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Minimising Print-through

By Michael Gerzon

Some recent results (see reference) by E D Daniel and D L A Tjaden on tape print-through have an important practical consequence to users of audio tape and to designers of tape mechanisms who wish to avoid print-through.

For many years there have been arguments about whether tape should be stored 'oxide in' (*ie* with the tape oxide coating facing the reel hub) or 'oxide out'. Most people who have come across this have been faintly sceptical of the claim that 'oxide out' tape storage reduces print-through but many people who have tried it have found that indeed it seems to work.

At last the above mentioned research has provided the true answer. For the least objectionable print-through, tape should be stored oxide in (as usual) on the take-up spool but oxide out on the feed spool. It is clear that those who claimed that oxide out storage gave less print-through store their tapes on the feed spool.

An oversimplified account of what happens is as follows (see the reference for fuller details): when a signal is recorded, the magnetisation of the tape causes external magnetic fields to appear symmetrically on either side of the tape coating. These fields cut across the coating of adjacent layers of tape, generally in a diagonal direction. Print-through causes these adjacent layers to become magnetised by the fields both laterally (*ie* in the direction of rotation of the tape) and perpendicularly (*ie* across the thickness of the oxide coating). The external fields caused in turn by these lateral and perpendicular magnetisations of an adjacent layer add up on one side of its tape coating, and subtract on the other (see Fig 1). The print-through effect is symmetrically disposed about the coating of the layer which causes the print-through. The print-through will therefore have an 'additive' effect on, say, the head side of the coating of the adjacent layer on one side and on the base side of the coating of the adjacent layer of the other side.

The net effect is that the playback head sees more print-through on one adjacent layer than on the other. True, the print-through is really the same on both adjacent layers but, whereas the stronger additive print-through is seen by the head on one, it disappears harmlessly through the tape base away from the playback head on the other. Thus either the pre-echo will be stronger than the post-echo, or vice-versa.

Which echo will be worst in any particular case? A good rule of thumb is that a layer of tape will cause worse echoes on adjacent layers by print-through through its base than by print-through onto tape on its coating side (see Fig 2). For obvious musical reasons, a pre-echo is much more annoying than a post-echo. Thus the tape should always be wound so that its oxide coating side points towards the music recorded earlier, as print-through from the coating side is least severe. This means: wind the tape oxide in on the take-up spool, and oxide out on the feed spool.

Thus, for any long-term storage of recorded tape, it is a good idea to store it oxide in and tail-end out (*ie* on the take-up spool). This procedure is in fact already widely used in the industry and it is worthwhile here pointing out the other overwhelming advantages of this mode of tape storage. Not only is the basic print-through less annoying, but the effect of print-through is reduced in two further ways. First, tape winding always occurs before replay rather than after, and it is well-known that fast winding helps to reduce print-through. Second, in a partly filled recording tape, the recorded portions will normally be stored with a smaller radius than the unrecorded portions. This means that any echo occurs sooner after the music, which at a tape speed of 38cm/s can cause an appreciable reduction in its annoyance value.

A further advantage of storage on the take-up spool is that, after a complete playback, the tape will be stored neatly wound, instead of with the rough wind often encountered with storage after fast rewind on the feed spool. Neat wind is not merely an aesthetic requirement. It renders the tape almost immune from handling damage to the tape edges, and prevents the edges of isolated layers of tape from being badly deformed or curled during storage. Neat wind also allows badly deformed tape (which suffers from severe drop-out) to smooth itself out gradually by means of the gentle pressure of adjacent tape layers. This often causes a marked reduction in drop-out during subsequent playbacks or recordings. This ability to prevent and cure tape deformations (other than stretching) is most effective with long play tape, less so with standard play. Neat wind also prevents dust and atmospheric contamination from covering the exposed oxide of poorly wound layers.

There are some lessons to be drawn in understanding how pre- and post-echo differ. Never leave recorded tapes oxide-in on the feed spool for long periods, especially in warm conditions. Similarly, never leave recorded tape oxide-out on the take-up spool longer than necessary. If independent recordings are made on different tracks of a tape (*eg* half track mono or quarter

track stereo) wherever possible make both in the same direction so that the same mode of storage will minimise print-through on both. This is particularly important on archive material and, if it is not possible to switch to the unused track(s) on the record head of a standard machine, the expedient can be adopted of using one track at a time of a two track stereo machine for half track mono, or two tracks at a time of a four channel machine for quarter track stereo.

It is worth looking at the possibility of storing the tape oxide out on the feed spool and oxide in on the take-up spool. On conventional ('oxide in') tape machines, this means putting a 180° twist in the tape between the feed spool and the head block. This is only practical if there is room for such a twist on the thickest tape likely to be used when the feed spool is full. Some machines do not have enough room for a twist, or can manage it only with long play tape. One must beware of those machines that cause the feed spool to 'swallow' twists when fast rewinding. Certainly avoid trying to fast-rewind with a twist when the tape is slack. DIN hubs or plates are out when a twist is used, as are spools with a very wide open space between spokes. To prevent mishaps it is normally better to use a twist that tends to make the tape rise off the reel, rather than one in the opposite direction that tends to cause it to fall.

Occasionally it has been found that when a twist is used with very full reels on some machines drop-out and wow-and-flutter can occur, especially with standard play tape. Despite all these possible snags, though, a 180° tape twist after the feed spool is practical on many good 6.25mm tape machines. It is doubtful, however, if a twist will ever work with, say, a 50mm machine. Also, it is clearly difficult to edit tape with a twist, especially if one tries to avoid touching (and hence contaminating) the oxide surface.

Another way of getting oxide out on the feed spool and oxide in on the take-up spool is to use a tape deck whose feed-spool motor is wired up to apply rewind and playback tension in an anticlockwise direction, as in Fig 3. This is an ideal arrangement on a suitably designed deck, except that some tapes already recorded may be stored oxide in on the feed spool, as may new unrecorded tape. Clearly there will not be time to rewind unrecorded tapes during a recording session, and we are thus stuck with the ever-recurring problem of compatibility. The two methods of storage are incompatible on machines on which tape twists cannot be used. The problem ceases within an individual organisation if all the storage is on the take-up spool, and if the manufacturer supplies new tape oxide-out. As a desperate expedient, the tea-boy (or his equivalent) could rewind new recording tape to oxide out as it arrives. Even so, inter-studio problems may still arise unless take-up spool storage is always adhered to.

One dangerous solution to these problems is to have the feed spool switchable to either direction. What an ideal way absent-mindedly to ruin precious master tapes! Readers of this journal are well placed to try and think out their own solutions to this dilemma – if indeed it is a dilemma. Many will take the probably reasonable attitude that, as a recorded tape will only be on feed spools for short periods, print-through won't have time to set in, so oxide in will be satisfactory on the feed spool. Fine – but don't leave recorded tape on the feed spool during hot weekends.

Is the difference in print-through between the two modes of tape storage worth worrying about anyway? The difference between pre- and post-echoes can be several dB and most people who have tried it find the difference clearly audible. One might argue that with Dolby and good tape it doesn't matter but this is clearly a matter of personal tolerance to faults. It is in any case good engineering practice to avoid a defect in the first place rather than to attempt to cure it after it has struck. Clearly, all archive material, and all material such as electronic music whose existence depends on tape, should be stored either tail-end-out and oxide in or tail-end-in and oxide out, preferably the former.

One last point. Once an idea gets into the heads of those in the audio world it tends to hang on and on and on, long after its *raison d'être* has disappeared. So it is necessary to point out that the difference in levels between pre- and post-echo is caused by the ability of present day tape to be magnetised perpendicular to its surface. If in future a tape (perhaps a CrO_2 type) should come into use which does not have this ability then the difference will disappear, and whether oxide in or oxide out tape storage is used will then no longer matter. But it certainly does matter with present-day tapes.

Reference

Eric D Daniel, 'Tape Noise in Audio Recording', *Journal of the Audio Engineering Society,* vol 20, pages 92 to 99 (especially 97 and 98), March 1972

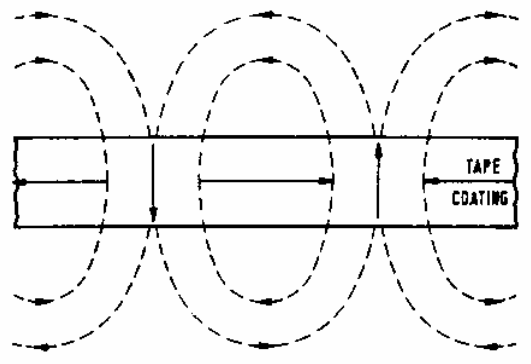

Fig 1: Lateral and perpendicular magnetisation of a tape coating can cause external magnetic fields that add on one side of the coating and subtract on the other

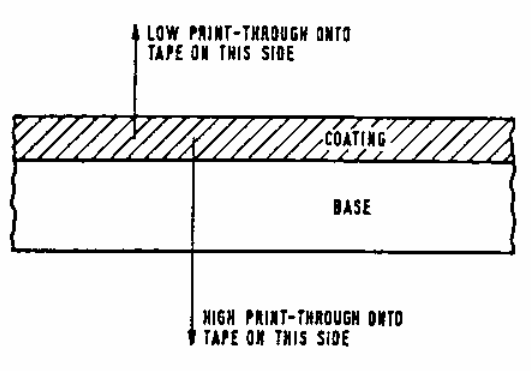

Fig 2: Effective print-through caused by a recorded layer of tape

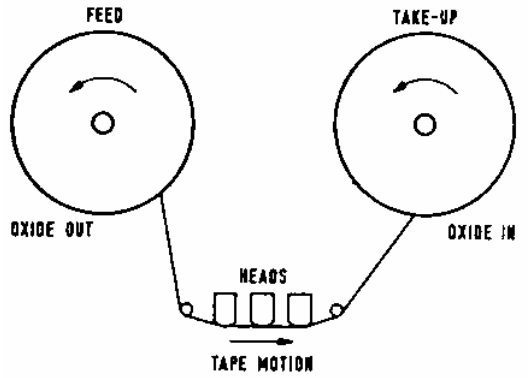

Fig 3: Tape deck with oxide-out feed spool. The curved arrows show the direction of motor torque during playback