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SERVICE BULLETIN

MAINTENANCE AND MODIFICATION DATA

Broadcast Products Division

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Equipment: MW-5/5A **Date** April, 1980

SUBJECT: TROUBLESHOOTING TIPS AND UPDATE INFORMATION.

The contents of this bulletin are troubleshooting tips intended to simplify problems that can require extensive troubleshooting. Additional information concerning transmitter operation and product improvements is also provided in this bulletin.

I. PROBLEM: DC overloads as soon as the high voltage is turned on.

A DC overload is sensed in the return lead of the high voltage supply at 1R17 or in the step start circuitry of the high voltage transformer primary. In early MW-5 transmitters not having the step start overload sensing circuit (A4A1 K4), a DC overload at turn-on may be characterized by blown step start resistors. If your transmitter lacks the protection for the step start resistors, some of the methods employed in the following procedure may not be feasibly applied to your situation.

Disconnect the audio lines from the transmitter.

Carefully observe the actions of the plate current and power output meter while depressing the HIGH VOLTAGE ON button. If the plate current meter in the isolated plate section momentarily deflects upscale the overload current is being conducted through the modulator section (the PA and modulator are in series, with the plate current meter between the modulator plate and the PA cathode). If the power output meter also deflects upscale, the RF section is indicated to be functioning correctly. If neither the plate current meter nor the power output meter deflect as described, it is evident that the overload current is not through the PA tube or modulator section. You will probably find that the supply current meter deflects upscale when the high voltage is applied.

Having made these important initial observations, you can quickly arrive at the specific cause of the problem. Below are some specific causes, listed under some general headings. The sequence of the steps listed under each heading is primarily based on the most likely source of the problem. Each step assumes that the preceding step has been done.

A. DC Overloads - Plate current meter does not momentarily deflect.

1. Bad DC blocker 1C12 or RF bypass capacitor 1C11. Disconnect the plate of the PA tube and either of the modulator screen circuit breakers (be sure to tape the loose wire to avoid shorting to ground). Turn the high voltage on. If a DC overload occurs, then 1C11 and/or 1C12 are possibly the problem. Remove them from the transmitter and turn the high voltage on. If the high voltage stays on, 1C11 and/or 1C12 are defective. Install one of them in 1C11's position to determine which is bad. You cannot effectively check them with an ohmeter or capacity checker.

2. Shorted filter capacitor 1C1 and/or C15. Disconnect the positive output from the rectifiers. The transmitter should not overload then if either capacitor is at fault.

3. Shorted rectifiers. The high voltage rectifiers can be checked for shorts with an ohmeter. It is important to remember that high voltage rectifiers typically measure open or a high resistance in the forward direction. This is because the forward voltage drop of the rectifier is often greater than the battery voltage of the ohmeter. You should never measure resistance less than infinity in the negative direction.

B. DC Overloads - Plate current meter deflects, power output meter does not.

1. Complete loss of PA grid drive. The PA tube developes its bias from the RF drive, so it will conduct heavily without it. To check the PA grid drive, turn the filaments on and ground terminal 5 of the RF oscillator board. The PA grid current will generally be slightly higher than its usual value when the high voltage is on.

   If low or zero PA grid current is the cause for the overloads, the overloads will not occur with the PDM off (power controls set for minimum or terminal K of the PDM control board grounded).

   If there is no PA grid current, check the oscillator board for output, RF DRIVER VOLTS, IPA I, RF DRIVER I, and the condition of the PA grid circuit components.

   Each output of the RF modules (A1-A5) should be a squarewave whose duty cycle is 50 ± 5%. The ringing on the squarewave is normal. The fault indicators

for the RF DRIVER modules (DS2-DS5) sense differences between the module output signals, therefore, will illuminate only if there is output from at least one of the RF modules.

No output (22-35 volts peak to peak) from the RF oscillator could be caused by:

a. +30V not present on the board. Check fuse.

b. Defective crystal. Switch to the other oscillator.

c. Defective oscillator transistor 1A2A1 Q1 or Q2. Switch to the other oscillator.

d. 1A2A1 CR1 shorted. Measure for 15V at the cathode.

e. 1A2A1 CR2 shorted. Measure for 5.1V at the cathode.

f. 1A2A1 Q3 defective. Check for the 5V squarewave at the collector.

g. 1A2A1 U1 defective. Check for squarewave output at the carrier frequency at terminal 8 of the oscillator board.

h. 1A2A1 Q4 shorted. Check 1A2A1 R23 and R24 for over-dissipation.

Causes for zero IPA current would be:

a. No drive to the IPA input. Check continuity from pin 3 of the oscillator board to pin 1 of the IPA module.

b. 1A2A3 F1 blown and probably Q1 and Q2 on the IPA module are shorted.

Other than a failed RF DRIVER module, the cause for low RF DRIVER current is most likely in the PA grid circuit, resulting in an unloaded condition for the RF DRIVER. Check RF DRIVER volts. If this is normal, proceed to examine the PA grid circuit for broken connections. Check for open grid resistors. Change the PA tube if nothing is found.

C. DC Overloads - Plate current and power output meter deflect.

This is indicative of a modulator problem.

1. Disconnect the plate of the modulator and either of the modulator screen circuit breakers (be sure to tape the loose wire to avoid shorting to ground). Check to see if the overload still occurs. If it does, 1C5, 1C8, 1C10, or 1CR15/1CR16 are shorted. The best method of pinpointing the faulty component is by disconnecting each of them one at a time until the bad component is found. Be sure to leave the modulator plate and modulator screen circuit breaker disconnected until that time. You cannot effectively check these capacitors with an ohmeter or capacity meter. The high voltage test in the transmitter is most effective.

2. If the DC overloads will not occur with the modulator plate and modulator screen circuit breaker disconnected, reconnect only the plate. A DC overload under these conditions would indicate a bad modulator tube or a loss of modulator grid bias. Check the modulator grid voltage with just the filaments on. It should be approximately -230V. If this is not so, it could be a fault of the bias supply on 1A5, Q2 on the Audio Driver, or CR8-CR11 on the audio driver. Measure the voltage at 1A1TB1-21 to determine if the bias supply is working. Q2 on the Audio Driver may be removed at this time since its only purpose is to boost positive modulation capabilities. The voltage drop across 1A1A3 CR8-CR11 should be about 230 volts with the filaments on. Normally the modulator grid voltage will remain at -230 volts with the modulator screen circuit breaker disconnected and the high voltage on.

3. If the DC overloads happen only when you reconnect the modulator screen circuit breaker, this indicates the PDM signal is always in a full-on state. This is a fault of the circuitry driving the modulator tube.

   a. Reconnect the modulator screen circuit breaker. Ground terminal K of the PDM control board. Test the transmitter again for overloads. If no overloads occur, then the damper diodes, PDM oscillator, and negative feedback are suspect. The damper diodes 1CR1 - 1CR13 may be checked individually with an ohmeter. The PDM oscillator output can be checked with a scope at the collector of 1A1A1 Q2 while the filaments are on. The first step towards fixing a possible negative feedback problem is replacing 1A6 CR1. Negative feedback will not be present unless there is RF power output. Other checks of the feedback circuit may be made with an ohmeter.

b. If the transmitter still overloads with terminal K of the PDM control board grounded, there is a problem on either the PDM or Audio Driver boards. At this point, it is important to remember that the modulator screen supply provides the positive voltage for the Audio Driver 1A1A3, and is only energized when the high voltage contactors are closed. Disconnect at least 2 of the 3 wires from the primary of T4, the high voltage transformer. Ground terminal K on the PDM control board. Turn the transmitter on. A modulator screen overload may occur due to the fact the plate is disconnected. If so, turn the modulator screen voltage down. Note the action of the modulator grid voltage when depressing the plate on button. Normally the voltage will not change, but in this case will swing towards zero volts.

Causes for this are as follows:

1A1 CR1 shorted. Check for 39V at cathode with the filaments on.

1A1A3 Q2 shorted. It should already have been removed.

1A1A1 Q5 shorted. The collector voltage of Q5 is approximately 4 volts in its normal on state and 8 volts in its off state with just the filaments on. The off state voltage increases to 10 volts with the screen supply energized. Q5 should be off with terminal K grounded.

1A1A1 Q3 shorted. Measure the voltage drops of 1A1A1 CR3 and the base emitter junction of Q4. Each should be about 0.6 volts normally, indicating that Q3 is turned off. 1A1A2 terminal K should still be grounded for this measurement.

II. PROBLEM: Poor positive peak capability.

Drive the transmitter directly with an audio signal generator. The enhancer in the MW-5A should be bypassed. Verify the positive peak limit with a scope connected to the modulation monitor output of the transmitter. Remove audio from the transmitter.

Causes for poor positive modulation capability are as follows:

1. Low supply voltage. Compare your present supply voltage with that on the factory test data. 13 to 14.5 KV is typical.

2. Low PA grid current. Grid current of greater than or equal to 225 MA is usually sufficient for positive peak performance. A bad PA tube, an open grid resistor, a failed RF DRIVER module, or low output from the oscillator board can cause low PA grid current. A downward deflection of PA grid current with modulation may indicate that the PA tube is bad or that the neutralization circuit is broken or severly misadjusted.

3. Poor PA efficiency. Compare the efficiency with the factory test data. Check the tuning of the third harmonic resonators. The grid resonator should be adjusted for a dip in plate voltage. The plate resonator should be adjusted for a peak in the efficiency reading on the output meter or by adjusting for the correct PA plate waveform on a scope.

4. Poor modulator efficiency. Compare the supply current with that on the factory test data. High supply current confirms that the modulator efficiency is poor. Causes for poor modulator efficiency are as follows:

   a. Inefficient drive to the modulator. Check the PDM signal at pin 10 of the audio driver with a scope. The signal should closely resemble that shown on the PDM and audio driver schematic. If it does not, trace the signal back through the audio driver and PDM boards. Components that typically degrade the slope of the PDM signal are leaky zener diodes coupling the PDM signal and the transistors which amplify it. The slope of the PDM signal is important with respect to modulator efficiency and audio distortion.

      Once you have located the area where the signal differs in shape from that shown on the board and schematic, try substituting new components for the suspected ones. You may otherwise find it difficult to determine which component is at fault. In this case, a component has developed an unacceptable amount of leakage.

   b. A bad modulator tube. Substitute a different one.

   c. PDM frequency grossly out of its normal range. Typically the range of adjustment is 70-90 Khz. The greatest sensitivity to PDM frequency is 10 Khz distortion. Secondary effects are noise and frequency response.

   d. Grossly improper PDM filtering. Place a scope probe through the screen mesh above the modulator tube to sample the modulator plate waveform. Except for a small amount of ringing on the top of the signal, it should

look very much like the grid signal (Pin 10 of the Audio Driver). If this signal is distorted at the plate, but not at the grid, there is a filtering problem. A physical inspection of 1L1, 1L2, and 1L3 is recommended. A change in the inductor will most likely be visible. Capacitors 1C5, 1C8, and 1C10 should be substituted, but a capacity checker may be able to locate the bad capacitor.

e. Bad tube socket. Check the modulator screen current and make continuity checks to verify that the screen voltage is actually getting to the tube.

III. Poor Frequency Response

1. Check the negative feedback voltage at terminal N on the PDM control board. It should be -12 to -16 volts with 5 Kw output.

2. If the frequency response rolls off several DB at 10 Khz, examine the PDM filter coils 1L1-1L3. A change in these coils is usually visible.

3. Check the PDM frequency. It should be in the range of 70-85 Khz. Changes within this range have an effect on 10 Khz distortion, noise, and a relatively small effect on response.

4. Make substitutions in the PDM filter for 1C5, 1C8, and 1C10. Improper PDM filtering will affect high frequency response.

5. Poor antenna sidebands can also affect high frequency response. Test the transmitter into a dummy load and/or make an impedance sweep of the antenna.

6. Components which could affect low frequency response are 1A1A2 T1, C3, and C5.

IV. High Distortion, Several Percent at All Frequencies

1. Troubleshoot the shape of the PDM waveform without audio as in 4a under Poor Positive Peak Capability in this bulletin.

V. PROBLEM: No power output, no plate voltage, no plate current with high voltage circuitry activated.

1. Check the multimeter for the presence of supply voltage and screen voltage. Each supply should be energized

when the high voltage circuitry is on. Absence of either voltage will cause this symptom except that a modulator screen overload may occur if the 14 Kv supply voltage is missing.

2. Note the modulator bias reading with the high voltage on.

   a. If it is at or near zero, the circuitry driving the modulator is probably working properly. Check the modulator screen current reading. If it is high, the modulator plate circuit may be open. Low or zero screen current under these conditions would indicate a bad modulator tube, open screen circuit, or possibly an open cathode circuit. Remove all primary power and check continuity from the modulator plate to the PA filament. It should measure less than 100 ohms. Ohmeter checks of the screen and cathode circuits may also be made.

   b. If the modulator bias is over 200 volts negative when the high voltage is on, the PDM and Audio Driver are holding the modulator tube cut off. Remove any connection at 1TB2-9 (EBS/Phasor Off) which may be holding the PDM Off.

      Aside from the EBS/Phasor Off and the adjustment of the power controls, components likely to cause the modulator bias to be fully negative with the high voltage on are as follows:

      1A2A2 K6 The contacts may be sticking in a closed condition or the relay coil is not being de-energized by 1A4 K4 when the high voltage is turned on.

      1A1A3 Q1 shorted.

      1A1A3 CR15 Measure 47 volts at the cathode of CR15 with the high voltage circuitry activated.

      1A1A3 CR1-CR6 shorted.

      1A1A1 Q4 shorted.

      1A1A1 CR4 shorted. Measure 15 volts at the cathode.

      1A1A2 R22, R23 open. Check with an ohmeter, or measure forward bias on the base emitter junction of 1A1A1 Q3 (approximately 0.6 volts).

Neutralization

Neutralization is not particularly critical on this transmitter. Tube replacements may be made without re-neutralizing.

Should you desire to check neutralization, follow either of these procedures. Disconnect all primary power. Connect an RF signal generator to the bottom side of 1A3 C12 in the PA section. Disconnect the RG-58 coaxial cable at C12. Set the signal generator to your carrier frequency. Connect a scope to the plate of the PA tube. Adjust the neutralization capacitor for minimum deflection on the scope.

Another method of neutralizing is by using the RF driver as the signal source. Ground terminal 5 of the RF oscillator board with just the filaments on. Loosely couple the PA plate to an oscilloscope by placing a scope probe through the screen above the PA. Adjust the neutralization capacitor for minimum deflection on the scope.

VSWR Trip Adjustment

Turn the high and low power controls to minimum. Turn the transmitter off and remove, then invert the directional coupler. The reflected portion will now sample forward power. Switch the power output meter to reflected. Turn the transmitter on and gradually turn the power output up until 400 watts is registered on the meter. The VSWR circuit should trip at this point. If adjustment is necessary, turn 1A2A2 R26 fully clockwise. Turn 1A2A2 R32 3/4 of its rotation counter-clockwise. With the power output meter reading 400 watts reflected, adjust R26 counter-clockwise until a VSWR trip occurs. Turn the power controls to minimum, then gradually bring the transmitter power output up. Observe where the VSWR trip point occurs. If necessary, adjust R32 to obtain the correct threshold of 400 watts.

Tube Life

Generally this has been 3-4 years for both the PA and modulator. Signs of aging could be:

1. A gradual increase in distortion.

2. A gradual reduction in positive peak capability.

3. Steadily decreasing PA grid current.

4. Filament voltage having an effect on distortion, positive peaks, and grid current.

Multiturn Power Controls

A multiturn replacement is now available for the high and low power controls. It is a direct replacement for CTS type 305, Bourn 3861C-122-253A, and Allen Bradley GP2604 OS 253 MA.

It is not a direct replacement for the flat, blue CTS or Mallory potentiometers as are used for the dissipation and carrier shift controls. The flat CTS and Mallory potentiometers were used for high and low power controls in early productions, therefore, these potentiometers will not be printed circuit board compatible with some older MW-5 transmitters. Check to see what your transmitter uses before ordering this part.

Part Number	Description
550-0976-000	25K ohm 3/4 watt multiturn cermide thick film CTS type VA305