BZ5MX1000U
Application for FCC Certification
Modulator Input
1000 Watt UHF Translator

ACTIVE DEVICES AND FUNCTION LIST

DEVICE	TYPE	FUNCTION
MODULE: UHF Visual/Aural RF Detector #41D1607		
Q1, Q6, Q12, Q14	MPS8598	General Purpose
Q2, Q7, Q11, Q13	MPS6515	Amplifier
Q3, Q8	2N5771	Hi-speed Switching
Q4, Q9	2N4351	N-CH Switching
Q5, Q10	2N4401	General Purpose
Q15, Q16, Q17	MPSH17	VHF Mixer
U1, U8	TDA2595	Horizontal Combination
U2, U7	74LS221N	Monostable Multivibrator
U3	MC78L05CP	+5V Voltage Regulator
U4, U5, U6, U9, U10	LM358N	Op Amp
MODULE: Power Amplifier Interface PCB #21B1789		
U1	74HC08AD	Quad 2 I/P AND Gate
VR1	MC78L05ACD	+5V Voltage Regulator
MODULE: Front End Amplifier #21B1752		
Q1	MMBT2222ALT1	General Purpose
U1	MHW9182	Hybrid Amplifier
U2 to U6	LM324D	Op Amp
VR1	MC7824CD2T	+24V Voltage Regulator

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DEVICE	TYPE	FUNCTION
MODULE: Intermediate Power Amplifier #21B1791		
Q1, Q2	MRF181S	4W Mosfet
Q3	MMBT2907ALT1	General Purpose
U1	MC1723CD	Adjustable Voltage Regulator
MODULE: Driver Pallet #21B1751		
Q1	MRF374	Power Mosfet
U1	MC78M09CDT	+9V Voltage Regulator
MODULE: Pallet Amplifier #21B1639		
Q1, Q2	MRF374	Power Mosfet
U1	MC78M09CDT	+9V Voltage Regulator
MODULE: Linear Regulator #41D1673		
Q3	TIP36C	Bipolar Power
Q4, Q5, Q7	2N7002LT1	N-CH Mosfet
U1	MC1723CD	Adjustable Voltage Regulator
U2	MC74AC11D	Triple 3 I/P NAND Gate
U3	MC14050BD	Hex Buffer/Non Inverting
U4	MC3423D	Voltage Sensor
U5, U11, U15, U21 to U24	MOC212S	Opto-isolator
U6	LM319H	Linear Hi-speed Comparator
U7, U8, U9	LF351D	Wideband Op Amp

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ACTIVE DEVICES AND FUNCTION LIST

DEVICE	TYPE	FUNCTION
MODULE: Linear Regulator #41D1673		
U10, U29	MC74AC109D	2 I/P AND Gate
U12, U16, U18, U26, U41	LM555CM	Binary Decoder
U14, U28	MC74HC393D	Dual Binary Counter
U17, U25	MC74AC32D	Quad 2 I/P OR Gate
U20, U27, U40, U42	MC74AC04D	Hex Inverter
U30, U31	MC74AC08D	Quad 2 I/P AND Gate
U33, U34	MOC3041S	Opto-isolator
VR1	TL431ACD	Programmable Precision Vltg Regulator
MODULE: Control PCB #30C2065		
Q1 to Q18	MSD601-RT1	Small Signal
U1, U2, U9, U10, U14, U28, U29, U31, U32, U35	LM324D	Dual Op Amp
U3, U34, U37	MC14066BD	Quad Bilateral Switch
U5, U11, U12, U13, U15, U21, U22, U24, U25, U26, U27, U45, U46	MOCD207	Dual Opto-isolator
U7, U36, U39	MC14490DW	Hex Contact Bounce Eliminator
U8, U41	LM555CM	Binary Decoder
U16, U17, U20, U33	MMPQ2222A	General Purpose Amp
U18, U23	MC14053BD	Triple 2-CH Multiplexer/Demultiplexer
U19	MC14073BD	Triple 3 I/P AND Gate
U30	MC14528BD	Dual Monostable Multivibrator
U38	74HC08AD	Quad 2 I/P AND Gate
U40, U42	74HC04AD	Hex Inverter

BZ5MX1000U
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ACTIVE DEVICES AND FUNCTION LIST

DEVICE	TYPE	FUNCTION
MODULE: Control PCB #30C2065 (cont'd)		
U43	X9C103P	Digital Pot
VR1, VR2	MC34064P5	Under-voltage sensing
MODULE: AC Distribution PCB #30C2064		
Q1, Q2	2N2222	General Purpose
U1	LM324N	Dual Op Amp
U2, U6	ILQ1	Opto-isolator
U3, U4, U5	MC34161P	Power Supply Monitor

30C2065G1 CONTROL BOARD

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

The MX1000 control system is completely self contained on a hinged panel at the front of the transmitter. From this panel, the user can turn the transmitter on and off, raise and lower the output power, and monitor all critical parameters and status. The interface for remote control of the transmitter is also provided from this panel.

The control system handles all the interlocking control, protects the transmitter against excessive VSWR and displays power supply status. Meters are provided for monitoring output power, reflected power, P/S currents and AGC voltage.

Figure 1 Front Panel

2. CIRCUIT DESCRIPTION

GENERAL

The circuitry is generally divided into various functional sections. Each section performs different functions and is typically shown on a separate sheet of the schematic. The circuit board used in the MX1000 was designed for dual uses. On the MX1000, this board is configured to control a single transmitter. In another configuration (internally referred to as Group-2), this board controls dual PA/Power supply cabinets.

ON/OFF CONTROL AND INTERLOCK FUNCTIONS (PAGE 1 OF THE SCHEMATIC).

The ON/OFF state of the transmitter is determined by the state of the latching relay K6. Note that OFF switch S11 is connected such that it is always enabled (this is a built in safety feature of the transmitter: pressing S11 at any time, even if the transmitter is in remote mode will latch K6 into the OFF state). The ON switch S12 is only enabled when the LOCAL/REMOTE switch Sl0 (shown in LOCAL mode) is placed in the LOCAL position. If S10 is in REMOTE mode, the remote inputs are enabled and can turn on and off the transmitter.

Interlock connections to the control board are on J2. The signals from the interlock circuitry in the transmitter are opto-isolated (U21, U22 and U24A) for circuit protection. Interlocks include the airflow in the cabinet and the air temperature in the exhaust duct as well as another 'External' interlock that can be connected to patch panel or coax switch interlocking circuits. The outputs of the opto-isolators are fed to AND gates U19B and U19C. If an interlock opens or fails in any way, these gates will remove the drive from the base of transistors Ul 7A and B. These transistors buffer the ON command from K6 to turn on the power supplies.

Interlock failure also latches the associated latching relay (K3, K4, K7, K8, or K9). These relays remain latched until a reset command is issued. If an interlock is opened and then restored, the latching relay remains latched. This ensures that a "history" or record of the interlock failure is retained. On early versions of the transmitter, this would cause the interlock LED to remain off until the reset was given. Later versions of the control circuit included a circuit that would cause the LEDs to blink on and off after the interlock was restored but before the reset was pressed. A blinking LED indicates that the interlock was opened but subsequently restored.

Note that the command to turn on the blower is sent directly from relay K6 and is not included in the interlock circuitry.

METERING DISPLAY CIRCUITRY (PAGE 2 AND 3 OF THE SCHEMATIC)

The circuitry shown on pages 2 and 3 of the schematic is identical in function. The two sets of circuitry simply drive different meters. The metering circuit on the control board serves to route the selected signal (coming from various points within the transmitter) to the front panel display meter. As both metering circuits are the same, only the circuitry on page 2 of the schematic will be described.

A debounce IC is used as a latching circuit for the meter selection switches. The debounce ICs U6 and U7 (MC14490) use an oscillator to debounce the switch inputs. Capacitor C31 is connected between to pins 7 and 9 of U7 and determines the frequency of oscillation. Buffer inverter U42A is used to connect the oscillator output of U7 to pin 7 of U6. When a switch is pressed, R33 is temporarily removed from the circuit allowing the oscillator to oscillate and the debounce IC debounces the switch inputs. When the switch is released, R33 is grounded, causing the oscillations to stop. At the point the oscillation is stopped, the output of the debounce IC latches. The outputs remain latched in the last known state until the debounce oscillator is functioning (user presses a selector switch). The outputs of U6 and U7 drive the selector inputs of CMOS analog switch ICs U3 and U4. The output of these analog switches drive the digital panel meter via buffer amplifier U9C and calibration pot R217.

The schematic shown on page 3 is identical in design to that of page 2, except for the obvious component designation changes and that the buffer amplifier output drives the analog power

meter. This meter is current driven, so the adjustment pot R219 adjusts the current being fed through the meter, as opposed to the voltage being fed to the meter.

AGC AND VSWR PROTECTION (PAGE 4 OF THE SCHEMATIC).

The AGC circuitry is designed to maintain the power of the transmitter at a particular power level, however the AGC circuit is also used to generate cutback protection in the event of excessive output VSWR.

Output power is sampled and detected by the RF detector board and fed to the AGC circuitry J8. U35A buffers the voltage and feeds the metering display circuitry through calibration pot R164. U35B is configured as a comparator, using the voltage from NOVPOT U43 as a reference voltage against the sampled output voltage. The output of U35B feeds the AGC output via buffer amplifier U35C. AGC enable switch S23 is shown in the "disable" position. In this position, the AGC voltage is grounded through forward biased transistor U33D, thus disabling the ACG part of the circuit.

U43 is a solid state Non Volatile Digital Potentiometer. The IC has an internal pulse counter and internal switching logic and the solid state equivalent of a stepping motor to connect the taps in an internal string of resistors, one at a time to its "wiper" terminal. Programmable non-volatile memory is provided within the device to maintain its last setting and restore that setting during power-up. U41 is configured as a clock pulse generator providing the required clock signal to U43. VR1 is a safety device that disables the raise/lower circuitry from operation during power fail or power-up conditions. This prevents inadvertent transmitter power changes. The output of VR1 feeds AND gate U38A. Pressing the RAISE (S20) or LOWER (S17) switch causes the other input to U38A to go high. This has the effect of starting the clock generator, U41, and placing a low on pin 7 of U43. If the RAISE switch was pressed, pin 2 of U43 is low as well, causing the "wiper" pin (pin5) of U43 to rise in voltage. If the LOWER switch was pressed, pin2 of U43 stays low, causing pin 5 of U43 to lower in voltage.

AGC SYSTEM OPERATION

The function of the Automatic Gain Control system is to keep the transmitter operating at 100% over varying environmental conditions. The intent of this system is not to compensate for device failures, or excessive loss in output systems due to mismatch or poor tuning. Power FETs have some inherent change in gain over operating temperature and this is the reason for the AGC system. Generally, the AGC is set up with 10 - 15% headroom. Typically, this is done by disabling AGC, setting the exciter for a tx output power of 115%, then, with the AGC enabled, lowering (or raising) the power for a nominal 100% output. Of course, this can only be done (properly) with a healthy transmitter, at normal operating temperature. The AGC control sends a voltage to a variable attenuator located in the 4-way splitter module. This voltage is varied, depending on the gain of the PA modules, to keep the transmitter output constant.

The detected sample of the reflected power is fed to comparator U29B. This signal is compared to a factory set threshold level determined by resistor combination R142, R146,R138 and R125. As the reflected power increases to this preset level, the output voltage from U29B will increase. The output of U29B feeds buffer amplifier U35C and thus overrides the AGC voltage, causing the transmitter power to drop. In addition, op-amp U29C compares the output voltage from U29B to a factory preset level as determined by R137/R13O. As the output of U29B increases due to VSWR, U29C will turn on the CUTBACK LED D56 on the front panel display.

The forward power telemetry is also sent to op-amp U28B where it is amplified by a factor of two and then passed through a pot. The output from the pot is then sent to op-amp U28C. However, if the output of the pot is too low, diode CR28 will pass a voltage of approximately 2.7V to the input of the diode. The other input of op-amp U28C receives the reflected power telemetry. Now, when pot R128 is set properly, if the reflected power telemetry reaches the same voltage as the forward telemetry from pot R128, then you have high VSWR and the transmitter should be shut off. The transmitter will be shut off because the output of op-amp U28C will cause relay K11 to

trip. When K11 trips, it sends a "VSWR OUT TRIP" indication to and gate U19A which causes the transmitter to turn off. It will also cause K10 to trip, and stay tripped until a reset command is issued, causing the VSWR trip led to record the VSWR trip. Now, once K11 trips, the input capacitor to U31 A will start to charge. When it passes +5V, relay K11 will be set back to it's original state and the transmitter will turn on again. In this way, a momentary VSWR will cause the transmitter to trip off and then restart. However, each time relay K11 trips, the monostable IC U30B sends a pulse to slightly charge capacitor C92. If the transmitter trips 3 times in succession, capacitor C92 will have charged past the voltage present on the negative input of U31B, which is provided by the voltage divider of R150 and R154. Should this happen, op-amp U31B will cause relay K5 to trip. This will turn off the transmitter until a reset command is issued.

INTERCONNECTION WITH THE TRANSMITTER (PAGE 5 OF THE SCHEMATIC)

Information from the various modules within the transmitter are fed to the control board via J3. Table 1 details the signals and pins.

Table 1

1	Reset Command	All Regulators
2	Over Current Status	Regulator 1
4	Current Telemetry	Regulator 1
5	Over Voltage Status	Regulator 1
6	Lockout Status	Regulator 1
9	Over Current Status	Regulator 2
11	Current Telemetry	Regulator 2
12	Over Voltage Status	Regulator 2
13	Lockout Status	Regulator 2
16	Over Current Status	Regulator 3
18	Current Telemetry	Regulator 3
19	Over Voltage Status	Regulator 3
20	Lockout Status	Regulator 3
23	Over Current Status	Regulator 4
25	Current Telemetry	Regulator 4
26	Over Voltage Status	Regulator 4
27	Lockout Status	Regulator 4

The lockout information from the regulators is an open collector signal, these signals are bused together to a “collective” lockout indication. The trip information is connected together in a similar manner. Diode CR32 connects the trip and the lockout lines so that either a trip or a lockout of the regulators will cause opto U31A to turn on U16B, causing the REGULATORS OK LED to turn off. In addition, relay K1 will latch, causing the REGULATOR TRIP LED to turn on. K1 is also connected to remote interface J5 which will indicate that a regulator tripped. If a regulator trips, and then locks out, the REGULATORS OK LED will be off. However the REGULATOR TRIP LED will blink, indicating the lockout. U8 is configured as an oscillator that controls the ‘blinking’ of the LEDs The clock signal from U8-3 passes through U5A only if a regulator has locked out. This signal then alternately turns U16A on and off.

The current telemetry signals from the regulators are used for front panel metering and also telemetry. These voltages pass through calibration pots R221, R225, R229 and R233. From here they are buffered by op amp U2 and sent to both the remote control interface and to the analog switches that send the signals to the meters.

Note: In the case of parallel 1kW cabinets, the information from the second amplifier cabinet is returned to the control board via J4.

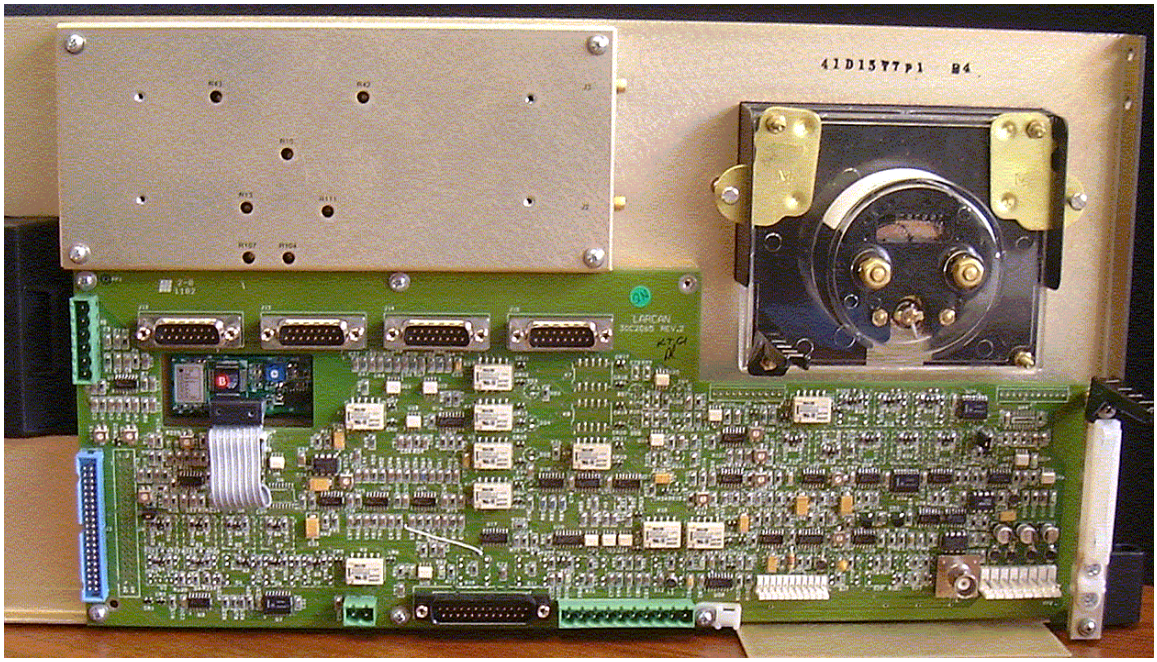

Figure 2: Rear View of Control Panel

REMOTE CONTROL (PAGE 6 OF THE SCHEMATIC)

This page illustrates the routing of the remote control interface. Connector J11 is a 25 pin D-shell connector that comprises the majority of the remote control interface connection. Remote control connections are detailed in Table 2. When the front panel REMOTE switch is pressed, a remote arming voltage is present and the grounding of a remote control input will result in that command being issued. A remote reset command on J11-5 will cause the opto U24 to send a reset command. This reset is split into an active low and an active high reset by transistors U20 B and D.

Connectors J12, J13, J14, and J15 bring information from the PA's to the remote interface. On those connectors pin 3 brings the cutback voltage, and pin 5 brings a RF OK indication. The cutback voltage is buffered by op amps U10A, B ,C,D while the RF OK indication is isolated by opto isolators U11A, U11B, U12A, U12B.

Table 2

Pin	Signal	Function
1	PA 1 Current	Telemetry
2	PA 2 Current	Telemetry
3	PA 3 Current	Telemetry
4	PA 4 Current	Telemetry
5	Reset	Command
6	ON	Command
7	OFF	Command
8	AGC Raise	Command
9	PA 1 Cutback	Telemetry
10	PA 2 Cutback	Telemetry
11	PA 3 Cutback	Telemetry
12	PA 4 Cutback	Telemetry
13	Reflected Power	Telemetry
14	Vis. Fwd. Power	Telemetry

15	Aur. Fwd. Power	Telemetry
16	AGC Lower	Command
17	PA 1 RF OK	Status
18	PA 2 RF OK	Status
19	PA 3 RF OK	Status
20	PA 4 RF OK	Status
21	Ext Interlock	Status
22	Temperature Interlock	Status
23	Air Flow Interlock	Status
24	Cab. 2 Temp. Interlock**	Status
25	Cab. 2 Air Flow Interlock**	Status

3. TESTING AND TROUBLESHOOTING

For the most part, there is very little servicing that can be done to this circuit in the field. The circuitry uses surface mount technology (SMT) and can be very difficult to service with conventional tools. There are adjustments that are preset at the factory and do not require readjustment under normal circumstances in the field. The following tests are in essence, functional tests that can be performed to determine it the circuitry is indeed working properly. In the event that the circuitry is not functioning the way it should, it is suggested that firstly, a visual inspection be done for obvious problems, secondly, that wiring into and from the circuit board be inspected and finally, that the circuit board be removed and replaced. For these tests, if the board functionality is tested in the transmitter, it is recommended that the breakers for the blower, and power supplies be left off.

METERING SWITCHES

- Ensure that JP1 and JP2 are installed. *Note: on the MX1000 version of this board, some switches are not installed. These are for the dual cabinet version of the controller.*
- On power-up the LEDs on the VIS switch for POWER METERING should be lit as should the LED on the PA1 switch for METERING.
- When a switch button is pressed the corresponding LED should illuminate.
- Select the VIS metering function on the POWER METERING section. Connect a variable power supply set to 4 volts to J8-9. Adjust R164 for a reading of 100% on the power meter. R219 may need adjustment in order to get the correct deflection on the meter.
- Select the RFL metering function. Using the variable supply, apply 4 volts to J8-6. Adjust R117 for a reading of 100% on the meter.
- Select the AUR metering function. Connect the variable supply to J8-11. Note that the board has no adjustment for the meter deflection in this function. In the transmitter calibration of this function is done on the RF detector board. There should be meter to deflection for 4 volts input.
- Select the AGC metering function. Press the OFF switch. Measure the voltage on the BNC connector J16. Adjust R217 so that the voltage measured at the BNC connector appears on the LCD display (±0.1 volts).
- Select the PA1 metering function. Apply a voltage between 1 and 2 volts to J3-4 and verify that there is a meter reading. Note: a voltage higher than 2 volts will cause a reading of “1” on the screen indicating an over-range condition.
- Select the PA2 metering function. Apply a voltage between 1 and 2 volts to J3-4 and verify that there is a meter reading.
- Select the PA3 metering function. Apply a voltage between 1 and 2 volts to J3-4 and verify that there is a meter reading.
- Select the PA4 metering function. Apply a voltage between 1 and 2 volts to J3-4 and verify that there is a meter reading.

30C2065G1 CONTROL BOARD

INTERLOCKS

- Install jumpers across:

  J2-1 and J2-2
  J2-3 and J2-4
  J2-5 and J2-6

- Press the reset button. The EXTERNAL, TEMP, and AIR LEDs should all be illuminated.
- Remove the jumper across J2-1/J2-2. The EXTERNAL LED should extinguish. Re-install the jumper. The LED should stay off until RESET is pressed. While the Led is on you should see ground on J11-21, while the led is off, J11-21 will be floating.
- Remove the jumper across J2-3 and J2-4. The TEMP led should turn off. Re-install that jumper. The Led should stay off until you press reset. While the Led is on you should see ground on J11-22, while the led is off, J11-22 will be floating.
- Remove the jumper across J2-5 and J2-6. The AIR led should turn off. Re-install that jumper. The Led should stay off until you press reset. While the Led is on you should see ground on J11-23, while the led is off, J11-23 will be floating.
- Again remove the jumper across J2-5 and J2-6. The AIR led should turn off. Re-install the jumper. Put the board in remote (push in the remote button so the led on the switch is turned on) and by grounding J11-5 you should be able to turn on the LED again.

CONTROL

In Remote mode, the local ON button (on the tx front panel) will not work. The OFF button will still work. This is a built-in safety feature of the transmitter.

- Verify that the REMOTE switch is in the Local, or 'out' position. The corresponding LED should be off. The transmitter controller is in 'Local' control mode.
- Press the ON switch and verify that its corresponding LED is illuminated. Press the OFF switch and verify that its LED is illuminated and the ON LED is extinguished.
- Press the REMOTE switch to set the control into 'Remote' mode. The LED on the REMOTE switch should be illuminated. Press the OFF switch. The OFF LED will illuminate. Verify that when the ON switch is pressed, there is no change in state.
- Set the control back to 'remote' mode.
- Ground J11-7, and verify that the OFF LED turns on.
- Ground J11-6 and verify that the ON LED turns on and the OFF LED is extinguished.
- Verify that with the control in 'local' mode that the above two steps have no effect on the transmitter on/off state.
- Press RESET. Verify that the REG OK LED is illuminated and the REG TRIP LED is extinguished.
- Verify that by grounding J3-2 (or any one of J3 pins 2,5,9,12,16,19,23,26), the REG TRIP LED illuminates and REG OK LED turns off. The REG TRIP LED will only turn off when RESET is pressed and there is no ground on J3-2 any of the other pins noted above.
- Ground J3-6 (lockout). The REG TRIP LED should now blink. The LED will blink as long as J3-6 is grounded (Any one of J3 pins 6, 13, 20, 27).

REMOTE STATUS AND TELEMETRY INTERFACE

- Using a variable power supply set at approximately 4 volts, the voltage applied at pins listed in the first column will be buffered and appear at the pin on the second column.

J12-2	J11-9
J13-2	J11-10
J14-2	J11-11
J15-2	J11-12

- Grounding the pin listed in the first column, will result in a grounded pin in the second column

J12-5	J11-17
J13-5	J11-18
J14-5	J11-19
J15-5	J11-20

- Apply a voltage (~4 volts) to J8-11. The same voltage should appear at J11-15.
- Apply a voltage to J8-9. Adjust R164 for the same reading at J11-14.
- Apply a voltage to J8-6. Adjust R117 so for the same reading at J11-13.

AGC CIRCUITRY

- Install jumpers across J2-7,8 and across J2-9,10.
- Press the ON switch.
- Apply +5V to J8-9. Do not apply any voltage to any other pins on that connector.
- Push the ACG ENABLE switch. The LED on the switch should illuminate indicating AGC control is enabled.
- Measure the voltage on the AGC connector J16.
- With the transmitter in local control mode, alternately pressing the AGC RAISE and LOWER buttons you should be able to lower and raise the voltage on J16 (note: RAISE will actually decrease the voltage and vice versa).
- Set the control to remote mode. The AGC RAISE and LOWER switches will no longer vary the voltage on J16. By alternately grounding pins J11-8 and J11-16 you should be able to lower and raise the voltage on connector J16 (remotely).
- Press the OFF switch.
- The voltage on J16 should be substantially higher (approximately 8 volts or higher).
- Press the ON switch.
- Remove the voltage on J8-9. Apply +5V to J8-6.
- Monitor the voltage at J16. Adjust R138 for approximately 1 volt at J16.
- Adjust R137 and verify that DS6 can be turned on and off by this adjustment.
- Apply +4V to J8-9. Adjust R128 for 4.0 Volts at U28-9.
- Apply +4V to J8-6. The VSWR TRIP LED should illuminate and the VSWR L/O LED will illuminate after a few seconds.
- Remove the voltage from J8-6. Press RESET to clear the VSWR TRIP and VSWR L/O LEDs.
- Briefly touching +4V to J8-6 and removing it 3 times within a few seconds will cause theVSWR L/O LED to come on and stay on until RESET is pressed.

4. PARTS LIST

Level	Item	Description
0	40D2320G1	CONTROL PANEL ASSY (MX1000)

Part Number	Description	Quantity
217B6666P6	METER ORDER FROM SIMPSON	1
1123	BEZEL METER	1
DPM2VC	DIGITAL PANEL METER	1
41D1607G1	R.F. DETECTOR ASM VIS+AUR See PUB 01-08 for details	1
16.325	BEZEL EXTENDED BLACK	15
16.27	EXTENDER FOR EXTENDED BEZELS	15
16.327	LENS FOR RECT LED (YELLOW)	13
16.327-08	LENS RED (TX OFF)	1
16.327-02	LENS GREEN (TX ON)	1
16.300-09	BUTTON BLACK	15
30C2065G1	PCB CONTROL (MX1000) ASSY R-4:	1