

## Tape Recorder Electrical Alignment In 5 Easy Steps

The electrical alignment of an analog audio tape recorder can be a confusing task, but it need not be. This article is intended to reduce or eliminate the confusion.

### Playback vs. Record

The first thing to keep very clear is there are record adjustments *and* there are playback adjustments. When watching the VU meters, many adjustments appear to have the same effect. If the recording and playback adjustments are mixed up, then you can get hopelessly lost. The result likely will be that the machine will not be calibrated correctly and the playback quality will not be what had been desired. This is very probable when the recordings are played on other machines.

### Playback Standards

The playback adjustments that are made to an analog audio recorder are done using established industry standards. Using these industry standards insures that recordings will playback properly with the same tonal balance on all tape recorders and players aligned to that standard. There are a number of different standards which may be confusing. In the United States and much of the world, the NAB (National Association of Broadcasters) standards are those which are used. In Europe many countries follow the German DIN (Deutscher Industrie Normenausschuss) standards. The world organization for defining these standards is the IEC (International Electrotechnical Commission). The purpose of all these standards is to define the proper conditions for playback interchange of recordings. The parameter which is most critical and user adjustable is the playback equalization.

Once the playback electronics are adjusted for the proper frequency response (playback equalization), then the record electronic adjustments should be made. The playback adjustments should not be touched until the next time a complete recorder alignment is made. More specifics on these playback adjustments will be covered later.

### Record Adjustments

The record electronic adjustments are made after the user has selected what tape to use. The record side of the tape machine is thus customized for that type of tape.

There are three basic record adjustments common to all professional analog audio recorders. They are: 1) recording bias level, 2) record level and 3) record equalization. The

adjustment potentiometers are not always identified with these exact names and there are additional potentiometers on many machines for other parameters.

All tapes do not require the same adjustment settings for each of these parameters. In fact, the very critical user believes that adjustments need to be optimized for each lot (and sometimes even each roll) of tape. In practice the professional quality audio tapes of the world are made consistent enough that this slight roll-to-roll and even lot-to-lot variations are usually not large enough to cause problems, even without readjustment. There are also different brands of tape which have similar characteristics making them close enough to be used interchangeably.

### Alignment Steps

#### 1. Set Playback Level

The desired operating level needs to be selected and then a playback (reproduce) alignment tape used to set the playback level which matches the operating level. The operating level (record level) that is used is another matter of personal choice. It is dependent on two primary factors: 1) what type of tape is going to be used and 2) how much headroom is desired between the operating level and the tape's maximum recording level.

Table 1 lists the maximum operating levels recommended for 3M analog audio mastering tapes.

Table 1

| Tape Type | Maximum Recommended Operating Level |
|-----------|-------------------------------------|
| 3M 808    | 200 nWb/m (+ 1 dB over NAB 0)       |
| 3M 809    | 200 nWb/m (+ 1 dB over NAB 0)       |
| 3M 806    | 250 nWb/m (+ 3 dB over NAB 0)       |
| 3M 807    | 250 nWb/m (+ 3 dB over NAB 0)       |
| 3M 226    | 370 nWb/m (+ 6 dB over NAB 0)       |
| 3M 227    | 370 nWb/m (+ 6 dB over NAB 0)       |
| 3M 250    | 370 nWb/m (+ 6 dB over NAB 0)       |
| 3M 996    | 520 nWb/m (+ 9 dB over NAB 0)       |

(nWb/m stands for nano Weber per meter of track width. NAB 0 is recognized in the U.S. as being 185 nWb/m.)

Headroom is the difference between the operating level and the level where the tape begins to cause objectionable distortion in the playback signal. This output is called the tape's Maximum Output Level (MOL). The

MOL is essentially the same level as the maximum record level where the distortion point is reached. It is generally considered that 8 dB between the operating level at 1 kHz and the MOL is the minimum headroom. Thus the table of operating levels is based on the level which is a dB below the point where MOL is reached. MOL is accepted as being the point where 3% third order harmonic distortion occurs in the playback of a pure sine wave recorded tone.

Some engineers prefer greater headroom than the 8 dB. This can be dependent on the type of music they're recording, the type of situation (live concert or studio recording) or how conservative they are with their recording meter levels. This is a matter of personal preference.

### Operating Level Cross Reference

Your desired operating level may be different from the reference fluxivity level on your reproduce alignment tape. If this is the case, use the chart below to normalize the operating level to the reference level found on typical reproduce alignment tapes.

| Desired Operating Level, nWb/m | Reference Fluxivity Level on Reproduce Alignment Tape, nWb/m |       |       |       |
|--------------------------------|--|-------|-------|-------|
|                                | 185  | 200   | 250   | 370   |
| 520 (+9 VU)                    | -9 VU  | -8 VU | -6 VU | -3 VU |
| 370 (+6 VU)                    | -6 VU  | -5 VU | -3 VU | 0 VU  |
| 250 (+3 VU)                    | -3 VU  | -2 VU | 0 VU  | +3 VU |
| 185 (0 VU)                     | 0 VU   | +1 VU | +3 VU | +6 VU |

#### Procedure

1. Determine the desired operating level.
2. Determine the reference (fluxivity) level of the reproduce alignment tape you are using.
3. In the chart, find the VU reading at the point where the values from steps 1 and 2 intersect.
4. When reproducing the reference level tone from the calibration tape, set reproduce gain so the VU meter reading found in step 3 is achieved.

#### Example:

1. Desired operating level for 3M 806 is 250 nWb/m.
2. Reference level on alignment tape is 3M 185 nWb/m.
3. The VU reading is -3 VU at the intersection of the column and row from steps 1 and 2.
4. Set reproduce gain so VU meter reads -3 VU when reproducing the reference level tone from the calibration tape.

## 2. Set Playback Equalization

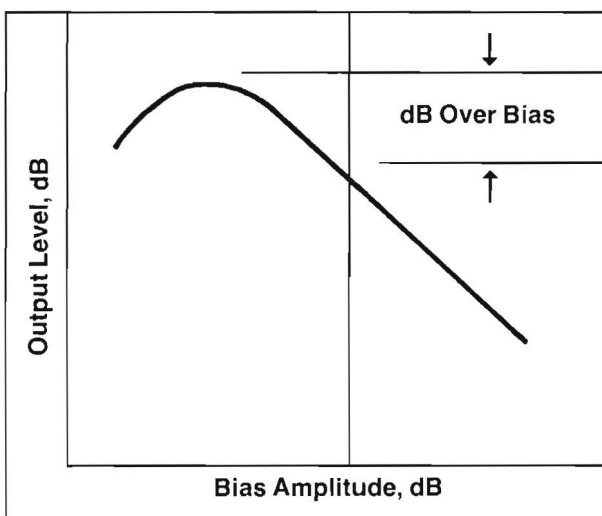
Use the playback alignment tape to adjust the playback frequency response (equalization). There are usually instructions with the test tape on its use and what tones are recorded on the tape. All professional recorders have high frequency playback equalization which needs to be set for the flattest possible overall response. Often this means setting the high frequency playback equalizer to make the 10 kHz playback tone the same level as the reference level tone on the tape, usually 500 Hz or 1 kHz.

Some recorders also have a low frequency playback equalization adjustment. Here again set it for the flattest overall response comparing the low frequency tones with the reference level tone.

## 3. Set Recording Bias Amplitude

While recording a pure sine wave tone, the bias current needs to be adjusted to get the optimum playback signal. The "proper" bias for any analog tape is a compromise of many factors and, therefore, there will be differing opinions on the proper bias from different users. Today it is most common for bias to be set while recording a high frequency tone. The bias is reduced so that a peak high frequency output level is found while recording. Then the bias is increased to a predetermined amount of over bias. By over bias, we mean that the output level has been reduced by the specified number of dB beyond the peak. See Figure 1 illustrating this:

Figure 1



Tape and recorder manufacturers often suggest what the amount of over bias should be while recording a specified frequency. It is most common to use 10 kHz as the recorded frequency when adjusting bias. Table 2 shows the recommended amount of 10 kHz over bias using a typical record head with a 0.25 mil gap. Older machines today use this record head gap. Older

machines often have wider head gaps. Different record head gaps will result in different amount of over bias for the same performance. The following table lists the recommended 10 kHz over bias for 3M's professional analog audio mastering tapes.

**Table 2**

| Tape Type  | dB of 10 kHz Over Bias |          |
|------------|------------------------|----------|
|            | @ 15 ips               | @ 30 ips |
| 3M 808/809 | 1.0 dB                 | 0.5 dB   |
| 3M 806/807 | 1.5 dB                 | 1.0 dB   |
| 3M 226/227 | 3.0 dB                 | 1.5 dB   |
| 3M 250     | 3.0 dB                 | 1.5 dB   |
| 3M 996     | 4.0 dB                 | 2.0 dB   |

These are, of course, guidelines to get the user in the right ball park for bias amplitude. Many users and equipment manufacturers will vary these amounts slightly to achieve what they believe are optimum results.

#### **4. Set Recording Level**

While recording a midband frequency tone (usually 1 kHz), adjust the record level control so that a 0 VU input signal plays back at 0 VU. (Remember that the previously made playback setting should NOT be changed.) The adjustment is made to a recording control and yet the effect is upon playback.

#### **5. Set Record Equalization**

Set the tone generator to the frequency of 10 kHz. While recording this tone, adjust the record equalization control so that the playback of the tape is the same as the input level. At 15 and 30 ips, this is done at 0 VU level. At slower speeds (e.g. 7.5 and 3.75 ips) it should be done at -10 to -20 VU. The record level reduction is done to make sure that the record level is not so high as to be saturating the tape with signal. This isn't a problem at the higher speeds.

#### **Summary**

With an understanding of the parameter to be adjusted and the parameter to be monitored during playback, the above procedures are not difficult. They do, however, require a good playback alignment tape and a tone generator. The procedures can become time consuming if a multi-channel recorder is being aligned. All five of these adjustments need to be made on every track. Obviously the more tracks, the more time it may take. The more difference from the current setup to that of a new tape, the most time it takes to readjust the three record adjustments on each track. For this reason, many tapes are designed to have similar bias, record level, and record equalization characteristics. With many newer generation microprocessor controlled machines, these adjustments can then be made automatically.

If you have questions about these procedures or about our mastering tape products, please feel free to contact:

3M Professional Audio Technical Service  
Professional Audio/Video and Specialty  
Products Laboratory  
3M Center Building 236-1B-06  
St. Paul, MN 55144-1000