In this section, we discuss two parameters which should be monitored and adjusted at the broadcast television transmitter - depth of modulation and ICPM. These two measurements are commonly made with time domain instruments such as waveform monitors or oscilloscopes. Most of the other tests for characterizing transmitter performance are made with a spectrum analyzer and are not addressed in this publication.

To make these measurements, a high-quality demodulator such as the Tektronix TV1350 or 1450 is required. These instruments provide envelope and synchronous detection demodulation. Unlike envelope detectors, synchronous detectors are not affected by the quadrature distortion inherent in the vestigial sideband transmission system. For measurement purposes, the effects of quadrature distortion should be removed so as not to obscure distortions from other sources.

A quadrature output is available when the instrument is operating in the synchronous detection mode. Envelope detection is most similar to the demodulation used in most home receivers and is also available in the TV1350 and 1450.

The TV1350 and 1450 produce a zero carrier reference pulse which provides the reference level required for depth of modulation measurements. This pulse is created at the demodulator output by briefly reducing the amplitude of the RF signal to the zero carrier level prior to demodulation.

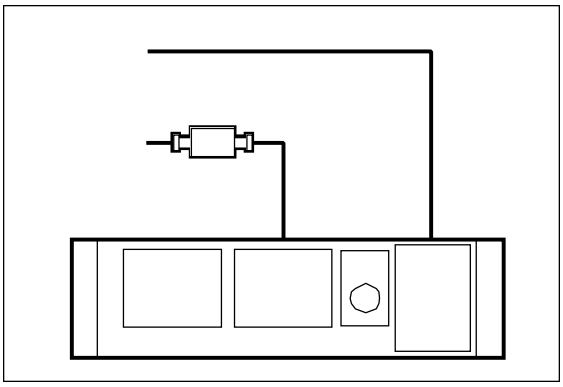

Figure 103. How to set up the 1780R for ICPM measurements.

DEFINITION

ICPM (Incidental Carrier Phase Modulation) is present when picture carrier phase is affected by video signal level. This distortion occurs in the transmitter.

ICPM errors are expressed in degrees using the following definition:

ICPM = arctan (quadrature amplitude/video amplitude).

PICTURE EFFECTS

The effects of ICPM will depend on the type of demodulation used to recover the baseband signal from the transmitted signal. ICPM shows up in synchronously demodulated signals as differential phase and many other types of distortions. With envelope demodulation, the demodulation typically used in home receivers, the baseband signal is generally not as seriously affected and the effects of ICPM are rarely seen in the picture. The sound, however, is another matter.

ICPM may manifest itself as audio buzz in the home receiver. In the intercarrier sound system, the picture carrier is mixed with the FM sound carrier to form a 4.5 MHz sound IF. Audio rate phase modulation in the picture carrier can therefore be transferred into the audio system and heard as a buzzing noise.

TEST SIGNALS

ICPM is measured with an unmodulated linearity signal. A staircase is generally used but a ramp signal may also be used.

MEASUREMENT METHODS

ICPM is measured on an XY plot of VIDEO OUT versus QUADRATURE OUT with the demodulator operating in the synchronous detection mode. A phase error will produce an output from the quadrature detector. If this phase error varies with amplitude, the result is a tilted display. The demodulator zero carrier reference pulse must be turned on and the detection mode set to synchronous. Select the SLOW time constant when using the 1450.

Waveform Monitor. To display ICPM on a waveform monitor, connect the demodulator outputs to the waveform monitor inputs as shown in Figure 103. Select ICPM in the 1780R MEASURE menu or EXT HORIZ on the 1480 front panel.

Although it is not strictly necessary, it is generally recommended that the signals be lowpass filtered to make the display easier to interpret. With either the 1780R or the 1480, this can be accomplished in the vertical channel by selecting the LOWPASS filter. Use an external 250 KHz lowpass filter for the horizontal (see Figure 103).

The display resulting from this configuration, which appears on the right-hand screen in the 1780R, is shown in Figures 104 and 105. The amount of tilt (deviation from the vertical) is an indication of ICPM. There is no ICPM in the signal shown in Figure 104 while distortion is present in Figure 105. When adjusting the transmitter for minimum ICPM, make the line as nearly vertical as possible.

The 1780R has an electronic graticule which can be used to quantify the amount of tilt. The waveform should be positioned so the small dot corresponding to the zero carrier reference pulse is set on the cross at the top of the screen. The horizontal magnification will automatically be set to X25 when this mode is selected. If desired, X50 magnification can be used for greater resolution. Start with the two graticule lines widely separated and use the knob to move them together to the point where a graticule line first contacts one of the dots. Disregard the "loops" in the ICPM display. These correspond to the staircase step transitions and are not indicative of distortion. The amount of ICPM distortion is indicated on the screen (see Figure 105).

An external ICPM graticule is available for the 1480. Position the zero carrier reference pulse, which shows up as a small dot, on the cross at the top of the graticule. The graticule is calibrated for 2 degrees per division when the horizontal magnifier is set to X25 or 1 degree per division with X50 horizontal magnification. Read the amount of ICPM from the graticule at the point of maximum distortion.

VM700T Automatic Measurement. The VM700T provides an ICPM measurement in the AUTO mode. In this case the quadrature signal must be connected to the "C" input.

NOTES

31. Configuring the 1480. 1480-series instruments are shipped with unblanking disabled in the EXTERNAL HORIZONTAL mode to prevent damage to the CRT. ICPM measurements can be made in line select with the instrument in this mode. For full-field ICPM measurements, the unblanking must be enabled. Instructions on how to accomplish this can be found in the OPERATING CHANGES section of the 1480-series manual.

32. Other XY Displays. Any XY display can be used to measure ICPM. Connect QUADRATURE OUT to the horizontal and VIDEO OUT to the vertical and use the formula given on page 62 to calculate the amount of distortion. For small errors, some amount of gain will be needed to improve the measurement resolution. Lowpass filters in both channels are recommended.

33. Phase Noise. Some demodulators have large amounts of phase noise which make it difficult to make ICPM measurements. The Tektronix 1450 has sufficiently low phase noise as do all TV1350 units shipped after July, 1998. Older TV1350 units can be retrofitted to improve phase noise performance. Contact your local Tektronix service department for information on how to update older instruments.

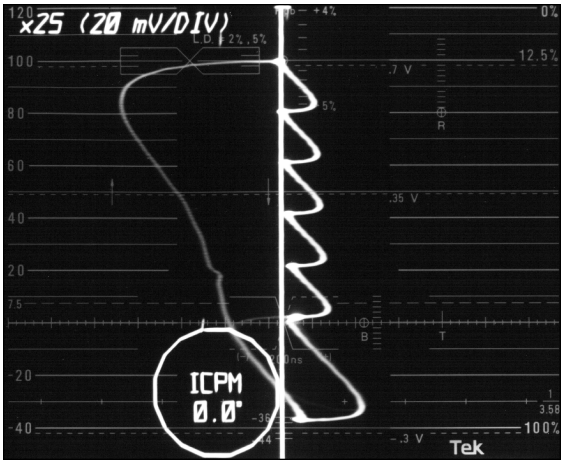

Figure 104. The 1780R ICPM display with no distortion present.

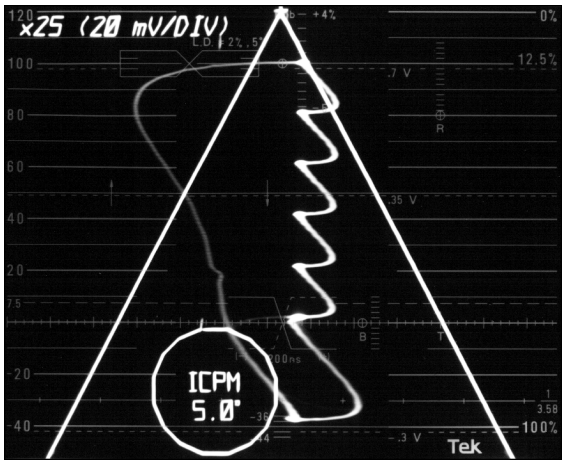

Figure 105. The 1780R electronic graticule indicating an ICPM distortion of 5 degrees.

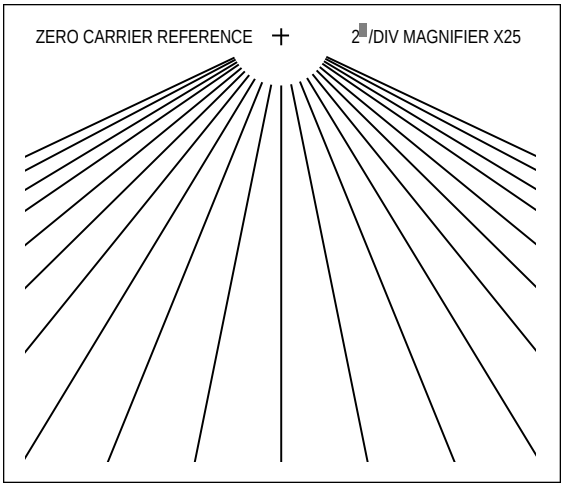

Figure 106. The 1480 ICPM graticule.

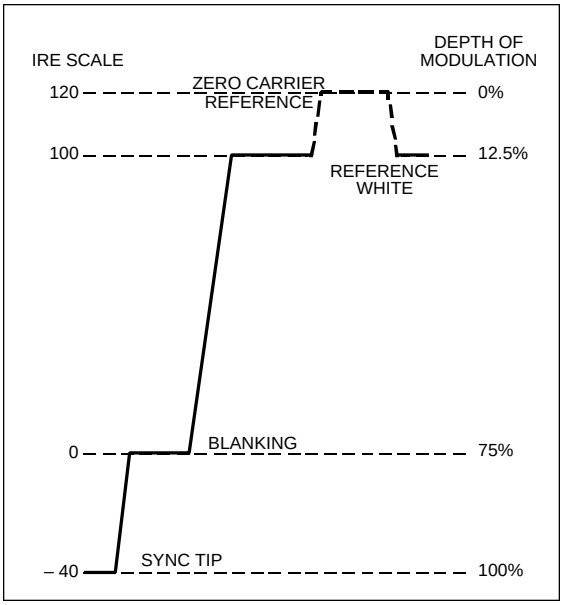

Figure 107. Depth of modulation levels.

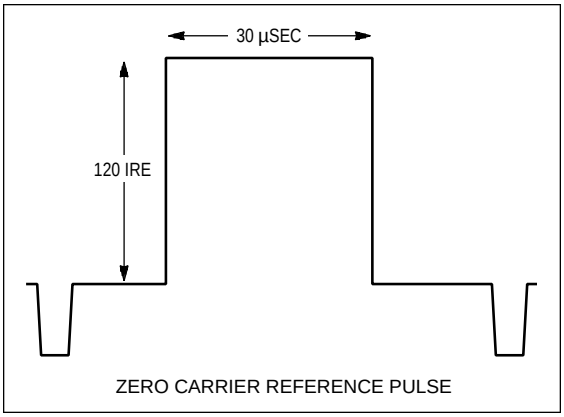

Figure 108. The zero carrier reference pulse typically occurs on line 20 but can be moved to other lines.

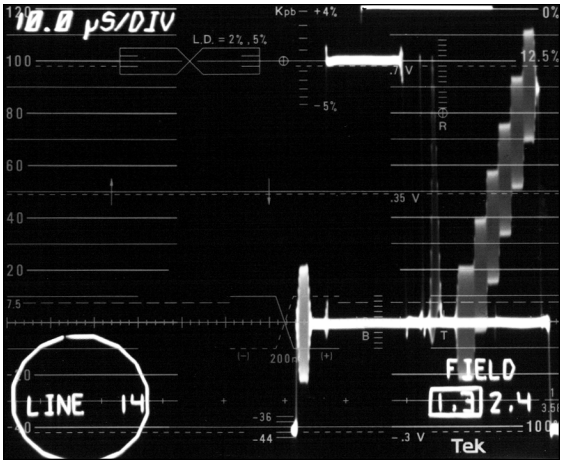

Figure 109. Video levels can be compared to the depth of modulation scale on the right-hand side of the graticule. Note the zero carrier pulse at 120 IRE.

DEFINITION

Depth of modulation (percentage of modulation) measurements indicate how video signal levels are represented in the RF signal.

The NTSC modulation scheme yields an RF signal that reaches its maximum peak-to-peak amplitude at sync tip (100%). In a properly adjusted signal, blanking level corresponds to 75% and peak white to 12.5%. The zero carrier reference level corresponds to 0% (see Figure 107).

PICTURE EFFECTS

Overmodulation often shows up as nonlinear distortions such as differential phase and gain. ICPM or white clipping may also result. Undermodulation often results in degraded signal-to-noise performance. The picture effects of these distortions were discussed earlier.

TEST SIGNALS

Depth of modulation measurements can be made with any signal with peak white (100 IRE) and blanking level (0 IRE) references. This signal is used in conjunction with the zero carrier reference pulse (Figure 108) which typically occurs in the vertical interval on line 20.

MEASUREMENT METHODS

Modulation depth is measured at the output of a precision demodulator by verifying that the video signal modulates the vision carrier as shown in Figure 108. Overall amplitude is not critical, but it should be adjusted in the system to be approximately 160 IRE from sync tip to zero carrier at 100% transmitter power. This will minimize the effects of nonlinearities in the measurement system.

Waveform Monitor. Most waveform monitors, including the 1780R and 1480, provide a depth of modulation scale on the right-hand side of the graticule. Use the variable gain to position the zero carrier reference pulse on the 0% mark at the top of the screen and sync tip on the 100% mark (see Figure 109). Verify that white level and blanking level occur at the prescribed points on the graticule scale. The voltage cursors can also be used for this measurement.

NOTES

33. Envelope Detection. Depth of modulation measurements should be made with the demodulator in the envelope detection mode to minimize effects of ICPM. Quadrature distortion will not affect modulation depth.