

Analog Tape Recorders

Basics of Analog Recording

The tape recorder is the principal instrument of the classic electronic music studio. The technical quality of the composition is limited by the decks used, and may be further compromised by how the decks are used.

The factors that determine the possible quality of a recording made on any analog deck are tape speed and track width. (Surprisingly, the electronic design of the deck has a relatively small effect on quality as long as drastic flaws are avoided. The difference in price among various decks of the same format primarily reflects durability of the machine.) Speeds and widths in common use today are:

speeds	widths	tracks
30 ips	2"	16-24
15 ips	1"	4-16
7 1/2 ips	1/2"	2-16
3 3/4 ips	1/4"	1-8
1 7/8 ips	1/8"	2-8

You can probably find decks that run at all combinations of these, but as a general rule, the wide tapes are run at the faster speeds. The ubiquitous cassette finishes last at 1 7/8ips on 1/8" tape. The track width depends not only on the width of tape but on the number of tracks stuffed on the tape.

The format most commonly used is 1/4" tape: 2 tracks at 7 1/2 or 15 ips. This meets minimum standards for broadcast audio quality while remaining reasonably economical. Cassettes and 1/2" 8-track are also widely used.

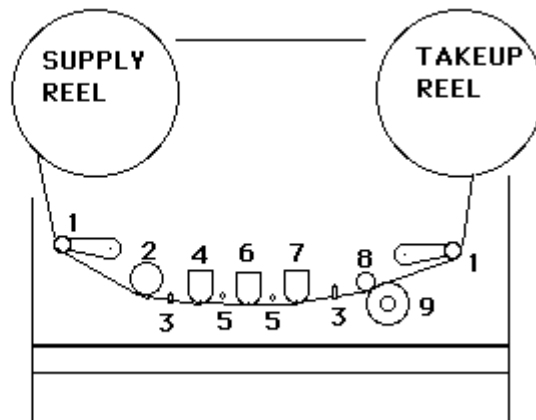
The track numbering of 1/4" four track format tape is a little confusing. The tracks are actually numbered from top to bottom 1,2,3,4; but since the quarter track stereo consumer format recorded left channel on track 1 and right channel on track 3, you occasionally see controls grouped 1,3,2,4. If you are constructing tape for four track playback, use 1=left front, 2= left rear, 3=right front, 4=right rear

The Generic Tape Deck

All tape decks have two main systems: some mechanical apparatus for moving the tape past the heads, and electronics for recording on and playing back from the tape. Sometimes these parts are physically as well as conceptually separate, but most often they are in the same box.

The Mechanical System

1. TENSION ARM
2. IDLE ROLLER
3. GUIDE
4. ERASE HEAD
5. TAPE LIFTERS
6. RECORD HEAD
7. PLAY HEAD
8. CAPSTAN
9. PINCH ROLLER



Tape Path

Tape is threaded from left to right on most modern tape decks. Tape starts from the SUPPLY REEL, runs past one or two TAPE GUIDES or TENSION ARMS, past the ERASE, RECORD, and PLAY HEADS (remember the order), between a CAPSTAN and PINCH ROLLER, past more guides and arms, and finally onto the TAKEUP REEL.

Motion of the tape is controlled by the capstan. This is a steel shaft which is always turning at a constant speed. When the PLAY button is pushed, the rubber pinch roller squeezes the tape against the capstan and the tape is pulled past the heads. The TAKEUP MOTOR winds the tape onto the takeup reel as this goes on. Some back tension is necessary to keep the tape tight against the heads. This is generally applied by providing a little power to the SUPPLY MOTOR (Which always runs backwards; it may also be called the rewind motor.), although there are other methods.

When the tape is to be rewound, the pinch roller stays away from the tape and full power is applied to the supply motor making the tape zip backwards. (A low power is applied to the take up motor to keep the tape tight.) To save wear and tear on the heads and to suppress some loud annoying sounds, one or two TAPE LIFTERS pop up to pull the tape away from the heads during this operation. When the machine is in the

FAST FORWARD mode, the same sort of things go on, but this time the takeup motor gets full power.

There are brakes on both reel motors to stop the tape quickly and gently. Because the tape and reels can build up a fair amount of momentum, care must be taken in going from one of the fast modes to the play mode to avoid damaging the tape. Machines vary in their approach to this problem:

- Some make you push STOP before PLAY.
- Some have a time delay if PLAY is pushed in a fast mode. (They stop first, then play.)
- Some electronically keep track of the tape motion.
- Some have to be carefully operated.

In any case, you have to spend time getting to know your machine.

Edit Mode

I mentioned earlier that the tape lifters pop out during the fast modes to keep the tape off the heads. Some decks do this in STOP mode too. (This is cheaper, since the lifters can be attached to the pinch roller mechanism.) In either case, we often want to hear the tape in fast or stop modes, so the better machines have a way to defeat the tape lifters. There are different names and different versions of this process; here are the most common:

STOP EDIT

allows you to hear the tape as you move it by hand so you can find specific sounds.

DUMP EDIT

is a play mode in which the takeup reel doesn't turn. This allows large sections of tape to be run off into a wastebasket or other appropriate receptacle.

CUE

allows you to hear the tape in the fast modes. (Some decks only cue while the buttons are held down.)

The most advanced decks have a SHUTTLE lever that enables you to do all of these without actually touching the tape.

Somewhere along the tape path is a gimmick that prevents the transport from working unless the tape is threaded tightly. This may involve a tension arm, a small wire switch, or even a light and sensing device.

Basic Controls

These controls are the ones you will be using the most:

Transport Motion

These get the tape going. They are PLAY, REWIND, FAST FORWARD, STOP, and sometimes PAUSE.

Record Safety

Prevents accidental recording (and erasure). This is most useful when there is a separate switch for each channel.

Record Button

Most often used in conjunction with PLAY, this starts the recording process. Many decks do away with the SAFETY feature by making you push both PLAY and RECORD to start recording.

Monitor Select

Allows the choice of listening to the input signal or the signal on the tape. If this is set to "tape" and the tape is not moving, you hear nothing. A third choice on some decks allows you to listen to the tape as it goes by the record head. (see SYNC, section 2.8)

Other Features

The basic electronic requirements for a tape deck are an amplifier and bias oscillator for recording and a preamplifier for playback. With the most expensive decks that is all you get. Less expensive machines are usually bristling with extra features to attract the consumer. Here are a few of the extras you will find.

Microphone Preamps

These used to be very common because the presence of a microphone input defined the class of machine (consumer or professional) for determining import duty. They would be useful if they were ever very good.

Mic-Line Mixing

This allows you to do "voice-overs" as you are recording music. I guess somebody does this. (An interesting variation on this is found on many Revoxes. If only one channel is recording, both inputs mix to that channel.)

EQ and Bias Switches

Allows you to easily change styles of tape. Vital on cassette decks, some of which now do this automatically.

Noise Reduction

Vital on cassette decks and multitrack reel to reel machines.

Output Volume Controls

Surprisingly, this is rather rare.

Headphone Outputs

These are almost universal. Some decks have an independent level control for headphones.

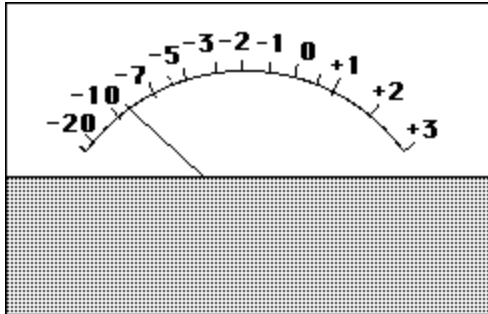
Variable Speed

This is exquisitely useful for electronic music purposes. Most decks seem to have it these days, but the range of the built in kinds is usually not very wide. The best are those available as accessories to a few decks.

Level Meters

These are not really an option, but decks vary widely as to style and quality of these.

Traditional VU Meters



These developed in the old days of radio, when they indicated the percentage of legal modulation a station was generating. They also had a dB scale, with 0dB at the 100% modulation point, which is the only scale we pay attention to any more. On most tape decks, the 0dB point is some standard recording level. (The standard used most studios for reel to reel machines is 250 nanoWebers per Meter.)

There are two vital factors to keep in mind when you are using VU meters:

1. They measure the average signal, and move rather slowly. This means brief peaks will not be properly indicated and may distort. As a hedge against this problem, many meters now have a red light that lights when the signal hits +6dB. The actual recording level you use will depend heavily on the material. As a general rule, keep the meter just below 0dB, with short excursions into the red zone allowed.
2. They do not have a flat frequency response. Most meters exaggerate the low frequency readings and do not respond to signals above 8 khz very well. A good rule is to keep bright signals down an extra 6 dB. (An especially good idea, since high frequency signals are the most likely to be distorted in the recording process.)

Peak Meters

These are seen mostly in European and Japanese gear. They look much like VU meters, but they do not average the signal. Instead they jump to the highest level and fall back rather slowly. If a signal were measured on both a VU and a peak meter, the peak reading would appear higher-- tape deck manufacturers compensate for this by moving the numbers. The result is that you record the same way on either, keeping the music just above 0 on the loudest parts.

Zero on a peak reading meter corresponds to +4 on a VU meter.

LED Meters

These are very much in style on Japanese cassette decks. They actually perform better than VU meters as far as frequency response is concerned, but do not average in quite the same way. The main disadvantage is that cheap ones do not have enough segments to properly show what is going on. The best ones combine the peak and VU functions, with the highest led staying on longer than the others, which means you can always see the highest level reached in the last two or three seconds.

Tape Counters

Most tape decks have numerical readouts that keep track of your location on the tape. These may be electronic or mechanical in design, but that really makes no difference. What really matters is what the counters count. The inexpensive kind (found on most cassettes) count turns of the takeup reel. (Actually about four numbers go by for each turn.) Since the amount of tape wound varies according to direction of operation as well as location on the tape, these meters are only useful for coarse operation. Counters on more expensive decks actually measure the tape with a special wheel and are quite accurate. Tape decks occasionally have auto stop or locate features which react to the tape counters.

Calibrated Level Controls

Professional quality decks usually do not have output level controls, because level is best controlled at the mixer. (The fewer controls there are, the less the chance of a mistake.) When such a control is provided, there is usually a switch (or sometimes a "click" on the knob) to set the output at calibrated level. All of the studio machines are calibrated to provide -10 dBV at the patch bay when the VU meter reads 0. The new four track decks have calibration clicks on the inputs also.

Tape Bias calibrations

For quality operation, any tape deck must be carefully adjusted for the tape in use. This complex procedure will be described in the technical manual that comes with the better decks.

Cleaning Heads

In order to get a good recording, the tape must be in very intimate contact with the heads. The wavelength of a 15kHz tone recorded at 15 ips is one thousandth of an inch, so a separation of half that amount can be expected to cause some loss of signal.

This is not much thicker than a fingerprint. You can not expect good results unless the heads are clean.

Heads can be cleaned with denatured or 91% isopropyl alcohol on a cotton swab. Procedure is simple, just dip the swab in the alcohol and scrub each head. If there is anything on the head that will not come off with this method, find a technician. Cleaning at the beginning of your session should be adequate, unless you get carried away with the grease pencil.

If you notice a build-up of tape oxide on the capstan or tape guides, you may clean these also. Do not clean anything else.

Recording Tips

The best decks will only give results comparable to their use. In addition to the detailed instructions in the rest of this article, the following tips are offered in the interests of quality recording.

Label your tapes carefully and thoroughly. Proper labeling reduces the number of times a tape must be played. Include:

- your name
- name of tape
- date recorded
- speed and format
- noise reduction (essential on cassettes)
- heads or tails
- details of calibration tones

You may put this information on the box or on the tape reel. (The name of the tape and your name must be on the tape reel of course.) I like to number my reels and put most of the information on the box.

Keep tapes tail out. (That means in the just played rather than the just rewound state.) This will reduce print-through and deformation of the tape.

Put leader at the beginning and end of important tapes. This greatly reduces fumbling around in front of the class.

Place **calibration tones** at the beginning of finished tapes. This simplifies the process of making copies. The easiest way to do this is to record an entire reel at your favorite calibration level (such as 0vu) and frequency (say 700 hz) and cut off sections as they are needed. Separate the tone from the piece with a long leader so there is no print through.

Use noise reduction where appropriate, but do not use noise reduction where it is not needed. Synthesizer licks, with their restricted dynamic range and pure, easily distorted tones, are usually better off without noise reduction. So are sounds at extremely high or low frequency, and sounds that are pretty much continuous.

Keep the number of generations to a minimum. For example, if you have pitch shifted a sound, and later decide you like the result better if it is also flanged, you will be one generation ahead if you back up a step and pitch shift and flange the original source on one pass.

Keep your levels high. You can always turn sounds down in the final mix, but if you try to raise the volume of weakly recorded material, you will get a lot of noise.

Spot distortion early and redo the process if necessary. Distortion grows as tapes are copied, and it cannot be removed once it occurs.

Note On Mastering

Mastering is the creation of a final version of your project, ready to duplicate. This is done by the duplication house, to match the equipment they will use to make your cassettes or CDs. Premastering is making the tape you will send to the dupe house. Usually a premaster is a first generation mixdown, but if your project has several cuts, the premaster will be assembled from the best mix of each.

Here are the rules.

- Use DAT or 1/4" reel to reel.
- Record DAT at 44.1 khz.
- Record reels at 15 ips (or 30 if you've got it.)
- Start with a 1 khz tone at -12 on a DAT or 0 on a reel. Label these.
- On a reel follow with a 10khz tone at 0. Label these.

Have 5 to 10 seconds leader on analog or recorded silence on DAT between cuts. DATs must have no unrecorded spots. If you want index numbers during songs (or transitions with no silence) indicate the absolute time these are to occur.

Be sure that all songs are the same level. If you are having cassettes made, compress about 2:1. Adjust the threshold for the sound you want.(If you don't the dup house will do more!)

Send the Master, but keep two copies.

This is taken from literature put out by one popular dup house. They all differ slightly in their requirements.

Recording on a Revox With a Microphone

[Note: The UCSC Electronic Music studios feature Revox PR-99 tape recorders as the workhorse analog machine. These or similar models are so common I have included operating instructions for them. Adapting these instructions to other brands of deck is only a matter of detail.--pqe]

One of your first assignments will be to make a recording of a sound with the microphone.

1. Disconnect the deck you are using from the monitor to avoid feedback.
2. Thread your tape. [Notice the flapper that sometimes covers the play head. If the tape winds up on the wrong side of this thing, it will not play back.]
3. There is an adapter in the studio that allows the microphone to be plugged directly into the front of the Revox tape recorders. Make that connection, checking that you are using the proper channel. (Instructions assume left channel.)
4. Set switches:

- POWER ON
- MONITOR INPUT
- REC-L ON
- INPUT SELECT MIC-LO

- REC-R OFF
- SYNC OFF

5. Turn INPUT LEVEL RIGHT off. Position the microphone and make a few trial sounds, adjusting INPUT LEVEL LEFT so that the meter just reaches into the red zone. (Both meters will respond actually. Pay attention to the left one.)

If you must turn the INPUT LEVEL control above 7 to get a strong reading on the VU meter, move the microphone closer to the source. If the LEVEL setting winds up at 2 or lower, move the mic away.

6. Zero the tape counter.

7. Push the REC and PLAY buttons together. When the tape has started, make your sound, then STOP the tape.

8. When you listen to the tape, take care to avoid feedback through the studio monitors. Prevent this by switching the MONITOR switch to TAPE, and by turning the INPUT LEVEL down.

9. Select the tape deck on the studio monitor switch, REWIND to the zero point on the counter, and PLAY what you have just recorded. Under these conditions the tape should sound identical to the actual sound. Listen for these problems:

WEAK SIGNAL

The INPUT LEVEL control was set too low, or the switch was on MIC HI.

NOISE WITH WEAK SIGNAL

The microphone is too far from the source.

NOISE WITH STRONG SIGNAL

The sound you are attempting to record is too faint for these surroundings.

DISTORTED STRONG SIGNAL

The INPUT LEVEL control was set too high. (Watch for the flashing red light.)

DISTORTED WEAK OR MODERATE SIGNAL

The microphone was too close to the source.

TOO MUCH BASS

The microphone was too close to the source.

WEAK HIGH FREQUENCY

The microphone was not pointed directly at the source.

If at first you don't succeed, try take two. Remember to disconnect the tape deck from the studio monitor before you turn up the microphone.

Some Common Mistakes in Using the Revoxes

Switches

To record a signal from the patch bay, the INPUT SELECTOR switch must be set to AUX. The OUTPUT SELECTOR switch should be set on STEREO. If it is set on LEFT or RIGHT, you will only hear one channel.

The tape dump switch on the PR-99 will prevent rewind or fast forward, and of course, dump tape during play.

The older Revoxes have an input sync feature. If a track is in sync mode, it won't go into record.

Threading

There is a hinged shield that flips up over the playback head when the play button is pushed. If the tape is in front of that shield, there will be no sound.

The head cover plate can be removed. There is no reason to do this, but students often do, hoping it will make the tape easier to mark for splicing. If the machine is threaded with the plate off, it is very easy to get the tape behind the tape lifters, and the tape will not move when the play button is pushed.

VU Meters

The VU meters will respond fine to very low frequency sounds, but tape won't. The VU meters will also respond if you patch your signal to the output instead of the input, but nothing will record.

Overheating

If a Revox is run for 24 hours in a row, it will begin to behave strangely (wouldn't you?).

Varispeed

Check it.

Editing On the Revox

Finding the Spot

The slide switch just below the head assembly puts the deck into edit mode. When this switch is to the left, the tape is against the head so that the sound on the tape may be heard when the reels are moved by hand. You get out of edit mode either by pushing PLAY or by pushing the pinch roller toward the capstan. NEVER ATTEMPT TO PUSH THE SLIDE SWITCH TO THE RIGHT. (When you are in edit mode the fast modes will operate only while you press the buttons.)

To find the splice point, enter edit mode, put a hand on each reel, and move the tape back and forth. You are looking for the very beginning or end of the sound. The faster you turn the reels, the more natural the tape sounds, so the best way to move the tape is in quick, short jerks. You will soon find that it is easier to find the beginnings of sounds than the ends, and that it is quite hard to find one sound in a complex texture. You can zero in on sounds by rocking the tape back and forth in shorter and shorter chunks. Wind up with a movement to the left if you are finding the start of a sound.

Once you have found the sound, mark the tape with a dot over the play head using a grease pencil (never use ink or chalk).

Splicing the Tape

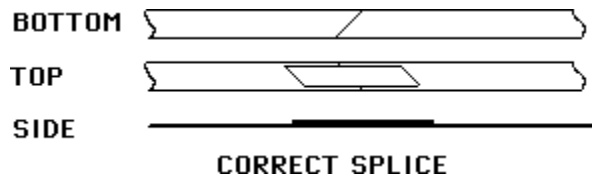
Make sure your hands are clean and free of oil.

Before you splice, cut a three or four inch strip of splicing tape and stick it to the Formica block (These are 2X5" bits of formica glued to the top of the table near the splicing block.). Use a razor blade to cut the strip into "tabs" 3/4 in. long.

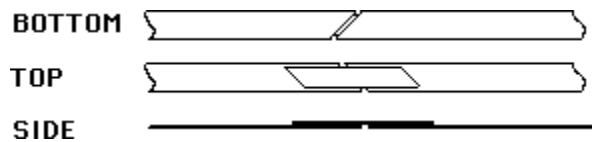
Place the tape in the splicing block back side up (that's the black side of the tape with Ampex 406) with your mark over the diagonal notch. The tape will stay put because of the way the block is grooved. Using the notch as a guide, cut the tape with a quick motion of the razor blade towards yourself. Pull the separate pieces of tape out the ends of the block and repeat the process at the other splice point.

Place the two pieces of tape you wish to splice in the block so the ends butt together but do not overlap. Use the point of the razor blade to pick up one of the precut tabs of splicing tape and set it in the block across the splice. Rub the back of the splicing

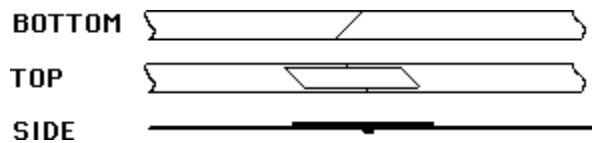
tape until it sticks. Remove the spliced tape from the block by pulling up smartly at both ends, the tape should snap out without wrinkling. Set the splice on the raised portion of the block and rub on the back of the splicing tape until all of the bubbles are gone. You may wish to use a hard object for this if your thumbnail is not up to the job.



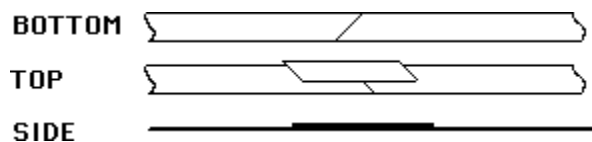
Examine your splice. Any of the following mistakes will make trouble eventually.



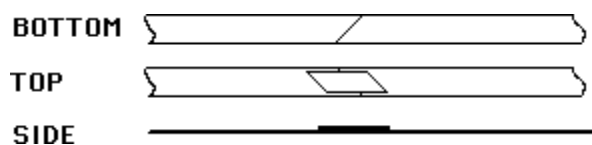
GAP BETWEEN THE TAPE ENDS. Any exposed sticky stuff is bad, as it will make the tape hang up on the reel. This is often caused by a difference in the way the two pieces of tape are cut. The Revox will stop when it encounters such splices.



TAPE OVERLAPPED. This will thump as the tape is played.



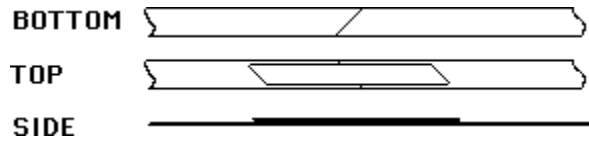
SPLICING TAPE HANGING OVER THE EDGE. This will make the tape hang up in the reel or at the tape guides.



If you make the piece of **SPLICING TAPE TOO SHORT**, the splice will not last long.



If you leave too many BUBBLES under the splicing tape, or if you handle the tape with GREASY FINGERS, the splice will not last long either.

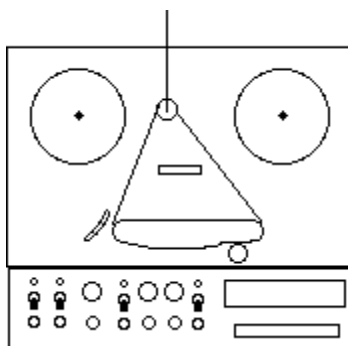


If you make the piece of SPLICING TAPE TOO LONG, the tape may "thump" going by the heads.

TO take a splice apart, bend it backwards right at the join and peel the recording tape off the splicing tape.

Tape Loops

The tape loop is one of the oldest tricks in the business, but it is still effective. Making a loop is simple; you merely splice the end of a piece of tape to its beginning. It is the playing of a loop that is sometimes tricky. The tape must be kept in the proper relationship to the heads and cutoff sensor without benefit of the takeup or supply reels.



Short loops are very easy in the UCSC Studio. Above each tape deck there is a counterweighted pulley on a string. Thread the loop in the machine in the usual way and hook the pulley under the top of the loop. The weight keeps the tape taut and the

loop can be played. Take care to avoid the reel platforms, as they will spin when the loop is played. If the loop rubs them, you will get a fluttery sound.

Longer loops require the use of two pulleys, and perhaps one of the metal hooks, but still work in a straightforward manner.

The very longest loops require the use of a microphone stand. Thread the loop around one or two pulleys and a mic stand placed where it will do the most good. In cramped quarters you can pass the loop through pulleys and then back over your shoulder.

Here are some additional tips:

Always mark the direction of your loop with an arrow. It's a good idea to put a number on it too.

The best way to store a loop is to coil it up around your thumb and put it in a matchbox. If you plan on keeping a lot of loops around, you may want to buy a little plastic box with a lot of compartments. Tape loops left hanging around the studio will not last long.

Very short loops may be played inside out. The head guard will keep them in place.

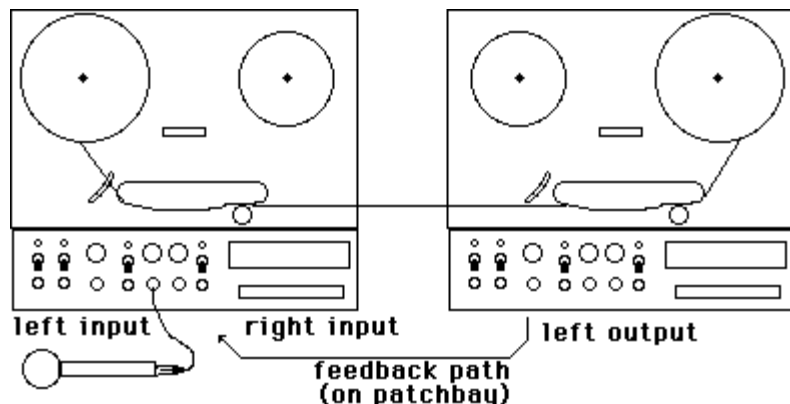
If you play a loop and nothing happens, the loop is probably backwards. The second most likely cause is that the tape is outside the flip-up head shield.

Tape Echo

If tape loops are not the oldest trick in the book, then tape echo is, but even this hoary old cliché has its uses now and again. Tape echo is developed by the distance between the record and play heads on a tape deck. The tape must take some time to travel this distance. Therefore, if you are listening to the tape as you are recording you hear the recorded sound a little later than the original.

Multiple echos are achieved by using a mixer to combine some of the playback signal with whatever is being recorded. This is a feedback situation and care must be taken to see that echos diminuendo as they come around rather than build up. Whenever you do tape echo keep your awareness on the knob that controls the level of the feedback

signal. After some practice you will be able to control the echos to the point where you can keep a constant signal level.



Here's how to set up basic echo on the revox:

Patch a source (better not use a microphone the first time you do this) to the left channel of a Revox. (Set both input switches to aux to get the patch bay).

Patch from the LEFT OUTPUT to the RIGHT INPUT of the same Revox.

Select the Revox output on the monitor.

Set the Revox switches: MONITOR TAPE, RECORD-L ON, RECORD-R OFF, both input level knobs down.

Start recording and start the source. Turn the left input level up until you hear the recorded material. Turn the right input level up until echos start. Now by playing with the two level controls you can vary the number of echos, the relative levels of the echo and original, or even eliminate the original and sustain the echos. (This works on the Revoxes because of the internal mixing feature. If you do this on another tape deck you will need a mixer in the patch.)

The first variation on this is to use two tape decks for longer delay. (Remember Pauline Oliveros' "Bye-bye Butterfly"?) The patch is almost the same:

Connect the source to the left input of the left hand deck, and the left output of the right hand deck to the right input of the left hand deck. The right hand deck does not need an input. Set the left hand deck to record and the right hand deck to play.

Thread the tape from the supply reel of the left hand deck through both sets of heads to the take up reel of the right hand deck. Hang a loop pulley on the tape to keep it taut.

Start both decks playing (they better be set at the same speed!). The right hand deck is deliberately a smidgeon faster than the left so the tape will stay tight.

Put the left deck in the record mode and apply the source. Presently you will hear an echo. The levels are controlled as above.

If you play with the varispeed at this point you can get some interesting Doppler effects. You will soon find the limits of this technique.

The most interesting applications of tape delay involve processing the feedback signal. This is simple to add, merely patch from output to input by way of some processing device. Now whatever that device does will be doubled for each echo, often with startling results. I leave the various possibilities to your experimentation.

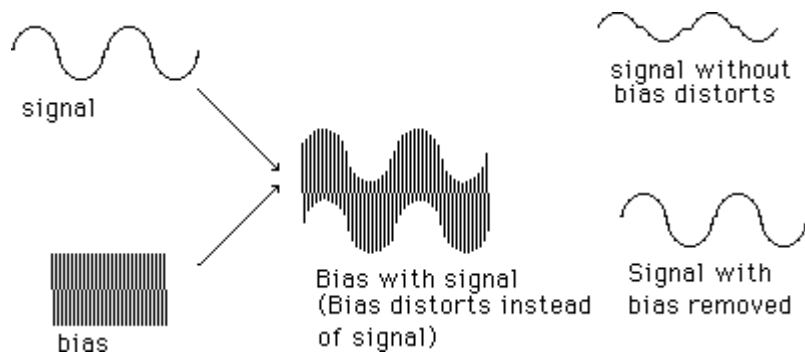
The Lowdown on Getting Good Sound With a Cassette Deck

With the very best analog tape decks it is possible to get a recording quality that is as good as digital. Unfortunately, such decks, which run at 30 ips and use extra wide tape, are more expensive than DAT machines. Since most of us cannot even afford DATs, our problem is more prosaic: how to get acceptable sound from a cassette.

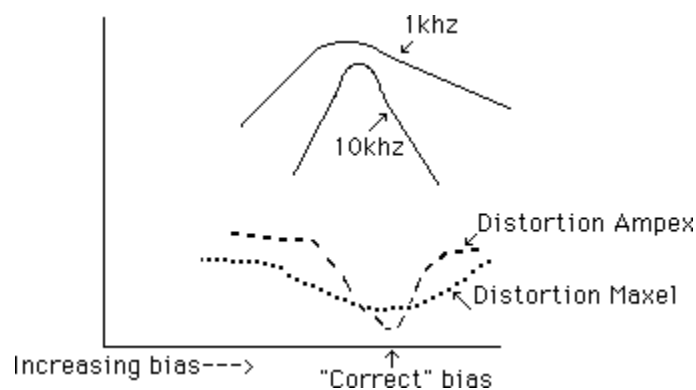
The cassette has two strikes against it. The tape is very narrow, and it moves very slowly. The effect of both factors is to reduce the amount of signal that can be recorded. Since the tape has a certain amount of noise built in, the basic quandry is to get the signal as hot as possible (to be louder than the noise) but not distorted due to tape saturation. To really understand what is going on, we need to look at three factors that are normally hidden from the user-- tape bias, equalization, and azimuth.

Bias

All analog tape is recorded with a high frequency AC bias added to the signal to reduce distortion.



Changing the amount of bias has several effects on the result. As bias is increased, the level of the output increases up to a point, then falls off again. This effect is more pronounced at high frequency than at 1000 hz, so the overall frequency response changes. Also, as bias increases, distortion decreases, and then begins to creep back in. By the time distortion bottoms out, the signal level has usually peaked and fallen 1.5 to 2 dB. The tightness of the distortion curve depends on the brand of tape-- some require a very precise bias adjustment to give best distortion, others are more forgiving.



Bias is one of the things that is changed when you set the deck for type I or type II tape. This is often automatic, (keyed by a cutout on the cassette shell) but if it is not, you must get it right for good sound. Many cassette decks allow the user to make a small adjustment in the bias level. Generally this is used to trim up the high frequency response-- increasing bias reduces the highs.

Since bias is just a very high frequency signal, it is possible for the highest partials of the music to act as additional bias and paradoxically reduce the high frequency response. The Dolby HX PRO feature is a circuit that compensates for this, adjusting the amount of bias according to the spectral content of the recorded signal.

Equalization

As a hedge against noise, the signal recorded on the tape has a high frequency emphasis. When played, the electronics reduce the high end to normal level, effectively filtering the tape noise.^[2] Unfortunately, this has the side effect of making highs very likely to distort. For standard cassette tape this emphasis starts at about 1 kHz^[3]. With premium tape, which is quieter, the emphasis is moved up an octave^[4] so that the highs will not hit saturation so soon. This is also set with the type I /type II switch, which must be checked for both recording and playback.

NOISE REDUCTION

Noise reduction systems are an elaboration on the equalization concept. All versions depend on ENCODING before recording and then DECODING upon playback, so you must be sure to do both according to the same rules. There are two basic types of noise reduction, each with a series of variations.

DBX

In the dbx system, the signal is compressed by 2:1 when recorded, and then expanded upon playback. This definitely reduces noise by 20 or 30 dB and also prevents distortion, but it can have two bad side effects. Sometimes you can hear the noise "pumping" (especially on bass tracks), and if there is any loss of high frequency signal during the recording, (common enough in cassettes) the decoding will not be accurate. DBX type II addresses the second problem by keying only on the mid band signal. This is usually all right, but material that is principally high or low may be distorted because it is read as no signal during encoding and amplified.

Once a tape has been encoded with dbx, it sounds horrible if played without decoding.

DOLBY

The dolby systems also compress upon recording and expand during playback, but they do this within restricted frequency bands:

Type A covers the entire audio spectrum with four bands. This is the old professional standard. It avoids most of the pumping of dbx, but does not give as obvious benefit on silences (only about 10 dB).

Type B deals only with the region above any recorded frequencies. This is used often on cassettes (where the A system would cost more than the deck does) because most noise is high frequency in nature. It gives a 10 dB reduction in the high hiss area, which sounds like cutting the noise in half.

Type C has two bands, basically using type B twice. The overall noise reduction is about 20 dB.

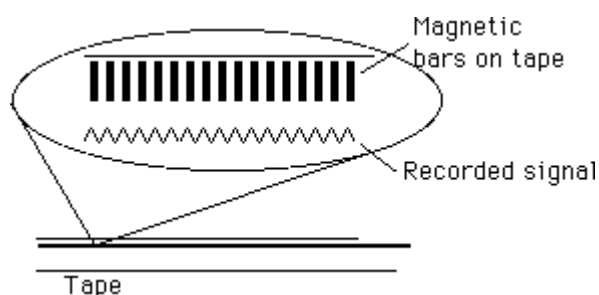
Type SR is quite complex, resulting in an analog tape that is quieter than digital.

The latest flavor of Dolby is type S, an advanced system optimized for cassettes. It is not widely available, but should be very nice when it appears on affordable decks.

Probably the best feature of Dolby is that B and C encoded tapes are usable without decoding. The high frequency response will not be right, but the sound is not too awful. As a matter of fact, playing an unencoded tape with type B decoding will sound quiet, and lots of decks don't have much in the way of high frequency anyway. The worst feature of B is that if the deck does loose highs in the recording process, the Dolby circuit will make things worse.

AZIMUTH

If the signal on a recorded tape were visible, it would look like a series of short bars perpendicular to the tape edge, rather like a tire track. This distance between the bars depends on the frequency and tape speed, and is in fact the wavelength of the signal on the tape. For a signal of 15kHz on cassette tape, this distance is 0.000125 inches or about the width of a fine hair.



Azimuth is the angle of the tape head to the tape. If this is not the same for playback as it was for recording, the gap (which is the part of the head that actually detects magnetism) would straddle two bars, reducing the amount of signal. (The spaces between the bars represent the negative parts of the cycle.) Thus azimuth errors tend to reduce high frequency response. This is purely a mechanical matter, and is primarily affected by the cassette shell. High quality tape will be in a good shell, cheapies often are not.

SO, HOW DO YOU GET DECENT SOUND OUT OF A CASSETTE?

1. Spend some bucks and get a decent deck. The ninety dollar wonders usually are very poor in the mechanics that assure consistent azimuth, and probably add flutter (tape speed variations caused by a not round or bent capstain) as well. Don't go overboard, of course. A deck priced in the \$200 to \$300 range will probably be fine. Features to look for are adjustable bias, HX PRO, and DOLBY C noise reduction.

2. Use good tape, and always use the same kind. Sometimes you have to experiment with several brands to find the one that is best on your deck. The decks in the studio work well with type II Maxell or TDK, but they are tweaked for the BASF that I sell. Tapes wear out faster than you think. After thirty or forty rewindings the the oxide begins to flake off and the lubricant that lines the walls of the shell (there aren't any reels in there) goes away,.

3. Keep the deck clean, and protect it from bumps. With wavelengths the size of a hair, it doesn't take much grunge to reduce high frequency response. Some brands of tape advertise head cleaning leader. This can't really do much, and whatever it does do will only happen the first few times the tape is played. Clean the heads with 91% isopropyl[5]alcohol. Azimuth will not change by itself, but it can when the deck is dropped, or if a cassette is forced in or out.

4. Set the deck for the proper tape type. Often this is a switch, but many decks select between standard and Type II/metal tape as indicated by a notch on the shell right next to the record protect tab. Be sure you never cover this notch. Even if the deck switches automatically, you have to use a switch to select metal or type II. (Very few decks record well on metal tape.)

5. If the deck has adjustable bias, set it so the highs sound correct. This is easy on a three head machine (the sound quality should not change when you switch from input to tape), but on most decks you have to make a series of trial recordings.

6. Record at the proper level. Most people try to get too hot a signal on the tape. The meters on the deck are peak meters, so steady tones should be recorded at -4 to avoid distortion. Most decks begin to lose high frequency response above -10.

7. Label your tapes. Then you don't have to play them (and wear them out) to find out what they are. Write the type of noise reduction used on the label so it will be played properly.

Source: http://www.co-bw.com/Audio_Analog_Recorders.htm