PATRICK S. FINNEGAN

A. M. Monitoring Problems

• The modulation monitor should provide us with reliable information about the carrier modulation during programming and yield accurate results when we are performing tests of the transmission system. There can be component failures in the monitor, as well as incorrect calibrations or operations, which produce erroneous indications. Faults in the transmitter itself may produce misleading indications on the monitor. This month we will discuss some of the problems of monitoring and testing the system.

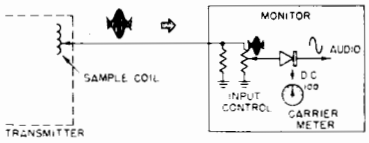


Figure 1. Adjust sample coil taps to keep feed within specs. Then adjust input control so the carrier meter indicates 100.

RF INPUT LEVEL

Almost all of the functions in the monitor depend upon the audio output of the detector for their correct operation. The audio coming from the detector is determined by the rf input level to the detector. Maintaining the correct rf input to the detector is very important for the accuracy of the monitor.

There are two aspects of level control that must be considered: the amount of rf which is fed into the monitor, and the amount of rf fed into the detector. The monitor feed can be checked out with an oscilloscope and then taps changed in the transmitter so that this level does not exceed the amount specified in the manual for that monitor—excessive power at this point will burn out cable terminating resistors (if used) and the monitor input potentiometer. Once the feed amplitude is checked to be within specified limits, the input control on the monitor should be adjusted so that the carrier level meter on the monitor reads 100 (without modulation).

POWER CHANGE

Although the rf level into the detector must be constant, many stations operate at a different power level at night than they use during the day. These power changes can be very substantial; for example, 5 kW day—1 kW night, 1 kW day—250W night, etc. Where a special receiver is used ahead of the monitor, the AGC action will usually maintain the output reasonably constant over a 12 dB input change. Late model transmitters incorporate an automatic circuit to do this, with a direct feed to the monitor. Older model transmitters do not have the automatic correction and must be adjusted manually at the monitor.

The automatic circuit in the transmitter is usually a relay and a wirewound potentiometer. If the relay fails to operate it is quickly obvious because the monitor shows some drastically different indications. A more common but lesser problem occurs when the wirewound potentiometer straddles a couple of the wires in the pot and produces an erratic output that changes the monitor input only a few per cent, but throws the monitor indications off this same amount. The best cure for this problem is to change the tap on the sample coil in the transmitter until a position is found where the pot can operate at a more solid position.

CARRIER SHIFT

Carrier shift is a transmitter problem that can produce inaccurate modulation indications on the monitor. The shift can be either positive or negative, but the most common variety is negative carrier shift. Many of the older transmitters exhibit considerable carrier shift when being modulated at high levels with superprocessed audio. Carrier shift is basically a decrease (or increase) in the average carrier power during modulation, and it has essentially the same effect on the monitor as lowering the rf input level control to the detector by the same amount. If carrier shift is a problem with your transmitter, here is a way to check out its effect on the

monitor indications of modulation.

Observe the rf signal coming out of the transmitter on an oscilloscope, set the monitor input to 100 on the carrier meter, and then modulate the transmitter to 100 per cent negative with an audio tone. Increase the modulation level until the two negative envelope peaks just "kiss"—this is 100 per cent negative modulation. (Assume the transmitter has 5 per cent negative carrier shift.) The carrier level meter on the monitor will now indicate 95 instead of 100, which you had set previously. The modulation meter will indicate about 95 per cent modulation, and if you check the flasher circuit, it will indicate 95 per cent modulation. Thus, the monitor indicates 95 per cent modulation, yet the 'scope verifies the fact that the carrier is 100 per cent modulated! If the station is operating with this amount of carrier shift, the technicians should be alert to the fact that when the monitor indicates peaks of 95 per cent that is 100 per cent modulation.

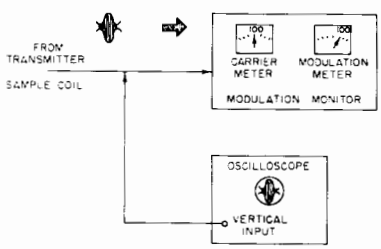
Operational problems can occur if the operator is not alert to the effect on modulation indications caused by carrier shift. In the example just discussed, if the operator should observe that only 95 per cent is shown on the monitor, he may try to increase the modulation up to 100 per cent indication by increasing the audio input to the transmitter. This would now overmodulate the transmitter, cause channel "splatter" and increase distortion.

When carrier shift develops in a transmitter that normally exhibits very little shift, the carrier level meter will indicate this and should warn the operator that troubles have developed or are brewing in the transmitter. The p.a. tube may be going sour, or a solid state p.a. module is defective or some similar problem is present.

LINEARITY

Poor linearity in the transmission system can create problems in monitoring, as well as in the audio signal itself, and it can also be an indicator of problems that are brewing, but at this stage are only showing up as poor linearity. (Our concern here is for the input/output signal amplitude fidelity,

Figure 2. A setup to measure the effect of carrier shift on monitor indications.



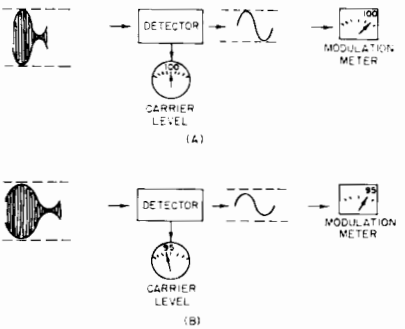


Figure 3. Negative carrier shift has the same effect on a monitor as adjusting the input control to reduce rf input to detector. (A) Without carrier shift. (B) With 5% negative carrier shift.

rather than the asymmetrical modulation technique.) The audio recovered in the monitor should have the same amplitude fidelity as the audio which goes into the transmitter; otherwise there is non-linearity in the system. An oscilloscope with good linearity itself can be used to check system linearity, indicating whether the nonlinearity is in the transmitter or in the monitor.

Set up the oscilloscope to observe the unmodulated rf out of the transmitter. The 'scope is going to be used as the monitor, so line up the rf signal peaks with horizontal graticule lines on the cro face. Select a line for the zero axis of the rf carrier and then at least four main divisions above and below this zero axis. There should be a half division line or mark between each main horizontal line. Center the rf trace so that the peaks are exactly on main line 2 above and main line 2 below zero center. Be careful to maintain the zero axis on this center horizontal line. Set the carrier level meter on the monitor to 100. Introduce audio tone directly to the transmitter behind the processors.

Modulate the transmitter to 100 per cent negative modulation and use the 'scope as the modulation indicator. Align the peak to peak amplitude of the waveform with the +4 and −4 horizontal lines of the graticule. Both sides of the waveform are symmetrical, so it is only necessary to work with one side, but keep it centered on the axis. With the 'scope indicating 100 per cent modulation, the modulation meter should indicate 100 per cent (0 dB) also. This is the calibrating point.

Now reduce modulation until the peak envelope is at + 3.5 lines; this is 75 per cent modulation and the monitor should indicate 75 per cent (−2.5 dB) modulation. Again lower the modulation until the positive peak is at +3 lines; this is 50 per cent modulation

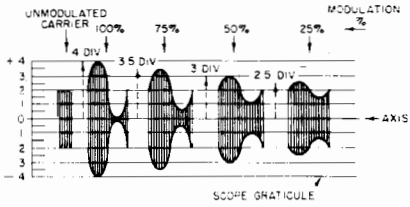


Figure 4. Use the oscilloscope graticule to determine the modulation percentage.

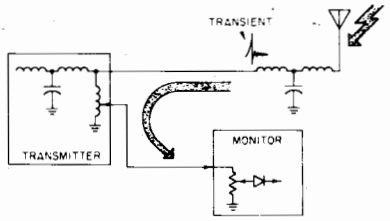


Figure 5. Transients from lightning discharges can damage the detector diodes.

and the monitor should indicate 50 per cent (−6) dB modulation. Reduce the modulation still further until the peak is now at + 2.5 line. This is 25 per cent modulation and the monitor should indicate 25 per cent (−12 dB) modulation. The linear system will require those dB changes in the audio for equivalent percentages of modulation. So compare notes—if the audio input levels do not agree with the required dB changes, then there is nonlinearity in the transmitter. But if the transmitter is linear and the modulation meter does not agree with the 'scope percentages (and the dB's), then there is a monitor problem.

TRANSIENTS

The monitor which taps directly into the output circuitry of the transmitter for its feed is susceptible to damage from transient surges caused by lightning discharges down the tower. The tuned circuits and line losses will reduce the effect, but a strong surge may get through and either damage or destroy the detector diodes. The transmitter need not be on the air for this to happen. It can occur in the middle of the night when the station is off the air. So if there has been a severe electrical storm and the monitor is now acting erratically, showing low indications or none at all. check out the detector diodes.

PEAK FLASHER

The peak flasher and the modulation meter will not always agree during program modulation. This is a normal situation and it is the reason for the

peak electronic flasher. The modulation meter circuit has special damping and ballistics, so there must be a series of peaks in a time span for it to build up to read a peak value. The peak flasher will indicate any peak that exceeds its threshold setting. But if the modulation is a sine wave, then the peak flasher and the modulation meter should agree. If they do not, calibration is called for, as per the instruction manual.

MODULATION METER

The response of the modulation meter circuit must be within ½ dB across the audio band of 30 Hz to 10 kHz (to meet FCC requirements). You can check the response curve of this circuit by use on an oscilloscope and tone modulation of the transmitter. Select a modulation percentage that will be easy to identify and maintain on the 'scope. Set the reference tone as you would in running response measurements in a proof run. We are doing the same thing, but are now using the 'scope as the modulation monitor. By keeping the modulation percentage the same for each tone as indicated on the 'scope, the transmitter's response variations will not enter into the consideration. As you make each tone test and set it to the modulaion percentage you decided upon, compare the indications on the modulation meter. If they do not track within ½ dB across the audio band to 10 kHz, some maintenance is called for in the monitor.

SUMMARY

There are many problems which can beset the monitoring function of the a.m. station. We have only had space to discuss a few of them here. The modulation monitor is an operational test instrument, and as such, it is no different than any test instrument that measures equipment in the shop or workbench. Results depend upon the accuracy of the instrument, the procedures used, and correct interpretation of the results. The operator should look upon the monitor in this light. ■