PVDM PRO AUDIO AFFAIRS

Quick Reference Guide To Calibrating Tape Decks

Orginal document: http://www.mrltapes.com/choo&u.pdf

1. Standards

There are standards for recording audio signals to tape. Why are there standards?
Because:

- Every type of tape has different characteristics. And every piece of equipment has it's own specifications. You need to be able to exchange tapes with other decks and those tapes need to reproduce *exactly* the same.
- For technical reasons, the signal recorded on magnetic tape does **not** have a flat frequency response. Thus, some form of record **equalization** is used. For reproduction, this equalization needs to be reversed. Both these equalizations need to be standardized on the machine.

There are two main standards of EQ:

NAB (North America Broadcast)
IEC (International Electrotechnical Commission)

speed: (in/s)	equalization standard:
30	IEC2
15	NAB (US), IEC (Eur)
7,5	NAB (US), IEC (Eur)
3,75	'NAB&IEC'

There are different calibration tapes for each:

1. speed — example: 19 cm/s
2. equalization standard — example: IEC
3. fluxivity — example: 320nWb/m

So a calibration tape could be specified as: 38cm/s, IEC, 520nWb/m.

2. Tapes & fluxivities

Fluxivity is the amount of magnetic field that can be stored on a tape, in nanoWeber per meter. Reference fluxivity is a signal of known magnetic magnitude, usually at 1 kHz. Common values are 185, 200, 250, 320, 355 and 520 nWb/m.

MRL calibration tapes start with a tone at 0dB at the reference fluxivity.

- 3,75 and 7,5 in/s tapes have the frequency tones recorded at **-10dB** to avoid tape saturation. This is a historical artifact, with modern tapes -5dB would be sufficient!
- 15 and 30 in/s tapes have the frequency tones recorded at **0dB** (reference fluxivity).

Difference between VU meters (US) and PPM meters (used in European studios):

- **VU** meters are only accurate in the range -6 to +3 dB. If you have a VU meter, it is not accurate at -10dB. Use an external level meter!
- **PPM** meters have a long linear level scale and can read -10dB accurately.

Choose a reference fluxivity:

- a higher fluxivity means more signal can be put onto tape, increasing the signal-to-noise ratio and dynamic range.
- the original reference fluxivity was 185 nWb/m (1950's!).
- modern devices and modern tapes can do much more, but interchangability will become an issue!
- For that reason most consumer decks are still calibrated to 185 nWb/m.

Four conflicting requirements for choosing a reference fluxivity:

1. ***progress in tape development.***
   The Maximum Output Level or **MOL** (the point at which the 3rd level harmonic distortion becomes >3%) is some 10dB greater than the old, original reference tape.
   So, if the reference fluxivity is kept the same (185), then distortion will be reduced due to the better tape characteristics.
   But if the reference fluxivity that will be used is increased, there will be less background noise in the recordings.
2. ***PPM meters versus VU meters***.
   A VU meter averages the signal over roughly 200 ms, and thus reads about 10dB below the signal peak levels.
   A PPM meter averages over 5 to 10 ms, and reads about 3dB below the signal peak levels.
   The difference is typically about 8dB. How should the reference fluxivity be set to accommodate the difference in scale markings and averaging times?
3. ***Conflicting goals in level controlling.***
   Given a range of different tapes, do you want uniformity of level across all tapes, or get maximum dynamic of the medium by recording at the highest possible level without distortion?
   Uniformity is used in broadcast or audio libraries; in a recording studio maximum output is wanted.
4. ***Maximizing the dynamic range.***
   The dynamic range lies between tape noise at low levels and allowed distortion at high levels. Originally the dynamic range was maximized by recording on high level. Noise Reduction (NR) systems introduced in the 60's (Dolby, dbx) increased the dynamic range with 10 dB or more, making it unnecessary to record at high levels and it would even seriously degrade the performance of the NR.
   For instance, when using very high output tape (Quantegy 499, RMGI 900) without NR, but also sometimes other tapes with NR, use 355 (+6dB) reference fluxivity. With this, a ±3 dB offset on a VU meter will let you set up for reference fluxivities in the range 250...500 nWb/m (+3 to +9 dB)

fluxivity @ 1 kHz	fluxivity level in dB re 185 nWb/m 700Hz
185	0
200	+1 dB
250	+3 dB

280 (=G320)	+4 dB
315	+5 dB
355	+6 dB
500	+9 dB

3. Fringing compensation.

When *full-track* tapes are reproduced on *multi-track* heads, a small low-frequency measurement error called “fringing” occurs. Calibrationtape is corrected for this fringing at ½ inch, 1 inch, and 2 inch width tapes, but not ¼ inch tapes.
The MRL ¼ inch (6.3 mm) width tapes are suitable for use on full-track mono players. When they are used on stereo or multi-track reproducers, the low-frequency response will be in error by 1- to 2-dB because of fringing.

Tape formula does not make a difference for making a calibration tape, because in the end all signals are calibrated and thus are independent of the tape used.
All MRL tapes use Studio Master 911, except the tapes at 500 nWb/m or higher, where higher saturation values are required. SM900 is used there.

Before using a calibration tape, the heads and tape guides should be cleaned and demagnitized. The tapes are stored ‘tails out’.

4. Shifting the Equalization Standard.

In general, you will need a separate Calibration Tape for each different *speed* and *equalization*. The exception is the following group, whose members are identical on a wavelength basis: that is, you can play any of these Calibration Tapes at any of these speeds, set the reproducer equalizers for flat response, and have a correct calibration:
7.5 in/s IEC (IEC1), 15 in/s IEC (IEC1), 30 in/s AES (IEC2)
Of course the frequency range scales with speed, and the playing times scale inversely with speed.

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Reference Fluxivity of the Calibration Tape That You Have	Desired Reference Fluxivity	Set Reproducer Gain So Volume Indicator Reads
180 nWb/m at 1000 Hz (= 185 nWb/m at 700 Hz)	185 200 250 G320 355 500	0 dB -1 dB -3 dB -4 dB -6 dB -9 dB
200 nWb/m at 1000 Hz	185 200 250 G320 355	+1 dB 0 dB -2 dB -3 dB -5 dB

	500	-8 dB
250 nWb/m at 1000 Hz (= 260 nWb/m at 700 Hz)	185 200 250 G320 355 500	+3 dB +2 dB 0 dB -1 dB -3 dB -6 dB
G320 nWb/m at 1000 Hz	185 200 250 G320 355 500	+4 dB +3 dB +1 dB 0 dB -2 dB -5 dB
355 nWb/m at 1000 Hz (= 370 nWb/m at 700 Hz)	185 200 250 G320 355 500	+6 dB +5 dB +3 dB +2 dB 0 dB -3 dB
500 nWb/m at 1000 Hz	185 200 250 G320 355 500	+9 dB +8 dB +6 dB +5 dB +3 dB 0 dB

There is a possibility to use a calibration tape from the opposite standard: a correction table is used to adjust the levels. The complete table is here: http://mrltapes.com/eqtables.txt

3. levels

There are 3 levels in a tape recorder:
1. Reference Fluxivity. The magnetic fluxivity on the tape. The Reference Fluxivity is intended to be used to set the reproducer gain so that the VU meter reads Reference Deflection (0 dB).
2. Reference Output Voltage. The electrical voltage levels at the connectors (line level). There are 2 standards:
   a) +4VU (studio standard). 0 dB equals 1.25V @ 600 Ohm. Usually balanced.
   b) -10dBV (semi professional). 0 dB equals 315 mV. Load impedance >10kohm, usually unbalanced
3. Level indicated by the meter (program meter).

All levels can be expressed in decibels, but the values are NOT the same.
The choice of calibration tape (fluxivity level) is totally independent of the line level output of the reproducer.

4. Bias

When recording, magnetic tape has a *nonlinear response* as determined by its **coercivity**. Without bias, this response results in poor performance especially at low signal levels. A recording signal which generates a magnetic field strength less than tape's coercivity is unable to magnetise the tape and produces little playback signal. Bias increases the signal quality of most audio recordings significantly by pushing the signal into more linear zones of the tape's magnetic transfer function.

The amplitude of the bias current has the following effects:

- the high-frequency response is better with **less** bias.
- the distortion is better with **more** bias.
- the modulation noise of the recording, which is dependent on the tape speed and the particular tape type.

Therefore the "optimum" bias depends on both the *tape* type and the *recording speed*. The general idea is that the recording sensitivity (the reproduced output level for a fixed low recording level) is low for low bias current, increasing with increasing bias to a maximum sensitivity, then decreasing with a further increase of bias current.

- At the studio mastering speeds of 15 and 30 in/s, the effect of bias on frequency response is minimal, so one often biases for minimum distortion