STANDARD AND PROCEDURES FOR VIDEO LEVEL MEASUREMENT

Setting video levels would be easy if only the cable operator could call up a test pattern when he was ready to set levels. In that sense the broadcast engineer has it much easier. The cable TV head-end technician must make do with whatever TV signal happens to be on at the time he is ready to set levels. A video waveform can be subjected to a wide variety of measurements that are outside the scope of this paper. We will limit our discussion to measurement of the voltage of the video waveform.

Video level measurement trouble can exist because the peak voltage, as seen on a wide-band oscilloscope and maximum brightness are not necessarily the same thing. Only the luminance component of the signal contributes to the picture brightness. Thus, if there is considerable color saturation (chrominance) in the picture at the time that peak-to-peak video voltage is measured, the scope reading could be 10 to 20 percent higher than that of the actual luminance component of the video signal.

The chrominance component of a color television signal can be found clustered about the color burst and occupies the frequency band from about 3 MHz to 4 MHz. The luminance component of the color television signal is located primarily in the 2 KHz to 600 KHz frequency band. Fine luminance picture detail does of course overlap the band occupied by chrominance, but since the energy of the luminance component in the 3 MHz to 4 MHz band is usually quite low, it may be filtered out to make luminance measurements without significantly impairing test accuracy.

Since only the luminance component of the video waveform contributes to picture brightness, a filter must be provided to separate the chrominance signal from the luminance signal when the brightness produced by a given video waveform is to be measured.

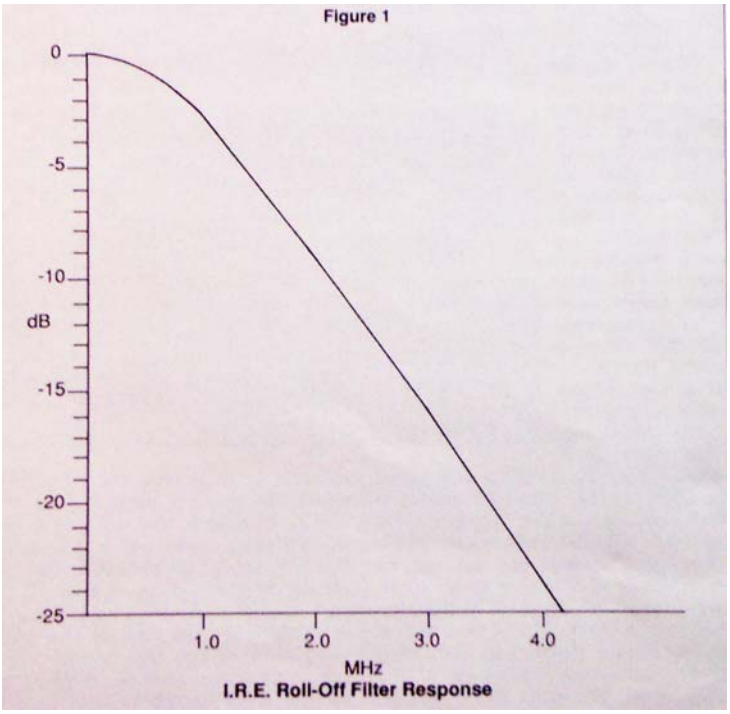
A talented video professional can closely estimate the actual luminance amplitude on a test pattern, even when buried by chrominance signals. However, even the experts disagree when the picture content continually changes. Technicians often interpret the waveform they observe differently according to their own experience and the setting of the oscilloscope controls. This is particularly true if a regular oscilloscope is used. Even with a video waveform monitor a significant reading error will occur if the wrong video low-pass filter is switched in.

NEW TECHNOLOGY:

An entirely new type of test instrument has recently become available, called the CM-2 Camera Master video test instrument. It measures Sync, Luminance, Composite, and Color-Burst in I.R.E. units, also Focus, and 60 Hz Ground-Loop in volts. These measurements are read on a digital scale instead of an oscilloscope This Camera Master is the size of an ordinary hand-held digital meter, and is battery-operated for portability. Since the Camera Master read-out is digital, video level setting becomes more consistent and not subject to interpretation.

This measurement technique recognized that high frequency chrominance information can cause errors in TV luminance measurement, so a special filter was proposed that retains the luminance part of the TV signal but filters out the chrominance component. This filter is generically known as the “I.R.E.” filter (see Figure 1). Television waveform monitors are equipped with this filter (as well as others) that must be switched in when making video voltage measurements.

Figure 1

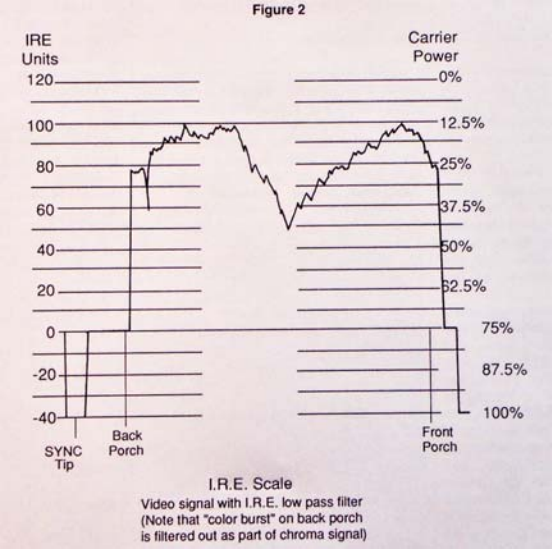


I.R.E. Roll-Off Filter Response

Unfortunately, ordinary scopes do not have such a filter. If you do not have a proper television waveform monitor with the I.R.E. filter, do not despair you can obtain an I.R.E. filter to connect to your scope. With this filter connected to the broadband scope you can as least get the same volts peak-to-peak reading as with a standard video waveform monitor.

The IRE (now the IEEE) standard measures video in IRE units instead of volts peak-to-peak. Since most cable companies and equipment manufacturers consider 1.0 Volt p-p as representing the maximum brightness of a video picture, then this translates to 140 IRE units. Of that, 40 IRE units constitute the amplitude of the sync pulse as measured from the “Back Porch”, and 100 IRE units constitute maximum brightness, also as measured from the Back Porch (see Figure 2). For 1.0 Volt p-p video signal, each IRE unit represents 7.14 millivolts peak-to-peak. So when the video signal is 1.00 volts peak-to-peak, then the Sync Pulse should be 0.2857 volts or 28.6 percent and the picture component should be 71.4 percent of the composite video signal.

Figure 2



I.R.E. Scale

Video signal with I.R.E. low pass filter (Note that "color burst" on back porch is filtered out as part of chroma signal)

Waveform monitors are also equipped with a special scale calibrated in IRE units. However, it is not necessary to use this unit of measurement when the main interest is to set video to 1 Volt p-p everywhere that the television signal appears at base-band in the head-end. Thus, an ordinary scope, without the special IRE graticule can be used, as long as an external IRE filter is used with it to remove the chrominance component.

The maximum video carrier power occurs during the tip of the Sync Pulse, therefore -40 IRE units correspond to 100% carrier power (see Figure 2). Also note that 100 IRE units equals 12.5% video carrier power not zero carrier power. Since 12.5% carrier power corresponds to 87.5% depth of modulation (100% - 12.5% = 87.5%), then this is the maximum modulation permitted for the luminance component of the video signal. The extra 12.5% remaining of the video carrier is reserved for the chrominance components otherwise color would be “wiped out” on bright scenes. These relationships reveal why “scope” readings (without the IRE filter) can easily result in serious mal-adjustment of the TV modulator.

Measurement of the video signal amplitude can be made without interrupting service by including a “BNC T” connector in the cabling between the base-band video source (i.e. the satellite receiver video output connector) and the input to the television modulator. Since the Camera Master has a high impedance input, the video signal can be measured without changing the level when the meter is connected.

The Camera Master, Wave-Form monitor with a high impedance input, or Scope with the IRE filter, should be directly connected to the BNC T because a long cable attached at this point could create reflections that may impair the picture by causing ghosts or ringing to appear. It is particularly useful to provide a panel mounted BNC T so that all of the TV modulators in one rack of equipment can be measured from the front of the rack. A short 10 or 12 inch cable can be used to connect the Camera Master to this panel mounted connector without impairing the video signal.

ACCURACY:

Even with an IRE filter, scopes do get out of adjustment so that calibration for 1.0 Volt p-p becomes “iffy”. Also the waveform amplitude can be read differently according to the interpretation of each operator.

A digital Camera Master meter ensures consistent video voltage readings independent of operator “eye”. It reads Sync amplitude, White Luminance amplitude and peak-to-peak Composite video amplitude. The scale is calibrated in IRE units. Since the meter has a digital read-out, there is no interpretation required. The IRE filter is built-in, insuring measurement according to the IRE standards. The Camera Master has a basic accuracy of 1 percent +/- 1 IRE unit or 1 percent +/- 0.01 volts, so readings taken with this meter will be many times more accurate than even a recently calibrated scope.

CONCLUSION:

This paper emphasizes that video peak-to-peak readings must be made with a filter that blocks out the chrominance component and that measurements made with a standard broadband oscilloscope can lead to substantial errors in head-end level setting. Video waveform monitors are available that enable video level measurements according to IRE standards, but these monitors are quite expensive. Ordinary scopes can be used, provided that an IRE roll-off filter is used in conjunction with them. Finally, it is proposed that peak-to-peak voltage measurements of video can be made much more accurately and conveniently by a Camera Master than with a waveform monitor.

(Excerpts from Frank McClatchie article in CED magazine March 1989).

CAMERA MASTER II

The Camera Master II is a digital, hand-held, battery operated meter that measures six different characteristics of any video signal. Use it for fast and accurate set-up of any video source.

SYNC (40 IRE Units) Use this to check for correct end of line terminations and camera sync output level.

LUMINANCE (100 IRE Units) Enables the camera Iris to be accurately adjusted to the correct brightness setting for uniform level and to prevent DVR overload.

COMPOSITE (140 IRE Units) Measures the peak to peak level of the video signal. 140 IRE Units = One Volt of video.

COLOR BURST (40 IRE Units) Measures color burst amplitude on the Back Porch of video. Used to measure cable slope loss at high frequency and adjust video amplifiers.

FOCUS Used to adjust camera for best focus on scene. Maximum meter reading occurs at sharpest focus. The digital read-out eliminates operator subjective guess work.

GROUND-LOOP This measures the troublesome 60Hz ground loop voltage that causes Bars on the video picture. You can use this measurement to verify that no ground loop exists in the video before you leave the job.

The Sync, White, and Composite amplitude measures the sync-to-white ratio and the overall video waveform amplitude on any part of an NTSC CCIR (CCTV) or PAL video system, including camera origination, video levels in Distribution Amplifiers, Video Switchers, CCTV installations, Studios, Microwave and Satellite transmission systems. The hand-held battery operated CAMERA MASTER will allow you to take video measurements anywhere. You will be able to trouble-shoot camera installations and do the job faster with confidence.

SYNC	**SPECIFICATION**
Amplitude	10-100 IRE Units (40 Nominal)
Accuracy	1% +/- one digit
Type of measurement	Sync to Back Porch
LUMINANCE	
Amplitude	0-199 IRE Units (100 Nominal)
Accuracy	1% +/- one digit
Video content	Luminance, (I.R.E. Filter)
Type of measurement	Peak White to Back Porch
Control	Camera Iris (Iris Control)
COMPOSITE	
Amplitude	0-199 IRE Units (140 Nominal)
One Volt Peak-to-Peak	140 IRE Units
Accuracy	1% +/- one digit
Type of measurement	Sync to Peak White
COLOR BURST	
Amplitude	0-100 IRE Units (40 Nominal)
Color Burst frequency	3.579 MHz (CCTV / NTSC)
Accuracy	1% +/- one digit
Correction Control	Cable Slope Equalizer
FOCUS	
Maximum sharpness	Maximum Number Display (focus Ring)
GROUND LOOP	0-1.99 Volts (Ground Shield Measure)
VIDEO INPUT	
Video Standard	CCTV, NTSC, Composite
Impedance	Hi-Z (Loop-through Bridging)
Connectors	2 BNC (Female) Loop-through
POWER	
Battery Type	9 Volt Alkaline or Ni-cad
Ni-cad Charger	Sold Separately
Automatic Shut-off	2-3 Minutes (2 Min. Typical)
Low Battery Indicator	Rapid Flashing LCD
MECHANICAL	
Size	4”W. x 8”L. x 2”D.
Material Housing	ABS
Numeric Display	½” High 3-1/2 Digit LCD Display
Measurement Selector	5 Position Rotary Switch
Tilt-Stand	Folding Wire Bail