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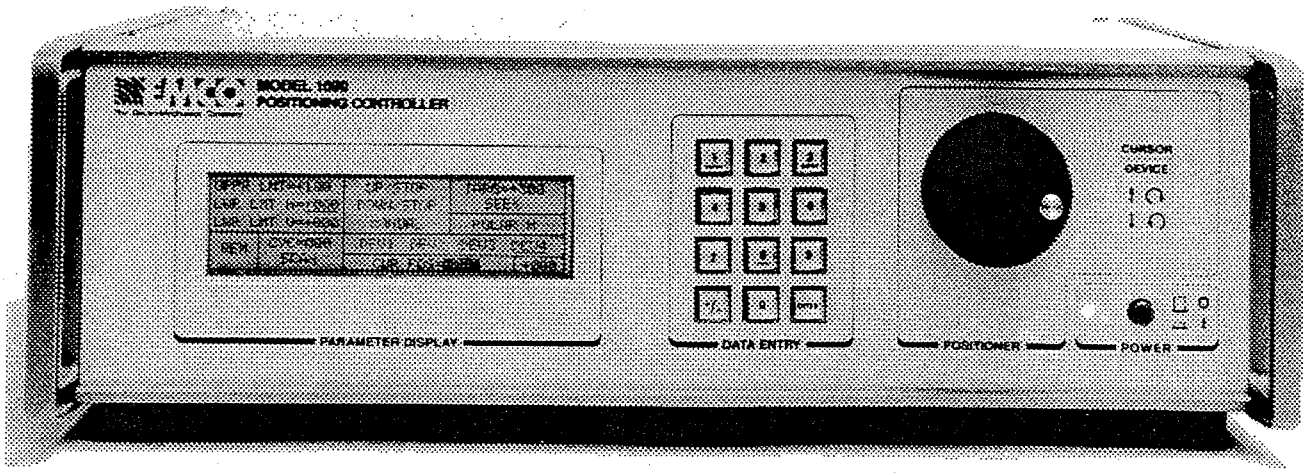
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MODEL 1090
POSITIONING CONTROLLER

OPERATION MANUAL



The Electro-Mechanics Company

EMCO - USA PO Box 1546 Austin, Texas 78767 • 800-253-3761 • 512-835-4684 • Telex 797627 • Fax 512-835-4729
EMCO - EUROPE Munchner Str. 2 D-8137 , Berg 1 West Germany • 08151/89161 • Fax 08151/16610
EMCO - ASIA Jovial Court #8E Discovery Bay, Lantau Island, Hong Kong • 852-987-5667

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INSTRUCTION AND OPERATION MANUAL

FOR THE

EMCO MODEL 1090

POSITIONING CONTROLLER

GENERAL DESCRIPTION

The Electro-Mechanics Company (EMCO) Model 1090 Positioning Controller is designed for use with EMCO Antenna Positioning Masts and Turntables to accomplish a variety of EMC tests including FCC and VDE compliance testing.

Four control ports located on the rear panel of the controller allow for the connection of up to four masts, turntables or any combination of both type of devices. Identification codes sent to the controller by the connected devices are used to determine the nature of the devices connected, so that the controller may treat each device appropriately (auto-configuring itself to the environment).

The front panel of the controller contains a 240 X 64 dot, backlit, graphic liquid crystal display (LCD) used for the display of device parameters and operational information. Also on the front panel is a numeric keypad which is used for entering or altering device parameters and invoking functions. A multi-purpose control wheel has been provided to aid in stepping through menu items or for the manual positioning of either masts or turntables.

Control of all devices may be accomplished either in the local mode, through direct interaction with the front panel controls, or in remote mode through use of the GPIB (IEEE-488.1/488.2 standard interface bus) port located on the rear panel. In the remote mode of operation, a reduced instruction set mode, emulating EMCO Models 1050 and 1060 positioning controllers has been provided.

UNPACKING AND ASSEMBLY INSTRUCTIONS

The Model 1090 Positioning Controller is shipped in a container with an instruction manual, power cord, and appropriate packing material to prevent damage. Unpacking consists of removing the manual, the power

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prevent damage. Unpacking consists of removing the manual, the power cord, and the Model 1090 from the container.

No assembly is required.

PREPARATION FOR USE

Power Requirements

The Model 1090 accepts any AC power source input within the range of 90-250V, 50-400Hz. No voltage selection is required. For the application of AC power, a three-conductor power cable is shipped with the instrument. Connecting this cable to an appropriate AC power source causes the instrument chassis to be connected to earth ground.

BEFORE SWITCHING ON THIS INSTRUMENT, THE PROTECTIVE EARTH TERMINAL OF THIS INSTRUMENT MUST BE CONNECTED TO THE PROTECTIVE CONDUCTOR OF THE POWER CORD. THE POWER CORD SHALL ONLY BE CONNECTED TO A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THIS PROTECTIVE ACTION MUST NOT BE DEFEATED THROUGH THE USE OF AN EXTENSION CORD WITHOUT A PROTECTIVE EARTH CONDUCTOR.

Mast/Turntable Connections

Connection to Model 1090 from either a mast or a turntable is accomplished by means of a single multi-conductor cable (included with the mast or turntable). The cable terminates in a circular bayonet-style connector which is identical at each end. The cable is symmetrical in that either end may be connected to the controller. When connecting the control cable to the controller, caution is advised to observe the keying of the connector in order to prevent possible damage to the connector shell. Additionally, it is advised that excessive lengths of cabling (more than six feet) is not recommended to hang freely from the rear panel of the controller as this will place undue mechanical stress on the connectors and the panel.

Masts and turntables may be connected in any sequence to the four Device Interface Ports located on the rear panel of the instrument. If there are to be less than four devices connected to the instrument, it is recommended

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(though not required) that devices be connected in numerical order starting with the Device 1 Interface Port.

GPIB Interconnections

The Model 1090 is compatible with the General Purpose Interface Bus as described in IEEE-488.1/488.2 standard. A "D" connector has been provided on the 1090 rear panel for connection to a GPIB bus. When making this connection, please note that as a practical matter, the stacking of more than three cables on any one connector should be avoided as this places undue mechanical stress on the connector and rear panel of Model 1090. Additionally, the two connector lockscrews should be made finger tight to avoid the connection being loose during operation.

Provisions have been made for the setting of the instrument's talker/listener bus address through the front panel. Instructions on how to perform this operation may be found in the section of this manual entitled "Setup Menu." Instructions for the programming of the instrument's GPIB interface may be found in the section of this manual entitled "Programming Model 1090 for Remote Operation".

Rack Mounting

The Model 1090 may be ordered with a rack mount option. This option may be either factory or field installed. This option provides capability for installation in a universal E.I.A. 19 inch rack. The instrument requires 5.25" of rack height (three standard rack height units).

OPERATION

Local Mode

The Model 1090 is a menu driven instrument. In the local operation mode the current menu is presented on the Parameter Display, and contains the operational parameters which may be altered, and functions which may be invoked. A parameter must be selected before it may be altered, and similarly a function must be selected before it may be invoked. The current parameter/function selection is displayed in reverse video (light characters on a dark background). The current selection is changed by utilizing the POSITIONER wheel on the front panel. Rotating the POSITIONER clockwise will sequentially select menu items in a forward

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direction, while rotating the wheel in a counter-clockwise direction reverses the order of menu item selection.

Entering new parameter values or invoking functions is accomplished by means of the numeric keypad. If the selected menu item is an operational parameter such as a lower or upper limit, the keypad will be open for numeric entry. As each key is pressed, the corresponding digit will be pushed into the keypad buffer located at the lower right corner of the parameter display. When the contents of the keypad buffer is equal to the desired value, pressing the ENTER key will transfer this value to the selected parameter.

If the selected menu item is a function such as SEEK or UP/STOP, the keypad will serve to invoke the function. The key which will invoke the function (typically the ENTER key) will be illuminated. More information on specific parameters and functions is detailed in following subsections of this manual.

Setup Menu

The setup menu contains parameters that will either directly affect the instrument's user interface, or will globally apply to each of the connected masts and/or turntables. The setup menu is entered and exited by simultaneously pressing the two keys of the keypad labelled "SETUP" (the "1" and "3" keys.) This menu is illustrated in Figure 1. The operation of these parameters is detailed individually below.

Setting the CURSOR RATE. The cursor rate parameter determines the speed with which the cursor will step through the menu items as the POSITIONER is rotated. There are two settings for the CURSOR RATE, SLOW and FAST. To alter the present setting, select this parameter by first positioning the reverse video cursor over it. The setting may now be toggled by pressing the "+/-" key.

Turning the PANEL-LIGHT ON/OFF. The setting of the PANEL-LIGHT parameter determines whether or not the Parameter Display will be backlit. To toggle the state of this parameter, first select the parameter using the POSITIONER, then press the "+/-" key to turn the backlight ON or OFF.

Turning the Audio ALARM ON/OFF. The setting of the ALARM parameter determines whether or not the audio alarm will be active. This alarm is used to signal the operator in the event of illegal data entries or upon a mast/turntable reaching a preset limit. To toggle the state of this parameter, first select the parameter using the POSITIONER, then press the "+/-" key to activate or deactivate the audio ALARM.

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CURSOR RATE SLOW PANEL-LIGHT ON ALARM ON	TURNTABLE MODE NON-CONTINUOUS
POLAR OFFSET DEV1=+000 DEV3=+000 DEV2=+000 DEV4=+000	AUTOINCREMENT=+000
	LISTEN ADDRESS=08

Figure 1. Setup menu layout

UPPR LMT=+400		UP/STOP	TARG=+100
LWR LMT H=+100		DOWN/STOP	SEEK
LWR LMT V=+100		MANUAL	POLAR H
REM	CYC=001 SCAN	DEV1 DEV2 DEV3 DEV4	
		CUR POS=+100	+000

Figure 2. Main menu for antenna masts with factory default settings for the parameter values.

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CW LMT=+359		CW/STOP	REM
CCW LMT=+000		CCW/STOP	MAN
CYC=001 SCAN	TARG=+000 SEEK	DEV1 DEV2 DEV3 DEV4	
		CUR POS=+000	+000

Figure 3. Main menu for turntables with factory default settings for the parameter values.

DEV1=+100	M1	ADDRESS NOT DETECTED	LOCAL LOCK-OUT OFF
DEV2=+100	LD +100		
DEV3=+000	UL	LISTEN ADDR=08	
DEV4=+000	M2	* NO ERROR *	
	AD 1		

Figure 4. Remote mode display layout

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Setting Values for POLARization OFFSET. The polarization offset parameter is a vertical displacement (in centimeters) which is applied to the CURRENT POSITION whenever antenna polarization is changed on a mast. The first step in setting this parameter is to determine what the required value is. This will vary with antenna and mount. First, place the mast carrier in the horizontally polarized position, and measure the antenna height. Change the polarization to vertical and note the new antenna height. Subtract the height of the vertically polarized antenna from the antenna height while horizontally polarized, and note this value. Return to the setup menu and position the reverse video cursor over the POLAR OFFSET parameter associated with the device under control. Key in the result of the above subtraction (negative values are permitted). The controller will automatically add this value to the current position parameter when the antenna polarization changes from vertical to horizontal. In the same manner, this value is subtracted from the current position parameter when the polarization is changed from horizontal to vertical. Initializing this parameter to its correct value will insure that the controller does not report erroneous current position data due to changes in antenna polarization.

Setting the TURNTABLE MODE. The TURNTABLE MODE parameter defines how the controller will respond when the current position of a turntable reaches and/or exceeds 360 degrees. If this parameter is set to CONTINUOUS, then the controller will ignore the clockwise and counter clockwise limits which are set in the controller and the current position indicator will reset to zero upon reaching 360 degrees, and will similarly be set to 359 degrees as the table's current position passes through 0 in the opposite direction. **Note that when the controller is operating in the continuos mode, it is capable of turning the turntable in either direction indefinitely if the mechanical limits on the turntable motor base are disabled.** If the parameter is set to NON-CONTINUOUS, the controller will stop the turntable when the current position reaches either one of the clockwise or counter-clockwise limits; depending on the direction of movement of the turntable. To set the TURNTABLE MODE, first place the reverse video cursor over the parameter's present value, and utilize the "+/-" key to toggle this value.

Setting the AUTOINCREMENT Value. The AUTOINCREMENT parameter is associated with the SEEK function, and is applied to both masts and turntables. Each time a SEEK operation is completed, the value of the AUTOINCREMENT parameter will be automatically added to the TARGET parameter value. This value may be either positive or negative. To set this parameter, first place the reverse video cursor over the present value, and use the numeric keypad to enter the desired value (no ENTER is required).

Setting the LISTEN ADDRESS. This parameter is actually the

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talker/listener address of the instrument when being operated in remote mode through the GPIB. To set the address, first place the cursor over the present value and use the numeric keypad to enter the desired value (no ENTER is required). The power to the controller should be turned off and then back on for any change of the LISTEN ADDRESS to take effect.

It should be noted, that all of the parameters described above are stored in non-volatile RAM. When power to the instrument is cycled, the values that have been entered will be retained, and need not be reset.

Main Operating Menu

There are two unique main operating menu types; one for the mast and one for the turntable. The menu displayed will be dependent upon the type of the device under control. Two sets of parameters, corresponding to the mast and the turntable, for each one of the four device ports are stored in the non-volatile RAM (total of eight parameter set memory banks). Upon initial power up, the 1090 Controller will examine its four device ports for identification of the connected devices on these ports. The controller will, then, display the appropriate main menu for the first sequentially available device on its ports.

NOTE:WHEN IT IS DESIRED TO CONNECT ONE OR MORE NEW DEVICES TO THE AVAILABLE DEVICE PORT(S) OF THE CONTROLLER, THE USER MUST FIRST TURN OFF THE POWER TO THE CONTROLLER AND THEN CONNECT THE DEVICE(S) TO THE PORT(S). THIS ACTION WILL ASSURE THAT THE CONTROLLER NOTICES THE PRESENCE AND TYPE OF THE NEWLY CONNECTED DEVICE(S).

Refer to Figures 2 and 3 for the following discussion of each of the main menu items.

Mast Related Parameters and Functions

Setting the UPPeR LiMiT. The UPPER LIMIT parameter defines a programmable upper limit of travel (in centimeters) which is independent of the mechanical limits set at the motor base. This value may not exceed +600 and may not be set lower than the value of the active lower limit (horizontal or vertical); factory default setting is +400. While the reverse video cursor is positioned over the current setting of the UPPER LIMIT, this parameter may be changed. Key in the new desired value through the numeric keypad, and verify this value is correct as it appears in the keypad buffer area. Press the ENTER key to transfer the new value to the UPPER LIMIT parameter.

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Setting the LoWeR LiMiTs. The LOWER LIMIT parameters define programmable lower limits of travel (in centimeters) which are independent of the mechanical limits set at the motor base. The Model 1090 provides two unique LOWER LIMIT values (in centimeters) for use with masts. Separate and independent limits are provided for horizontal and vertical polarizations. The limit in effect will be indicated by an underscore. This feature offers the operator additional insurance against antenna damage in instances where a long element, when vertically polarized, has the potential for collision with the ground. The values of these parameters may not be set lower than +50 and higher than the upper limit parameter value; factory default setting is +100. To set the limits, after positioning the cursor over the limit to be changed, key in the desired value through the numeric keypad and press ENTER.

Invoking the UP/STOP Function. To cause the mast carrier to move in the upward direction, first place the cursor over the UP/STOP function. Press the ENTER key. The mast shall commence motion, and the ENTER key will illuminate to indicate that it is an active key. Pressing the ENTER key a second time will cease motion. Note that the cursor may not be moved once the device has been set in motion. This is a safety feature, designed to assure immediate access to the STOP command.

Invoking the DOWN/STOP Function. The operation of the DOWN/STOP function is similar to the UP/STOP function, except that it will set the mast to a downward motion. Please see the above paragraph for a complete description.

Changing Antenna POLARization. To change the antenna polarization, first place the cursor over the POLAR parameter. The "+/-" key will illuminate to indicate that it is the active key. Pressing the "+/-" key will toggle the polarization between horizontal (H) and vertical (V). Note that as the polarization changes the active lower limit (underscored) will also change. Verify that the new lower limit is correct. Factory default setting is horizontal polarization.

Turntable Related Parameters and Functions

Setting the ClockWise LiMiT. The CLOCKWISE LIMIT parameter defines a programmable clockwise limit of travel (in degrees) which is independent of the mechanical limits set at the motor base. This value may not exceed +359 and may not be set lower than the value of the counter-clockwise limit; factory default setting is +359. While the reverse video cursor is positioned over the current setting of the CLOCKWISE LIMIT, this parameter may be changed. Key in the new desired value through the numeric keypad, and verify this value is correct as it appears in the keypad buffer area. Press the ENTER key to transfer the new value to the

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CLOCKWISE LIMIT parameter.

Setting the Counter-ClockWise LiMiT. The COUNTER-CLOCKWISE LIMIT parameter defines a programmable counter-clockwise limit of travel (in degrees) which is independent of the mechanical limits set at the motor base. This value may not be set lower than 0 and may not exceed the value of the clockwise limit; factory default setting is 0. While the reverse video cursor is positioned over the current setting of the COUNTER-CLOCKWISE LIMIT, this parameter may be changed. Key in the new desired value through the numeric keypad, and verify this value is correct as it appears in the keypad buffer area. Press the ENTER key to transfer the new value to the COUNTER-CLOCKWISE LIMIT parameter.

Invoking the CW/STOP Function. To cause the turntable to move in the clockwise direction, first place the cursor over the CW/STOP function. Press the ENTER key. The turntable shall commence motion, and the ENTER key will illuminate to indicate that it is an active key. Pressing the ENTER key a second time will cease motion. Note that the cursor may not be moved once the device has been set in motion. This is a safety feature, designed to assure immediate access to the STOP command.

Invoking the CCW/STOP Function. The operation of the CCW/STOP function is similar to the CW/STOP function, except that it will set the turntable to a counter-clockwise motion. Please see the above paragraph for a complete description.

Mast and Turntable Common Parameters and Functions

Invoking the MANUAL Function. The MANUAL function allows the operator to directly control the movement of the mast/turntable by means of the POSITIONER knob. To invoke the function, first select it by placing the cursor over the word MANUAL (MAN in case of the turntable). Press the ENTER key. A series of three short tones shall sound to announce that the MANUAL function is active. Further motion of the POSITIONER knob will now be directed to the device under control, and not the cursor. If a mast is being controlled, clockwise motion of the knob will correspond to upward motion. If a turntable is being controlled, clockwise motion of the knob will correspond to clockwise motion of the table. While the MANUAL function is active, pressing the ENTER key at any time will cease all motion and cause the MANUAL function to be exited, this will be announced by one short tone.

Selecting Devices to Control. The current device under control is underscored in the device selection parameter area. To select a new device for control, place the cursor over the desired device and press the ENTER key. If the alarm sounds upon pressing the ENTER key, this is an

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indication that the device selected is unavailable for control (not connected to the controller or has been connected to the controller after the last controller power-up). After pressing the ENTER key, the PARAMETER DISPLAY will blank briefly, and then return with a main operating menu appropriate for the device selected.

Invoking the SEEK Function. The SEEK function allows the operator to describe a desired TARGET position for the device under control, and then set the device in motion to "seek" that position. Before invoking the SEEK function, initialize the TARGET parameter by keying in the desired target position, placing the cursor over the current TARGET value and pressing the ENTER key. Next, place the cursor over the word "SEEK" and press the ENTER key. The device will commence motion, and stop when either the TARGET position has been reached or the ENTER key is pressed a second time. Once motion commences, the POSITIONER knob will no longer affect the cursor. This is a safety feature to insure the device under control may be stopped quickly if desired. Upon reaching the TARGET position, the alarm shall sound a series of two short tones. Note that if the AUTOINCREMENT parameter (in the setup menu) has a non-zero value, the TARGET position will be incremented by the value of this parameter. See the section on the setup menu for further details on AUTOINCREMENT. The target position may, at no time (including application of the AUTOINCREMENT value), be set to a value outside the two displayed limits of the device's position.

Invoking the SCAN Function. The SCAN function allows the operator to initiate cyclic motion in the device under control. A cycle is defined as movement from the LOWER/COUNTER-CLOCKWISE LIMIT to the UPPER/CLOCKWISE LIMIT and back to the LOWER/COUNTER-CLOCKWISE LIMIT. The number of cycles that the device will perform is controlled by the CYCLES parameter. As each cycle is completed, the displayed value of the CYCLES parameter will be decremented to indicate the number remaining. Before invoking the SCAN function, place the cursor over the CYCLES parameter and key in the desired value and press the ENTER key. Then place the cursor over the word "SCAN". Pressing the ENTER key will now initiate the SCAN. Note that once motion has commenced, pressing the ENTER key at any time will cause the motion to cease. While the device is moving, the POSITIONER knob will not affect the cursor. This is a safety feature to insure that the device under control may be stopped quickly if desired.

Entering the REMote Mode. The Model 1090 provides for two methods of entering the REMOTE (GPIB control) mode. The first method is automatic, the instrument will enter the REMOTE mode immediately upon receiving its talker/listener address over the GPIB bus. The second method is manual, and is accomplished by placing the cursor over the REMOTE function and pressing the ENTER key. After a series of

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three short tones, the Parameter Display will blank momentarily, and return with the REMOTE mode screen.

Changing the CURrent POSition. The CURRENT POSITION parameter is saved in non-volatile RAM and hence is properly retained during power cycling of the instrument. However, since any physical movement of a mast/turntable, while the instrument is not energized, will not be reflected in the CURRENT POSITION, it is highly recommended that this parameter be verified at the beginning of each test session. To change this parameter, place the cursor over the old value, key in the desired value through the numeric keypad and press the ENTER key. This parameter may not be set lower than the lower/counter-clockwise limit and higher than the upper/clockwise limit displayed on the main menu of the device under control. Factory default settings are +100 for masts and 0 for turntables.

Remote Mode

Remote Screen

When the instrument is placed in the REMOTE (GPIB control) mode, either manually or automatically, a unique screen is presented to the operator. This screen is illustrated in Figure 4. The following is a discussion of the information presented within that screen.

Current Position Information. On the left side of the display, the current position of all four devices is presented, regardless of how many devices are connected to the 1090 controller. The units for these values are centimeters for masts and degrees for turntables.

Command Queue. An area just left of center is reserved for a command queue. Contained here is a list of the last five commands (plus any arguments) received by the Model 1090 over the GPIB bus. What is displayed is actually the parsed command, additional spaces or illegal characters will not be displayed, and all characters will appear as upper case.

ADDRESS DETECTED Indicator. In the display's upper half, just right of center is an indicator of a detected Talker/Listener address. Normally this area will contain the words "ADDRESS NOT DETECTED" to indicate that the instrument is not currently addressed as either a Talker or a Listener on the GPIB bus. The "NOT" will disappear whenever the instrument is being addressed by the bus.

LOCAL LOCK-OUT Indicator. In the upper right corner of the display is an indicator of the status of Local Lock-out. This indicator shall read

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either "LOCAL LOCK-OUT ON" or "LOCAL LOCK-OUT OFF" accordingly. It should be noted that if Local Lock-out is asserted (ON) by the bus controller, then all front panel controls will be rendered inactive, including the RETURN TO LOCAL key (8) on the keypad.

Talk/LISTEN ADDRess Indicator. On the right half of the display, just below center is an indicator of the currently selected Talker/Listener address. This two digit address is displayed in decimal, and represents the current address of the 1090 controller on the GPIB bus.

Error Reporting. In the lower right corner of the display, an area has been reserved for the reporting of errors occurring during GPIB data and command transfers. See the Appendix at the back of this manual for an explanation of these messages.

Return To Local. If the Local Lock-out is not asserted (OFF), it is possible for the operator to force the instrument back into the local (front panel control) mode of operation. Under these conditions, the LOCAL key (8) on the numeric keypad will be illuminated, indicating it is active. Pressing the key will cause all moving devices to cease motion, the Parameter Display to blank briefly, and then return with the main operating menu, and control of the instrument to transfer to the front panel.

Programming Model 1090 for Remote Operation

Model 1090 controller recognizes a variety of GPIB (remote) commands. These commands are categorized into three sets; reduced, expanded, and IEEE-488.2 standard mandatory sets. The following are the description of the three sets and their commands.

NOTE: All commands described below may be in either lower case, upper case, or a combination of both. It is recommended, although not required, to terminate each command (including its argument, if any) with the delimiter ";". A space is required between a command and any argument that might follow it.

Reduced Instruction Set

This instruction set is identical to that of the EMCO Model 1050/1060 controllers. Additionally, if one mast and one turntable are connected to the 1090, these devices will be caused to reside at sequential addresses on the GPIB bus. The lower of these two addresses is always even, and will be applied to the mast, the higher or odd address will be applied to the turntable. For example, if the Talker/Listener address is set to 09, then 09

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turntable. For example, if the Talker/Listener address is set to 09, then 09 will be the high address (because it is odd) and will be applied to the turntable. The lower address will therefore be 08 and will be applied to the mast. The factory default setting for the Talker/Listen address is 08.

If there are more than one of each type of device is connected to the controller, the address for that device type will apply to the device that is connected to the lowest device port number. For example, if there are two masts connected to the device 1 and device 2 ports and two turntables connected to the device 3 and device 4 ports of the controller, the reduced instruction set commands for the mast will apply to the mast on device 1 port and for the turntable will apply to the one on device 3.

NOTE: When the 1090 controller's state of operation changes from the local mode to remote mode, it is placed in the Reduced Instruction Set mode by default.

IT IS IMPORTANT TO NOTE THAT THE CORRECT INTERPRETATION OF CERTAIN COMMANDS SENT TO THE 1090 IS DEPENDENT ON THE SELECTION OF THE APPROPRIATE MODE (REDUCED OR EXPANDED). IT IS THEREFORE RECOMMENDED THAT THE PROGRAMMER INSURES THAT THE CORRECT MODE IS SELECTED BEFORE ALLOWING THE CONTROLLING SOFTWARE TO PROCEED.

"CC" - Counter-clockwise. This command is applied to the turntable, and causes motion to commence in the counter-clockwise direction if the table has not already reached its counter-clockwise limit. No argument is used with this command.

"CL" - Counter-clockwise Limit. This command is applied to the turntable and provides two distinct functions. The first of these functions is to ready the instrument to respond with the current setting of the counter-clockwise limit when queried. Secondly, if this command follows the "LD" command (see below), it will cause the value of the LD argument to be loaded into the counter-clockwise limit register. No argument is used with this command.

"CP" - Current Position. This command applies to both the mast and the turntable and has two distinct functions. The first of these functions is to ready the instrument to respond with the current position of the addressed device when queried. Secondly, if this command follows the "LD" command (see below), it will cause the value of the LD argument to be loaded into the current position register of the addressed device. No argument is used with this command.

"CW" - Clockwise. This command is applied to the turntable and causes

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clockwise motion to commence given that the turntable has not already reached its clockwise limit. No argument is used with this command.

"DN" - Down. This command is applied to the mast, and causes motion to commence in the downward direction, given that the mast has not already reached its lower limit. No argument is used with this command.

"LD" - Load. This command is applied to both the mast and the turntable, and is used to input a numerical value to the instrument. If followed by one of the parameter commands (CP, CL, WL, LL, UL), this numerical value will be loaded into the appropriate parameter register. An argument must be used with this command, and the proper syntax is, then, "LD (+/-)XXX (DG/CM)" where the sign and the units are optional, and the numerical value is expressed in decimal. It should also be noted that if a parameter command is to follow, it may be sent as part of the same string, and need not be separated with a carriage return or line feed.

"LL" - Lower Limit. This command applies to the mast and performs two distinct functions. The first function is to ready the instrument to respond with the current setting of the lower limit when queried. Secondly, if this command follows the "LD" command (see above), it will cause the value of the LD argument to be loaded into the lower limit register. No argument is used with this command.

"M2" - Select the Expanded Instruction Set. This command causes the instrument to move into the Expanded Instruction Set mode. Upon the issuance of this command, all subsequent commands will be interpreted according to the definitions found in the section of this manual titled "Expanded Instruction Set". **It is important to note that not only are more commands available in the Expanded Instruction Set mode, but also commands found in the Reduced Instruction Set may adopt new definitions.** See the individual discussions for details.

"PH" - Horizontal Polarization. This command applies to the mast, and will cause the antenna carrier to move (if the antenna is in vertical polarization) to the position for horizontal polarization. Note that this command will have no effect on masts not equipped with the 90 degree polarization option.

"PV" - Vertical Polarization. This command applies to the mast, and will cause the antenna carrier to move (if the antenna is in horizontal polarization) to the position for vertical polarization. Note that this command will have no effect on masts not equipped with the 90 degree polarization option.

"P?" - Query State of Polarization. This command applies to the mast and will ready the instrument to respond with the present state of antenna

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```
200  ENTER 709;POS                 !query the current position
210  IF POS<45 THEN GOTO 200       !contin. query until 45 is reached
220  OUTPUT 709;"ST;"              !stop the turntable
```

Expanded Instruction Set

The Expanded Instruction Set allows the programmer access to all of the new features of the Model 1090. As a result of this, it contains many new instructions and an unavoidable increase in programming complexity. Each of the instructions is discussed here in detail. This section should be read thoroughly as well as the discussion on "Programming the Service Request" before an attempt is made to utilize the 1090 Controller's full range of features under GPIB control. Some of these instructions, as noted below, may also be executed in the Reduced Instruction Set mode.

✳**"AD" - Activate Device.** This command causes the activation of one or more devices (masts or turntables.) Commands issued that invoke functions or set parameter values are applied only to devices which are activated. Once a device is activated, it will remain so until deactivated using the "DD", Deactivate Device command (see below). If a command ("UP" for example) is issued, and no devices are currently active, it will be ignored. Additionally, if more than one device is activated, any issued command, such as "UP", will effect all of the active devices. It is important to note that dissimilar devices (masts and turntables) can not be coincidentally activated. Any attempt to do so will result in a device error. An argument is required by this command, the argument may be a device number (1, 2, 3 or 4) or a combination of device numbers (separated by commas). Below is a usage example.

```
10  REMOTE 708                    !place instrument in remote mode
20  OUTPUT 708;"M2;"              !select expanded instruction set
30  OUTPUT 708;"AD 1;"            !activate device number 1
40  OUTPUT 708;"AD 2,3;"          !activate devices 2 and 3
50  OUTPUT 708;"AD 1,2,3,4;"      !activate all four devices
```

⇧**"AD?" - Query Active Devices.** This command readies the instrument to respond to query with a numerical value which represents the currently active devices. The value returned is in decimal format, in the range of 0 to 15. To interpret the result, convert this value to binary. Once in binary format, the least significant bit will correspond to device 1, the next to device 2, etc. A binary digit equal to 1 will be indicative of an activated device. Below is a usage example.

```
10  OUTPUT 708;"AD?;"             !ready instrument to respond
20  ENTER 708;VAL                 !retrieve the numerical value
30  DISP VAL                      !display the decimal value
```

seek ⇧**"AI" - Set Autoincrement.** This command is used to set the value of

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Seek

the autoincrement parameter. Note that there is only one autoincrement parameter which is applied to all four devices. An argument is required for this command, and must be of decimal form, in the range of -999 to +999.

"AI?" - Query the Autoincrement. This command readies the instrument to respond with the current setting of the autoincrement parameter when queried. No argument is required with this command.

"CC" - Counter-clockwise. This command is applied to turntables only. Issuing this command will cause all activated devices to commence counter-clockwise motion, assuming these devices have not already reached their counter-clockwise limits.

"CL" - Counter-clockwise Limit. This command is applied to turntables only, and is used to set the value of the counter-clockwise limit. Upon issuing the command, this parameter will be changed for all active devices. This command requires an argument which is of decimal form, in the range of 0 to clockwise limit. Below is a usage example.

```
10  ! device 1 is a turntable
20  OUTPUT 709;"M2;"              !select Expanded Instruction Set
30  OUTPUT 709;"AD 1;"            !activate device 1
40  OUTPUT 709;"CL +250;"         !set counter-clockwise limit to 250
                                  !degrees
```

"CL?" - Query the Counter-clockwise Limit. This command is applied to turntables only. Issuing this command readies the instrument to respond with the counter-clockwise limit of the specified device when queried. An argument is required, and must be a device number (1, 2, 3, or 4). The value returned will be a signed decimal number. Below is a usage example.

```
10  ! no devices are currently active, this is not a
20  ! requirement of the CL? command. device 1 is a turntable
30  OUTPUT 709;"M2;"              !select Expanded Instruction Set
40  OUTPUT 709;"CL? 1;"           !ready the instrument to respond
40  ENTER 709;LIMIT               !read the current limit setting
50  DISP LIMIT                    !display the decimal value
```

"CP" - Set the Current Position. This command may be applied to both masts and turntables, and is used to set the current position. Upon issuing the command, this parameter will be changed for all active devices. This command requires an argument which is of decimal form, in the range of lower/counter-clockwise limit to upper/clockwise limit.

"CP?" - Query the Current Position. This command may be used for both masts and turntables. Issuing this command readies the instrument to respond with the current position of the indicated device when queried.

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An argument is required, and must be a device number (1, 2, 3, or 4). The value returned will be a signed decimal number.

"CW" - Clockwise. This command may be applied only to turntables. Issuing this command will cause all activated devices to commence clockwise motion if these devices have not already reached their clockwise limits.

scan

"CY" - Set Cycles. This command is used to set the value of the Cycles parameter for all active devices. An argument is required, and must be a decimal value in the range of 1 to 999.

"CY?" - Query Cycles. This command readies the instrument to respond with the current setting of the CYCLES parameter of the specified device when queried. An argument is required, and must be a device number (1, 2, 3, or 4). The value returned will be an unsigned decimal number in the range of 1 to 999.

⇧**"DIM?" - Query Moving Devices.** This command may be used to determine which devices are currently in motion. Issuing this command readies the instrument to respond with a decimal value indicative of the moving devices when queried. The value returned is in decimal format, in the range of 0 to 15. To interpret the result, convert this value to binary. Once in binary format, the least significant bit will correspond to device 1, the next to device 2, etc. A binary digit equal to 1 will be indicative of a device in motion.

✱**"DD" - Deactivate Device.** This command will deactivate a device or devices that are currently active. An argument is required by this command, the argument may be a device number (1, 2, 3 or 4) or a combination of device numbers (separated by commas).

⇧**"DID?" - Device Identification.** This command will prepare the instrument to respond with an identification byte when queried. The returned identification byte contains information about the ports which have a device connected to them and the type of the device that is connected to each port. The byte is returned in its decimal representation which may have a value between 0 and 255. In order to interpret the returned value, the decimal value should be converted to its 8-bit binary representation. The first four least significant bits (bits 1 - 4) of the byte correspond to the four device ports of the 1090 Controller; i. e. the least significant bit (bit 1) corresponds to port 1, the next bit (bit 2) to port 2, etc. A binary value "1" in any of these four bits indicates that there is a device connected to the corresponding port. The most significant four bits (bits 5 - 8) correspond to the least significant four bits (bits 1 - 4); i. e. bit 5 corresponds to bit 1, bit 6 to bit 2, etc. A value "1" in any of the bits 5 through 8 means that the corresponding device (represented by the

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corresponding bit in the first four bits) is a turntable, where a bit value "0" means that the device is a mast.

"DN" - Down. This command is applied to masts only. Issuing this command will cause all activated devices to commence downward motion, assuming these devices have not already reached their lower limits. No argument is used with this command.

⇧**"DS?" - Device Status.** This command is used in the determination of a Service Request's origin. Issuing this command readies the instrument to respond with the contents of the Device Status Register when queried. (For a detailed explanation of the Device Status Register and its function, see the discussion on Programming the Service Request later in this manual). The value returned is in decimal format, in the range of 0 to 15. To interpret the result, convert this value to binary. Once in binary format, the least significant bit will correspond to device 1, the next to device 2, etc. A binary digit equal to 1 will be indicative of a device requesting service.

⇧**"DSE" - Device Status Enable.** This command is used to set the contents of the Device Status Enable Register. (For a detailed explanation of the Device Status Enable Register and its function, see the discussion on Programming the Service Request later in this manual). A decimal argument is required with a value in the range of 0 to 15. To determine this value, start with a binary byte. The least significant bit will correspond to device 1, the next to device 2, etc. If a device is to be enabled, make the corresponding bit a 1, else make it a 0. Convert the completed byte to decimal, this will be the value of the command's argument.

⇧**"DSE?" - Query the Device Status Enable Register.** This command readies the instrument to return the contents of the Device Status Enable Register when queried. (For a detailed explanation of the Device Status Enable Register and its function, see the discussion on Programming the Service Request later in this manual). The value returned is in decimal format, in the range of 0 to 15. To interpret the result, convert this value to binary. Once in binary format, the least significant bit will correspond to device 1, the next to device 2, etc. A binary digit equal to 1 will be indicative of an enabled device.

"LH" - Set the Horizontal Lower Limit. This command may be applied only to masts. Issuing this command will set the Lower Limit associated with horizontal antenna polarization of all active devices. A decimal argument, in the range of +50 to the upper limit is required.

"LH?" - Query the Horizontal Lower Limit. This command readies the instrument to respond with the present setting of the Horizontal Lower

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Limit for the specified device when queried. An argument is required, and must be a device number (1, 2, 3, or 4). The value returned will be a signed decimal number.

"LL" - Set the Lower Limits. This command may be applied only to masts, and will change the current setting of the Lower Limits (both horizontal and vertical) for all active devices. A decimal argument is required, and must be in the range of +50 to the upper limit.

"LV" - Set the Vertical Lower Limit. This command may be applied only to masts. Issuing this command will set the Lower Limit associated with vertical antenna polarization of all active devices. A decimal argument, in the range of +50 to the upper limit is required.

"LV?" - Query the Vertical Lower Limit. This command readies the instrument to respond with the present setting of the Vertical Lower Limit for the specified device when queried. An argument is required, and must be a device number (1, 2, 3, or 4). The value returned will be a signed decimal number.

"MODE?" - Query the Mode. This command is used to determine which mode (Reduced Instruction Set or Expanded Instruction Set) the instrument is operating in. Issuing this command readies the instrument to respond with a two byte string indicative of the operating mode when queried. The string returned will be "M1" if in the Reduced Instruction Set mode, or "M2" if in the Expanded Instruction Set mode.

"M1" - Select the Reduced Instruction Set. This command causes the instrument to move into the Reduced Instruction Set mode. Upon the issuance of this command, all subsequent commands will be interpreted according to the definitions found in the section of this manual titled "Reduced Instruction Set".

"PH" - Horizontal Polarization. This instruction is applied to masts only and will cause the antenna carriers of all active devices to move (if in vertical polarization) to the position for horizontal polarization. Note that this command will have no effect on masts not equipped with the 90 degree polarization option.

"PV" - Vertical Polarization. This instruction is applied to masts only and will cause the antenna carriers of all active devices to move (if in horizontal polarization) to the position for vertical polarization. Note that this command will have no effect on masts not equipped with the 90 degree polarization option.

"P?" - Query State of Polarization. This command will ready the instrument to respond with the present state of antenna polarization for the

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specified device when queried. An argument is required, and must be a device number (1, 2, 3, or 4.) Upon query, the instrument will return a single ASCII character. The character will be a "V" if the antenna is vertically polarized or an "H" if the antenna is horizontally polarized.

†**"RTL" - Return To Local.** This command will change the state of operation of the instrument from remote mode to local mode. Execution of this command will cause all moving devices to cease motion, the Parameter Display to blank briefly, and then return with the main operating menu, and the control of the instrument to transfer to the front panel.

†**"SC" - Scan.** This command may be applied to both masts and turntables. Issuing this command will cause all active devices to commence scanning between their preset lower and upper limits. The number of scans performed will be determined by the value of the CYCLES parameter which must be independently set prior to issuing the "SC" command.

†**"SK" - Seek.** This command may be applied to both masts and turntables. Issuing this command will cause all active devices to commence seeking for their preset TARGET value. The TARGET parameter must be independently set prior to issuing the "SK" command.

"ST" - Stop. This command is applied to masts and turntables, and causes the immediate cessation of motion of all active devices.

Seek **"TG" - Set the Target.** This command may be applied to either masts or turntables, and will set the TARGET parameter of all active devices. A decimal argument is required, and must be in the range of the active lower limit (horizontal or vertical) to upper limit.

"TG?" - Query the Target. This command may be applied to either masts or turntables. Issuing this command readies the instrument to respond with the present TARGET parameter setting of the specified device when queried. An argument is required, and must be a device number (1, 2, 3, or 4). Upon query, the instrument will return a signed decimal value.

"UL" - Set Upper Limit. This command may be applied to masts only, and will alter the setting of the Upper Limit for all active devices. A decimal argument is required, and must be in the range of the active lower limit (horizontal or vertical) to +600.

"UL?" - Query the Upper Limit. This command may be applied to masts only. Issuing this command readies the instrument to respond with the present Upper Limit setting of the specified device when queried. An

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argument is required, and must be a device number (1, 2, 3, or 4). Upon query, the instrument will return a signed decimal value.

"UP" - Up. This command may be applied to masts only. Issuing this command will cause all activated devices to commence upward motion, assuming these devices have not already reached their upper limits. No argument is used with this command.

"WL" - Set Clockwise Limit. This command is applied to turntables only, and is used to set the value of the clockwise limit. Upon issuing the command, this parameter will be changed for all active devices. This command requires a decimal argument, in the range of the counter-clockwise limit to +359.

"WL?" - Query the Clockwise Limit. This command is applied to turntables only. Issuing this command readies the instrument to respond with the clockwise limit of the specified device when queried. An argument is required, and must be a device number (1, 2, 3, or 4). The value returned will be a signed decimal value.

✷ **In the Reduced Instruction Set mode, this instruction is recognized but will have no effect.**

✞ **This instruction is also valid in the Reduced Instruction Set mode.**

IEEE-488.2 Standard Mandatory Instruction Set

In order to comply with the IEEE-488.2 standard, the following instruction set has been provided for the user. All of the commands of this instruction set may be used in either the Reduced or the Expanded Instruction Set modes.

"*CLS" - Clear Status. This command will clear all Event Registers summarized in the Status Byte (For a detailed explanation of the Status Byte and the Event Registers, see the discussion on Programming the Service Request).

"*ESE" - Set the Standard Event Status Enable Register. This command allows the programmer to alter the contents of the Standard Event Status Enable Register. (For a detailed description of this register and its function, see the discussion on Programming the Service Request). A decimal argument in the range of 0 to 255 is required. This argument, when expressed in binary form, directly represents the bit values of the Standard Event Status Enable Register.

"*ESE?" - Query the Standard Event Status Enable Register. This

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command readies the instrument to respond with the contents of the Standard Event Status Enable Register when queried. (For a detailed explanation of this register and its function, see the discussion on Programming the Service Request). The response will be a signed decimal number in the range of 0 to +255. This value, when expressed in binary form, directly represents the bit values of the Standard Event Status Enable Register.

"*ESR?" - Query the Standard Event Status Register. This command readies the instrument to respond with the contents of the Standard Event Status Register when queried. (For a detailed explanation of this register and its function, see the discussion on Programming the Service Request). The response shall be a signed decimal in the range of 0 to +255. This value, when expressed in binary form, directly represents the bit values of the Standard Event Status Register. Note that upon reading this register, its contents will be cleared.

"*IDN?" - Identify. This command offers the programmer the ability to determine the nature of the device located at a given address on the GPIB bus. Issuing this command readies the instrument to respond with an ASCII character string when queried. The string that is sent ("EMCO,1090,X.X") uniquely identifies the instrument as an EMCO Model 1090. The X.X parameter is a place-holder for the firmware revision level.

"*OPC" - Arm the Operation Complete Flag. Issuing this command will cause the instrument to set the Operation Complete bit of the Standard Event Status Register when all moving devices have stopped. (For a more detailed description of this operation, see the discussion on Programming the Service Request).

"*OPC?" - Query the Operation Complete. Issuing this command will ready the instrument to respond to query with a single character message. If all moving devices have stopped, the message will be "1" (one) else it will be "0" (zero.)

"*RST" - Reset. Issuing this command will initiate an instrument reset. The instrument shall remain in the remote mode, however, all moving devices will be immediately stopped, and the command queue shall be cleared. The state of the Status Register Data Structure will remain unchanged (for a description of the Status Register Data Structure, see the discussion on Programming the Service Request).

"*SRE" - Set the Service Request Enable Register. This command allows the programmer to alter the contents of the Service Request Enable Register. (For a detailed description of this register and its function, see the discussion on Programming the Service Request). A decimal argument

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in the range of 0 to 255 is required. This argument, when expressed in binary form, directly represents the bit values of the Service Request Enable Register.

"*SRE?" - Query the Service Request Enable Register. This command readies the instrument to respond with the contents of the Service Request Enable Register when queried. (For a detailed explanation of this register and its function, see the discussion on Programming the Service Request). The response shall be a signed decimal value in the range of 0 to +255. This value, when expressed in binary form, directly represents the bit values of the Service Request Enable Register.

"*STB?" - Query the Status Byte. This command readies the instrument to respond with the contents of the Status Byte when queried. (For a detailed explanation of this register and its function, see the discussion on Programming the Service Request). The response shall be a signed decimal value in the range of 0 to +255. This value, when expressed in binary form, directly represents the bit values of the Status Byte.

"*TST?" - Self Test. This command readies the instrument to respond with a byte indicative of the self test result. Since the 1090 Controller cannot test its internal circuits without destroying the non-volatile parameter values or with absolute certainty of the cause of any failure, the returned message will always be "0" (zero).

"*WAI" - Wait to Continue. Issuing this command will cause the instrument to place execution of the next command on 'hold' while there are devices in motion. Once motion has ceased, the next command will be executed normally. Note that while a command is on 'hold' additional commands will not be accepted. Normal operation will continue (the "*WAI" command will be released) after the command on 'hold' has been executed. **The time-out option of the GPIB bus controller must be disabled before the execution of the "*WAI" command.**

Programming the Service Request

The Service Request is a form of interrupt, used by instruments on the GPIB bus to inform the controller in charge of changes in status or the existence of a problem. Once an instrument initiates a Service Request, the bus controller must serially poll all the instruments on the bus to determine the source of the interrupt. The instruments respond to the serial poll with a Status Byte which indicates whether or not the instrument is the originator of the Service Request. Once the bus controller finds the originator of the interrupt, it may further interrogate the instrument (read the Status Register Data Structure elements) to discern the exact nature of the request for service.

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Each instrument incorporates a Status Register Data Structure. Elements of this structure are largely unique to the instrument, however there are several elements which are standard, as defined in the IEEE 488.2 specification. This data structure provides a means to record "events" and selectively determine if a certain type of "event" should initiate a Service Request. What follows is a discussion of this Status Register Data Structure as it exists in the Model 1090, and how the programmer may use it to properly generate Service Requests on the GPIB bus.

When the 1090 Controller is programmed to initiate a service request upon occurrence of a selected condition and once the selected condition occurs and initiates a request for service, the 1090 Controller will wait indefinitely for the GPIB bus controller to conduct a serial poll on the 1090 Controller. Upon the completion of the serial poll by the bus controller, the 1090 Controller will resume normal operation state and will be ready to respond to the bus controller's inquiries about its Status Register Data Structure.

The Status Byte. The contents of this register form the response to a serial poll initiated by the bus controller in charge. Contained within this register are two single bit summary messages, and one Master Summary Status message. Below, the function of each bit is tabulated.

- Bit 0 - Not used (reset to 0.)
- Bit 1 - Not used (reset to 0.)
- Bit 2 - Not used (reset to 0.)
- Bit 3 - Not used (reset to 0.)
- Bit 4 - Message Available (MAV.) This bit will be set to a 1 if there is a message in the instrument output queue. (Since the Model 1090 always has a message waiting in the output queue, this bit is always set to a 1.)
- Bit 5 - Standard Event Status Summary bit (ESB.) This bit will be set to a 1 if any of the enabled events in the Standard Event Status register occur.
- Bit 6 - Master Summary Status (MSS.) This bit will be set to a 1 if any of the enabled bits of the Status Byte are set to 1.
- Bit 7 - Not used (reset to 0.)

Upon receiving a Service Request, the bus controller will serially poll all instruments on the bus. In response to this poll, each instrument will, in turn, send its Status Byte. The bus controller will examine Bit 6 (MSS) of this Status Byte to determine if the associated instrument is requesting service. Conversely, once the MSS bit is set to a 1 within the 1090 Controller, the instrument will issue a Service Request.

The Service Request Enable Register. This register is used in conjunction with the Status Byte Register. If any bit within this register is

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set to a 1, the corresponding bit of the Status Byte will be enabled, and hence contribute towards the Master Summary Status bit. For example, if Bit 5 of the Service Request Enable Register contains a 1, and the corresponding bit of the Status Byte (ESB) is caused to equal 1, the Master Summary Status bit will be set to a 1, and a Service Request initiated. If the ESB had been set to a 1 but Bit 5 of the Service Request Enable Register was cleared to a 0, then the MSS would remain cleared to a 0, and no Service Request initiated. **Note that the bit of the Service Request Enable Register corresponding to the MSS (Bit 6) is not used in the calculation of the MSS.**

The contents of this register may be changed using the "*SRE" command, and queried through use of the "*SRE?" command.

ESR

The Standard Event Status Register. This register is a standard structure as defined in the IEEE 488.2 specification. The bit definition as implemented in the Model 1090 is tabulated below.

1 Bit 0 - Set to 1 if an Operation Complete message is initiated.
2 Bit 1 - Not used (reset to 0.)
4 Bit 2 - Not used (reset to 0.)
8 Bit 3 - Set to 1 if an internal error occurs.
16 Bit 4 - Set to 1 if an error results from a command execution.
32 Bit 5 - Set to 1 if an erroneous command is received.
Bit 6 - Not used (reset to 0.)
Bit 7 - Set to 1 upon the initial power up.

Any enabled bits in this register (see The Standard Event Status Enable Register below) that are set to a 1 will cause the Standard Event Status Bit (ESB) of the Status Byte to also be set to 1. In this way, lower level events such as the detection of an illegal command can be used to initiate Service Requests. In such an instance, the bus controller would read the instrument's Status Byte, detect that the MSS and the ESB bits were set, indicating that service has been requested because of an event which is defined by the Standard Event Status Register. The controller may then query the contents of the Standard Event Status Register, find Bit 5 set and from this determine that an illegal command has been received by the instrument.

The contents of this register may be queried using the "*ESR?" command. It should be noted that this command will cause the register to be cleared after it is read. The only other command that will affect the contents of this register is the "*CLS" command which will reset all it's bits to 0. The only way bits within this register may be set to a 1 is by the detection of an associated "event".

ESE

The Standard Event Status Enable Register. Each bit of this register

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may be used to enable the corresponding bit of the Standard Event Status Register. In this way, bits within the Standard Event Status Register may be selectively used to calculate the state of the Standard Event Status Bit (ESB) of the Status Byte, and hence initiate a Service Request.

The contents of this register may be altered using the "*ESE" command, and may be queried using the "*ESE?" command.

The Device Status Register. This register contains information regarding the status of the four devices (masts and/or turntables). The least significant four bits each correspond to one of the four devices, bit 0 (least significant) corresponds to Device 1, bit 1 to Device 2, etc. Each of these bits shall have a value of "0" until a device event occurs (a moving device ceases motion) at which time it will be set to "1". These bits are reset to zero upon one of two conditions; 1) the instrument enters the remote mode or, 2) the GPIB bus controller issues the "DS?" command and queries the contents of this register. This register is used in conjunction with the Device Status Enable Register to determine whether or not an Operation Complete message should be initiated (Setting of the Operation Complete Bit of the Standard Event Status Register to 1).

The contents of this register may not be set directly by the programmer, but may be queried using the "DS?" command.

The Device Status Enable Register. The contents of this register determine which of the four devices are to be considered in generating the Operation Complete message. Bit 0 (least significant) corresponds to Device 1, bit 1 to Device 2, etc. A bit value of 0 signifies that the corresponding device will be ignored in the generation of the Operation Complete message, whereas a bit value of 1 signifies that the corresponding device will be considered when determining an Operation Complete condition. It should be noted that an Operation Complete message will not be initiated until all devices specified in the Device Status Enable Register have registered an event (ceased motion.)

The contents of this register may be altered using the "DSE" command, and queried using the "DSE?" command.

The following is a short programming example, included to clarify the operation and interaction of the registers within the Status Register Data Structure. Additionally, a method of handling a Service Request is presented.

```
005  ! Device 3 connected to the 1090 will be indexed prior to
010  ! each measurement. Set up the 1090 to issue a Service
015  ! Request each time Device 3 reaches its target position
020  ! (ceases motion.)
025  !
```


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```
025  REMOTE 708                    !place the 1090 in Remote mode
030  ! 1) Enable Device 3 to form the Operation Complete Message.
035  ! 2) Enable the Operation Complete message to form the
040  !     Standard Event Status Bit summary message (ESB) and
045  ! 3) Enable the ESB to form the Master Summary Message
050  !     (MSS) and hence generate a Service Request.
055  !
060  OUTPUT 708;"DSE 4;"           !enable Device 3 (bit 2=1)
065  OUTPUT 708;"*ESE 1;"          !enable the Op. Comp. (bit 0=1)
070  OUTPUT 708;"*SRE 32;"         !enable the ESB (bit 5=1)
075  ! Enable the bus controller to recognize Service Request
080  ! interrupts, and define the interrupt handling subroutine.
085  ! *OPC
090  !
095  ON INTR 7 GOSUB 500           !define the interrupt handler
100  ENABLE INTR 7                 !enable SRQ interrupts
105            :
110            :


500  ! Upon receiving an interrupt, 1) poll the 1090 (read the
505  ! Status Byte) to determine if it is requesting service
510  ! 2) read the 1090's Status Register Data Structure to
515  ! determine the nature of the request (reading the struc-
520  ! also serves to clear all the registers.)
525  !
530  SB=SPOLL(708)                 !retrieve the Status Byte and de-
535  IF BIT(SB,6)=1 GOTO 545       !termine if service is requested
540  RETURN                        !if not, return to program.
545  !
550  OUTPUT 708;"DS?;"             !query the Device Status Register
555  ENTER 708;DS
560  OUTPUT 708;"*ESR?;"           !query the Standard Event Status
565  ENTER 708;ESR                 !Register
570  IF BIT(ESR,0)=1 GOTO 580      !verify the Op. Comp. bit is set
575  RETURN                        !in not, return to program.
580  IF BIT(DS,2)=1 GOTO 590       !verify Device 3 has completed its
585  RETURN                        !operation, if not return
590  !
595  ! place the user specific measurement routine here...
600  !
605  RETURN
```

*OPC

*OPC must be set again

tells you what caused SRQ

tells you which device caused SRQ

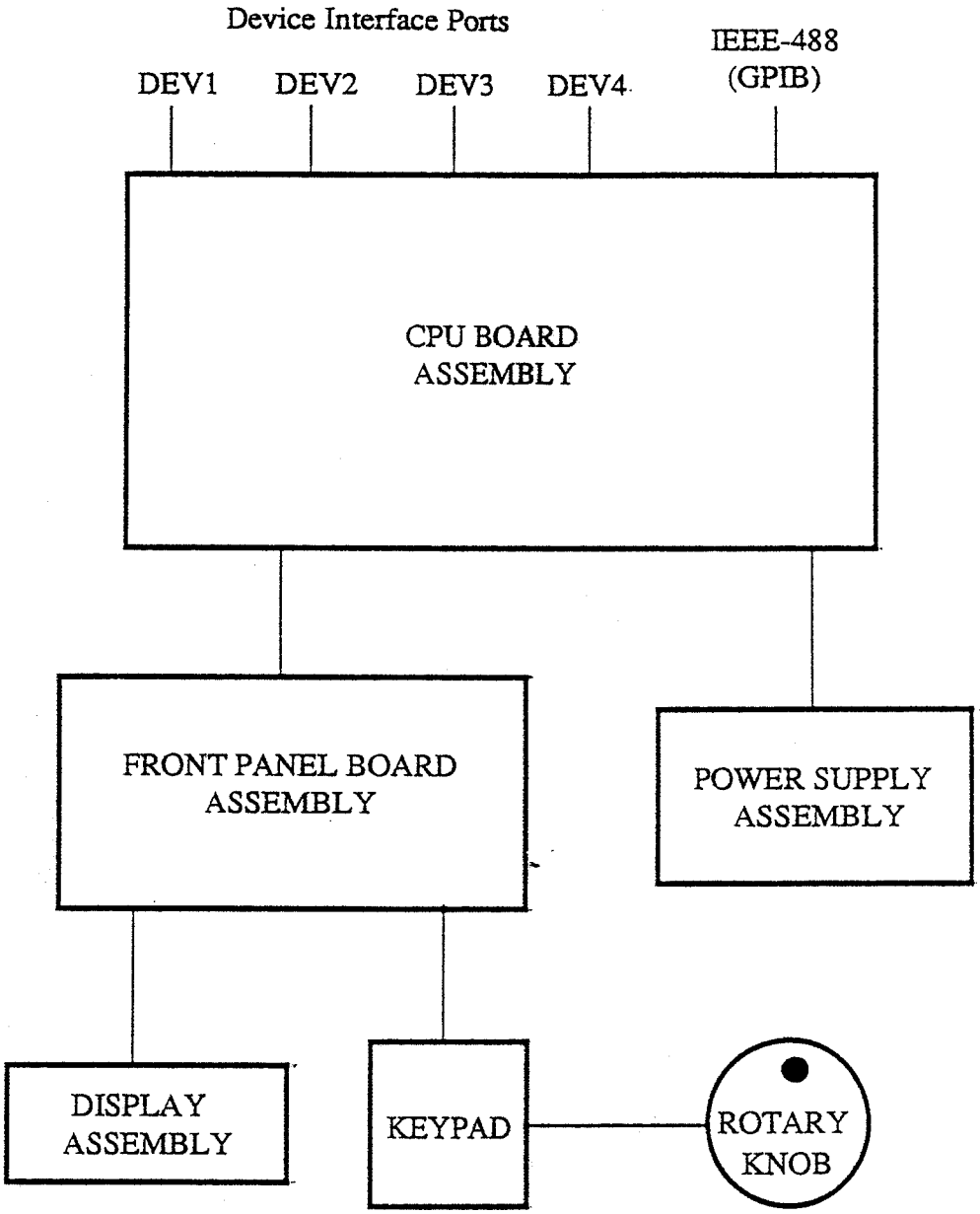
* When operation is complete OPC is disabled 3/16/94

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SYSTEM BLOCK DIAGRAM AND SCHEMATICS

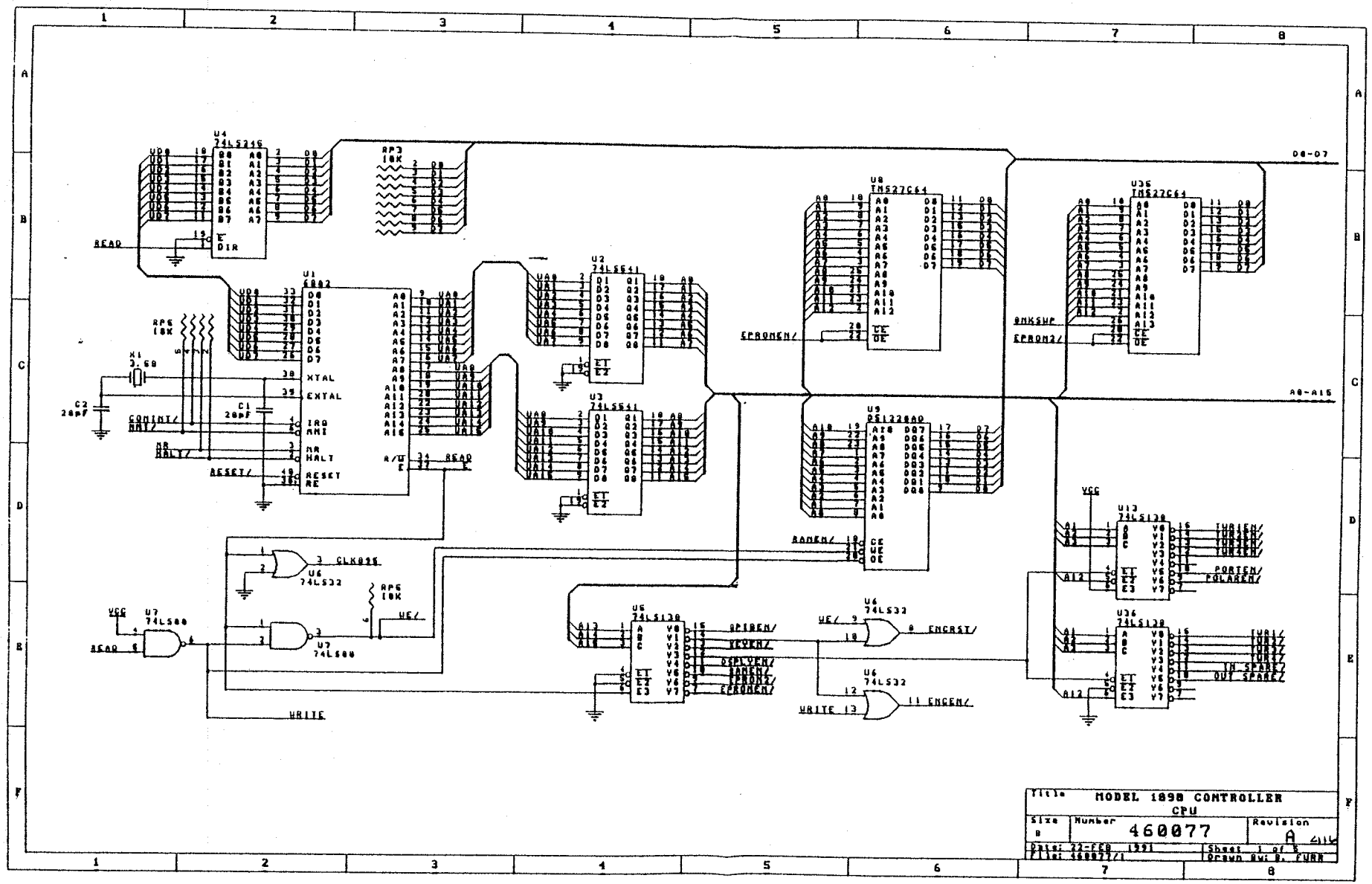
The following are the 1090 Controller's block diagram and the schematic drawings of all the printed circuit boards.

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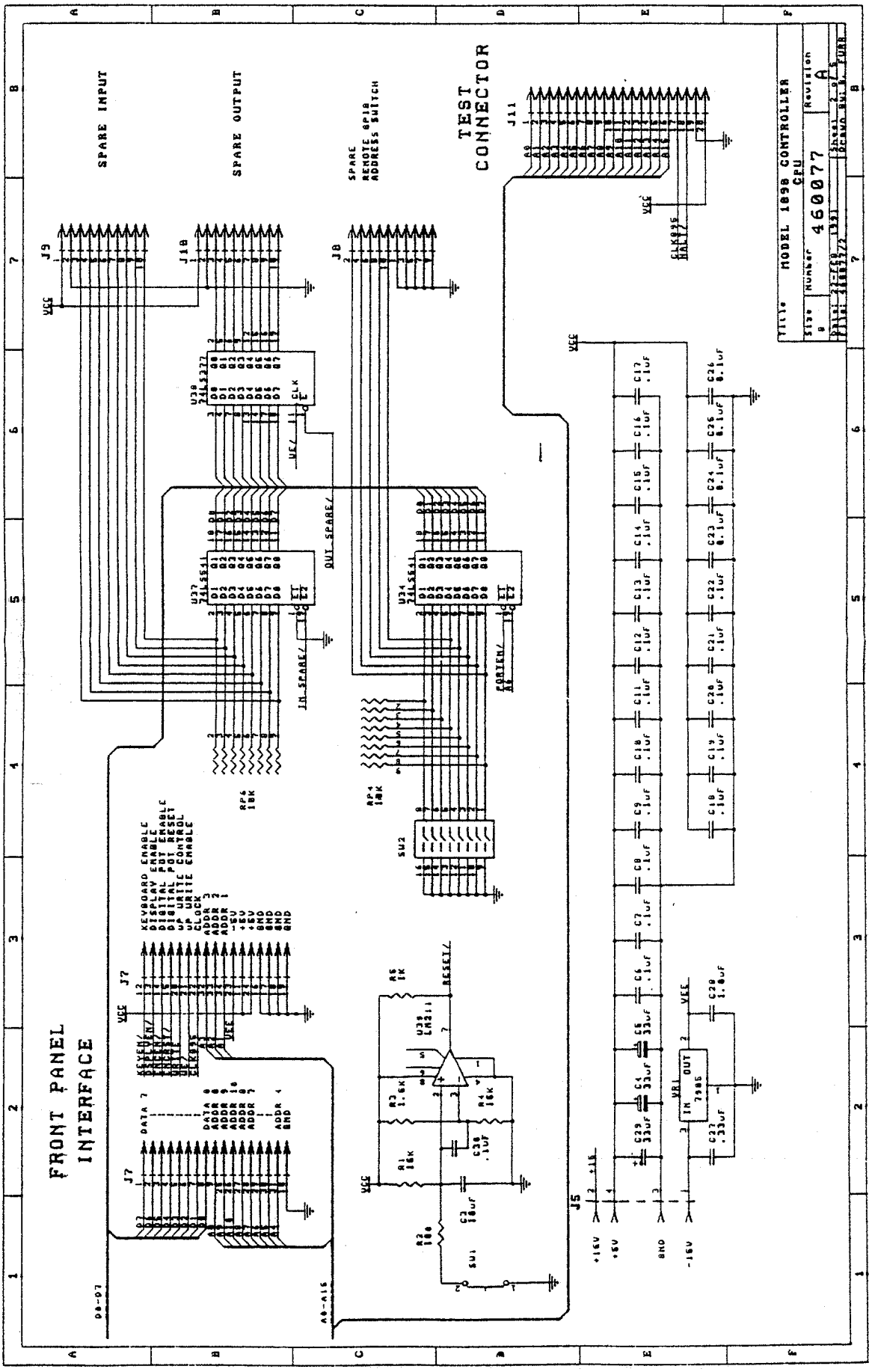


MODEL 1090 CONTROLLER SYSTEM BLOCK DIAGRAM

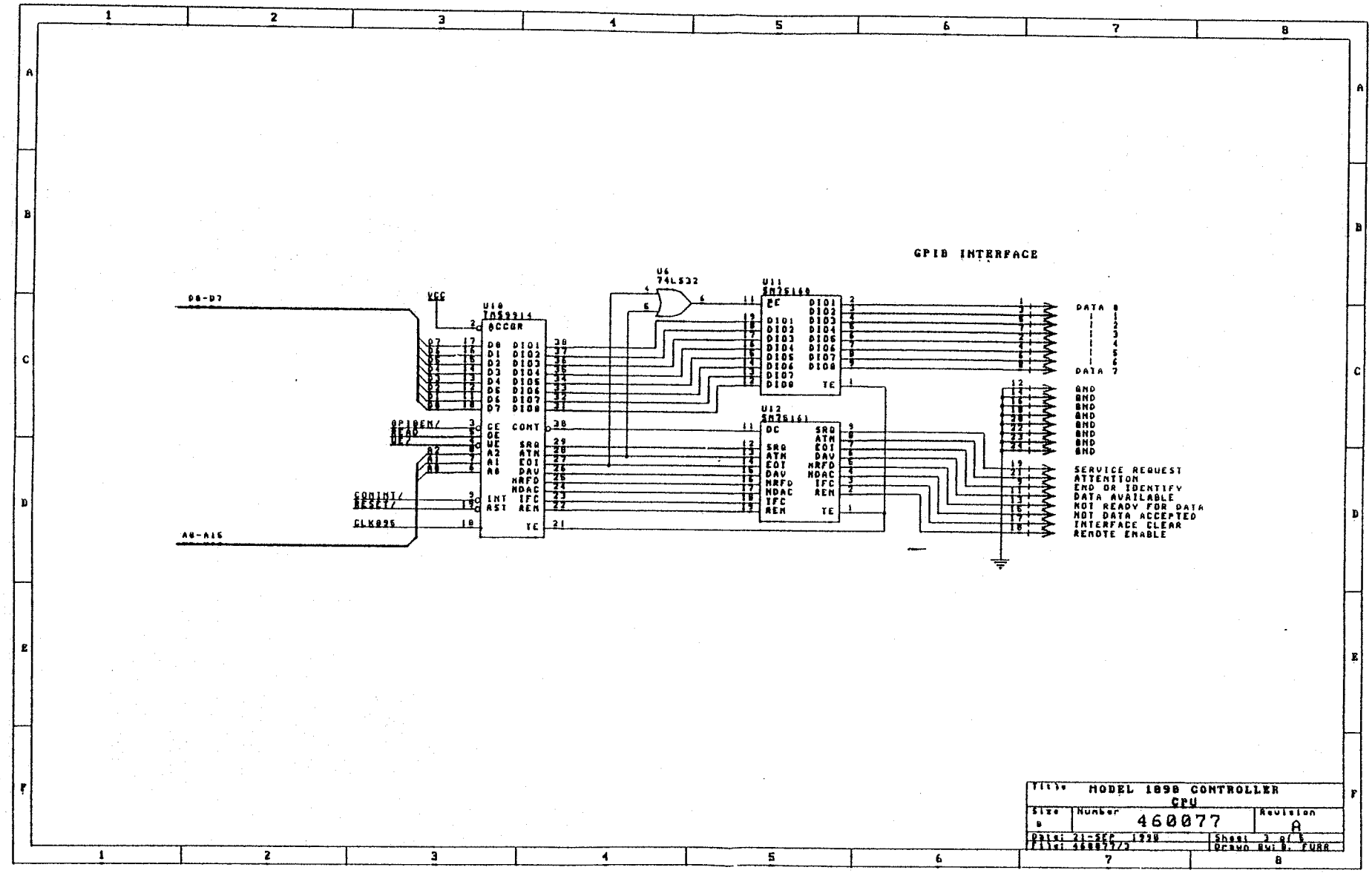
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