

# Alignments

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## **THIS IS A VERY DETAILED ALIGNMENT PROCEDURE...**

**For a Printable PDF FILE so you can print out this whole alignment procedure GO HERE:**

**Printable Alignment instructions**

[Printable PDF Alignment OUTLINE](#)

**for a simple outline of a basic tape recorder alignment go here: [Alignment Outline only](#)**

**or [Go Directly To Bias Procedure](#)**

### TAPE RECORDERS

Basic Alignment Procedures  
for Ampex and other Professional Machines

see note at end of alignment procedures for Studers !!

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## **THIS IS A VERY DETAILED ALIGNMENT PROCEDURE...**

### TAPE RECORDERS

Basic Alignment Procedures  
for Ampex and other Professional Machines

Please do a few test alignments to get familiar with the procedure!

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Notes for STUDER Machines: the basic alignment procedures are ALMOST the same as for Ampex and MCIs except that you must set the INPUT level BEFORE you adjust the Record level. In these machines the Input level also affects the record level, so if you adjust the Input last, as you would on an Ampex you would mess up the whole record alignment....  
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- 1) Turn off the machine. Carefully de-mag the heads and all other non-rotating parts.
- 2) Turn the machine on. Carefully clean the machine, using cotton swabs and Isopropyl Alcohol or Head Cleaner. Do not drip any liquid

down the capstan (you will destroy the motor bearings!) Look at the heads and check for dirt and wear.

NOTE: Some brands of head cleaner will melt plastic, so be sure not to drip any cleaner on plastic parts!

3) Make sure the machine is in the NON-RECORD mode (SAFE)

4) Select REPRO Select the correct speed

5) Decide on your REFERENCE LEVEL (0 VU should equal your reference level). Most studios use a '0VU' magnetic level between what is known as a "'+3 level" up to a "+9 level".

NOTE: This is amount of magnetism that is recorded onto magnetic tape. A '+9 level' recording has more magnetism at "0vu" than a "+3 level" recording at "0vu".

6) Play your test tape. Play the LEVEL SET SECTION (700 hertz or 1000 hertz). Set this to 0 VU (if your test tape is at your desired reference level!!! if not you must compensate!!) Adjust only the REPRO LEVEL. Set the Level Set Section of the test tape for the correct VU meter reading if your operating level is different than the level on the Test Tape!!!

Example: Say you want an Operating Level of '+5' on tape, and have a +3 level test tape. Since 0 VU (your reference level on the RECORDER'S VU METERS) will equal +5, you would see -2 on the VU meter when a tape 2 db lower is played back.

Since +3 is 2 db lower than +5, you would set the Level Set Section of the test tape so the meter reads -2db VU. Thus '0VU' now equals +5, your chosen Operating Level. then all the tones on the Test tape should equal that same '-2 VU' since all the tones on the tape are equal level.

NOTE: We are only using the tape recorder's VU meters. What this means is that when we playback a signal we recorded at our 'operating level' the VU meters on our recorder will read '0vu'.... the output of the tape recorder will be the standard '+4dbm' of course, since that's the way machines are set up....

Thus ANY REFERENCE LEVEL at '0vu' will be '+4dbm' at the machine's output jacks. We set the playback and record levels to record a MAGNETIC level onto tape that corresponds to our desired 'reference level', but that reference level should always be adjusted so it reads '0vu' on the machine's vu meters... no matter if we choose a "+3" level, a "+6" level or a "+9" level... they all should read '0vu' on the TAPE RECORDER's VU meters.

Zero VU on the tape recorder (in playback and recording) is always equal to our desired 'reference level.

7) Set up the oscilloscope to show phase. Make sure you know what head screw is used to adjust azimuth. IF YOU DON'T KNOW DON'T DO IT !! Only a technician should adjust Multi-track Azimuth!!!!

8) Play the azimuth section of the test tape. Adjust REPRO HEAD AZIMUTH for proper reading (straight line from lower left to upper right, facing the oscilloscope)

9) Play another frequency. Check that this frequency is again in proper phase alignment. (if not readjust azimuth, and look at another

different frequency to check it)

10) Replay the LEVEL SET SECTION of the test tape. Set level.

11) Go to the 10 khz section. Adjust REPRO HIGH FREQ EQ for the same setting as the Level Set Section. You may want to check the machine by playing various frequencies back and checking the output levels. Note that for low frequencies, fringing will take place and you will get incorrect low frequency readings (below 200 hertz). But you can see if the machine is "in the ballpark" using a test tape's low frequency section.

==== repeat the above steps in Sync mode making the same adjustments but adjusting the sync controls rather than the Reprro controls...  
Sync level, Sync eq and so on....

12) Remove the test tape from the recorder.

----- RECORD ADJUSTMENTS -----

13) Place a roll of the same type of tape (456, 499 or GP9) you will be recording onto the machine and of course one you can erase. Place the machine in RECORD READY.

14) Feed a 1000 (or 700) hertz sine wave at +4 dbm to both channels of the recorder. Begin recording. Set the machine so it monitors REPRO, and the VU meter shows the REPRO output.

15) Adjust RECORD LEVEL till the meter reads 0 VU. This is now recording at your chosen operating level.

16) Feed 10khz to the recorder at +4 dbm. Set the oscilloscope to read phase. Adjust the RECORD HEAD AZIMUTH (only if you know how to do it), for proper AZIMUTH and phase on the 'scope, Monitoring REPRO.

17) Feed another frequency to the recorder again at +4 dbm. Check the Phase on the 'scope. If not in phase, readjust the RECORD AZIMUTH, and check with another frequency.

18) If you need to BIAS the recorder, see the BIAS section described below and perform the BIAS procedure now....!!!!

19) Feed 1000 hz to the recorder at +4 dbm. Adjust RECORD LEVEL until the VU meter reads 0 VU. (Monitoring REPRO)

20) Feed 10khz to the recorder at +4 dbm. Adjust RECORD HIGH FREQ EQ (proper speed) until the VU meter reads 0 VU. (Monitoring REPRO). See note if you are at speeds less than 15 ips !!

21) Feed 50 hz to the recorder (at 15 ips) or 80 hz to 100 hz (for 30 ips), to the recorder at +4 dbm. Carefully adjust the REPRODUCE LOW FREQUENCY EQ (proper speed) until the VU meter reads 0 VU. (monitoring REPRO).

22) Stop the machine. Select INPUT. Adjust the INPUT LEVEL for a 0 VU reading (monitoring INPUT) Note that on some machines this step must be done before adjusting RECORD LEVEL, since INPUT LEVEL feeds RECORD LEVEL. Check your machine to see if this is the case!

23) Begin recording again. If you have changed BIAS, select BIAS,

and adjust BIAS CAL until the vu meter reads 0 VU (monitoring BIAS). Careful , don't adjust BIAS LEVEL, just BIAS CAL (on Ampex machines).

24) Begin recording your tones at the head of the tape. Label your tape as to operating level, frequency of the tones you've put on the tape (1khz, 10khz, low freq.), state Dolby 'A' or 'SR' or state NO DOLBY, and note track format and speed, as well as type of tape. If DOLBY A, put Dolby Tone after low freq. tone, if Dolby SR put the SR set-up signal onto tape.

Example of label on tape box:

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2 Track, 15 ips 456 tape   Tones at head

1khz, 10khz, 50 hz at 0 VU (+3 level: 250 nW/m)
No Dolby

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25) Use 1 minute for 1 khz, 30 seconds (or more) for other tones. You may also want to put 1 khz on your left track only to establish which track should be left.

---- you should do a few practice alignments before you do any serious recording. Make sure all the levels match, and that the machine sounds great!

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#### BIAS

1) Bias should be done at the proper audio frequency for the speed you're using. Note that there IS a relationship between gap distance and the frequency you should use to set the bias, but as a general rule you everyone uses 10 khz for all speeds, except 7 1/2 ips and slower speeds.

The "Proper" frequencies are 10 khz for 15 ips; 20 khz for 30 ips and 5 khz for 7 1/2 ips. Almost everyone uses 10 khz, and changes their "Overbias" level to compensate for the different speeds.

2) After setting rough RECORD LEVELs, Feed 10 khz to the recorder at +4 dbm ( "0" VU) from your console. Begin recording, MONITORING REPRO. (Azimuth MUST be already set on both the RECORD head and the REPRO head!!)

3) Turn the BIAS LEVEL pot Counter-Clockwise (less bias) until the VU meter (which is monitoring REPRO) drops by about 2db or more. Then turn the BIAS LEVEL control Clockwise until the VU meter shows the maximum output of your 10 khz you are recording. Turn the bias pot a little back and forth to make sure you are on the "peak".

THEN CONTINUE TURNING THE BIAS LEVEL CONTROL  
CLOCKWISE (more bias) UNTIL THE VU METER DROPS 3.5db PAST  
THIS PEAK READING... for Ampex 456. If you're using 499  
or GP 9 tapes overbias by 4 db, at 15 ips...

THESE SPECS ARE FOR 15 ips !!!!

go to step 4 below..

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NOTE: As a general 'rule of thumb' guide ....

456 bias using 10 khz - 15ips = 3.5 db overbias / 30ips = 2 db overbias

499 bias using 10 khz - 15ips = 4db overbias / 30ips = 2db overbias

GP9 bias using 10khz - 15 ips = 4bd overbias / 30 ips = 2 db overbias

different engineers and techs may like different bias levels  
and often different machines require more or less bias than above

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NOTE: In reality, you should use 20khz as the bias record signal  
at 30ips rather than 10khz as we do with 15 ips....  
speed doubled from 15 to 30, and bias audio frequency doubled as well.

This means the frequency vs. headgap relationship remains the same  
for 15 ips and 30ips. But using 20 khz often is tough to do  
since many worn machines may 'waver' or fluctuate too much  
for a good VU meter reading.... thus we compromise and use  
10khz audio for biasing at 30 ips but in order to do this we  
must set the bias for about half the normal bias for 15 ips.

All this basically equals out the changes between 15 and 30 ips,  
and makes biasing somewhat simple.... using a 10 khz tone for  
both speeds.

SEE STEP 7 FOR 7 1/2 ips BIAS INSTRUCTIONS!

4) This is the OVERBIAS point for 456 tape (3.5 db overbias at 15 ips)

This places you in the best operating range for 456, while 499  
wants about 4db overbias at 15 ips (2db overbias at 30ips!!). Each studio  
will have it's own chosen overbias level for the type of tape they're  
using and the type of machine they're recording on, so always ask!!

You can overbias anywhere from 3 db to 5 db and still get good results.

5) Bias controls the amount of distortion, noise recorded onto tape and  
other parameters, so be careful with bias. Note that some machines  
must be overbiased slightly more or less than the norm, depending  
on head wear and the type of heads. Always ask the studio what  
their standard is.

6) The final adjustment is to set the BIAS CAL control. Select BIAS,  
and adjust the BIAS CAL (on Ampex recorders) pot until the VU meter reads 0 VU.  
Bias Cal is just a reference, and it does not change actual bias level  
being fed to the record head. Setting this reference allows you to  
return to this preset bias level without having to completely rebias the  
machine, and it will show you if something has changed in the bias  
circuitry.

6a) Many machines also have a "Master Bias" adjustment which will change  
the overall Bias level to all channels. If your machine has this control,  
you'd make a choice as to biasing each individual track to it's  
"correct" bias, or to set each track to the "peak" level, and then  
use the "Master Bias" control to set the overall bias correctly.  
Usually you'd want to "peak" bias each track individually, and then  
set the bias using the Master Pots.

7) If you are using 7 1/2 use 1 khz instead of 10 k, and only go 1/2 db  
past the peak reading. You may use this as a rule of thumb: 1/2 past  
the peak (clockwise= more bias) for any speed and for any tape, at 1  
khz. Using 1 khz is not as accurate as using 10 khz, but always puts  
you in the general range you need to be in.

Now Go BACK to the RECORD ALIGNMENT above and start again from Step 1

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#### Tape Recorder Tests and Checks.....

There are other tests you may want to make if your recorder is either new or hasn't been in use often.

The first is to test erase by recording a 1 khz signal at operating level then rewinding the tape to the pre-recorded 1 khz section. Then remove the input signal and begin recording again. Monitor REPRO. Increase your monitor level (board or power amp level) until you hear hiss. Only a extremely small amount of the tone should come through, if any at all. If a lot of tone comes through, the machine is not erasing properly, and it should be brought to the attention of a technician.

The second test is to go to a blank section of the tape, and record, without an input signal, monitoring REPRO. All you should hear is a nice constant hiss, not pops or "tape gravel", and there should be no hum.

This indicates that the machine is in good operating condition and does not have any noise problems.

A third test is to record a 1 khz section at the head of a tape, then turn the tape over (the recorded tone is now at the tail) and replay the recorded tone, and compare it to the oscillator that fed the recorder. Listen for a change in frequency between the oscillator and the tape. If drastic, the speed is changing between the head and tail of the tape. Note that you WILL hear some beating, since the 2 frequencies cannot be in the same phase!

If you don't have an oscilloscope, you can still adjust azimuth, and be as accurate as with the o'scope. Remember that all consoles are Voltage amplifiers, and that all of the VU meters on a professional recording console (as well as most Semi-pro boards) read the output voltage (and NOT THE POWER). Two equal and in-phase voltages will add by 6db when selected to the same output buss. Thus you first patch the tape recorder to 2 different input channels of your board, making sure that the board's eq is out, and that there is no Echo Send or Aux Sends on. Then select just one channel (Track #1) and send it to any one buss. Set that one channel's fader level so that your buss output VU meter reads -6 VU. Then turn off that channel.

Next turn on your other channel, (it would be Track 16 for a 16 track, track 24 for a 24 track and so on...) send it to the same buss as the other channel, and again set that track's channel fader level so the buss output meter again reads -6 VU.

Then turn both channels on. Since two in-phase signals should add together by 6 db, you now should be reading 0VU on the meter. If the meter is near 0 VU and is stable (not moving around much), you're ok. If the meter reads less than 0 VU, adjust azimuth until the meter reads as close to 0VU as possible, with as little meter movement as possible. Make sure re-set your -6 vu levels on each channel after making any azimuth adjustments !!!

This then will allow you to set azimuth quickly and accurately without having to use an oscilloscope. In case you forget how much two in phase signals add, you can always first try it with an oscillator (which

every good board has), connected to two input channels of the board.  
Try it.... it really works!!

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The following steps are for 7 1/2 ips alignments ONLY !!!!  
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The only difference in 7 1/2 ips or slower speed alignment is that you CANNOT RECORD HIGH FREQUENCY TONES AT OPERATING LEVEL. Because of the amount of EQ required, if you try to record tones at operating level the high frequency tones will go into SATURATION, that is the tones will be a maximum level and no further increase in EQ will get more out of the machine. Setting EQ or biasing at operating level at 7.5 ips or slower will result in a SEVERLY misaligned machine.

SO most test tapes for low speeds give you a LEVEL SET section at operating level, then all the rest of the tones are at -10 db below the operating level. This is to remind you that you cannot do a record alignment at operating level.

You must align the machine at -10 db, except for the first and last tones, (LEVEL SET) which are at the tape's reference level. Set the LEVEL SET for 0 VU, then the next tone for -10 VU. Set REPRO EQ so the -10 db 10khz tone plays at -10 VU. Then Reset the REPRO LEVEL on the LEVEL SET section (which is at the test tape's reference level) so it corresponds to your chosen operating level.

Next perform a normal record alignment, but ALL TONES SHOULD BE RECORDED 10 db BELOW OPERATING LEVEL. (-10 VU)

Note that you cannot BIAS the recorder at operating level either, if you use 10 khz. It is much easier to use 1 khz for bias (1/2 db overbias at any speed), since there is almost no EQ Record boost at 1 khz, you CAN record 1 khz (and frequencies below that) at Operating Level.

But you can NEVER RECORD HIGH FREQUENCIES AT 7 1/2 AT OPERATING LEVELS !!!

The only tone that you should put on a client's 7 1/2 ips tape is 1 khz at Operating Level.

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