TEMPORARY

INSTALLATION and OPERATING MANUAL

MPC-11(AM)

MODULATION and POWER CONTROLLER

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14 JUNE '83

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Silver Spring, Maryland

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SECTION 1 GENERAL INFORMATION

1.1 INTRODUCTORY DESCRIPTION

The Potomac Instruments' Modulation and Power Controller, model MPC-11(AM), is designed to monitor and control the modulation level and RF power output of an AM radio transmitter.

The MPC is designed to function as a "stand-alone" instrument, that is, it can operate independently of other station equipment, except for the active transmitter. Only a single RF sample is required to provide input signal to both the modulation and power control sections of the instrument.

The MPC also includes a number of indicators, alarm outputs, and test functions specifically designed for ATS applications, and the instrument meets or exceeds all pertinent FCC requirements for ATS. The MPC-11 connects directly to the Potomac Instruments' ATP-11 Automatic Transmitter Processor, through a single cable.

Remote control interfaces and devices for operating local alarms have also been provided, and analog outputs, proportional to both the modulation correction and power correction are available for remote metering or auto-logging. Two separate balanced 600 ohm audio channels are provided, either for stereo applications, or for interfacing with independent MAIN and ALTERNATE/AUXILLIARY systems.

1.1.2 POWER CONTROL

Although simple in concept, automatic control of transmitter RF power presents a number of engineering difficulties. One problem relates to the differences in transmitter power control mechanisms. Response time, raise-lower assymmetry and backlash, minimum change as a function of motor inertia, control circuit voltage & current, over-control and burnout protection, all these characteristics may vary widely among different transmitter models.

Another problem is related to the fact that most transmitters do not provide an output indicating the amount of of raise-lower adjustment which has been made; in this respect, transmitter control is open loop, or "unobservable" in control theory terminology.

Another area of concern is the fact that in some installations, the transmitter is capable of power output greatly exceeding the normal legal limit for a particular pattern and/or power level. In this case, a degradation or failure in the power sample (i.e. a toroid coupler with shorted turns, a degraded detector diode, etc.), or a malfunction in the power controller, can result in out of tolerance operation, and possibly damage to the facility.

To cope with these and other problems, Potomac Instruments has developed a unique power control method. Transmitter power adjustment is made by a series of short raise or lower contact closures. The "dwell" (closed) time of each contact closure is separately adjusted for each transmitter, to a fixed time duration corresponding to a user determined power change. Thus, transmitters of very different raise-lower characteristics can be controlled with approximately the same response dynamics.

An up-down counter, which is incremented or decremented for each raise or lower adjustment, respectively, provides a continuous approximation of the NET (raise minus lower) power adjustment. Again, in control theory terminology, this scheme is referred to as an "open loop state estimator." The estimator (counter) is utilized to establish limits on the net transmitter adjustment, and provides panel and remote metering of the power correction.

SECTION 2
INSTALLATION and SETUP

2.1 OVERVIEW

The following steps summarize the tasks required to connect the MPC-11 into a radio transmitter installation and place it in operation. The applicable sections of the detailed procedure are indicated for each step.

1. Connect the required status inputs at J4. (See 2.3.2)

2. Connect desired alarm indicators at J4. (See 2.3.2)

3. Connect transmitter raise-lower power circuits to power controller interface at TB1. (See 2.3.3)

4. Connect audio source through modulation controller at TB2 and/or TB3. (See 2.3.4)

5. Connect required jumpers at TB1, TB2, and TB3. (See 2.3.3 and 2.3.4)

6. Make initial settings of MPC controls. (See 2.4.2 and 2.4.3)

7. Apply AC power to MPC.

8. With transmitter operating, perform the power controller set-up, and place the power controller in operation. (See 2.4.2)

9. Observe power controller operation and finalize adjustments as required.

10. With transmitter operating under automatic power control, perform modulation controller set-up and place modulation controller in operation. (See 2.4.3)

11. Observe modulation controller operation and finalize adjustments as required.

2.2 OPTIONAL OPERATING MODES AND ADJUSTMENTS

2.2.1 NOTES ON POWER CONTROLLER BOARD OPTION SWITCH

The power adjustment estimator (counter) contributes two functions: The first provides the operator with an approximate indication of the net transmitter power adjustment; the second allows limits to be set on the maximum net raise or lower adjustment.

For certain installations, the latter feature may not be important because the transmitter adjustment range is already limited, either by user settable "stops", or because of inherently limited transmitter power capacity. In this case, the user can disable the raise limit and/or the lower limit feature.

Conversely, for a system with a large excess power capacity or a wide raise or lower adjustment range, power control limits may prevent operation with high distortion, power greatly exceding legal limits, or even damage to the transmitter, phasor, or the antenna system.

The power controller goes on hold if the power sample abruptly drops to less than 80% of normal power. However possibilities exist for partial failure of the power sample: Shorted turns on a toriodal transformer, a detector diode which has developed low back resistance, bad connectors or cables, misadjusted power controller or wrong status inputs--any of these problems can result in an erroneous power sample.

The MPC-11 is normally shipped with the power controller option switch S1 set so the power controller goes on hold when the correction reading reaches +16 or -15 counts (+16 or -14 with the "Double Count" option--see below).

Assuming a DWELL adjustment which provides approximately 2% power change for each raise or lower contact closure, the net power adjustment range will be limited to approximately +32% and -30% from normal power.

If "tighter" adjustment limits are desired, the DOUBLE COUNT option switch can be set; this option causes the correction counter to count each raise or lower contact closure twice, resulting in a hold condition at +8 and -7 net corrections; setting this option thus limits the net power adjustment to +16% and-14% for the assumed DWELL adjustment.

Note that, with the double count option, the operator may have to check the correction reading and reset the counter more often than for the single count mode.

Another option available to the user will automatically reset the correction counter when the pattern and/or the transmitter is changed. This feature may be useful if one or more patterns or transmitters are relatively unstable with respect to power. For this option to function reliably, the DAY-NIGHT-3RD and/or the MAIN-ALT/AUX statuses must be false (open) for at least 50 micro-seconds during the change-over sequence; that is, the contacts providing the pattern and/or the transmitter status must be "break-before-make". This condition is easily obtained in most installations.

2.2.2 SUMMARY OF OPTION SWITCH SETTINGS, POWER CONTROLLER BOARD

S1(POS.1) LOWER COUNT LIMIT.. [Factory set OPEN]	OPEN: Power controller goes on hold when NET correction reaches -15 counts (-14 counts for DOUBLE COUNT option--see below); sets limit on lower adjustment.

CLOSED: Correction counter is reset to zero when NET correction reaches -15 counts (-14 counts for DOUBLE COUNT option); no limit on lower adjustment.

S1(POS.2) RAISE COUNT LIMIT.. OPEN: Power controller goes on hold when NET correction reaches +16 counts; sets limit on raise adjustment.

[Factory set OPEN]

CLOSED: Correction counter is reset to zero when NET correction reaches +16 counts; no limit on raise adjustment.

S1(POS.3) DOUBLE COUNT....... OPEN: Correction counter increments (decrements) by one count for each raise (lower) contact closure.

[Factory set OPEN]

CLOSED: Correction counter increments (decrements) by TWO counts for each raise (lower) contact closure.

S1(POS.5) CAR. SHIFT COMP.... OPEN: Disables carrier shift compensation function.

[Factory set CLOSED]

CLOSED: Carrier shift compensation will depend on setting of CARRIER SHIFT adjustment on rear. (See text.)

S1(POS.7) RESET ON CHANGE.... OPEN: Disables option.

[Factory set OPEN]

CLOSED: Power correction counter is reset to zero when change in pattern and/or transmitter.

S1(POS. 4,6,8)............... NOT DEFINED.

2.2.3 DWELL BALANCE ADJUSTMENT

If the power correction counter must be frequently reset because of assymmetry in a transmitter raise-lower mechanism, it may be possible to improve the condition by adjusting the internal DWELL BALANCE control. This single-turn potentiometer is located near the power supply connectors on the power controller board. The adjustment is factory set to the center-of-range position for equal raise and lower dwell time.

Before adjusting the DWELL BALANCE control, first ascertain that the assymmetry cannot be eliminated by service or adjustment of the transmitter raise-lower mechanism.

Rotating the DWELL BALANCE control CW will increase the raise dwell time relative to the lower dwell time, and vise-versa; the maximum adjustable difference between raise and lower dwell times is approximately +/- 20%. A CW rotation of the pot is indicated if the power correction trend is in the positive (raise) direction, and vice-versa.

The optimum adjustment will have to be determind by trial and error (like adjusting a clock); the success of the procedure will depend on the repeatability of the assymmetry. Note that only one DWELL BALANCE adjustment is provided; if transmitters of different raise-lower characteristics are to be controlled, a compromise setting may be required.

2.2.4 NOTES ON REAR BOARD OPTIONS

AN internal 5 Volt source is connected to the LOGIC HIGH REFERENCE (LHR) input through a steering diode, when S1(2) is closed. (See par. 2.3.2.) The steering diode prevents loading on an externally connected LHR source greater than 5 V. For externally connected LHR voltage of 5 V or less, the internal 5 V source must be disconnected by opening S1(2).

Also see par. 2.3.2.

2.2.5 SUMMARY OF OPTION SWITCH SETTINGS, REAR BOARD

S6(POS.1) ATS-ON STAT........	OPEN: ATS-ON status input is active.
[Factory set CLOSED]	CLOSED: ATS-ON status forced LO (true), independent of input.
S6(POS.2) INTERNAL LHR.......	OPEN: Internal 5 Volt logic high reference (LHR) is disconnected.
[Factory set CLOSED]	CLOSED: Internal +5 V connected to LHR input through steering diode.
S6(POS.3) PATTERN STATS......	OPEN: DAY,NIGHT,3RD status inputs active.
[Factory set CLOSED for Non-directional system, otherwise set OPEN]	CLOSED: Forces DAY status LO (true), independent of input.
S6(POS.4) BATTERY CHARGER....	OPEN: Disconnects 9 V battery charger circuit.
[Factory set OPEN]	CLOSED: Connects charger circuit to 9 V battery.

2.3 MPC-11 INTERFACE

2.3.1 RF SAMPLE

> WARNING. RF sample voltage in excess of 18V RMS, unmodulated, can damage the MPC. Note that the RF voltage on the load (output) end of UNTERMINATED cables can greatly exceed the source (input) end voltage. Also, improper termination can damage some RF sampling devices, such as toroids.

A sample of the modulated RF signal must be applied to J9, the BNC connector on the rear of the MPC; the sample voltage must be between 1.8V and 18V RMS when unmodulated. Before connecting the RF sample, determine the proper position of the INPUT R switch (near J9 on the rear). If the sample is "T'd" off a cable terminated on another unit (such as a modulation monitor), set the INPUT R switch to 3K OHMS; if the sample cable requires a 50 OHM termination, set the INPUT R switch to 50 OHMS.

2.3.2 J4, STATUS and ALARMS

The MPC status inputs and alarm outputs at J4 are compatable with a wide range of logic levels and external devices.

To accommodate a wide range of input levels, J4 includes a LOGIC HI REFERENCE (LHR) input; all input HI and LO levels are 2/3 MIN and 1/3 MAX of LHR, respectively. LHR voltage is normally equal to, and derived from,the chip supply voltage of the unit originating the logic signals: +5 volts is standard for TTL and STTL families, +3 volts to +20 volts is utilized for CMOS.

The LHR input is also internally connected to a +5V supply through a steering diode. For 5 volt logic, the external LHR voltage connection can be eliminated, possibly with some degradation in noise immunity. For logic supply voltage less than 5 volts, the MPC internal +5 volt reference must be disconnected by opening DIP switch S6 (position 2) on the MPC-11 REAR board.

Note that all J4 logic inputs are pulled high to the LHR through 15k ohm resistors. Thus, an open circuit is always a good logic HI, and a contact closure to ground is a good logic LO, for any value of LHR voltage.

The ten alarm outputs from J4 are all driven from open drain FETs (similar to open collectors) with an open circuit rating of +50 volts DC and capable of sinking 100 mA. These outputs can operate relays, lamps, sounders, etc., up to 5 watts. When interfacing to external logic inputs, pull-up resistors must be connected from each alarm output to the logic supply of the external unit; the resistors must provide source current of at least 1 mA when grounded (thus 4.7 K ohms maximum for 5 volt logic).

J4, STATUS & ALARMS (25 Pin Female "D" Connector, on Rear)

1	GND	14	GND
2	NC	15	ATS-ON STATUS (LO)
3	NC	16	OVER MOD ALARM (HI)
4	UNDER MOD ALARM (HI)	17	MOD CTL ALERT (HI)
5	MOD OUT ALARM (HI)	18	OVER PWR ALARM (HI)
6	UNDER PWR ALARM (HI)	19	PWR CTL ALERT (HI)
7	PWR OUT ALARM (HI)	20	NOT DEFINED
8	NC	21	MPC-FAIL ALARM (HI)
9	NC	22	PROGRAMMED HOLD STATUS (HI)
10	MAIN STATUS (LO)	23	ALT/AUX STATUS (LO)
11	DAY STATUS (LO)	24	NIGHT STATUS (LO)
12	3RD STATUS (LO)	25	LOGIC HI REF (Input voltage)
13	NC		

NOTES: All STATUSES are inputs to MPC
All ALARMS and ALERTS are outputs from MPC
(HI / LO) indicates the TRUE condition.

For "stand-alone" applications, the user will have to provide certain inputs to the MPC-11 at the STATS & ALARMS connector, J4. Basically, the MPC must select a separate adjustment for each power level and/or signal source utilized in the user's system. For example, MAIN and ALTERNATE MAIN or AUXILIARY transmitters, possibly with different RF sampling devices, and DAY, NIGHT, PRE-SUNRISE, or CRITICAL HOURS pattern/power levels, normally require separate power level adjustments. The MPC provides six separate power (sample input level) adjustments: a MAIN and ALTERNATE/AUXILIARY transmitter are separately designated for three different patterns/powers: DAY, NIGHT, and THIRD (PRE-SUNRISE or CRITICAL HOURS).

The user must provide a status input corresponding to the MAIN and ALT/AUX transmitters. For non-directional systems, any of the three pattern status inputs can be wired to ground at J4; alternatively, closing DIP SWITCH S6 (position 3) on the REAR board will maintain the MPC-11 in the DAY mode.

For directional systems, the pattern status must also be provided. Note that the MPC will remain on HOLD unless one transmitter and one pattern status are both TRUE. (However, the MPC is not protected against improper operation if more than one transmitter and/or pattern status are selected.)

The MPC includes a "PROGRAMMED HOLD" input, which is useful for certain ATS sequences; for stand-alone operation, the PROGRAMMED HOLD input, if not utilized by the user, must be connected to ground.

An ATS-ON status input is also provided at J4; the FALSE condition (HI=OPEN=ATS OFF) causes the MPC to HOLD. If not utilized, this input can be connected to ground, or alternatively, DIP SWITCH S6 (position 1) on the REAR board can be closed to maintain the ATS-ON condition.

2.3.3. POWER CONTROLLER INTERFACE, TB1 (10 Terminal Block, on Rear)

RAISE and LOWER Relay Contacts. (TB1-2 thru 5): The moveable and normally open contacts of the raise and lower relays are available at terminals 2 through 5 of TB1; the relay contacts are completely isolated from other circuits and ground. Standard contacts are rated at 115V AC or 28V DC, to 2 Amps; contacts with a higher current rating are available. The raise and lower contacts can be wired directly to the raise and lower control circuits of most transmitters. For inductive loads (such as motors) transient suppressing devices, such as VARISTORS, should be provided.

MPC-FAIL Output. (TB1-6): Normally this output is internally switched (electronically) to the +15 volt supply. For an MPC-FAIL condition, the 15 volt connection is opened, and the output is pulled LO with a resistor to ground. The MPC-FAIL output is used to supply coil voltage to the MPC RAISE and LOWER relays, and, (as a user option), the modulation control bypass relays.

> CAUTION. The MPC-FAIL output has limited current capability, and should never be connected to external loads requiring more than 25 mA.

MPC-ON Input. (TB1-6): For normal operation, this input requires +15 volts, which is applied to the RAISE and LOWER relay coils, and the internal $\overline{\text{MPC-RELEASE}}$ status. Opening the MPC-ON connection prevents the RAISE or LOWER relays from being energized, and places both the power controller and the modulation controller on HOLD, a condition called MPC-RELEASE.

The MPC-ON input is connected to the MPC-FAIL output, either directly with a jumper across the TB1 terminals, or through an external contact. The latter arrangement alows the user to place the MPC into the RELEASE condition manually, or through the remote control unit.

Power Controller RESET Input. (TB1-8): This is an optional connection which can be left open. Depending on the configuration of the Power Controller OPTION Switches, the power controller may go on HOLD if the CORRECTION counter reaches its maximum raise or lower count. The counter can be reset through the remote control unit or ATS system by providing a contact closure from the RESET input to ground. Also, the power controller will remain on HOLD for as long as the RESET input is grounded.

POWER CORRECTION ANALOG Output. (TB1-9): A DC voltage proportional to the POWER CORRECTION reading is provided for remote metering, logging, external alarms, or other purposes. The output voltage is zero for ZERO CORRECTION, and increases to approximately +3 volts or -3 volts for readings of +15 or -15 counts respectively; the load resistance should not be less than 2,000 ohms.

The power correction analog voltage (and the like specified modulation correction analog output) can be connected directly to any (non-antenna) channel of the Potomac Instruments' DAP-11. The DAP input level adjustments can be set for a full scale digital reading of +/-15, +/-1ØØ%, +/-(power change), or any scale factor convenient for a printed log and/or CRT display; 1ST and/or 2ND LIMITS can be keyed-in, as required.

GROUND. (TB1-1Ø) Wired to chassis. (Note that TB1-1 is not connected)

2.3.4. MODULATION CONTROLLER INTERFACE, TB2 and TB3 (1Ø Terminal Block, on Rear).

AUDIO 1 6ØØ ohms (TB2-5 thru TB-1Ø): These are input, output, and ground terminals for one of the two modulation controller audio channels. Each channel has the following characteristics:

INPUT, TB2-6 and TB2-7: Impedance, 6ØØ ohms or 3ØK ohms, balanced and floating; maximum input level = 14 V P-P (+16 dBm / 6ØØ ohms); maximum common-mode voltage = . Either terminal may be grounded for single-ended operation.

OUTPUT, TB2-9 and TB2-1Ø: Impedance 6ØØ ohms, balanced to ground (like transformer winding with grounded center-tap), 3ØØ ohms either terminal to ground; maximum undistorted output level = 28 V P-P across 6ØØ ohms (+22 dBm / 6ØØ ohms), or 56 V P-P open circuit; half output voltage from either terminal to ground.

GAIN: Voltage gain = Ø dB nominal with 6ØØ ohm load, (either input impedance), +6 dB nominal with no load. From either terminal to ground, gain = -6 dB with 3ØØ ohm load, Ø dB with no load. Gain varied up to +/- 5.8 dB from nominal in response to modulation conditions. Note that the actual modulation controller gain, for a 6ØØ ohm load, is always indicated directly by the MODULATION CORRECTION meter on the front panel.

FREQUENCY RESPONSE: DC to 2Ø KHz, -Ø.2 dB max.; at 1ØØ KHz, -1 dB typ; at 2ØØ KHz, -3 dB typ.

PHASING: The voltage at TB2-9 is in phase with the voltage at TB2-6, as indicated by dots.

BYPASS RELAY: While input terminals 6 & 7 are always connected to the modulation controller input, output terminals 9 & 1Ø are connected to the moving arm of a DPDT relay. The relay connects the output terminals to the modulation controller output when energized, and directly to the input terminals when deenergized. The controller is thus bypassed when the relay is not energized.

CONNECTIONS: In a typical transmitter installation in which processed audio is fed to the transmitter by a 6ØØ ohm balanced line, it is only necessary to (1) remove this line from the transmitter and connect it to TB2-6 and TB2-7, grounding the shield at TB2-8, and (2) run a new line from TB2-9 and TB2-1Ø to the transmitter input terminals, observing phasing. The original connection will then remain until the bypass relay is energized (see TB3-7 below).

Before making connections, however, it must be determined that the signal level normally required to achieve maximum transmitter modulation is no greater than the maximum MPC-11 input of +16 dBm (14 v p-p). If a higher level is needed, attenuation ahead of the MPC-11 and amplification following it are required.

If it is desired to bridge the modulation controller input across an existing 600 ohm line, an internal input terminating resistor must be removed. This 619 ohm resistor is located on an internal PC board, close to the connector bringing the inputs and outputs from the terminal block, and the only resistor parallel to the connector. The input impedance is then 30K ohms.

For line impedances other than 600 ohm balanced, the input and output characteristics listed above must be used to design a system in which under normal operating conditions the gain of the modulation controller is close to its center value, as indicated by a reading of 0 dB on the Modulation Correction Meter.

AUDIO 2 600 Ohms (TB3-1 thru TB3-5): These are input, output, and ground terminals for the second audio channel. The inputs, TB3-1 and TB3-2 correspond to TB2-6 and TB2-7 of Channel 1, and outputs TB3-4 and TB3-5 correspond to TB2-9 and TB2-10 of Channel 1. All description of Channel 1 applies to Channel 2.

USES OF TWO CHANNELS: The second channel may be used to feed audio to a second transmitter and is especially useful when the second transmitter has a different source and input level from the main transmitter. It can be used in an AM stereo installation in which it is desired to control the right and left channels separately ahead of the stereo generator, rather than the L & R output of the stereo generator. If there is no other use for Channel 2, its input terminals may be bridged across the Channel 1 input terminals, with the Channel 2 input resistor removed, to provide a redundant channel in case of a failure in Channel 1.

MPC ON (TB3-6): Refer to TB1-6.

BYPASS RELAY COILS (TB3-7): The coils of the bypass relays for both audio channels are connected between TB3-7 and ground. A jumper must be connected from TB3-7 to TB3-8, in which case the relays are de-energized only when the MPC-11 power supply is de-energized, or to TB3-6, in which case the relays may be de-energized under other conditions as described under TB1-6.

This jumper is supplied connected; it should be removed before set up and kept ready for re-installation during this procedure.

+15V (TB3-8): A power supply output provided to energize the bypass relays. Do not use this source to power external equipment.

MOD CORR (TB3-9): This is a dc voltage proportional to the modulation controller gain (in dB), derived from the same source which drives the Modulation Correction Meter. The open-circuit voltage varies from +0.8 volt at +5.8 dB gain to -0.8 volt at -5.8

dB gain and is zero at 0 dB gain. The source resistance is 4700 ohms.

GND (TB3-10): Terminal connected to the modulation controller circuit ground, which is also chassis ground.

2.3.5 FULL ATS INSTALLATIONS

For installations including the Potomac Instruments' ATP-11 Automatic Transmission Processor at the transmitter site, the MPC is provided with a ribbon cable which is connected from J4, MPC-11 to J5, ATP-11. This connection provides the MAIN, ALT/AUX, PATTERN, and other statuses to the MPC, and returns the various ATS alarm outputs from the MPC to the ATP. Normally, no J4 connections are required from the user.

Most full ATS installations also include a TIU-11 Transmitter Interface Unit. The TIU-11 normally includes an MPC-11 interface cable (a six-conductor drop lead with spade lug terminations), which connects to the raise and lower relay terminals, the MPC-FAIL, the MPC-ON, and the GROUND terminals of TB1.

The modulation controller connections are the same as for stand-alone installations.

2.4 MPC SET UP

2.4.1 NOTES ON POWER CONTROLLER SET UP

The user must consider various factors related to the power controller adjustments:

a. Window. An operating power "window" is defined as the range of power error, symmetrical with respect to normal (zero error) power, within which no power correction is made. The window is user adjustable from approximately +/-1.5% to +/-4.5%. Note that since the same window is set for all patterns and transmitters, the minimum useable window will probably be determined by the transmitter with the greatest carrier shift or other instability. The window adjustment is initially set to +/-3% by the factory.

b. Dwell. A power error outside the window, sustained for approximately 10 seconds, will result in a power correction, unless the power controller is on HOLD for any reason. The power corrections are made by one or more raise or lower contact closures; each contact closure will be of CONSTANT TIME DURATION determined by the DWELL adjustment; a separate DWELL adjustment is provided for each of six power modes. The normal DWELL adjustment range is from approximately 0.1 seconds to approximately 1.0 seconds. (This range can be scaled up or down with a single component value change.)

   The minimum dwell time for a particular transmitter is related to the start-stop inertia of the raise/lower mechanism. The maximum dwell time must never result in a power change which exceeds the window, since this will result in continuous raise-lower cycling, with possible damage to the transmitter.

   The optimum dwell time is that which results in a power correction equal to slightly less than 1/2 the window. For example, with a window adjustment of +/-3%, a DWELL adjustment resulting in a power change of 2.5% to 3.0% will maintain power close to normal conditions with a minimum of cycling.

   The DWELL adjustment also affects the maximum net total power adjustment range and certain protection features discussed below.

c. % ERROR meter. The power % ERROR meter responds to a true-average detector, and is calibrated in carrier-component power relative to normal (zero error) power. Thus, with no carrier shift compensation (see below), the % ERROR indication provides an accurate measure of the transmitter carrier power shift, averaged over the meter response time of approximately 1.5 seconds.

   A transmitter with low modulation related carrier shift should present a minumum of power control problems.

d. Carrier Shift Compensation. If the average carrier-component power changes by more than approximately 4% from zero modulation to full modulation, a wider than normal window adjustment may be required to eliminate raise-lower cycling with program content.

To reduce this problem, a carrier shift compensation circuit has been developed for the MPC power controller. This circuit senses the modulation level, and automatically adds or subtracts a compensating detector component which partially cancels the detected carrier shift. The action of the circuit is delayed until the modulation exceeds approximately 50%, since typically, most carrier shift occurs above this level; the maximum compensation is limited to approximately 6% at 125% positive peak modulation.

Depending on the transmitter design and adjustment, carrier shift can be either positive or negative with increasing modulation. A single-turn screwdriver adjustable potentiometer is provided on the MPC rear panel to set the carrier shift compensation. With the adjustment centered (slot vertical), zero compensation is provided at all modulation levels. Rotating the pot CW or CCW will increase positive or negative compensation respectively, as required.

The effect of the compensation will be apparent as a reduced fluctuation of the % ERROR readings. The adjustment procedure is described below.

Note that the same carrier shift compensation is applied to all controlled transmitters and power levels; thus, a compromise setting may be required in systems incorporating transmitters with different modulation characteristics.

2.4.2 POWER CONTROLLER ADJUSTMENTS

1. Set the front panel TEST switch to OPERATE.

2. Set the AC POWER switch to ON; the green AC POWER lamp and the red MPC-FAIL lamp should both light immediately. Approximately five seconds after AC power is applied, the MPC-FAIL lamp should go out.

3. Set the TEST switch to BATT (battery). The green BATT lamp should light brightly. Return the TEST switch to OPERATE.

   WARNING. Leaving the TEST switch in the BATT position continuously will discharge the battery.

4. In the RF POWER group on the MPC-11 front panel, momentarily press the HOLD-RESET switch to the RESET position, then set the switch to HOLD.

5. Set the MTR (meter) switch to the CORR (correction) position; check that the front panel POWER meter indicates ZERO on the CORRECTION scale, then set the MTR switch to the ERROR position.

6. On the rear of the MPC, set the single turn CARRIER SHIFT potentiometer to the ZERO position (adjustment slot vertical).

7. Carefully adjust the transmitter for proper RF power output with normal modulation.

   NOTE. Depending on the type of RF power meter available (thermocouple RMS or average), it may be best to adjust the transmitter to licensed power with modulation off, and then to reapply normal modulation.

8. Locate the PLUS and MINUS lamps on the rear of the MPC. These lights show whether the adjusted RF sample level is greater or less thanthe level representing zero power error.

9. Note the green front panel lamps indicating the selected pattern (DAY, NIGHT, THIRD), and transmitter (MAIN, ALT/AUX); check that one (only one) pattern and one transmitter lamp are on.

10. Determine which pattern and transmitter indicators are lighted, and locate the corresponding INPUT LEVEL screwdriver adjustment on the rear. If the PLUS light is ON, rotate the INPUT LEVEL adjustment CCW, if the MINUS light is ON, rotate the adjustment CW; continue adjusting to a setting where the PLUS and the MINUS lights just change state or alternately flicker with equal average brightness.

    Check that the reading on the % ERROR meter is very close to ZERO, or is fluctuating symmetrically about ZERO; if necessary, make a small readjustment of the INPUT LEVEL to obtain the "best" ZERO % ERROR reading.

    NOTE. At this point in the procedure, the effects of modulation related carrier shift should be checked. With the modulation controller on HOLD, slowly vary the transmitter modulation from zero to normal level while observing the % ERROR meter. The magnitude and direction of the carrier shift from zero to full modulation, and the amount of error fluctuation during varying program content, will effect user decisions on WINDOW and DWELL adjustments, and the amount (or need for) CARRIER SHIFT compensation.

11. <u>CARRIER SHIFT compensation:</u> (Optional adjustment). Rotate the <u>CARRIER SHIFT potentiometer</u> on the rear panel in the direction which minimizes the change in % ERROR reading from low modulation to full modulation (sustained zero modulation is normally an unrealistic condition). The INPUT LEVEL potentiometer should be readjusted as necessary to obtain the minimum error indication as the modulation is varied.

    As indicated above, it may be necessary to compromise the optimum CARRIER SHIFT compensation to accommodate transmitters of different modulation characteristics.

12. <u>WINDOW Adjustment:</u> The operating power window is factory <u>adjusted to +/-3%.</u> If the OVER power and UNDER power lights both blink occasionally as, the % ERROR reading fluctuates

symmetrically about zero with normal variation in program content, then the WINDOW adjustment (and INPUT LEVEL adjustment) is probably close to optimum for the transmitter under control. Since the same window is used for all operating modes, the "worst" transmitter or power level should be determined for the final window setting.

If the OVER and UNDER lights seldom or never come on for any transmitter or power level, then the window can be reduced by rotating the WINDOW potentiometer CCW on the rear panel. The minimum window is approximately +/-1.5% power. Reducing the window will "tighten" the control on the transmitter power. However, reducing the window will also require smaller power adjustments, that is, a shorter raise and lower DWELL time, as discussed below.

If either the OVER power or the UNDER power lights are on frequently or continuously, check that the INPUT LEVEL is properly adjusted so the reading on the % ERROR meter is fluctuating symmetrically about ZERO error. If the OVER and UNDER lights are alternately on frequently, for any transmitter or power level, then the window should be increased by rotating the WINDOW potentiometer CW. The maximum window is approximately +/-4.5% power.

DWELL ADJUSTMENTS:

NOTE. Because the raise-lower characteristics of different transmitter models vary widely, separate DWELL adjustments are provided for a MAIN and ALT/AUX transmitter for each pattern. Normally the dwell time is adjusted so the change in transmitter power for each closure of the raise or lower relay results in a power change equal to 1/3 to 1/2 the window. For example, with the window adjusted to +/-3% (6% overall width), the DWELL should be adjusted for a power change of from 2% to 3%. DWELL adjustments are usually set to the minimum of Ø.1 seconds by the factory.

13. With the power controller on HOLD, manually mis-adjust the transmitter for a power output of approximately 9Ø% of normal power. The ERROR meter should show the actual power error (1Ø% low), and the UNDER power light should be on continuously.

14. Momentarily press the HOLD-RESET switch to RESET, and then release the switch to the center (normal) position. After approximately five seconds, the green LED in the UNDER-RAISE lamp should blink on, indicating that the raise relay is being momentarily energized. The transmitter power should be automatically raised in steps until the % ERROR meter indication is within the window. Observing the % ERROR meter, note the change in transmitter power corresponding to each closure of the RAISE relay.

    If the DWELL time is too short for the transmitter raise-lower mechanism, power may be changed erratically or not at all. If the DWELL time is too long, the final power change may "overshoot" the zero error condition; in an extreme case, the power change may completely overshoot the window which will result in raise-lower cycling.

15. Determine which transmitter and pattern indicators are lighted on the front panel, and locate the corresponding DWELL screwdriver adjustment on the rear. The 22 turn potentiometer provides a 10:1 range, normally from 0.1 seconds to 1.0 seconds. To reduce the DWELL time, rotate the adjustment CCW; to increase the DWELL time, rotate CW. After rotating the potentiometer a few turns, repeat steps 13 through 15 until the desired power adjustment is obtained.

16. Set the HOLD-RESET switch to HOLD, and manually raise the transmitter power to at least 105% of normal power. The % ERROR meter should indicate the error (+5%), and the OVER power light should be ON continuously.

17. Momentarily press the RESET-HOLD switch to RESET, and then release the switch to the center (normal) position. After approximately five seconds, the green LED in the OVER-LOWER lamp should blink, indicating that the lower relay is being momentarily energized. The transmitter power should be automatically lowered in steps until the % ERROR indication is within the window. Observing the % ERROR meter, check that the incremental raise and lower power changes are approximately the same percentage. A large difference between the raise power change and the lower power change may indicate a problem in the MPC or in the transmitter raise-lower mechanism.

18. Check, and repeat if necessary steps, 13 through 17 until the proper operation is obtained.

This completes the normal set-up for one transmitter. The INPUT LEVEL and DWELL adjustments will have to be performed for each transmittter and/or power level. The WINDOW and CARRIER SHIFT adjustments may have to be compromised to accommodate all operational situations.

It would be anticipated that the set-up adjustments will be optimized as the user gains experience with the features and characteristics of the MPC and the transmitter system.

The INPUT LEVEL adjustments should be checked on a 30 day maintenance/calibration schedule; the DWELL, WINDOW, and CARRIER SHIFT adjustments, once finalized, should not require resetting.

2.4.3 MODULATION CONTROLLER ADJUSTMENTS:

NOTE: It is assumed at this point, that all RF, audio, and control connections to the MPC-11 have been made as described in Section 2.3, MPC Interface.

Before setting up the modulation controller the power controller setup procedure, steps 1-10 of Sections 2.4.3, must be completed. Then proceed as follows:

1. Set the rear panel switches as follows:

POSITIVE MODULATION LIMIT: to the desired maximum positive modulation level.

NEGATIVE MODULATION LIMIT: to the desired maximum negative modulation level.

UNDER MODULATION LIMIT: to the modulation level below which the controller should not respond. An initial setting of 70 per cent is suggested.

GAIN STEP PERIOD: to the desired time period between gain increase steps. An initial setting of 1.9 sec. is suggested. (3.8 sec for s/n 101, 102, and 103).

2. Check that the Bypass Relay Coil jumper has been removed but is ready at hand.

3. To place the Modulation Controller in operation for the first time:

a. Operate the transmitter with modulation applied and check for normal operation. Note that the transmitter modulation input is now connected directly to the audio source because the MPC bypass relays are de-energized.

b. Set the HOLD-OPERATE switch to HOLD. The HOLD lamp should come on.

c. Set the CORR-0 dB switch to 0 dB long enough to see the Modulation Correction Meter reading settle at 0 dB.

d. Install the Bypass Relay Coil jumper between TB3-7 and TB3-8 and observe transmitter operation. Audio is now being supplied to the transmitter from the modulation controller because the bypass relays are now energized, but if connections are correct the level should be the same as in (a) above. No change in transmitter operation should be seen.

e. Set the HOLD-OPERATE Switch to OPERATE. The modulation controller should now vary its gain to maintain the desired modulation conditions, and small changes in the Modulation Correction Meter reading should be observed. The indicator lamps also show the action being taken by the controller as described in Section 3.

4. Observe modulation controller operation over an extended period with different types of modulation, at the same time watching the station's Modulation Monitor. If it is desired to modify the controller's action, the rear panel controls may be further adjusted with the help of the following notes.

a. To reduce gain fluctuations: A longer Gain Step Period will result in less gain variation because the rate of gain increase will be lower. A higher Under Modulation Limit will have a lesser effect, by reducing the range of peak values the controller will try to correct. The gain variation should be less than 1 dB most of the time, but may be greater for a lower-than-normal level program source, or for music with long soft passages.

b. To change peak modulation as observed on the Modulation Monitor: It is likely that in some installations the peak limits set by the modulation controller may appear to disagree with the peak indications of the Modulation Monitor. The Positive Limit and Negative Limit switches may be adjusted to obtain the desired result as indicated on the Modulation Monitor, but a large disagreement should be cause for concern.

c. Rapid gain reductions greater than 1 dB may be caused by high modulation at high frequencies. Such an effect can be reduced by adjusting the Pos LPF and Neg LPF adjustments clockwise until the desired effect is observed. If the Positive Limit switch is set at 125 per cent, however, use of these adjustments may allow the 125 per cent limit to be exceeded.

d. To increase response speed, reduce the Gain Step Period setting.

e. Rapid small gain changes may occur under some conditions of asymmetrical modulation, when the negative modulation peaks are greater than the positive modulation peaks. In this case the negative peaks tell the controller to reduce gain, while the positive peaks tell the controller to increase gain at the same time. The resulting gain changes may be rapid but are usually small and have no effect perceptible to the listener.

SECTION 3
OPERATION

3.1 CONTROLS AND INDICATORS

CENTER GROUP

AC POWER switch:	In OFF position, opens one side of AC line, after fuse; also disconnects battery. Note that locking-type toggle must be pulled out from panel to change position.
AC POWER lamp:	Lights when +15V and -15V supplies, and battery voltage, are within tolerance.
TEST switch (11 positions):	OPERATE position for normal operation. Ten remaining positions provide MPC and ATS test functions described in MAINTAINENCE section.
DAY, NIGHT, THIRD lamps:	Indicates selected antenna pattern and/or power level status. One (only one) light must be on for normal operation
MAIN, ALT/AUX lamps:	Indicates selected transmitter status. One light must be on for normal operation.
BATT lamp:	Variable brightness indicates state of charge of 9V battery, when TEST switch in BATT position; light off for voltage less than approximately 6V.
MPC-FAIL lamp:	Indicates MPC-FAIL condition. Implies MPC-FAIL ALARM output.

MODULATION GROUP

CORR(INCR/DECR)-Ødb switch:	Used to preset modulation controller gain. CORR INCR (mom), with TEST switch in INCR position, causes gain to increase in Ø.1 dB steps, at a rate determined by GAIN STEP PERIOD switch, on rear. CORR DECR (mom), with TEST switch in DECR position, causes gain to decrease in Ø.1 dB steps, at a rate determined by modulation conditions.

ØdB (mom) sets gain to unity.

OVER MODULATION lamp: Short blink indicates reduction in modulation caused by positive or negative peaks exceeding setting of POSITIVE LIMIT and/or NEGATIVE LIMIT switch, on rear.

Steady ON indicates over-modulation condition (1Ø peaks exceeding +125% or -99% per minute); remains ON for up to 6Ø seconds after condition corrected. Implies OVER MOD ALARM output.

UNDER MODULATION lamp: Short blink indicates step increase in modulation, because no positive peaks exceed level 5% below setting of POSITIVE LIMIT switch, for time equal to ten times setting of GAIN STEP PERIOD switch, on rear.

Steady CN indicates under modulation condition (no positive peaks exceeding setting of UNDER LIMIT switch, on rear, for approximately 1Ø seconds). Causes modulation controller HOLD; implies UNDER MOD ALARM output.

MODULATION OUT lamp: Indicates no positive peaks exceeding 1Ø% modulation for approximately 3Ø seconds. Causes modulation controller HOLD; implies MOD OUT ALARM output.

MOD CONTROLLER HOLD lamp: Indicates modulation controller is on HOLD (gain held constant at value existing when lamp lights). Implies MOD CTL ALERT output.

HOLD-OPERATE switch HOLD position places modulation controller on HOLD

OPERATE position provides normal operation.

MODULATION CORRECTION meter: Indicates modulation controller gain (both channels) from -6 dB to +6 dB, relative to Ø dB = unity gain. Pointer at outer ends of red shaded areas indicates gain limits reached, causing HOLD condition.

POWER GROUP

CORR-ERROR MTR switch: Selects CORRECTION or %ERROR POWER meter scales. (Does not effect POWER CORRECTION ANALOG output.)

OVER POWER lamp: DIM RED indicates power greater than window.

BRIGHT RED indicates over-power condition (power > 105% of normal); after 15 seconds, implies OVER PWR ALARM output.

GREEN indicates LOWER relay energized.

UNDER POWER lamp: DIM RED indicates power less than window

BRIGHT RED indicates under-power condition (power < 90% of normal); after 15 seconds, implies UNDER PWR ALARM output.

GREEN indicates RAISE relay energized.

POWER OUT lamp: DIM RED indicates power less than 80% of normal. Causes power controller HOLD; implies PWR CTL ALERT output.

BRIGHT RED indicates power less than 5% of normal; implies PWR OUT ALARM output.

POWER HOLD lamp: Indicates power controller is on HOLD. Implies PWR CTL ALERT output.

HOLD-RESET switch: HOLD position places power controller on HOLD

RESET (mom) position sets power correction counter, and CORRECTION meter to ZERO.

POWER meter: CORRECTION scale indicates NET power adjustment (raise minus lower contact closures) from -15 to +15 counts. Red shaded area implies PWR CTL ALERT output.

% ERROR scale indicates transmitter power error relative to normal (zero error) power, from -13% to +7%. Red shaded areas shows over-power and under-power conditions.

3.2 SUMMARY of HOLD CONDITIONS

MPC HOLDING (MODULATION AND POWER CONTROLLER HOLD LIGHTS BOTH ON)

a. MPC-FAIL condition. MPC-FAIL light on, POWER LIGHT OFF if related to power supply or battery problem.(Check battery.)
b. No connection from TB1-6 to TB1-7. (See par. 2.3.3)
c. PROGRAMMED HOLD status input is HIGH. (See par. 2.3.2)
d. ATS-ON status input is false (HI). (See par. 2.3.2)
e. No MAIN or ALT/AUX status and/or no DAY, NIGHT, or THIRD pattern status, as shown by front panel indicators. (See par. 2.3.2)
f. PWR CTL and MOD CTL on HOLD for different reasons.(See par. 3.2)
g. TEST switch not in OPERATE position.

POWER CONTROLLER HOLDING (PWR HOLD LIGHT ON).

a. Power controller at end of range. Check POWER CORRECTION meter.
b. Input level low; PWR OUT light ON dim or bright indicating power sample less than 80% of normal. (See par. 3.1 and 3.4)
c. RESET-HOLD switch in HOLD position.
d. External RESET-HOLD input LO(grounded) at TB1-8.(See par. 2.3.3)

MODULATION CONTROLLER HOLDING (MOD HOLD LIGHT ON).

a. HOLD-OPERATE switch in HOLD position.
b. Modulation controller attenuation at end of range, indicated on MODULATION CORRECTION meter.
c. Modulation percent less than UNDER LIMIT switch setting on rear; UNDER MOD lamp on.
d. Modulation percent less than 10%; MOD OUT light ON.

3.3 AC POWER and BATTERY

Note that a locking-type toggle switch is provided for AC POWER to prevent inadvertent change in position; the toggle must be pulled away from the panel to be moved. In the OFF position the AC POWER switch also disconnects the internal battery. If the MPC-11 is unplugged and not being used, the AC POWER switch should be set to OFF to conserve the battery. If the MPC is operating when AC POWER is lost, the modulation controller correction and the power controller correction will be "remembered" because of the battery back-up of the controller circuitry. This feature prevents a "bump" in modulation level as AC power returns and insures that the net POWER CORRECTION count and meter reading will be retained.

For any of the conditions listed in par. 5.2, the MPC-FAIL lamp will light, the MPC will go on HOLD, and the MPC-FAIL alarm output will go TRUE. Note that the MPC-FAIL condition persists for approximately 5 seconds after valid AC line power is applied; thus, a momentary AC "drop out" will cause a 5 second MPC-FAIL ALARM.

3.4 POWER CONTROLLER OPERATION

Once set up, the power controller should require a minimum of user attention.

Under normal operation, only green lamps should be lighted continuously. Typically, the OVER or UNDER lights will occasionally blink dimly, indicating that the power has momentarily drifted outside the power window.

If the power controller goes on HOLD, no automatic power adjustments will be made; if the HOLD lamp is lighted, the cause should be detemined immediately. (See par. 3.2.) Note that the power level alarms will remain active in the HOLD condition.

If the power controller goes on HOLD or if the net POWER CORRECTION exceeds the count indication in the red shaded area of the POWER CORRECTION scale, the POWER CONTROLLER ALERT output will become TRUE; this output (or any other power controller function) is not affected by the position of the MTR switch.

If an OVER or UNDER lamp is lighted for five seconds continuously, and if the power controller is not on HOLD, the RAISE or LOWER relay will momentarily close for the "dwell" duration, causing a transmitter power adjustment; a RAISE or LOWER contact closure is indicated by a blink of the green LED in the corresponding RAISE or LOWER lamp.

An OVER or UNDER lamp lighted brightly indicates that the power has drifted more than 5% high or 10% low respectively; this is an out-of-tolerance condition and, if it persists for more than 15 seconds continuously, the corresponding OVER POWER or UNDER POWER alarm output will go TRUE.

If the sample drops below a level corresponding to approximately 80% of normal power (a condition defined as power "DOWN"), the OUT lamp will become dimly lighted, and the power controller will go on HOLD.

If the RF power drops below 5% of normal power, the power OUT lamp will become brightly lighted, the power controller will go on HOLD, and the POWER OUT alarm output will go TRUE. For ATS applications, the POWER OUT alarm is used as a status to indicate that transmitter power has decayed to a safe level before automatically changing patterns.

For full ATS operation, the alarm outputs described above cause corresponding lights and aural alarms on the MAP-11 at the monitoring and alarm location. Certain of these statuses are defined by the FCC as "FAIL-SAFE" or "ALARM" conditions which must be implemented for legal ATS operation. The OVER MOD, OVER PWR, UNDER MOD, and UNDER PWR alarms cause like-named FAIL-SAFE or ALARM conditions. The POWER OUT alarm is logically OR'd with the MODULATION OUT alarm, to produce the FCC defined TRANSMISSION OUT ALARM condition. The MPC-FAIL alarm is logically OR'd with the DAP-FAIL alarm (derived from the DAP-11) to produce the FCC defined SAMPLE FAIL FAIL-SAFE condition.

The POWER CONTROLLER ALERT and the MODULATION CONTROLLER ALERT alarms cause a like-named light on the MAP-11; "ALERT" conditions are not FCC defined.

The raise-lower characteristics of a typical modern transmitter are usually quite symmetrical. That is, if the raise function is energized for a certain time duration--say 2 seconds--and then the lower function is energized for exactely the same time duration--2 seconds--then the transmitter power will return to the same value as before the raise-lower operation.

The power controller normally corrects for RF power variations caused by primary voltage fluctuation, changes in environmental conditions, and very often, inexact adjustment of transmitter power controls for one or more patterns; these,and other sources of power variation, are more or less cyclical over a 24 hour period. Under these conditions, the net (raise minus lower) power corretion will typically vary between certain plus and minus readings over the day, but will remain within these corretion "peaks" over a number of days or weeks.

Howerever, because of the open-loop nature of the power adjustment estimator(counter), and with small assymmetries in the system, it would be expected that over long periods of time, the net correction reading would gradually move towards one end of the CORRECTION meter scale; for this reason, the correction count should be checked, and reset if necessary, at normal maintainence intervals.

On the other hand, if the operator finds that the net power corretion is drifting toward the maximum plus or minus reading within an abnormally short time period (hours or days instead of weeks), he should interept this effect as an indication that a problem may be developing in the system. For example, a rapid accumulation of RAISE corrections may indicate a "soft" final amplifier, failing IPA or exiter, or a failing power sample.

SECTION 5
MAINTAINENCE

5.1 SCHEDULED CHECKS AND MAINTENANCE.

For ATS operation, the FCC has specified that "the ATS equipment shall have facilities to permit testing of the automatic control and alarm devices (which) may be accomplished without interrupting the station transmission." A TEST switch has been provided on the MPC-11 front panel to simulate various modulation and power conditions including all FCC defined FAIL-SAFE and ALARM conditions. It should be emphasized that these TEST switch settings do not simply light a lamp and/or output a status, but instead simulate the condition in a way which tests as much of the pertinent MPC circuitry as is practical.

For proper operation of the power controller tests, the POWER %ERROR must not exceed +/-4%. Note that the MPC will go on HOLD for all TEST switch positions, except OPERATE (normal operation).

To check the power controller operation, set the power controller on HOLD, manually raise (lower) the transmitter power approximately 5%, and then set the HOLD-RESET switch to the center (operating) position; the power controller should automatically lower (raise) the power to within the window. Check both RAISE and LOWER operation.

5.2 SUMMARY of MPC-FAIL CONDITIONS

Any of the following conditions will cause the MPC-FAIL lamp to come on and the AC power lamps to go out:

a. AC line voltage less than approximately 90 volts.
b. +15V or -15V regulated supplies less than approximately [12V] or +15V supply greater than approximately 18V.
c. High ripple on + or - supplies.
d. Battery voltage less than approximately 6V.
e. TEST switch in MPC-FAIL position.

Any of the following conditions will cause the MPC-FAIL lamp to come ON with the AC POWER lamp remaining ON:

f. RAISE relay and/or LOWER relay energized continuously for more than approximately 5 seconds.
g. RAISE relay and LOWER relay energized simultaneously (no delay).
h. Short circuit to ground on MPC-FAIL output at TB1-6.
i. MPC-FAIL condition persists for 5 seconds after application of normal line voltage.

W.W. MPCMANUAL
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