SMPTE ENGINEERING GUIDELINE

EG 24-1995
Revision of EG 24-1991

Video and Audio Alignment Tapes and Procedures for 1-in Type C Helical-Scan Television Analog Recorders

1 Scope

This guideline describes the use of a manufacturer's alignment tape(s) intended for aligning type C television analog recorders to SMPTE specifications.

2 Normative references

The following documents contain provisions which, through reference in this text, constitute provisions of this guideline. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this guideline are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

ANSI S4.6-1982 (R1992), Method of Measuring Recorded Flux of Magnetic Sound Records at Medium Wavelengths

ANSI/IEEE 152-1992, Audio Program Level Measurement

ANSI/SMPTE 12M-1995, Television, Audio and Film — Time and Control Code

ANSI/SMPTE 19M-1991, Television Analog Recording — 1-in Type C — Records

ANSI/SMPTE 20M-1991, Television Analog Recording — 1-in Type C Recorders and Reproducers — Longitudinal Audio Characteristics

ANSI/SMPTE 26M-1995, Video Recording — 1-in Helical-Scan Recorders — Raw Stock for Reference Tapes

EIA -189-A, Encoded Color Bar Signal

IEEE Std 205-1958 (R1972), Method of Measurement of Television Luminance Signal Levels

NAB Standard for Magnetic Tape Recording and Reproducing (Reel-to-Reel)

SMPTE RP 85-1991(R1995), Tracking-Control Record for 1-in Type C Helical-Scan Television Tape Recording

SMPTE RP 86-1991 (R1995), Video Record Parameters for 1-in Type C Helical-Scan Television Tape Recording

IEC Publication 94, Magnetic Tape Sound Recording and Reproduction Systems: Dimensions and Characteristics

ITU-R Report 624-4 (MOD F), Characteristics of Television Systems

3 General specifications

3.1 Recorder

The recorder used to record this tape shall comply with ANSI/SMPTE 19M.

3.2 Record dimensions

The dimensions of pertinent records making up this tape shall conform to ANSI/SMPTE 19M.

3.3 Tape stock

The tape stock shall be as specified in ANSI/SMPTE 26M.

Approved October 17, 1995

3.4 Tracking control signal

The tracking control signal shall conform to SMPTE RP 85, except that the tolerance specified in clause 3.1 shall be tightened to ± 0.4 ms.

3.5 Time and control code

Time and control code, if provided, shall conform to ANSI/SMPTE 12M, and shall be recorded on audio 3 record. The reference flux level for time and control code shall be as defined in ANSI/SMPTE 20M.

4 Audio

4.1 General notes

4.1.1 Test equipment

Properly calibrated test equipment including, but not limited to, an rms voltmeter as specified in ANSI/IEEE 152, or equivalent, is essential for the following tests.

4.1.2 Procedures

All adjustments must be made with due attention to the machine manufacturer's instructions.

4.1.3 Audio calibration

The short circuit tape flux on the tape shall be determined by means of the calibrated short-gap ferromagnetic core reproducer technique. This technique is described in ANSI S4.6 and the following references:

McKnight, J.G. Flux and flux-frequency response measurements and standardization in magnetic recording. Journal of the SMPTE. 78(6): 457-472; June 1969.

Lovick, R. C.; Bartow, R. E.; and Scheg, R. F. Recording and calibration of super-8 magnetic reproducer test films. Journal of the SMPTE. 78(6): 473-481; June 1969.

4.2 Confidence heads

All audio adjustments should be made to the confidence/monitor heads as well as the main record/play heads to ensure maximum quality in all modes of operation.

4.3 Audio signal specifications

The following specifies the various generic signals which might be used on a tape. If signal other than these are used on a tape, the nature of the actual signals shall be carefully and fully defined.

4.3.1 Recorded audio flux level

The recorded reference level shall conform to ANSI/SMPTE 20M, except that the short circuit flux recorded on the tape of each frequency shall be within ± 0.5 dB of the level specified. The tolerance, ± 0.5 dB, may be extended to ± 2.0 dB provided the manufacturer supplies a calibration chart with the tape (see annex A).

4.3.2 Audio test calibration

The calibration values in decibels furnished with the tapes shall represent the levels to be added algebraically to the reproducer output level when the particular tape is reproduced. With the addition of these values, the output level of the reproducer in decibels will be that which would have resulted if the short circuit flux on the tape at a given frequency had been exactly as specified in ANSI/SMPTE 20M.

4.3.3 Audio flutter

The unweighted flutter content of the recording shall not exceed 0.1% rms, when measured in accordance with NAB Standard for Magnetic Tape Recording and Reproducing (Reel-to-Reel).

4.3.4 Signals

All recorded signals shall conform to ANSI/SMPTE 20M unless otherwise specified.

4.3.5 Reference level tone

The reference level tone shall be 100 Hz ± 2% recorded at the reference flux level.

4.3.6 Pink noise

Pink noise, if recorded, shall be 10 dB below reference level.

4.3.7 Frequency response

The following signals, recorded 10 dB below reference level, shall be contained in this section: 1kHz (reference), 63 Hz, 125 Hz, 250 Hz, 1kHz, 2 kHz, 4 kHz, 8 kHz, 10 kHz, 12.5 kHz, 16 kHz, 1 kHz. The frequency of each recorded signal shall be ± 3% of its specified value. The tones shall be recorded in the order given. Each tone shall have a duration of at least 20 seconds except the initital and final 1 kHz reference tones whose duration shall be at least 30 seconds.

4.3.8 Azimuth/stereo phase

Azimuth/stereo phase shall be as specified in ANSI/SMPTE 20M, but be tightened to ensure that the relative phase relationship between the audio 1 and audio 2 signals does not exceed 10° within the specified range of 100 Hz to 12 kHz. The required frequencies shall be as specified in IEC 94.

4.3.9 Crosstalk

Tones of 63 Hz, 1 kHz, and 16 kHz shall be recorded on channel 1 only and then channel 2 only. These tones shall be recorded + 8 dB above reference level.

4.4 Definitions

4.4.1 flux level: The absolute short-circuit recorded magnetic flux level in nanowebers per meter (nWb/m). ANSI/SMPTE 20M defines the standard audio reference flux density (see annex A).

4.4.2 frequency response: The amplitude vs frequency characteristic of a circuit or flux given as the frequency-by-frequency deviation, in decibels, from either zero deviation or from a specified response.

4.4.3 azimuth: The angle in a plane parallel to the tape, between the head gaps and a line drawn perpendicular to the reference edge of the tape.

4.4.4 height: The distance of a head or record, along the plane of the tape, perpendicular to the reference edge of the tape.

4.4.5 rotation: Rotation of a head around a line which is parallel to the plane of the tape (drawn through the centerline of the head as defined by the manufacturer) and perpendicular to the reference edge of the tape.

4.4.6 zenith: The angle, in a plane perpendicular to the tape, between the head gaps and a line drawn perpendicular to the reference edge of the tape.

4.4.7 peak value: The true peak value of the signal, measured by observing a true peak-reading measuring device, such as an oscilloscope, and comparing the peak amplitude of the observation to the peak amplitude of the stated reference.

4.4.8 pink noise: A random noise signal having equal energy in equal logarithmic frequency intervals over the bandwidth of interest.

4.4.9 record: The magnetic flux recorded on the tape.

4.5 Use of a reference level tone

4.5.1 Preliminary adjustments

The reference level tone may be used for setting the preliminary head mounting adjustments, such as coarse rotation, azimuth, zenith, and height, by setting the appropriate mechanical adjustments for highest and most stable output.

4.5.2 Channel polarity

The reference level tone may also be used as a relative channel polarity check by using an appropriate measuring systm such as an X-Y display oscilloscope or phase meter.

4.5.3 Noise reduction systems

The reference level tone may also be used for calibration purposes to produce the reference voltage for setting the operating point of level-dependent noise-reduction systems.

4.6 Use of an azimuth tone or tones

While observing the output of the two main channels on an approximate measuring device, such as a phase meter or X-Y display oscilloscope, the azimuth, rotation, and zenith controls should be adjusted to produce maximum amplitude combined with minimum phase error between the two channels. If more than one azimuth adjustment tone is provided, the initial adjustment is often performed using the lower-frequency tone with fine adjustment done using the higher-frequency tone.

(Care must be taken to avoid misadjusting azimuth by one full cycle. After final adjustment has been accomplished using the higher-frequency tone, performance with the lower-frequency tone should be rechecked. Use of the pink noise azimuth alignment procedure below avoids this potential problem.)

4.7 Use of pink noise

4.7.1 Azimuth

Pink noise can be used for azimuth adjustment similar to the procedure described above using discrete tones. However, pink noise has an advantage over discrete tones because it produces unambiguous results (one cannot misadjust by one full cycle).

4.7.2 Frequency response

Pink noise can also be used for frequency-response adjustment if the machine's output is fed to an appropriate measuring device such as a spectrum analyzer, real-time analyzer, or frequency selective voltmeter. However, because pink noise provides limited frequency resolution, and because it is a stochastic, i.e., random, signal, it does not stimulate the mechanism of fringing as greatly as do discrete sine tones.

4.8 Uses of frequency response tones

The frequency response tones may be used for setting playback equalization for the flattest possible frequency response.

5 Video

5.1 General notes

5.1.1 Test equipment

A properly calibrated vectorscope and waveform monitor capable of measuring differential gain and differential phase, or equivalent test equipment, are essential for the following tests.

5.1.2 Procedures

All adjustments must be made in conformance with the machine manufacturer's instructions.

5.1.3 Recorded video parameters

The recorded video parameters shall conform to those specified in SMPTE RP 86, except that the tolerance specified in clause 5 shall be tightened to ± 0.02 MHz and the nominal values specified in other sections shall be held as close as possible.

5.1.4 Video calibration

All video measurements of luminance levels shall be made in accordance with IEEE Std 205.

5.1.5 Video signals

Video synchronizing waveforms and video amplitudes shall conform to ITU-R 624-4.

5.2 Video signal specifications

The following specifies the various generic signals which might be used in a tape. If signals other than these are used on a tape, the nature of the actual signals shall be carefully and fully defined.

5.2.1 Color bars

100% saturated, 75% amplitude color bars conforming to EIA-189-A.

5.2.2 Multiburst

A white pulse followed by a series of six sine-wave bursts. The white pulse width and the width of each sine-wave burst should be one-seventh the width of the scan line between the end of H blanking and the start of H blanking. The white bar level shall be at 100 IRE units ± 1 IRE unit. The axis of the burst shall be at a level of 55 IRE units ± 1 IRE unit. The peak-to-peak amplitude of the bursts shall be 90 IRE units ± 1 IRE unit. The frequencies of the bursts in time sequence shall be 500 kHz, 1.5 MHz, 2.0 MHz, 3.0 MHz, 3.58 MHz, and 4.2 MHz.

5.2.3 Multipulse

A series of pulses whose hamlf-amplitude duration (HAD) is to be 20T for the 1-MHz signal and 10T for the remainder. All amplitudes are to be 100 IRE units

± 1IRE unit. The frequencies are to be 1.0, 2.0, 4.0, 4.8, and 5.8 MHz.

5.2.4 Modulated ramp

A continuous ramp extending from 0 to 100 IRE units and repeating at a line rate. Color subcarrier having a peak amplitude of 40 IRE units ± 2 IRE units shall be added to the ramp signal.

5.2.5 Window and pulses

A window signal, a modulated 12.5T (1.56 miscosecond) pulse, and a 2T (0.25 miscosecond) sine-squared pulse. All signals shall extend from 7.5 IRE units ± 2.5 IRE units to 100 IRE units ± 1 IRE unit. The window signal shall have a 1T (0.125 microsecond) rise time.

5.2.6 Chroma field

A flat, full-field signal corresponding to the cyan bar of EIA-189-A at 75% amplitude.

5.2.7 Gray field

A flat, full-field signal at 50 IRE units.

5.2.8 Vertical interval test signals

Vertical interval test signals are located on lines 10 through 19. Some or all of the following list of signals may be added to both fields:

line 10 2T and 12.5T pulses and 1T bar
line 11 modulated ramp
line 12 modulated ramp
line 13 modulated ramp
line 14 multiburst
line 15 multiburst
line 17 2T and 12.5T pulses and 1T bar
line 19 multiburst

Results of measurements using vertical interval test signals may not be the same as full-field signals due to head-to-tape contact at the ends of the scan.

5.3 Use of color bars

Color bars may be used to calibrate luminance, chrominance, and color-burst playback output amplitudes, both absolute and relative.

5.4 Use of modulated ramp

Modulated ramp may be used to adjust the playback-differential gain and differential-phase performance of the VTR. Adjustment should be made to minimize both differential gain and phase.

5.5 Use of multiburst/multipulse

Multiburst/multipulse may be used to adjust playback frequency response. General practice is to adjust for maximum flatness of the waveform.

6 Tracking accuracy

6.1 General notes

6.1.1 Test equipment

For the following tests, a properly calibrated oscilloscope, or equivalent, is needed.

6.1.2 Procedures

Since there is a specific adjustment procedure for each VTR, the manufacturer's instructions should be followed.

6.2 Control-track phase and level

Control-track phase and level are best adjusted using a flat-field test signal. It is recommended that a split-field signal not be used for this adjustment. The procedure is to adjust the tracking contol for maximum RF output, then verify proper video and sync RF waveforms against the manufacturer's specifications. This adjustment must be performed whenever the control-track head is moved or replaced. This adjustment must be made and verified for each video head.

Finally, if a control-track level control is provided, the manufacturer's specific instructions for this adjustment should be followed.

6.3 Track straightness

This adjustment is especially critical to interchangeability because it adjusts the physical relationship of the rotating heads to the tape and, thereby, directly influences conformity with the SMPTE specified track format. It is essential to perform this procedure after replacing any guiding element(s) in the tape path. Inability to meet specifications dictates repair of the defective tape path components. Even though the format is tightly specified, due to differences in transport and scanner design among various manufacturers, maximum track straightness will usually be achieved with an alignment tape from the manufacturer of the machine being adjusted.

Annex A (informative)
Audio recorded flux reference level considerations

ANSI/SMPTE 20M defines the audio reference flux density as 100 nWb/m of track width. However, since many type C recorders have historically been adjusted using alignment tapes which use 85 nWb/m of track width as their reference flux density, the user should carefully consider the impact of calibrating to the 100 nWb/m standard. If the aligment tape in use does not offer this flux level as reference, an adjustment may be made to compensate. Calibrating to the 100 nWb/m level will introduce a 1.41 dB (20 log 100/85) level differential between existing tapes calibrated at 85 nWb/m and those recorded after matching the 100 nWb/m of track width reference.