CONTENTS

FIGURES

1 INTRODUCTION

The MXi802 and MXi1002 transmitters consists of three separate chassis, two amplifier chassis units and one power supply / main control chassis unit. The chassis unit on the top is the power supply / main control that houses the 31C1936 control board, which is the subject of this publication.

Figure 1 MXi1002 Transmitter

The MXi dual amplifier control board is a single-circuit assembly that provides all of the control functions required for the MXi series of transmitters on a single circuit board. This board can be configured for a number of different transmitter types, power levels, transmission standards and options. The control board provides local front panel interface via ON/OFF and RESET buttons as well as a graphical user interface through a front panel LCD assembly with touchpad for user commands. The board implements controls/status/telemetries for remote control through a rear panel connector that will interface to a typical remote control system (such as Moseley or Gentner). An RS232 serial port is also provided to allow the operator to access the MXi through an external computer (with the appropriate software). The MXi control board has RF monitors for forward and reflected power and all the circuitry to support VSWR functions. Circuitry to control and monitor the +50V power supplies is also included on this board.

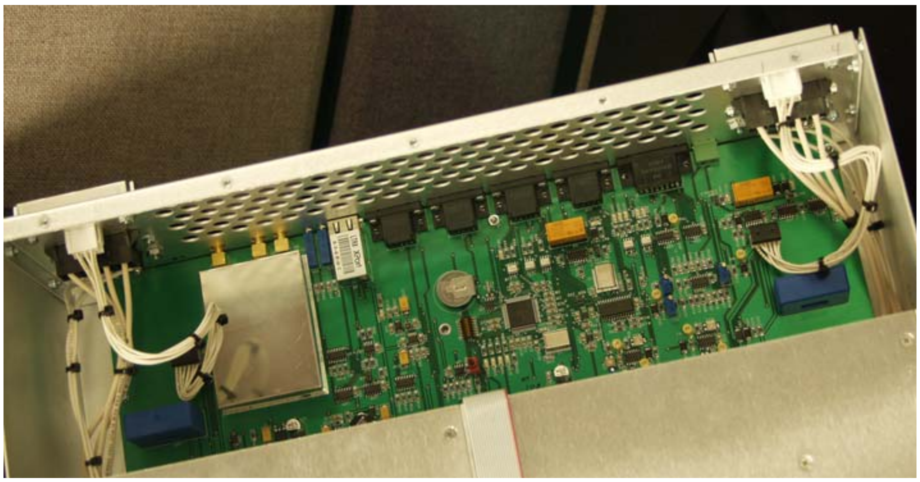

Figure 2 Main Control Board (31C1936)

The front panel of the chassis has the ON button and PWR status LED that the operator uses to turn the transmitter ON or OFF manually and the LED will indicate (when lit) whether the transmitter is in the ON state. Of course the transmitter has remote controls that enable the ON/OFF controls to be activated by off-site facilities.

The transmitter fault status and VSWR reset control is also provided on the front panel to easily determine if there is a fault condition and to reset any VSWR trip conditions.

Figure 3 Front Panel Controls & Status

The user interface to the amplifier is accomplished with the front panel LCD that incorporates a touchpad as an integral part of the unit. The LCD has the capability of displaying a variety of screens, which are selected by the user via the touchpad.

Figure 4 shows the LCD main menu, which shows the present status of the amplifier along with the selections of submenus.

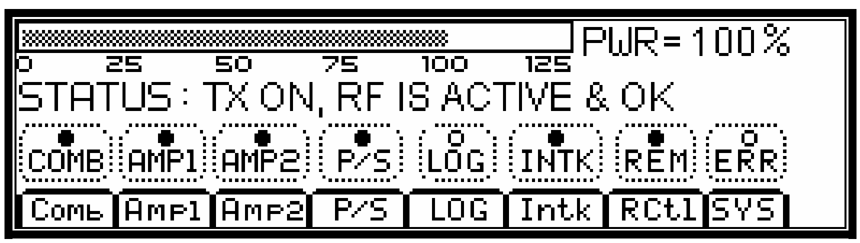

Figure 4 Main LCD Screen

The MXi board has a BDM (Background Debug Mode) connector that allows an external computer or laptop to download the software program into the CPU chip. The CPU chip holds the program in its internal Flash memory and so there is no external chip or device that need be replaced to change/upgrade the software.

2 GENERAL OPERATION

2.1 CONNECTOR AND SIGNAL DEFINITIONS

The connectors on the MXi control board are all shown in Figure 29, which is sheet #5 of the Schematic. The individual signals that are associated with each pin of the connector are also given. A brief description of each of the connectors on the board follows.

2.1.1 J1 AMP1 RS232 Connection

This connector would normally have a nine-pin ribbon cable attached and routed to the nine pin serial connector of Amplifier #1. A typical three-wire serial port (TxD, RxD and Ground) is implemented on this connector.

The main control unit receives serial data from the amplifier that provide the operating parameters of Amp1. The controller also sends serial commands to the Amplifier in response to operator commands.

This is the primary source of control and data for Amplifier #1

2.1.2 J2 AMP2 RS232 Connection

This connector would normally have a nine-pin ribbon cable attached and routed to the nine pin serial connector of Amplifier #2. A typical three-wire serial port (TxD, RxD and Ground) is implemented on this connector.

The main control unit receives serial data from the amplifier that provide the operating parameters of Amp2. The controller also sends serial commands to the Amplifier in response to operator commands.

This is the primary source of control and data for Amplifier #2

2.1.3 J3 Internet Connection

This connector is a standard RJ45 that is integral to the internet interface chip U3. It conforms to a standard internet device, which can be directly connected to the customers' internet service provider or router.

Note that although the hardware is provided on the board, it is still an optional feature that must be purchased additionally. The software to run this port is not included with the basic transmitter. The hardware is provided to facilitate future upgrades of the basic transmitter.

2.1.4 J4 Remote RS232 Connection

This connector is a typical three-wire serial port (TxD, RxD and Ground) without any additional handshaking or control lines. If an external device is connected (such as a modem) then it must be configured for no control lines or a null modem adapter must be used.

This output is an alternative to the internet connection in the case where internet is not available but a modem can be implemented. Note that although the hardware is provided on the board, it is still an optional feature that must be purchased additionally. The software to run this port is not included with the basic transmitter. The hardware is provided to facilitate future upgrades of the basic transmitter.

2.1.5 J5 Remote Controls

This uses a 15-wire ribbon cable to send status/telemetry and receive commands from the rear panel 15-pin D-shell connector. The transmitter must be in ‘Remote’ mode for the commands to be operational, however the output status and telemetry are always current.

This implements the standard remote control that is provided with the transmitter and is intended to be interfaced to an industry standard Remote Control System such as can be purchased from Moseley or Gentner.

2.1.6 J6 BDM (Background Debug Mode) Connection

This is used by the software developer to debug the software programmed into the HCS12 CPU.

The software program is also downloaded into the HCS12 CPU via this connector.

The operator has no real use for this connector since it requires a special programming device and its’ associated software.

2.1.7 J7 Phaser RF Input

This SMA connector receives the RF drive input from the modulator or upconverter (depending on the system). A phasing system that is integral to the controller will split this input into two separate outputs each with its own phasing adjustment. One output is allocated to the RF input of Amplifier #1 and the second output is allocated to the RF input of Amplifier #2.

2.1.8 J8 Amp1 Phased RF Output

This SMA connector sends the phase adjusted RF output to the RF input of Amplifier #1. A separate external RF cable is provided to make this connection. Warning, do not swap the RF cables used for Amp1 phased output and Amp2 phased output. The phasing adjustment takes the respective length of these cables into account.

2.1.9 J9 Amp2 Phased RF Output

This SMA connector sends the phase adjusted RF output to the RF input of Amplifier #2. A separate external RF cable is provided to make this connection. Warning, do not swap the RF cables used for Amp1 phased output and Amp2 phased output. The phasing adjustment takes the respective length of these cables into account.

2.1.10 J10 Combiner Power Samples & Amp Interlocks

This nine pin connector served a dual purpose. The DC sample outputs from the diode detector that represent RF forward, reflected and reject power are attached to this connector as inputs to be sampled by the main controller CPU.

The second function is a set of interlocks for each Amplifier that the main controller will use as an ON control for each amplifier. The contact will be closed if all interlocks are OK and the transmitter is in the ON state.

2.1.11 J11 Amp1 +50 Volt Power Supply Sensing

This uses a six-pin connector that has all the interface connections for the +50V power supply, which is associated with Amplifier #1. Included are an ON command, P/S OK status, the +50V sample and a ground reference from the power supply.

The last signal on this connector is a +12V power supply output that is used to power the MXi main controller board itself. The ground reference is shared with that of the +50V power supply.

2.1.12 J12 Amp2 +50 Volt Power Supply Sensing

This uses a six-pin connector that has all the interface connections for the +50V power supply, which is associated with Amplifier #2. Included are an ON command, P/S OK status, the +50V sample and a ground reference from the power supply.

The last signal on this connector is a +12V power supply output that is used to power the MXi main controller board itself. The ground reference is shared with that of the +50V power supply.

2.1.13 J13 Front Panel Switches, LCD and Touchpad

This uses a sixteen-wire ribbon cable to send and receive serial data from the Front Panel LCD/Touchpad assembly. The front panel interface board routes the signals from the two front panel switches and two front panel leds to this connector.

A typical three-wire serial interface (TxD, RxD and Ground) that communicates with the LCD/Touchpad is sent to the front panel interface board, which in turn connects to the LCD/Touchpad assembly.

A +12v power and ground is provided to the front panel interface board to power its' circuitry where it is regulated down to +5v for the LCD display assembly.

2.1.14 J14 Amp1 +50 Volt Power Supply Sense Output

This uses a six pin connector that has all the interface connections for the +50V power supply which is associated with Amplifier #1 that were input onto connector J11. Included are an ON command, P/S OK status, the +50V sample, +12V power supply and a ground reference from the power supply. All signals are direct pin for pin from J11 except for the current telemetry signal.

An additional power supply current telemetry signal is provided on this connector that was not present on J11. The MXi main control board has a built-in current sensor for the +50V DC output of the power supply associated with Amplifier 1. The heavy gauge wires for the DC output can typically carry up to 60 Amps and are not suitable for routing through a circuitry board. The +50V external wires are routed through the sensing aperture of the current sensor (though not truly connected through the main control board). The circuitry on the main board converts the signal from the current sensor into a telemetry output.

These signals go to an external connector on the rear panel of the control chassis. An external cable will route these signals to the MXi Amplifier #1 chassis. The Amplifier uses the +12Vfor power and the other signals to control and monitor its +50V power supply.

2.1.15 J15 Amp2 +50 Volt Power Supply Sense Output

This uses a six pin connector that has all the interface connections for the +50V power supply which is associated with Amplifier #2 that were input onto connector J12. Included are an ON command, P/S OK status, the +50V sample, +12V power supply and a ground reference from the power supply. All signals are direct pin for pin from J12 except for the current telemetry signal.

An additional power supply current telemetry signal is provided on this connector that was not present on J12. The MXi main control board has a built-in current sensor for the +50V DC output of the power supply associated with Amplifier 2. The heavy gauge wires for the DC output can typically carry up to 60 Amps and are not suitable for routing through a circuitry board.

The +50V external wires are routed through the sensing aperture of the current sensor (though not truly connected through the main control board). The circuitry on the main board converts the signal from the current sensor into a telemetry output.

These signals go to an external connector on the rear panel of the control chassis. An external cable will route these signals to the Amplifier #2 chassis. The Amplifier uses the +12V for power and the other signals to control and monitor its +50V power supply.

2.1.16 J16 External Interlock Input

Interlock supplied for customer use such as RF system interlock or RF Load.

Dry Contact across Connector J16 pins 1 and 2.

This two pin screw terminal connector expects a closed contact that implements a customer provided external interlock. If this interlock is closed, the operator will be able to turn on the two amplifiers via their respective interlocks provided at connector J10. If this external interlock is open, then neither amplifier will respond to the ON command.

This input is intended for an external emergency shutdown condition such as a fire detector, RF output system patch panel or coaxial switch. If there is no external interlock then this connector should be left with a wire shorting the two pins which will enable the interlock and ON commands.

2.2 JUMPER OPTIONS

2.2.1 Jumper E1 – Remote RS232

This jumper is only installed when the serial remote format is to be standard RS232 configuration. Note that you cannot have both the internet and RS232 driving the serial lines at the same time. The transmit data pins are tied together and routed into the microprocessor.

If the internet IC U3 is installed then this jumper MUST not be installed.

If there is no internet U3 installed, then this jumper can be installed.

Note that this jumper only enables the hardware portion of the RS232 interface. The remote RS232 software is a product option and may not be operational on a given unit. If the option was purchased then the proper software would be stored inside the microprocessor and the remote software on the Laptop Computer would also be provided.

Installed = RS232 Remote Serial Communications

Not Installed = Internet Communication or None.

2.2.2 Jumper E2 – Manual Reset

This jumper allows the operator to reset any VSWR trips via an external remote control line on J5 pin 6. This remote control would come from any standard remote control system such as Moseley or Gentner. When asserted, this remote control will directly reset the VSWR Trip relay without any software intervention by the microprocessor. Of course, the VSWR trip will only be cleared if the VSWR condition on the transmitter has been resolved.

Installed = Allow Remote VSWR Trip Reset

Not Installed = Deny Remote VSWR Trip Reset

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2.2.3 Jumper E3 – VSWR Trip Disable

When installed, this jumper disables the VSWR trip interlock of the transmitter and its controller. This is normally only to be used with setting up the VSWR trip level for the amplifier. In normal operation, this jumper should always be removed, since it removes the VSWR protection from the amplifier. In the presence of a VSWR condition, this could result in damage to the amplifier FET devices.

Installed = Disable any VSWR Trips

Not Installed = Enable all VSWR Trips

2.2.4 Jumper E4 – Manual On/Off Command

This jumper would be installed to allow the operator to manually turn the amplifier ON or OFF via the front panel ON/OFF button that would directly control the ON/OFF relay and bypass the HC12 microcontroller. In normal operations, the front panel ON command is read by the microcontroller which in turn will energize the ON relay if the system is in LOCAL mode. This primarily allows for a Remote mode where local commands are ignored.

The jumper would normally only be installed if the operator wants to test the transmitter or for some reason wishes to manually bypass the microprocessor and its' remote controls for troubleshooting reasons.

When installed, this jumper would prevent the operator from remotely turning the transmitter off when the front panel button is in the ON position.

Installed = Allow Front Panel ON/OFF button to override ON relay

Not Installed = Allow the microprocessor to control the ON relay

2.2.5 Jumper E5 – Manual Phasing

The MXi802 and MXi1002 transmitters have two Amplifiers that need to be phased into the two way RF combiner. A phasing circuit is provided on the main control board. The source of the phasing controls can either be from two pots accessed via the rear panel or directly from the microprocessor DAC outputs set by the LCD commands. Jumper E5, when installed, will force the rear panel pots to be used for phasing control. If E5 is not installed then control is given to the microcontroller. The operator can then decide to remain with the rear panel pot control or to use the front panel Phasing adjustments through the LCD menus. The phasing is normally only done once at setup and thus the factory will use the rear panel pots for phasing since these are fixed hardware items.

Installed = Force Phaser control via rear panel pots

Not Installed = Allow the microprocessor to control the phasers

2.2.6 Jumper E6 – Peak/Average Current Amp1

This jumper controls whether the +50V power supply current sensors on the main controller will use a peak detecting circuit or an average detecting circuit. The peak detecting circuit is normally only used in analog NTSC/PAL applications where the peak sync current is the value to be displayed since this makes the current reading independent of video content levels. All other digital applications would use the average current setting.

AMP1 Current Sensing

PkI Position = Analog, measure the Peak Sync Current

AveI Position = Measure the Average Power Supply Current

2.2.7 Jumper E7 – Peak/Average Current Amp2

This jumper controls whether the +50V power supply current sensors on the main controller will use a peak detecting circuit or an average detecting circuit. The peak detecting circuit is normally only used in analog NTSC/PAL applications where the peak sync current is the value to be displayed since this makes the current reading independent of video content levels. All other digital applications would use the average current setting.

AMP2 Current Sensing

PkI Position = Analog, measure the Peak Sync Current

AveI Position = Measure the Average Power Supply Current

2.3 FRONT PANEL INTERFACE BOARD

The 31C1936 controller board connects to a separate front panel interface board via a 16 wire ribbon cable. Connector J13 on the main controller board is wired to connector J1 of the front panel interface board via this 16 wire ribbon cable. The front panel interface board is located at the front of the power supply chassis whereas the controller board is located in the rear of the power supply chassis.

The MXi has a very simple set of front panel controls and indications that consists of three primary sections, the LCD interface, the ERROR status/reset and the transmitter ON/OFF status/control.

The schematic and assembly for the Front Panel Interface board (21B2537G1 Rev 0) are given in Figure **30**.

The VSWR trip status is displayed via a front panel (red) LED, which will be illuminated whenever a VSWR Trip condition has occurred.

The ON/OFF pushbutton is used to turn the transmitter ON or OFF for local or remote control. This button is an alternate action device that, once pressed, remains in the ON state (pressed in). If the operator presses the button a second time, it releases into the OFF state. The function of this button can be set up to directly control the ON/OFF relay K2 and bypass the CPU control by installing jumper E4. Jumper E4 would only be installed for testing or emergency operations. Normal operation has jumper E4 removed such that the CPU reads the state of the ON/OFF button and will in turn activate the relay E4.

The LCD provides a graphical user interface (GUI) that allows the operator to monitor and control the operation of the Mxi transmitter

2.3.1 LCD Interface

The MXi provides a graphical user interface via a front panel LCD display with integrated touchpad. This touchpad communicates to the main controller through a standard 9600 baud RS232 interface. This is a simple three wire interface (TxData, RxData & Ground) with no handshaking hardware lines. The front panel interface board connects to the LCD with a 10 wire ribbon cable J3, that is attached directly to a 10 pin connector on the LCD display. The sequence of signals on this 10 pin cable follows a standard 9 pin D-shell layout where the last 10^{th} pin is not used.

The LCD also requires a +5V power that is provided through a 2 pin connector (+5V and ground) J2, on the front panel interface board. The front panel interface board receives a +12V input from the main controller board and then regulates this down to +5V for the LCD display. The main controller board does indeed have its own +5V power but it was decided that running a +5V supply through the 16 pin ribbon cable on top of the two high current power supplies might result in noise pickup. It was for this reason that the +12V is sent over the 16 wire cable and then regulated near the LCD itself on the front panel interface board.

2.3.2 Error LED and Reset Control

The front panel Error LED (DS1) is located on the front panel interface board and indicates if there is a current error condition on the amplifier. Typical Errors would be VSWR Trips, Interlocks open, Power supply overcurrent, etc. The microprocessor software code on the main controller board provides the signal to drive this LED and will illuminate it whenever a current Error Condition exists.

The front panel interface board has a momentary switch S1 that is used to reset the current Error condition. This switch is a two pole device where one pole directly resets the VSWR Relay on the main controller board and the second pole is fed into the microprocessor to reset any error conditions that the software has detected.

2.3.3 Front Panel On/Off Control and Status

The front panel ON LED (DS2) is located on the front panel interface board and indicates if the ON relay on the main controller is currently activated in the ON state. This LED will illuminate green when the relay is active.

This switch is an alternate action device that, once pressed, remains in the ON state (pressed in). If the operator presses the button a second time, it releases into the OFF state. The function of this button can be set up for a variety of operations depending on how the circuit board jumpers are configured.

Allows the MXi CPU to directly control all local and remote ON/OFF commands. The front panel ON/OFF command will only operate when the system is in local and the remote commands will only operate when the system is in remote.

2.4 TRANSMITTER ON/OFF CONTROLS

The MXi transmitter can respond to a number of ON and OFF command sources depending on the onboard jumper settings. These sources can be Front Panel, External Remote Controls or Serial Remote Controls.

The Front Panel controls will be active when the transmitter is in Local Control (set by the front panel LCD) or in System Bypass mode (set by installing E4)

The External Remote Controls are individual control inputs provided at the rear panel of the control chassis and are compatible with most industry standard remote control systems such as Gentner or Moseley. These remote control will only be active when the transmitter is in Remote Control (set by the front panel LCD) and the System Bypass mode is disabled (E4 must be removed).

The Serial Remote Controls are an extra cost option that must be purchased at the time of purchase. Note that not all models of MXi have this option available and must be verified with LARCAN sales personnel. These serial commands operate from a LARCAN Customized program and are enabled in a similar manner to the External Remote Controls. These remote control will only be active when the transmitter is in Remote Control (set by the front panel LCD) and the System Bypass mode is disabled (E4 must be removed). If provided with the transmitter, this feature would have its' own manual and description and as such will not be dealt with in this publication.

2.4.1 Front Panel ON/OFF Controls

The front panel ON/OFF button can operate in two modes, either "Normal" or "System Bypass". Note that the system interlocks (like VSWR trip and Ext1) have priority over the ON/OFF commands. That is if one of the interlocks are open then the transmitter will remain OFF even if an ON command has been issued.

In ‘System Bypass’ mode, jumper E4 is installed such that when the operator presses the front panel ON/OFF button into the ON state (ie pressed in) then this directly activates the ON/OFF relay K2 without any CPU intervention. In this state, the CPU cannot turn off the transmitter and thus remote OFF commands will not work even when the system is in the Remote mode. The ‘Bypass’ mode is only meant for special conditions when the operator is either troubleshooting the ON/OFF commands or is checking CPU control of the relay K2. The only time that this mode is left active is when the operator determines there is a definite problem with the CPU ON/OFF controls. If operating in ‘Bypass’ mode, then the transmitter should either be in ‘Local’ or all Remote ON commands should be removed to insure there is no other ON command in addition to the front panel button. This allows the front panel ON/OFF button to remove the ON commands from K2 and shut off the transmitter. If the system is in Remote and a Remote ON command has been issued then this will continue to send an ON command to ON/OFF relay K2 even after the front panel ON/OFF button has been released.

In ‘Normal’ mode, jumper E4 is not installed such that when the operator presses the front panel ON/OFF button, the state of this button is read by the CPU which will then send the appropriate ON or OFF command to the ON/OFF relay K2. If operating from the Front Panel button, then the transmitter should be in ‘Local’ mode as set from the front panel LCD. This tells the CPU to ignore all remote commands and only turn the transmitter ON or OFF depending on the state of the front panel button.

2.4.2 Remote ON/OFF Controls

The External Remote Controls are individual control inputs provided at the rear panel of the control chassis and are compatible with most industry standard remote control systems such as Gentner or Moseley. These remote control will only be active when the transmitter is in Remote Control (set by the front panel LCD) and the System Bypass mode is disabled (E4 must be removed).

There are separate Remote ON and Remote OFF commands provided to the operator and require a momentary active low pulse to activate. The CPU records the last selected state of the Remote ON or OFF in a variable called RemOn. When a Remote ON command is issued, then this internal RemOn variable is set to ON and when a Remote OFF command is issued, then this internal RemOn variable is set to OFF. When the transmitter is in Remote mode, the CPU checks this RemOn variable and will set the ON/OFF relay K2 to the desired state.

The purpose of this internal RemOn variable is to allow the CPU to restore the desired K2 state after a power failure or if the operator changes over to Local mode and then back into remote mode. If the operator changes over to Local mode then the transmitter will be either ON or OFF depending on the state of the front panel ON/OFF button. After returning back to the Remote mode, the transmitter will be either ON or OFF depending on the state of the RemOn variable. Of course at any time the operation may issue a remote ON or OFF command to change this RemOn variable as long as the transmitter is in the Remote mode.

Note that when in the Local mode, all remote controls are inactive and have no effect. The remote telemetry and status outputs are active at all time though.

2.5 RF LEVEL SIGNALS

The control board receives three DC levels from the diode detector that represent the RF power levels of the forward, reflected and reject powers. These signals are input on connector J10 at the rear panel.

The MXi board buffers these signals with appropriate gains factors and allows the operator to calibrate the output voltage levels depending on the actual measured output power. The resulting DC level is used by the CPU D/A converter to determine the actual operating power and display it on the LCD display.

These output RF signal level voltages are also buffered and sent to the Remote Control connector J5 as telemetry outputs.

Note that the voltage output levels are proportional to the square root of the output power. That is, if the output level is 1.0v and rises to 2.0v then this represents a fourfold increase in power.

2.6 VSWR TRIP AND LOCKOUT OPERATION

The MXi has built-in VSWR protection to prevent damage to the amplifier from excessive power being reflected back from the output system. This VSWR protection becomes operational when reflected power exceeds 10% of forward power. The system shuts down the amplifier for a few seconds and then tries to restart again. This is done to check if the VSWR was a temporary condition that could have been caused by a lightning strike nearby. The LCD shows the TRIP status light on the third row of the LCD to indicate that a VSWR trip had occurred. If the condition persists such that three VSWR trips occur within 1 minute, the system completely shuts down. The LCD will then illuminate the L/O (Lockout) status light on the LCD to show that a Lockout has occurred.

2.7 INTERLOCKS

Interlocks on the MXi can be divided into two different types: hard interlocks that shut down the transmitter without any CPU intervention and soft interlocks that are generated by the CPU chip in response to abnormal system parameters.

2.7.1 Hard Interlocks

There are hardware interlocks that directly affect the ON/OFF relay K2 by removing the +12V arming voltage on its coil and preventing it from turning on. There are only two of these interlocks as follows:

2.7.1.1. VSWR Relay K2

Contact from VSWR Trip relay K1 pins 11 and 13.

Contact will be closed (OK) if there is no VSWR condition. When in the closed position, a +12 volt arming voltage will be routed from K1 pin 13 onto P1 pin 11.

Contact will open whenever a VSWR is detected. This will remove the +12 volt arming voltage for K2.

Note: Jumper E3 disables this interlock by applying a +12 volt arming voltage at the output of K1 pin 13.

Caution: Jumper E3 is intended for setup purposes only. Leaving this jumper installed will disable the VSWR trip protection function and can result in damage to the RF transistors if VSWR condition occurs!!

2.7.1.2. External #1

Interlock supplied for customer use such as RF system interlock or RF Load.

Dry Contact across Connector J16 pins 1 and 2.

This two pin screw terminal connector expects a closed contact that implements a customer provided external interlock. If this interlock is closed, the operator will be able to turn on the two amplifiers via their respective interlocks provided at connector J10. If this external interlock is open, then neither amplifier will respond to the ON command.

This input is intended for an external emergency shutdown condition such as a fire detector, RF output system patch panel or coaxial switch. If there is no external interlock then this connector should be left with a wire shorting the two pins which will enable the interlock and ON commands.

2.7.2 Soft Interlocks

There are parameters that the CPU monitors and if they indicate an error condition, the CPU will set the appropriate error flag and issue a log entry. Such parameters are power supply over current and over voltage.

Since the power supply has internal protection built in for these parameters there is no need to have the CPU shut the transmitter down on these conditions and so they result in error messages and log entries only.

At this time there are no soft interlocks implemented for the MXi transmitter but it is possible that some could be added in future version of the software program. If this were the case, the operator should not have the Local ON switch configured to the Override state by having jumper E4 installed, then CPU will be unable to shut off the amplifier via relay K2. This results in the front panel ON switch will providing a permanent ground (when pressed in) to the pin 16 of relay K2 that effectively bypasses the CPU ON command. In this override state, all soft interlocks would become disabled.

3 LCD GUI INTERFACE AND TOUCHPAD

The user interface to the transmitter is mainly accomplished with the front panel LCD that incorporates a touchpad as an integral part of the unit. The touchpad consists of a thin membrane attached to the LCD surface which implements a software-driven menu selection system. The LCD has the capability of displaying a number of different screens, which are selected by the operator via the touchpad.

Each of the separate display screens (called Menus) is detailed in the following subsections along with their respective touchpad menu options. When the MXi transmitter is first powered on or returns from an AC power outage, the LCD displays a screen [Power Up Screen] that only shows for a few seconds and describes the particular transmitter that this MXi is configured for. The same MXi controller board, LCD and software is used for a number of different transmitter configurations. The one specific Power Up Screen reflects the current transmitter configuration. This same information is available on the General Menu screen described in a later subsection.

Note that there are no touchpad menu options on this screen, since it only displays for a few seconds. After these seconds have passed, the MXi proceeds into the Main Menu screen described in the next section.

3.1 Main Screen and Touchpad Operations

The Main Menu screen as shown below gives the operator all of the most pertinent values and status to verify the operation of the transmitter. This screen is the one that is normally left displayed when no maintenance or diagnostic checks are being performed. It is from this Main screen that all of the other submenu screens can be accessed. If the operator has switched to another submenu, it is recommended that the LCD is returned to the Main screen, since this shows an overview of the system operation.

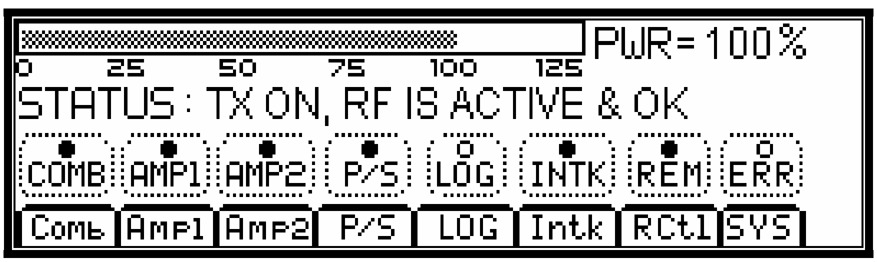


Figure 5 Main Menu Screen

The Main screen can be subdivided into four distinct sections, the main forward RF power at the top line, the transmitter status on the second line, the individual subsystem status on the third line and the submenu options on the fourth and last line.

The first line shows the forward RF power that the transmitter is currently generating. This is the power that is actually being sent out to the antenna or system load. There are two elements that show the same information but in different formats. The bar graph gives a graphic display of the RF power output level and is calibrated for 100% at the transmitter's rated output power. The bar graph will display up to 125% but it is not recommended that the operator increase the power beyond the rated power without prior approval from LARCAN field service. When the power exceeds 110%, the bar graph becomes more solid and darker in the area above 110% to indicate that an overpower condition is present.

The same information is provided to the left of the bar graph in a three-digit display, which shows the current power output. When calibrating or setting up the transmitter, this three-digit display value should be used as a reference for the current transmitter power (not the bar graph). This display has a maximum value of 169% power when the transmitter detectors are set up for a DC output of 4.0 at full power. This value is derived from the fact that the detector can output a maximum of 5.0VDC to the telemetry circuits, which translates to an output power of 169%. Of course, this is a maximum display value on the LCD fixed by circuit constraints and the operator should never be approaching this type of power level with the transmitter. If a display of 169% is indeed shown, then either there is a problem with the detector or the power of the transmitter is in fact exceeding 169% and should be attended to immediately.

The second line of the LCD shows the current state of the transmitter and any important errors that are current. This line typically tells the operator if the transmitter has been asked to be in the ON state. The transmitter is placed in the ON state either by the local front panel ON button or by a remote ON command. If the transmitter has been turned off by the operator, the LCD reports that the transmitter is OFF normally (i.e., it was not due to an error).

If an error condition has occurred that caused the transmitter to shut down, the LCD displays that the transmitter is OFF and then shows what the error condition is that has caused the shutdown. As an example, if the External#1 interlock is open, the LCD displays TX IS OFF, EXT1 INTERLOCK OPEN.

The third line of the display has a number of status lights with a legend describing the particular status underneath and all enclosed in a dashed line box. When the light is fully darkened, it indicates that this particular status is true. When the light is hollow, it indicates that this particular status is false. Each status is detailed below.

3.1.1 COMB Status LED

This status represents the state of the combined RF output of the MXi transmitter. There are different conditions for this LED to be lit depending on whether the transmitter is currently ON or OFF.

If the transmitter is ON, then the output power telemetry cannot fall more than 160 mV under the AGC reference level. That is if the AGC is set for 100% power (voltage of 4.0v), then the COMB LED will be lit only if the output power telemetry is higher than 3.84v (or 92 % power). Note that the output power is proportional to the square of the telemetry voltage. This indicates that the transmitter is outputting a power level that is near to the desired output power level

If the transmitter is OFF, then the VSWR Lock status must be false and Ext1 Interlock must be closed for the COMB LED to be lit. This indicates that the transmitter would be ready to produce power if activated.

- Lit when the Tx is ON and Output Power OK, or when Tx is Off but Ext1 Intk and VSWR Lockout are OK.
- Not lit when RF power is low or either Ext1 Intk is open or a VSWR Lockout has occurred.

3.1.2 AMP1 Status LED

Status that indicates the condition of RF amplifier #1.

The amplifier(s) report their operating parameters to the central control unit via a RS232 serial stream. The central control monitors this stream and will indicate an error if the amplifier stops communicating. This communications must be operating whether the amplifier RF output is ON or OFF.

If the amplifier is ON, then the output power telemetry cannot fall more than 160 mV under the AGC reference level. That is if the AGC is set for 100% power (voltage of 4.0v), then the AMP1 LED will be lit only if the output power telemetry is higher than 3.84v (or 92 % power). Note that the output power is proportional to the square of the telemetry voltage. This indicates that the transmitter is outputting a power level that is near to the desired output power level

If the transmitter is OFF, then the VSWR Lock status must be false and Thermal Interlock must be closed for the Amp1 LED to be lit. The Thermal Interlock is monitored instead of the Ext1 of the amplifier since the main control uses the Ext1 interlock to shut off the amplifier power. So if the transmitter is turned off, then the Ext1 interlock of the amplifier would normally become open. This LED status indicates that the amplifier would be ready to produce power if activated.

- Lit when Comms is OK, the Amp is ON and Output Power OK or Amp is Off but Thermal Interlock and VSWR Lockout are OK.
- Not lit when Comms is lost, RF power is low or either Thermal Intk is open or a VSWR Lockout has occurred.

3.1.3 AMP2 Status LED

Status that indicates the condition of RF amplifier #2.

The amplifier(s) report their operating parameters to the central control unit via a RS232 serial stream. The central control monitors this stream and will indicate an error if the amplifier stops communicating. This communications must be operating whether the amplifier RF output is ON or OFF.

If the amplifier is ON, then the output power telemetry cannot fall more than 160 mV under the AGC reference level. That is if the AGC is set for 100% power (voltage of 4.0v), then the AMP2 LED will be lit only if the output power telemetry is higher than 3.84v (or 92 % power). Note that the output power is proportional to the square of the telemetry voltage. This indicates that the transmitter is outputting a power level that is near to the desired output power level

If the transmitter is OFF, then the VSWR Lock status must be false and Thermal Interlock must be closed for the Amp2 LED to be lit. The Thermal Interlock is monitored instead of the Ext1 of the amplifier since the main control uses the Ext1 interlock to shut off the amplifier power. So if the transmitter is turned off, then the Ext1 interlock of the amplifier would normally become open. This LED status indicates that the amplifier would be ready to produce power if activated.

- Lit when Comms is OK, the Amp is ON and Output Power OK or Amp is Off but Thermal Interlock and VSWR Lockout are OK.
- Not lit when Comms is lost, RF power is low or either Thermal Intk is open or a VSWR Lockout has occurred.

3.1.4 P/S Status LED

Status that indicates the +50V power supply to the RF amplifiers is currently ON and are operating properly. Note that the power supply voltage and current are monitored by both the amplifier and the main control board via independent circuitry. This status runs from the monitoring circuitry on the main controller board and not from the amplifier(s). The telemetry values for power supply voltage/current on the other LCD menu are derived from the amplifier serial stream. So it is possible that the LCD values are correct but this status is not when the amplifier circuitry is reading correctly but the main controller is not. A loss of this status should indicate to the operator to investigate the reading from the main controller board.

- Lit when the Power Supplies are ON, the voltage is over +50V
- Not lit when the Power Supplies are either OFF or has some operational problems.

3.1.5 LOG Status LED

Status that shows that there are current entries in the LOG file.

- Lit whenever one or more LOG entries are currently in the LOG file via the LOG submenu.

Note these may not be new LOG entries, if the operator checks the LOG file but does not clear it. The log entries status remains lit even if there are no new Logs. The operator should clear the Logs once viewed so that this Log status indicates a new Log entry.

- Not Lit when there are no current Log entries

3.1.6 INTK Status LED

Status that indicates the interlocks to the RF amplifier are all operating properly.

- Lit when interlocks Ext1, VSWR Trip and VSWR Lockout are closed (i.e., OK).
- Not lit when or one of the interlocks are opened.

If this status LED is not lit, then the operator should then check the INTK submenu to determine the source of the problem. Note that the same individual interlock status can be found on the other submenus as well, but the INTK submenu is a place where all the individual interlocks are displayed in one place.

3.1.7 REM Status LED

Remote Status for the remote controls, operator controlled via the REM submenu.

- Lit when the system is in REMOTE mode and enables remote commands.
- Not lit when in LOCAL mode and remote commands are disabled.

3.1.8 ERR Status LED

Status that shows an error either is current or has occurred since last check. This is a composite of the other status and is a general indication that something is wrong. One of the error conditions is VSWR Trip, which is a saved status. The VSWR Trip indicates that a VSWR condition had occurred (but may no longer be present). The operator must press the front panel reset button (or issue a reset command remotely) to clear the VSWR Trip condition.

The user should check the AMP screens and the Interlock screen to check the source of the error.

- Lit when both Amps are communicating, Ext1 is closed, VSWR Trip and VSWR Lockout are not present.
- Not lit if either Amp is not communicating, Ext1 is open, VSWR Trip or VSWR Lockout have occurred.

3.1.9 SubMenu Select Buttons

The fourth line of the LCD holds select buttons that will cause the LCD to jump to different submenu screen that provides more detailed information on a certain aspect of the MXi operations. Each submenu screen has an 'OUT' button that allows the user to return to this main screen.

The submenu select buttons with a brief description is given below:

- COMB = Combined Submenu, Shows combined powers, Agc Reference and Amp1/2 forward powers
- AMP1 = Amplifier #1 Submenu, Shows Amp1 powers, Agc Reference, Status
- AMP2 = Amplifier #2 Submenu, Shows Amp2 powers, Agc Reference, Status
- P/S = Power Supply Submenu, Shows voltage, current and status for both 32V Power Supplies
- LOG = Log Submenu, Give access to log entries recorded by the system
- INTK = Interlock Submenu, Shows the current status of the system interlocks
- RCTL = Remote Control Submenu, Remote/Local controls, Command counts and Baud Rate selection
- SYS = General System Submenu, System status and configuration parameters and Real Time Clock

3.2 COMBINED SCREEN

The Combined RF Amplifier submenu is entered by pressing the COMB submenu button on the main LCD screen. This submenu displays all the various power, status and controls for the combined RF output and the forward RF power for each amplifier. Each display item and control is described as to its meaning and function.

The LCD displays a typical COMB submenu as follows:

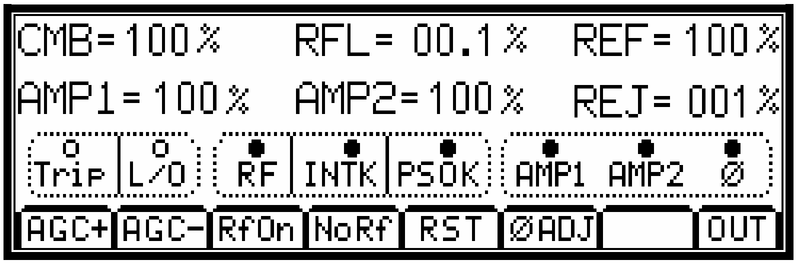


Figure 6 Combined Power Screen

The first line shows the three possible RF values. The first item is the combined forward power denoted as CMB that represents the total output RF power from the transmitter and would be the same value that is displayed on the Main LCD menu. This is represented as a percentage of the full rated output power of the transmitter.

The second item on the first line is the reflected power from the transmitter. This represents the total power that is being reflected back from the RF output system into the transmitter. The maximum amount of power that should be displayed is 10.0%, since the VSWR protection circuit shuts down the amplifier whenever the reflected power exceeds 10.0%. The expected reflected power would normally be under 1.5% and a value higher than this indicates an issue with the RF output system. When the reflected power increases, the amplifier automatically cuts back the forward power. When a value of 1% or higher is shown on the RFL power reading, a FWD power reading of less than 100% would be expected.

The third item on the first line is the AGC reference level. This is the desired power level that the automatic gain control of each amplifier will try to maintain at its output. Note that the main controller does not actually perform the AGC function but sends this AGC reference level to each of the amplifiers via the RS232 communications and the individual amplifiers will then use this level as a reference for their own AGC control circuitry.

The first two items of the second line shows the output powers of Amplfier1 and Amplifier2 respectively as reported by the RS232 serial stream from each amplifier. If the main controller loses communications with an individual amplifier for over 5 seconds, it will null out its telemetries and this output power will show 0%. In reality the output power may not be zero but it will display a zero value to alert the operator to an error condition. If the COMB power shows 100% but the amplifier power shows 0%, then a communications problem is most likely.

The third value of the second line is combined reject power denoted as REJ. When the two amplifiers are combined via the two way combiner, any amplitude or phase variance between the amplifiers will result in power being routed to the reject load of the combiner. The presence of reject power indicates either a phasing problem or that one amplifier is much lower in power than the other.

The third line of the display has a number of status lights with a legend describing the particular status underneath and all enclosed in a dashed line box. When the light is fully darkened, it indicates that this particular status is true. When the light is hollow, it indicates that this particular status is false. Certain related status are grouped together in the same box. The purpose of these status is to point the operator to the area that is currently causing the RF transmitter to be shut down. Each status is detailed as follows.

3.2.1 TRIP Status LED

VSWR Trip Status

- Lit when the system has seen at least one VSWR trip, can be reset by operator using LCD touchpad, front panel reset button or a remote reset command
- Not lit when there have been no VSWR trips since the last time this was cleared.

Note that this does not mean that there is a current VSWR trip but that one did occur.

The operator may have this status as true (with no Lockout status) and still have the RF amplifier active.

3.2.2 L/O Status LED

VSWR Lockout Status

- Lit when the system has seen three VSWR trips in under 1 minute.

When a VSWR trip occurs, the MXi controller will reset the trip automatically and repower the RF amplifier. If three trips occur within 1 minute, the Lockout status is set and the RF amplifier will remain OFF. The Lockout status can be reset by the operator using LCD touchpad, front panel reset button or a remote reset command.

- Not lit when there have been no VSWR trips since the last time this was cleared.

3.2.3 RF Status LED

If the transmitter is ON, then the output power telemetry cannot fall more than 160 mV under the AGC reference level. That is if the AGC is set for 100% power (voltage of 4.0v), then the RF LED will be lit only if the output power telemetry is higher than 3.84v (or 92 % power). Note that the output power is proportional to the square of the telemetry voltage. This indicates that the transmitter is outputting a power level that is near to the desired output power level.

- Lit when transmitter is ON and RF power is near the set AGC reference level
- Not lit when the transmitter is either OFF or the RF output power is low.

3.2.4 INTK Status LED

Interlock inputs that affect the RF amplifier are all closed and OK.

- Lit when interlocks VSWR Lockout, VSWR Relay and Ext1 are closed (i.e., OK).
- Not lit when at least one of the above interlocks are opened.

The VSWR Lockout is related to the VSWR Relay status in that both are driven off the state of the VSWR Relay on the MXi board. When a VSWR condition occurs, the VSWR Relay is opened momentarily to allow the system to clear any VSWR condition and try to restart the transmitter.

During this time the VSWR Relay interlock will be open (false), but the VSWR Lockout status will still be OK since less than 3 VSWR trips have been detected. Once more than 3 trips have been detected in the 1 minute time frame then the VSWR relay will not be reset and both the VSWR LockOut and VSWR Relay will be open.

3.2.5 PSOK Status LED

Power Supply OK status, the +50V power supply to the RF amplifier is currently ON and is operating properly.

- Lit when the Power Supply is ON. The P/S voltage, current and status are all OK.
- Not lit when the Power Supply is either OFF or has some operational problems.

3.2.6 AMP1 Status LED

Status that indicates the condition of RF amplifier #1.

The amplifier(s) report their operating parameters to the central control unit via a RS232 serial stream. The central control monitors this stream and will indicate an error if the amplifier stops communicating. This communications must be operating whether the amplifier RF output is ON or OFF.

If the amplifier is ON, then the output power telemetry cannot fall more than 160 mV under the AGC reference level. That is if the AGC is set for 100% power (voltage of 4.0v), then the AMP1 LED will be lit only if the output power telemetry is higher than 3.84v (or 92 % power). Note that the output power is proportional to the square of the telemetry voltage. This indicates that the transmitter is outputting a power level that is near to the desired output power level

If the transmitter is OFF, then the VSWR Lock status must be false and Thermal Interlock must be closed for the Amp1 LED to be lit. The Thermal Interlock is monitored instead of the Ext1 of the amplifier since the main control uses the Ext1 interlock to shut off the amplifier power. So if the transmitter is turned off, then the Ext1 interlock of the amplifier would normally become open. This LED status indicates that the amplifier would be ready to produce power if activated.

- Lit when Comms is OK, the Amp is ON and Output Power OK or Amp is Off but Thermal Interlock and VSWR Lockout are OK.
- Not lit when Comms is lost, RF power is low or either Thermal Intk is open or a VSWR Lockout has occurred.

3.2.7 AMP2 Status LED

Status that indicates the condition of RF amplifier #2.

The amplifier(s) report their operating parameters to the central control unit via a RS232 serial stream. The central control monitors this stream and will indicate an error if the amplifier stops communicating. This communications must be operating whether the amplifier RF output is ON or OFF.

If the amplifier is ON, then the output power telemetry cannot fall more than 160 mV under the AGC reference level. That is if the AGC is set for 100% power (voltage of 4.0v), then the AMP2 LED will be lit only if the output power telemetry is higher than 3.84v (or 92 % power). Note that the output power is proportional to the square of the telemetry voltage. This indicates that the transmitter is outputting a power level that is near to the desired output power level

If the transmitter is OFF, then the VSWR Lock status must be false and Thermal Interlock must be closed for the Amp2 LED to be lit. The Thermal Interlock is monitored instead of the Ext1 of the amplifier since the main control uses the Ext1 interlock to shut off the amplifier power. So if the transmitter is turned off, then the Ext1 interlock of the amplifier would normally become open. This LED status indicates that the amplifier would be ready to produce power if activated.

- Lit when Comms is OK, the Amp is ON and Output Power OK or Amp is Off but Thermal Interlock and VSWR Lockout are OK.
- Not lit when Comms is lost, RF power is low or either Thermal Intk is open or a VSWR Lockout has occurred.

3.2.8 PHASE Status LED

Status that shows if the reject power is sufficiently lower than the combined forward power.

When the transmitter is turned ON, both amplifiers should be generating RF power. The main controller has phasing circuitry that allows these two amplifier outputs to be combined through a 2-way combiner to the RF output. This combining depends on the relative phasing of the two amplifiers and any phase error will result in some of the power of the amplifiers being routed into the reject load of the combiner. A similar but less pronounced effect will occur if the output amplitude of the two amplifiers are different.

The reject load power from the combiner is measured by the main controller and compared to the combined output power. Note that the output power is proportional to the square of the telemetry voltage. The system checks that the reject power telemetry is less than 1/8th of the combined forward power telemetry. This would mean that the actual reject power must be 1/64th of the combined forward power for the status to be true. This would translate into having reject power lower than about –18db than the forward power.

The forward power must be greater than 10% for this status to be calculated since at low combined forward powers the reject power measures will most often just read zero and be meaningless.

- Lit when forward power is greater than 10% and the reject power is less than 1/64 of forward power
- Not lit when either the forward power is under 10% or reject power is greater than 1/64 of forward power.

3.2.9 SubMenu Select Buttons

The fourth line of the LCD hold select buttons that will control combined operation plus allow access to a second level of submenu. The select buttons with a brief description is given below:

- AGC+ = Increases the transmitter AGC reference level in 1-2% steps
- AGC- = Decreases the transmitter AGC reference level in 1-2% steps
- RfON = Restores the AGC reference level to previous point. Only valid after an RfOFF command.
- NoRF = Sets the AGC reference level to zero & stores old level.
    - Note AGC can only reduce RF to a minimum of around 10-20%
- RST = Reset Control will issue a VSWR Trip reset command
- PhAdj = Phase Submenu, Calls up the Phasing Submenu (level 2 submenu)
- OUT = Returns LCD to the main LCD screen.

3.3 PHASING SCREEN

The Phasing submenu is entered by pressing the COMB submenu button on the main LCD screen. This submenu displays all the various power, status and controls for the combined RF output and the forward RF power for each amplifier. Each display item and control is described as to its meaning and function.

The LCD displays a typical Phasing submenu as follows:

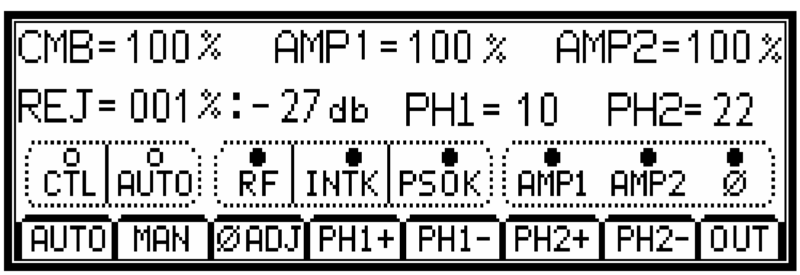


Figure 7 Phasing Screen

The first line shows the three possible RF values. The first item is the combined forward power denoted as CMB that represents the total output RF power from the transmitter and the next two items are the individual amplifier forward powers.

The second line has two measures of reject power, one shows percentage and the second is the amount the reject power is down from the forward power (in dB). The REJ reading is the power in percentage that has a minimum value of 1%. This represents a reject level that is –20db under the forward power but in practice the reject power will be often lower than this. The second reading is the reject power in dB below the forward power level. This allows the operator to adjust the phasing and reduce the reject power to a level lower than 1%. A reject level of around –30db is typical.

The last two readings of the second line are the hexadecimal values sent to the two CPU D/A converters respectively. The range of these values are from $00 to $FF where $FF is equivalent to decimal 255. These values are provided to indicate to the operator when the DAC level has reached either the lowest or highest limit.

3.3.1 CTL Status LED

This status LED indicates whether the CPU has control over the phasing voltage via its internal DAC. This really depends on whether jumper E5 is installed or not. If E5 is installed then the CPU has no control and the rear panel potentiometers directly control the phasing. If E5 is not installed then the CPU can select whether the rear panel pots will control the phasing or if its own DAC outputs will control the phasing.

- Lit when the CPU has control of the phasing voltages (jumper E5 is not installed)
- Not lit when the CPU does not have control of the phasing voltages (jumper E5 is installed).

3.3.2 AUTO Status LED

This status LED indicates whether the CPU has given control of the phasing voltage to its internal DAC or if the rear panel potentiometers control the phasing.

- Lit when the CPU has given phaser control to the rear panel potentiometers
- Not lit when the CPU has given phaser control to its internal DACs

3.3.3 RF Status LED

If the transmitter is ON, then the output power telemetry cannot fall more than 160 mV under the AGC reference level. That is if the AGC is set for 100% power (voltage of 4.0v), then the COMB LED will be lit only if the output power telemetry is higher than 3.84v (or 92 % power). Note that the output power is proportional to the square of the telemetry voltage. This indicates that the transmitter is outputting a power level that is near to the desired output power level.

- Lit when transmitter is ON and RF power is near the set AGC reference level
- Not lit when the transmitter is either OFF or the RF output power is low.

3.3.4 INTK Status LED

Interlock inputs that affect the RF amplifier are all closed and OK.

- Lit when interlocks VSWR Lockout, VSWR Relay and Ext1 are closed (i.e., OK).
- Not lit when at least one of the above interlocks are opened.

The VSWR Lockout is related to the VSWR Relay status in that both are driven off the state of the VSWR Relay on the MXi802 board. When a VSWR condition occurs, the VSWR Relay is opened momentarily to allow the system to clear any VSWR condition and try to restart the transmitter. During this time the VSWR Relay interlock will be open (false), but the VSWR Lockout status will still be OK since less than 3 VSWR trips have been detected. Once more than 3 trips have been detected in the 1 minute time frame then the VSWR relay will not be reset and both the VSWR LockOut and VSWR Relay will be open.

3.3.5 PSOK Status LED

Power Supply OK status, the 50V power supply to the RF amplifier is currently ON and is operating properly.

- Lit when the Power Supply is ON. The P/S voltage, current and status are all OK.
- Not lit when the Power Supply is either OFF or has some operational problems.

3.3.6 AMP1 Status LED

Status that indicates the condition of RF amplifier #1.

The amplifier(s) report their operating parameters to the central control unit via a RS232 serial stream. The central control monitors this stream and will indicate an error if the amplifier stops communicating. This communications must be operating whether the amplifier RF output is ON or OFF.

If the amplifier is ON, then the output power telemetry cannot fall more than 160 mV under the AGC reference level. That is if the AGC is set for 100% power (voltage of 4.0v), then the COMB LED will be lit only if the output power telemetry is higher than 3.84v (or 92 % power). Note that the output power is proportional to the square of the telemetry voltage. This indicates that the transmitter is outputting a power level that is near to the desired output power level

If the transmitter is OFF, then the VSWR Lock status must be false and Thermal Interlock must be closed for the Amp1 LED to be lit. The Thermal Interlock is monitored instead of the Ext1 of the amplifier since the main control uses the Ext1 interlock to shut off the amplifier power. So if the transmitter is turned off, then the Ext1 interlock of the amplifier would normally become open. This LED status indicates that the amplifier would be ready to produce power if activated.

- Lit when Comms is OK, the Amp is ON and Output Power OK or Amp is Off but Thermal Interlock and VSWR Lockout are OK.
- Not lit when Comms is lost, RF power is low or either Thermal Intk is open or a VSWR Lockout has occurred.

3.3.7 AMP2 Status LED

Status that indicates the condition of RF amplifier #2.

The amplifier(s) report their operating parameters to the central control unit via a RS232 serial stream. The central control monitors this stream and will indicate an error if the amplifier stops communicating. This communications must be operating whether the amplifier RF output is ON or OFF.

If the amplifier is ON, then the output power telemetry cannot fall more than 160 mV under the AGC reference level. That is if the AGC is set for 100% power (voltage of 4.0v), then the COMB LED will be lit only if the output power telemetry is higher than 3.84v (or 92 % power). Note that the output power is proportional to the square of the telemetry voltage. This indicates that the transmitter is outputting a power level that is near to the desired output power level

If the transmitter is OFF, then the VSWR Lock status must be false and Thermal Interlock must be closed for the Amp2 LED to be lit. The Thermal Interlock is monitored instead of the Ext1 of the amplifier since the main control uses the Ext1 interlock to shut off the amplifier power. So if the transmitter is turned off, then the Ext1 interlock of the amplifier would normally become open. This LED status indicates that the amplifier would be ready to produce power if activated.

- Lit when Comms is OK, the Amp is ON and Output Power OK or Amp is Off but Thermal Interlock and VSWR Lockout are OK.

- Not lit when Comms is lost, RF power is low or either Thermal Intk is open or a VSWR Lockout has occurred.

3.3.8 PHASE Status LED

Status that shows if the reject power is sufficiently lower than the combined forward power.

When the transmitter is turned ON, both amplifiers should be generating RF power. The main controller has phasing circuitry that allows these two amplifier outputs to be combined through a 2-way combiner to the RF output. This combining depends on the relative phasing of the two amplifiers and any phase error will result in some of the power of the amplifiers being routed into the reject load of the combiner. A similar but less pronounced effect will occur if the output amplitude of the two amplifiers are different.

The reject load power from the combiner is measured by the main controller and compared to the combined output power. Note that the output power is proportional to the square of the telemetry voltage. The system checks that the reject power telemetry is less than $1/8^{th}$ of the combined forward power telemetry. This would mean that the actual reject power must be $1/64^{th}$ of the combined forward power for the status to be true. This would translate into having reject power lower than about –18db than the forward power.

The forward power must be greater than 10% for this status to be calculated since at low combined forward powers the reject power measures will most often just read zero and be meaningless.

- Lit when forward power is greater than 10% and the reject power is less than 1/64 of forward power
- Not lit when either the forward power is under 10% or reject power is greater than 1/64 of forward power.

3.3.9 SubMenu Select Buttons

The fourth line of the LCD holds select buttons that will control phasing operations.

The phasing system uses a pair of DC voltages applies to phasing circuits associated with each amplifier. Each amplifier has its own phasing circuit and control voltage. Changing the DC voltage on the circuit will increase the phase delay for that particular amplifier.

There are two possible sources of phase adjusting voltages, one is from the potentiometers on the back of the MXi802 chassis and the second is from the CPU D/A outputs. Jumper E5 when installed will force the use of the back panel potentiometers and effectively disable the CPU D/A controls. As mentioned previously, the ‘CTL’ status LED on line 3 of this LCD display will indicate if E5 is removed and the CPU has control of the phasing voltages. When the CPU has control, the operator can use the menu buttons to adjust the phasing. The CPU can also be configured to route the potentiometers to the phasing voltages even if it has control. In most cases the factory will use the rear panel potentiometers and jumper E5 will be installed.

The select buttons with a brief description is given below:

- AUTO = If jumper E5 is removed, this will allow the CPU D/A to control the phasing voltages
- MAN = If jumper E5 is removed, the CPU to route the potentiometers to the phasing voltages
- PhADJ = Non-functional – reserved for future uses.
- PH1+ = Increase the D/A voltage to phaser1 that is associated with Amplifier #1
- PH1- = Decrease the D/A voltage to phaser1 that is associated with Amplifier #1
- PH2+ = Increase the D/A voltage to phaser2 that is associated with Amplifier #2
- PH2- = Decrease the D/A voltage to phaser2 that is associated with Amplifier #2
- OUT = Returns LCD to the COMB submenu LCD Screen.

3.4 AMPLIFIER1 (AMPLIFIER2) SCREEN

The RF Amplifier submenu is entered by pressing the AMP1 (or AMP2) submenu button on the main LCD screen.

This submenu displays all the various power, status and controls for the RF amplifier. Each display item and control is described as to its meaning and function.

The AMP1 and the AMP2 submenus are identical except the first button on line four of the LCD display will denote ‘Amp2 VRST’ when the Amp2 screen is being accessed. Of course when in the Amp2 submenu, the values displayed are those for Amplifier #2.

The LCD displays a typical AMPS submenu as follows:

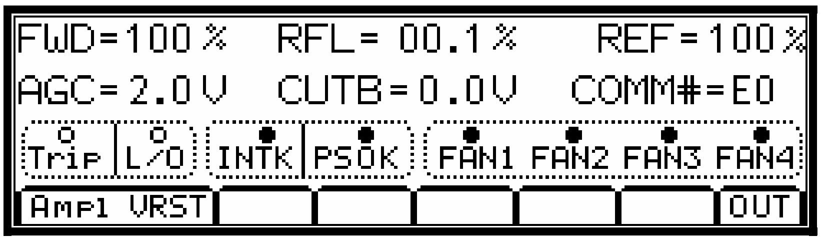


Figure 8 Amp1 Submenu

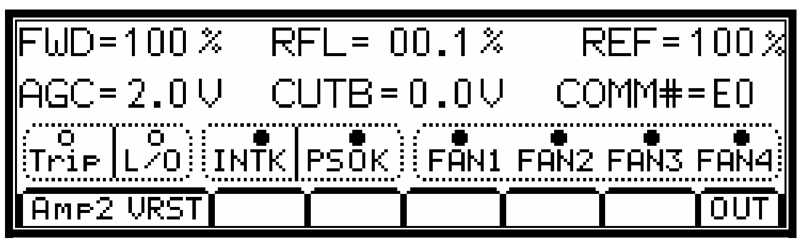


Figure 9 Amp2 Submenu

The first line shows the three possible values. The first item is the forward power denoted as FWD that represents the total output RF power from the amplifier and would be the same value that is displayed on the Main LCD menu. This is represented as a percentage of the full rated output power of the transmitter.

The second item on the first line is the reflected power from the amplifier. This represents the total power that is being reflected back from the RF 2-way combiner back into the amplifier. The maximum amount of power that should be displayed is 10.0%, since the VSWR protection circuit shuts down the amplifier whenever the reflected power exceeds 10.0%. The expected reflected power would normally be under 1.5% and a value higher than this indicates a problem with the RF output system. When the reflected power increases, the amplifier automatically cuts back the forward power. When a value of 1% or higher is shown on the RFL power reading, a FWD power reading of less than 100% would be expected.

The third item on the first line is the AGC reference level. This is the desired power level that the automatic gain control of each amplifier will try to maintain at its output. Note that the main controller does not actually perform the AGC function but sends this AGC reference level to each of the amplifiers via the RS232 communications and the individual amplifiers will then use this level as a reference for their own AGC control circuitry.

The first item of the second line shows the telemetry of the AGC voltage that the MXi controller uses to regulate the power generated by the RF amplifier and maintain it at 100% (or an other operator defined level). The AGC voltage sent to the RF amplifier can range from 0 to 10VDC, however, the A/D converter of the MXi CPU chip can only receive a level of 0 to 5VDC. To satisfy this requirement, the hardware circuitry divides the actual AGC control voltage by two and displays this half value on the LCD.

The second item of the second line shows the telemetry of the Cutback voltage that the MXi controller uses to reduce the power generated by the RF amplifier in the presence of reflected power (VSWR condition). The Cutback voltage sent to the RF amplifier can range from 0 to 10VDC, however, the A/D converter of the MXi CPU chip can only receive a level of 0 to 5VDC. To satisfy this requirement, the hardware circuitry divides the actual Cutback control voltage by two and displays this half value on the LCD.

Note that when Cutback is present, the AGC voltage will have both an AGC component and a CUTBACK component. That is, if the amplifier was set for 100% power and there is no VSWR, the LCD would show something like AGC=0.45V and CUTB=0.01V. When there is a VSWR condition, the LCD would show something like AGC=1.45V and CUTB=1.00V. The AGC voltage displayed is a composite of 0.45 volts of AGC action and 1.0V of cutback action.

The third item of the second line shows serial stream number in hexadecimal that will range from $00 to $FF. Each time the amplifier sends a new serial stream to the main controller, it will increment this number to help the main controller to identify a new set a data from the previous one. In normal operation, this number should be incrementing around once per second. Once the value reaches $FF the next stream will wrap this counter back to $00 again.

The third line of the display has a number of status lights with a legend describing the particular status underneath and all enclosed in a dashed line box. When the light is fully darkened, it indicates that this particular status is true. When the light is hollow, it indicates that this particular status is false. Certain related status are grouped together in the same box. The purpose of these status is to point the operator to the area that is currently causing the RF amplifier to be shut down. Each status is detailed as follows.

3.4.1 TRIP Status LED

VSWR Trip Status

- Lit when the system has seen at least one VSWR trip, can be reset by operator using LCD touchpad.
- Not lit when there have been no VSWR trips since the last time this was cleared.

Note that this does not mean that there is a current VSWR trip but that one did occur.

The operator may have this status as true (with no Lockout status) and still have the RF amplifier active.

3.4.2 L/O Status LED

VSWR Lockout Status

- Lit when the system has seen three VSWR trips in under 1 minute.

When a VSWR trip occurs, the MXi controller will reset the trip automatically and repower the RF amplifier.

If three trips occur within 1 minute, the Lockout status is set and the RF amplifier will remain OFF.

The Lockout status can be reset by the operator pushing the RST button on the LCD touchpad.

- Not lit when there have been no VSWR trips since the last time this was cleared.

3.4.3 INTK Status LED

Interlock inputs that affect the RF amplifier are all closed and OK. The amplifier Ext1 interlock is the last in the chain and will only be closed if all the other previous interlocks are also true (these include Vswr, Thermal, TxSw).

- Lit when transmitter is ON and all interlocks are closed (i.e., OK).
- Not lit when the transmitter is either OFF or one of the interlocks are opened.

If the transmitter has indeed been set to ON and the front panel ON LED is lit, an error is present.

The operator should then check the INTK submenu to determine the source of the problem.

3.4.4 PSOK Status LED

Power Supply OK status, the 50V power supply to the RF amplifier is currently ON and is operating properly.

- Lit when the Power Supply is ON. The P/S voltage, current and status are all OK.
- Not lit when the Power Supply is either OFF or has some operational problems.

If the Power Supply has indeed been set to ON and the front panel ON LED is lit, an error is present.

3.4.5 FAN1 Status LED

Status that shows if FAN1 is currently operational.

When the transmitter is turned ON, all the fans are turned on.

- Lit when fan rotational status is true, this only happens if the fan is actually rotating.
- Not lit when the fan is not rotating; if the other fans are OK, this indicates a failure.

3.4.6 FAN2 Status LED

Status that shows if FAN2 is currently operational.

When the transmitter is turned ON, all the fans are turned on.

- Lit when fan rotational status is true, this only happens if the fan is actually rotating.
- Not lit when the fan is not rotating; if the other fans are OK, this indicates a failure.

3.4.7 FAN3 Status LED

Status that shows if FAN3 is currently operational.

When the transmitter is turned ON, all the fans are turned on.

- Lit when fan rotational status is true, this only happens if the fan is actually rotating.
- Not lit when the fan is not rotating; if the other fans are OK, this indicates a failure.

3.4.8 FAN4 Status LED

Status that shows if FAN4 is currently operational.

When the transmitter is turned ON, all the fans are turned on.

- Lit when fan rotational status is true, this only happens if the fan is actually rotating.
- Not lit when the fan is not rotating; if the other fans are OK, this indicates a failure.

3.4.9 SubMenu Select Buttons

The fourth line of the LCD holds select buttons that will control operations. Note that the Amp1 VRST control button also helps the operator to identify which screen is currently displayed since the AMP1 and AMP2 submenu screens look identical except for this menu button marking.

There are only two active controls on this submenu as described below:

- Amp1 VRST = VSWR Reset Control for Amplifier #1
- OUT = Returns LCD to the main LCD Screen.

3.5 POWER SUPPLY SCREEN

The Power Supply submenu is entered by pressing the P/S submenu button on the main LCD screen.

This submenu displays the status, voltage and current for the two +50V power supplies. The screen is split vertically where the left side show the AMP1 power supply parameters and the right side shows the AMP2 power supply parameters. Only the AMP1 display items and controls are described since the AMP2 values are identical in function.

The LCD displays a typical P/S submenu as shown below.

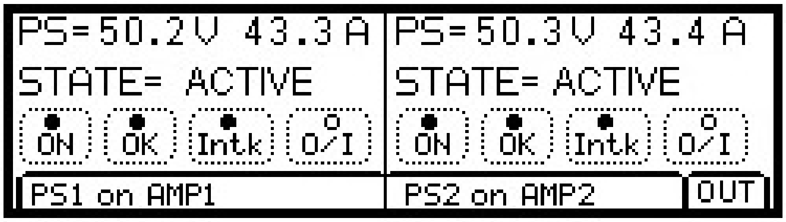


Figure 10 Power Supply Submenu Screen

The first line gives the measured telemetry values for the power supply voltage and current for the +50V power output. The second line gives the power supply state, which can have three possibilities: ACTIVE (operating normally), OFF NORMAL (turned off by operator) or OFF TRIPPED (off due to an error). **Note**: if the power supply is OFF, there will be no voltage or current telemetries.

The third line has four status lights that will tell the operator which element has caused the power supply to shut off.

3.5.1 PS ON Status LED

Power Supply ON Command

- Lit when the Power Supply ON command has been issued by the MXi controller.
- Not lit when the Power Supply has been shut down by the Controller (not due to an error).

3.5.2 OK STAT Status LED

Power Supply OK status, the 50V power supply generates this internal status that all is OK.

- Lit when the Power Supply is ON. The P/S voltage, current and status are all OK.
- Not lit when the Power Supply is either OFF or has some operational problems.

If the Power Supply has indeed been set to ON and the front panel ON LED is lit, then an error is present.

3.5.3 INTK Status LED

Interlock inputs that affect the power supply are all closed and OK.

- Lit when transmitter is ON and all interlocks are closed (i.e., OK).
- Not lit when the transmitter is either OFF or one of the interlocks are opened.

If the transmitter has indeed been set to ON and the front panel ON LED is lit, an error is present.

The operator should then check the INTK submenu to determine the source of the problem.

3.5.4 O/I Status LED

Status that shows if power supply has experienced an overcurrent condition

The power supply has a maximum output current of around 60 Amps and therefore the overcurrent is set for 55 Amps. If the output current reaches this value then the overcurrent status will be activated

- Lit when the power supply had or is currently experiencing an overcurrent
- Not lit when no overcurrent has occurred since the last time it was cleared

3.5.5 SubMenu Select Buttons

The fourth line of the LCD has a label ‘PS1 on AMP1’ and ‘PS2 on AMP2’ that has no control function but is only displayed to indicate which values are associated with PS1 and PS2.

There is only one menu button selection for the Power supply menu and that is the rightmost button labeled OUT which exits this submenu. When the operator is finished in the submenu, an OUT command returns to the Main LCD screen.

- OUT = Returns LCD to the main LCD Screen.

3.6 LOGS SCREEN

The LOGS submenu is entered by pressing the LOGS submenu button on the main LCD screen.

This submenu begins by displaying the first three log entries that are stored in the internal log table. If there are fewer than three entries, only those one or two log entries are displayed. The first three lines of the display are used to display log entries and the last line is used for menu button options. The LCD displays a typical LOGS submenu as follows:

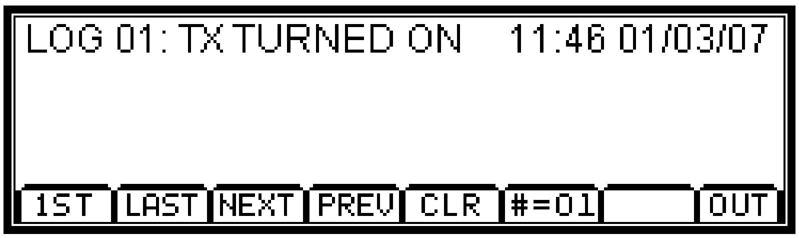


Figure 11 Logs Submenu Screen

The logs are displayed up to three at a time, in the order in which they were detected in the controller. That is, the logs are in chronological order from the time they were received. The seventh menu button on the fourth line of the LCD shows the total number of log entries [our example shows entries #=01].

A maximum of 99 log entries can be held in the log table. If the log table already contains 99 entries and a new log has occurred, the oldest log is discarded and the new log is entered into the table. In this manner the log table will hold the 99 most recent logs.

In the fourth menu button line of the LCD, the first four button selections (from the left side) allow the operator to navigate through the log table when there are more than three logs. If there are three logs or less, all the entries are already displayed on the LCD.

The first menu button is labeled 1^{ST} and causes the display to return to the beginning of the log table and display the first three entries.

The second menu button is labeled LAST and causes the display to jump to the end of the log table and display the last three entries.

The third menu button is labeled NEXT and causes the display to scroll down one log entry. If the LCD was displaying LOGS 2-4, then pressing NEXT displays LOGS 3-5.

The fourth menu button is labeled PREV and causes the display to scroll up one log entry. If the LCD was displaying LOGS 2-4, then pressing PREV displays LOGS 1-3.

The fifth menu button is labeled CLR and causes the log table to be cleared and the LCD will have no logs to display and the count will revert back to zero #=00. As noted previously, the log count is located in the seventh menu button position. Pressing this button does not perform any function.

The eighth menu button is labeled OUT and causes the LCD screen to return to the Main Menu.

3.7 Combined Interlocks Screen

The Combined Interlocks submenu is entered by pressing the INTK submenu button on the main LCD screen.

This submenu displays all the various interlocks for the RF amplifier. Each display item and control is described as to its meaning and function.

The LCD displays a typical INTK submenu as follows:

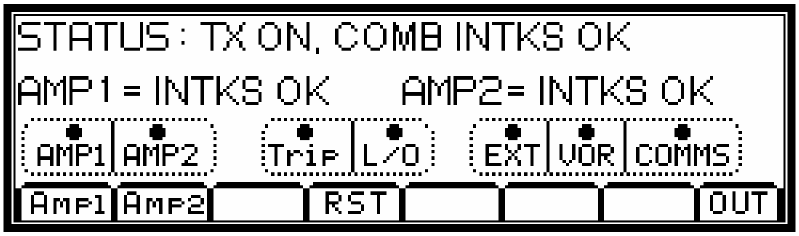


Figure 12 Transmitter On, Interlocks OK Screen

The first line of the LCD shows the transmitter ON/OFF status and the resulting interlock status. If the transmitter has been turned ON and the Interlocks are OK, then the RF amplifier is indeed receiving the +32V power feed. Note that some interlocks will not be closed if the transmitter has been purposely shut down. An example of this would be the AMP1/AMP2 interlock. If the transmitter is shut down, the controller will shut down the fans since they are not needed and the fan interlock status for the amplifier would then normally be OFF. This makes it important to indicate to the operator the intended state of the transmitter as either ON or OFF to correctly interpret the subsequent status.

The second line of the LCD shows the individual Amplifier interlock status. It will display a short message indicating the status of the amplifier interlock or fault. If more information is desired regarding the amplifier interlock then the operator can select the AMP Interlock submenu to access this data.

The third line of the display has a number of status lights with a legend describing the particular status underneath and all enclosed in a dashed line box. When the light is fully darkened, it indicates that this particular status is true and that interlock is closed (OK). When the light is hollow, it indicates that this particular status is false and the interlock is open (BAD). Certain related status are grouped together in the same box. The purpose of these status is to point the operator to the area that is currently causing the RF amplifier to be shut down. Each status is detailed below.

3.7.1 AMP1 Interlock Status LED

The status for the Amp1 interlock is determined from values sent from Amplifier #1 to the main controller via the serial stream. The communications from amplifier #1 must be good for this status to show OK.

- Lit when Amp1 Comms is OK, Amp1 Ext1 and VSWR Interlocks are closed.
- Not lit when either Amp1 Comms is bad, Amp1 Ext1 is open or Amp1 VSWR Interlock is open

3.7.2 AMP2 Interlock Status LED

The status for the Amp2 interlock is determined from values sent from Amplifier #2 to the main controller via the serial stream. The communications from Amplifier #2 must be good for this status to show OK.

- Lit when Amp2 Comms is OK, Amp2 Ext1 and VSWR Interlocks are closed.
- Not lit when either Amp2 Comms is bad, Amp2 Ext1 is open or Amp2 VSWR Interlock is open

3.7.3 TRIP Status LED

VSWR Trip Status

- Lit when there have been no VSWR trips since the last time this was cleared.
- Not lit when the system has seen at least one VSWR trip.

Note that this does not mean that there is a current VSWR trip but that one did occur.

The operator may have this status as true (with no Lockout status) and still have the RF amplifier active.

This can be reset by the operator using the LCD touchpad button RST or by the front panel Reset button.

3.7.4 L/O Status LED

VSWR Lockout Status

- Lit when there is no VSWR Lockout condition.
- Not lit when the system has seen three VSWR trips in under 1 minute.

When a VSWR trip occurs, the MXi controller will reset the trip automatically and repower the RF amp. If three trips occur within 1 minute, the Lockout status is set and the RF amplifier will remain Off. The Lockout status can be reset by the operator pushing the RST button on the LCD touchpad.

3.7.5 EXT1 Interlock Status LED

This is the external #1 interlock that is accessed from the rear panel of the main control chassis. The main controller verifies that this interlock is closed before and transmitter ON command is issued to the individual amplfiers. Often this interlock is used to validate the state of the RF output system or site condition.

- Lit when the external #1 interlock is closed.
- Not lit when the external #1 interlock is open. Either there is a fault or the transmitter has been turned off.

3.7.6 VOR Status LED

Video Operated Relay Control, this is used in some configurations to control the ON/OFF transmitter state.

When enabled or configured, the transmitter will respond to the VOR input by turning ON or OFF.

This function is client specific and would not be enabled in most transmitter configurations.

Most sites can safely ignore this status unless it has been specifically requested by the customer.

- Lit when VOR is present and the transmitter is enabled to be ON.
- Not lit when VOR is off, the transmitter is OFF only if the VOR function is enabled.

3.7.7 COMMS Status LED

Communications to both amplfier #1 and amplifier #2

- Lit when both amplifiers are properly sending their serial data to the main controller
- Not lit when either Amp1 or Amp2 has failed to send valid serial data within 5 seconds.

3.7.8 SubMenu Select Buttons

The fourth line of the LCD has four button selections which are available to the user. Two buttons select the amplifier interlock submenus, one button is for VSWR reset and the last exits this menu.

- AMP1 = Selects the Amplifier1 Interlock Submenu LCD Screen.
- AMP2 = Selects the Amplifier2 Interlock Submenu LCD Screen
- RST = Resets the VSWR trips (on the main controller and both amplifiers).
- OUT = Returns LCD to the main LCD Screen.

3.8 AMP1 (AMP2) INTERLOCK SCREEN

The Amplifier Interlock submenu is entered by pressing the AMP1 (or AMP2) submenu button on the Combined Interlock LCD submenu screen. This is a level 2 submenu which is accessed from a level 1 submenu which in turn is accessed from the level 0 main screen.

This submenu displays all the various interlock conditions for the amplifier. Each display item and control is described as to its meaning and function.

The AMP1 and the AMP2 submenus are identical except the first button on line four of the LCD display will denote ‘Amp2 RST’ when the Amp2 screen is being accessed. Of course when in the Amp2 submenu, the values displayed are those for Amplifier #2.

This submenu displays all the various interlocks for the RF amplifier. Each display item and control is described as to its meaning and function.

The LCD displays a typical INTK submenu as follows:

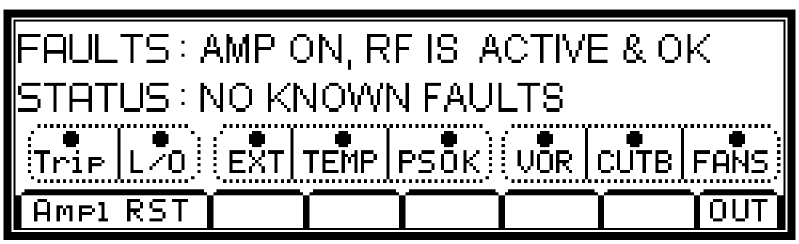


Figure 13 Amp1, Interlocks Screen

The first line gives a status of whether the amplifier is ON or OFF and if any fault conditions exist.

The second line gives a more detailed description of any existing amplifier faults

The third line of the display has a number of status lights with a legend describing the particular status underneath and all enclosed in a dashed line box. When the light is fully darkened, it indicates that this particular status is true and that interlock is closed (OK).

When the light is hollow, it indicates that this particular status is false and the interlock is open (BAD). Certain related status are grouped together in the same box. The purpose of these status is to point the operator to the area that is currently causing the RF amplifier to be shut down. Each status is detailed below.

3.8.1 TRIP Status LED

VSWR Trip Status

- Lit when there have been no VSWR trips since the last time this was cleared.

- Not lit when the system has seen at least one VSWR trip.

Note that this does not mean that there is a current VSWR trip but that one did occur.

The operator may have this status as true (with no Lockout status) and still have the RF amplifier active.

This can be reset by the operator using the LCD touchpad button RST or by the front panel Reset button.

3.8.2 L/O Status LED

VSWR Lockout Status

- Lit when there is no VSWR Lockout condition.
- Not lit when the system has seen three VSWR trips in under 1 minute.

When a VSWR trip occurs, the MXi controller will reset the trip automatically and repower the RF amp.

If three trips occur within 1 minute, the Lockout status is set and the RF amplifier will remain Off.

The Lockout status can be reset by the operator pushing the RST button on the LCD touchpad.

3.8.3 EXT Status LED

This is the external #1 interlock that is accessed from the rear panel of the amplifier chassis. The main controller uses this interlock as an ON/OFF control for the amplifier. When the transmitter has been turned OFF, then this interlock to the amplifier would be open (false).

- Lit when the external #1 interlock is closed.
- Not lit when the external #1 interlock is open. Either there is a fault or the transmitter has been turned off.

3.8.4 Temperature Interlock Status LED

This is the thermal interlock that derived from a thermal switch mounted on the amplifier heatsink. The heatsink thermal is mounted between the RF devices where the temperature should be at its peak value. When the temperature exceeds the rating the thermal opens and shuts down the amplifier. After the amplifier cools down, the thermal will close again and the amplifier will cycle back up again.

- Lit when the thermal interlock is closed.
- Not lit when the thermal interlock is open.

3.8.5 VOR Status LED

This is the VOR interlock (Video Operated Relay) that is not normally implemented for most transmitter models and is a special order. The VOR input uses an external circuit in the modulator to inform the transmitter if video is present. This will cause the transmitter to turn ON when video is present and turn OFF when video is lost.

- Lit when the VOR input is true (video present, active low).
- Not lit when the VOR is false (no video).

3.8.6 PSOK Status LED

Power Supply OK status, the 50V power supply to the RF amplifier is currently ON and is operating properly.

- Lit when the Power Supply is ON. The P/S voltage, current and status are all OK.

- Not lit when the Power Supply is either OFF or has some operational problems.

If the Power Supply has indeed been set to ON and the front panel ON LED is lit, an error is present.

3.8.7 Cutback Status LED

Status that shows if the amplifier is not in cutback mode.

When the amplifier is turned ON, if the reflected power exceeds a specific level (nominally 1% of forward power) then the system will cutback the forward power in order to avoid a VSWR trip and protect the amplifier itself. The cutback voltage will increase as the reflected power increases until a VSWR trip occurs. This status LED shows that the cutback is below 1.2 volts which is a typical value when the reflected power is at about 2%

- Lit when the cutback voltage is under 1.2 volts (reflected power is low)
- Not lit when the cutback voltage is over 1.2 volts (reflected power is high)

3.8.8 FAN2 Status LED

Status that shows if all amplifier fans are currently operational. The MXi amplifier has four cooling fans in the fan assembly. This status does not indicate which fan is faulty but just that one or more of the four fans are not operational. The operator can return to the AMP submenu that is accessed from the COMB submenu to determine which of the four fans is faulty.

When the amplifier is turned ON, all the fans are turned on.

- Lit when all four fan rotational status are true, this only happens if the fan is actually rotating.
- Not lit when one or more of the fans are not rotating or the amplifier has been turned OFF.

3.8.9 SubMenu Select Buttons

The fourth line of the LCD holds select buttons that will control operations. Note that the Amp1 RST control button also helps the operator to identify which screen is currently displayed since the AMP1 and AMP2 submenu screens look identical except for this menu button marking.

There are only two active controls on this submenu as described below:

- Amp1 RST = VSWR Reset Control for Amplifier #1
- OUT = Returns LCD to the Comb Interlock LCD Screen.

3.9 REMOTE CONTROLS AND RS232 SERIAL SCREEN

The Remote Control submenu is entered by pressing the RCtl submenu button on the main LCD screen.

This submenu displays all the various parameters that affect the remote controls and the remote RS232 status communications stream.

The LCD displays a typical RCtl submenu as follows:

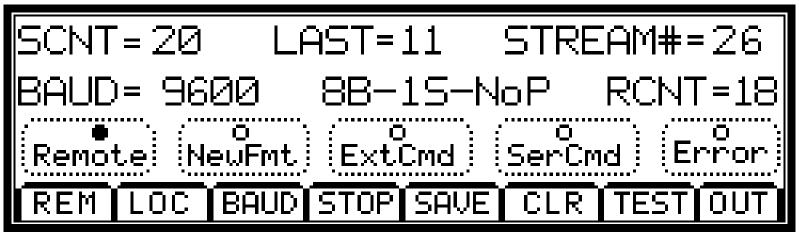


Figure 14 Remote Control Submenu

The first line of the LCD shows three parameters that can assist the operator in checking remote RS232 serial operations.

The first item is the SCNT=20, which is the count of serial remote commands that have been received by the MXi. The value is a hexadecimal count (20 in our example which is 32 decimal) which will increment upon the arrival of a new serial remote command. The source of the serial command is via the RS232 serial program. When the count hits $FF the next command will cause it to roll over to a value of $00.

The second item is the LAST=11, which is the actual hexadecimal value assigned to the remote command that was just received. The operator can use this information to determine what command has been received and determine whether the action has been indeed taken.

The third item is the STREAM#=26, which is the actual hexadecimal count of the number of serial streams sent out the RS232 port. The MXi sends a complete serial stream out the RS232 port about once per second and so this count should increment around once per second. When the count hits $FF, the next command causes it to roll over to a value of $00. The operator can use this information to verify that the MXi is indeed sending serial data and can compare the stream number to that received by the remote computer program.

The second line of the LCD shows three parameters that can assist the operator in checking remote operations and setups.

The first item is the BAUD=9600, which is the serial baud (bits per second) that is currently being used by the MXi to send serial data out the RS232 port. The value can be set by the operator and can range from 300 to 38,400 bits per second. The operator would need to set this baud to match the remote PC and modem setup.

The second item is the 8B-1S-NoP, which is the serial format that is being used for the RS232 stream. This stands for 8 data bits, 1 stop bit and no parity. The operator should set his remote computer to match this serial format setting. The only parameter that can be changed by the user is the number of stop bits. The user can set either 1 or 2 stop bits.

The third item is the RCNT=10, which is the actual hexadecimal count of the last RS232 or external remote commands that were received. Note that this is a count of commands received via the RS232 serial port or commands from the individual J5 remote commands. The operator can uses this information along with the SCNT value from line #1 of the LCD to determine the source of the remote command. If the RCNT increments but the SCNT does not, then the recent remote command came from J5. If both the SCNT and the RCNT increment, then the recent remote command came from the RS232 stream.

The third line of the display has a number of status lights with a legend describing the particular status underneath and all enclosed in a dashed line box. When the light is fully darkened, it indicates that this particular status is true or active. When the light is hollow, it indicates that this particular status is false and inactive. Each status is detailed as follows.

3.9.1 Remote

The operator has the option of allowing remote commands or disabling them. When performing some sort of maintenance or local setups, the operator will usually disable any remote commands until the work on the transmitter is completed. If the operator has elected to disable the remote mode, be careful not to forget to put the transmitter back in Remote mode or else the remote controls will not be operational. The menu button options on the bottom line of the LCD provide the controls to Enable/Disable remote controls.

- Lit when Remote commands are enabled.
- Not lit when Remote commands are disabled.

3.9.2 NewFmt

New Serial Format has been selected but not taken.

The operator has the option of changing the baud rate or number of stop bits for the serial RS232 communications. If a change has been selected, it is not implemented until the operator presses the SAVE menu button on the LCD. This status tells the operator that the recently selected format is different from the one currently being used for the serial stream.

- Lit when there is a pending change in the serial format.
- Not lit when there is no serial format change or the selected format is the same as the current one.

3.9.3 ExtCmd

External Serial Command Received

The external remote control system can assert a command onto the individual remote inputs at J5. The MXi will set the ExtCmd status if a valid command has been received. This is useful in detecting remote commands issued to the MXi from the remote control system. This bit can be cleared by the CLR menu button on the LCD.

- Lit when an external serial command from J6 has been received.
- Not lit when no external serial command from J6 has been received since the last clear.

3.9.4 SerCmd

RS232 Serial Command Received

The external computer will send a four-byte serial stream of a specific format to ask for a certain action to be taken. The MXi will set the SerCmd status if a valid command has been received. This is useful in detecting serial transmissions between the external computer and the MXi. This bit can be cleared by the CLR menu button on the LCD.

- Lit when a RS232 serial command from the computer has been received.
- Not lit when no RS232 serial command from the computer has been received since the last clear.

3.9.5 Error

Serial Input Stream Error

The external computer will send a four-byte serial stream of a specific format to ask for a certain action to be taken. The MXi monitors the format of this four-byte serial stream and sets the Error status if the stream has the wrong format. This is useful in determining if there is a serial transmission problem between the external computer and the MXi. This bit can be cleared by the CLR menu button on the LCD.

- Lit when an error was detected in the RS232 command stream since the last clear.
- Not lit when no error has been detected in the RS232 command stream since the last clear.

3.9.6 SubMenu Select Buttons

The bottom line represents the menu selection buttons with a possible option of eight different selections. The operator just needs to press the touchpad (lightly) either on or just above the desired menu select button.

The first two buttons from the left control the Remote mode of the MXi transmitter. The operator has the option of allowing remote commands or disabling them. When performing some sort of maintenance or local setups, the operator will usually disable any remote commands until the work on the transmitter is completed. If the operator has elected to disable the Remote mode, be careful not to forget to put the transmitter back in Remote mode or else the remote controls will not be operational. The first menu button Remote enables the remote commands and the second button Local disables the remote commands. The status light labeled Remote on the third line of the LCD indicates the current state of the transmitter.

- Remote = Enable Remote Operation for the MXi
- Local = Disable Remote Operations for the MXi

The BAUD button on the bottom of the LCD touchpad causes the baud to increment from the current displayed baud up to the next higher one. At the same time, the NewFmt light on the third line lights to indicate that a new serial format (Baud or Stop bits or both) is pending but not taken. Successive pushes of the BAUD button cause the baud to increment until it reaches the maximum of 19,200 baud, after which it will roll back to 300 baud, which is the lowest rate. Note that when setting the baud, if the NewFmt light is on, the rate displayed on the screen is the new baud that is not yet programmed. The MXi will still operate at the original Baud rate until the new one is saved.

If the user presses the STOP menu button, then the number of stop bits in the serial format will toggle between 1 and 2. The new desired number of stop bits will be displayed in the second line of the LCD within the 8B-1S-NoP section where the stop bits will be either 1S or 2S in this string. At the same time, the NewFmt light on the third line will light to indicate that a new serial format (Baud or Stop bits or both) is pending but not taken.

Once the operator is satisfied with the new baud and Stop bits, pressing the SAVE button causes the MXi to implement the new serial format. Pressing the CLR button abandons all selections and revert to the previous baud and Stop bits without any action being taken.

The CLR button will also clear the SCNT value on the first line, the RCNT value on the second line along with the ExtCmd, SerCmd and Error status lights on the third line.

- BAUD = Increment the target baud rate for RS232 communications
- STOP = Toggle between one or two Stop bits
- SAVE = Save the new Serial format values (Baud & Stop)
- CLR = Restore previous Serial format values (abort changes) and clear Remote command counters
- TEST = Unimplemented, this button has no function
- OUT = Returns LCD to the main LCD Screen.

3.10 General Screen

The General submenu is entered by pressing the GEN submenu button on the main LCD screen.

This submenu displays all the configuration and setup information of the particular model of MXi transmitter. The first line displays the transmitter type, the second line displays the software code and revision, the third line displays the LARCAN ID number that is used in the factory to determine options, date the boards were made and other information. This information is not really important for day to day operations but can be useful when dealing with LARCAN service in verifying the transmitter configuration.

The bottom line represents the menu selection buttons with a possible option of eight different selections. The operator just needs to press the touchpad (lightly) either on or just above the desired menu select button.

The first two buttons from the left control allow access to two level 2 submenus. One is for setting up the real time clock and the second is for internet setup. Note that the internet is a purchased option and may not be functional on a given transmitter configuration.

- RTC = Go to the Real Time Clock Submenu
- INET = Go to the Internet Setup Submenu
- OUT = Returns LCD to the main LCD Screen.

3.10.1 Real Time Clock Submenu

The Real Time Clock submenu is entered by pressing the RTC submenu button on the SYS submenu LCD screen.

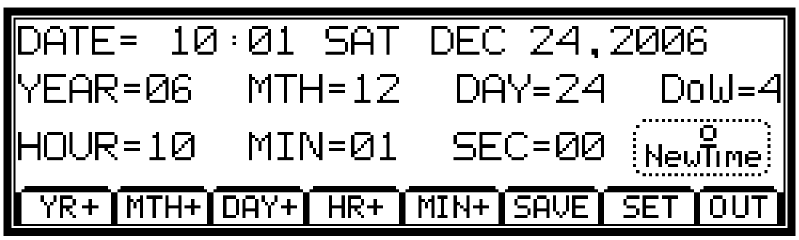


Figure 15 Real Time Clock Submenu Screen

This submenu displays the current time and date in the real time clock chip and allows the operator to reset the time and date.

The first line displays the current time and date as known by the real time clock. The time/date will be used for any logs that the system records.

The second and third lines have target date and time values used by the operator when resetting the current time or date. The operator can use the control buttons on line four of this LCD to increment the various time/date elements. The DoW (Day of Week) is not changed by the operator but the system calculates this value from the other time & date parameters.

The status LED ‘NewTime’ on the third line of the LCD will be lit when there is a new value set by the operator in any of the time or data values on lines two or three.

3.10.2 SubMenu Select Buttons

The bottom line represents the menu selection buttons with a possible option of eight different selections. The operator just needs to press the touchpad (lightly) either on or just above the desired menu select button.

The first five buttons from the left allow the operator to set a new time or date for the system. The user can set the Year, Month and Day of the date portion. The system will automatically adjust the DoW (day of week) depending on the date set. The operator can set the Hour and Minute of the time but seconds will be set to zero so if a person wants to calibrate to the second then if the current time is 11:40.22 then set the time for 11:41.00 and press SAVE when the reference time hits 11:41.00

Once a value is changed, the 'NewTime' status LED will be lit showing a new time/date has been entered. This LED will extinguish when the operator either saves the new time, resets the values or exits this submenu.

If a person makes an error setting the values (like incrementing the year too many times), the SET button will reset the default values again.

- YR+ = Increment the year. The maximum value is 49 after which it wraps back to 06.
- MTH+ = Increment the month. After a value of 12, the value will wrap back to 01
- DAY+ = Increment the day. Maximum value is the number of days in current month (accounts leap years)
- HR+ = Increment the hour. This is a 24 hour format and the value can range from 00 to 23
- MIN+ = Increment the minute. This can range from 00 to 59, after a value of 59 it wraps back to zero
- SAV = Save the new time values into the Real Time Clock
- SET = Reset the time and date values back to their defaults.
- OUT = Returns LCD to the System Submenu LCD Screen.

3.11 INTERNET SETUP SCREEN

The Internet Setup submenu is entered by pressing the INET submenu button on the System submenu screen.

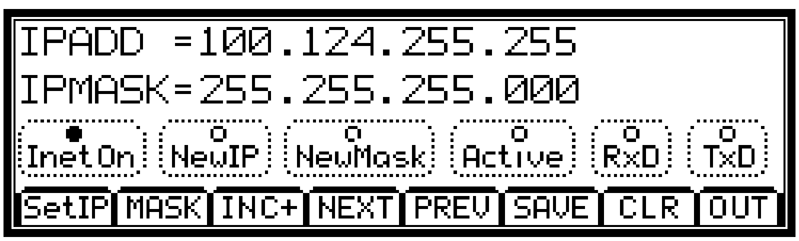


Figure 16 Internet SetUp Submenu Screen

This submenu displays all the configuration and setup information for the internet option. Note that this is a purchased option that must be specified at the time of order. This function will not work unless specifically enabled and configured at the factory.

The internet functionality is beyond the scope of this manual and so only a brief description will be given here. When the option is purchased a separate publication will be supplied.

The first line shows the current IP address that the MXi will respond to. This value must be obtained from the customers IT personnel or network provider. LARCAN cannot provide this since it is customer network dependant.

The second line show the IP Mask value that restricts the range of IP addresses that the MXi unit will respond to. This can be used to restrict access to a certain IP address or groups of IP addresses. Again, consult your local IT person for this value.

The third line has a number of status LEDs that indicate the various possible conditions of the internet operation. These are defined as follows

- Inet On = Internet interface is active and will respond to external requests [factory setting]
- NewIP = Operator has changed (but not yet saved) and new IP address
- NewMask = Operator has changed (but not yet saved) and new IP Mask address
- Active = The internet is currently receiving or transmitting data
- RxD = Data is being received
- TxD = Data is being transmitted

3.11.1 SubMenu Select Buttons

The bottom line represents the menu selection buttons with a possible option of eight different selections. The operator just needs to press the touchpad (lightly) either on or just above the desired menu select button.

The first seven buttons are involved in setting the Internet address and Mask Addresses. Each of these addresses are divided into four sections of three digits each. The operator can increment each of these three digit numbers separately and then move on to the next set if required. Once completed the new values can be saved.

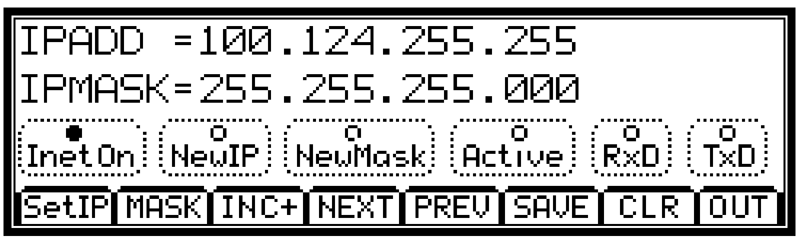


Figure 17 Internet SetUp Submenu Screen

- SetIP = Set a new IP address, Moves cursor to the first 3 digit number (100 in this case)
- Mask = Set a new IP Mask address, Moves cursor to the first 3 digit number (255 in this case)
- INC+ = Increment the current IP or IP Mask number, If current number is 100 then go to 101
- NEXT = Move to the next 3 digit IP number, If at the last digits then nothing is done
- PREV= Move to the previous 3 digit IP number, If at the first digits then nothing is done
- SAVE = Save the new IP or IP MASK address
- CLR = Restore the default IP addresses and discard any changes made
- OUT = Returns LCD to the System Submenu LCD Screen.

4 SETUP PROCEDURES

The following sections detail the various set up procedures for the MXi transmitter system. These procedures should only be done by qualified personnel. If the calibrations and setups are done improperly, it can result in the transmitter being prone to damage.

The transmitter is normally set up in the factory for the particular operating power required when first installed. Set up procedures would only be required if certain elements of the MXi transmitter had to be replaced or repaired that would have affected the calibrations. An example of this would be the MXi controller board itself, the output RF couplers, the RF cables or the 50V power supply.

If the output power is being changed, then some setup and calibration would be needed since the transmitter would be set up for the previous RF power level. **Caution:** do not increase the power output of the MXi transmitter beyond the original factory set level without first consulting LARCAN field service.

4.1 RF SIGNAL LEVELS

The RF detectors and signal levels are normally calibrated at the factory or by LARCAN field personnel and should not require onsite re-adjustments except in the following circumstances.

- The desired output power level of the transmitter is to be changed from the factory setting for a full 100% power reading. Note that the operator should not just increase and readjust power beyond the recommended rating of the transmitter without prior approval from LARCAN technical services.
- A replacement MXi control board or output coupler has been installed in the transmitter.

This procedure assumes that the RF signal level is being set-up with the transmitter connected to an RF modulator input and output load (or antenna) that is the actual configuration it is intended to operate with.

4.1.1 Test Equipment Required

a) An RF power meter such as the HP 436A or similar. For analog transmitters, a BIRD through-line wattmeter is sufficient.

b) An adjustable DC power supply with a range of 0 to +10 volts.

c) A Spectrum Analyzer, HP 8558B or similar (optional).

If the operator wishes to set up the unit on the bench, then a number of extra pieces of test equipment are necessary.

- An RF generator/modulator that will replicate the desired signal and level
- An analog transmitter would need a video generator such as Tektronix 1900 or similar
- A modulator such as LARCAN TTC (Catel X - ATM -1600 - 6 - 01/01) or similar.
- An upconverter such as Philips PM 5690 or similar (or one supplied with transmitter)
- A digital transmitter would need the Pulse Modulator
- RF Load rated at the transmitter power and associated cable

4.1.2 Verify Output Power Level

1. Attach the RF output power measuring device (Wattmeter or Average Power Meter) to the RF output.
2. Turn down the drive level of the modulator/upconverter before applying the RF input signal.

3. Turn up the drive level until the output power measures the desired reading. Do not use the meter of the transmitter itself to determine output power, since at this point it may be uncalibrated. Also check the reject power voltage at R68. This voltage should be less than .50 volts which represents a reject power of around 6%. If the reject power is higher than this then it will not be advisable to attempt to get 100% output power since too much power is being dumped into the reject load. If this is the case then proceed to step 4.2 and phase the two amplifiers to minimize reject power.
4. When increasing the power, it is always instructive to measure the current on the 50VDC supplies in case there is a problem with how the output power meter is connected or working. If the supply current is increasing but the output power is not, set the drive to a sufficiently lower level and double check your setup.

4.1.3 Calibrate Forward Power Level

1. When the RF output power is at the desired level, do the following checks:
    a) For the forward power sample, the voltage at R52 should be at least 4.5v with 8.0VDC as a maximum
    b) If not, then you have either too much power or too high a coupling in the directional coupler.
2. Reverify the output power and insure that it is indeed correct. It is extremely important that you have the power level measured correctly since the transmitter will be set to show this as 100% output
3. Adjust potentiometer R54 until the voltage at TP5 is about 4.0VDC.
4. At this point, the meter on the transmitter should read 100%. If it is slightly above or below 100% (no more than a few percent) then tweak pot R54 until it reads 100 %.

4.1.4 Calibrate Reject Power Level

1. Insure that the RF output power is at the 100% level.

   The operator can use a spectrum analyzer to measure the forward monitor test point and record its' level for 100% power. This is optional.
2. Shut down one of the Amplifiers. This can be done by disconnecting one of the Ext1 interlock wires on the rear of the Amplifier chassis.
3. Verify the voltage at TP5 is about 2.0VDC and forward power is around 25% (this can vary by a few percent).

   The operator can also use a spectrum analyzer to measure the forward monitor test point, it should be –6db down from its full power level.
4. The voltage at R68 should be above 2.25 volts with a maximum of 4.0 volts. This represents the Reject power level as measured by the 2 way output combiner.

   Adjust Pot R72 until the voltage at TP7 measures about 2.0 volts, the front panel LCD should show a Reject power level of around 25%
5. Restore the interlock on the Amplifier and return the transmitter to full power. At this point verify that the Forward power is now 100% and the reject power is zero. If the reject power is greater than zero then the amplifiers need to be phased.

4.1.5 Calibrate Reflected Power Level

1. The reflected power is a special case and needs to be calibrated by feeding a known voltage to the MXi control board reflected power DC sample input. This is due to the fact that it is difficult to set up an actual VSWR condition that is both accurate and safe for the amplifier in the manner that it is done at the factory.
2. To calibrate the reflected power, install jumper E3 that prevents any VSWR trips.
3. With the transmitter at full power, record the voltage at R52. This represents the full power forward signal as measured by the combiner.
4. Shut down the transmitter and disconnect the 9 pin cable from J10 of the control board. This will allow an injection of an external reflected power DC sample into J10.
5. Set the DC power supply to 0 volts and then attach the positive lead to J10 pin 2 with either a clip lead or special D connector with a single wire on pin 2. Connect the negative of the power supply to the MXi Power Supply Chassis or if using a special D connector on J10 then apply the negative to pin 4.
6. Adjust the power supply to a voltage that is .316 times the measure forward voltage at R52. That is, if the voltage at R52 was 5.0 volts for full power then the power supply should be set for 1.58 volts. This is due to the fact that the maximum reflected power allowed is –10db of the full forward power level or 10%. The voltage that represents this is of course the square root of .10 which is .316
7. Verify that the power supply voltage appears at resistor R60 and then adjust potentiometer R62 until the voltage at TP6 is 4.0VDC. The front panel LCD should read a reflected power of about 10 %.
8. Remove the power supply and reattach the combiner cable to J10. Turn the transmitter ON again and verify that the forward power is still 100%, the reflected power should be under 2.0% (depending on your output system) and the reject power should be near zero.

Note: Make sure that you remove jumper E3 when done, else you will have no VSWR protection!

4.2 TRANSMITTER PHASING

When the transmitter is operating and power is being dumped into the reject load, then the two amplifiers need to be phased so that their outputs add constructively into the combined output of the two way combiner.

Amplifier phasing is accomplished by adjusting the two phasing pots on the rear panel of the MXi control chassis.

Set the front panel LCD into the Phasing Submenu. From the Main Screen, press the COMB button and then from the COMB screen press the PHI button. This will bring you into the phasing screen as shown below.

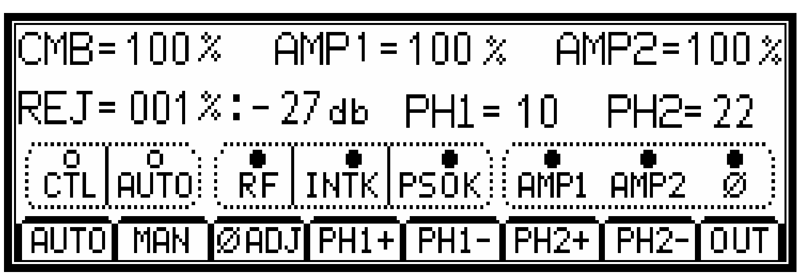


Figure 18 Phasing Screen

Make sure that jumper E5 is installed which forces the system to use the two rear panel potentiometers for phasing. Factory default has jumper E5 installed. The ‘CTL’ status LED of the above phasing LCD screen will be hollow (not lit) when jumper E5 is installed so you need not open the box to check for this.

Increase the power slowly and watch the AMP1 and AMP2 powers rise and check the CMB power and REJ power levels. Once Reject reaches over 5% or either AMP reaches 100% then stop increasing the power and proceed to phasing. Both Amps should have similar output power levels (one should not be more than 10% higher or lower then the other).

Adjust rear panel pots R84 and R96 until the reject power is minimized. The LCD provides Reject power in percent and in –db down from maximum forward power.

The percentage power will indicate a value greater than zero whenever the reject power is over –22db. Once below this level the operator can fine tune the phasing by watching the –db indicator. A level of –30db or better is considered sufficient and a minimum of –26 db would be expected.

Once phased, continue to increase the power until the COMB level is at 100% or until one of the AMPS is over 105 %. If the reject power increases then repeat the phasing process to minimize it again.

Note if one or both AMP powers are over 105% but the COMB power is not near 100% yet then you may need to recheck your power calibrations.

If the reject power will not minimize, there could be an RF cable problem between the two Amplifiers and the main Controller (make sure you didn't swap the AMP1 and AMP2 RF cables as this will definitely affect your phasing).

4.3 VSWR PROTECTION

The VSWR protection does not really need any setup or calibration since it is fixed to trip when the reflected power is –10dB of the forward power level. The important elements are to have the forward and reflected powers calibrated properly.

4.4 REMOTE CONTROL INTERFACE BAUD

Note that unless the optional serial RS232 remote interface option was purchased, there is no reason to change the Baud Rate since this function is not operational. Also if the Internet interface was purchased, then this baud rate change will have not effect.

The Remote Control submenu is entered by pressing the RCtl submenu button on the main LCD screen.

This submenu will display all the various parameters that affect the remote controls and the remote RS232 status communications stream. It will allow the operator to set the baud that is used to communicate with an external computer. The other parameter that can be adjusted is the number of stop bits.

The LCD displays a typical RCtl submenu as follows:

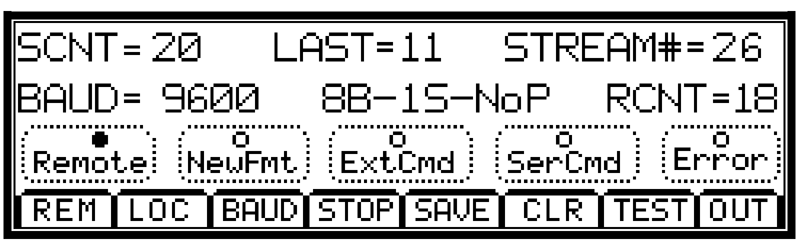


Figure 19 Remote Control Submenu Screen

The BAUD button on the bottom of the LCD touchpad will cause the baud to increment from the current displayed baud up to the next higher one. At the same time, the NewFmt light on the third line lights to indicate that a new serial format (Baud or Stop bits or both) is pending but not taken. Successive pushes of the BAUD button will cause the baud to increment until it reaches the maximum of 19,200 baud, after which it will roll back to 300 baud, which is the lowest rate. Note that when setting the baud, if the NewFmt light is on, the rate displayed on the screen is the new baud that is not yet programmed. **Note**: The MXi will still operate at the original baud until the new one is saved.

If the user presses the STOP menu button, then the number of stop bits in the serial format will toggle between 1and 2. The new desired number of stop bits will be displayed in the second line of the LCD within the 8B-1S-NoP section where the stop bits will be either 1S or 2S in this string. At the same time, the NewFmt light on the third line lights to indicate that a new serial format (Baud or Stop bits or both) is pending but not taken.

Once the operator is satisfied with the new Baud and Stop bits, pressing the SAVE button causes the MXi to implement the new serial format. Pressing the CLR button abandons all selections and revert to the previous Baud and Stop bits without any action taken.

4.5 POWER SUPPLY VOLTAGE AND CURRENT CALIBRATION

To set up the power supply voltage and current readings, the operator must enter the Main Power screen on the LCD. The Main Power screen is the top level menu and is the one with the power bargraph.

The power supply voltage and current is measured for both +50V power supplies by this main Controller board but each Amplifier control board also measures its own power supply voltage and current as well. Thus, each power supply is monitored by two separate boards. Each of these performs a different function regarding the transmitter.

The amplifier control board (31C1897) located in the amplifier chassis provides its power supply voltage and current information in its' serial stream. This is the data displayed on the P/S submenu of the LCD display. The voltage and current readings on the display is actually what the amplifier is measuring not the Main Controller.

The Main Controller (31C1936) measures both supplies as a safety backup. It uses the voltage and current information to update some of the LCD status and to generate a P/S OverCurrent trip and Log. The main Controller checks to verify that both power supply voltages are above the minimum value of 27.5 volts and the power supply current does not exceed 60 Amps. If both of these conditions are true then the LCD status of P/S or PSOK on the 'Main Power', 'COMB' and 'PHASING' LCD submenus will be true. All other power supply status on the rest of the LCD screens are derived from the amplifier serial stream data.

The following submenu gives a 'P/S' status on the third line of the LCD that is controlled by the voltage and current for both of the 50V power supplies. Each display item and control is described as to its meaning and function.

The LCD displays the main Power menu when both power supplies are OK:

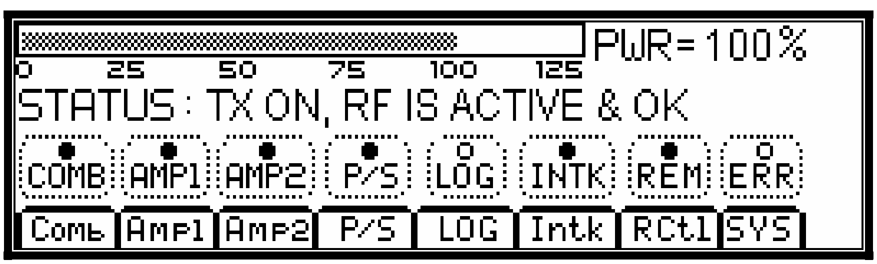


Figure 20 Main Power Screen

Selecting the 'P/S' menu entry on the main Power screen will cause the LCD to display the Power Supply submenu. The display shows the voltage, current and status for both power supplies:

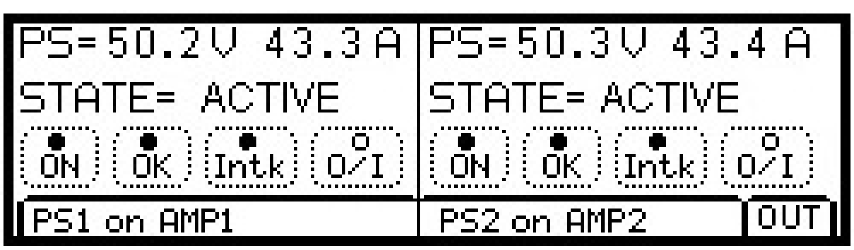


Figure 21 Power Supply Screen

31C1936 CONTROLLER BOARD

1. To set up the voltage reading, turn on the transmitter and verify that both power supplies are indeed running.

2. With a voltmeter, measure the actual voltage from the power supply for Amp1. Looking from the front of the MXI, the AMP1 power supply is located on the right side of the chassis. The power supply voltage can be measure directly on the power supply lugs or at R22 of the control board.

   Adjust potentiometer R23 until the voltage provided at TP1 measure about 1/10 of the actual voltage. That is, if the power supply voltage is 50 volts then the voltage at TP1 should be 5.0 volts.

3. With a voltmeter, measure the actual voltage from the power supply for Amp2. Looking from the front of the MXi, the AMP2 power supply is located on the left side of the chassis. The power supply voltage can be measure directly on the power supply lugs or at R28 of the MXi802 board.

   Adjust potentiometer R29 until the voltage provided at TP2 measure about 1/10 of the actual voltage. That is, if the power supply voltage is 50 volts then the voltage at TP2 should be 5.0 volts.

4. To set up the current reading, the power supply should be ON as in the above paragraph and enough RF drive (at least 50%) should be applied to get a reasonable current level for calibration.

5. Use a clamp-on current Ampmeter to measure the current draw from the Amp1 50V power supply. There are typically four wires used to connect the power supply to the RF amplifier, two are for ground and two are for the +50V. Insure that both of the +50 volts wires are included in the clamp-on meter. However, make sure that none of the ground wires are included (only the +50V wires) or else the reading will be too low.

6. If the MXi is configured as an Analog NTSC transmitter, then the current sensing must be set to Peak Sync which is accomplished by setting both E6 and E7 in the 'Pk I' position. For all other modulation types, jumpers E6 and E7 should be in the average 'Ave' position.

7. Verify the current for Amp1 power supply with the clamp-on Ampmeter. The voltage expected at the test point would be the measure current (in Amps) times .07. In this manner a measured current of 40 Amps would expect a test point voltage of .7 x 40 Amps = 2.8 volts. Adjust pot R33 so that the current telemetry output at test point TP3 equals the calculated voltage.

8. Verify the current for Amp2 power supply with the clamp-on Ampmeter. The voltage expected at the test point would be the measure current (in Amps) times .07. In this manner a measured current of 40 Amps would expect a test point voltage of .7 x 40 Amps = 2.8 volts. Adjust pot R37 so that the current telemetry output at test point TP4 equals the calculated voltage.

5 REMOTE CONTROL CONNECTIONS MXI TRANSMITTER

On the rear of the main Controller Chassis, the remote control connections are available on a 15-pin male D-shell connector J5 of pc board 31C1936. This includes all of the remote controls, status and telemetries available to the operator for combined operations. The signal designations for each pin of J5 can be viewed on sheet 5 of the schematic in Figure 29.

Each individual amplifier also provides a 15 pin D-connector on the rear of the chassis that provides remote control/status/telemetry that particular amplifier itself. These remote signals are routed from the MXi Control board via a 15-wire ribbon cable from connector J6 of the MXi Control board. In this publication, the individual amplifier remote signals will be listed but not described in detail since this information is already included in the Amplifier Control Board publication

It is not recommended to use the remote controls of the individual amplifiers themselves since the combined version of these controls are provided on the main controller and the amplifier AGC raise/lower controls will not operate since the main controller overrides this function. Also the ‘Remote’ status of the individual amplifiers will not be valid since this function is now handled by the main controller itself.

However, the balance of remote telemetry and status signals of the individual amplifiers should be always available for the operator to connect to their remote control system if desired.

5.1 COMBINED REMOTE CONTROLS

The Transmitter MODE must be in REMOTE for any of these remote controls to be operational. The transmitter is placed in the REMOTE mode via the touch LCD menu options as described in Section 3. The main LCD screen has a status light to show if the REMOTE MODE is active.

To place the transmitter into REMOTE MODE, the operator must enter the REMCTL submenu on the LCD and enable the REMOTE MODE.

This controller has the option of allowing manual ON control whereby the front panel ON switch directly controls the ON/OFF relay K2. This function is enabled by installing jumper E4. If E4 is installed, then the front panel ON switch must be placed in the OFF (extended) position to allow remote ON/OFF controls. The reason for this is that, when the system is in manual forced ON mode then there is no way for the microprocessor to shut off K2 since it is being manually held on by the front panel switch. If E4 is not installed, then the ON/OFF remote controls will operate normally.

The MXi provides 5 remote control inputs that effectively replicates its own front panel and LCD mode control buttons. These five controls consist of ‘Tx ON’, ‘Tx OFF’, ‘Reset’, ‘Agc Raise’ and ‘Agc Lower’.

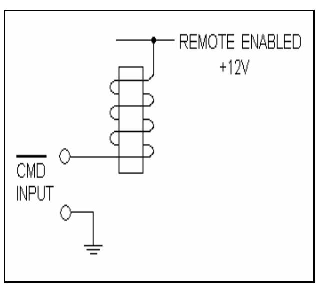


Figure 22 Remote Controls Circuit

The combined remote controls are active low, opto-isolated inputs configured as shown, all of which require a GROUND for assertion and the activator to be able to sink 15mA or more for at least 200 milliseconds to accomplish reliable keying. Each of these is current-limited by an individual resistor.

31C1936 CONTROLLER BOARD

TX D-Connector (J5)	Designation	Description
Pin 4	RC_TX_On	Turns Transmitter ON
Pin 5	RC_TX_Off	Turns Transmitter OFF
Pin 6	RC_Reset	Resets VSWR Trips
Pin 7	RC_AGC+	AGC (Power) Raise
Pin 8	RC_AGC-	AGC (Power) Lower
Pin 15	Ground	Ground Reference

5.1.1 RC_TX_On Remote Transmitter ON Control

The MXi controller has the facility to force the ON/OFF function to follow the front panel ON button. Jumper E4 is a two-position jumper that can be installed to enable this function. When E4 is installed and the front panel button is in the ON position, this will force the transmitter to the ON state regardless of the remote or CPU controls. If the front panel button is in the OFF position with E4 installed, then the remote ON command will function normally. When jumper E4 is not installed, then the remote ON command will function normally as well.

An active low signal applied to the RC_TX_On command input causes the CPU to read this active state and if the transmitter is in REMOTE mode, then the CPU will issue an ON command to the ON/OFF relay K2.

Note that this changes the transmitter’s state to ON (when in REMOTE) such that after any subsequent power outage, the MXi transmitter will return to its previous state.

If the operator changes the transmitter’s MODE from REMOTE to LOCAL, the ON/OFF state of the transmitter will be controlled by the position of the front panel ON/OFF button.

If the operator changes the transmitter’s MODE from LOCAL to REMOTE, the ON/OFF state of the transmitter will revert to the previous state when REMOTE MODE was active.

5.1.2 RC_TX_Off Remote Transmitter OFF Control

The following description assumes that jumper E4 is either not installed or if installed the front panel ON switch is in the OFF position allowing the remote ON and OFF commands to operate normally.

An active low signal applied to the RC_TX_Off command input causes the CPU to read this active state and if the transmitter is in REMOTE mode, the CPU removes the ON command from the ON relay K2.

Note that this changes the transmitters’ state to OFF (when in REMOTE) such that after any subsequent power outage, the MXi transmitter will return to its previous state.

If the operator changes the transmitter’s MODE from REMOTE to LOCAL, the ON/OFF state of the transmitter will be controlled by the position of the front panel ON/OFF button.

If the operator changes the transmitter’s MODE from LOCAL to REMOTE, the ON/OFF state of the transmitter will revert to the previous state when REMOTE MODE was active.

5.1.3 RC_RESET Remote RESET Control

The remote reset command can have two different possible operations depending on whether jumper E2 is installed or not. The purpose of this command is primarily to reset the VSWR trip relay and attempt to place the transmitter back on the air. Of course, it is assumed that the operator has removed the cause of the VSWR condition (like an iced up antenna) or else the trip will just re-occur.

If jumper E2 is removed (this is the normal mode), the reset command is fed only to the CPU chip, which then issues a VSWR reset command to relay K1, only if the MXi system is in Remote Mode.

If jumper E2 is installed, the external remote reset command is manually routed to the VSWR relay reset coil and effectively bypasses the CPU chip. In this configuration, a remote reset command clears the VSWR relay and does not depend on the MXi being in Remote Mode.

The CPU maintains a record status of a past or current VSWR trip that has not been acknowledged by the operator. The purpose of this status is to record that a VSWR trip had occurred even though the VSWR condition has cleared itself and the transmitter has automatically restored power. When either a remote or front panel reset command is issued, the CPU reads this command and clears its VSWR tripped status as well.

5.1.4 RC_AGC+ Remote AGC Raise Control

The main controller does not directly control the AGC itself but just maintains a desired AGC reference power. It then sends a command to each amplifier instructing them to set their AGC level to this new value. The main controller monitors the serial stream output of each amplifier to compare the amplifier AGC reference to its own. If these values are different then the main controller will resend the AGC set command to the amplifier(s).

Note that the AGC control depends on attenuating the RF amplifier. For AGC to be fully operational, there must be more than enough input RF level to the amplifier so that the control can attenuate the input RF and thus control the power level.

The MXi amplifier unit uses an onboard DAC (D/A Converter) to provide a reference level of where the operator wishes the output power to be set to. It will compare the actual detected power level to this reference level and then generate an attenuation signal to the RF front end amplifier to achieve this desired power level.

The AGC+ raise control will increase the reference level of the main controller in steps of around 1-2 %. It is recommended that the customers remote control system apply a 100 ms pulse to this command input to cause a one step increase in the AGC reference level. The manufacturer does not recommend the AGC be raised above 110% of rated power and in fact the control will ignore AGC raise commands when the reference level is set to high in order to protect the amplifier.

When raising the AGC, the operator should check that the actual power level is increasing and not just the reference level. This can be immediately seen by viewing the overall transmitter power level or by locally viewing the LCD display. If the amplifier stops responding to AGC raise commands then it is most likely that either one or both amplifiers have hit the upper limit of RF drive input. If the operator has connected each amplifiers AGC telemetry level to the remote system, then the AGC voltage (amount that the RF input is attenuated) can be viewed. Once this voltage reaches zero, then there is no more RF input drive available.

Note if you have run out of RF Drive and have continued to increase the AGC, then it is recommended to reduce the AGC until the transmitter begins to come back into AGC control range.

Note that this changes the transmitter’s AGC reference (when in REMOTE) such that after any subsequent power outage, the MXi transmitter returns to its previous state.

5.1.5 RC_AGC- Remote AGC Lower Control

The main controller does not directly control the AGC itself but just maintains a desired AGC reference power. It then sends a command to each amplifier instructing them to set their AGC level to this new value. The main controller monitors the serial stream output of each amplifier to compare the amplifier AGC reference to its own. If these values are different then the main controller will resend the AGC set command to the amplifier(s).

Note that the AGC control depends on attenuating the RF amplifier. For AGC to be fully operational, there must be more than enough input RF level to the amplifier so that the control can attenuate the input RF and thus control the power level.

The MXi amplifier unit uses an onboard DAC (D/A Converter) to provide a reference level of where the operator wishes the output power to be set to. It will compare the actual detected power level to this reference level and then generate an attenuation signal to the RF front end amplifier to achieve this desired power level.

The AGC- lower control will decrease the reference level of the main controller in steps of around 1-2 %. It is recommended that the customers remote control system apply a 100 ms pulse to this command input to cause a one step decrease in the AGC reference level. The lower limit of the AGC range is usually around 25%, meaning that though the operator can reduce the AGC reference all the way to zero, the attenuator in the MXi Amplifier can only reduce the power down to around 25%.

When lowering the AGC, the operator should check that the actual power level is decreasing and not just the reference level. This can be immediately seen by viewing the overall transmitter power level or by locally viewing the LCD display. If the amplifier stops responding to AGC lower commands then it is most likely that either one or both amplifiers have hit the lower limit of RF drive attenuation. If the operator has connected each amplifiers AGC telemetry level to the remote system, then the AGC voltage (amount that the RF input is attenuated) can be viewed. Once this voltage reaches around 5 volts, then there is no more RF input drive attenuation available.

5.2 EXT1 Secondary External #1 Interlock

The main controller also has a pair of contacts at J16 that is labeled as EXT1 interlocks on the rear panel. This contact is place in series with the coil of the ON/OFF relay K2 such that if the contacts between J16 is open then relay K2 is de-energized and the transmitter is forced OFF.

This is not really a remote control, but it could be used as a simple ON/OFF by supplying a set of controlling contacts across EXT1+ and EXT1–. There is no real polarity required and the + and – designations are just to differentiate the two pins.

5.3 Combined Remote Status Outputs

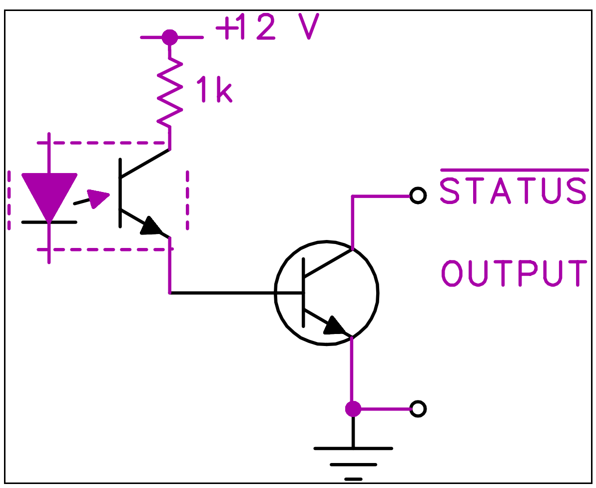


Figure 23 Status Outputs

These are current sinking open collector outputs, out of quad pack MPQ2222 (2N2222A) NPN transistors driven by opto-isolator devices. The available output sink current is dependent on the gain of the NPN and the opto-isolator transfer ratio. Generally, one can expect at least 100mA of sinking current for each output listed here. Because these are open collector, they can be used in special applications, such as on-site warning signal activation if desired, but they are limited in external circuit voltage to maximum 60VDC. Each status (in parentheses) indicates what it means when in its active low condition.

The MXi provides five remote status outputs that represent the current operating state of the transmitter.

TX D-Connector (J5)	Designation	Description
Pin 10	RS_Remote	Tx is in Remote Mode
Pin 11	RS_Err	Tx has an error
Pin 12	RS TXOn	Tx is turned ON
Pin 13	RS VTrip	VSWR Trip Occurred
Pin 14	RS_VLock	Tx is OFF due to VSWR
Pin 15	Ground	Ground Reference

5.4 COMBINED TELEMETRY OUTPUTS

These are buffered OpAmp outputs, out of quad pack LM324 operational amplifiers. The available output voltage is limited to the range of 0 – 5VDC. The OpAmp can reliably source around 5mA of current and so a relatively high impedance input of at least 2K ohms should be used. Each telemetry has a description to indicate what parameter it is measuring.

The MXi provides three remote telemetry outputs that represent the current operating levels of the transmitter.

TX D-Connector	Designation	Description
Pin 1	FWD PWR	Forward RF power level
Pin 2	RFL PWR	Reflected RF power level
Pin 3	REJ PWR	Reject RF power level
Pin 15	Ground	Ground Reference

5.5 AMPLIFIER REMOTE SIGNALS

The following tables show the individual remote signals that are available at each of the amplifier rear panel D connectors. The tables of signals are given here for reference only, for more detailed discussion please refer to the amplifier manual

The remote status of each amplifier can be used by the operator to obtain information on the operation of each amplifier. Note that the 'RS_Remote' status is not valid since this function is handled by the main controller itself. The other status can be monitored and indicate valid information.

The remote telemetries of each amplifier are the most useful in a MXI802 configuration since the individual amplifier RF power, AGC and Cutback levels are not available on the main controller chassis and do provide the operator with useful information.

TX D-Connector	PC Board Connector	Designation	Description
Amplifier Remote Controls			
Pin 1	J6 Pin 1	RC_TX_On	Turns Transmitter ON
Pin 9	J6 Pin 2	RC_TX_Off	Turns Transmitter OFF
Pin 2	J6 Pin 3	RC_Reset	Resets VSWR Trip
Pin 4	J6 Pin 7	RC_VOR	VOR On Controls
Pin 12	J6 Pin 8	Ground	Ground Reference
Pin 15	J6 Pin 14	EXT1+	Secondary Ext1 Intk
Pin 8	J6 Pin 15	EXT1–	Secondary Ext1 Intk

TX D-Connector	PC Board Connector	Designation	Description
Amplifier Remote Status			
Pin 10	J6 Pin 4	RS_Remote	Amp is in Remote
Pin 3	J6 Pin 5	RS_TX_On	Amp is ON
Pin 11	J6 Pin 6	RS_Error	Amp Error Occurred
Pin 12	J6 Pin 8	Ground	Ground Reference

TX D-Connector	PC Board Connector	Designation	Description
Amplifier Remote Telemetries			
Pin 5	J6 Pin 9	RT_FWD	Forward RF power level
Pin 13	J6 Pin 10	RT_RFL	Reflected RF power level
Pin 6	J6 Pin 11	RT_AUR	Aural RF power level (optional)
Pin 15	J6 Pin 12	RT_AGC	AGC voltage (1/2 scale)
Pin 7	J6 Pin 13	RT_CUTB	Cutback voltage (1/2 scale)
Pin 12	J6 Pin 8	Ground	Ground Reference

6 CIRCUIT DESCRIPTIONS

6.1 M9S12E128 MICROPROCESSOR

The Motorola M9S12E128 microprocessor (often referred to as the CPU or HC12) performs all of the control interface and communications in the MXi transmitter system. It is a 44-pin surface mount PLCC type device that is permanently soldered to the circuit board and is not field serviceable or easily replaced without special surface mount tooling. A brief description of the part is given in this. More detailed information on this part can be obtained from the Motorola web site.

6.1.1 Microprocessor Configuration

The HC12 chip used in the controller comes with 128K bytes of non-volatile flash memory, which can be erased and reprogrammed to allow updating of software code or system parameters. The MXi code is typically much smaller than 128k and so would fit in either size of Flash memory. The HC12 chip has a dedicated serial input pin designated as the BDM (Background Debug Mode) port that is used to program the internal Flash memory and for debug testing. The MXi is programmed at the factory and it is not expected that reprogramming would be required in the field, although it is possible to do with the proper software. System parameters and status that need to be retained during power failures (such as the LOG entries) are also stored in the Flash memory.

Most of the external pins on the HC12 are configured as programmable Input/Output (I/O) ports, where the software program determines whether a certain pin is to be configured as either an input or output. The pins on the HC12 are grouped together in sets called PORTs. These Ports will have eight pins (or fewer) to support the byte wide data path in the CPU.

Similar functions are usually grouped on the same port if possible however a few ports must handle varied I/O due to system parameters.

The definition of each Port pin is as follows:

PORT AD0-7 A/D Converter Inputs

PAD0	Input	Power Supply #1 Current
PAD1	Input	Power Supply #1 Voltage
PAD2	Input	Power Supply #2 Current
PAD3	Input	Power Supply #2 Voltage
PAD4	Input	Combined Forward Power
PAD5	Input	Combined Reflected Power
PAD6	Input	Combined Reject Power
PAD7	Input	Spare (unused) A/D input

PORT AD8-15 Remote Controls

PAD8	Output	Remote Status: Error
PAD9	Input	Remote Control: TxOff Command
PAD10	Input	Remote Control: Reset Command
PAD11	Input	Remote Control AGC Raise Command
PAD12	Input	Remote Control AGC Lower Command

PAD13	Output	Remote Status: Tx ON
PAD14	Output	Remote Status: VSWR Trip
PAD15	Output	Remote Status: Remote Mode

PORT E **Misc Functions**

PE0	Input	Remote Control: TxOn Command
PE1	Input	IRQ: From Spi UART
PE4	Output	LED: Phaser Adjusted
PE7	Input	Crystal Select [fixed]

PORT M **Serial Comms, DAC, I/O**

PM0	Output	DAC0: Phaser #2 Control
PM1	Output	DAC1: Phaser #1 Control
PM3	Output	PHASER: Control Select
PM4	Input	SCI2: RxData
PM5	Output	SCI2: TxData
PM6	Input/Output	IIC: Data
PM7	Output	IIC: Clock

PORT P **Misc Functions**

PP0	Input	Amp2 PsON Status
PP1	Input	Amp2 PsON Status
PP2	Input	Spare (E9 is unused)
PP3	Input	VSWR Trip Status
PP4	Output	VSWR Reset Control
PP5	Input	Ext1 Intk Status

PORT Q **DIP Switch**

PQ0	Input	DipSw #2
PQ1	Input	DipSw #3
PQ2	Input	DipSw #4
PQ3	Input	DipSw #5
PQ4	Input	DipSw #6
PQ5	Input	DipSw #7
PQ6	Input	DipSw #8

PORT S	**Serial Comms, SPI, XPortCtl**	
PS0	Input	SCI0: RxData
PS1	Output	SCI0: TxData
PS2	Input	SCI1: RxData
PS3	Output	SCI1: TxData
PS4	Input	SPI: MISO
PS5	Output	SPI: MOSI
PS6	Output	SPI: SCLK
PS7	Output	XPORT: Reset Control

PORT T	**Misc Functions**	
PT0	Input	PS1 On Status
PT1	Input	PS2 On Status
PT2	Input	Phaser Control Status
PT3	Output	CPU: TxON Command
PT4	Input	LED: General
PT5	Output	LED: General
PT6	Output	LED: General
PT7	Output	DipSw #1

PORT U	**Front Panel Inputs, OnRelay Status**	
PU0	Input	OnRelay: ON Status
PU1	Input	Reset Switch (Front Panel)
PU2	Input	On Switch (Front Panel)
PU3	Output	LED: Error Status (Front Panel)

The HCS12 provides a number of separate serial interfaces to external components, these are the synchronous peripheral interface (SPI), the IIC bus and the serial communications interface (SCI). A brief description is given here but more detail on the serial circuitry is given in Section 6.1.3 of this publication

There are three independent RS232 compatible serial ports implemented on the HCS12 denoted as SCI ports. One port communicates with the front panel LCD, the other two ports are each assigned to communicate with one of the two RF amplifier assemblies.

The SPI implements a four-wire clocked serial port that has four signals, Slave Select (SS), Master Out Slave In (MOSI), Master In Slave Out (MISO) and Serial Clock (SCLK). The HCS12 is always set as the Master who initiates all serial communications. The SPI port is used to communicate with the MAX3110 UART (U4).

The IIC port is a two wire serial bus that supports a number of devices sharing the same bus lines. This is a synchronous serial protocol that consists of a serial clock and serial data line. Each device on the bus has its own address that allows multiple devices to be attached to the same bus. In this application, there is only the one Real Time Clock (U5 , DS1307) device on the IIC bus

The microprocessor uses +5 volts as a power source that is derived from the +12 volts input provided by the two DC power supplies. The two +50 volt power supplies have an auxiliary +12 volt output rated at 3 Amp each to run the control circuitry of the main board. These +12 volt outputs are always active from the DC power supplies even when the +50 volt output is not activated. The main controller board diode-Ors these two +12 volt inputs into a single supply at around +11.5 volts which accounts for the diode drops. This +11.5 volt power then feeds the input of a +5 volt regulator VR1 that in turn provides the +5 volt power to the CPU and associated circuitry. Any reference on the schematics to +12v will usually imply this 11.5v composite power.

The CPU requires that the +5 volt power not fall below 4.6 volts to insure reliable operation. A power monitoring chip, U9 monitors the composite +12v that is input to the 5v regulator. The regulator will be able to generate +5v as long as its' input is above 7.5 volts. U9 will generate a reset to the CPU whenever the +12 volts falls below 9.5 volts which is sufficiently above the regulators 7.5 volt threshold. This will insure that the CPU will be in Reset long before the +5 volt begins to fall. The monitor chip U9 also has the reset switch S2 as an input, such that when this switch is pressed, a reset to the CPU is generated that is independent of the +12 volt or +5 volt voltage levels.

6.1.2 Software Program

The software program is written in HCS12 assembly language to allow for maximum flexibility and small code size. The HCS12 program directly controls the hardware and assembly language easily facilitates this.

The 128 Kbyte internal flash memory holds the software program. It is typically downloaded into the CPU via a special BDM programmer that would be attached to a computer or laptop. The assembler creates Motorola Srecord files of the software binary image that is used to download into the flash.

The Flash memory also holds all the system parameters (such as AGC level, Remote Mode, Logs, etc) that need to be retained between power outages. The flash memory is ideal for this since it is quick to program and retains data during power outages.

The microprocessor has a COP (Computer Operating Properly) timer, which acts as an internal watchdog timer. The main loop of the software program must service this COP timer within 1 second or the microprocessor will issue an internal reset command and restart the program. This watchdog timer prevents the software program from remaining in an endless loop and hanging up the system.

6.1.3 RS232 Serial SCI Communications

There are three independent RS232 compatible serial ports implemented on the HCS12 denoted as SCI ports. Each port implements the standard three-wire serial port (Rx Data, Tx Data and Ground) that would interface to a typical computer port. The baud is settable from 300 up to 38,400 bits per second but are normally set for 9600 baud. The baud rate is derived from the system oscillator clock at 8.0000 MHz. This frequency is recommended by the manufacturer to easily obtain the most common baud rates.

The first serial port designated as SCI0 is used to communicate with the Front panel LCD display. The LCD receives serial data from the CPU to display the appropriate transmitter parameters on the screen. The LCD has an integral touchpad that allows the operator to navigate the menu system. The CPU will regularly (about once per second) query the LCD if there were any touchpad presses. The LCD touchscreen sends back position co-ordinates for the LCD touchpad for processing by the CPU. The serial output from the CPU is at CMOS levels (0 to +5v) and must be converted into RS232 levels (-10v to +10v). This is accomplished via a RS232 driver chip (U8) that has a built-in DC inverter to convert the unipolar CMOS levels into the bipolar RS232 levels. These RS232 signals are routed to the front panel via a 16 wire ribbon cable J13.

The second and third SCI serial ports designated as SCI1 and SCI2 are allocated to communicating with external amplifiers Amp1 and Amp2 respectively. The circuit for each of these amplifiers are identical and so only Amp1 will be described here. Each amplifier has its own microprocessor that serially communicates with the main controller. This interface receives commands from the main controller and reports back the amplifier operating parameters for display on the LCD. Each amplifier has a number of controls, status and telemetry values. This made the choice of serial communications ideal. A direct hardwired solution would have required a cable with a large number of wires that is impractical for this situation.

The serial output from the CPU is at CMOS levels (0 to +5v) and must be converted into RS232 levels (-10v to +10v). This is accomplished via a RS232 driver that has been built into the SPI UART chip (U4). Note that the RS232 drivers in the SPI UART chip are completely independent of the UART function itself. Therefore, the RS232 driver portion of U4 is used for the two SCI ports from the CPU chip to the amplifiers. The RS232 output is then sent to a standard 9 pin Dshell connector J1 located at the rear of the pc board so that it protrudes through a cutout in the rear chassis panel. An external 9 wire ribbon cable is used to connect this main controller Dconnector to the 9 pin Dconnector on the rear of the amplifier chassis.

The SPI implements a four-wire clocked serial port that has four signals, Slave Select (SS), Master Out Slave In (MOSI), Master In Slave Out (MISO) and Serial Clock (SCLK). The HCS12 is always set as the Master who initiates all serial communications. The SPI port is used to communicate with the MAX3110 UART (U4). The HCS12 will send out its' data stream from the MOSI line and reads any responses from the external (Slave) devices via the MISO line. The SCLK is a serial clock (set for around 64K baud) that synchronizes the data transfer. The presence of this clock allows much higher data rates than the asynchronous SCI serial protocol. The SS line is a select that enables the MAX 3110 UART when low.

The serial output from the UART can either be sent to the Xport Ethernet device (U3) or to a rear panel RS232 D-Connector J4 via a RS232 driver chip U6. The transmit data from the CPU can be sent simultaneously to both the Xport device and the RS232 driver. However, only one of these output ports can drive the input data line at one time. Jumper E1 is provided to enable the RS232 data transmit.

The Ethernet or RS232 outputs are purchased options for the 802 transmitter that must be requested at the time of order. If the RS232 combined output is ordered, then the Xport Ethernet device will not be installed on the board and jumper E1 will be present. Alternatively, if the Xport Ethernet is requested, then jumper E1 will not be present.

NOTE: It is very important that jumper E1 is not installed if the Xport Ethernet device U3 is installed in the board. Doing so will most likely cause damage to both the Ethernet device and the RS232 driver!!

This configuration of the board is done at the factory during system setup and should never be changed in the field without prior instruction by Larcan personnel.

The IIC port is a two wire serial bus that supports a number of devices sharing the same bus lines. This is a synchronous serial protocol that consists of a serial clock and serial data line. Each device on the bus has its own address that allows multiple devices to be attached to the same bus.

In this application, there is only the one Real Time Clock (U5 , DS1307) device on the IIC bus. The CPU regularly queries this chip (denoted as the RTC) to update its internal time and date. Most communications involves the CPU reading from the RTC chip. The only time the RTC chip is written occurs when the operator updates the time/date via the front panel LCD. This would normally only be done once at system setup or after some number of months to update the RTC and accommodate any time discrepancy. More detailed information on the RTC chip is given in following sections of this publication

6.1.4 BDM Programming Port

The board is fitted with two RF detectors, which respond to RF samples fed from RF directional couplers mounted on output combiner of the Amplifier heatsink. The modulation envelope blanking level is measured because it remains constant, regardless of the picture content of the transmission. Measurement occurs during the back porch. Both sections of the board are configured in a similar way.

6.2 IIC Real Time Clock

For the following description, refer to Figure 25 (Sheet #1 of the Schematic) in the upper section of the drawing for the IIC real time clock circuitry. This DS1307 is a National SemiConductor device that provides independent timekeeping for the main CPU chip to timestamp its' LOG entries.

The interface between the device and the CPU consists of a two wire synchronous data stream that consists of a DATA line and a CLOCK line. The clock synchronized the data transfers allowing for higher data rates. The data line has a format specified by the IIC standard that allows multiple devices to share the same data line where each device has a specific address that it will respond to.

The DS1307 uses an external 3.0 volt lithium battery and 32.758 KHz crystal to maintain its internal clock even when the DC power has been removed from the board. The main CPU will read the value of the real time clock every minute (and of course after initial power up) to insure that the system time is current.

6.3 SPI UART

The Maxim MAX3110 is a full single channel serial UART with integral RS232 drivers and receivers. The device uses the SPI interface to communicate with the HC08 CPU. A brief description of the part is given in this section. More detailed information on this part can be obtained from the Maxim/Dallas Semiconductor web site.

This device can implement a full serial port with data and handshaking lines. In this application, the handshaking lines are not used and these inputs/outputs are used for general signal purposes. The RTS output is used as a remote control TX_FAIL output status and the CTS input is used to read the Thermal Interlock status.

The UART has its own 1.8432MHz crystal to generate the appropriate bauds. The CPU program sets up the baud as 9600 as the default but this can be altered by user command via the LCD touchpad menus.

An interrupt line is provided by the UART to signal the HC08 CPU when it is available for more data to transmit or when new data has been received. The device can also interrupt the HC08 in the presence of certain types of serial transmission error conditions.

The HC08 uses all four of the SPI interface lines to communicate with the UART, since it must both send data to the UART that must be transmitted and must read data from the UART that has been received. The CPU output Slave Select (SS) line is used to enable SPI communications with the UART. The HC08 has assigned the UART to provide communications between the HC08 and the LCD unit.

The UART has two RS232 drivers and two RS232 receivers that will translate the RS232 level to CMOS/TTL levels. One driver/receiver pair is used to interface the UART serial data to the LCD. The second driver/receiver pair is used to interface the HC08 serial data to the external computer.

6.4 XPort Ethernet Interface

For the following description, refer to Figure 25 (Sheet #1 of the Schematic) in the upper right section of the drawing for the XPORT circuitry. This XPORT device receives a TTL level serial stream from the CPU chip and converts this into the internet protocol serial output.

The operation of such a device is by nature quite complex and is beyond the scope of this manual. The Xport device is fully integrated and has no serviceable parts, so it is not truly necessary for the operator to troubleshoot or examine the part. If it does not function properly then it is either the 3.3 volt power supply or the Xport part itself that would be defective.

6.4.1 CPU Interface

The CPU communicates the system data to the SPI Uart via the synchronous SPI port as described in section 6.3 of this publication. Note that the SPI port of the CPU is dedicated to the Uart which in turn services the Xport device. The SPI Uart then uses standard TTL transmit data (TxD) and receive data (RxD) to forward the system data stream onto the Xport device. Hardware handshaking lines Request to Send (RTS) and Clear to Send (CTS) are used to control the data flow between the Uart and the Xport.

6.4.2 External Interface

The Xport device receives the serial data stream from the SPI Uart, which in turn receives the data stream from the main CPU. The Xport will then convert this data into the internet TCP/IP serial format onto the RJ45 type connector. In the same manner commands from the external internet connection will be sent by the Xport to the SPI Uart and then onto the main CPU chip.

The Xport has a built in RJ45 connector that allows a direct connection to the internet service provider jack or to a system router or gateway. It is impossible for a manufacturer to anticipate every possible network setup or know the IP address to be used and so it is up to the final user to get this information from their own service provider or IT administrator. The internet connection is a purchased option and will only be enabled if this option was indeed purchased from the manufacturer. The physical hardware may be present but if the option wasn't purchased then the software would not be loaded and the Xport will not be operational.

6.4.3 Software Programs

The Xport device must be loaded with operating software at the factory for its' functions to be enabled. The internet connection is a purchased option and will only be enabled if this option was indeed purchased from the manufacturer. This is the server software that provides the data stream from the transmitter onto the internet connection.

Some applications may have a client software that is run on the remote PC and interprets the data stream and presents it in a recognizable form such as power levels, voltages, currents and status. The internet option will have its own separate publication which would be provided separately when this option has been purchased.

6.4.4 3.3V Regulator

The Xport device requires a 3.3 volt supply voltage at a current rating of around 200 milliAmps. The MXi control board only has +12 volts and +5 volts available and so a separate 3.3 volt regulator is provided for the Xport. Switching regulator U2 is a Maxim MAX1685 regulator that can take a +12 volt supply input and provide a 3.3 volt output at the 250 milliamps. The circuit for this regulator is shown in Figure 30 (Sheet #1 of the Schematic)

6.5 POWER SUPPLY VOLTAGE AND CURRENT MONITORING

For the following description, refer to Figure 26 (Sheet #2 of the Schematic) in the lower right section of the drawing for the power supply voltage and current monitoring circuitry.

6.5.1 DC Power Supply

The MXi is fitted with two independent +50 volt power supplies, each of which powers one of the two Amplifier chassis. Both of these power supplies are located in the main Control chassis along with the main controller board that is the subject of this publication.

The main Controller monitors the +50 volts output and current of both power supplies to insure that they are operating within the recommended parameters. The individual Amplifier Chassis control board also monitors their own +50 volt input and current as well. Thus, each of the +50v power supplies have their voltage and current monitored by both the main control chassis board (31C1936) and the individual MXi Amplifier Control board

(31C1897). The reason for the dual monitoring is that in the case where an individual amplifier cannot communicate serially with the main Controller, the MXi can view its own internal power supply monitoring to determine if the power supply is ON and operating in a reasonable range.

The voltage and current monitoring done by the main MXi Controller board is used for error processing such as overcurrent and power supply OK status as displayed on the LCD. The LCD status influenced by the measurements of the main Controller are the ‘P/S’ status LED of the Main Power Screen, the ‘PsOK’ status of the COMB screen and the ‘PsOK’ status of the PHASING screen.

The actual LCD current and voltage readings on the P/S submenu are what the individual Amplifier control boards have measured and not what the main Controller board is measuring. Also the individual ‘PsOK’ status of each amplifier in the AMP1, AMP2 and INTK submenus are those received in the serial stream(s) as measured by the individual amplifiers.

6.5.2 Current Metering And Telemetry

The MXi board has a built-in Hall Effect current sensor that is able to measure the current drawn by each RF amplifier from their respective +50 volt power supply. The standard MXi transmitter would have a 100 amp current sensor for each power supply. Figure 26 shows the current monitoring circuitry.

The Hall Effect sensor requires +12v and –12v supply voltages to maintain linearity especially at lower currents. The MXi only has a +12v power source input and therefore a fixed low current (about 250 mA) inverter is implemented by U32 to generate the required –12v supply voltage. The resulting voltage is sent to both of the Hall Effect Sensors, U16 sensor for Amp1 and U19 sensor for Amp2.

The circuitry for the current sensing for the Amp2 power supply is identical to that of Amp1, thus we will only describe the operation of the Amp1 current sensing.

The two high current +50 volt DC wires are fed through an aperture in the Hall Effect Sensor U16 as these are routed from the power supply to the rear panel connector (and from there onto the individual amplifier). These high current wires do not make actual physical contact with the main Control circuit board. The Hall Effect Sensor is effectively a current source output that is 1/2000 of the current through the aperture of the sensor. If the DC current is 40 Amps, then the sensor will generate a current of 20 mA.

The Hall Effect output current of U16 is fed through the 150 ohm resistor R35 to convert it to a voltage where the 40 Amps input current would generate 20 mA of output current resulting in a voltage across R35 of 3.0 volts. This voltage is sent to two parallel OpAmps circuits.

U17B buffers this voltage and feeds it through 51k resistor R129 and onto Jumper E6. If E6 is in the ‘Ave’ position then R129 acts with C72 and R131 to act as an average power detector. The charge/discharge constant of R129 and C72 results in a time constant of around 5 msec, which is sufficient for constant power digital signals.

U17A is configured as a zero-drop diode for peak detection since the rectifier diode CR20 is inside the feedback loop of the OpAmp that effectively eliminates the diode voltage drop. This feature is important for lower currents to maintain the linearity since the .6 volt diode drop is typically around 20% of the full scale current sensing voltage. U17A feeds its output through 2k resistor R132 and onto Jumper E6. If E6 is in the ‘Pk I’ position then R132 acts with CR20, C72 and R131 to act as a peak power detector. The charge constant of R132 and C72 results in a time constant of around 200 usec which is sufficient to follow the vertical sync peaks and the discharge constant of R131 and C72 is around 51 msec to follow slower changes in the current level.

The voltage on C72 is sent to OpAmp U33B that has a gain of 1.5 so that our 40 Amp input current would result in a voltage of 4.5 volts at the output of U33B. This output is required to allow calibration of the current and to compensate for variations in components and Hall Effect Sensors.

The output of U33B is buffered by OpAmp U33A which sends this voltage out the back panel and onto Amplifier #1. The circuitry in Amplifier #1 will receive this voltage and has it own built in calibration circuits.

The output of U33B is also sent a voltage divider that consists of resistor R130, potentiometer R33 and resistor R36. Adjustment of potentiometer R33 allows the operator to calibrate the power supply current for the MXi802 main Controller. This calibrated voltage is buffered by OpAmp U34A which sends this voltage to test point TP3 and also to the A/D input of the CPU chip U1.

6.5.3 Voltage Metering

The Power Supply voltage is expected to be +50 volt DC +/- 0.5V and is fed into the MXi board from one connector J11 for P/S #1 (for Amplifier #1) and connector J12 for P/S #2 (for Amplifier #2). The voltage sensing circuitry for the Amp2 power supply is identical to that of Amp1, thus we will only describe the operation of the Amp1 voltage sensing.

The +50 volts from J11 pin 1 is fed to a resistor divider consisting of R22 and R25 where an input of 50 volts would result in a voltage of around 4.4 volts at R25. A 5.1 volt zener is provided across R25 to insure that this voltage does not exceed +5v which is the limit of the CPU A/D circuits. This voltage is buffered by OpAmp U14A and then fed to a second resistor divider consisting of potentiometer R23 and resistor R26. Adjustment of potentiometer R23 allows the operator to calibrate the power supply voltage for the MXi Main Controller.

OpAmp U34A buffer this calibrated voltage and sends this to test point TP1 and also to the A/D input of the CPU chip U1. As mentioned in the calibration section of this publication, the voltage at TP1 should be 1/10th of the actual input power supply voltage.

6.6 REMOTE CONTROLS AND STATUS

For the following description, refer to Figure 26 (Sheet #2 of the Schematic) in the upper section of the drawing for the power supply monitoring circuitry.

The Remote controls and status are located on the left side of the Schematic and are all optically isolated from the external interface to protect the CPU chip of the MXi from damage.

The remote controls are all active low signals that require about 10 mA of current sinking capability. Each of the Remote Controls has an indicator LED to help the operator verify if a particular remote command has been issued. Note that most remote controls are momentary closures and so the indicator LED will only illuminate for the time that the remote command is actually active. The external remote interface unit must be able to withstand a pullup voltage of +12 VDC.

The Remote status are all optically isolated open collector outputs that will sink around 100 mA of current and can be pulled up to +30 VDC. This type of output is industry standard and will interface to most commercial remote control systems.

6.7 RF METERING, REMOTE TELEMETRY AND VSWR

Figure 31 shows the circuitry associated with the RF Metering, Remote Telemetry and VSWR functions. Each of these is described as follows.

6.7.1 RF Power Metering

The MXi receives three DC levels from the diode detector that represent the RF power levels of the forward, reflected and reject powers. These signals are input on connector J10 at the rear panel.

Figure 27 shows the circuitry that is used to filter and buffer these DC signals from the combiner and then send them onto the D/A converter of the CPU.

OpAmp U23A buffers the forward power voltage with a gain of around 1.1 and then uses potentiometer R54 to calibrate the DC output voltage for a given RF output power level. This output from R54 is voltage limited to a maximum of 5.0 by zener CR10 to prevent any damage to the D/A converter which has a +5.0 maximum signal limit. The output of the zener is sent to unity buffer OpAmp U24A which provides a low impedance output into the

D/A converter. The same zener output signal is also sent to buffer OpAmp U26A that provides a low impedance telemetry output for the Remote Control connector J5.

The circuitry for the reflected and reject powers are virtually identical to that of the forward power described above except that the OpAmp gain for the reflected power input is 3.0 instead of 1.1 since the level of the reflected power is typically much lower than either the forward and reflected power.

Note that the voltage output levels are proportional to the square root of the output power. That is, if the output level is 1.0v and rises to 2.0v then this represents a fourfold increase in power.

The output error voltage from U15A is fed through a resistor divider that has jumper E16 in the middle of it. If E16 is installed, this shorts out any error voltage from U15A and disables the AGC action. This jumper should not be normally left installed, it is typically only used during setup operations and should be removed for everyday operations.

If E16 is not installed, the AGC error voltage is fed to the input of buffer OpAmp U15D and then out the MXi control board to the RF PreAmp attenuator via connector J10. The voltage at the PreAmp reduces the drive level to the RF amplifier and thus reduces the output power.

The AGC error voltage from U15A is divided by two with resistor divider R90/R92 and sent to the inputs of buffer OpAmps U15B and U15C. U15B provides AGC voltage telemetry for the remote control and U15C provides AGC voltage telemetry for the HC08 CPU that is displayed on the LCD.

The Cutback circuitry monitors the level of reflected power and compares it to a preset level. If the reflected power exceeds the reference level then an AGC voltage is produces that reduces the transmitter output power. The purpose for doing this is to protect the Amplifier devices from damage resultant from too much RF power reflecting back from the output system.

The reflected power sample is send to OpAmp U17C which compares this with the reference level set by potentiometer R15 and test point TP6. This reference level is set up by sending –16dB of the transmitter forward power into the reflected port and adjusting R105 until the MXi begins to just start reducing the transmitters output power.

When the reflected power exceeds the reference level, OpAmp U17C will generate an error voltage that is fed into the AGC output OpAmp U15D via diode CR12. This has the same effect as an AGC reduction.

The Cutback voltage from U17C is divided by two with resistor divider R98/R99 and sent to the inputs of buffer OpAmps U19B and U19A. U19A provides Cutback voltage telemetry for the remote control and U19B provides Cutback voltage telemetry for the HC08 CPU that would be displayed on the LCD.

The VSWR trip circuit provides protection to the RF amplifier in the presence of a persistent and high level reflected power condition. The VSWR system is set to trip at a reflected power level of –10dB down from the forward power.

OpAmp U17 compares the reflected power voltage with the forward power voltage. When the RF detector setup is done, the reflected power voltage is set for 4.0V when it is at a level of –10dB lower that the full rated forward power. The forward power voltage is set for 4.0V when it is at the full rated forward power level. When these two voltages are equal, then the reflected power is indeed –10dB under the forward power level.

In the case that the forward power sample has been removed or improperly setup, it is possible for the forward power level to be near 0V or very low. In this condition, any amount of reflected power would cause a VSWR trip, which is undesirable and unnecessary. To prevent this event, OpAmp U17B forces a minimum forward power level of about 1.5V into U17D that would require a minimum reflected voltage of 1.5V to cause a VSWR trip. This represents a reflected power level of around –8.5dB instead of –10dB.

6.7.2 Remote RF Telemetry

The board is fitted with two RF detectors, which respond to RF samples fed from RF directional couplers mounted on output combiner of the Amplifier heatsink. The modulation envelope blanking level is measured because it remains constant, regardless of the picture content of the transmission. Measurement occurs during the back porch. Both sections of the board are configured in a similar way.

6.7.3 VSWR Protection Circuitry

The board is fitted with two RF detectors, which respond to RF samples fed from RF directional couplers mounted on output combiner of the Amplifier heatsink. The modulation envelope blanking level is measured because it remains constant, regardless of the picture content of the transmission. Measurement occurs during the back porch. Both sections of the board are configured in a similar way.

When the reflected level exceeds –10dB, set coil of relay K2 is energized, causing a VSWR trip to occur. Relay K2 is a two-coil latched relay where energizing the set coil causes the contacts of K2 to move into the set position and remain there even after the coil is de-energized. Once a VSWR trip has occurred, the relay K2 will remain in the set position until a signal is sent to the other reset coil that moves the contacts back into the original clear position.

The relay K2 can be reset from one or more of three sources.

The HC08 CPU can always activate the coil from its PC5 pin. This pin forces the output of NAND gate U18A high which activates the base of transistor U6C that in turn will energize the reset coil of K2. The second source is the remote control RC_RST command at connector J6 pin 2. When jumper E18 is installed, the remote control RC_RST command can directly drive the base of transistor U6C that in turn will energize the reset coil of K2. The third source is the front panel RESET button. When the front panel RESET button is pressed in, it directly energizes the reset coil of K2.

The VSWR relay has two poles, one for the transmitter interlock and the second for status. The interlock pole is part of the arming interlock chain of the ON/OFF relay K1. If the K2 contact is opened (i.e., there was a VSWR trip), the arming voltage is removed from ON/OFF relay K1 and the transmitter shuts down. Note that jumper E17 is provided to override the VSWR relay trip contacts. This jumper is only for setup purposes and should never be left installed in normal operations.

Note: Leaving the jumper E17 installed will defeat all the VSWR protection and could result in damage to the RF amplifier if a high reflected power condition occurs.

The second pole of K2 lights status LED DS10 when the relay has tripped under VSWR condition. The other side of this pole is fed into the CPU, which uses this to determine if K2 is tripped or not.

6.8 ON/OFF RELAY K2 CONTROLS

The ON/OFF relay K1 and associated circuitry is shown in Figure 32. Relay K1 is a four-pole, single-side stable relay that requires a constant voltage applied to its coil to maintain contact closure. The contacts of this relay provide the control signals to activate the +50V power supply and the cooling fans.

There are two elements that determine if power is applied to the coil of K1. One is the +12V arming voltage on the positive side of the coil that comes from the interlock chain. Four interlocks are placed in series with this coil such that all four must be closed in order for K1 to receive its +12V arming voltage. The four interlocks are Thermal, Tx Switching, External #1 and VSWR Trip. If any of these interlocks are open, then the relay will not be energized and transmitter amplifier will be shut down.

The second element that determines if power is applied to the coil of K1 is the control signal on the negative side of the coil. Note that LED DS5, which can be seen on the MXi front panel, indicates that the ON control signal has been issued to relay K1. This control signal can come from one or more of three sources.

The HC08 CPU can always activate the coil from its PC6 pin. This pin activates the base of transistor U10B that in turn will energize the coil of K1. The second source is the remote control TX_ON command at connector J6 pin 1. When jumper E7 is installed, the remote control TX_ON command can directly energize the coil of K1. The third source is the front panel ON button. When jumper E5 is in the INT position and the front panel ON button is pressed in, then the coil of K1 will always be energized.

When K1 is energized, all four poles of the relay will close and cause the transmitter to generate RF power.

Two poles are connected in parallel and send +12V (or +24 volts in some applications) to the fans at connector J8. Two poles are used since the current rating of one relay pole is not sufficient for the total current draw of up to four fans. One pole is used to send a +12V command to the +32V power supply. This command causes the power supply to activate and send its +50V to the RF amplifier. The last pole is used for status, when closed a ground is sent to the remote control status output RS_TX_ON at J6 pin 5. When K1 is not energized, the ground of this pole is sent back to the HC08 which uses this input to determine if the relay K1 is energized or not.

6.9 RF PHASING

The RF amplifier systems of the MXi802 and MXi1002 transmitter consists of two amplifiers running in parallel, and each one requires an input signal of approx. +6 dBm at the input of its driver to produce full output. To drive two amplifiers in parallel then requires twice as much signal as would a single amplifier. The phasing circuitry that allows these two amplifiers to be combined also in a minimum –3db reduction in signal and the splitter that provides two outputs from the single input also results in a further –3db drop in signal. Because an upconverter/modulator output is limited in amplitude, it becomes necessary that a RF gain state be provided with power gain of at least +6db be provided so that one upconverter signal can drive these two amplifiers. Each amplifier regulates its own RF output level independently via AGC circuitry but both amplifiers are set for the same output level. Individual adjustments for phase delay compensate for conditions such as small variations in amplifiers and in cable dimensions.

The phase delay adjustment capability is important. A wavelength in free space by definition is approximately 300/f meters long. The small dimensions of a wavelength at 860 MHz in polyethylene or Teflon insulated coaxial cable (which is about .66 of free space wavelength) will make small errors in cable fabrication become significant. At 860 MHz, a wavelength is about 300 ÷ 860 = 0.349 meters or 34.9 cm; in typical cable, a wavelength is about .66 of this, or 23.2 cm. A typical cable fabrication tolerance of ±6 mm represents a phase error of ±6 mm ÷ 232 mm x 360° = ±9.3°, which is enough to result in significant termination (reject load) power dissipation in the power amplifier output combiner network. Individual phase controls are therefore provided to minimize phase errors.

Likewise a gain difference of as little as 1 dB between amplifiers in the system can be significant, and it is desirable that any difference be minimized, thus the system automatically sets the output level of each amplifier to be the same.

6.9.1 Splitter and Phasing Circuitry

RF from the modulator/upconverter or modulator switcher arrives at J7 and is split into two equal but 90° phase displaced signals by HY2. The arrangement of the quadrature coupler components inside HY2 results in the RF signal at C58 arriving 90° later than the signal delivered to C69. R102 is the termination for the hybrid, and normally sees no signal except in the unlikely event of a mismatch in one or the other input circuit.

The signal level of these two outputs will of course be –3db lower than that of the input signal itself. These outputs are then fed into identical phasing/gain circuits.

The circuitry for Amp1 is identical to that of Amp2 and so we will describe the operation of Amp1 giving Amp2 components in brackets. The RF signal at the input of HY1 (HY3) is split into two equal components 90° apart at the two ports marked –3 dB. Because these ports are terminated in reactances due to CR14 + L2 and CR15 + L3 (L5 + CR16, L6 + CR17) and are not perfect resistive terminations, the signal on these –3 dB ports is reflected back into the coupler and these reflections add in the isolation port, when both reactances are identical.

This "reflection addition" in the isolation port will occur a little later than the incident signal at the input, due to the time required for the effective capacitances at the –3 dB ports to charge and discharge through the combined impedance of the coupler and the series inductances. This is an oversimplified explanation, but the amount of time, thus phase delay, depends on the effective capacitance. The capacitances of varactor diodes CR14 and CR15 (CR16 and CR17) are variable, depending in turn on the amount of DC reverse bias applied to them through R78 and R79 (R96 and R97) from U29 pin 2 (U29 pin 12), so the net result is an adjustable phase delay through HY1 (HY3).

The amount of phase delay is set by voltage coming out from analog switch U29 pin 2 (U29 pin 12).

The output of the phase adjusting stage passes through a fixed pad R91, R87, R92 (R111, R107, R112) which provides some isolation for the phase adjuster and provides a match for the subsequent amplifier.

U28 and U31 are Mini-Circuits RF amplifier IC device type GALI-6F, designed to operate from +8V to +12V. These operate Class A, thus are constant current supplied and are fed from the system +12V through dropping resistor R83 (R104). L4 (L7) isolates the RF output from the power supply. These devices provide a nominal 12dB of gain to make up the losses associated with the input splitter, the phase adjustment stage, and the matching/isolation pads between them.

Design objective was unity gain overall when measured from the board input to either output.

6.9.2 Phasing Controls

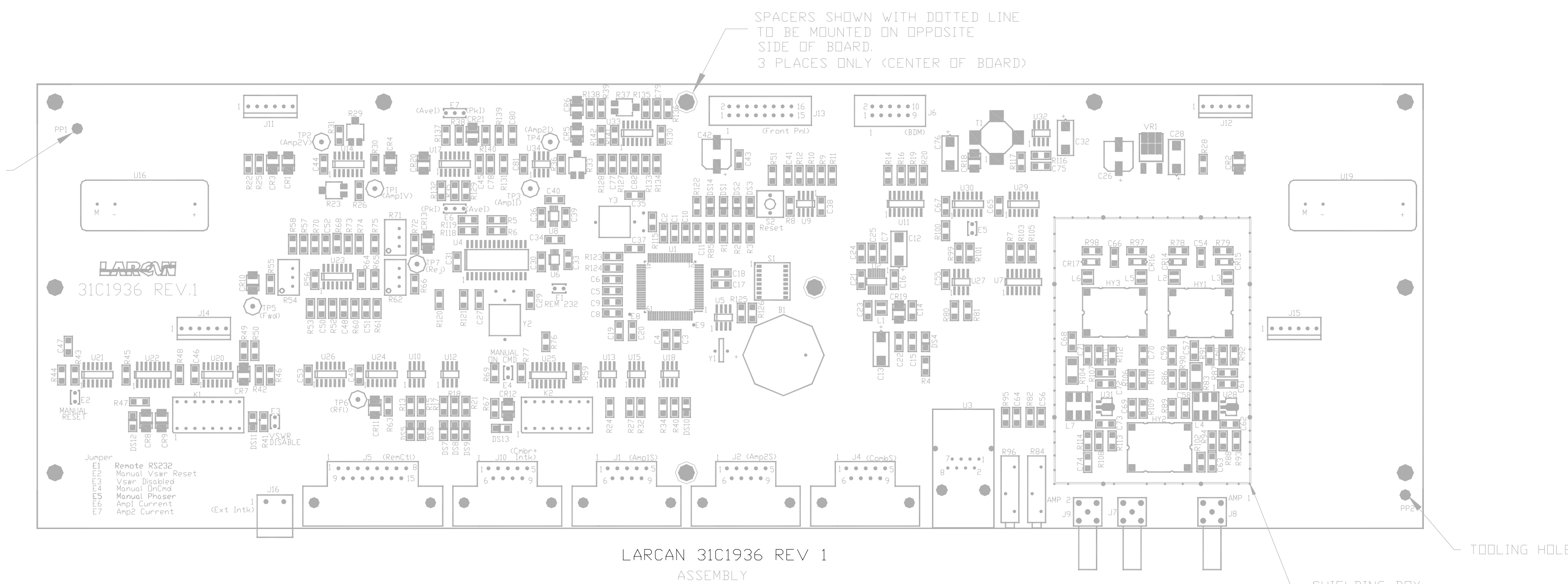
Each leg of the phasing circuit requires a DC voltage (in the 0 to +10v range) to adjust the relative phase for Amplifier1 and Amplifier2. There are two possible sources of this DC adjust voltage, one is from the rear panel potentiometers and the second is from the CPU D/A converter outputs. An analog switch is used to select between these two possible driving sources.

The analog switch U29 has four independent switches each consisting of an input pin, an output pin and enable pin (for switch #1, Input = 1Y, Output = 1Z, Control = 1E). The analog switch is powered from +12 volts to allow signals up to +10 volts to be passed through the switch. When the switch enable input is held at +12 volts then the voltage at the input pin is passed through to the output pin. When the voltage at the enable pin is held at 0 volts, the voltage at the input pin is isolated from its output pin and the output pin is held in a high impedance state.

Multiple output pins can be connected together as long as only one of the enable pins is activated at one time. This allows the analog switch to be used as a signal multiplexor. In this application, the analog switch is configured as two independent 2-input multiplexors, which are used to select either the CPU D/A control voltage or the manual potentiometer output voltage. One multiplexor is for Amp1 and the second for Amp2.

The phasing pots are designated R84 for Amp1 and R96 for Amp2. They both feed of the +12v supply through a 2k series resistor to provide a DC control voltage that can range from 0 volts up to +10 volts. These control voltages are fed into analog switch inputs 2Y (for Amp1) and 3Y for Amp2.

The CPU D/A outputs are designated ‘PH1 ADJ’ for the Amp1 control and ‘PH2 ADJ’ for the Amp2 control. These D/A signals can only range from 0 volts up to +5 volts since the CPU itself only has a +5v power source. An OpAmp circuit with a gain of 2 is provided to increase the range of these signals up to +10 volts so that they are the same range as the manual pots. The OpAmp U27A provides the DC control for Amp1 phasing at the 1Y input of analog switch U29. The OpAmp U27B provides the DC control for Amp2 phasing at the 4Y input of analog switch U29.



Jumper		Configuration (Typical)	Configuration (Alternate)
E1	Remote RS232	Internet = Not Installed	RS232 = Installed
E2	Manual Vswr Reset	Installed	Test Only = Not Installed
E3	Vswr Disabled	Not Installed	Test Only = Installed
E4	Manual OnCmd	Remote Control = Not Installed	Manual Override = Installed
E5	Manual Phaser	Pot Control = Installed	LCD Control = Not Installed
E6	Amp1 Current	Digital = "AveI" position	Analog = "PkI" position
E7	Amp2 Current	Digital = "AveI" position	Analog = "PkI" position

Figure 24 MXi Controller Board Assembly Diagram 31C1936A1 Rev 1.0

31C1936 CONTROLLER BOARD

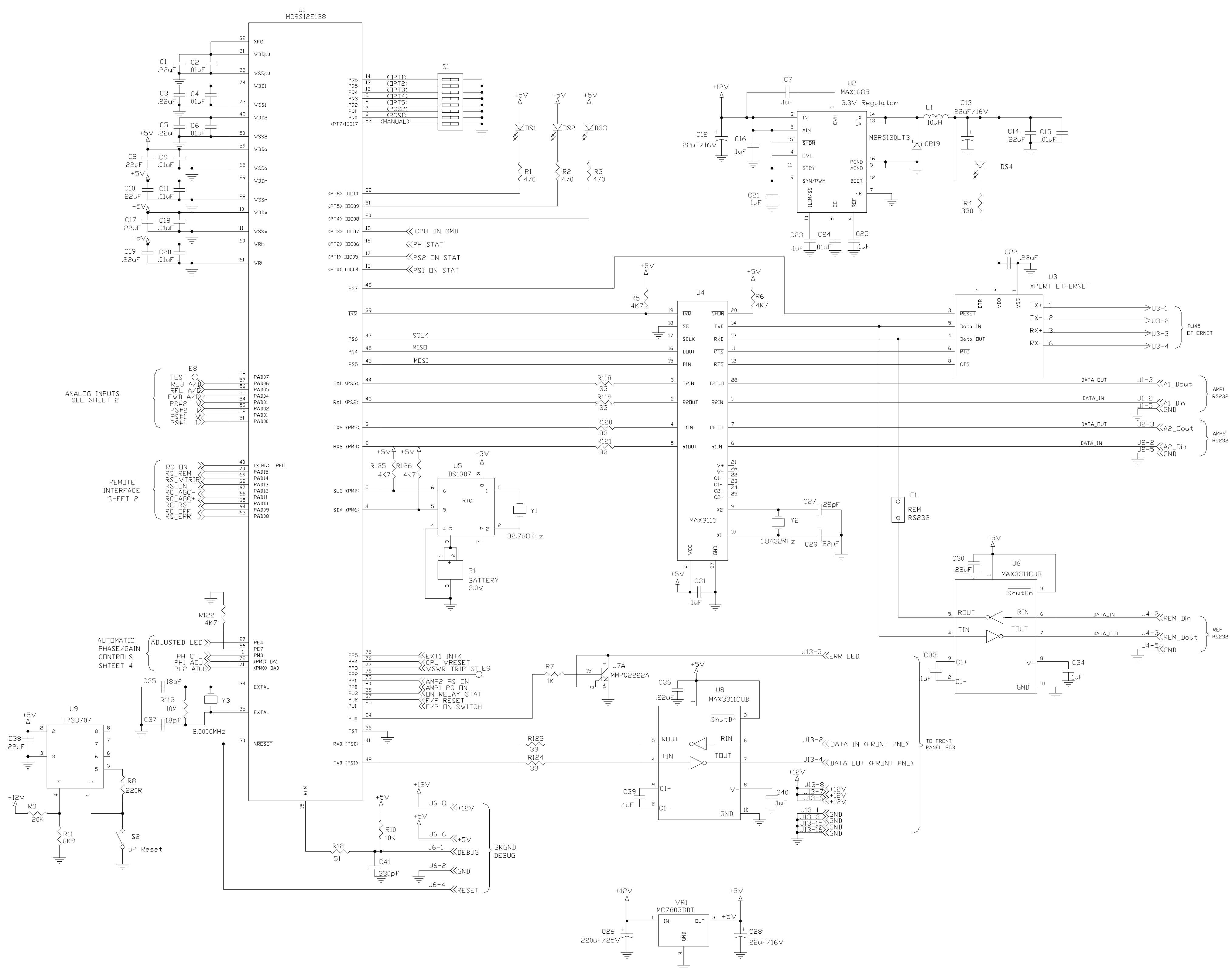


Figure 25 MXi Controller Board Schematic 31C1936 sht1 Rev 1.0

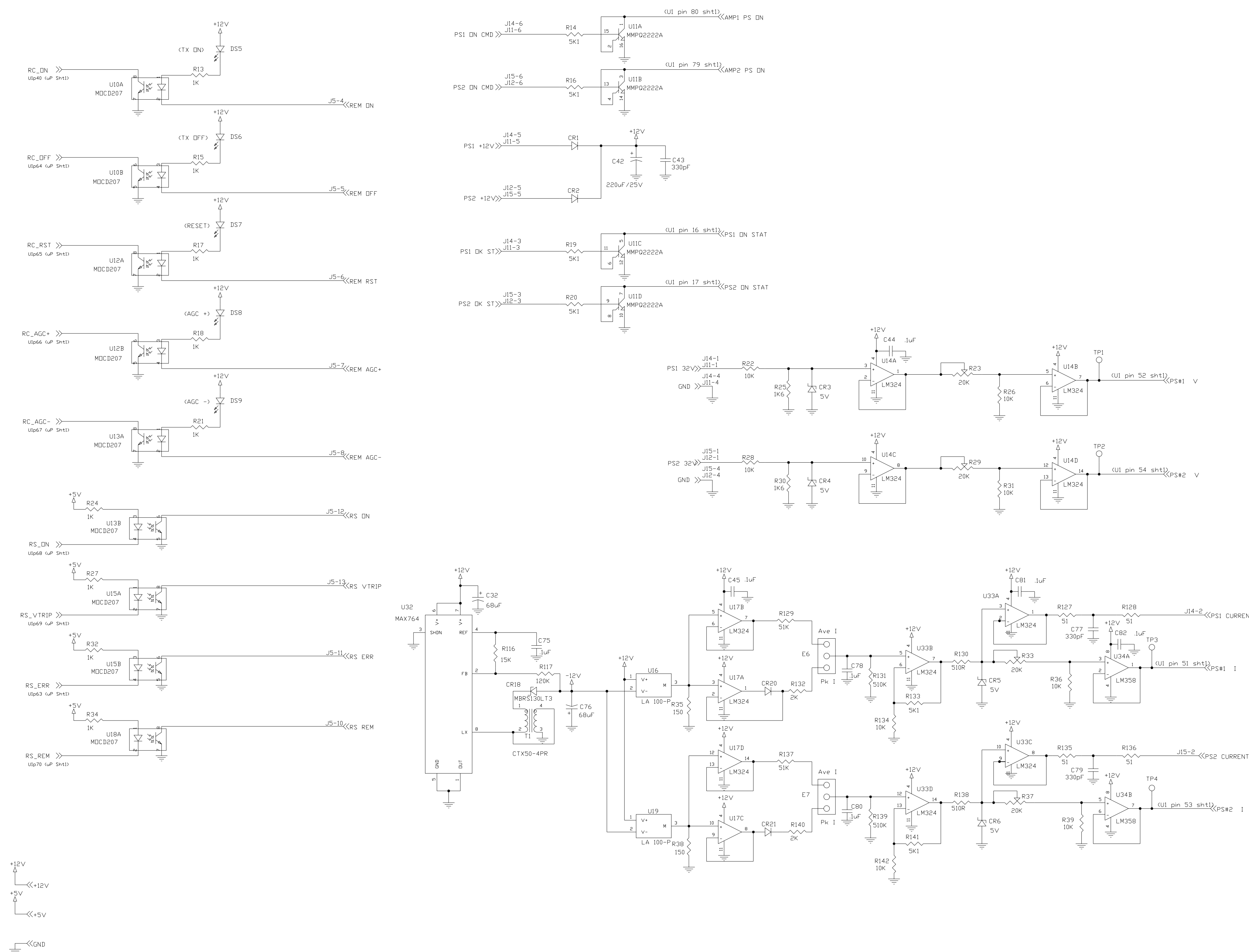


Figure 26 MXi Controller Board Schematic 31C1936 sht2 Rev 1.0

31C1936 CONTROLLER BOARD

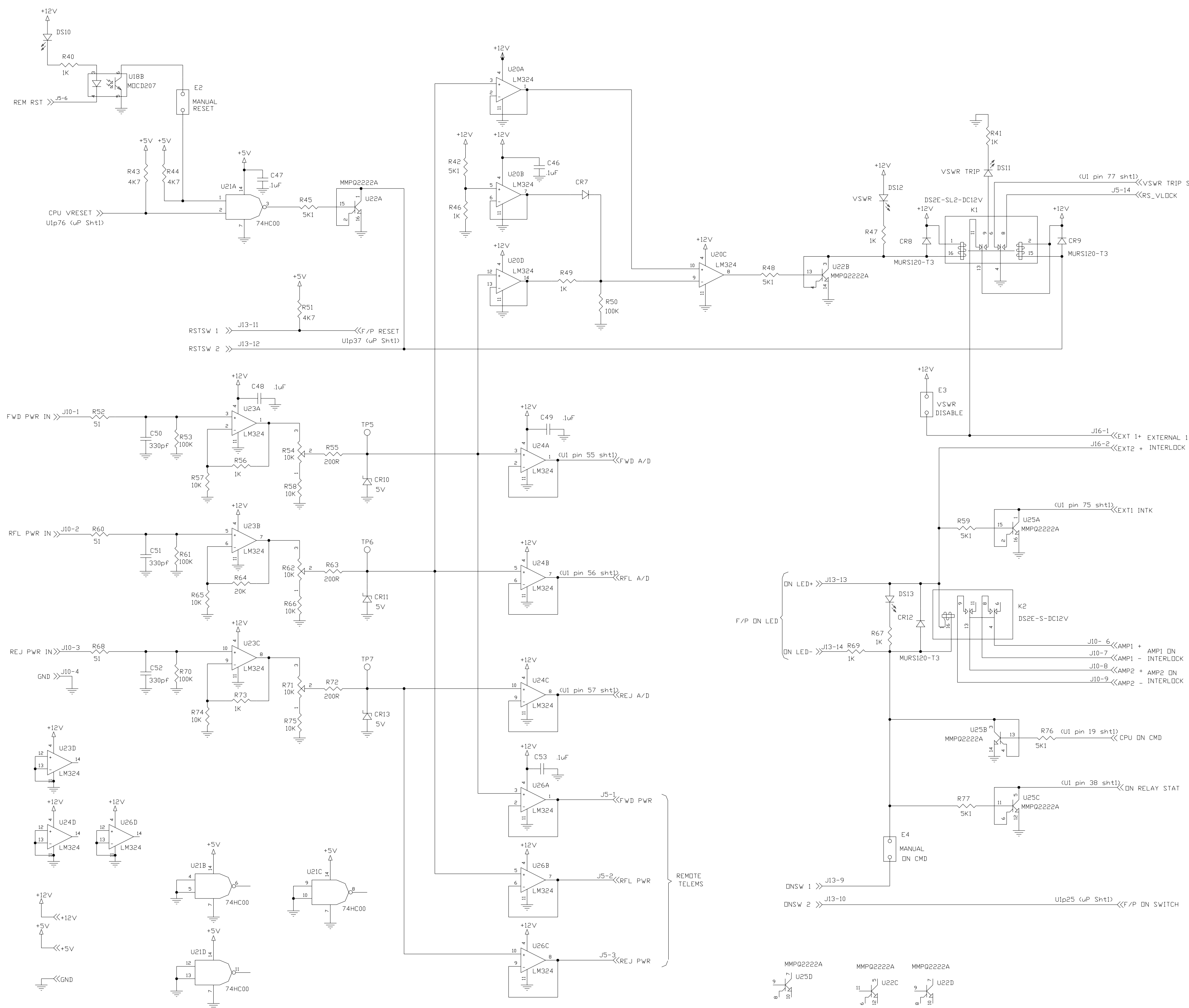


Figure 27 MXi Controller Board Schematic 31C1936 sht3 Rev 1.0

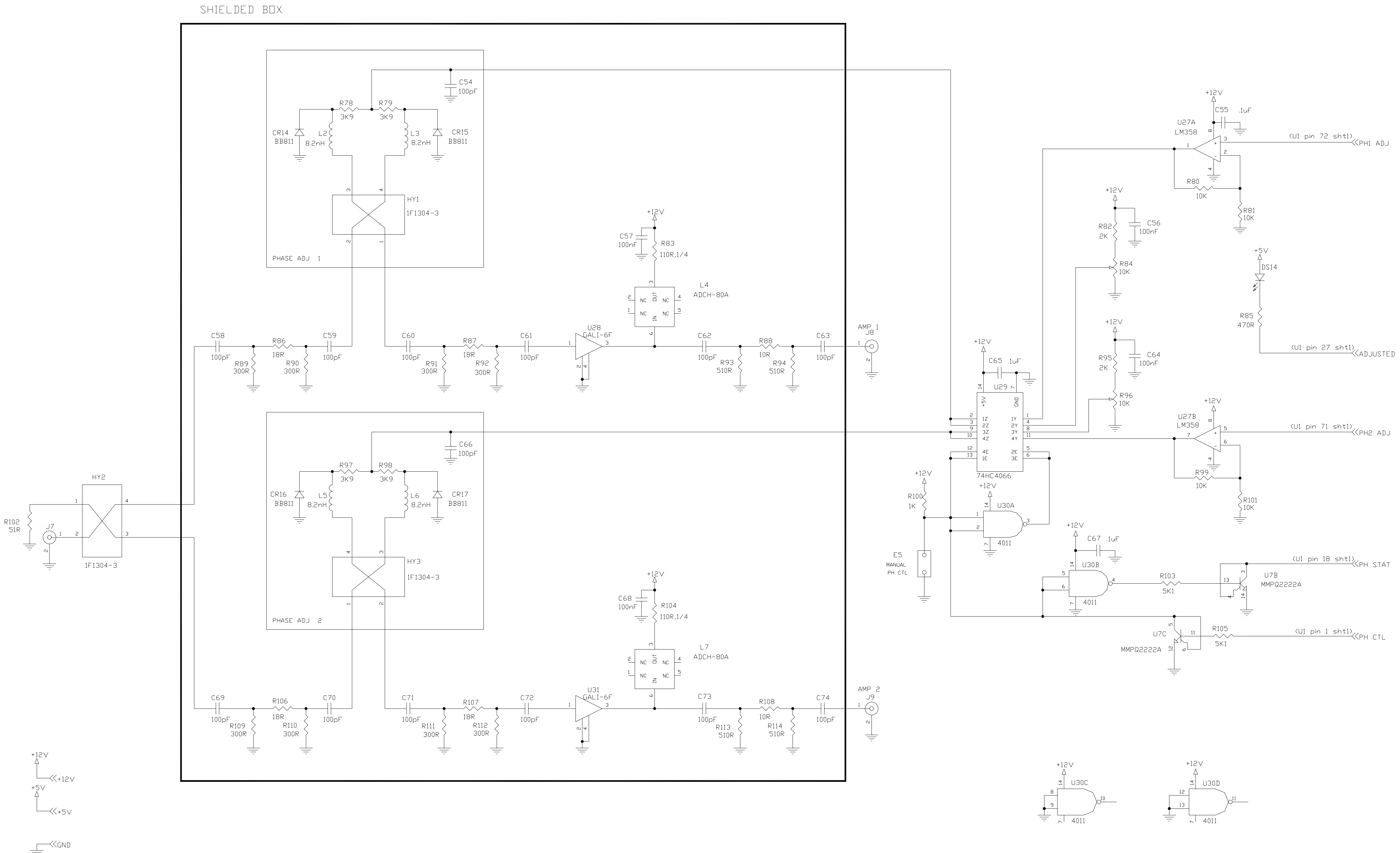


Figure 28 MXi Controller Board Schematic 31C1936 sht4 Rev 1.0

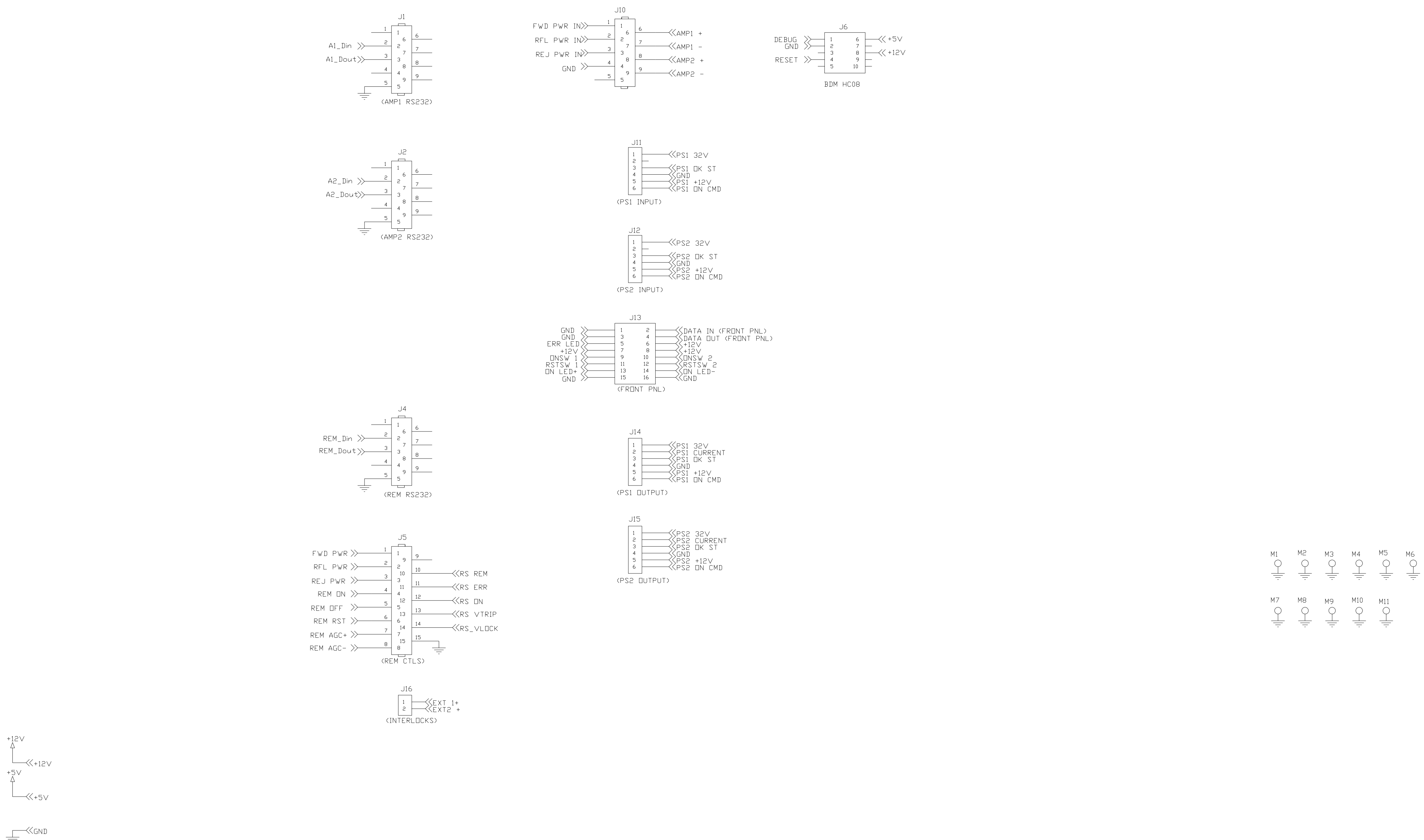


Figure 29 MXi Controller Board Schematic 31C1936 sht5 Rev 1.0

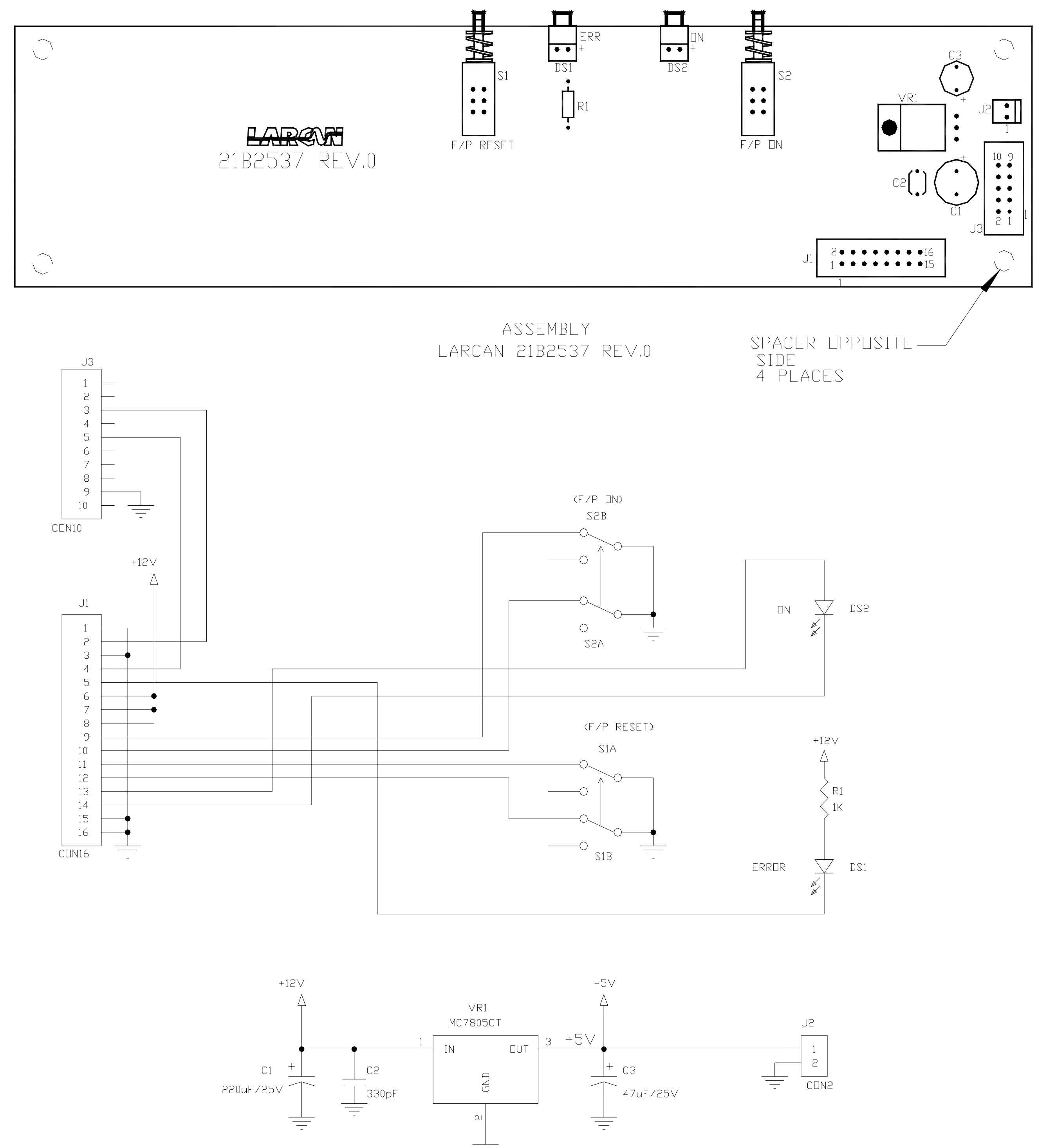


Figure 30 MXi Front Panel Interface Board Assembly 21B2537A1 and Schematic 21B2537S1

NOTES