repeatedly depress the MNU key until menu screen #1 is displayed as illustrated below:

```
THD = 00        SNC = 01
CLK = 02        WVF = 03
```

Enter the key sequence: 959 ENT

Repeatedly depress the MNU key until the menu screen #5 is displayed as illustrated below:

```
CFG = 16        ALM = 17
FLM = 18        CLM = 19
```

Enter the key sequence: 16 ENT

The CFG screen will now be displayed. Depress the A key to display the present Unit Address. It may be changed to any value from 0 to 30.

The following key sequence will change the unit address to 16:

16 PRG ENT

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TABLE 4-1

COMMONLY USED GPIB ABBREVIATIONS

ABBREVIATION	DEFINITION
ATN	Attention. A logic line on the GPIB asserted only by the controller to indicate the data on the bus represents a bus message.
CR	An ASCII carriage return.
DCL	Device Clear. A universal bus message to initialize all instruments to their power-on states.
END	End. A message conveyed when a talker uses the EOI line with the last data byte of a data string.
EOI	End Or identify. A logic line on the GPIB asserted by a talker to indicate the last byte of a data string.
EOS	End Of String. A delimiter message that consists of a data byte(s) to indicate the end of a data string.
GET	Group Execute Trigger. A GPIB message to trigger an addressed instrument.
GTL	Go To Local. A GPIB message to put an addressed instrument in the local control mode.
IFC	Interface Clear. A logic line on the GPIB asserted by the controller to clear all interfaces (ex., default to unlisten and untalk).
LF	An ASCII line feed.
REN	Remote Enable. A logic line on the GPIB asserted by the controller. REN enables an instrument to go to remote when addressed.
SDC	Selected Device Clear. A GPIB message to initialize an addressed instrument to its Power-on state.

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TABLE 4-2

UNIT ADDRESS GROUP

LISTEN ADDRESS	HEX	BINARY						DECIMAL	ASCII
			A5	A4	A3	A2	A1		
0	20	001	0	0	0	0	0	32	SP
1	21	001	0	0	0	0	1	33	!
2	22	001	0	0	0	1	0	34	"
3	23	001	0	0	0	1	1	35	#
4	24	001	0	0	1	0	0	36	$
5	25	001	0	0	1	0	1	37	%
6	26	001	0	0	1	1	0	38	&
7	27	001	0	0	1	1	1	39	'
8	28	001	0	1	0	0	0	40	(
9	29	001	0	1	0	0	1	41	)
10	2A	001	0	1	0	1	0	42	*
11	2B	001	0	1	0	1	1	43	+
12	2C	001	0	1	1	0	0	44	,
13	2D	001	0	1	1	0	1	45	-
14	2E	001	0	1	1	1	0	46	.
15	2F	001	0	1	1	1	1	47	/
16	30	001	1	0	0	0	0	48	0
17	31	001	1	0	0	0	1	49	1
18	32	001	1	0	0	1	0	50	2
19	33	001	1	0	0	1	1	51	3
20	34	001	1	0	1	0	0	52	4
21	35	001	1	0	1	0	1	53	5
22	36	001	1	0	1	1	0	54	6
23	37	001	1	0	1	1	1	55	7
24	38	001	1	1	0	0	0	56	8
25	39	001	1	1	0	0	1	57	9
26	3A	001	1	1	0	1	0	58	:
27	3B	001	1	1	0	1	1	59	;
28	3C	001	1	1	1	0	0	60	<
29	3D	001	1	1	1	0	1	61	=
30	3E	001	1	1	1	1	0	62	>
UNL	3F	001	1	1	1	1	1	63	?

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4.3 MESSAGE FORMAT

The message sent to the 959XPT must have the following format for each parameter:

HHHDXXX----------E±NND

where

H = Letter mnemonics for each message header
D = Optional header extension to specify output (ref. table 3-5)
X = Alpha, numeric argument or # for message header argument.
E = Optional ASCII E for exponent identification
± = Exponent sign
N = Exponent value 0 to ±63
D = Message string delimiter. (CR) (LF) or (LF) standard

More than one message header with its corresponding argument may be sent in one setup string with a common delimiter.

The ASCII # symbol is used in a ramp program to designate that the start of the ramp is the existing output value. This feature is useful when remotely calibrating the 959XPT without knowing the existing CAL coefficient.

4.3.1 NUMERIC DATA FIELD

Parameter values may be sent to the 959XPT as an unsigned value with a decimal point or a decimal point with an exponent. Phase may be sent as a signed value.

The Decimal Point for numeric data values may be either sent or inferred. The two following ASCII strings will represent 115 volts to the Model 959XPT.

AMP115
AMP115.0

There may be any number of digits following the decimal point, not to exceed the 256 byte DMA buffer, but only the Least Significant Digit (LSD) of resolution will be recognized. The LSD for amplitude is tenths of volts. The LSD for frequency is either hundredths, tenths or Hertz for up to 99.99 Hz, 999.9 Hz or 9999 Hz respectively.

Any parameter's numeric value may be of a mixed form with a decimal point and exponent.

The exponent may be a numeric, with or without leading zeros, up to a value of ±63. The following ASCII strings will represent 115 volts to the 959XPT:

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AMP1.15E2
AMP1.15E+2
AMP1.15E+02
AMP1150E-1

A positive exponent value is represented by either an ASCII "+" or an unsigned value.

4.3.2 PROGRAM HEADERS

A Program Header is a mnemonic of a series of three ASCII characters used to select an 959XPT function or identify the data it precedes. The header is an abbreviation of the program function it identifies.

The header may be followed by a header extension to separately program each output to different values. If an extension is not added to the header all outputs will be programmed to the header's argument. See Table 4-3 for the definition of the Program Headers and their related arguments.

Any header that is sent to the 959XPT without an argument will cause the front panel display to show the corresponding screen.

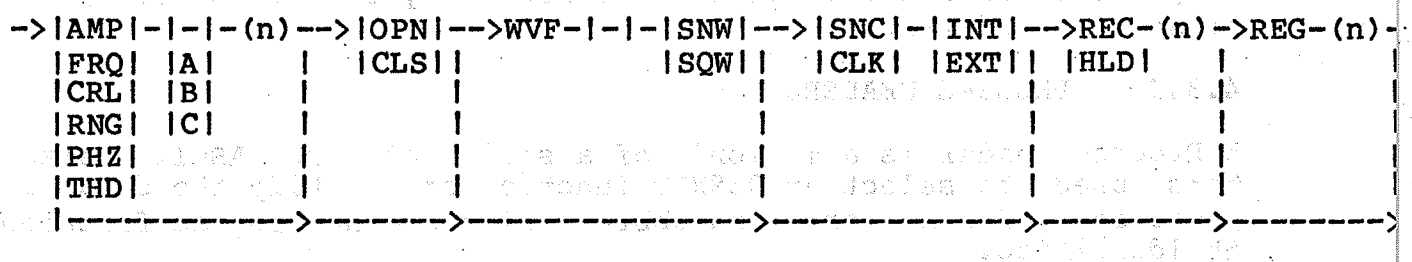
The program header extension works on the trailing exception rule. This characteristic can be used to shorten the setup string. The following example demonstrates the trailing exception rule by programming the phase A and B outputs to 20% distortion and phase C to 0%:

THD 20 THD C 0

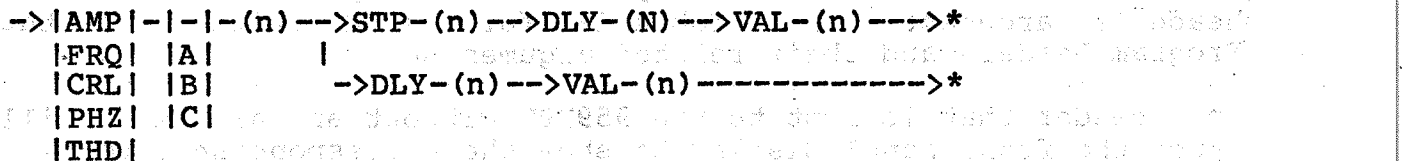
Refer to Figure 4-1 for a summary of all possible APE command sequences.

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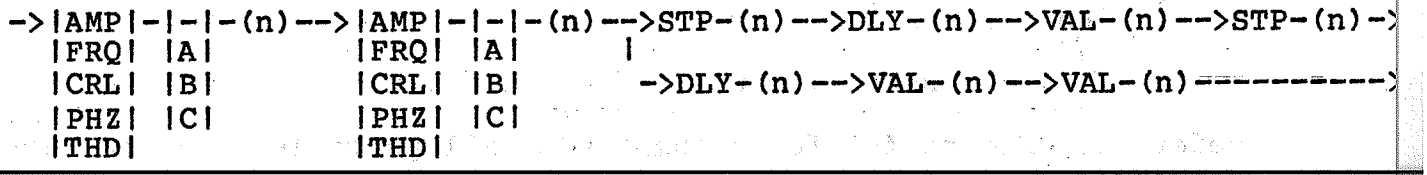
TO PROGRAM OUTPUT PARAMETERS:



TO RAMP OR STEP ONE OUTPUT PARAMETER:



TO RAMP OR STEP TWO OUTPUT PARAMETERS:



TO REQUEST TALKING OF CALIBRATION COEFFICIENTS:

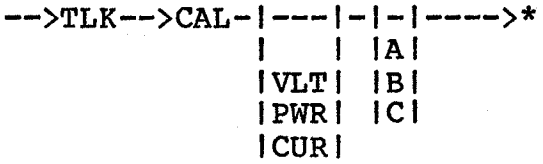


FIGURE 4-1

ABBREVIATED PLAIN ENGLISH COMMAND SEQUENCES

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TO SPECIFY THE SERVICE REQUEST INTERRUPT:

```
-->SRQ-(n)--->*
```

TO CALIBRATE MEASUREMENT:

```
-->CAL->|VLT|-|-|-(N)---->
        |CUR|  |A|
        |PWR|  |B|
              |C|
```

TO REQUEST TALKING A PROGRAMMED PARAMETER OR MEASURED VALUE:

```
-->TLK-->|AMP|-|-|----->*
         |FRQ|  |A|
         |CRL|  |B|
         |RNG|  |C|
         |PHZ|
         |SNC|
         |CLK|
         |MNU|
         |ELT|
         |VLT|
         |CUR|
         |PWR|
         |APW|
         |PWF|
         |ALM|
         |FLM|
         |CFG|
         |POF|
         |THD|
```

TO RECALL A REGISTER:

```
-->REC-(n)--->*
```

* Represents either an IEEE-488 END or EOS message. The EOS message may be either an ASII Carrage Return(CR), Line Feed(LF) or just LF.

n Represents a numeric value.

FIGURE 4-1 (continued)

ABBREVIATED PLAIN ENGLISH COMMAND SEQUENCES

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TABLE 4-3
PROGRAM HEADERS

HEADER	EXTENSION	ARGUMENT	DEFINITION
AMP		# or numeric from 0.0 to RNG value.	Amplitude in volts.
CAL VLT	A, B, C	Expected	Actual voltage at remote sense
CAL CUR	A, B, C	Expected	Actual current from power
CAL PWR	A, B, C	Expected	
CLK		INT,EXT	Clock source
CRL	A, B, C	Numeric value 0.00 to 100.0 (Maximum current of system)	Current limit in amps
DLY		Numeric data from 0.00 to 9999	Delay in seconds
FRQ		Numeric data from 45.00 or LLM to HLM value	Frequency in hertz.
HLD		Numeric data .001 to 99.99	Hold-up time in seconds from Current Limit.
PHZ	A, B, C	# or numeric data from 0.0 to ±999.9	Phase angle in degrees.
PRG		0 through 16	Register load
REC		0 through 16	Recall register
THD	A, B, C	0 through 20	Total Harmonic Distortion (%)

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TO SPECIFY THE SERVICE REQUEST INTERRUPT:

```
-->SRQ-(n)--->*
```

TO CALIBRATE MEASUREMENT:

```
-->CAL->|VLT|-|-|-(N)---->
        |CUR|  |A|
        |PWR|  |B|
              |C|
```

TO REQUEST TALKING A PROGRAMMED PARAMETER OR MEASURED VALUE:

```
-->TLK-->|AMP|-|-|----->*
         |FRQ|  |A|
         |CRL|  |B|
         |RNG|  |C|
         |PHZ|
         |SNC|
         |CLK|
         |MNU|
         |ELT|
         |VLT|
         |CUR|
         |PWR|
         |APW|
         |PWF|
         |ALM|
         |FLM|
         |CFG|
         |POF|
         |THD|
```

TO RECALL A REGISTER:

```
-->REC-(n)--->*
```

* Represents either an IEEE-488 END or EOS message. The EOS message may be either an ASII Carrage Return(CR), Line Feed(LF) or just LF.

n Represents a numeric value.

FIGURE 4-1 (continued)

ABBREVIATED PLAIN ENGLISH COMMAND SEQUENCES

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TABLE 4-3
PROGRAM HEADERS

HEADER	EXTENSION	ARGUMENT	DEFINITION
AMP		# or numeric from 0.0 to RNG value.	Amplitude in volts.
CAL VLT	A, B, C	Expected	Actual voltage at remote sense
CAL CUR	A, B, C	Expected	Actual current from power
CAL PWR	A, B, C	Expected	
CLK		INT,EXT	Clock source
CRL	A, B, C	Numeric value 0.00 to 100.0 (Maximum current of system)	Current limit in amps
DLY		Numeric data from 0.00 to 9999	Delay in seconds
FRQ		Numeric data from 45.00 or LLM to HLM value	Frequency in hertz.
HLD		Numeric data .001 to 99.99	Hold-up time in seconds from Current Limit.
PHZ	A, B, C	# or numeric data from 0.0 to ±999.9	Phase angle in degrees.
PRG		0 through 16	Register load
REC		0 through 16	Recall register
THD	A, B, C	0 through 20	Total Harmonic Distortion (%)

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TABLE 4-3 (CONT.)
PROGRAM HEADERS

HEADER	EXTENSION	ARGUMENT	DEFINITION
REG		0 through 16	Register load
RNG	A, B, C	0.0 to limit value of range	Amplitude range and limit value in volts.
SNC		INT,EXT	Synchronize
SRQ		0, 1 or 2	Service Request disable, enable or at completion of program.
STP		From parameter minimum to maximum value	Step size
TLK		Any program header or other argument	Set up 959XPT to talk argument when talk addressed.
TRG			Execute (Trigger) set-up parameters on GPIB "GET" message.
VAL		From parameter minimum to maximum value.	Final ramp or step value in volts, hertz, amps, degrees, sine wave or square wave.
WVF		SNW,SQW	Waveform
OPN			Open output relays
CLS			Close output relays
VLT	A, B, C		Used with TLK to request measurement of the output voltage.
ELT			Used with TLK to request total accumulated run-time.
CUR	A, B, C		Used with TLK to request measurement of the output load current.

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TABLE 4-3 (CONT.)
PROGRAM HEADERS

HEADER	EXTENSION	ARGUMENT	DEFINITION
PWR	A, B, C		Used with TLK to request measurement of the True output power.
APW	A, B, C		Used with TLK to request measurement of the Apparent output power.
PWF	A, B, C		Used with TLK to request measurement of the output power factor.
PZM	A, B, C		Used with TLK to request measurement of the output phase angle.
FQM			Used with TLK to request measurement of the output frequency.

NOTE: If Extension does not follow the header, the argument will be applied to all phases.

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4.3.2.1 AMPLITUDE (AMP)

The AMP header is used to identify the amplitude command. The argument is a numeric data field from 0.0 to the limit set by the RNG value. An attempt to program a value higher than this value will generate an error and a SRQ on the GPIB.

The following ASCII strings will program the voltage given in the left column:

A,B,C 0.0 volts	AMP0					
A,B,C 10.5 volts	AMP10.5	or	AMP1.05E1	or	AMP105E-1	
A,B,C 100 volts	AMP100	or	AMP100.0	or	AMP1E2	

4.3.2.2 FREQUENCY (FRQ)

The FRQ header is used to identify the following numeric data as frequency.

The following string will program the frequency to 60.56 Hz.

```
FRQ 60.56
```

4.3.2.3 PHASE (PHZ)

The PHZ header with the optional A, B or C extension is used to identify the following numeric data as phase.

The PHZ header sent with no extension will program the B and C outputs in phase with phase A. The phase of the A output will lead the EXT SNC signal or EXT lock and clock signal by the value programmed.

The following example will program the A, B and C outputs to 90 degrees relative to an external sync signal when operating in the EXT SNC mode:

```
PHZ 90
```

The following example will program phase B to 240.5 degrees and phase C to 119.3 degrees leading phase A.

```
PHZB 240.5 PHZ C 119.3
```

4.3.2.4 CURRENT LIMIT (CRL)

The CRL header with the optional A, B or C extension is used to identify the Current Limit Command. The argument is a numeric data field from 0.0 to the maximum rated current of the power system.

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NOTE

A current limit value of 0 will inhibit the 959XPT's response to a current limit fault condition.

The following string will program a current limit of 13.5 amps for all three phases:

CRL 13.5

4.3.2.5 TOTAL HARMONIC DISTORTION (THD)

The THD header with the optional A, B or C extension is used to identify the Total Harmonic Distortion command. The argument is a number data field from 0 to 20. The data is interpreted as % THD.

The following string will program all outputs to 20% THD:

THD 20

To enable the phase B distortion to be 10% when all outputs are programmed to 115.0 volts for 1 second, the contents of register 1 recalled and the entire operation loaded into register 0, use the following string:

THD B 10 AMP 115 DLY 1 VAL 115 REC 1 REG0

To enable the waveform to be undistorted for 10 seconds at 115.0 volts before going to 0 volts and to load the operation into register 1 send following string:

THD 0 AMP115 DLY10 VAL0 REG1

To perform the operation specified in register 0, send the following string:

REC 0

Note that the distortion will be only on phase B for 1 second. All outputs will then remain at an undistorted output of 115.0 volts for 10 seconds before programming to 0.0 volts.

If a programmed turn-on at 90 degrees is required, the Voltage waveform must be first stopped at 90 degrees. The following example will first program the phase A output to 0.0 volts at 90 degrees and preset the frequency to 50 Hz.

FRQ50 PHZA90 AMP0 VAL0

The output amplitude will then be programmed to 120 volts with 20% distortion that reduces to 0% in .01 second steps.

AMP120 THD20 STP1 DLY.01 VAL0 STP0

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NOTE

The voltage will start at the 90 degree point.

4.3.2.6 RAMP INFORMATION

4.3.2.6.1 DELAY (DLY)

The DLY header is used with a parameter that has a numeric argument (ex. AMP, FRQ, PHZ, CRL, CAL) in a single step program.

The numeric argument is in seconds with four decade resolution from 0.001 to 9999 seconds.

The STP header with VAL may be used with DLY to completely specify a ramp program.

The following string will first step the voltage to 125 volts for 2.55 seconds and return to 115 volts.

AMP 125 DLY 2.55 VAL 115

The following string will ramp the voltage from 10 volts to 115 volts with 1.5 volt/.5 sec. steps:

AMP 10 DLY .5 STP 1.5 VAL 115

When an AMP header with an argument of 0 is used, the waveform will stop and drop to zero volts at the point specified by the PHZ A value.

The followign ASCII string will stop the waveform at 0 degrees for .01 seconds and return to 115 volts:

PHZ A 0 AMP 0 DLY .01 VAL 115

Refer to paragraph 3.4.6 and 3.4.10 for additional information.

4.3.2.6.2 STEP (STP)

The STP header is used to identify the following argument numeric value as the increment or decrement value for a FRQ, CRL, AMP, PHZ or CAL ramp. Refer to paragraphs 3.4.6 and 3.4.10 for additional information.

The following example will ramp all outputs from 130 volts in 1.5 volt/.5 sec. steps to 10 volts.

AMP130 DLY.5 STP1.5 VAL10

4.3.2.6.3 VALUE (VAL)

The header VAL is used to identify the following numeric argrument as the final Value of a ramp or step.

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If the VAL argument is larger than the initial value for the parameter to be ramped, the ramp will increment with step size defined by STP and DLY. With the VAL argument less than the initial value, the ramp will decrement from the initial parameter. Refer to paragraphs 3.4.6, 3.4.10, 4.3.2.6 and 4.3.2.7 for additional information.

A ramp or step operation can be stopped at anytime by the GPIB message Group Execute Trigger (GET).

The following example will decrement the output amplitude from 120 in .1 volt/.2 sec steps to 100 volts after a Device Trigger.

```
AMP 120 DLY.2 STP.1 VAL100 TRG
```

The following example will simultaneously ramp the Frequency from 400 to 5000 Hz at a rate of 10 Hz per second and the Amplitude from 5 volts in increments of .5 volts per step:

```
RNG270 AMP5 FRQ400 STP10 DLY1 VAL5000 STP.5
```

A GPIB Service Request will be generated at the end of a ramp if SRQ2 is included in the setup string.

4.3.2.7 REGISTER (REG)

The REG header is used to load the register specified by the following numeric data with the preceding data. The numeric value is from 0 to 15. The PRG header is identical to the REG header and is included to standardize other AC power controllers with the 959XPT.

The following example will load a ramp program that will step the voltage from 10 to 115 volts with 1 volt/.5 sec steps at 400 Hz into register 0.

```
FRQ400 AMP10 DLY.5 STP1 VAL115 REG0
```

4.3.2.8 RECALL (REC)

The REC header is used to recall previously loaded data from a register identified by the following register number (0 to 15).

The following example recalls and outputs the parameters stored in register 0 by an example in paragraph 4.3.2.7.

```
REC0
```

The following example recalls the parameters in register 0 and outputs the parameters after the IEEE-488 "GET" message.

```
REC0 TRG
```


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The following is an example of register linking. The voltage and frequency is maintained at 115 volts and 60 Hz for 5 seconds and then the program contained in register 0 is recalled and executed. The program is stored in register 1.

```
FRQ60 AMP115 DLY5 VAL115 REC0 REG1
```

The program is initiated by the following ASCII string:

```
REC1
```

4.3.2.9 RANGE (RNG)

The RNG header is used to select a range defined by the ALM screen RNG, LLM and HLM values. The numeric value following the RNG header will also define the upper limit for the AMP value.

The RNG value will select the higher range if the value is greater than the lower range value defined by the ALM screen.

If the range and voltage amplitude are to be programmed by the same data string the RNG header and argument must precede the AMP header or a syntax error will be generated.

The following example will select the 270 range from the 135/270 range pair with an upper amplitude limit of 210 volts.

```
RNG210
```

NOTE

The voltage range-change will occur only with compatible power source systems. The power sources must have the proper range-change hardware.

4.3.2.10 SERVICE REQUEST

After power-up the GPIB Service Request (SRQ) will be generated by the 959XPT after any error (example, syntax, output fault, etc.). This SRQ output can be inhibited by the SRQ header followed by the single digit "0". The SRQ can be reenabled by the SRQ header followed by 1. Sending SRQ2 to the 959XPT causes an SRQ to be generated after the execution of a setup string. The setup string can be of any type: ramp, calibration, etc.

The following example disables the 959XPT GPIB SRQ.

```
SRQ0
```

After the generation of an SRQ, the status byte may be read from the 959XPT. Refer to paragraph 4.5.

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4.3.2.11 SYNCHRONIZE (SNC)

The SNC header is used with the EXT argument to synchronize the phase A output to an external sync input. The phase A output will be phase referenced to the sync input with the displacement equal to the PHZ A value.

The following ASCII string will program the phase A output to 0 degree relative to the external sync input.

```
PHZA0 SNC EXT
```

Sending the ASCII string SNC INT will disable the sync input.

4.3.2.12 CLOCK (CLK) (optional)

The CLK header has an argument of either EXT or INT. The CLK header with the EXT argument will make the 959XPT a slave to another 959XPT system. The slave 959XPT will operate at the same frequency as the master 959XPT. Phase A of the slave will be related to phase A of the master by the PHZ A value of the slave.

NOTE

The clock option is only available for the 959XPT if the associated power source or MXT10 Interface Module has the LK option.

The following ASCII string will enable the CLOCK and LOCK inputs to the associated slave 959XPT:

```
CLK EXT
```

NOTE

If there is no signal at the CLOCK input at the rear panel if the associated power source or MXT10 Interface Module, the output will go to zero volts.

The ASCII string CLK INT will return the 959XPT to its programmed frequency.

4.3.2.13 TRIGGER (TRG)

The TRG header has no argument. When the TRG mnemonic is included in a setup string to the 959XPT, it will delay execution of the string until the GPIB Device Trigger message is sent by the bus controller.

The Trigger mode may also be enabled in the local mode by programming setup parameters without depressing the ENT key. The 959XPT will then execute the setup values in the remote mode when the Device Trigger is received.

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The following example will recall the parameters from register 0 and delay execution until the GET message is received. (Note: GET is the abbreviation for the GPIB Group Execute Trigger message and does not represent a series of ASCII characters.)

```
RECO TRG
```

4.3.2.14 WAVEFORM (WVF) (Optional)

The header WVF is used to identify the following argument as the Sine Wave (SNW) or Square Wave (SQW) function of the Waveform.

The following example will program all outputs to the square wave function.

```
WVF SQW
```

NOTE

The Waveform selection is only available when a 959XPT is used with a power source compatible with Square Wave operation.

4.3.2.15 OPEN (OPN) AND CLOSE (CLS) (Optional)

The OPN and CLS headers open and close an optional output relay in the power source. There is no argument associated with these headers.

When the OPN or CLS headers is received by the 959XPT it will drop the output voltage to zero volts for 50 milliseconds for the output relays to switch.

4.3.2.16 TALK (TLK)

The TLK header is used to set up the 959XPT to talk data. When the TLK header has a program output parameter as its argument, the 959XPT will report its programmed output value for the argument. Table 4-4 is the list of all arguments for the TLK header.

Table 4-5 shows the response format for all TLK arguments with no A, B or C extension.

4.3.2.17 VOLTAGE (VLT)

VLT may be used as an argument to the header TLK with an A, B or C extension.

When used as an argument, it will set up the 959XPT to measure the output voltage with 0.1 volt resolution.

When VLT is used as a header in a string with no argument, it will cause the 959XPT front panel to display the measured output voltage.

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TABLE 4-4
TLK ARGUMENTS

ARGUMENT	EXTENSION	DATA	DEFINITION
ALM	A, B, C	RNG,LLM,HLM	Amplitude limit screen contents
APW	A, B, C	VA or KVA	Measured Apparent Power output
CFG	A, B, C	LSN,CFB,PHZ	CFG screen contents including IEEE-488 listen address.
CUR	A, B, C	Current in amps	Measured current.
ELT	A, B, C	H,M,S	Total accumulated time.
FLM	A, B, C	FRQ,LLM,HLM	Frequence limit screen contents.
FQM		Hertz	Measured Output Frequency
PZM	A, B, C	Degrees	Measured output phase angle
CAL CUR	A, B, C	0 to 255	Calibration Coefficient
CAL VLT	A, B, C	0 to 255	Calibration Coefficient
CAL PWR	A, B, C	0 to 255	Calibration Coefficient
POF	A, B, C	degrees	Programmed phase calibration coefficients
PWF	A, B, C	0.000 to 1.000	Measured power factor.
PWR	A, B, C	watts or kilowatts	Measured power output.
VLT	A, B, C	Voltage in volts	Measured output voltage.
ANY PROGRAM HEADER			Programmed value of the Argument.

NOTE: If Extension does not follow the argument, the data will contain A, B and C information.

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TABLE 4-5
TALK STRING RESPONSE

TLK STRING SENT TO 959XPT		RESPONSE FROM 959XPT AFTER ADDRESSED TO TALK			
TLK	ALM	ALM	RNG0	LLM135	HLM270
TLK	AMP	AMP	A000.0	B000.0	C000.0
TLK	APW	APW	A0000	B0000	C0000
TLK	CFG	CFG	LSN0001	CFB0210	PHZ0120
TLK	CLK	CLK	INT		
TLK	CRL	CRL	A100.0	B100.0	C100.0
TLK	CUR	CUR	A00.04	B00.15	C00.16
TLK	ELT	ELT	H0052	M0027	S0010
TLK	FLM	FLM	FRQ0400	LLM0045	HLM5000
TLK	FRQ	FRQ	400.0		
TLK	FQM	FQM	399.9		
TLK	PHZ	PHZ	A090.0	B240.0	C120.0
TLK	PWR	PWR	A0.000	B0.000	C0.000
TLK	PWF	PWF	A1.000	B1.000	C1.000
TLK	PZM	PZM		B240.2	C119.9
TLK	REG 0	ACTUAL CONTENTS OF REGISTOR 0			
TLK	SNC	SNC	INT		
TLK	THD	THD	A0	B0	C0
TLK	VLT	VLT	A004.9	B004.9	C005.0
TLK	WVF	WVF	A SNW	B SNW	C SNW

NOTE: If an A, B or C extension follows the TLK argument (ex. VLT), the response string will contain only the corresponding data.

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4.3.2.18 CURRENT (CUR)

CUR may be used as an argument to the header TLK with an A, B or C extension.

When used as an argument, it will set up the 959XPT to measure the output current in amps with 0.01 amp or 0.1 amp resolution.

When CUR is used as a header in a string with no argument, it will cause the 959XPT front panel to display the output current.

4.3.2.19 POWER (PWR)

PWR may be used as an argument to the header TLK with an A, B or C extension.

When used as an argument, it will set up the 959XPT to measure the output power in watts or kilowatts with 1 watt or .01 kilowatt resolution.

When PWR is used as a header in a string with no argument, it will cause the 959XPT front panel to display the output power.

4.3.2.20 POWER FACTOR (PWF)

PWF may be used as an argument to the header TLK with an A, B or C extension.

When used as an argument, it will set up the 959XPT to measure the output power factor from 0 to 1.000 with resolution.

When PWF is used as a header in a string with no argument, it will cause the 959XPT front panel to display the output power factor.

4.3.2.21 APPARENT POWER (APW)

APW may be used as an argument to the header TLK with an A, B or C extension.

When used as an argument, it will set up the 959XPT to measure the Apparent Power output in VA or KVA with 1 VA or .01KVA resolution.

When APW is used as a header in a string with no argument, it will cause the 959XPT front panel to display the measured output Apparent Power.

4.3.2.22 FREQUENCY MEASUREMENT (FQM)

FQM may be used as an argument to the header TLK. There is no extension for this argument.

When FQM is used as an argument, it will set up the 959XPT to measure the output frequency in hertz.

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When FQM is used as a header, it will cause the 959XPT front panel to display the measured output frequency.

4.3.2.23 PHASE ANGLE MEASUREMENT (PZM)

PZM may be used as an argument with an extension A, B or C for the header TLK.

When used as an argument, PZM will set up the 959XPT to measure the phase angle of phase B and C relative to phase A. The measurement is made at the Remote Sense terminals. Phase A is measured relative to an External Sync input.

When PZM is used as a header, it will cause the 959XPT front panel to display the phase measurement screen.

4.3.2.24 CURRENT LIMIT HOLDOFF (HLD)

The HLD header is used to specify a hold-up time in response to a current limit. The argument is any value from 0.001 to 99.99 seconds. The default value is 0.1 seconds.

If the load exceeds the programmed Current Limit (CRL) value for the time period specified by the HLD argument, the output will default to 0.0 volts.

4.4 MESSAGE SEPARATOR

A complete message consists of a header and an argument. Since more than one message can be sent in a setup string, message separators included in the string between the message will make it more readable to the human operator. There are three message separators recognized by the 959XPT: the comma (,), semicolon (;) and a space. Since these separators are treated as no-ops, they may be dispersed throughout a setup string.

The following are two examples of the use of separators:

```
FRQ400;AMP115;WVF SQW

FRQ400;AMP115;PHZ,B,240;PHZ,C,120;WVF,SQW
```

4.5 STATUS BYTE

Once the bus controller has detected the SRQ, it must determine the instrument needing service by the Serial Poll. During the polling routine the instrument needing service will return a Status Byte (STB) greater than decimal 63. The Status Byte values for various faults are given in Table 4-6.

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TABLE 4-6

STATUS BYTE VALUES

STATUS BYTE (DECIMAL)	ASCII MESSAGE OR CONDITION
71	CRL FAULT
72	TEMP FAULT
90	RNG RANGE ERROR
91	AMP RANGE ERROR
92	FRQ RANGE ERROR
93	PHZ RANGE ERROR
94	CRL RANGE ERROR
95	RMP RANGE ERROR
96	SYNTAX ERROR
97	BUS LOCAL ERROR
98	EXT SYNC ERROR
99	CPU MEMORY ERROR
100	DMA OVERFLOW
101	CFG, ALM, FLM, CLM RANGE ERROR
127	The response after SRQ2 is included in a setup string and execution of the string is complete.

4.6 END OF STRING

The End of String (EOS) delimiter recognized by the 959XPT is the ASCII Line Feed (LF). Carriage Return (CR) followed by Line Feed may also be used for EOS. The End or Identify (EIO) IEEE-488 message END will also be recognized.

The END message is sent by setting the IEE-488 End or Identify line true with the last data byte.

4.7 GROUP EXECUTE TRIGGER

The trigger mode of the 959XPT is enabled when the mnemonic TRG is added to a setup string. The trigger command may be inserted anywhere in the string. When the mnemonic is detected by the 959XPT, it will delay execution of the new setup values until the GPIB Device Trigger is sent by the bus controller.

The trigger mode may also be enabled in the local control mode by programming parameter values without depressing the ENT key. The Model 959XPT will then execute the setup values in the remote mode when the Device Trigger is received.

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The following setup string will recall the values from register 9 and delay execution until the GET message is received. (Note: GET is the abbreviation for the GPIB Group Execute Trigger message and does not represent a series of ASCII characters. (See Table 4-1).

```
REC9TRG
```

To set up 0 volts, 400 Hertz and wait for GET:

```
FRQ400AMP0TRG
```


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TABLE 4-7
HP SERIES 80 CONTROLLER STATEMENTS

STATEMENT	DESCRIPTION
CLEAR 7	Universally sets all instruments to their power-on states by sending the GPIB message DCL
CLEAR 701	Sets only instrument with listen address "1" to its power-on state by sending the GPIB message SDC.
LOCAL 7	Universally sets all instruments into their local control mode by deasserting REN.
LOCAL 701	Sets only instrument with listen address "1" to its local control mode by sending the GTL message.
REMOTE 7	Sets REN true.
REMOTE 701	Sets instrument with listen address "1" to remote.
ABORTIO 7	Clears all instrument interfaces to unlisten and untalk by toggeling IFC.
RESUME 7	Sets ATN false.
OUTPUT 701; "AMP"; V	Sends the data string AMP followed by the numerical value of variable V to the instrument with listen address "1".
STATUS 7,1;A	This statement reads the SR1 register of the series 80 controller for the interrupt cause. This statement is necessary to clear the Service Request flag in the controller.
ENABLE INTR 7; 8	This statement allows the series 80 controller program to be interrupted when a GPIB instrument generates an SRQ.
ON INTR 7 GOSUB100	This statement will cause the program to go to an interrupt subroutine at 100.
TRIGGER 7	This statement triggers all addressed instruments by sending the GET message.
TRIGGER 701	This statement will trigger only the instrument with listen address "1" by sending the GET message.
A=SPOLL (7)	Sets variable A equal to the decimal value of the Status Byte of an instrument previously addressed to talk.
A=SPOLL (701)	Sets variable A equal to the decimal value of the Status Byte of the instrument with listen address "1".

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4.8 HEWLETT PACKARD SERIES 80 PROGRAM EXAMPLES

For the following program examples, the 959XPT listen address is "1" and the controller interface is select code "7".

Table 4-7 lists some of the Series 80 Controller statements that may be useful in programming the 959XPT on the GPIB. For additional statements and their descriptions refer to the Hewlett Packard I/O Programming Guide for the Series 80 Computer.

The following program will step the 959XPT program voltage from 0 volt to 130 volts in .1 volt steps:

```
10 REMOTE 7
20 FOR V-0 TO 130 STEP .1
30 OUTPUT 701; "AMP"; V
40 NEXT V
50 END
```

The following program will load the parameters of 115 volts and 400 hertz. The Model 959XPT will output the parameters only after the K1 special function key of the Series 80 Controller is depressed to send the GET message.

```
10 REMOTE 701
20 OUTPUT 701 ; "AMP115 FRQ 400 TRG"
30 ENABLE KBD 32+64 ! ENABLE PAUSE AND SPECIAL FUNCTION KEYS
40 ON KEY # 1 GOTO 100 ! USE KEY K1 FOR DEVICE TRIGGER
50 GOTO 40

100 TRIGGER 701
110 END
```

The program example for SRQ uses the statements STATUS, ON INTR, ENABLE INTR, AND SPOLL.

The STATUS statement in line 20 is necessary to clear the Controller status register from any possible previous Service Request (SRQ) interrupts. The HP I/O Programming Manual is not clear on the use of the STATUS statement but it must be used after every SRQ and before enabling or reenabling the SRQ interrupt to prevent false SRQ indication. Line 30 causes the program to go to the interrupt subroutine at line 100.

The ENABLE INTR statement in line 40 enables the SRQ to generate an interrupt. A setup string in line 60 causes an SRQ to be generated by the 959XPT. The SRQ interrupt subroutine is between lines 100 and 150.

The STATUS statement in line 120 clears the SRQ.

Line 130 generates a Status Byte from the 959XPT with listen/talk address "1".

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```
10  REMOTE 701 ! PUT INSTRUMENT#1(959XPT) INTO REMOTE
20  STATUS  7,1,;Z!  READ STATUS TO CLEAR HP  SERIES  80  STATUS
    REGISTER.
30  ON INTR 7 GOSUB 100! ON SRQ GO TO ROUTINE AT LINE 100.
40  ENABLE INTR 7;8! ENABLE HP SERIES 80 FOR SRQ INTERRUPT.
50  ! THE FOLLOWING SETUP STRING WILL GENERATE AN SRQ AFTER COM-
    PLETION.
60  OUTPUT 701; AMP105 DLY10 VAL115 SRQ2.
70  WAIT 20000!
80  DISP "SETUP STRING DIDN'T GENERATE AN SRQ".
90  END
100 ! SERVICE REQUIEST FOR DEVICE 1
110 ! USE SERIAL POLL TO DETERMINE STATUS BYTE
120 STATUS 7,1;Z ! READ STATUS TO CLEAR SRQ
130 A=SPOLL (701)
```


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SECTION 5 CALIBRATION

5.1 GENERAL

Paragraph 5.3 is a procedure for calibration of the output voltage and phase angle. Paragraph 5.4 is a procedure for calibration of the voltage, current and power measurements.

Calibration of the 959XPT requires a compatible power source or an MXT10 Interface Module connected to a T-series power source.

5.2 REQUIRED TEST EQUIPMENT

Table 5-1 lists all of the equipment needed to calibrate the programmed output and the measurement functions of the 959XPT.

TABLE 5-1

Required Test Equipment

TEST EQUIPMENT	TO CALIBRATE:
Fluke 8506A AC DVM	the programmed output voltage.
Valhalla 2300 Power Analyzer	the measured output power and current.
Philips PM6671	the programmed output frequency
Pearson Model 3468 100 Amp Current Transformer	the current limits

5.3 OUTPUT CALIBRATION

The following subsections of this paragraph describe the calibration of the programmed output voltage and phase angle. paragraph 5.3.3 describes a check on the programmed output frequency. The output frequency does not require a regular calibration interval to maintain its rated accuracy. If a related component has been replaced or a frequency check reveals an out-of-spec condition, perform paragraph 5.3.3.

5.3.1 EQUIPMENT HOOKUP

Figure 5-1 shows the connection of the AC voltmeter, frequency counter and oscilloscope to the output of a power system. The power system must be connected as shown in Figures 2-1, 2-2 or 2-3. The calibration equipment shown in Figures 5-1 connects to the power system load terminals.

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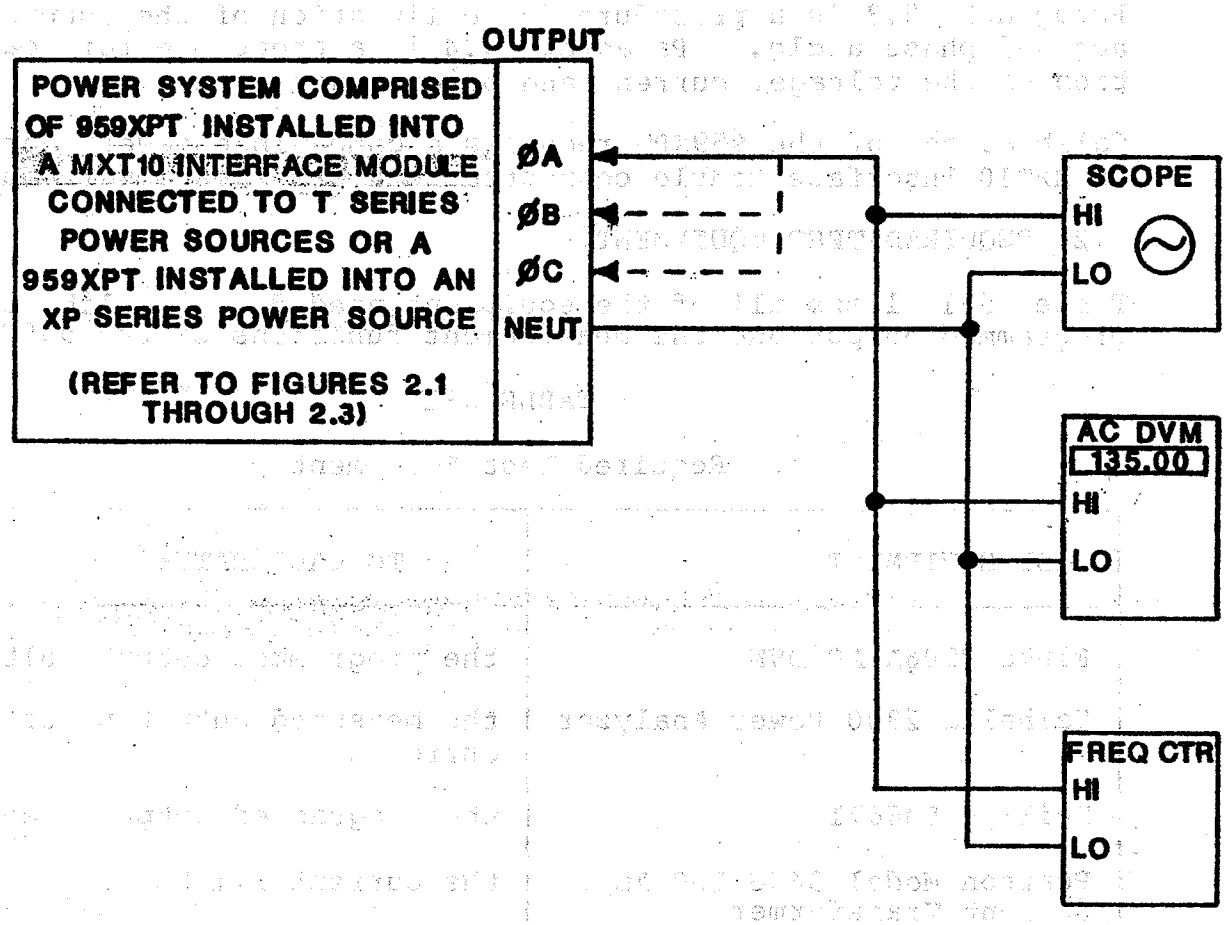


FIGURE 5-1
TEST EQUIPMENT CONNECTION FOR OUTPUT CALIBRATION

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5.3.2 CALIBRATION ADJUSTMENT

To calibrate the output voltage, remove the front panel. Refer to Figure 5-4 for front panel removal and the location of R39. Program the output frequency to 400 Hz and the output voltage to 100 volts.

1. Adjust the power source front panel GAIN control for the programmed voltage indication on an external TRMS AC voltmeter connected to the phase A output. If the power system consists of more than one power source connected in series, the output voltage of each source must be matched within 1% of each other.

2. Program 60.0 Hz and adjust pot R39 on the 959XPT for the programmed voltage on the external TRMS AC voltmeter. To adjust R39 remove the 959XPT front panel.

3. Repeat steps 1 and 2 as necessary.

4. Repeat steps 1 through 3 for phase B and C. Connect the TRMS AC voltmeter to the output that is to be calibrated. Refer to the following table for the adjustment in step 2:

PHASE	ADJUSTMENT
A	R39
B	R48
C	R47

5.3.3 FREQUENCY CHECK

1. Connect the frequency counter across the phase A output.

2. Program 100 volts and 400 Hz.

3. Check that the output frequency is 400.0000 $\pm$.004 Hz.

If the frequency is not within the limit, remove power from the power source. Remove the 959XPT. Detach the 959XPT front panel keyboard and display. Refer to Figure 5-4. The keyboard and display assembly is electrically attached to the 959XPT with a ribbon wire. Locate an adjustment at the right hand corner of the top PC assembly,

Reinstall the 959XPT and program 100 volts and 400 Hz. With the frequency adjustment, adjust the output frequency to 400.0000 $\pm$0.004 Hz.

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THD = 00 SNC = 01

*CLK = 02 *WVF = 03

FIGURE 5-2

First Menu Screen

*May not be displayed. Depends on configuration.

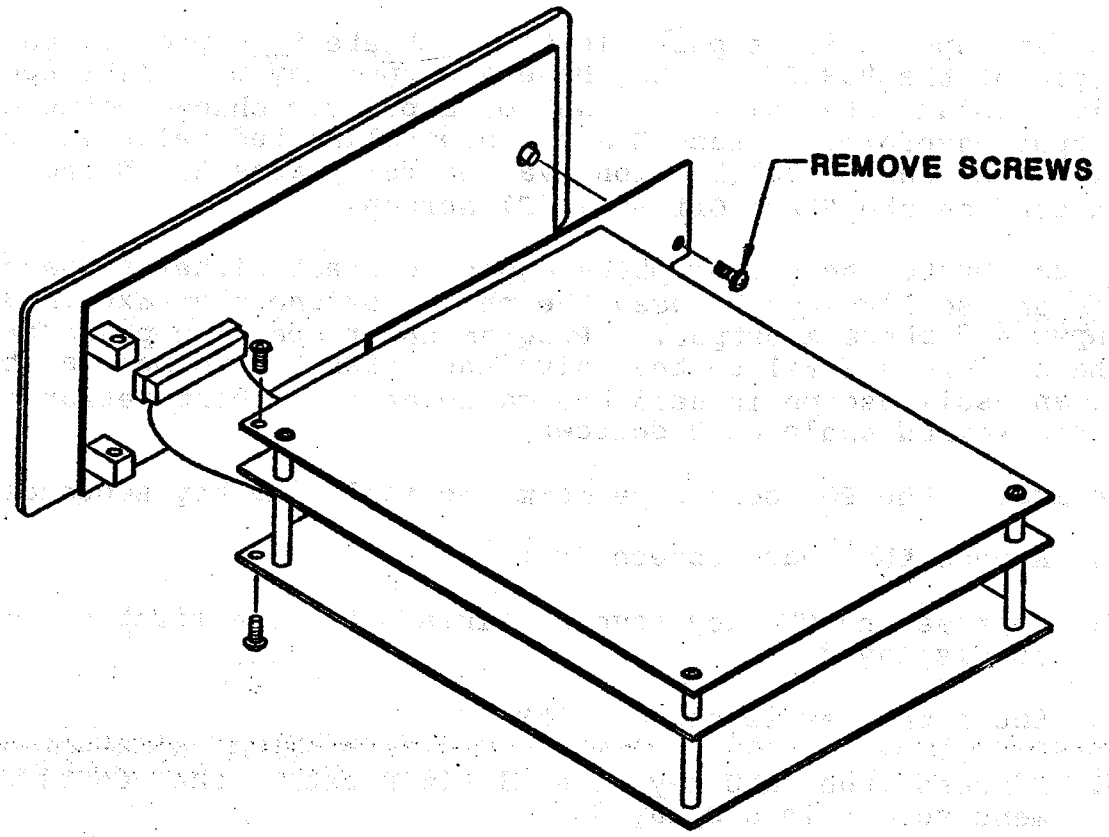
CFG = 16 ALM = 17

FLM = 18 CLM = 19

FIGURE 5-3

Configuratiion Menu Screen

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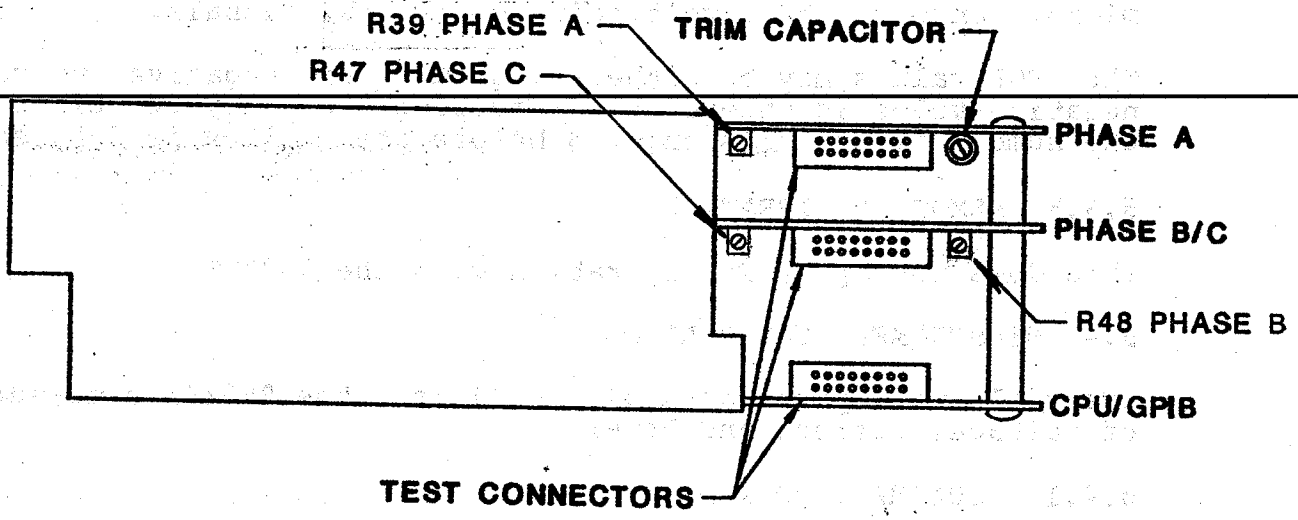


FIGURE 5-4

FRONT PANEL/KEYBOARD DISPLAY REMOVAL

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5.3.4 OUTPUT PHASE ANGLE CALIBRATION

As an option it is possible to calibrate the programmed phase angle of the 959XPT. The phase A output may be calibrated relative to an external sync input or a program change point of the output waveform. Phase B anc C are calibrated relative to phase A. The phase calibration values for phases A, B and C are entered on the Phase Offset (POF) screen.

To calibrate the putput phase angle, connect either a Phase Meter or an oscilloscope between the phases or the the external sync input and phase A output. Program the respective phase from the Phase screen (PHZ) to the value the 959XPT is to be calibrated. If an oscilloscope is used the calibration is best performed with a programmed angle of 0 degrees.

To access the POF screen perform the following key sequences:

1. Access the Phase screen (PHZ).

2. Depress the MNU key several times until the first menu screen is displayed.

3. Enter the key sequence: 959 ENT

4. Depress the MNU key several times until the Configuration menu screen is displayed.

5. To display the POF screen enter the key sequence: 20 ENT

If an oscilloscope is used and the respective phase is programmed to 0 degrees and 200 Hz, a 3 degree error is represented by 41 microseconds of the 0 volt point of the two signals.

The POF values may be either a positive or negative value. A negative value is entered by depressing the . key two times after the numerical value is entered before the PRG key is depressed.

5.3.5 REMOTE CALIBRATION

This does not apply for operation with the 959XPT.

5.4 MEASUREMENT CALIBRATION

The following paragraphs will calibrate the 959XPT's measurement of Voltage, Current and Power.

5.4.1 EQUIPMENT HOOKUP

Figure 5-5 is the connection of the test equipment for calibration of all measurements. The loads should represent a value close to the maximum rated load for the power source used with the 959XPT. Refer to the power source instruction manual for the recommended load values. The exact value of the load is not critical and will not affect the calibration. The load, however,

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must be constant during calibration of current and power.

5.4.2 VOLTAGE MEASUREMENT

Before calibration of the voltage measurement function, paragraph 5.3 must have been performed.

For calibration of voltage measurement perform the following steps:

1. Remove any load from the 959XPT power system and program either 100 or 200 volts and 200 Hz.

2. Depress the MNU key several times until menu screen 1 is displayed. Refer to Figure 5-2.

3. Enter the key sequence: 959 ENT.

4. Depress the MNU key several times until the configuration menu screen is displayed. Refer to Figure 5-3.

5. Enter the key sequence 13 ENT to access the CAL VLT screen.

6. Enter the key sequence of

   100 (*) PRG ENT if the output is 100 volts

   or

   200 (*) PRG ENT if the output is 200 volts.

7. After approximately 5 seconds the volt measurement function will be calibrated for all three phases.

5.4.3 CURRENT AND POWER SETUP

Connect the load to the output of the Digital Power Analyzer as shown in Figure 5-6. Connect the output of the power system to either the 10 amp or 100 amp position of the Digital Power Analyzer. The 10 amp connector must be used with 653XP and 1953XP Power Sources. Either the 10 amp or 100 amp position is used with the MXT10 Interface Module. When the MXT10 is used with the 3001TCA, 1501TPM or 1501TC, the 100 amp position is used.

*If the A, B or C key is depressed at this point in the sequence, only the respective phase measurement will be calibrated.

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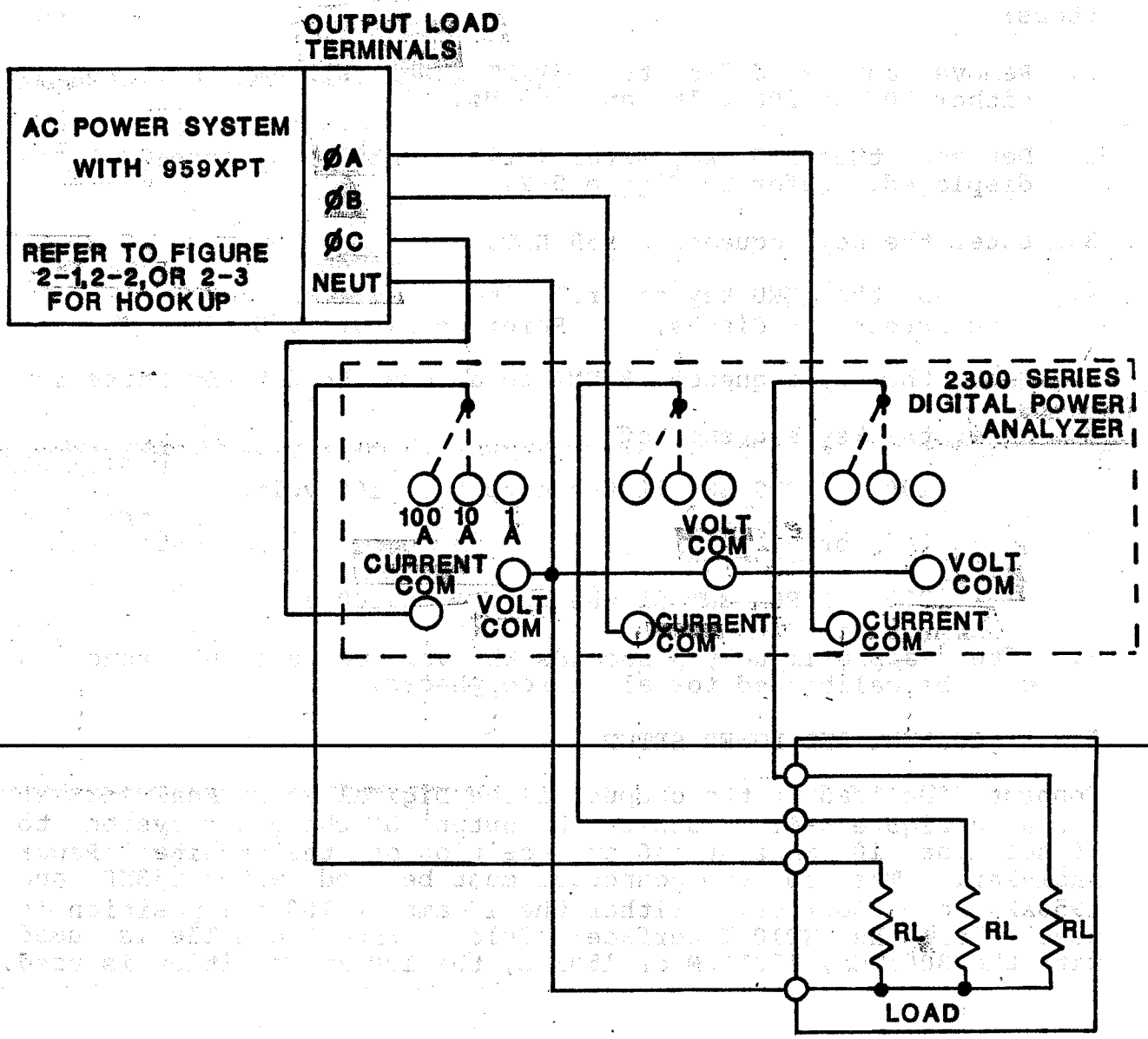


FIGURE 5-5
MEASUREMENT CALIBRATION EQUIPMENT HOOKUP

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5.4.3.1 CURRENT MEASUREMENT CALIBRATION

To calibrate the Current Measurement function, perform the following steps:

1. Use the load resistance specified in Table 5-2 for the total rated VA per phase and voltage range of the power system. If dual range operation is possible, use the lowest voltage range. Program the 959XPT for the VOLTS value for the MAXIMUM CURRENT from Table 5-2. Program the frequency to 50.00 Hz.

2. If any calibration screen is already displayed, the Current Calibration screen (CAL CUR) may be displayed by depressing either the MON or PRG keys and then skip to step 6. If a calibration screen is not displayed, press the MNU key several times until menu screen 1 is displayed. Refer to Figure 5-2.

3. Enter the key sequence: 959 ENT

4. Depress the MNU key several times until the configuration menu screen is displayed. Refer to Figure 5-3.

5. Enter the key sequence: 14 ENT to access the CAL CUR screen.

6. Set the 2300 Digital Power Analyzer front panel switches to read the phase A current. Record the value for entry into the 959XPT.

7. Enter the key sequence:

   (value from step 6) A PRG ENT

8. Repeat steps 6 and 7 for phase B and phase C.

5.4.3.2 POWER MEASUREMENT CALIBRATION

To calibrate the Power Measurement function, perform the following steps:

1. Program the 959XPT for the volts value for the MAXIMUM CURRENT from Table 5-2 and 50 Hz.

2. If any calibration screen is already displayed, the Power Calibration screen (CAL PWR) may be displayed by depressing either the MON or PRG keys and then skip to step 6. If a calibration screen is not displayed, depress the MNU key several times until menu screen 1 is displayed. Refer to Figure 5-2.

3. Enter the key sequence: 959 ENT

4. Depress the MNU key several times until the configuration menu screen is displayed. Refer to Figure 5-3.

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5. Enter the key sequence 15 ENT to access the CAL PWR screen.

6. Set the 2300 Digital Power Analyzer front panel switches to read the phase A power. Record the value for entry into the 959XPT.

7. Enter the key sequence:

   (value from step 6) A PRG ENT

8. Repeat steps 6 and 7 for phase B and C.

5.4.4 REMOTE MEASUREMENT CALIBRATION

The 959XPT measurement functions may be remotely calibrated. The equipment hook-up must agree with Figure 5-5. The values in the following CUR and PWR strings must be derived from the 2300 Digital Power Analyzer.

To calibrate the measured voltage, first program the 959XPT to the Amplitude value and then send the following string:

CAL VLT (1) (Programmed Amplitude Value)

To calibrate the measured current, send the following string:

CAL CUR (2) VALUE

To calibrate the measured power, send the following string:

CAL PWR (2) VALUE

5.4.5 ALTERNATE CURRENT AND POWER MEASUREMENT CALIBRATION

The calibration of current and power in paragraphs 5.4.3.1 and 5.4.3.2 may be replaced with a procedure that only uses a Precision Current Transformer and TRMS voltmeter. Refer to those paragraphs for supplemental 959XPT calibration information.

5.4.5.1 CURRENT

1. Apply the correct load from Table 5-2. Monitor the load current with Precision Current Transformer and program the 959XPT to the VOLTS value from Table 5-2 and 50 Hz.

2. Access the 959XPT CAL CUR screen. Refer to steps 2 through 5 of paragraph 5.4.3.1.

NOTES:
(1) May include an A, B or C extension.
(2) Must be either A, B or C extension.

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3. Enter the current value measured from phase A load by the Precision Current Transrformer for the CAL CUR A value. Refer to step 7.

4. Repeat for phase B and phase C for multiple phase systems.

5.4.5.2 POWER

1. Perform step 1 of paragraph 5.4.5.1 while monitoring the voltage across the load with the precision TRMS voltmeter.

2. Access the 959XPT CAL PWR screen. Refer to steps 2 through 5 of paragraph 5.4.3.2

3. Calculate the power by multiplying the TRMS voltage by the current measured by the Precision Current Transformer. Enter this calculated power value for the CAL PWR A value. Refer to step 7 of paragraph 5.4.3.2.

4. Repeat for phase B and phase C for multiple phase systems.

5.4.6 CURRENT LIMIT CALIBRATION (MXT10 only)

This adjustment should only be required if the MXT10 CURRENT LIMIT ASSEMBLY (A4) or CURRENT TRANSFORMER ASSEMBLY (A3) has been replaced with a new assembly.

The current limit adjustments are made with the top cover of the MXT10 removed. Refer to Figure 5-6 for the location of the adjustments on the assembly A4.

For the following adjustments, refer to Table 5-2 for programmed Current Limit value (CRL) and the Load Resistance (RL). These values are a function of the total VA per phase and the voltage range of the power system. If the power system is to be operated over two voltage ranges, the current limit must be set on the lowest range.

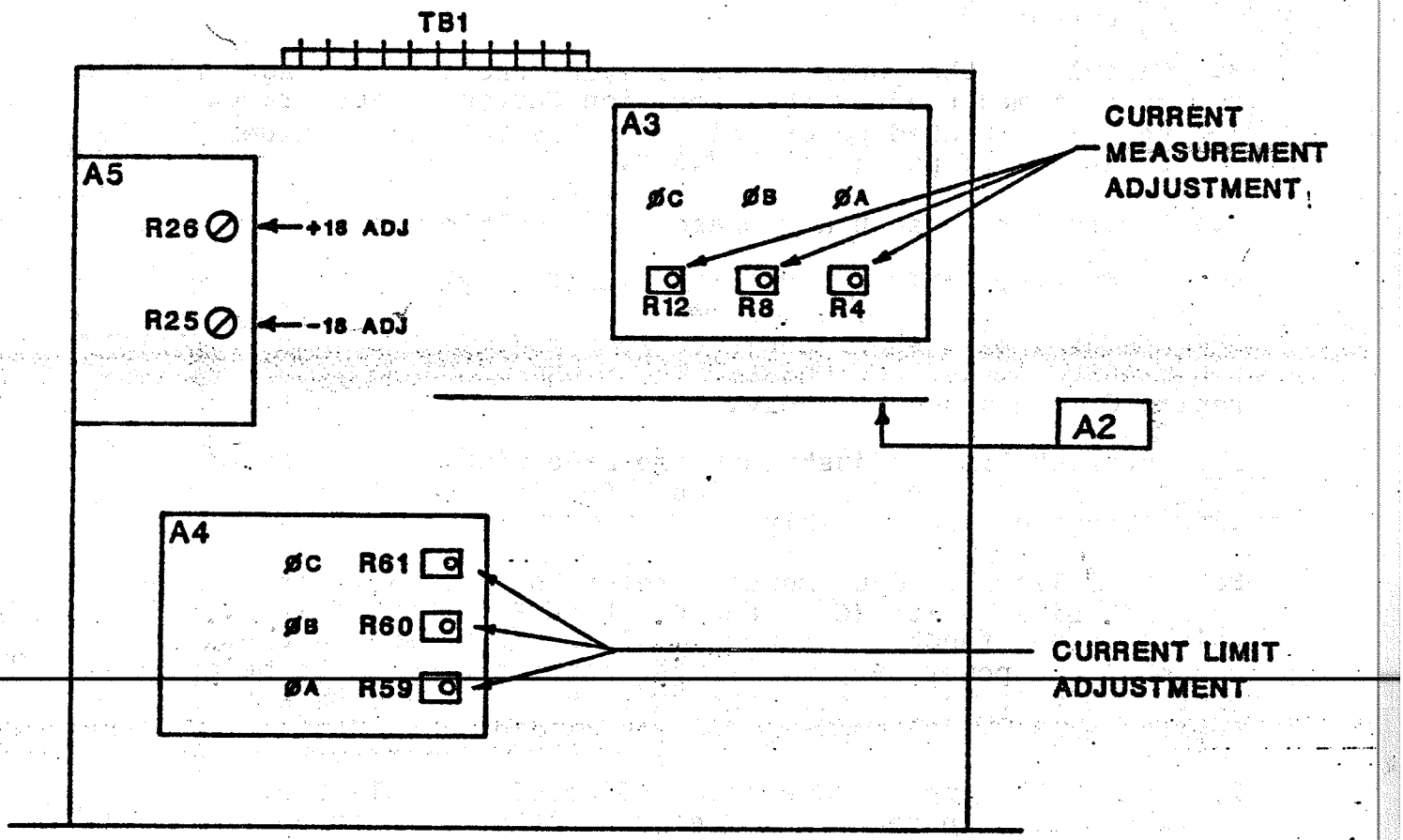
1. Apply the appropriate load indicated in Table 5-2. Monitor the output current with Precision AC Current Transformer and AC DVM.

2. Program the 959XPT to the CRL value (ex., CRL = 22.73 for two stacked 1501TPMs, 3000 VA, on 156 volt range).

3. Program the output frequency to 50 Hz. Program the output amplitude to the VOLTS value from Table 5-2 for the MAXIMUM CURRENT.

4. Verify the output remains at the programmed output voltage without the output defaulting to 0.0 volts. If the output defaults and the 959XPT displays the "CRL FAULT" message, turn the current limit adjustment counterclockwise and repeat step 3.

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A2 OSCILLATOR INTERCONNECT PC ASSY
A3 CURRENT SENSE PC ASSY
A4 CURRENT LIMIT PC ASSY
A5 DC POWER SUPPLY ASSY

FIGURE 5-6
MXT10 TOP VIEW REFERENCE OUTLINE

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5. While monitoring the Precision AC Current Transformer, use the 959XPT up and down keys to vary the output amplitude until the output current reaches the ISET value of Table 5-2.

   Very slowly, adjust A4R59 until the phase A system output voltage drops to the 959XPT's initialization voltage and the CRL FAULT message is displayed.

6. Again program the output amplitude to the VOLTS value from Table 5-2. Verify the output remains at the programmed value.

7. Using the 959XPT UP key slowly increase the output voltage while monitoring the output current. Verify the 959XPT indicates a Current Limit at a current less than the CLM value from Table 5-2. If not, repeat steps 3 through 6.

8. Repeat steps 1 through 7 for phase B and C of multiphase system. Apply the load in step 1 to the phase to be calibrated. Refer to Figure 5-6 for the location of the adjustment in Step 5.

9. Seal all adjustments.

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SOURCE	TOTAL VA PER PHASE	LOWEST VOLTAGE RANGE	MAXIMUM CURRENT AMPS (VOLTS)	SET CURRENT (ISET)	CURRENT LIMIT (CRL)	LOAD RESISTANCE (RL)	MAXIMUM TRIP (CLM)
3001TCA	3000	130	27.27 (110)	28.1	27.27	4.03	28.64
X2	6000		54.54 (110)	56.2	54.54	2.02	57.28
X3	9000		81.82 (110)	84.3	81.82	1.34	85.92
3001TCA	3000	260	13.64 (220)	14.05	13.64	16.12	14.32
X2	6000		27.27 (220)	28.10	27.27	8.06	28.64
X3	9000		40.91 (220)	42.15	40.91	5.37	42.96
X4	12000		54.54 (220)	56.2	54.54	4.03	57.28
3001TCA	3000	156	22.73 (132)	23.41	22.73	5.80	23.86
X2	6000		45.45 (132)	46.82	45.45	2.90	47.72
X3	9000		68.18 (132)	70.23	68.18	1.93	71.58
3001TCA	3000	312	11.32 (265)	11.66	11.32	23.40	11.89
X2	6000		22.64 (265)	23.32	22.64	11.70	23.77
X3	9000		33.96 (265)	34.98	33.96	7.80	35.66
X4	12000		45.28 (265)	46.64	45.28	5.85	47.54
1501TPM	1500	130	13.64 (110)	14.05	13.64	8.06	14.32
X2	3000		27.28 (110)	28.10	27.28	4.03	28.64
1501TPM	1500	156	11.36 (132)	11.71	11.36	11.61	11.93
X2	3000		22.73 (132)	23.42	22.73	5.80	23.86
1001TC	1000	130	9.09 (110)	9.36	9.09	12.1	9.54
X2	2000		18.18 (110)	18.72	18.18	6.05	19.08
1001TC	1000	260	4.55 (220)	4.68	4.55	48.4	4.77
X2	2000		9.10 (220)	9.36	9.10	24.17	9.54
1001TC	1000	156	7.57 (132)	7.8	7.57	17.43	7.95
X2	2000		15.14 (132)	15.6	15.14	8.71	15.9
1001TC	1000	312	3.54 (265)	3.88	3.77	70.23	3.96
X2	2000		7.75 (265)	7.77	7.54	35.11	7.92
161T	160	120	1.45 (110)	1.49	1.45	75.86	1.52
161T	160	240	.727 (220)	0.75	.727	302.6	0.76
101T	100	135	0.95 (105)	0.98	0.95	110.5	1.00
101T	100	270	0.476 (210)	0.49	0.476	441.1	0.5
751TPM	750	130	6.82 (110)	7.02	6.82	16.13	7.16

FULL LOAD CURRENT AND CURRENT LIMIT VALUES

TABLE 5-2

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SECTION 6 THEORY OF OPERATION

6.1 GENERAL

This section first provides functional descriptions of the elements of the 959XPT block diagram shown in Figure 6-1.

The circuit components of the 959XPT AC Power Controller are mounted on five circuit boards:

Mother Board (A2)
Keyboard (A1)
Phase A/Reference Board (A5)
Phase B/C Board (A4)
Central Processing Unit/GPIB (CPU/GPIB) Board (A3)

6.2 CENTRAL PROCESSING UNIT/GPIB (CPU/GPIB) BOARD

A microprocessor is installed on the CPU/GPIB Board. The microprocessor, memories and other devices on the board, comprise the elements of the CPU. The microprocessor also has its own seven-input interrupt controller, and three internal timers. A block diagram of the CPU/GPIB Board is shown in Figure 6-2.

In the local mode, the microprocessor receives its inputs from the Keyboard. Alternately, it receives them from a remote computer (Bus Controller) over an IEEE-488 General Purpose Interface Bus (GPIB). Whether under local or remote control, it programs the output frequency, voltages and phase angles for Phases A, B and C.

The microprocessor communicates with the GPIB through a programmable GPIB adapter. The General Purpose Interface Bus (GPIB) is the source of remote inputs. The GPIB adapter provides the communication link between the microprocessor and the GPIB. It is a complex device containing all the registers and functional sections required for interfacing the GPIB to the CPU.

The microprocessor and the GPIB interface adapter are configured for direct transfer of data to or from the GPIB and memory. This is referred to as Direct Memory Address (DMA).

There are two memory devices for the CPU. One is read-only memory (ROM). The other is non-volatile random-access memory (NVRAM). The firmware is stored in ROM and continuously executed by the CPU. During operation, the NVRAM unit functions as a random-access memory (RAM).

The NVRAM device has an internal lithium battery which maintains the stored data when power is removed. The battery has an expected life of 10 years. In addition to its normal RAM functions, NVRAM retains calibration and default values when power is removed.

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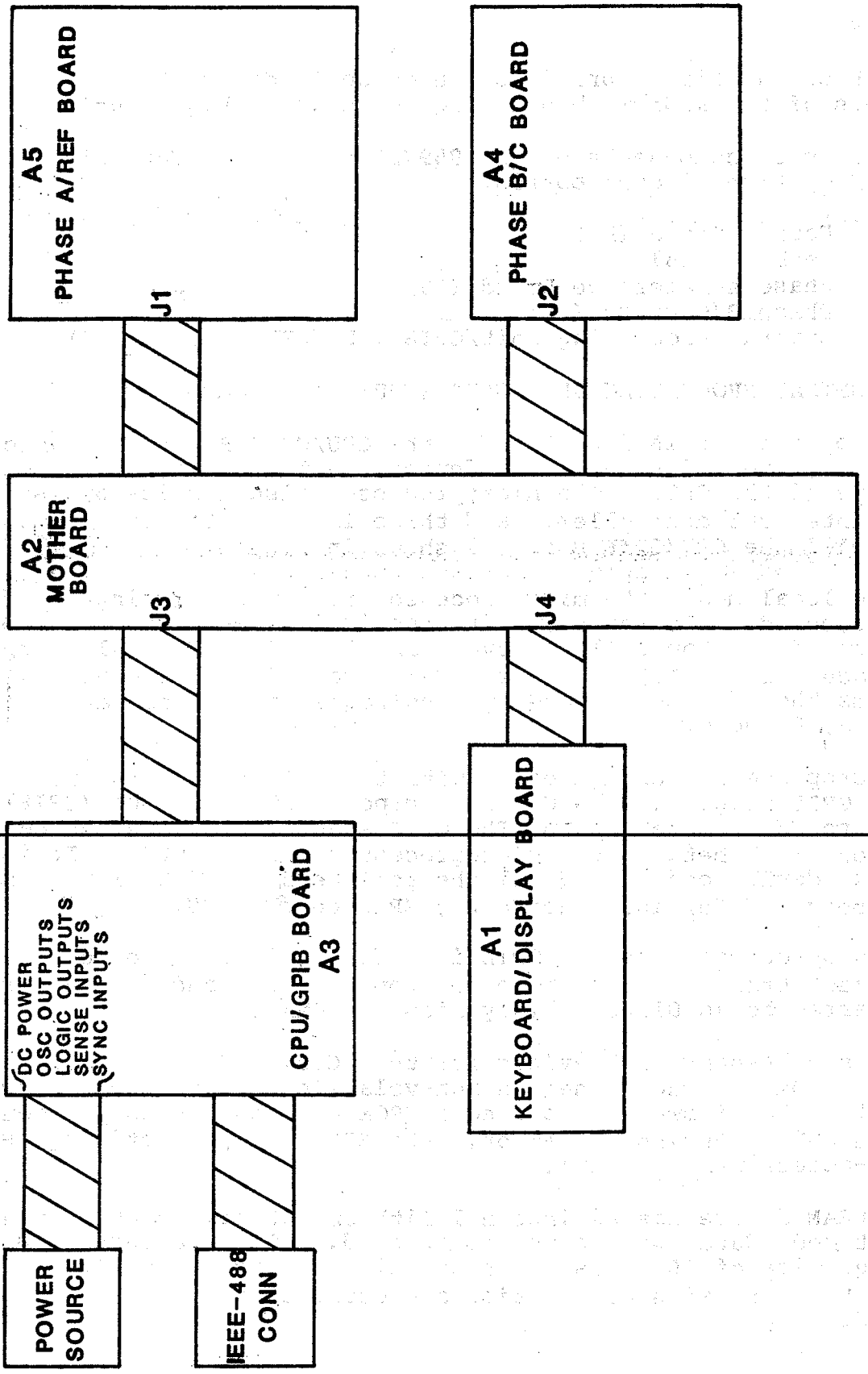


FIGURE 6-1

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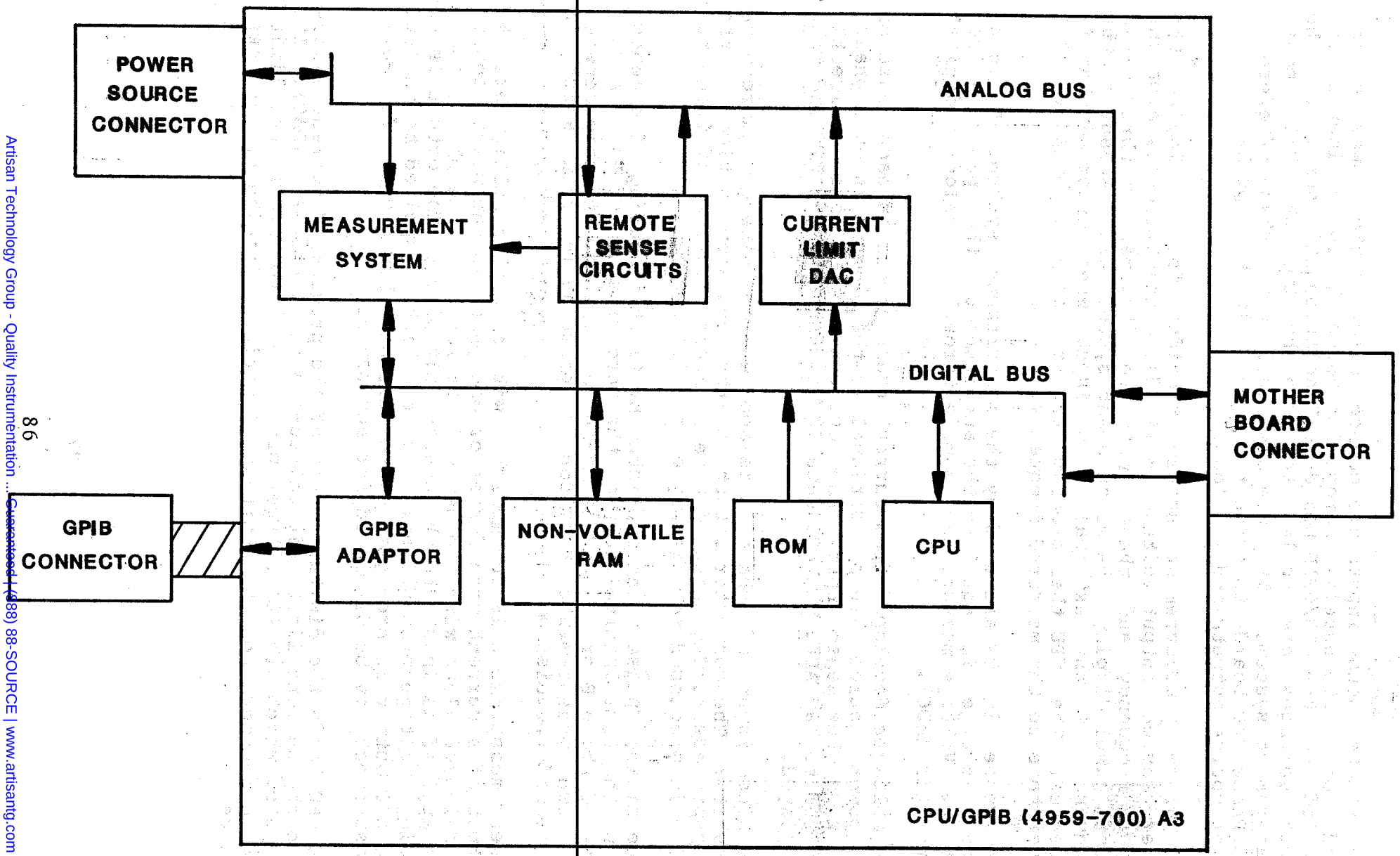


FIGURE 6-2
CPU/GPIB BLOCK DIAGRAM

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The remote sense inputs are connected across the power source loads or, alternately, across its outputs. These inputs are applied to the CPU/GPIB board for isolation and scaling. The input voltages are scaled for use by the CPU/GPIB board measurement system. They are also used on the Phase A/Reference and Phase B/C boards to correct for the voltage drops between the power source outputs and its loads.

The parameter measurement system provides for displaying the power source output voltage amplitude, current, power, apparent power, frequency and phase angle to the operator through the front panel display. The measurement system also measures the frequency of the external sync input when external sync is selected. The CPU then programs the frequency of the sine wave generators to the measured frequency.

The sense inputs are used by the measurement system. A sense input voltage is equal to the amplitude of the power source output. Voltage measurement is made through an analog-to-digital converter (ADC).

The voltages developed from current transformers in each phase of the power source are proportional to the current in each phase. As with the sense input, the current inputs are indirectly applied to an ADC. The ADC data is processed by the CPU and then displayed.

The sense input of Phase A is applied to a sine-to-square wave converter. The converter output starts and stops a timer in the microprocessor. The measured time is representative of frequency which is processed for display on the front panel.

Determining phase is accomplished by first measuring frequency. Then the time interval between the zero crossing of Phase A and that of Phase B or Phase C is measured. The relationship between the two measurements provides the phase angle data which is processed for display.

Power measurement is accomplished with an analog multiplier. An output of a current transformer of one phase in the power source is selected along with the sense input from the same phase. These are applied as inputs to the analog multiplier. The output is an analog voltage proportional to power which is applied to an ADC. The ADC output is processed by the CPU and then displayed. Power measurement may be displayed for any phase.

The CPU loads the digital values of the programmed current limits into the current limit digital-to-analog converter (DAC). Its outputs, which are DC voltages proportional to the current limit, are connected to the current limiting circuits of the power source.

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6.3 MOTHER BOARD

The mother board simply provides interconnections between the other boards. The only components on the mother board are one 26-pin and three 60-pin connectors. The connector designators and the circuit boards that are inserted into them are:

CIRCUIT BOARD DESIGNATOR	MOTHER BOARD CONNECTOR
Phase A/Voltage Reference (A5)	J1
Phase B/C Board (A4)	J2
CPU/GPIB/Measurement (A3)	J3
Keyboard/Display (A1)	J4

Note that the pins of J3 are not connected to like numbered pins on J1 and J2. That is because the CPU/GPIB Board is physically inverted relative to the Phase A/Reference Board and the Phase B/C Board.

6.4 KEYBOARD/DISPLAY BOARD

The operator interfaces with the 959XPT through the front panel which is part of the Keyboard (A1). It includes a twenty-key keypad, a REMOTE indicator, a liquid crystal display (LCD) and a display viewing angle control. A block diagram of the Keyboard /Display Board is shown in Figure 6-3.

When a key is pressed, it creates an interrupt output to the microprocessor mounted on the CPU/GPIB Board. The microporcessor then interrogates the Keyboard, determines which key was pressed and performs the appropriate routine. It stores the key code in memory until the ENTER key is pressed. It then performs the function in accordance with the entered data. When the microprocessor reads the keyboard, the enable causes a tone to be generated from a speaker on this board.

When the 959XPT operates in the remote mode, it receives its programming data over the General Purpose Interface Bus (GPIB). In that mode, the REMOTE indicator is illuminated.

The LCD is completely self-contained with its own internal data registers. The CPU loads data into the display registers which represents the programmed values of voltage, frequency or phase.

6.5 PHASE A/REFERENCE BOARD

The Phase A/Reference Board has a number of functions. The most important are generation of a clock proportional to programmed frequency, precise DC reference voltages for the sine wave generators, and generation of the Phase A sine wave. These and other functions of the board are discussed in the following paragraphs. A block diagram of the Phase A/Reference Board is shown in Figure 6-4.

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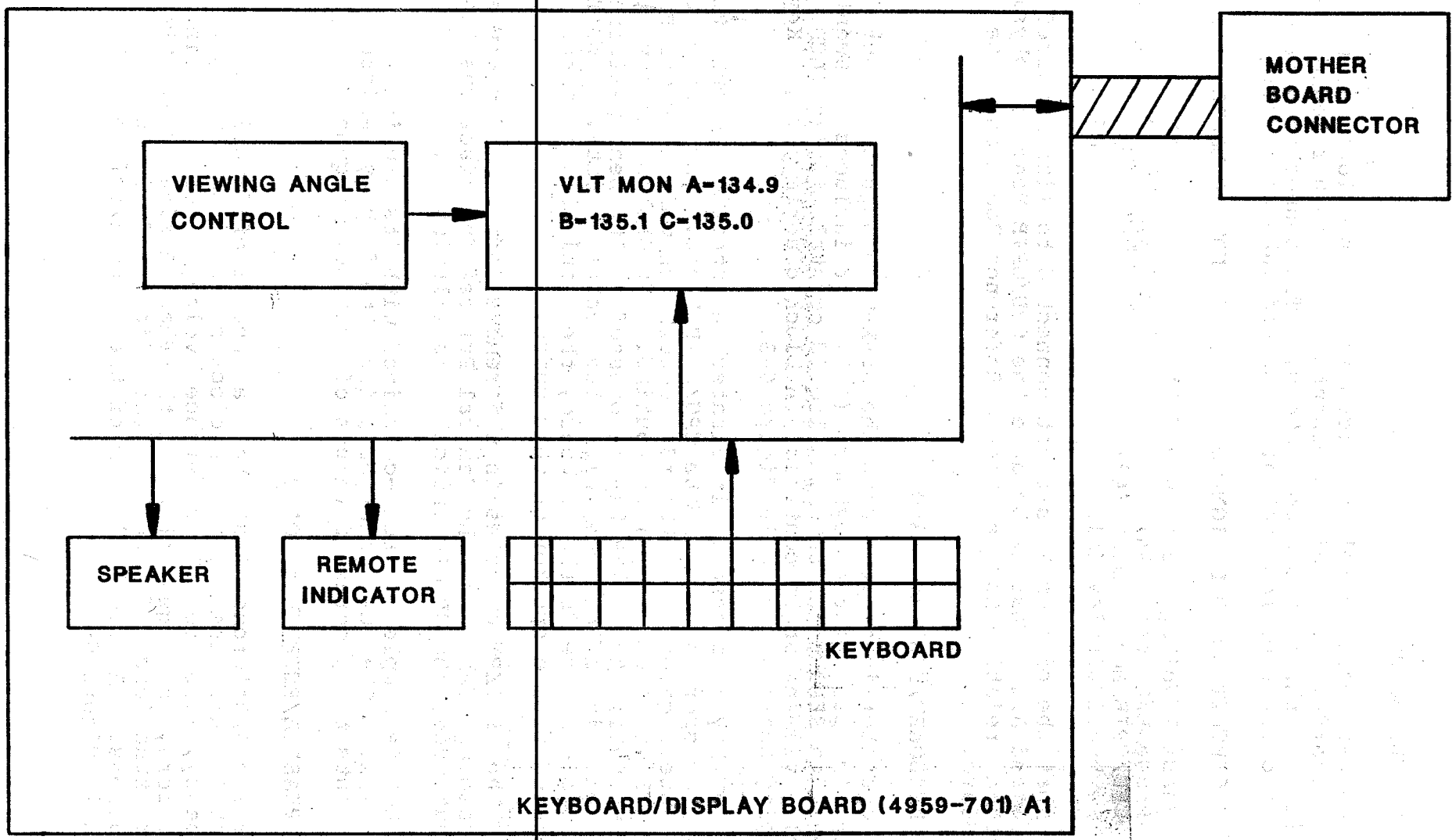


FIGURE 6-3
KEYBOARD/DISPLAY BLOCK DIAGRAM

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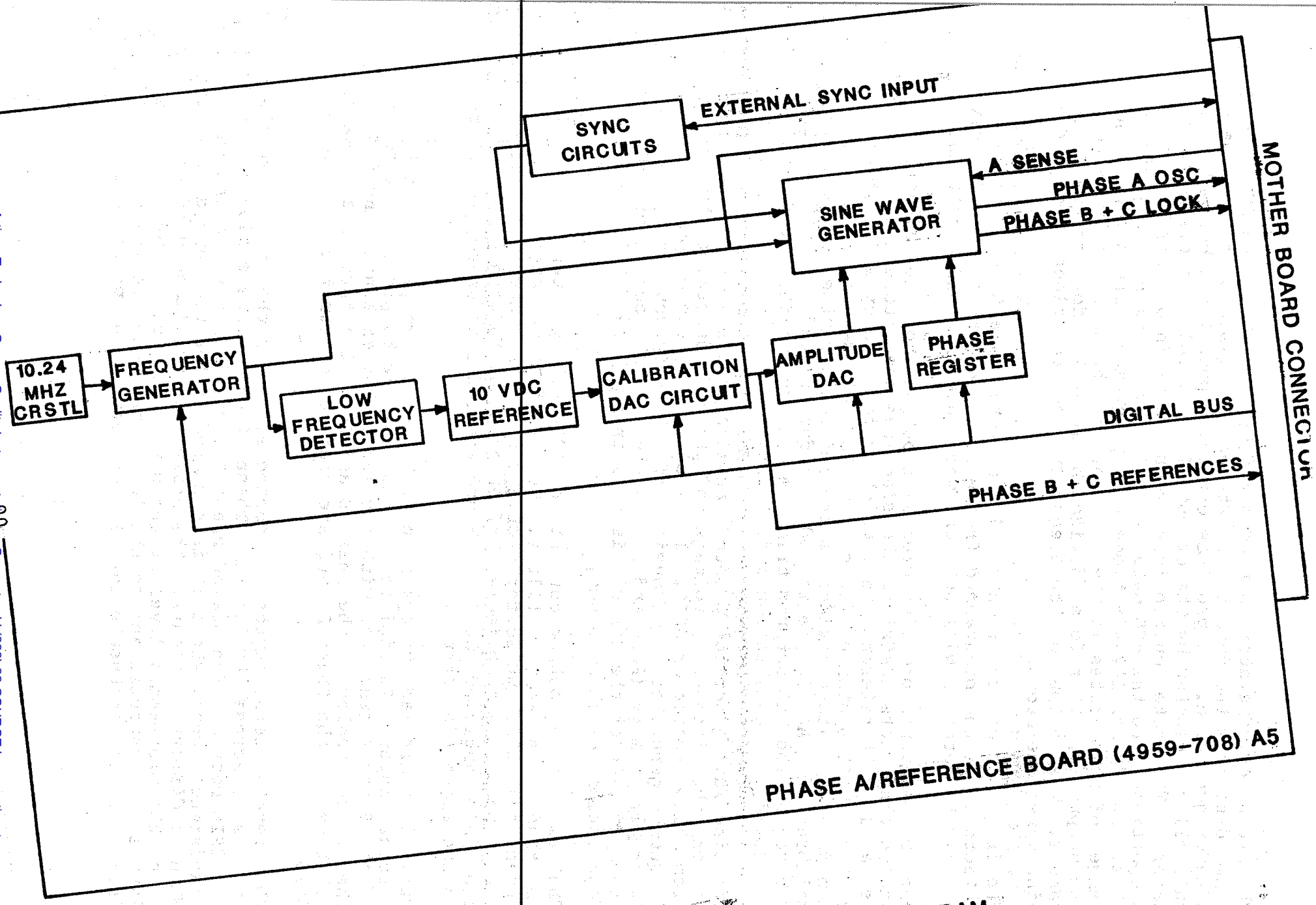


FIGURE 6-4
PHASE A/REFERENCE BOARD BLOCK DIAGRAM

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The frequency generator is programmed by the CPU. The BCD program data from the data bus is stored in registers on the Phase A/Reference board. It provides control inputs for a bank of rate multipliers clocked by the output of a crystal-controlled oscillator. The rate multipliers produce a train of clock pulses proportional to the BCD data at their inputs which is precisely 1024, 10,240 or 102,400 times the programmed frequency. The range of pulse rates is the same for the three frequency ranges. The output is, therefore, divided by 10 or 100 for the two lower ranges. The output of the frequency generator clocks the three sine wave generators.

The frequency generator output is monitored by a Lower Frequency Detector. If the programmed frequency is less than approximately 40 Hz, the detector will turn off the phase A, B and C outputs.

The DC reference provides precision outputs to the digital-to-analog converters (DACs) of the sine wave generators. Its source is a 10-volt reference unit which is followed by a calibration system. That system consists of voltage dividers and a quad DAC. A node at a voltage divider is the reference source output. The calibration DAC is programmed from data stored in NVRAM on the CPU Board. The DAC outputs trim the voltages at the divider nodes to provide the calibration adjustment.

The sine wave generator produces an AC output for Phase A which is of the frequency, voltage and phase as determined by inputs from the Keyboard or GPIB. It is clocked by the output of the frequency generator. It consists of a ten-bit counter system, a read-only memory (ROM) and a digital-to-analog converter (DAC). The operation of the circuit is explained in the detailed circuit descriptions of this volume.

The sine wave output consists of 1024 voltage steps which is smoothed by a two-pole filter. The Phase A generator also produces one clock pulse for each cycle of the output frequency. The pulse occurs at 0 degrees of Phase A and is used to reference the phase angle of the Phase B and Phase C sine wave generators to the Phase A generator.

Provisions are made to synchronize the sine wave generators to an external input. In addition, it is possible to program the phase of the Phase A generator with respect to the external sync input. The phase angles of the Phase B and Phase C outputs are always relative to the Phase A and are programmed from the keypad or GPIB.

The remote sense inputs are connected across the power source outputs or across its loads. These AC inputs are scaled on the CPU/GPIB board. The scaled Phase A input is routed to the Phase A/Reference board where it is compared to the programmed value. When a difference occurs, the Phase A output is servoed to produce the programmed level at the sense inputs. Thus, if the inputs are connected across the load, the power source output is increased to compensate for IR drop between the power source and

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the load. If the required compensation is greater than that which can be developed or if the output fails, a fault signal is generated to the CPU and the outputs are returned to the 5-volt default level.

6.6 PHASE B/C BOARD

The Phase B/C Board contains two sine wave generators, one for Phase B and one for Phase C. Both are near-duplicates of the sine wave generator on the Phase A Board. They are clocked by the clock output of the frequency generator on the Phase A/Reference board. Thus, their frequency is always that of Phase A. Their phases, relative to Phase A, are maintained by a pulse from the Phase A sine wave generator. The pulse loads the phase values programmed into their respective data registers at each zero-degree crossing of Phase A. A block diagram of the Phase B/C Board is shown in Figure 6-5.

The sense inputs for Phase B and Phase C are on the CPU/GPIB board. The levels are scaled at that point, but the compensation circuits are located on the Phase B/C board.

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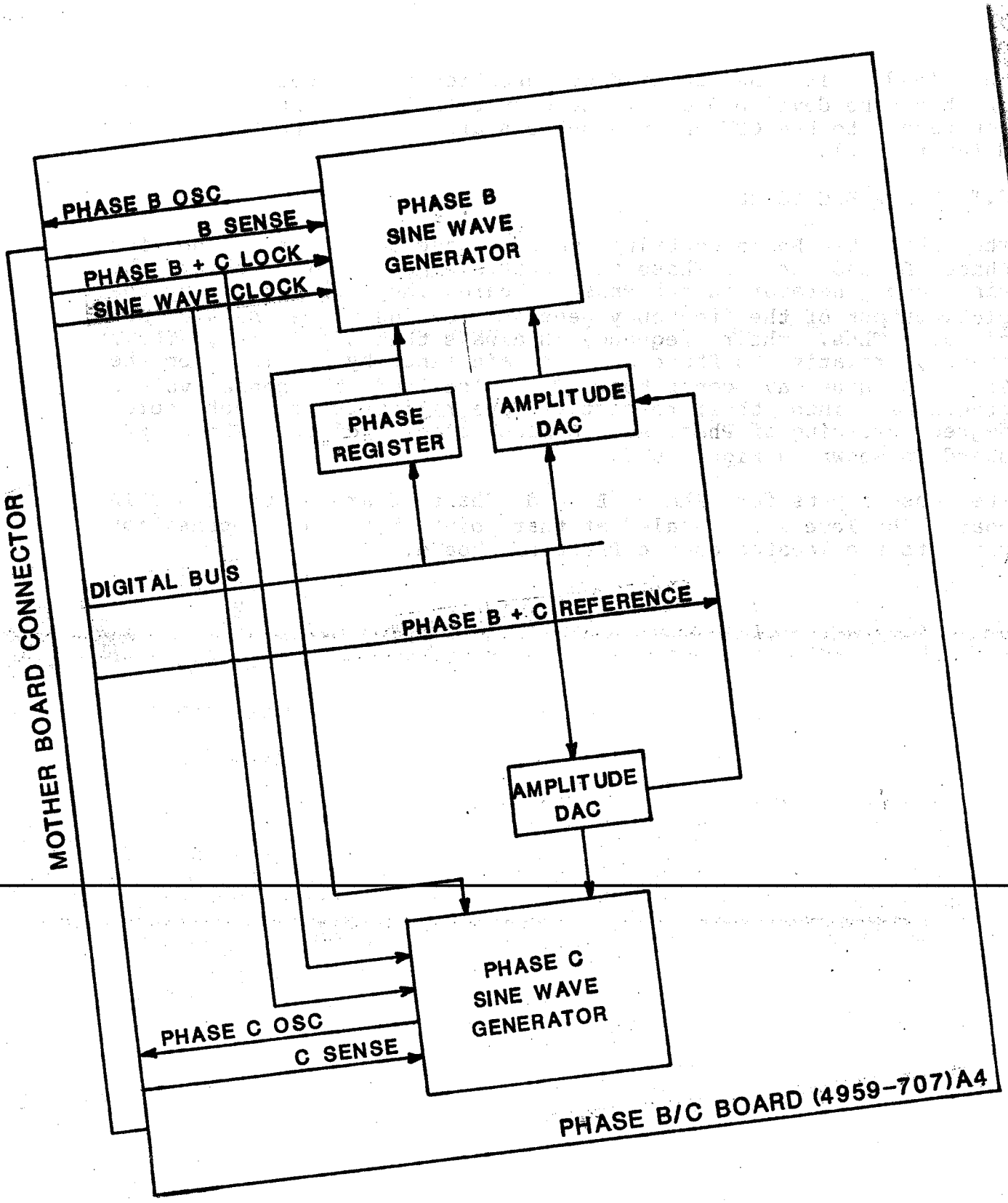


FIGURE 6-5
PHASE B/C BOARD BLOCK DIAGRAM

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SECTION 7 MAINTENANCE AND TROUBLESHOOTING

7.1 GENERAL

The 959XPT has no routine maintenance requirements other than calibration. For a detailed description of the calibration procedure refer to Section 5 of this instruction manual.

The majority of the troubleshooting of the 959XPT may be performed with the 959XPT mounted in the XP power source or in the MXT10 Interface Module. Some additional testing may be required using the California Instruments Extender Assembly, part number 4930-705.

7.2 ASSEMBLY REFERENCE DESIGNATOR

The assemblies shown in Figure 7-1 have the following descriptions:

ASSEMBLY	REFERENCE DESIGNATORS	PART NUMBER
Keyboard/Display	A1	4959-701-1
Mother Board	A2	4959-702-1
CPU/GPIB	A3	4959-700-3
Phase B/C	A4	4959-707-1
Phase A/Ref	A5	4959-708-1

7.3 TROUBLESHOOTING

The 959XPT is only a component of an AC power supply system. To determine if the 959XPT is the bad component of the system, and which assembly of the 959XPT is inoperable, use the Troubleshooting Flow Diagrams in Figure 7-2 and 7-3.

If the programmed output frequency and voltage of all phases is incorrect and it cannot be corrected by the calibration procedure in Section 5, replace assembly A 5.

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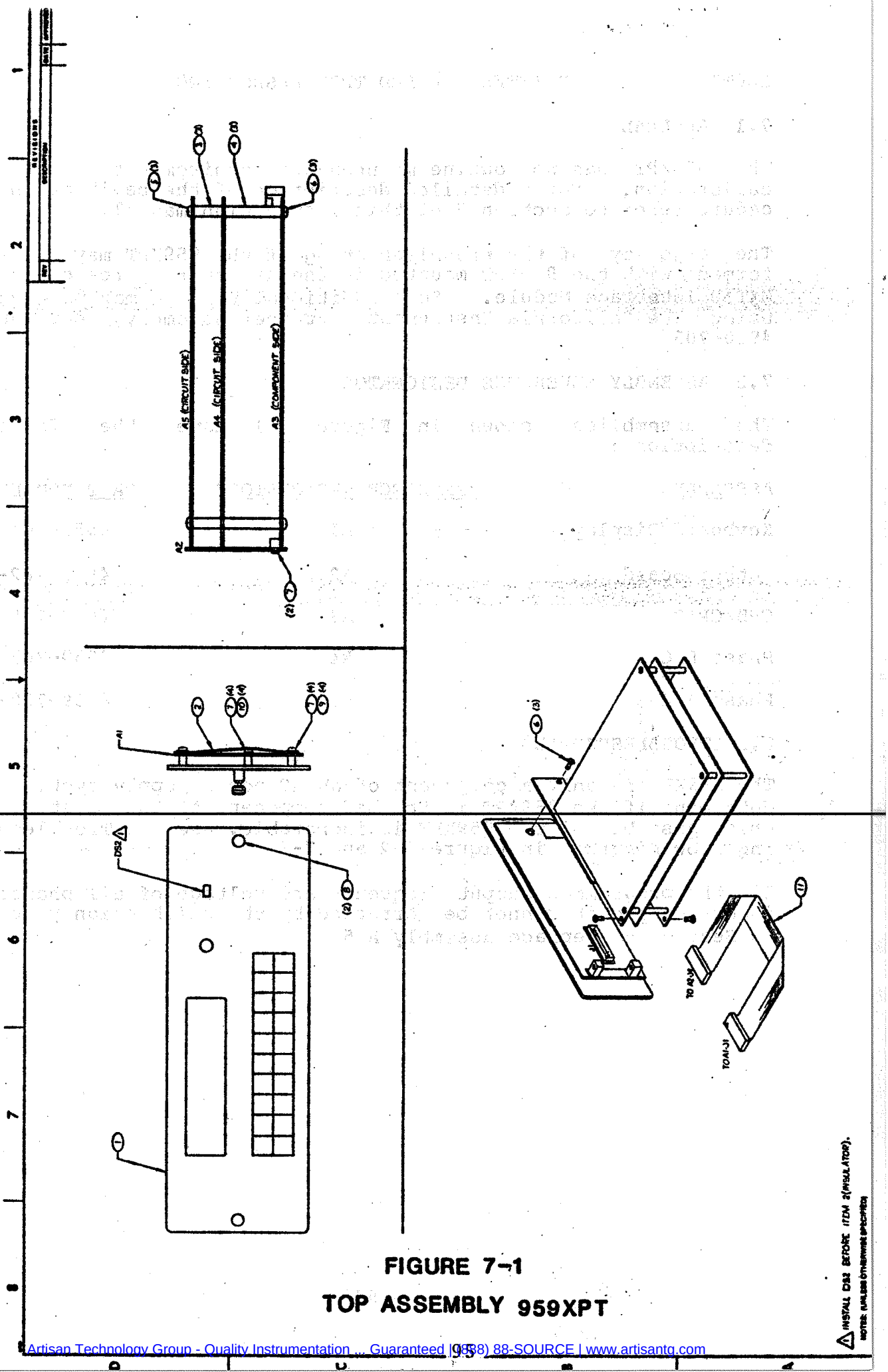


FIGURE 7-1

TOP ASSEMBLY 959XPT

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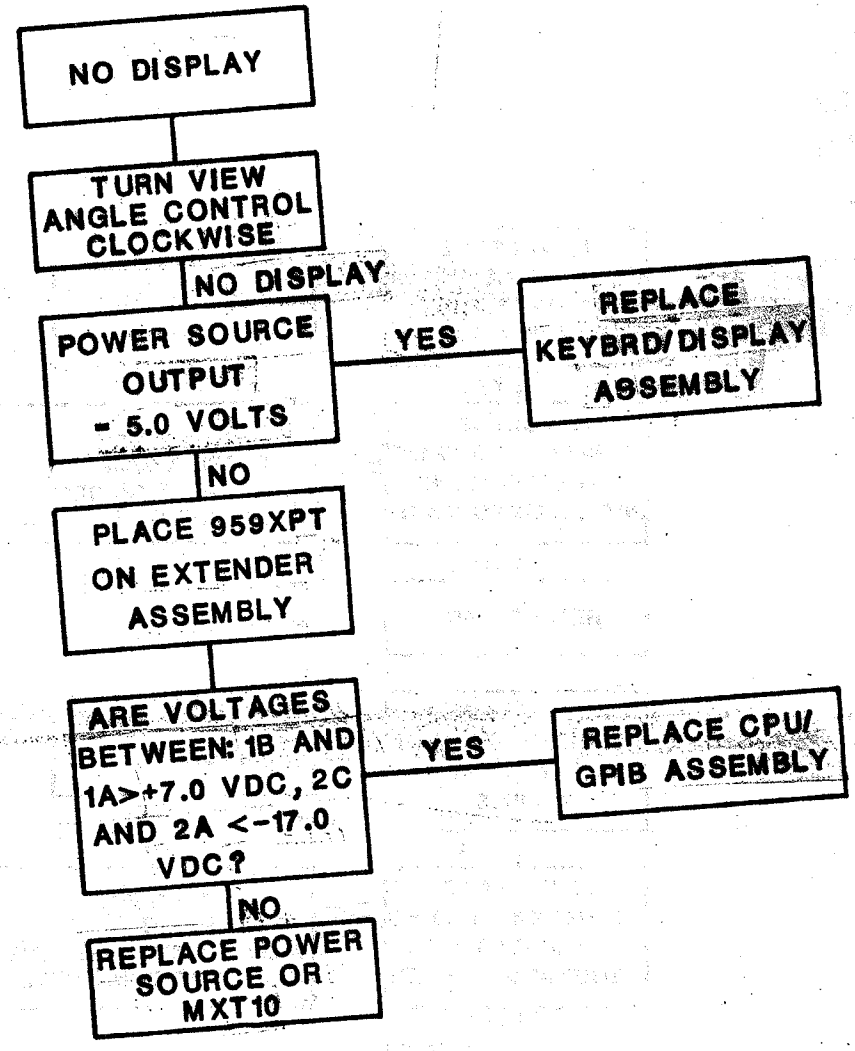


FIGURE 7-2
NO DISPLAY TROUBLESHOOTING FLOW DIAGRAM

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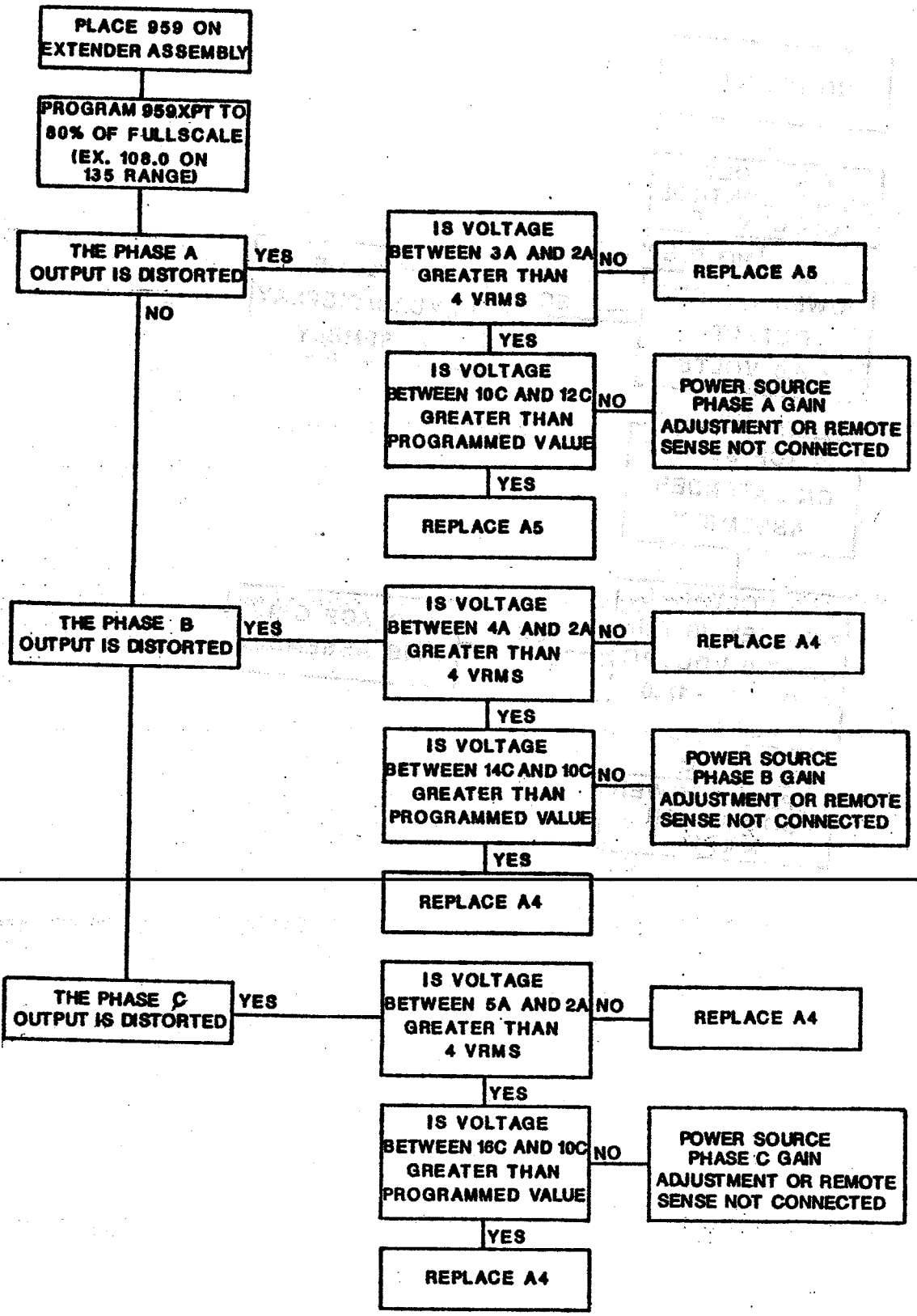


FIGURE 7-3
DISTORTED OUTPUT

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SECTION 8 REPLACEMENT PARTS

8.1 GENERAL

This section contains ordering information and complete lists of replaceable parts for the 959XPT AC Controller, Parts are listed by major subassembly in alphanumerical order of their reference designators, description, manufacturer's part number, manufacturer's code identification number (See Appendix A for list of manufacturers), and California Instruments stock numbers are indicated.

8.2 ORDER INFORMATION

In order to ensure prompt, accurate service, please provide the following information, when applicable, for each replacement part ordered.

a. Model number and serial number of the instrument.

b. California Instruments part number for the subassembly where the component is located (PARENT ITEM NO.).

c. Component reference designator (SEQ NO.).

d. Component description.

e. Component manufacturer's FSCM number (VENDOR).

f. California Instruments part number (COMPONENT ITEM NO.).

All replaceable part orders should be addressed to:

California Instruments
Attention: Customer Service
5150 Convoy Street
San Diego, California 92111-1266

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PARENT ITEM NO.
4959-404-3

TOP ASSY, REPLACEABLE PARTS.

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION	VENDOR	QTY
A1	4959-701-1	PC ASSY, KEYBOARD/DISPLAY	16707	1
A2	4959-702-1	PC ASSY, MOTHER	16707	1
A3	4959-700-1 or -2	PC ASSY, CPU/GPIB	16707	1
A4	4959-707-1	PC ASSY, B/C BOARD	16707	1
A5	4959-708-1	PC ASSY, PHASE A/REF	16707	1
DS2	250392	LAMP, LED, RED	72699	1
1	4959-201-1	PANEL, FRONT W/4959-201	16707	1
2	4959-202-1	INSULATOR	16707	1
3	210749	SPACER, #6 X 3/4", NYLON	83330	3
4	210770	STANDOFF, 6-32 X 13/8" PHN	06540	3
5	FS1038	SCREW, PNH, S/S, 6-32X1	96906	3
6	FS1030	SCREW, PNH, S/S, 6-32X3/8	96906	6
7	FS1011	SCREW, PNH, S/S, 4-40X1/4	96906	10
8	250325	FASTNER, CAPTIVE SCREW	94222	2
9	FS1079	WASHER, FLAT, S/S, #4	96906	4
10	FS1072	WASHER, SPLT, S/S, #4	96906	4
11	4959-203-1	CABLE ASSY, RIBBON, 26 PIN	16707	1

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Number	Vendor Name	City	State
0000A	Electricord	Westfield	PA
0000C	Jackson Bros.	Weedon,Surrey	GB
0000S(28564)	OPCDA (Relac Elect. Corp.)	Winsted	CT
0000W	Milton Ross Co.	Southampton	PA
0000Z(52745)	Tinco	Los Angeles	CA
000AC	Itac	Santa Clara	CA
000AD(551112)	Plessey (Westlake Cap. Inc.)	Westlake Village	CA
000AG	LaFrance	Philadelphia	PA
000AH(54363)	Jan Crystal	Ft. Myers	CA
000AL(53495)	Data Components, Inc.	Gardena	CA
000AM	Kraus & Naimer	Santa Monica	CA
000AN	Ritz Instrument Transformer	Redondo Beach	CA
000AS	Switches Incorporated	Mt. View	CA
000AT(62643)	United Chemi-Con	Rosemont	IL
000AU	JMJ Technical Prod. Inc.	Rendall Park	NJ
000AV(61837)	Semi Processes, Inc.	San Jose	CA
000AW	Hirose	Chatsworth	CA
000AX(63878)	Aptronics	Manter	OR
000AY	Silicon Power Cube Corp.	Long Beach	CA
000AZ(61271)	Fujitsu	Santa Clara	CA
000BA(61964)	Omron Electronics, Inc.	Schaumburg	IL
000BB	Hallmark Metals, Inc.	Glendora	CA
000BC	Toshiba America, Inc.	Tustin	CA
000BD(559082)	Electronic Essentials	Woodside	NY
000BE(57056)	Kel-Am	Eldon	MO
000BF(55205)	Berquist	Minneapolis	MN
000BG	Panasonic	Secaucus	NY
000BH	Century Components	Canyon Country	CA
000BI(54186)	Micro Power Systems	Santa Clara	CA
000BJ(06776)	Robinson Nugent	New Albany	IN
000BL(13150)	Beau Products (Vernitron)	Laconia	NH
000BN(91725)	Corebinder (Gerrard AJ & Co.)	Des Plaines	IL
000BO	Mitsubishi Electronics Amer.	Sunnyvale	CA
000BP	Silicon Power Cube	Long Beach	CA
000BR	Secme	Bagnolet	France
000BS	Panel Components Corp.	Santa Rosa	CA
00544	Metal-Cal Div., Avery Prod.	Inglewood	CA
00779	AMP Inc.	Harrisburg	PA
00853	Sangamo Electronic Co.	Pickens	SC
00866	Goe Eng. Co., Inc.	City of Industry	CA
01002	G.E. Co., Ind. & Pwr. Cap. Dept.	John St. Hudson Falls	NY
01121	Allen-Bradley Co.	Milwaukee	WI
01139	G.E. Co., Silicone Prod.	Waterford	NY
01295	Texas Instruments	Dallas	TX
01961	Pulse Engineering, Inc.	San Diego	CA
02111	Spectrol Electronics	City of Industry	CA
02113	Coilcraft, Inc.	Cary	IL
02335	Fairchild Controls Corp.	Hicksville,LI	NY
02375	American Insulating Mach. Co.	Philadelphia	PA
02538	Texas Electronics Co.	Dallas	TX
02660	Amphenol Corporation	Broadview	IL
02768	Illinois Tool Works, Inc. Use Code 172136	Des Plains	IL
03507	General Electric Company	Syracuse	NY
03508	General Electric Company	Syracuse	NY
03797	Eldema Corporation	Compton	CA
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls	NJ
03911	Clairex Corporation	New York	NY
04009	Arrow-Hart and Hegeman Elec.	Hartford	CT
04099	Capco, Inc.	Grand Junction	CO
04713	Motorola Semiconductor Prod.	Phoenix	AZ
04729	Universal Components Corp.	Green Brook	NJ
04963	3-M	St. Paul	MN
05245	Corcom Inc.	Chicago	IL
05276	Pomona Electronics., Inc.	Pomona	CA
05397	Kemet, Union Carbide Corp.	Cleveland	OH
05791	Lyn-Tron, Inc.	Burbank	CA
05820	Wakefield Engineering, Inc.	Wakefield	MA
05972	Loctite Corp.	Newington	CT
06383	Panduit Corp.	Tinley Park	IL
06514	Stanton, Wyco Metal Prod.	N. Hollywood	CA
06540	Amatom Elect. Hardware	New Rochelle	NY
06665	Precision Monolithics Inc.	Santa Clara	CA
06776	Robinson Nugent, Inc.	New Albany	IN
06915	Richco Plastics, Co.	Chicago	IL
07088	Kelvin Electric Company	Van Nuys	CA
07263	Fairchild Camera & Instr.	Mt. View	CA
07387	Birtcher Corporation	Los Angeles	CA
07556	Omitrack Calabro Plastics	Upper Darby	PA
07633	Epoxy Prod. Co., Allied Prod. Corp.	New Haven	CT
07707	USM Corp. (USM Fastener Div)	Shelton	CT
07716	IRC Incorporated Use Code 115818	Burrington	IA
07910	Loctite (Auto & Consumer Grp)	Mtn View	CA
08028	Spang Ind. (Magnetics Div)	Sandy Lake	PA
08057	Accurate Rubber and Plastics	San Diego	CA
08065	Spectra Strip (Amphenol)	Garden Grove	
08261	Blinn Delbert Co.	Pomona	CA
08289	Bristol Co. of Canada	Toronoto, Ont	Canada
08353	Ostby & Barton (Vemaline Prod. Div.)	Warwick	RI
08730	Signal Transformer	Brooklyn	NY
08779	GE (Semiconductor Prod. Div)	Auburn	NY
09214	C & K Components	Newton	MA
09353	Burndy Corp.	Norwack	CT
09922	Chicago Switch	Chicago	IL
10389	Cherry/Textron (Fastener Div)	Santa Ana	CA
11815	Elpac Electronics	Santa Ana	CA
12406	Clarostat Mfg.	Dover	NH
12697	Thermalloy Company	Dallas	TX
13103	Vernitron Corp (Beau Prod.)	Laconia	NH
13150	Sperry Corp. Elec. Systems	Great Neck	NY
13604	Burr-Brown	Tucson	AZ
13919	Semtech Corporation	Newbury Park	CA
14099	Elwood Sensors Inc.	Cranston	RI
14604	Cornell-Dubilier Elect. Corp.	Newark	NJ
14655	Hollingsworth Co.	Phoenixville	PA
14726	Electro Cube, Inc.	San Gabriel	CA
14752	Electronic Instrument and Specialty Corp.	Stoneham	MA
14908	ITT Semiconductors	Lawrence	MA
15238	Amatek Enk (Rodan Div)	Anaheim	CA
15454	Elec-trol	Northridge	CA
15636	Fenwall Electronics	Framingham	MA
15801	Ameico Teledyne, Inc.	Mt. View	CA
15418	Ansley	Los Angeles	CA
15912	California Instruments Co.	San Diego	CA
16067	Delco Radio Div., Gen. Mtrs.	Kokomo	IN
16758	Dennison	Framingham	MS
16956	Siliconix, Inc.	Santa Clara	CA
17856	Umpco	City of Industry	CA
18076	Vactec, Inc.	Maryland Heights	MO
18178	Concord Electronics Corp.	New York	NY
18310	Signetics	Sunnyvale	CA
18324	Vishay Instruments, Inc.	Malvern	PA
18612	Scambe Mfg. Co. (Sero Corp.)	Monterey Park	CA
18677	RCA	Mountaintop	PA
18722	Voltronics Corp.	Hanover	NJ
18736	Robison Company	Hawthorne	CA
19080	Buckeye Stamping Company	Columbus	OH
21604	Solitron Devices (Semi-conductor Group)	Riviera Beach	FL
21845	Elastic Stop Nut Corp.	Van Nuys	CA
22599	Product Components Corp.	Hastings-on-Hudson	NY
23050	Pamotor, Inc.	San Francisco	CA
23936	ECC	Burlington	MA
24011	Analog Devices, Inc.	Norwood	MA
24355	General Semiconductor Inc.	Tempe	AZ
24444	Paralco, Inc.	Paramount	CA
24796	Specialty Connector Co., Inc.	Greenwood	IN
24931	AEG-Telefunken Corp.	Somerville	NJ
24932	Amperex Electronic Corp.	Slatersville	RI
25403	Meter Master	Los Angeles	CA
25497	Marathon Electric Mfg. Corp.	Bowling Green	OH
26405	American Settler, Inc.	Costa Mesa	CA
26606	National Semi-Conductor Crp.	Santa Clara	CA
27014	Cutler-Hammer, Inc.	Milwaukee	WI
27191	Molex	Downers Grove	IL
27264	B & B Motor & Control Corp.	New York	NY
27335	IMB Electronic Products	Santa Fe Springs	CA
27556	Varo, Inc.	St. Garland	TX
27683	F-Dyne Electronics	Bridgeport	CT
27735	Hughes Aircraft	Newport Beach	CA
27832	Hewlett-Packard Co.	Palo Alto	CA
28460	Heyman Mfg. Company (Heyco)	Kenilworth	NJ
28520	Echlin Ltd.	Reedale Ont.	Canada
28606	Rexnord Inc. Tridair Ind.	Torrance	CA
29377	Bussaco Eng. Inc.	El Segundo	CA
29593	International Components Crp.	Asbury Park	NJ
30039	Aavid Engineering, Inc.	Laconia	NH
30161	Dorann Company	Sylmar	CA
30697	Electra/Midland (Repco/ Electra)	San Diego	CA
30983	Budwig Mfg. Co.	Pamona	CA
31027	Tridigm, Inc.	Pittsburg	PA
31951	Intersil	Cupertino	CA
32293	Bivar, Inc.	Santa Ana	CA
32559	Bourns Inc. (Trimpot Div)	Riverside	CA
32997	Jewell Electrical Inst. Inc.	Manchester	NH
33005	Logic Dynamics, Inc.	Gardena	CA
33035	Ringsbacher Murray Co.	Los Angeles	CA
33716	Ducommun, Inc.	Los Angeles	CA
33855	Caliber Corp.	Irvington	NJ
33901	Mills Resistor Co.	Los Alamitos	CA
34210	Silicon General	Westminster	CA
34333	Intel Corporation	Santa Clara	CA
34649	Aerovox Canada Ltd.	Amherst NS	Canada
35307	Linear Technology, Inc.	Burlington, Ont	CAN
37964	Ohmite Manufacturing Co.	Skokie	IL
44655	Parker-Kalon	Clifton	NJ
45722	Penn. Eng. and Mfg. Corp.	Doylestown	PA
46384	Midwest Components, Inc.	Muskegon	MI
46157	Monsanto, Electronic Special Products	Cupertino	CA
50322	Electronic Concepts, Inc.	Eatontown	NJ
50558	Mouser Corp.	Santee	CA
50811	Aries Electronics, Inc.	Frenchtown	NJ
51167	Accurate Screw Machine Co.	Hutley	NJ
51508	ICO/Rally	Palo Alto	CA
51705	Circuit Assembly Corp.	Costa Mesa	CA
52072	Timco	Los Angeles	CA
52745	Kintex, Inc.	Buffalo	NY
53076	Data Components, Inc.	Gardena	CA
53495	Edwards Sheet Metal Works	Fredericktown	OH
54361	Power-One Co.	Camarillo	CA
54407	Samtec, Inc.	New Albany	NY
55322	RAF Electronic Hardware, Inc.	Seymour	CT
55566	Sprague Electric Company	North Adams	MA
56289	RCD Components, Inc.	Manchester	NH
56637	United Chem-Con Corp.	Philadelphia	PA
57640	Kel-Am, Inc.	Eldon	MO
57856	Superior Electric Company	Bristol	CT
58474	Thomas and Betts Company	Elizabeth	NJ
59710	International Rectifier Semiconductor Div.	El Segundo	CA
59993	Xicor, Inc.	Milditas	CA
60395	Seeq Technology, Inc.	San Jose	CA
61394	Saronix	Palo Alto	CA
61441	Aromat Corp.	Mountainside	NJ
61529	Pulse Engineering, Inc.	College Park	MD
61735	Densitron Corp. of America	Torrance	CA
62483	United Chemicon, Inc.	Rosemont	IL
62643	Nitachi America Ltd.	San Jose	CA
62786	Ward Leonard Electric Co.	Mt. Vernon	NY
63743	Star Micronics, Inc.	New York	NY
63791	Allmetal Screw Prod. Co.	Garden City	NY
70318	Belden Manufacturing Co.	Chicago	IL
70903	Bud Industries, Inc.	Willoughby	OH
71218	Cambridge Thermionic Corp.	Cambridge	MA
71279	Bussman Mfg. Div. McGraw-Edison Co.	St. Louis	MO
71400	CTS Corporation	Elkhart	IN
71450	ITT Cannon Electric, Inc.	Los Angeles	CA
71468	Centralab Div. Globe-Union	Milwaukee	WI
71590	Coto-Coil	Providence	RI
71707	Chicago Miniature Lampworks	Chicago	IL
71744	Cinch Manufacturing Company	Chicago	IL
71785	Dow Corning Corp.	Midland	MI
71984	Elmenco (Electro Motive)	Willimantic	CT
72136	Dialight Corporation	Brooklyn	NY
72619	General Instruments	Newark	NJ
72699	Erie Technological Prod. Inc.	Erie	PA
72982	Beckman Instruments, Inc.	Fullerton	CA
73138	Consolidated Electronic Wire and Cable Corp.	Chicago	IL
73612	Federal Screw Products, Inc.	Chicago	IL
73734	Reinemann Electric Company	Trenton	NJ
74193	Harvey Hubbell, Inc.	Bridgeport	CT
74545	Illinois Condenser Co.	Chicago	IL
74840	E.F. Johnson Company	Waseca	MN
74970	TRW Electronic Components	Philadelphia	PA
75042	Kulka Electric Corporation	Mt. Vernon	NY
75382	Leviton Mfg. Co.	Little Neck	NY
75582	Littelfuse, Inc.	Des Plaines	IL
75915	Minor Rubber Co., Inc.	Bloomfield	NJ
76385	Pabst Eng. Equipment Co.	Elizabeth	NJ
77062	UnitedCarr Inc. Barwin Div.	Watertown	CT
77132	Potter and Blumfield Div, AMF	E. Princeton	IN
77342	Shakeproof Div, IL Tool Works	Chicago	IL
78189	Tinnerman Products, Inc.	Cleveland	OH
78553	Johns-Manville Products Corp	Chicago	IL
79130	Walden Robinoor Inc.	Long Island City	NY
79136	Ierick Mfg. Corp.	New Rochelle	NY
79963	Repco/Electra	Morristown	NJ
80031	United Transformer Co.	New York	NY
80223	Bourns, Inc.	Riverside	CA
80294	High Voltage Engineering Corp (Anderson Pwr Prod. Div)	Brighton	MA
80495	Triad Transformer Corp.	Venice	CA
81095	Winchester Electronics	Oakville	CT
81312	(Fed. Specs) Promulgated by General Services Administration Washington DC		
81348	Military Specification or Commercial Generic Number		
81349	Airpax Corp.	Cambridge	MD
81541	Raco Products Co.	Chicago	IL
81603	Bentley-Harris Mfg Co.	Lionville	PA
81851	Standard Grigsby	Aurora	IL
82104	Switchcraft, Inc.	Chicago	IL
82389	Rotron Mfg. Co., Inc.	Woodstock	NY
82877	Vector Electronics, Inc.	Sylmar	CA
82893	Herman H. Smith, Inc.	Brooklyn	NY
83330	Elco Tool & Screw Corp.	Rockford	IL
83486	Brady W.H. Co.	Milwaukee	WI
83640	RCA	Harrison	NJ
84884	Seastrom Mfg. Co., Inc.	Glendale	CA
86928	Marco-Oak Industries	Anaheim	CA
87034	Useco Div., Litton Ind.	Van Nuys	CA
88245	Mallory Capacitor Co.	Indianapolis	IN
90201	Augat, Inc.	Attleboro	MA
91506	Dale Electronics, Inc.	Columbus	NE
91637	Elco Corporation	Willow Grove	PA
91662	Industrial Devices, Inc.	Edgewater	NJ
91802	Keystone Electronics Corp.	New York	NY
91833	National Tel-Tronics	Meadville	PA
91967	Alpha Wire Corp.	Elizabeth	NJ
92194	Pentagon Products Co.	Washington	DC
93303	Southco, Inc.	Lester	PA
94222	Magnecraft Electric Co.	Chicago	IL
94696	Alco Electronic Prod., Inc.	No. Andover	MA
95146	RCA	Cincinnati	OH
95303	Methode Manufacturing Corp.	Rolling Meadows	IL
95354	Arnold Engineering Co.	Marengo	IL
95566	Vecraesor Company, Inc.	Chicago	IL
95987	Military Std		
96906	Electronic Engineering Co.	Santa Ana	CA
97525	Rubber Teck, Inc.	Gardena	CA
98159	Sealecto Corp.	Nameroneck	NY
98291	Isro Mfg. Co. (West)	Burbank	CA
98376	IERC	Burbank	CA
98978	Protective Closures Co., Inc. (Capluge Div)	Buffalo	NY
99017	Bell Industries, Inc.	Delavan	WI
99217	Permacell	New Brunswick	NJ
99742	IMC	Haywood	CA
99743	Delevan Electronics Corp.	Aurora	NY
99800			

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PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, and including the model number and serial number. On receipt of this information, service data or a Return Material Authorization (RMA) number will be given. Fill in RMA No. blank on shipping label attached opposite these instructions, pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No., or freight collect, will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS, San Diego, CA. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost, and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

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