Stereo Review's

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TAPE RECORDING & BUYING GUIDE® 1975

COMPLETE DIRECTORY • LATEST MODELS & FEATURES STEREO & 4-CHANNEL FOR HOME, AUTO, PORTABLE USE

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EQUIPMENT TEST REPORTS (HIRSCH-HOUCK LABS)

TAPE MACHINE BUYING TIPS

HOW TO USE RECORDERS CREATIVELY

USER'S GUIDE TO MAGNETIC TAPE

CHOOSING PORTABLE & MOBILE TAPE RECORDERS

14262

If you think there's a cassette or cartridge better than Columbia's we'll buy it for you.

Just try a new Columbia tape. If you still like your old tape better, return the Columbia tape to us, and we'll send you the one you prefer. Free.

Our problem

Most people who buy recording tapes are pretty happy with what they're using. So it's hard for someone with a new tape—even someone with all the experience in music and electronics that Columbia has—to get people to try it. Regular advertising just won't work.

We realized we'd have to come up with a really unusual introductory offer. To really challenge people to try our new FAIL-SAFE cassettes and cartridges. To see that they really are better than other tapes.

Our offer

1. Buy a new Columbia cassette or cartridge in any length you like.

2. Try it out. Record on it. Compare it to the tape you've been using. TDK, Memorex, Scotch. Any iron oxide tape.

3. If you're happy with Columbia, fine. You've bought yourself a great new tape. And we hope you'll keep buying Columbia.

4. But, if for any reason you're not satisfied with the Columbia tape, send it back to us. With your receipt, no more than 30 days after you bought it, and include a label from the tape you prefer. Your only cost is 50¢ for postage and handling.

5. We'll send you the tape you prefer. In the same length as the Columbia tape you returned.

Our experience

We don't think we're taking much of a chance with this offer. And we don't think we'll be sending out many TDKs, Memorexes, or Scotches. Because while you may have never seen one of our blank tapes before, we're not exactly newcomers to the recording business.

We've made hundreds of millions of pre-recorded tapes over the years. For our own record label, and even for a lot of our competitors. And through that experience we learned a lot about sound quality and product reliability that helped us develop the best blank tape for home recording. With more highs and lows. Without fuzzing or blurring the sounds. Without jamming in any kind of tape deck in any kind of weather. And with unique features that make recording a pleasure. Like our ConvertaQuad cartridge that works automatically on stereo or 4-channel. And extra adhesive labels to retitle your tapes when you re-record.

Our challenge

If you think there's a tape that's better than ours, it's because you just haven't tried ours. Columbia Magnetics, CBS, Inc., 51 W. 52nd St., N.Y. 10019.

We want to change your mind

CIRCLE NO. 5 ON READER SERVICE CARD

Stereo Review's

TAPE RECORDING & BUYING GUIDE® 1975

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TAPE TERMINOLOGY

Acetate Base—The transparent cellulose-acetate plastic film that forms the backing for many magnetic recording tapes.

Automatic Reverse—The ability of some four-track stereo tape recorders to play the second pair of stereo tracks automatically (in the reverse direction) without the necessity for interchanging the empty and full reels after the first pair of stereo tracks is played. (See also *Four-Track Recording*)

Automatic Shut-Off—A device (usually a mechanical switch) incorporated into most tape recorders that automatically stops the machine when the tape runs out or breaks.

Azimuth Adjustment—The mechanical adjustment of a magnetic head whereby exact alignment of the head gap with a standard tape-recorder magnetic pattern is achieved. Of prime importance for optimum high-frequency performance and recorder-to-recorder playback compatibility. (See also *Head Alignment*)

Azimuth Loss—The signal loss caused by lack of alignment between the playback-head gap and the signal recorded on the tape.

Backing or Base—The flexible material, usually cellulose acetate or polyester, on which is deposited the magnetic-oxide coat that "records" the taped signal.

Bias—A constant signal or tone added to the audio signal during recording to circumvent the inherent non-linearity of magnetic systems. The best (and most commonly used) bias is a high-frequency (usually 50,000 to 100,000 Hz) alternating current fed to the recording head along with the audio signal to be recorded.

Bulk Eraser or Degausser—A hand-held (or larger) device used to erase magnetic tape without removing it from the reel. It generally produces a strong alternating magnetic field that neutralizes all previously recorded magnetic patterns on the tape.

Cartridge—A sealed plastic container that holds tape of ¼-inch or narrower width. Designed to eliminate manual tape threading, cartridges operate on either the continuous-loop (single hub) principle or the reel-to-reel (double hub) system. Cartridge machines are usually smaller and simpler to use than ordinary open-reel units. (See also *Cassette*)

Capstan—The driven spindle or shaft in a tape recorder—sometimes the motor shaft itself—which rotates against the tape (which is backed up by a rubber pressure or pinch roller), pulling it through the machine at constant speed during recording and playback modes of operation. The rotational speed and circumference of the capstan determine tape speed.

Cassette—A type of tape cartridge operating on the hub-to-hub principle and now coming into wide use in portable and home machines.

Crosstalk—The undesired pickup of a signal from an adjacent track recorded on a tape.

Deck, Tape—A tape recorder designed specifically for use in a high-fidelity music system. It usually consists only of the tape-transport mechanism and preamplifiers for recording and playback. It does not include power amplifiers or speakers.

Decibel—Abbreviated "dB" or "db," it is a relative measure of sound intensity or "volume." It expresses the ratio of one sound intensity to another. One dB is about the smallest *change* in sound volume that the human ear can detect. (Also used to express voltage and power ratios logarithmically.)

Dolby—An electronic device or circuit that reduces the amount of noise (principally tape hiss) introduced during the recording process. It does this by boosting—in carefully controlled amounts—the strength of weak signals before they are recorded. During playback the signals (and the noise) are cut back by an exactly equivalent amount. The original dynamics are thus restored, but the noise is reduced by 10 to 15 dB. At one time found only in recording studios, simplified Dolby circuits designed especially for tape recording are now available to the audiophile as accessories or built into tape machines.

Dropout—During playback, the momentary loss of a recorded signal resulting from imperfections in the tape. These may take the form of non-magnetic foreign particles imbedded in and flush with the tape's surface. However, these imperfections are most commonly high spots on the tape surface that push the tape away from the magnetic head, thereby increasing the area affected (the "umbrella" effect).

Dual-Track Recorder—Usually a monophonic recorder with a recording-head gap that covers somewhat less than half the width of a standard quarter-inch tape, making it possible to record one track on the tape in one direction and (by turning the reels over) a second track in the opposite direction. Also known as "two-track" or "half-track."

Dub—A copy of another recording.

Dynamic Microphone—An electromagnetic pressure microphone that employs a moving coil in a magnetic field to convert sound pressure to electrical energy in a manner similar to that of an electric generator. Impedance and output are generally lower than those of the ceramic or crystal microphone types. Low impedance permits the use of longer connecting cables without high-frequency loss or hum pickup.

Dynamic Range—The voltage ratio (expressed in decibels) between the softest and loudest sounds a tape recorder or other device can reproduce without undesirable distortion in loud passages and excessive noise in soft ones.

Echo—A special facility found in some three-head tape recorders. Part of the slightly delayed output of the monitor head is fed to the recording head and mixed with the signal being recorded. The result is an "echo" of the material recorded a moment before.

Editing—The alteration of a tape recording by physical means to eliminate or replace undesirable portions, add portions not present in the original, or otherwise rearrange the original. Magnetic tape is unsurpassed for editing purposes, since it can be easily cut and spliced.

Equalization—The selective amplification or attenuation of certain frequencies. Also refers to recognized industry standards for recording and reproducing "characteristics" (such as the NAB Standard), the proper use of which can assure uniform reproduction of prerecorded tapes and improvement of a system's signal-to-noise ratio.

Erasure—The neutralization of the magnetic pattern on tape by use of a strong magnetic field, thereby removing the recorded sound from the tape. During recording, the erase head on a recorder automatically removes any sound previously recorded on the tape just before the tape reaches the record head. (See also *Bulk Eraser*)

This material has been adapted from "101 Terms A Glossary of Tape Recording Terms," published by the Magnetic Products Division of the 3M Company. Our thanks for their permission to bring it to you.

Extra Play—Also called "long play" or "extended play." Refers to tape that gives more than standard playing time on a standard reel because it employs a thinner base together with a thinner but usually more responsive oxide coating, and thus more tape can fit on a reel.

Fast Forward—The provision on a tape recorder permitting tape to be run rapidly through it in the normal play direction, usually for search or selection purposes.

Feed Reel—Also called "stock," "supply," or "storage" reel. The reel on a tape recorder from which the tape is taken as the machine records or plays.

Flutter—Very short, rapid variations in tape speed, causing pitch and volume variations that were not present in the original sound. A form of distortion.

Four-Channel Sound—Stereo produced by four loudspeakers, each being fed a different signal. At present four-channel tape machines are equipped with special heads and electronics that enable them to play back—and sometimes record—four tracks at a time.

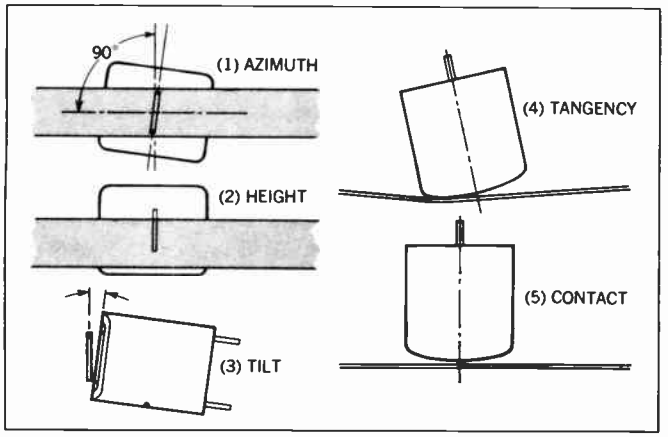
Four-Track or Quarter-Track Recording—The arrangement by which four different channels of sound may be recorded on quarter-inch-wide audio tape. These may be recorded as four separate and distinct tracks (monophonic) or two related (stereo) pairs of tracks. By convention, tracks 1 and 3 are recorded in the "forward" direction of a given reel, and tracks 2 and 4 are recorded in the "reverse" direction. (See also *Four-Channel Sound.*)

Frequency—The repetition rate of cyclic energy, such as sound or alternating electrical current, expressed in cycles per second (hertz or Hz) or thousands of cycles per second (kilohertz or kHz). By convention, "bass" frequencies in music extend from about 20 to about 200 Hz. "Treble" sounds are at the high-frequency extreme of the sound spectrum and may extend from 2 or 3 kHz to the frequency limit of audibility (about 18 to 20 kHz). "Middle" (or mid-erange) frequencies occupy the remainder of the spectrum, from 200 Hz to about 3 kHz.

Frequency Range—The span between the highest and lowest pitched sounds that a tape recorder or other sound-system component can reproduce at a usable output or volume level.

Frequency Response—Always specified as a range, such as 50 to 15,000 Hz; but in order to be meaningful it must be further defined in terms of decibel variation from absolute flatness over a specified frequency range (*e.g.*, ±3 dB from 50 to 15,000 Hz). An indication of a sound system's ability to reproduce all audible frequencies supplied to it, maintaining the original balance among the low, middle (or mid-range), and high frequencies.

Fig. 1. (1) Azimuth, or skew, in which the width dimension (corresponds to track width) of the head gap is a precise 90-degree angle to the tape edge. (2) Height, in which the gap-width dimension is centered on the standard track location. (3) Tilt, in which the face of the head must be simultaneously tangent to the same degree with both edges of the tape and without distortion of either of the latter. (4) The adjustment to assure that the tape is tangent with, and contacting the specific portion of, head face containing head gap, and remains so during playing of tape. (5) Adjustment toward or away from tape to assure proper contact pressure ("wrap") between head and tape.



Full-Track Recording—Applies to quarter-inch-wide (or less) tape only. It defines track width as essentially equal to tape width.

Gain—The voltage ratio of the output level to the input level for a system or component of a system. Usually expressed in decibels.

Gap—The effective distance between opposite poles of a magnetic head, measured in microinches or microns. Especially critical for playback heads in which gaps must be narrow in order to resolve (reproduce) high-frequency (short wave-length) signals. Recording heads generally have wider gaps than reproducing heads.

Harmonic Distortion—Distortion characterized by the appearance in the ouput signal of spurious harmonics of the fundamental frequency. Usually expressed as a percentage of the output signal.

Harmonics—Overtones that are integral multiples of the fundamental frequency. In properly balanced a.c.-biased tape recorders, only the odd-order harmonics (primarily the third) are generated by the recording process and these are very low in amplitude.

Head—In a magnetic-tape recorder, the generally ring-shaped electromagnet across which the tape is drawn. Depending on its function, it either erases a previous recording, converts an electrical signal to a corresponding magnetic pattern and impresses it on the tape (record function), or picks up a magnetic pattern already on the tape and converts it to an electrical signal (playback function). Most home recorders have a separate erase head, but combine the record and play functions in a single unit. Professional machines and those intended for the serious amateur have separate heads for erase, record, and playback.

Head Alignment—Includes all mechanical adjustments necessary to assure proper spatial relationships between the head gaps and the tape—or, more specifically, a properly recorded tape track. It may be separated into five attributes describing correct head attitude. See Fig. 1.

Head Demagnetizer or Degausser—A device used to neutralize possible residual or induced magnetism in heads or tape guides. Unless the recorder has an automatic head-demagnetizing circuit and non-magnetic tape guides, periodic use of a head demagnetizer may be necessary to avoid addition of hiss noise to, or even partial erasure of, prerecorded tapes.

Hiss—A high sibilant sound, most often found in tape recording or tape playback. The better the tape system, the lower the hiss.

Impedance—The resistance to the flow of alternating current in an electrical circuit, generally categorized as either "high" or "low," but sometimes given in ohms or millions of ohms (megohms). Commonly used to rate electrical input or output characteristics of component so that proper "match" can be made when interconnecting two or more devices (such as a microphone, tape recorder, and loudspeaker). Power loss or frequency discrimination can result from a "mismatch" of impedances between two units.

Index Counter—An odometer type of counter that indicates revolutions (not feet of tape), usually of the supply reel, thereby making it possible to index selections within a reel of tape and readily locate them later on a given machine.

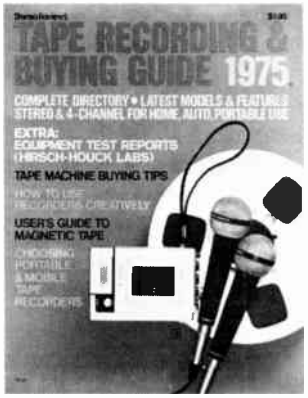
Input Signal—An electrical voltage embodying the audio information that is presented to the input of an amplifier, tape recorder, or other electronic component.

Input—The terminals, jack, or receptacle provided for the introduction of the electrical input signal voltage into an amplifier or other electronic component.

Intermodulation Distortion—Distortion that results when two or more pure tones produce new tones with frequencies representing the sums and differences of the original tones and their harmonics.

ips—Abbreviation for tape speed (inches per second).

Jack—Receptacle for a plug connector leading to the input or output



Cover shows the new Superscope C-108 portable cassette recorder; Beyer/Dynamic M-500 dynamic ribbon mikes, and TDK open-reel tape.

Cover Photo: Bruce Pendleton

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circuit of a tape recorder or other piece of equipment. A jack matches a specific plug.

kHz—Abbreviation for kilohertz, or one thousand cycles per second. For example, 19 kHz equals 19,000 Hz.

Leader and Timing Tape—Special tough non-magnetic tape that can be spliced to either end of a magnetic tape to prevent its damage and possible loss of recorded material. Either white or in colors, it usually has some type of marking that enables it to be used as a timing tape. It therefore can be spliced between musical selections to provide desired pauses in playback.

Level Indicator—A device on a tape recorder for indicating the level at which the recording is being made; it serves as a warning against under- or over-recording. It may be a light indicator or a meter. (See also *VU Meter*)

Low-Noise Tape—Magnetic tape with a signal-to-noise ratio 3 to 5 dB better than conventional tapes, making it possible to record sound (especially wide-frequency-range music) at reduced tape speeds without incurring objectionable background noise (hiss) and with little compromise of fidelity. Additional characteristics of most low-noise tapes include extremely good high-frequency sensitivity and a heavy-duty binder system for reduced ruboff of magnetic oxide and an increase in wear life over ordinary tapes.

Low-Print Tape—Special magnetic recording tape significantly less susceptible to print-through (the transfer of signal from one layer of tape to another), which results when tape is stored for long periods of time. These tapes are especially useful for "master recording" (making an original recording from which copies will be made) on professional-quality equipment.

Mil—One one-thousandth of an inch. Tape thickness is usually measured in mils.

Mixer—A device that allows two or more signal sources to be blended, balanced, and fed simultaneously into a tape recorder or amplifier.

Monophonic (Monaural) Recorder—Refers to single-channel recorders, as distinguished from stereophonic types. Current home recorders are almost all of the four-track stereo configuration.

Monitor Head—A separate playback head on some tape recorders that makes it possible to listen to the material on the tape an instant after the recording is made and while the recording is still in progress.

NAB Curves—Standard tape-recorder playback equalization curves established by the National Association of Broadcasters. (See also *Equalization*)

Noise—Unwanted electrical signals produced by electronic equipment, and rough or non-homogeneous oxide coatings on magnetic tape. Mostly confined to the extremes of the audible frequency spectrum where it occurs as hum and/or hiss, it may be reduced by good machine and tape design. (See also *Low-Noise Tape*)

Noise, Weighted—The noise measured within the audio frequency band using a measuring instrument that has a frequency-selective characteristic. The frequency sensitivity of the instrument is adjusted to correspond to that of the average human hearing response.

Open Reel—Tape systems that, for home applications, use up to 7-inch reels of tape. To start the tape, it must be threaded by hand from the full to the empty (or takeup) reel. Open-reel tape systems usually provide greater fidelity than cassette or tape cartridge systems, but that gap is closing rapidly. (See *Tape Speed*)

Output (also Maximum Output Level)—The useful signal delivered by a recorder using a particular type of tape, usually at an arbitrarily fixed level of harmonic distortion (1 or 3 per cent) and relative to the performance of a tape with standard characteristics (such as Scotch No. 111).

Oxide—The ferro-magnetic particles which, when properly dispersed in a plastic binder and coated on a backing or base, form the magnetic portion of magnetic tape. Conventional oxide particles are chemically known as gamma ferric oxide, are brown in color, acicular (needlelike) in shape, and of micron length. Less conventional

oxides have been developed that exhibit significantly different magnetic properties (and size).

Patch Cord—Sometimes called "signal lead." A short shielded wire or cable with a plug on either end (or with a pair of clips on one end) for conveniently connecting together two pieces of sound equipment such as a phonograph and tape recorder, an amplifier and speaker, *etc.* Not to be used for 120-volt current.

Pause Control—A feature of some tape recorders that makes it possible to stop the movement of tape temporarily without switching the machine from "play" or "record."

Playback—The reproduction of sound previously recorded on a tape. The opposite of *record.*

Playback Head—Magnetic head used to pick up a signal from a tape. Often the same head as is used for recording, but with its circuits changed by means of a record/play switch which also energizes the erase head. (See also *Head*)

Polyester Base—A plastic-film backing for magnetic tape used for special purposes where strength and resistance to temperature and humidity change are important. (Mylar is a du Pont trade name for their brand of polyester.)

Portable Recorder—Originally, any tape recorder designed for easy mobility and requiring connection to a 120-volt a.c. supply for operation. Recently the term has been applied specifically to battery-powered units that do not require external power for operation.

Prerecorded Tape—Tape recordings that are commercially available and generally embody the same material that is available on phonograph records.

Pressure Pad—A device that forces tape into intimate contact with the head gap, usually by direct pressure at the head assembly. Felt or similar material, occasionally protected with self-lubricating plastic, is used to apply pressure uniformly and with a minimum of drag on the backing (non-coated) side of the tape.

Pressure Roller—Also called "pinch roller" or "capstan idler." A hard-rubber roller that holds the magnetic tape tightly against the capstan, permitting the latter to draw the tape off the supply reel and past the heads at a constant speed. (See also *Capstan*)

Print-Through—Undesired transfer of magnetic pattern from layer to layer of tape on a reel. In most cases, will make recording unusable.

Raw Tape—A term sometimes used to describe tape that has not been used for recording. Also called "virgin" or "blank."

Reel-to-Reel—Designates those tape machines that do not use a cartridge or cassette. (See also *Open Reel*)

Rewind Control—A button or lever for rapidly rewinding tape from the takeup reel to the supply reel.

Saturation—The condition reached in magnetic tape recording where output does not increase with increased input, and hence distortion increases significantly. Useful for defining reference output levels, since it is independent of bias current.

Sensitivity—As used to describe the capabilities of raw tape, it indicates the relative output for a given input in the linear (low-distortion) portion of a tape's magnetic transfer characteristic. Sensitivity data plotted as a function of frequency (or wave length) gives frequency response, usually relative to a standard reference tape.

Separation—The degree to which two stereo signals are kept apart. Stereo realism depends on the successful prevention of their mixture in all parts of a hi-fi or tape system. Tape systems have separation capability superior to that of disc systems.

Signal-to-Noise Ratio—The voltage ratio, usually expressed in decibels, between the loudest undistorted tone recorded and reproduced by the recorder and the noise reproduced when the audio signal is reduced to zero.

Sound-on-Sound—A method by which material previously recorded on one track of a tape may be re-recorded on another track while simultaneously adding new material to it.

Splicing Block—A metal or plastic device incorporating a groove within which ends of the tape to be spliced are held. An additional diagonal groove provides a path for a razor blade to follow in cutting the tape. It makes splices very accurately using narrow-width ($^{7}/_{32}$") splicing tape. (See also *Tape Splicer*)

Splicing Tape—A special pressure-sensitive, non-magnetic tape used for joining two lengths of magnetic tape. Its "hard" adhesive will not ooze, and consequently will not gum up the heads or cause adjacent layers of tape on the reel to stick together.

Squeal—The audible noise caused by alternate sticking and release of tape. It may occur at heads, pressure pads, or guides where friction develops with the face or back side of a magnetic tape. It is largely eliminated by regular cleaning of suspected surfaces and by using a tape employing a built-in dry silicone lubricant.

Takeup Reel—The reel on the tape recorder that accumulates the tape as it is recorded or played.

Tape Guides—Grooved pins or rollers mounted between and at both sides of the tapehead assembly to position the magnetic tape correctly on the head as it is being recorded or played.

Tape Lifters—A system of movable guides that automatically prevents the tape from contacting the recorder's heads during fast forward or rewind modes of operation, thus preventing head wear.

Tape Loop—A length of magnetic tape with the ends joined together to form an endless loop. Used either on standard recorders, special "message-repeater" type units, or in four- or eight-track cartridge devices, it makes possible the repetitive playback of a recording without rewinding the tape.

Tape Monitoring—See *Monitor Head*

Tape-Transport Mechanism—The platform or deck of a tape recorder on which the motor (or motors), reels, heads, and controls are mounted. It includes those parts of the recorder other than the amplifier, preamplifier, loudspeaker, and case.

Tape Player—A unit that is not capable of recording and is used only for playing prerecorded tapes.

Tape Speed—The speed at which tape moves past the head in recording or playback modes. Standard tape speed for home use is $7^{1}/_{2}$ ips or half that speed ($3^{3}/_{4}$ ips). Speeds of $1^{7}/_{8}$ and $^{15}/_{16}$ ips are found on some machines, but on reel-to-reel recorders are usually suitable only for non-critical voice recording. Some cartridge machines, using special tape and circuits, achieve very good results at the slow speeds. Professional recording speed (for making original master tapes of music, for example) is usually 15 ips and sometimes higher.

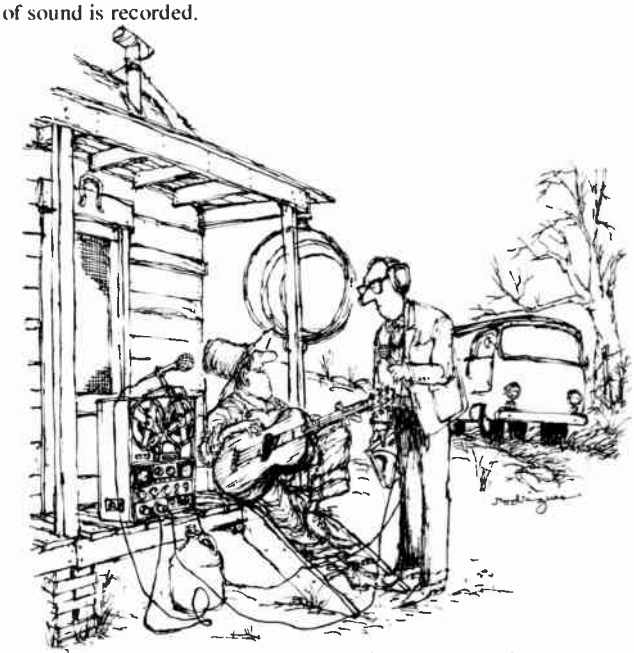
Tape Splicer—A device, similar to a film splicer, for splicing magnetic tape automatically or semi-automatically. Different models vary in operation, most using splicing tape; some professional units employ heat. (See also *Splicing Block*)

Telephone Pickup—Any of several devices used to feed telephone conversations into a tape recorder, usually without direct connection to the telephone line and operating by magnetic coupling.

Tensilized Polyester—A polyester tape backing that has been prestretched principally in the lengthwise direction to increase resistance to further stretching.

Tone Controls—Control knobs on a tape-recorder amplifier used to vary bass and treble response to achieve the most desirable balance of tone during playback.

Track—The path on the magnetic tape along which a single channel of sound is recorded.



"No, I didn't learn that one from my Grandpappy —fella name of Alan Lomax was thru here a while back."

Two-Track Recording—On quarter-inch-wide tape, the arrangement by which only two channels of sound may be recorded, either as a stereo pair in one direction or as separate monophonic tracks (usually in opposite directions).

Uniformity—In terms of magnetic tape properties, a figure of merit relating to the tape's ability to deliver a steady and consistent output level when being recorded with a constant input. Usually expressed in decibel variation from average at a mid-range frequency.

VU Meter—A "volume unit" meter that indicates audio-frequency levels in decibels relative to a fixed 0-dB reference level. The meter movement differs from those of ordinary voltmeters in that it has a specified ballistic response adapted to monitoring speech and music. Used in many home and most professional recorders to monitor recording levels and maintain them within the distortion limits of the tape.

Wave Length—In tape recording (and referring specifically to the tape magnetization created by pure single-tone recording), the shortest physical distance between two peaks of the same magnetic polarity; also, when expressed in mils, the ratio of tape speed (in ips) to recorded frequency (in kilohertz).

Wow—A form of distortion in sound-reproducing systems caused by relatively slow periodic variation in the speed of the medium (such as tape) and characterized by its effect on pitch.

Wrap—The length of the tape's path along which tape and head are in intimate physical contact. Sometimes measured as the angle of arrival and departure of the tape with respect to the head. A "good wrap" means a good tape-to-head-gap relationship. (See also *Head Alignment*) □

DIRECTORY OF MANUFACTURERS

(Continued on page 121)

Good time capsule.

Saving fleeting moments requires a quality tape recorder. But, just as a camera can be no better than its lens, tapes can be no better than the microphone. Whether it costs $200, $500—even $1,000—a tape recorder can be significantly improved by the addition of a Shure *unidirectional* microphone —a mike that can be 'aimed" so that only the target sounds will be recorded. Microphone misers who ignore this will never hear the *true* sound of recorded music lessons, parties, classes, speech therapy, sound movies and rehearsals. With Shure microphones, creating tomorrow's treasures is today's pleasure.

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TAPE MACHINE BUYING TIPS

Features and performance specifications to consider when choosing an open-reel, cassette or 8-track tape machine

By Julian D. Hirsch, Hirsch-Houck Laboratories

TAPE RECORDERS can be compared on the basis of their *features* and performance *specifications*. A feature is a physical characteristic, such as the number of motors or tape heads, that affects what a machine can do, while a specification describes *how well* it does something (frequency response and distortion are typical examples).

Although these parameters are defined in much the same way for all types of recorders—open-reel, cassette, and cartridge—the specific test methods and conditions differ appreciably. Also, the criteria for judging the performance of a cassette recorder, for example, may be quite different from those one would apply to an open-reel machine. If one understands the differences and similarities among the features and specifications of the basic types of recorders, and their importance to the user, the buyer is more likely to make a wise choice.

Tape Drive System. In all types of tape recorders, the tape is pressed between a rubber pinch roller and a capstan, or shaft, which turns at a constant speed. Ideally, the tape speed is determined entirely by the capstan diameter and its speed, assuming that there is no slippage between the capstan, tape, and pinch roller. Tape-speed *accuracy* and *constancy* are distinctly different, since it is possible to have a constant, but incorrect, speed. A constant speed error, if not excessive, is much more acceptable to the listener than any short term speed variation (no matter how slight). Exact speed is important to professional and broadcast users, since speed errors affect timing. A "dead" time or overrun of 30 seconds in a half-hour program, for instance, could be disastrous. The pitch error from such a speed discrepancy, however, would probably go unnoticed by most listeners.

The capstan of an inexpensive recorder is often driven by an induction motor similar to those used on many record players. While not truly "constant-speed" tape drives, they are usually within the 1% speed error tolerance considered acceptable in a cassette or low-priced open-reel recorder. Better cassette mechanisms (and almost all open-reel recorders) today use a constant-speed drive such as a synchronous motor whose speed is locked to the

power-line frequency. Another system uses a servo-controlled d.c. or a.c. motor whose speed is set by an internal adjustment and is independent of power-line frequency and voltage.

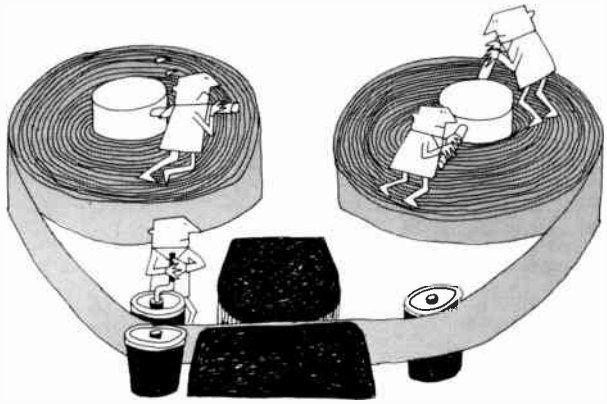
Flutter, which is caused by rapid fluctuations in tape speed, is expressed as a percentage change of playback frequency from a tape recorded at a constant frequency. Acceptable flutter levels differ widely, according to the sensitivity of the listener, the type of music, and the rate at which the flutter occurs. A weighted measurement is sometimes used, in which the flutter occurring at the most objectionable rate plays the largest part in determining the final figure. A weighted flutter measurement will always be less than an unweighted measurement, but there is no simple relationship between the two.

Most people cannot hear flutter levels under 0.1%, and good open-reel recorders usually boast less than that amount of weighted flutter at a 7½-ips tape speed. The best home machines may have less than 0.05% flutter. At lower tape speeds, such as 3¾ and 1⅞ ips, the flutter is usually a little higher, but will rarely exceed 0.15%, even on a moderately priced recorder.

Cassettes present a more difficult design problem, since the tape not only moves at a slow 1⅞ ips, but the supply and takeup reels and most of the tape guide path are within the cassette and not directly under the control of the recorder manufacturer. Nevertheless, with good-quality cassettes, most modern cassette recorders have less than 0.2% flutter, with the better ones measuring in the vicinity of 0.1 to 0.12%, and a few of the most refined models reaching 0.07%.

One way to minimize flutter is by means of a *dual-capstan* system, with a capstan on either side of the head assembly. The two are driven at slightly different speeds, so that the tape is always under a constant, and controlled, tension as it passes over the heads. Dual-capstan drives are used in some of the better open-reel and cassette recorders.

An eight-track cartridge has a single tape winding, formed into an endless loop. The tape is pulled out from the center of the pack, passes over the head(s), and rewinds on the outside of the pack. Since the tape speed must always be different entering and leaving the winding, there is some slippage or rubbing between adjacent tape layers. Even with the specially lubricated tape used in cartridges, this friction can cause flutter, in addition to the amount contributed by capstan speed irregularity. Although the best cartridge mechanisms have flutter specifications as low as 0.1%, in practice there are usually variations in flutter due to limitations of the cartridge itself. Often this is caused by a slipping drive capstan, which produces a low-frequency wow rarely found in other tape systems.



Tape Transport Control Systems. In a single-motor transport, used on a few open-reel machines and most cassette recorders, the capstan motor is also coupled to the supply and takeup reel hubs through a system of belts and clutches. Since the reels turn at different (and constantly changing) speeds, some slippage is always required in the drive system. Inevitably, there is some interaction affecting the capstan speed.

A better system is to use separate motors for the capstan and each of the reel hubs. A three-motor transport is less likely to require periodic adjustments of belts and clutches, and can move the tape much faster in fast-forward and rewind operation. Lower flutter is usually obtained when separate motors are used for reel and capstan drive. Although there is at least one cassette recorder with three motors, most of the better ones use only two motors—one for the capstan and one driving both hubs through belts.

Single-motor open-reel recorders usually have one or more levers or knobs which shift the belts and clutches in the mechanism to move the tape at normal forward speed, or at high speed in either direction. A separate recording interlock button must be operated together with the transport control to make a recording, so that one cannot accidentally erase a previously recorded tape. The controls of a single-motor tape transport usually require an appreciable operating force, since they perform the necessary operations directly through mechanical linkages.

Three-motor machines, in contrast, are usually controlled by solenoids, which are electro-magnetic actuators that do the work of shifting the mechanism. Only an electric circuit closure is needed to operate a solenoid, and this can be done by a push-button requiring only very light pressure. On some machines these buttons latch into place when

pressed, although this is not necessary to keep the solenoid in its operating position once it has been energized. The latching system does offer the user the option of setting up the machine in advance, so that when primary power is applied by an external clock timer, a recording can be made without an operator in attendance. Another feature of most three-motor systems is their ability to be remote controlled through an accessory unit on which the basic transport controls are duplicated.

Direct mechanical controls can easily be designed to delay the change of tape speed or direction sufficiently to prevent excessive stress on the tape (which could stretch, spill, or even break the tape). Solenoid systems do not offer this inherent protection, and the fast winding speeds of most three-motor machines require the user to be careful that the tape has fully stopped before going into normal speed from fast forward or rewind. On many modern three-motor recorders, a so-called "logic" system prevents incorrect operation of the controls. This consists of circuits which sense the reel speeds and delay any changes until they can be made safely. With a good logic protection system, it is possible to press the control buttons in any sequence, as rapidly as one wishes, without harm to the tape or the machine.

Most cassette recorders, whether they use one or two motors, have direct mechanical controls, usually of the familiar "piano key" variety. Because of the smaller, lighter structure of a cassette transport, and the very low inertia of the tape reels, there is little danger of operating the controls faster than the system can tolerate. Nevertheless, many cassette recorders are mechanically designed so that the "Stop" button must be pressed before switching from one tape speed or direction to another.

Recently, cassette recorders have appeared with solenoid controls. The advantages of rapid, light-touch control operation are as applicable to cassettes as to open-reel tape. In addition, the rapid response of the low-mass cassette makes it possible to shuttle the tape back and forth, and into the play mode, with much greater facility than on many open-reel machines.

Tape recorders vary widely in the speed at which they can rewind tape, or skip ahead in the "fast-forward" mode. In the open-reel format, a typical three-motor transport may be able to move 1200 feet of tape (30 minutes playing time at 7½ ips) in one minute or less, while some single-motor mechanisms require more than three minutes. Most cassette recorders require one to two minutes to move an equivalent amount of tape (a C-60 cassette), with the two-motor machines usually falling at the lower end of the range. A popular two-motor transport, used in recorders by Advent, Heath, and Wollensak, is noted for its fast tape movement and can handle a C-60 cassette in 45 seconds. Three-motor cassette transports can be faster, with a least one such model featuring less than 40 seconds for a C-60 cassette. For anyone who uses cassettes regularly, the time saved by a fast-winding transport can add significantly to the enjoyment of the system.

A servo-controlled fast-wind mode is sometimes used to maintain a constant tape speed and lessen the shock on the tape when it comes to a stop. However, the leader tape in most cassettes is usually strong enough to withstand a sudden stop without damage.

Tape Speeds. All else being equal, higher tape speeds allow a wider frequency response and dynamic range, and less distortion, as well as the reduced flutter mentioned earlier. However, the relationship is not linear, so that doubling tape speed will not, in general, produce a two-fold improvement in any aspect of tape performance.

Many of the advantages of higher tape speed result from using less recording equalization (a boost in the low- and high-frequency levels relative to the middle frequencies), which is needed to compensate for certain limitations of the tape heads and the magnetic tape itself. As a result, there is less distortion and compression of dynamics in a recorded program with considerable high-frequency energy when recording at higher speeds, giving the sound a cleaner and more "open" quality. Another benefit accrues from the fact that any given segment of program occupies a greater length of tape at high speeds. Consequently, "drop outs" and small tape imperfections found in every tape interfere with a smaller "piece" of the program and are, thus, less audible.

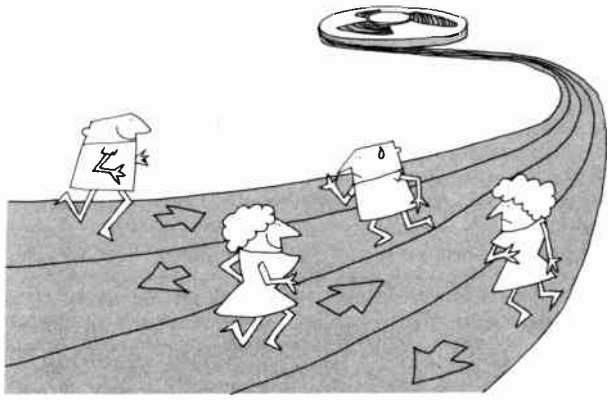
At lower tape speeds, it is still possible to maintain a useful frequency response to the highest audible frequencies by applying more high-frequency equalization and recording at a lower level to avoid saturating the tape (which causes distortion and compression). Inevitably, this reduces the dynamic range of the recording, since the noise level of the tape remains the same while the program level is reduced.

Most open-reel home tape recorders run at 3¾ ips and 7½ ips, and a few can also operate at 1⅞ ips or 15 ips. The 1⅞ ips speed, in open-reel machines, usually has a high-frequency response limited to 10,000 Hz or less, and is noticeably inferior in sound to the higher speeds. The 15-ips speed, in practice, does not offer any improvement in sound

over 7½ ips, except in ease of editing (since the program is spread over twice as much tape). The bulk of home recording can be done with complete effectiveness at the two major tape speeds. Typical recorders have a frequency response to more than 15 kHz at 3¾ ips and 20 kHz at 7½ ips. Their low-frequency design is dependent on head design and recording equalization. All recorders have a fairly uniform response down to 50 Hz, although a roll-off at lower frequencies is not uncommon.

Cassette recorders operate only at 1⅞ ips. In spite of this, their specially designed heads and cassettes' magnetic tape coatings, together with a considerably greater high-frequency recording equalization, result in a frequency response which can typically extends to at least 13 kHz, and often to 15 kHz or beyond. High-frequency tape saturation is much more likely to occur, unless the recording level is kept quite low, and when the program has a strong high-frequency content a slight "dulling" may be noticed when it is compared to an open-reel tape recording of the same material. Fortunately, the statistical relationship between program energy and frequency content allows most music to be recorded on a good cassette machine with little or no degradation of quality.

The eight-track cartridge operates only at 3¾ ips. Most cartridge machines are equipped only for playing commercially recorded tapes, whose quality is rather unpredictable (but rarely up to hi-fi standards). A few can also record on blank tapes, but most of these fall far short of matching the quality of an open-reel recorder operating at that speed, or even of a cassette recorder operating at half their speed. A few of the more recent eight-track recorders have a 15 kHz frequency response, but the difficulty of moving the tape forward at a higher-than-normal speed, and the impossibility of running it in reverse, makes recording in the eight-track format a clumsy business.



Heads and Track Formats. The function of a tape recorder's recording head is to convert an audio-frequency voltage or current to a corresponding magnetic field across a very narrow gap, over which the moving tape passes. This field magnetizes the tape coating, and when the same tape is later passed over a somewhat similar playback head, the magnetic flux from the tape is intercepted by its gap and induces an audio voltage in the winding within the head structure, which is (ideally) a duplicate of the original recorded signal.

The optimum gap width (along the direction of tape travel) is not the same for recording and playback functions, since a relatively wide recording gap can store more energy in the tape, while a very narrow playback gap is necessary to reproduce the highest frequencies. For this reason, among others, most open-reel recorders use a *three-head* configuration, with separate recording and playback heads (the third head is the *erase* head, which removes any previously recorded material before making a recording).

Another very practical advantage of the three-head system is the ability to monitor a recording directly from the tape an instant after it was recorded. Separate recording and playback amplifiers are needed for this and virtually every modern open-reel recorder is so equipped.

In cassette recorders, the situation is quite different. The cassette was not originally envisioned as a high-fidelity medium, and access to the tape was provided only for a single combined record playback head, plus an erase head. The loss of the off-the-tape monitoring ability is a minor inconvenience of this arrangement (the "monitoring" output of many cassette recorders is merely a signal taken from the input to the recorder, and is not necessarily representative of what has actually been recorded on the tape). Much more serious is the need for a compromise head design. Such a compromise generally favors the playback function, since the low speed of cassette tapes requires the utmost in extended high-frequency performance. Part of the price paid for this is the relatively low energy which can be stored on the tape (further exacerbated by the narrow track width, about which more later), in spite of the considerable amount of recording equalization which is used. In listening terms, this translates into a reduced signal-to-noise ratio, or dynamic range, which is inherent in cassette recording.

In recent years, ingenious designers have found ways to insert a separate playback head into the limited access openings of a cassette. In some cases, this has been a "monitoring" head of limited fidelity. But in others, it is a true optimized playback

head. As might be expected from the use of optimized recording and playback heads, the high-frequency performance of some of these machines has been substantially improved, with a frequency response to beyond 20 kHz in some cases. Also as might be expected, the price of a three-head cassette recorder is rather high, comparable to that of many of the better open-reel machines.

Due to limitations of the eight-track recording mode, there has been little incentive to add a third head to cartridge machines, even if it might be possible. It seems likely that the cartridge system will not be changed in this respect in the foreseeable future.

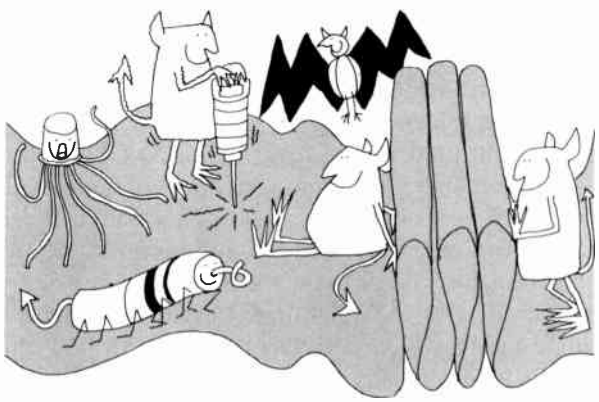
By *format*, we mean the manner in which the tape is utilized. This includes the width of the tape, the number and width of the tracks recorded on it, and the relationship between the various information channels recorded on the tape. Home open-reel recorders use a ¼-inch-wide tape, while various professional applications require tape widths up to 2 inches.

Full-track recording, occupying the entire width of the tape, provides the maximum tape utilization, and therefore the greatest dynamic range. It is also simple to edit, since the tape width is not used for other program material recorded in the reverse direction. Unfortunately, it is limited to one channel, or mono recording.

The highest quality stereo recordings are made in the half-track format, with one channel on each track and the tape used in only a single direction. This offers the same editing ease in stereo that the full-track format does in mono. However, in the interests of tape economy, most home recordings and commercially recorded tapes are made in a four-track (or quarter-track) format, with four tracks occupying the width of the tape. By recording a pair of stereo channels on two tracks in one direction, and after interchanging the reels, continuing on the other two tracks, the total playing time is doubled for the same length of tape. Since such a tape cannot be edited without sacrificing some of the program recorded in the opposite direction, only the forward direction of tape motion should be used if editing is contemplated. The four-track format has also proved to be ideally suited to four-channel (quadraphonic) recording, using one track for each channel and passing the tape only in one direction. By suitable switching of the recorder's electronics and selection of the desired segments of each head gap, a single machine can be used for stereo or four-channel recording or playback.

The cassette is a miniature of the four-track tape system. The tape is slightly more than half as wide as an open-reel tape, and has four very narrow tracks across its width. Except for its size, the cassette format is similar to the four-track open-reel tape (although the sequence of tracks is different), and is used in the same general ways – with two notable exceptions. Editing a cassette tape is so difficult as to be impractical, and the cassette is not as easily adapable to four-channel recording. This is not a technical limitation, but rather a licensing restriction imposed by Philips, inventors of the cassette system. Any cassette must be compatible with all forms of cassette players, so that a stereo recording can be heard (in mono, of course) through a mono player, and a mono cassette will play through both channels of a stereo machine. A single-pass four-channel recording would not meet this requirement. One proposed solution to the problem involves the use of eight tracks across the narrow cassette tape, with four tracks recorded in each direction. This is a formidable undertaking, and has not yet reached the marketplace.

The eight-track stereo cartridge is very similar to the suggested eight-track cassette system, except that the tape plays only in one direction. Four separate stereo programs, or two four-channel programs, can be carried on a cartridge tape. After each complete circuit of the tape loop, or under the manual control of the user, the playback head is shifted mechanically to contact the next pair (or quartet) of tracks. Since the cartridge uses ¼-inch tape, each track is about as wide as the cassette tracks and the performance is roughly comparable to that of a commercially recorded cassette. The 3¾-ips tape speed *should* give the cartridge an advantage, but this has not been realized in practice. However, cartridges remain the principal source of four-channel tape recordings.



Signal-to-Noise. Signal-to-noise ratio (S/N) is one of the most important characteristics of a tape recording system, since excessive noise can be heard clearly, even by an unskilled or non-critical

listener, and detracts severely from the naturalness of a recorded program. The noise in the playback output is caused by many factors, including variations in the tape coating, the recording bias waveform purity, the inherent noise of the transistors and resistors in the electronic circuits, and hum induced in the playback head by nearby transformers. All of these are susceptible to improvement, but cannot be completely eliminated. Whatever noise remains effectively sets a "floor" for the dynamic range of the reproduced program. The only way to increase dynamic range, once noise has been minimized, is to increase the output voltage from the playback head. With an efficient head design, the remaining variable is the amount of magnetic energy stored in the tape. All else being equal, the more energy in the tape, the greater will be the playback output level.

Great strides have been made in improving tape coatings, and today's best tapes combine a high energy-storage ability with low inherent noise, especially when compared to tapes made only a few years ago, or even to some of the low priced or inferior tapes still on the market. No matter what kind of recorder you use, do not economize on the tape if you expect to realize the performance potential of the machine.

One of the major factors in determining the overall S/N of a tape system is the track width. Roughly speaking, doubling the width of a track doubles the energy storage capability, and adds 3 dB to the output. This is why professional recording studios use half-track tapes, with widths of ½ inch or more. In the home-recording field, the four-track ¼-inch open-reel tape format is substantially better than the cassette or eight-track cartridge, whose track width is about half that of open-reel tape.

There are several ways to express the S/N of a tape recorder, and it is important to be sure when comparing different machines that the measurements were made in the same way. The predominant noise is heard as "hiss," with most of its energy concentrated in the region of a few kilohertz. Lower and higher frequency components, although they may contribute heavily to a measured noise output, are much less audible and therefore not as objectionable. To account for this, noise is usually measured with a "weighting" curve to produce a single figure which correlates better with how the noise sounds. This is a similar technique to that employed in weighted flutter measurements, although the actual weighting curves are very different.

The maximum signal capability of the system is limited by tape saturation, which shows up as increased distortion in the playback signal. The maximum signal is usually taken to be the 1,000-Hz input whose playback contains 3% total harmonic distortion, although sometimes a 2% distortion figure is used. The difference between the signal playback output corresponding to 3% THD, and the weighted noise from a segment of tape recorded with no input signal, expressed in decibels, is the S/N ratio.

Open-reel recorders can be expected to have a S/N of 45 to 50 dB at 1⅞ ips, 55 dB or better at 3¾ ips, and typically 60 dB or better at 7½ ips. There are wide variations among different makes and models of recorders, and some of the best 7½-ips machines can approach a 70-dB figure. With the Dolby noise reducing system, a few go beyond 70 dB, but it is often difficult to realize any practical advantage from this, since the noise level of the incoming program source, or the microphones, may well be greater than the recorder noise.

As one would expect, cassette recorders have substantially more noise, although the special tapes which have been developed for that application go a long way toward correcting the imbalance between open-reel and cassette performance. Without the Dolby system, 40 to 45 dB is typical of many recorders, with the best attaining slightly better than 50 dB. With Dolby noise reduction (which is really essential for cassettes), a number of good recorders exceed 60 dB S/N.

Only recently have high-performance tapes been available for eight-track cartridge recorders, and this has occurred simultaneously with the adoption of the Dolby system. Taken together, these two factors have made a dramatic improvement in cartridge S/N figures, from the 35 dB or so which was the norm, to a good 60 dB in the latest designs. Of course, most cartridge machines are used to play commercial tapes, but a number of these are now being issued with Dolby processing so that they can benefit from being played on a machine with the Dolby system.

Other Operating Features. There are a number of features which can add greatly to the operating convenience of a tape recorder, and many of them are offered by most competing manufacturers. Open-reel machines commonly are designed so that one channel can be operated in the playback mode, while the other channel is recording. By suitable switching or signal patching, this allows special effects such as copying one channel on to the other while adding new material, or adding an echo to a program while recording it. If such applications are of special interest to you, it might pay to select a recorder on which all the necessary signal connection can be made with a front-panel switch, instead

of the external jumper cables required by some machines.

Although most recorders provide for microphone and line-level inputs, some do not allow the two to be mixed. If "live" recording is a secondary consideration to you, there is no need for special emphasis on microphone facilities. You should also be aware that almost all tape recorders have a much poorer S/N ratio through their microphone inputs than through the line-level inputs. The amount of degradation varies widely among different recorders, and with how much microphone gain is used. Since the Dolby system cannot reduce noise coming into the recorder, it may prove to be ineffective under some live recording conditions if the microphone amplifier noise exceeds that of the rest of the recorder.

A useful feature of certain four-channel recorders is their ability to make multiple-track synchronized recordings. Any of the four tracks of the record head can be switched to serve as a playback head, and by monitoring it through headphones while recording on one or more of the other tracks, a multipart performance can be built up in several recording sessions, with all parts in synchronism.

Automatic-reverse operation is found on many open-reel decks. Usually it is limited to playback, but a few machines can also record in both directions. The elimination of the need to interchange reels after each tape "pass" is not only a convenience when listening, but in the recording mode it can prevent missing a portion of the program during reel switching process. The reversal is normally initiated by a conducting foil attached to the tape, or by pressing a button. In some recorders, no longer made, a subsonic tone was recorded for this purpose.

Automatic reverse is found on a number of cassette machines, and some can even record in both directions. Since it is not practical to add a conducting foil to a cassette tape, the end-of-tape motion sensor (which normally shuts off the mechanism) is used to reverse the tape direction.

The eight-track format is the most limited of all, allowing little more than basic recording and playback. Some cartridge machines have a "fast-forward" mode, which increases tape speed by a factor of 3 to 5 times. Although this is a far cry from the fast speeds of either a cassette or an open-reel recorder, it can be a great help in returning to the splice of the tape loop, where track changing takes place. Reverse operation is not possible with the cartridge.

Since a number of FM stations have been using Dolby processing on their transmissions, some Dolby-equipped recorders have provided switching for decoding the FM tuner outputs even when not making a recording. This useful feature is available on cartridge, cassette, and open-reel recorders. A recent change to a 25-μs FM pre-emphasis characteristic when the transmission is "Dolby-ized" has effectively obsoleted some of the older machines with this feature, but newer models usually have a switch to convert the tuner's 75-μs de-emphasis to 25 μs when listening through the Dolby system, or playing back a tape made from an un-decoded received transmission. Simple networks from several manufacturers can also be used to accomplish this conversion external to the equipment.

All recorders have meters for setting and monitoring recording and playback levels. Most of them respond too slowly to follow the brief peaks which can easily overload the tape, and allowance must be made for this when setting average levels. A few machines have fast-acting, peak-indicating meters, or light-emitting-diodes which flash on excessive signal peaks.

Some cassette recorders have peak limiters, or more usually automatic recording-gain-control circuits. These can be useful when recording a number of sounds arriving at very different levels, or when one cannot anticipate the maximum input level, since they can prevent serious tape overload or distortion. A good limiter, which comes into operation only at inputs exceeding the normal "0 dB" input, is often undetectable in its operation. However, such automatic-gain-control systems can seriously degrade the dynamics of a program, and should therefore be used only for voice recordings.

Another possible source of distortion, when recording very loud sounds, is the overloading of the recorder's input amplifier by excessive microphone output. This can happen even when the recording level is set low and the meters give normal indications. Should it occur (monitoring off the tape, if you are using an open-reel recorder, will speedily reveal it) the microphones can be moved away from the sound source, or an attenuator inserted into the signal path ahead of the recorder's input jack. Some recorders, both open-reel and cassette, have switchable microphone attenuators for this purpose.

Most recorders have headphone output jacks, for monitoring while recording. As a rule, these are specified for 8-ohm phones, and will deliver adequate volume into low-impedance phones. However, many headphones have a much higher impedance (commonly in the 200 to 600 ohm range) and cannot produce a listenable output level from a circuit designed to drive 8-ohm phones. Regrettably, this fact is not always made clear in the headphone specifications. The best way to avoid a mistake is to

listen to the combination of recorder and headphone you are contemplating purchasing.

Dolby Noise Reduction. A major factor in the acceptance of the cassette recorder as a true high-fidelity component was the development of the Dolby "B" noise-reduction system. A frequency response to beyond 13 kHz, and flutter levels of less than 0.15%, clearly pointed to the ultimate capabilities of the cassette medium, but the ever-present hiss prevented its serious consideration for top-quality hi-fi systems.

The Dolby "B" system, a simplified version of the professional "A" system used by recording companies, can substantially reduce high-frequency noise (hiss) introduced by the recording and playback process, with no loss of any high frequency program content (although it cannot affect any noise already present in the incoming program). It must be applied at the input to the recorder, and again at the playback output. At low levels, the high frequencies in the incoming program are boosted, with the amount and frequency range of the boost determined by the overall level and spectral content of the program. Higher program levels are recorded without modification. During playback, an inverse process takes place, with a dynamic variation in high-frequency roll-off controlled by the program characteristics.

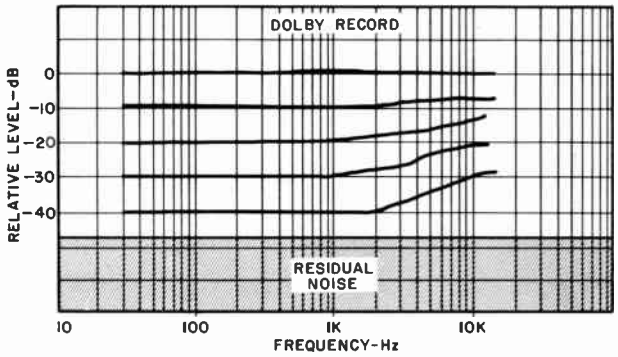
The result is a flat overall frequency response, while the noise introduced by the tape recording process is reduced by the amount of playback roll-off (typically 6 to 10 dB). Careful matching of recording and playback characteristics and operating time constants makes the operation of the Dolby system undetectable by the listener (except for the distinctly quieter background).

Virtually every high-quality cassette recorder has built-in Dolby circuits. Not only are these effective with homemade recordings, but many recorded cassettes are now issued with Dolby processing (identified by the distinctive Dolby trademark) and can benefit from the recorder's playback Dolby system. A few eight-track cartridge machines now have the Dolby system, and it is beginning to be used in commercially released cartridges, so that the noise which has been one of the barriers to the hi-fi acceptance of cartridges can be reduced to acceptable levels.

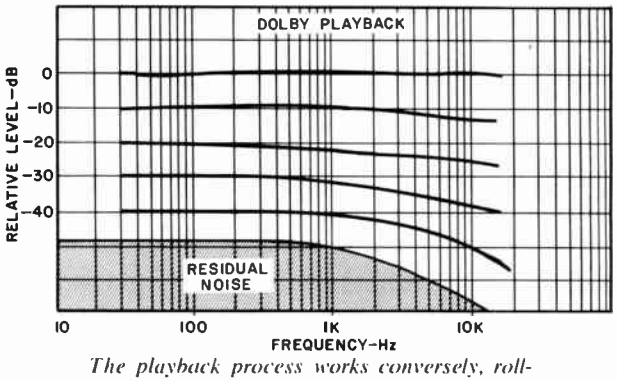
A "Dolby-ized" program can by played without a Dolby processor, but will sound "bright" and may have an exaggerated hiss level. Usually, a roll-off with the amplifier's treble tone control will restore a satisfactory tonal balance, and will even provide some measure of noise reduction.

Some high-priced open-reel recorders also have built-in Dolby systems. They are principally useful at the lower tape speeds (3¾ and 1⅞ ips), since a good machine operated at 7½ ips will often have less noise than the input signal, even without Dolby. External "add-on" Dolby units are available from several manufacturers for use with recorders lacking a built-in Dolby facility, or with FM tuners.

Other noise-reduction systems, usually not requiring specially processed recordings, have been developed by some manufacturers and sometimes incorporated in their recorders. In general, these have not been as effective as the Dolby system, and most of them have disappeared from the market. A notable exception is the JVC "Automatic Noise Reduction System" (ANRS) used in JVC cassette recorders. Although not exactly complemetary to the Dolby process, it accomplishes much the same results and can even be used to process Dolby recordings, or vice versa. The "errors" in the overall system response can be heard only with certain types of program material, by someone who is listening for them and knows what to listen for. □



The Dolby-B circuit boosts high frequencies during recording process, with emphasis given to low-level passages. Degree of pre-emphasis is dynamically regulated, based on level.



The playback process works conversely, rolling off the highs for low-level signals while leaving loud musical passages unaltered. Thus, recording process noise is reduced up to 10 dB.

HOW TO USE A RECORDER CREATIVELY

Here's a host of ideas on enhancing recordings with simple sound effects, audio games you can play and other ways to make fuller use of your tape recorder.

By Art Zuckerman

IN the mid-fifties, when all tape recorders were open-reel, monophonic types, recordists were likely to use their machines more creatively than many do today. The nature of the tape recorder then and the fact that so many early owners were also photography enthusiasts probably fostered this spirit of adventure.

It is unfortunate that this creative use of the tape recorder lapsed because a basic resource is being wasted—the ability to create original audio material. It exists, to a degree, with cassette units but really comes into its own with open-reel machines. Team an open-reel deck with a portable cassette recorder and you have a winning combination. Let's explore some of these creative possibilities.

You can perk up a party with the judicious use of your tape machine. In the days when recorders were a novelty, the "candid microphone" was popular entertainment. In fact, a chap named Allen Funt turned it into a career on radio that later expanded into "Candid Camera" of television. Electronic eavesdropping, however, has to be approached with caution, as it may not please some guests. So it's best to approach the party scene with your tape machine in more visible use.

One party pleaser is the switch-hit interview. You might say to your subject:

"We're taking a survey of the garbage-disposal habits in our community. Could you give me a rundown on the contents of your garbage can in a typical week?"

The reply might be something like:

"Egg shells, turkey bones and gizzards, steak fat, uneaten cat food, stale and mouldy bread, potato peels, rancid cheese. . . ."

After dismissing your subject, you then surreptitiously re-record your question, so it comes out:

"Everybody raves about your Stew Supreme. Would you please give us the recipe for this sumptuous delicacy?"

Another mirth maker is the tongue-tying trick. It calls for a recorder with separate record and playback heads and facilities for reverberation/echo effects. Have your subject listen to the recorder with earphones, set the machine for reverb mode and tape monitor, then ask your "victim" to recite into the mike something like Eliza Doolittle's "The rain in Spain falls mainly in the plain."

If your subject is like most people, there's almost no way he or she can do it. Hearing your own words a split second after uttering them, instead of instantaneously, is extremely disruptive. With a group in the right mood, the resulting breakups and sputtering are a howl. You can try a contest to see if some hardy soul can overcome the psychic barrier. The winner, if there is one, can be awarded a "Professor Henry Higgins Citation for Diction and Single-Minded Concentration."

Guessing games are made easy with a recorder. Simply prepare a tape in advance with the material to be divined. You may use musical passages, well-known voices dubbed from historical records, or

Create a windstorm by recording air escaping from balloon; fire can be simulated by crumpling cellophane, a crackling fire by breaking wooden matchsticks; rain is made by pouring sugar or salt down a chute of cellophane, aluminum foil; for hail substitute rice.

just everyday sounds around the house, like the brushing of teeth, a ping-pong ball bouncing on a rubber mat, a bottle being uncorked. Out of context, they're not at all easy to identify.

Want to try a little exercise in parlor psychology? Take a string of such offbeat sounds and play them in sequence. Then divide your guests into two teams, and ask them to write down their impressions of what they've heard. Husbands and wives are logical team groups. Next, read a contribution from Team A and invite the members of Team B to figure out who wrote it. Then go to Team B and repeat the process, going back and forth until you decide to declare a winner.

You can record a string of excerpted musical passages from discs, asking guests to identify composition and composer. Or more creatively, you can prepare an audio "historical quiz" by devising aural clues. For example, a sputtering engine, whirring sound, sputtering engine, crowds cheering, and "The Marseillaise" played in the background would suggest Lindbergh's crossing the Atlantic and landing in Paris.

Sounds, whether literal pickups or created effects, are the foundation, not only of a party game, but of any audio production from a show on the "CBS Radio Mystery Theatre" to your own taped "radio" show. They create the stage props and scenery of the imagination. Taping such effects is also a handy way to add them to a stage production. Today, there are three sources for effects: commercial records, the real thing, or your own fabrications.

There are sound-effect records available for everything from the street sounds of New York to North American frogs, from steam and diesel engines to rockets, missiles and space travel. The actual article is an ideal source, and one that is often easy to obtain with a good portable recorder. For example, it's no great trick to tape your own door slamming shut, or a doorbell ringing, or the telephone being dialed. You can even record the sound of bacon frying on the stove, or water boiling, or a teakettle whistling. But it isn't always easy to grab just the sound you need when you need it. So you may still want to fall back on studio effects that you can duplicate yourself.

Suppose you want to create a wind effect. You can achieve a pretty credible result by releasing air slowly out of a balloon over the mike. Played back one speed faster than the original recording, such a sound "take" converts into a howler of a storm. Here are others:

- Fire can be created with some cellophane, crumpled artfully in your hand near a microphone. A matchstick or two snapped every now and then adds the crackle of a wood fire. Want some rain to put the fire out? Just pour sugar down a chute fashioned from cellophane or waxpaper. Substitute rice

Blow bubbles in a glass of water and you have a babbling brook; blowing across the top of a partially filled bottle simulates a river steamer's whistle; hand mixer's motor sounds either like an outboard or marine diesel, depending on recorder's playback speed.

EDITING TAPE

Cut-and-splice editing is very much like editing motion-picture film, with one very important difference. You can't see the spot where you want to cut; you've got to locate it by ear.

This requires the use of a tape deck with either a cue or a pause control, which keeps the tape in intimate contact with the play head, circuits on, although the transport isn't moving. You can then turn or "rock" the reels by hand until your ears tell you you're at the desired spot.

You are actually listening for nulls on either end of the specific sound or passage you want to cut out. The more spread-out the sound, the easier it is to identify the nulls. That's why it's always best to use the highest speed available to record material destined for this kind of editing.

Once the cutting point is identified, it must be marked with a special editing pencil or a china marking pencil. The marking point will be right over the play head's gap, but it's best not to press the pencil point against the head. Instead, measure the distance from the head gap to a point on the recorder's face where marking is convenient, then always pull the tape to that point after the editing position has been located at the head.

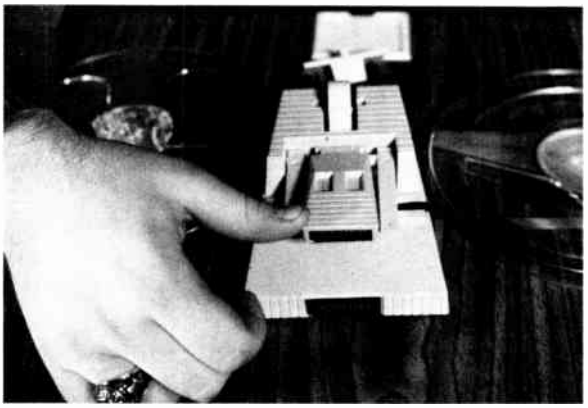
Actual cutting and rejoining is done with a splicer. One type, resembling a stapler, has built-in knives and tape clamps. The point on the tape to be cut is centered and the splicer arm is set for cutting. Then it is swung down for the cut. This operation is repeated on the other marked null point and the two diagonally cut ends are butted together and special splicing tape applied. The splicer arm is then set to "trim" and again swung down, this time trimming off the excess above and below the edges of the recording tape.

If a final production is assembled primarily by cutting and splicing, and you intend to keep it permanently, it should be dubbed onto an uncut tape. That way you will never have to worry about a splice pulling apart or breaking open.

Editall splicing-block channels hold tape while mitre groove guides razor blade for precise cut.

After ends of tapes are butted on diagonal cuts, pre-cut splicing tape is centered and pressed on.

With tape removed from block, backing is peeled from splicing tape, thus completing the splice.



Gibson-Girl-type slicer, resembling a stapler, has built-in tape clamps, cutting and trim knives.

for the sugar and your downpour will become a hailstorm.

● The distant rumble of an approaching thunderstorm can be simulated with an inflated balloon filled with BB shot. Just swirl the shot around, and play back the tape a speed lower than it was recorded. For a thunderbolt, shake the balloon sharply.

Screech of car brakes is a cinch to create with nail-embedded block of wood, pulled across a pane of glass. Walt Disney's "The Haunted House" disc for Hollowe'en is typical of available sound-effects records.

● If you want to bring the thunder close up, so that it makes the meek seek refuge under bedcovers, switch to a thunder sheet of tin suspended from a wooden frame. Bending the sheet will evoke a heavy rumble, and hitting it with a bass drumstick or a cloth-wrapped mallet will provide a very satisfying thunderclap. You may be able to enhance the effect by playing back a speed lower than the recording speed.

● Following a heavy storm it's common for brooks and streams to fill up and gurgle merrily away. You can suggest such a rushing brook by blowing gently through a pair of drinking straws in a glass of water. If the brook is supposed to feed ultimately into a navigable river—perhaps the mighty Mississippi herself—you can conjure up a majestic river steamer sounding her whistle by blowing across the mouth of a partially filled bottle.

● An outboard motorboat is easily suggested by an electric hand mixer played back one speed below the recording. If your deck permits you to drop to the next lower speed, your outboard will turn into a throaty diesel—on a cabin cruiser or a trans-continental truck rig.

● The diesel sound, with a little level juggling, can pass for an ordinary automobile. If you want that auto to slam on its brakes, try scratching a nail or two across a piece of glass. You can make a permanent brake squealer of a block of wood and three nails, bent slightly away from the direction in which they are pushed across the glass.

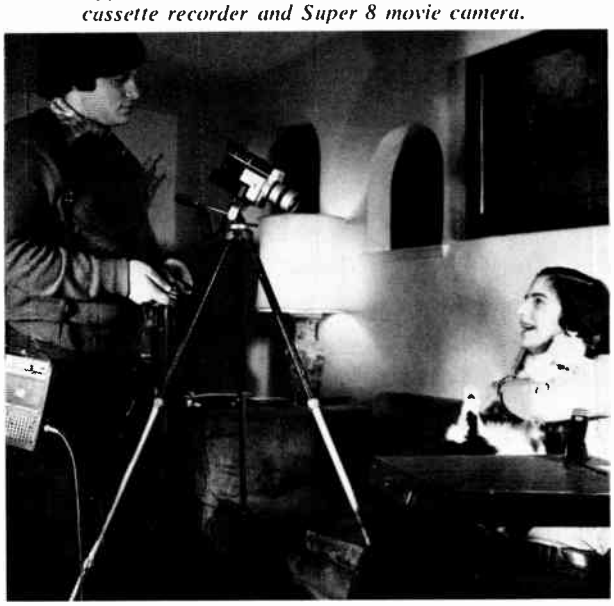
● Should your "car" fail to stop in time, the resulting collision can be simulated nicely by smashing a couple of aluminum baking tins together. Experiment with playback speed for the best effect. If the gas tank goes, you can let it be heard by smashing an air-filled paper bag—again experimenting with playback speed.

● Rising above such things, let's take to the air in a sleek jet. A home craftsman's propane torch will do the trick nicely, with a bit of nozzle and tape-speed adjustment.

● We shouldn't overlook one of the earliest of transportation modes, the horse. No bag of sound

Isolate the erase head from tape with strip of photographic film for sound-on-sound work.

Approximate synchronized sound using a good cassette recorder and Super 8 movie camera.



tricks is complete without hoofbeats. The classic way to create them is with a rubber ball cut in half. The halves are pounded against your chest in a rhythm appropriate to walking, cantering, trotting, or galloping.

There are, of course, many more sound effects you can create. A number of books (including this author's "Tape Recording for the Hobbyist") offer a variety of ideas. Once you get going, you'll undoubtedly come up with ideas of your own.

Effects are just part of an integrated production, whether it's a stand-alone program in sound, the audio accompaniment for a movie or slide show, or incidental music and effects for a stage play. The first step in putting together a production is to prepare a script. It's your blueprint. For a film's sound track it may be no more than a cueing sheet, a list of sequences with music cues and, possibly, simple narrative dialogue. The script for a full-blown production will require extensive dialogue and cues for effects as well as music. It will also cue in musical bridges between scenes. (There is one record at least, Elektra 75002/4, titled "Dramatic Cue Music," that's made to order for such bridging of scenes.)

You might launch your career as a "radio" producer by starting with an old commercial broadcast script. Most good public libraries have anthologies of the more memorable scripts of the 1930s and 1940s.

THE CREATIVE TAPE MACHINE

Although it's possible to do such work on a stereo cassette recorder, it's a lot easier to work with a contemporary open-reel machine. If your deck permits the mixing of mike and line inputs, or you use an auxiliary mike mixer, you can record all your background music and voice material, plus any sound effects, in mono mode during one pass. If mixing isn't possible, you can use the stereo mode, recording one track from microphone and the other from a line source.

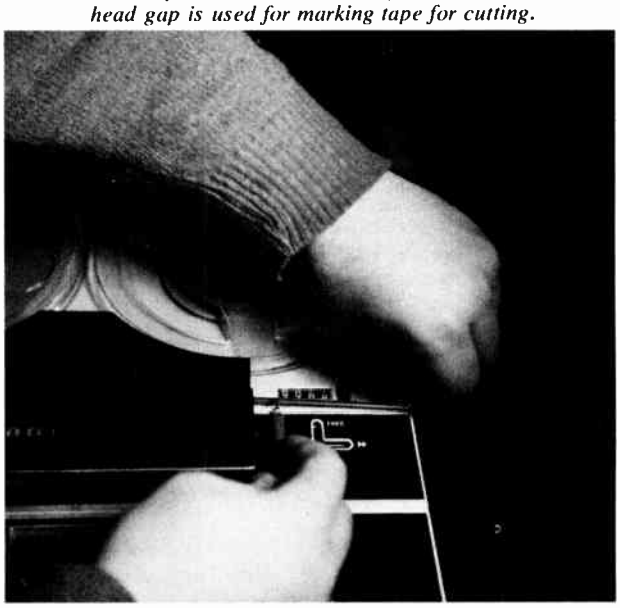
Many open-reel recorders make life easier by providing sound-over-sound facilities, allowing you to transfer the program from one track to another while you mix in material through a mike or line input. This permits you to lay down all the music, then rewind the tape and dub it to another track, fading at the appropriate places to add voice or other material. Should you make a mistake in this dubbing-over process, the music track is still intact, so you need only repeat the mixing operation.

Built-in mixing facilities permit you to set up a separate mike for sound effects so you can enter them with the dialogue easily. If you can't mix at least three inputs, you can obtain the same result with a second dubbing run, or you can invest in an external mixer. This can be an electronic unit with three or four mike channels and a phono input, or it can be a simple, double-input phone plug equipped with variable resistors. If you invest in an electronic mixer, be sure that its input and output impedances are compatible with your mikes and recorder.

If your tape deck isn't equipped for sound-over-sound work, two other options may be available. One is sound-with-sound, or multidub, and it consists of recording a second track to blend with a recording on the first track. This is easy with some of the open-reel recorders that still use a combina-

With cue or pause control engaged, reels can be hand-turned to locate nulls for cutting tape.

Precisely measured distance from playback head gap is used for marking tape for cutting.



tion record-play head. But otherwise it is pretty much limited to machines—most of them 4 channel—wired to permit a record head to be used for playback in just this application.

The other possibility is to isolate the erase head by putting a strip of photographic film between it and the tape, so that you can record over an existing recording without erasing it completely. The recording bias voltage erases a substantial part of the original recording, particularly high frequencies, which automatically pushes recorded music into the background when you add voice commentary or dialogue. Quality does suffer, but it's acceptable enough to make this approach workable.

In fact, this kind of recording-over technique is built into the better "super 8" magnetic-sound movie projectors, which record on an oxide stripe running along the film's edge, and such superimposition is a standard sound-movie production technique for amateurs. A tape recorder is the perfect complement to a recording sound projector because it simplifies the production job. Recorders are also useful to pick up sound while shooting movies, although there is a growing trend to movie cameras with built-in, sound-on-film, magnetic recording facilities. But such cameras are expensive, and most of them produce sound of relatively low quality.

Furthermore, sound recorded on film in the camera is very hard to mix with other sound sources, such as background music. That's why Hollywood prefers the double-system approach of a separate, synchronized recorder. A number of specialized amateur recorders are available for this purpose and a great many Super 8 cameras are equipped to team with them.

But if you have a good portable cassette recorder with a line output, you can make double-system sound movies on location that will come close enough to synchronization for all practical purposes. The trick is to mount the camera on a tripod, set up the shot or have a helper aim the camera, and operate both the camera and the recorder simultaneously by remote-control switches. The mike should be as close to the subject as possible, and it is helpful to have a separate remote switch for the recorder. Use a virgin cassette and, between takes, advance the tape a few feet. This separation of sound takes will make it easy to cue each sound segment to the beginning of each movie take. It will also prevent the buildup of cumulative synchronization error.

If you're working with a magnetic sound projector, you can transfer the sound onto the film directly from the cassette recorder; but you'll probably get better results if you transfer it first to an open-reel tape deck with cueing facilities. This permits the final transfer to film to be more precise.

Some silent Super 8 projectors are equipped for synchronizing with specially adapted cassette recorders. Others operate at such precise speeds that you can team then with an accurate tape unit and get reasonably good results even though they're not connected.

Setting sound to a slide show is much easier because you need only put a cueing tone or pulse on the tape to activate the slide-changer mechanism. You can get an accessory cueing unit, and some recorders have them built in. Barring that, you only need to record an audible click or tone on the tape to tell you when to change the slide. Not very elegant, but quite functional.

If a cassette portable is good for making movie-sound pickups on location, it's equally fine for adding field recordings to an open-reel "radio" production, or a reel of off-stage audio material for a play. This kind of sound transfer is actually a form of editing called "dubbing." If you make a cassette-to-reel transfer, the ideal is to have two open-reel recorders to work with, both equipped with cueing or pause controls. As in movie-sound, the dub can be made more selectively and precisely to the final program if it is first transferred from cassette to open reel.

The most precise editing, however, is done by physically cutting and splicing the tape, something very difficult to do on any form other than open reel. With this technique it is possible to take the words in a sentence and rearrange them into an entirely new sentence, or take all the goofs out of a musical performance, replacing them with good takes to achieve perfection. It's done by the pros every day.

Whether you edit by cut-and splice or by dubbing, it's always wise to use the highest speed on your tape deck. This simplifies locating the cutting point on a tape, and it makes cueing easier, too. In dubbing, it has the added value of minimizing accumulated sound degradation, particularly tape-hiss buildup.

Making a production in sound may seem like a lot of work, and it is. But it is also one of the most fascinating of pastimes. There is no limit to what you can create in a purely audio production. Like radio, the imagination of the listener is your stage, and you can project fantasy or recreate actual experience at will. You are working with a medium that generates the impression of reality in an immediate, you-are-there sense—a reality you can shape and manipulate.

It's hard to be much more creative than that. □

FOUR-CHANNEL TAPE RECORDER APPLICATIONS

"Sel-Sync" and echo provisions on some quadraphonic tape machines enable users to set up home studios.

By Leonard Feldman

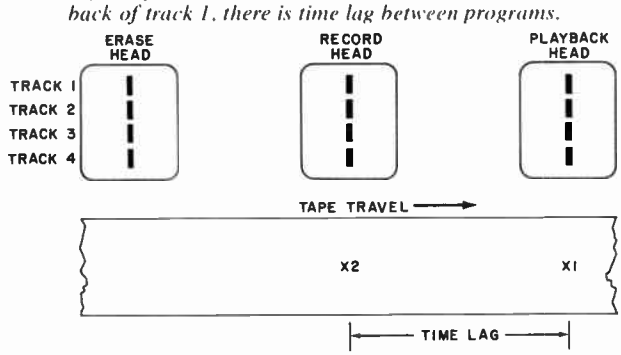
ACCORDING to several audio dealers surveyed recently, one of the hottest items in all of high-fidelity componentry is the 4-channel, open-reel tape deck. Of course, sales of these multi-track machines don't even come close to those of better stereo cassette decks, but when you consider the fact that reasonably good 4-channel decks sell for around $600.00 and up, as opposed to Dolby-equipped cassette machines that can be had for as little as $200.00 or sometimes less, consumer interest in the open-reel format seems unusual.

Add to this the fact that very few recording companies offer even a meager selection of pre-recorded 4-channel programming on open-reel tapes and the sudden interest in these expensive machines becomes even more puzzling. Surely, owners of 4-channel, open-reel decks are not spending that kind of money simply to transcribe their newly acquired CD-4 or matrix 4-channel records onto tape, although of course that is one application for these quadraphonic recorders.

A clue to the most popular usage of these machines was uncovered by further questioning of dealers and by thumbing through some of the recent product offerings from manufacturers who normally concentrate on such conventional products as tuners, amplifiers, and receivers. Suddenly, such companies as Pioneer are offering, what for them seem like an "odd ball" product, the new MA-62 6-channel mixing amplifier. This professional looking mini-console handles mike, line, and even phono inputs and can assign these inputs to the left, right, or both stereo channels. A couple of the input modules even feature "pan pots" which enable you to "move" the stereo image smoothly from left to right while the recording is taking place. Other mixers and portable mixing consoles, intended for consumer use, are manufactured by Shure, Teac, and Sony and some of them have more input channels and up to four output-channel facilities.

In addition, we found that microphone sales are better than ever at the consumer level, and we don't mean single microphone purchases to replace the original-equipment models supplied with cassette decks. We're talking about good dynamic and condenser microphones that sell from $50.00 and up. These are finding their way into home hi-fi systems in increasing numbers, as are separate Dolby noise-reduction systems, compress-expand systems, and others. From all this sales activity, we concluded that the big 4-channel decks aren't necessarily being used to record or play 4-channel programming at all! They are forming the basis of thousands of "home recording studios," often capable of turning out master tapes that rival some of the products turned out by professional studios.

Fig. 1. If track 2 is recorded while listening to playback of track 1, there is time lag between programs.



"SEL-SYNC" MAKES THE DIFFERENCE

At least three makes of multi-track tape decks sold to consumers have an important built-in feature that enables users to employ some of the same techniques used in recording popular music. While just about any stereo or 4-channel deck is equipped with three tape heads (erase, record, and playback), the physical position of these heads in relation to tape travel is normally that shown in Fig. 1. The tape passes across the erase head first, where any previously recorded material is erased. Desired new program information is then recorded onto the tape as it passes in front of the record head and, a fraction of a second later, the newly recorded program can be "monitored" by the playback head and its associated playback preamplifier.

This is a fine arrangement for making ordinary stereo or even 4-channel recordings, since it enables the operator to hear his recorded results (either via phones or through his speaker system) just a short time after the recording occurs. If he hears distortion, over-recording, or under-recording, he can correct control settings *almost* instantly. The delay is determined by the distance between the record and playback heads (in inches) divided by the tape speed (in inches-per-second).

Suppose, however, that you wanted to record one tape track at a time, adding other tracks later. You might want to record the singing of a "one man quartet"—in which you or a talented friend provide all four harmonizing vocal parts by making four separate single-track recordings which you would later mix together. With the head arrangement shown in Fig. 1, there is no way in which you could record the second, third, and fourth tracks in perfect synchronism with the first recorded track. Even listening with phones (so that the previously recorded track would not be picked up by your "live" mike), your newly added vocal part would be applied to track 2 just a little too late and, if you listened to a playback of track 2 and tried to add the track-3 program, it would be farther behind and so on.

This is where the principle of "Sel-Sync" comes in. It's an abbreviation for selective synchronization. Sel-Sync is the tradename used by Ampex, the well-known maker of professional tape equipment. It arises from the need to hear previously recorded tracks while simultaneously recording another signal in synchronization with them on the same piece of tape. It is the principle of Sel-Sync which is involved in many of the modern recording procedures in studios around the country.

Contrary to popular belief, most contemporary re-

cordings are not recordings of "live" musical events at all. Using as many as 16, 24, or even more tape tracks, recording engineers assign single instruments or voices to one or more of these tracks. Very often, individual tracks may be recorded at different times—even in different studios. A master recording will contain all of the individually recorded tracks and these are then "mixed down" by the recording engineer, often with the aid of the producer and the artists themselves. It is during this mix-down process that individual tracks may be equalized ("sweetened" is the term used in the trade), augmented by echo or reverberation effects, rebalanced in terms of relative levels and positioned in the stereo or quadraphonic sound field. Sophisticated as these secondary steps may be, none of them would be possible were it not for Sel-Sync, which permitted the synchronization of all tracks in the first place.

HOW SEL-SYNC WORKS

Although a record tape head is designed for optimum performance during its record function, there is really nothing to prevent one or more coils of the multi-track head from being connected to playback electronics and used as a playback head. If the record head were designed to do its best job in the recording function, chances are it would not exhibit the greatest frequency response or signal-to-noise characteristics when used as a playback head. However, if the sole purpose of its transition to a playback head is to enable recording artists to synchronize their efforts with previously recorded tracks, fidelity of reproduction heard through the monitoring phones is not that important.

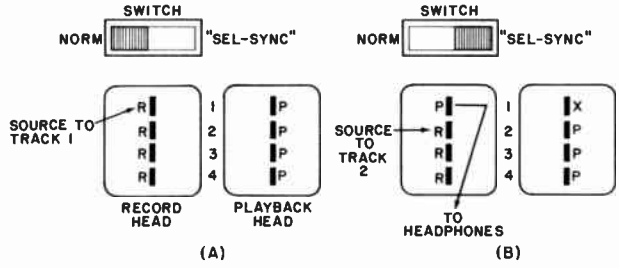


Fig. 2. How "Sel-Sync" works. See explanation below.

The principle of Sel-Sync is shown in Fig. 2. A single track (say, track 1) is recorded by the first program source. Recorders equipped with Sel-Sync will have a switch (usually a two-position slide switch) associated with each recording track. In the diagram, the switch is set to its normal or "record" position, thereby connecting the track-1 record coil and gap to the record electronics. After the tape is rewound, the track-1 Sel-Sync switch is moved to its alternate position, connecting the track-1 coil to the playback preamplifier. All other record tracks remain connected to their respective record electronics, so that any one of them can now be recorded while listening to the results recorded onto track 1.

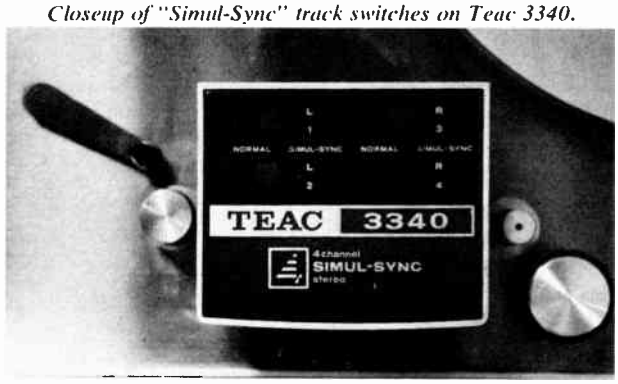
This procedure can be repeated until all four tracks have been individually recorded. Any one of the successively recorded programs can be used as the "monitoring" channel, except, of course, the track currently being used for the new track then being "laid down." If desired, two previously recorded tracks may be monitored simultaneously while the third is being added, so that the performer can hear both earlier recorded tracks while adding his third track, and so forth. If there is acoustic isolation between the playback systems and the performing artist, monitoring can be done by the "home recording engineer" over speakers while the performer uses phones for the same purpose.

The possibilities are almost endless and, if you use your hi-fi component system for playback (assuming it's a 4-channel system for a quadraphonic mix attempt or a stereo system for a 2-channel mix-down) the tape output jacks of the receiver or amplifier can now be fed to a second deck (open-reel or cassette) onto which your properly mixed-down version of the recording can be recorded. It is at this point that mixers become most useful, since each of the four "raw" tracks can now be treated as a signal source into the mixer, which, depending on its flexibility and control features, becomes your home-recording console. Even without this addition, you'll find that 4-channel decks equipped with Sel-Sync also have individual level controls for each channel or track which enable you to balance relative levels before the final "master" mix-down or dubbing is made.

At least three manufacturers we know of have 4-channel open-reel decks available that include the selective synchronization feature. Teac offers the feature, which it calls "Simul-Sync," on its Models 3340S and 2340R machines. The chief difference between the two is that the lower priced 2340 R unit accepts 7″ reels and operates at 3¾ and 7½-ips speeds, while the costlier version accepts 10″ reels and operates at 7½ and 15-ips tape speeds. In Akai's GX-400DSS 4-channel deck, the feature is called "Quadra-Sync." This machine operates at all three speeds, accepts large-size tape reels, and has automatic tape sensing (for program repeat during playback) besides. Dokorder's Model 1140 synchronizing function is called "Multi-Sync." This unit operates at the two higher speeds, features built-in electronic echo, sound-on-sound, and sound-with-sound recording. All of these machines have individual mike and line mixing controls for each channel, affording a great measure of flexibility even if a separate multi-channel mixer is not part of your home-recording set-up.

We visited a home-recording set-up which included a Teac 3340 and an Akai GX-400DSS. With two decks,

Closeup of "Simul-Sync" track switches on Teac 3340.



Akai GX-400DSS "Quadra-Sync" track-selector buttons.

Dokorder's 7140 2/4 channel deck with "Multi-Sync."

this enthusiast is able to do Sel-Sync recording of his masters and then transcribe the results, properly mixed and re-blended, to the second deck. The photos show closeups of the Simul-Sync switches on the Teac machine and the equivalent pushbutton switches (one for each track) on the Akai unit.

NOISE REDUCTION

A pair of Dolby noise-reduction units are used with these 4-channel decks. Why add Dolby to such fine decks, each of which can easily produce a signal-to-noise ratio of 60 dB or more when used with quality tape? Simply because if you're going to do any dubbing (successive copying of tape-to-tape), each dubbing process will add a few dB of noise to the finished product, so you want to start out with every last dB of signal-to-noise you can get. In this particular "home studio," the Dolby units are hooked up to the Teac deck, which serves as the master recorder. Dolby decoding is used during playback as the raw tracks are re-recorded onto the Akai machine, thereby affording more "headroom" to the finished mixed-down master tape.

Often the owner of this set-up has to transcribe his master tapes onto a cassette. To achieve best signal-to-noise ratio here, he uses a dbx Series 122 2-channel noise-reduction system. Working on a different principle from Dolby, this unit compresses the recorded material by 2 to 1 during recording and then, when the proper buttons are pushed, re-expands the program during playback by the same factor. The combined action increases the dynamic range by a wide margin while reducing noise and is especially useful with cassettes where over-recording or tape saturation is much more of a problem than with open-reel units.

OTHER APPLICATIONS

You can simulate four-channel sound when recording two-channel (some old stereo tapes, perhaps) by returning the monitor output to the record head. In effect, you use the time delay between the playback and record heads to obtain an echo effect.

A tape technique that's mind-boggling is sound that circles the room. This can be accomplished with a "pan pot" to gradually move the sound from one channel to another. (Two Teac AX-10 stereo echo units make it easy to achieve such results, by the way. They enable a user to vary the degree of echo and incorporate impedance-matching networks.)

Having four independent channels at hand, all in perfect synchronization, offers new recording opportunities. From the standpoint of quality, it beats sound-on-sound since the former is a second-generation recording (recorded on the originally recorded track) with attendant fidelity losses, while a Sel-Sync deck can provide first-generation tapes. So now it's easy to make four independent recordings (actually you can make seven first-generation recordings by using mix-down techniques). What can you do with at least four tracks? For starters, one track can be used for voice, a second for background music, a third for special effects, a fourth for voice-over or another voice, perhaps singing or whatever else you choose. You're only limited by your imagination.

ISN'T A STUDIO CHEAPER?

The equipment described here—which does not include any microphones or even the cassette machine used—adds up to nearly $4000.00. The question naturally arises whether a serious recordist (or musical group, or singer, or instrumentalist) wouldn't be better off renting time at a professional recording studio. Well, perhaps he would, but these days, studio time sells for upwards of $100.00 an hour if you're talking about a top studio—and the hours have a way of ticking by as you wait for studio set-up, do several unsuccessful takes, wait for an acceptable mix-down, and the like. With so many aspiring groups around, it's not surprising that they opt for a home set-up not unlike the one described, for then they can afford to do as many "takes" as are necessary for a good "auditioning tape."

More than one successful recording group has used this approach to "breaking in" to the entertainment field, and stories of these successes have led other aspirants to make the investment in this kind of equipment. By way of comparison, even the relatively moderately priced mixing console manufactured by Tascam (the professional division of Teac), and considered to be the logical "bridge" between consumer equipment and truly professional studio console equipment, costs nearly $2000.00 in its most elementary form. It can run several thousands more when equipped to maximum capacity, features, and number of input and output channels—and that's without considering even one tape deck or transport which would have to be used with the board.

Surprisingly, not everyone who owns the kind of equipment we have been discussing aspires toward producing a "golden record." Many are just seasoned audio enthusiasts who want the kind of recording flexibility and professionalism afforded by this kind of gear. Perhaps all they will record are "off-the-line" tapings of their favorite FM programs or dubbings from their favorite discs. But with imagination and good equipment, they can bring to bear an involvement and creativity that makes it all worthwhile and changes high fidelity from a passive hobby into a very active and exciting pastime. □

Pioneer's MA-62, a six-channel mixing amplifier.

HOW TO SELECT MICROPHONES

A layman's guide to choosing, connecting and using microphones for tape recorders.

By Robert B. Schulein Manager, Electroacoustical Systems, Shure Brothers, Inc.

IF you are involved with making live recordings, you are undoubtedly concerned about selecting appropriate microphones. Depending upon the application, one or more microphones may be required, as well as a mixer and a variety of accessories such as microphone stands, wind screens, and shock mounts.

For the amateur, the selection of an appropriate microphone is difficult because of the jargon associated with these products as well as the incomplete specifications often found in catalogues and ads.

In selecting a microphone for a particular applicatiom, it is important to properly combine a knowledge of microphone characteristics, tape recorder characteristics, and the acoustical environment in which the microphone will be used. These three areas are discussed here to help make selection of a microphone a matter of logic rather than of arbitrary choice.

In order to understand and interpret microphone specifications, it is important to understand the terminology involved. Various terms are commonly used to describe microphone performance characteristics. Some of the most important are: (1) Operating principles, (2) Frequency response, (3) Directional characteristics, (4) Output or rating impedance, and (5) Output level or sensitivity.

Principles of Operation. The primary function of any microphone is to convert an acoustical signal into an analogous electrical signal. There are many mechanisms by which such a conversion can take place. The most common are: (1) Relative motion of a wire or conductor in a magnetic field, (2) Motion of one electrode of a capacitor, and (3) Stressing a piezoelectric material.

Dynamic and ribbon microphones are examples of the first transducing principle. Such microphones can be constructed to operate over a wide frequency range, require no external power source, and are compatible with a variety of inputs.

The capacitor or condenser microphone makes use of the second transducing principle. Unlike the dynamic or ribbon type, this form of microphone requires electronic circuitry to convert the acoustically generated capacitance variations into electrical signals. The circuitry needed for this conversion usually consists of a d.c. or radio-frequency bias signal plus an amplifier. Although more complex because of this requirement, capacitor microphones are generally noted for their wider frequency response.

In recent years, a new form of capacitor microphone has evolved, making use of the electret principle of charge storage. This principle simplifies required electronic circuitry. Whereas the conventional capacitor microphone requires a high-voltage bias supply and a preamplifier, microphones using the electret principle require only a preamplifier. The electret can thus be thought of as a variable capacitor with a permanent bias voltage applied across it.

Ceramic and crystal microphones are examples of the third conversion principle. Ceramic types are more popular than crystals because of a superior ability to withstand temperature and humidity extremes. Either form of microphone is capable of good low-frequency response, but often displays a limited high-frequency response. Good low-frequency response is generally not achieved, however, due to the low-frequency roll-off produced when such microphones are connected to typical microphone inputs (see section on Microphone Matching).

Frequency Response. Perhaps the most publicized specification associated with microphones is frequency response. This specification, in its most complete form, is shown as a plot of output voltage in decibels vs frequency in hertz (cycles per second). The decibel (dB) is a means of expressing voltage ratios. For example, a 6-dB change corresponds to a 2 to 1 voltage ratio, and a 20-dB change to a 10 to 1 voltage ratio. Generally speaking, ±2 dB variations in frequency response curves are not subjectively detectable. Often, however, fre-

quency response is simply expressed as a frequency range (such as 50 to 15,000 Hz) with no mention of output variations in decibels or a plot indicating the response of a typical microphone. Without this information, microphones cannot be meaningfully compared.

When considering frequency-response specifications, it is important to consider the conditions under which the microphone was measured. Measurements are usually made in anechoic (echo-free) chambers, with the microphone pointed directly at the sound source (on-axis) two feet or more away. Since microphones are not always used on-axis at two feet or more, one should be aware of the effects produced when these parameters are varied.

For example, as the distance between the microphone and the sound source is decreased, all directional microphones exhibit, in varying degrees, a phenomenon known as proximity effect. This effect results in an increase in bass response, which may or may not be desired. In addition to a change in overall level, many microphones exhibit a change in frequency response as the source of sound moves off-axis. This change generally results in a loss of high frequencies and may be apparent for sounds as little as 45 degrees off-axis. An accompanying illustration shows the uniformity in off-axis response that should be expected from a well-designed directional microphone.

Directional Characteristics. All microphones can be categorized as directional or nondirectional. Nondirectional microphones, commonly referred to as omnidirectional microphones, show little variation of output voltage as the sound source moves off the axis of the microphone. These polar characteristics show variations in microphone sensitivity as the source of sound moves around the microphone. On the other hand, directional microphones are designed to exhibit large changes in output voltage as the sound source moves off-axis.

Of the many directional microphones available, the most common are the unidirectional and the bidirectional types. Bidirectional microphones show two major directions of sensitivity, whereas unidirectional microphones are primarily sensitive in one direction. A further subdivision of unidirectional microphones can be made: (1) Cardioid, (2) Super cardioid, and (3) Hypercardioid. Examples of these various directional polar patterns are pictured. Note, for example, that the output voltage of a cardioid microphone is 6 dB down (a factor of 1/2) for a 90-degree orientation to a sound source. When considering the directional characteristics of a microphone, it is important to realize that this characteristic can vary with frequency and that uniform polar response vs frequency is desirable.

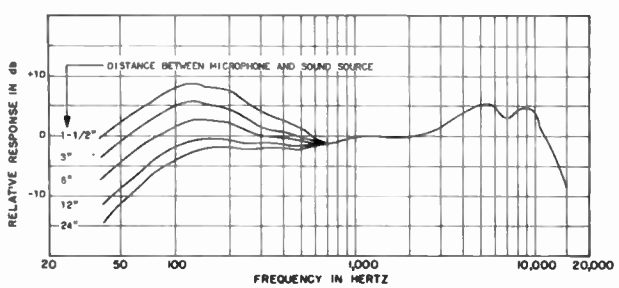
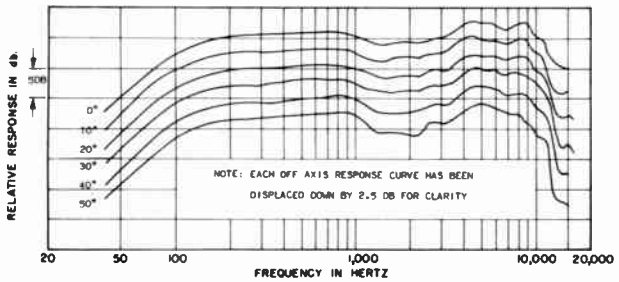


Fig. 1. Variations in frequency response due to proximity effect.

Fig. 2. Variations in response as sound source moves off-axis.



Output or Rating Impedance. Microphone specifications generally include the terms "high-" or "low-impedance" (often stated simply as hi-Z or low-Z). Impedance as applied to microphones can be considered as an opposition to current flow when the microphone is connected to an amplifier or tape recorder. From a circuitry standpoint, a microphone can be represented as a voltage generator with an output proportional to its sensitivity, in series with its output impedance. The nature of this impedance depends upon the microphone conversion principle and whether electronic circuitry is involved. The output impedance of dynamic, ribbon, or capacitor microphones (circuitry included) is almost purely resistive and varies anywhere from 50 ohms to 50 kilohms.

Output Level or Sensitivity. Perhaps one of the most confusing specifications associated with microphones is output level or sensitivity. The reason for this confusion is that listed sensitivity specifications are often incomplete and, consequently, cannot be used for direct comparison purposes. To properly specify the sensitivity of a microphone, three factors must be considered, as follows.

The sound pressure used to excite the microphone must be stated. This pressure is generally 74 dB SPL = 1 microbar (μbar) or 94 dB SPL = 10 microbars (1 microbar = 1 millionth of atmospheric pressure, which is 14.7 lb/in^2). Second, the resulting output voltage due to this sound pressure must be measured. Voltages ranging from 0.1 millivolt (−80 dBV) to 10 millivolts (−40 dBV) are common.

Finally, the magnitude and type of output impedance must be stated. (A statement of output imped-

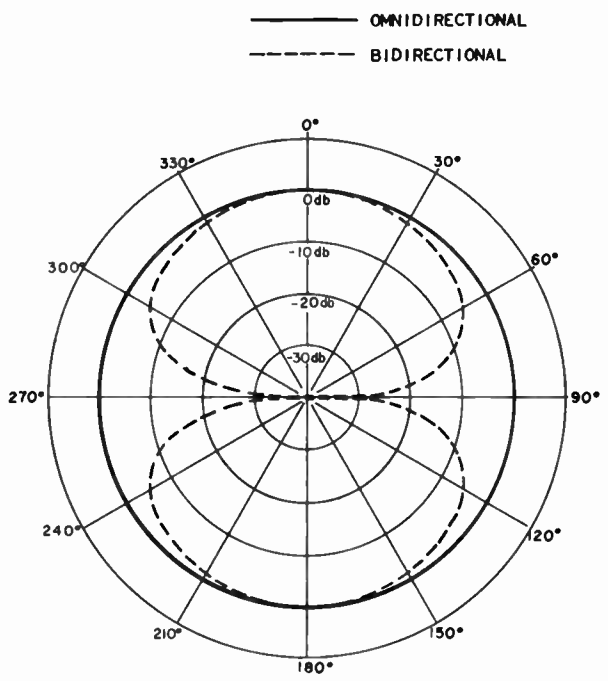


Fig. 3. Bi- and omnidirectional mike polar characteristics.

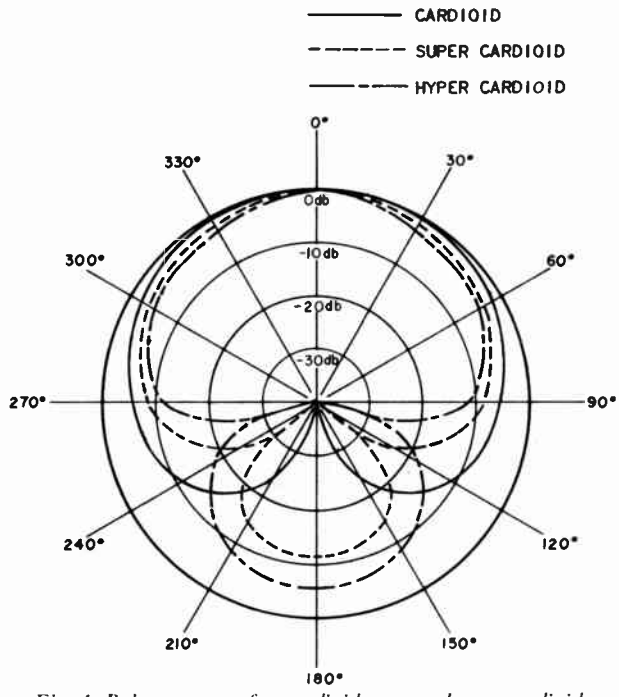


Fig. 4. Polar patterns for cardioid, super-, hyper cardioids.

ance is necessary due to the fact that two microphones may have the same sensitivity unloaded but different output impedances. The microphone with the lower output impedance is capable of delivering a higher output level to the microphone input preamplifier.) These three factors are combined to form two commonly found sensitivity specifications: (1) Open-circuit voltage sensitivity and (2) Maximum power sensitivity.

A properly stated open-circuit voltage specification might read as follows: −58 dB re 1 volt/1 μbar; output impedance = 30 kilohms (resistive). This means that for a resistive output impedance of 30 kilohms and 1 μbar sound pressure, the unloaded output voltage of the microphone, as expressed in decibel form, is −58 dB with respect to 1 volt. An output of −58 dB re 1 volt/1 μbar corresponds to 1.26 mV/1 μbar, which would be a typical output for conversational speech at about one foot. A less sensitive microphone would be represented by a larger negative dB number.

An example of a maximum power specification might be: −59 dB re 1 mW/10 μbar. This means that the microphone can deliver a power, expressed in decibel form, of −59 dB with respect to 1 milliwatt for a 10 microbar sound pressure. Although both of these specifications are complete and can be obtained from each other, the open-circuit voltage specification is the easiest to understand and relate to specific amplifier or tape recorder matching considerations.

In reviewing data sheets, one occasionally encounters a third specification, referred to as the RETMA or EIA sensitivity. Such specifications are typically on the order of −150 dB. This output specification is essentially a maximum available power specification, except that the reference sound pressure is .0002 microbar, and the internal impedance used depends upon the range in which the actual internal impedance falls.

As a rule of thumb, the open-circuit voltage sensitivity of high-impedance microphones is about 10 times (20 dB) greater than that of low-impedance microphones. Specifically, the average high-impedance microphone has an open-circuit voltage sensitivity of −60 dB re 1 V/1 μbar (1 mV/μbar) for a 20-kilohm resistive output impedance, whereas a low-impedance microphone has a −80 dB re 1 V/1 μbar (.1 mV/μbar) sensitivity for a 200-ohm resistive output impedance.

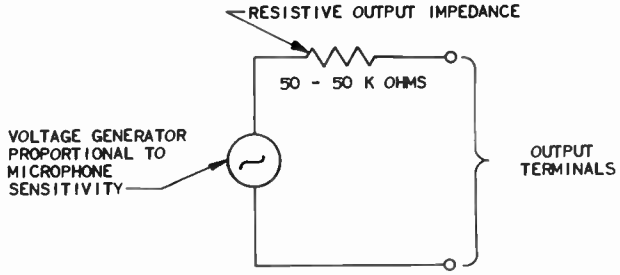
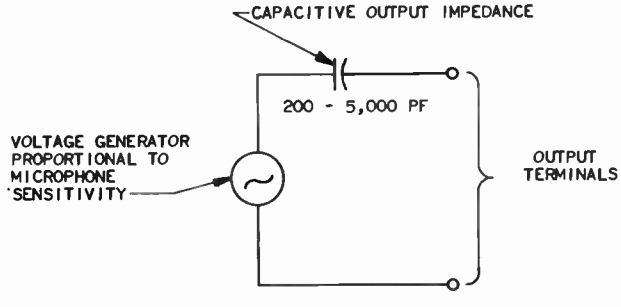


Fig. 5. Circuit equivalent of dynamic, ribbon, or capacitor mikes.

Fig. 6. Circuit representation of ceramic or crystal microphone.



MICROPHONE MATCHING

With this background in mind, consideration can now be given to the factors involved in connecting a microphone to a tape recorder. The term that is usually associated with this operation is "matching." One might ask the question: just what are we matching? Perhaps the best way to answer this question is to say that in matching we wish to achieve the following: (1) Minimal loss of microphone output signal, (2) Minimal degradation of frequency response, and (3) Minimum pickup of unwanted signals, such as 60-Hz hum.

What factors influence these performance goals? Whenever a microphone is connected to a tape recorder, a fraction of the signal generated by the microphone is not delivered to the recorder. This loss occurs because the output signal is divided across the internal impedance of the microphone and the input impedance of the tape recorder. To minimize this loss, the input impedance of the tape recorder should be as high as possible, preferably three or more times greater than the output impedance of the microphone. To keep this loss to say 2 dB

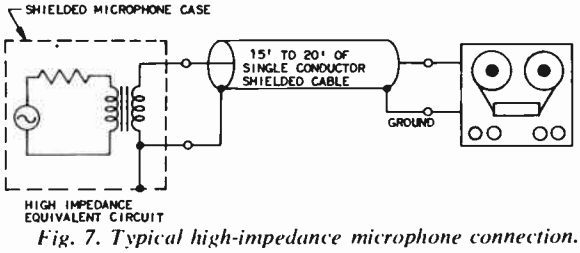
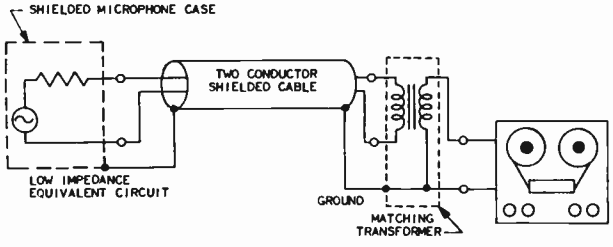


Fig. 7. Typical high-impedance microphone connection.

Fig. 8. Typical low-impedance microphone connection.



(which is hardly detectable), the input impedance of the tape recorder should be at least five times that of the output impedance of the microphone. As an example, consider a 200-ohm low-impedance microphone and a 20-kilohm high-impedance microphone. The low-impedance microphone should not be loaded with less than 1000 ohms, whereas the high-impedance microphone should be connected to at least a 100-kilohm input.

When ceramic or crystal microphones are used, the matching situation is somewhat different. Due to the capacitive nature of their output impedance, resistive loads tend to roll off their low-frequency response rather than attenuate overall level. In order to achieve usable low-frequency response, an input impedance of, typically, 1 megohm or more is needed.

To preserve good high-frequency response with dynamic, ribbon, or capacitor microphones, attention must be given to the length of the microphone cable used. Microphone cable acts as a shunting capacitor to the microphone, and depending upon the cable length and microphone output impedance, noticeable high-frequency loss may occur. Generally, if the output impedance of the microphone is low (600 ohms or less), several hundred feet of cable can be used with negligible high-frequency loss. On the other hand, if the output impedance of the microphone is high (20 kilohms or more), cables should be limited to 15 to 20 feet.

The undesired pickup of hum and buzzes can be avoided if proper attention is given to the microphone cable used. Electromagnetic hum is generally produced by such devices as power transformers or power lines, whereas various buzzes are electrostatic in nature and created by such things as fluorescent lamps or neon signs. A good grade of microphone cable with a braided mesh shield will effectively eliminate the pickup of electrostatic signals.

The pickup of electromagnetic signals is generally not a problem with high-impedance microphones because the signal voltages are relatively high and cable lengths are short. When long cable runs are necessary, low-impedance microphones are used to avoid high-frequency losses; however, the amount of hum pickup compared to signal level increases due to lower microphone output level. To cope with this problem, a balanced microphone line is typically used in conjunction with an additional transformer located at the tape recorder end of the cable. A balanced microphone line requires a shielded cable with two conductors shielded as opposed to a single-conductor shielded cable which is used for unbalanced microphone connections. The transformer serves two purposes. It balances out hum signals picked up on the microphone lines and steps up the microphone's output. In general, one should use a short length of single-conductor shielded cable with high-impedance microphones and a two-conductor shielded cable in a balanced configuration with low-impedance microphones, as illustrated.

Before making any decisions regarding microphone impedance, it is wise to consult the instruction manual for the particular type recorder or microphone mixer being used.

SELECTING THE MICROPHONE

At this point, it is convenient to consider the factors that make one microphone type the best choice for a particular application. The first question that is generally asked is how much should you expect to pay for a good microphone? With microphones available for from several dollars to several hundred dollars, this appears to be a difficult question to answer. Practically speaking, however, very excellent recordings can be made with microphones in the $25 to $75 price range. As the price increases, improvements in quality become more difficult to detect.

High-quality recordings depend on more than just the price of the microphone. Factors such as frequency response, directional characteristics, placement techniques, appropriate accessories, and recording techniques play an equal, if not a more important, role in obtaining high-quality recordings.

A second question that is often asked is what conversion principle is best to use. An honest answer to this question is that microphones employing each of the transducing principles previously discussed are capable of producing excellent results, but that some are more expensive than others or are less practical to use. As previously mentioned, crystal and ceramic microphones are seldom used for wide-response recordings because of the high amplifier input impedance required and the necessity for short cable lengths. Many ribbon microphones, on the other hand, require special protection from wind and explosive breath noises to prevent excessive stretching of the ribbon element. Capacitor microphones may be impractical because of their power supply requirements or relatively high cost. The evolution of electret capacitor microphone technology has, however, greatly reduced these disadvantages. The dynamic microphone still maintains high popularity based on performance, reliability, convenience and economy, although incursions have been made by other types.

Frequency Response Considerations. For making recordings of voice or music, a smooth frequency response from 100 to 10,000 Hz is generally desirable, while the response at 40 and 15,000 Hz should not be more than 10 dB down.

A falling response below 100 Hz is often desirable to minimize the pickup of low-frequency room noise produced by air-conditioning equipment or heavy truck traffic. Many microphones exhibit a response rise of 3 to 5 dB in the area of 7 kHz. This rise has the effect of adding more "presence" to voice and music as well as complementing the high-frequency roll-off of some speaker systems. To compensate for an increase in low-frequency response due to the proximity effect, some microphones employ a voice/music switch which introduces a low-frequency roll-off.

Directional Considerations. If the pickup of background noise is not a problem in a particular recording situation, an omnidirectional microphone is generally the best choice. This type of microphone is typically lower in cost than a directional microphone with comparable frequency response. Furthermore, it is less susceptible to pop, wind, and vibrational disturbances. Conversely, some form of directional microphone will be of value if the pickup of a specific background sound is undesirable. Here are some examples.

If the undesired sound is at 90° to the desired sound, a bidirectional microphone would be the logical choice. Such a microphone would also be desirable for the pickup of two sources facing each other. Examples of such situations would be two singers facing each other or individuals on both sides of a conference table.

To cope with a situation where the undesired sound is 180° with respect to the desired sound, some form of unidirectional microphones should be considered. Looking at the various types of cardioid responses, it should be pointed out that the supercardioid and hypercardioid characteristics offer an advantage over the cardioid for rejection up to about 130° or 140° off-axis. The basic cardioid, however, provides superior discrimination against sounds arriving from the rear. The basic cardioid polar characteristic also offers another advantage. Its output level does not drop off as rapidly as the source of sound moves off the most sensitive axis of the microphone. This characteristic is desirable when attempting to pick up a close-talking voice such as a singer who is holding the microphone in a variety of positions. Consequently, depending upon the direction of arrival of the unwanted sound, one particular directional characteristic is the best choice. If the unwanted sound is diffuse in nature and, therefore, lacking any particular direction, all of the discussed directional patterns provide essentially the same advantage.

When using any directional microphone, large objects such as walls or furniture should be as far as possible from the microphone. The reason for this is to prevent the reflection of undesired sounds towards the most sensitive axis of the microphone. As an example, consider a singer with his back against a wall and facing an undesired source of sound. Reflections from the wall would in this case be coming from the same direction as the singer's voice.

Microphone Placement. When recording voice, it is generally desirable to minimize the pickup of

background noises as much as possible. It is thus desirable to place the microphone as close as possible to the speaker. However, if close placement is not possible, a directional microphone will aid in the reduction of background noise as compared to an omnidirectional microphone. The use of a directional microphone is not always suggested however. If the speaker tends to move far off-axis of the microphone, the overall output level will change due to the polar characteristic of the microphone. This is particularly true when attempting to record a two-man interview by moving the microphone back and forth. Consequently, an omnidirectional microphone should be used in such instances.

For musical recordings, a certain amount of reverberant room pickup is generally desirable. Using omnidirectional microphones, a closer microphone-to-source distance is required than for unidirectional microphones for the same ratio of direct sound to reverberant pickup. This choice is consequently a matter of personal taste and the microphone distance restrictions of the particular recording situation. It is important to realize that proper microphone placement is a skill and that it, like any other skill, is not something that can be acquired from a textbook. A textbook, or an article such as this, can only serve as a guideline making one aware of basic principles and possible pitfalls. The skill comes from actual experience in making recordings and discovering the problems on a first-hand basis. One should not be disappointed if a first live recording is less than perfect.

Without doubt, the key to good microphone placement is experimentation. If possible, set up your recording equipment with time to experiment during a rehearsal so that changes can be made before the performance. Often, it is possible to talk to someone who has recorded a previous performance and is willing to give you some tips based on his experience.

Microphone Accessories. There are four factors concerning microphone performance that are often overlooked and can lead to a poor recording: pop or explosive breath interference, wind pickup, interference due to mechanical vibration, and overload due to high sound-pressure levels. Although most microphone manufacturers minimize these effects as much as possible in microphone construction, it is often beneficial to make use of available accessories to provide additional protection. Pop and wind sensitivity can be significantly reduced through the use of add-on pop and wind screens. Vibrational problems can be minimized through the use of isolation microphone stands or isolation microphone stand adapters. Very often, simply supporting the microphone on a vibration-free surface with an appropriate microphone stand will eliminate a major problem. In addition to these accessories, several manufacturers offer low-frequency roll-off filters which can be inserted directly into the microphone line to further reduce these objectionable signals.

Shure A53M isolation mount used with SM53 mike.

The fourth area of concern is indirectly related to the microphone and often results in distorted recordings. This factor is tape-recorder overload, which cannot always be corrected by the recording volume control. During the recording of high-level music, or close-talking vocal performances, relatively high voltages may be generated by the microphone that can easily overload the input microphone preamp of most tape recorders. A typical high-impedance dynamic microphone, for example, can produce an output of over two volts, when exposed to a 140-dB sound pressure level. There are very few cases in which the microphone itself overloads at such sound pressures, the exceptions being some condenser microphones where the internal electronics are overloading. In most situations, the only solution is to attenuate the output of the microphone. Various low-impedance attenuators are available which provide from 10- to 15-dB signal reduction.

An additional accessory that can often improve the quality of a recording is an appropriate microphone mixer. Since the typical stereo recorder contains only two microphone inputs, a mixer is required if more than two microphones are necessary for the particular recording. If, for example, an orchestra is being recorded with a soloist, a separate microphone could be used for the soloist and combined with a stereo pickup of the orchestra. With this recording arrangement, it is now possible to more accurately control the balance between orchestra and soloist.

In selecting a microphone for tape recording, it should be clear that no particular microphone is always the best choice. After considering the type of recordings to be made, the characteristics of the tape recorder to be used, and the acoustical environment involved, the guidelines offered here can help you make a logical choice. □

A USER'S GUIDE TO MAGNETIC TAPE

Properties and characteristics of today's breed of magnetic tape.

By Delos A. Eilers
Magnetic Audio/Video Products Div., 3M Company

IT is common to equate today's better-quality recordings with improvements in tape equipment and, although evolutionary changes in equipment are responsible for better signal-to-noise (S/N) ratio, extended frequency response at slower speeds, and reduced distortion, equally significant improvements have been made in the tape itself. Much of the improvement we can expect in the future will probably be directly attributable to tape.

First we should see just what magnetic recording tape really is. It has been likened to a "sandwich;" but this is true only in terms of an "open-faced sandwich."

Backing. The substrate, or base material, is a film. Once it was a paper film, then cellulose acetate, which has many fine properties but can deteriorate in time. The concept of permanence led to the development of polyester films as the base most commonly used today. Polyesters are much stronger than acetate, but, when overstressed, polyester will stretch more than acetate before breaking. This property is important in commercial and professional work, but not to the home recordist.

That stretch point will not be reached if the base material is made thick enough; of course, the thicker the base material the less you will spool onto a reel. But for the same thickness, it will be stronger and more durable than paper or acetate. Tape base material is generally available in 1.5-, 1-, or 0.5-mil thicknesses (mil = 1/1000 of an inch). The 1.5-mil tape will be the strongest. It is this stock that forms the basis for most of the professional mastering tape available today. The thinner tapes find their way into the consumer market where more tape time on a reel is important. The other virtue of the polyesters is their long-term stability. No one knows if they are truly *permanent*, but they don't seem to deteriorate, so polyester is the material to use if the recordings are of archival importance.

While acetate and polyester represent the bulk of tape manufacture, other materials—all plastics—have been tried. Only polyvinyl chloride (PVC) film has endured. It is a less expensive backing and is used in some parts of the world. Its strength falls between that of polyester and acetate, but it is more temperature-sensitive than either. Professional master tapes and most of the tapes offered to the consumer use polyester.

Binder. To record, the film must have magnetic particles, held in place by a binder. The chemistry and physics of binders are the most proprietary part of tape design and manufacture. Binders are responsible for differences between brands, between different qualities of tapes, and have made significant contributions to the evolutionary improvements in recording tapes.

The binder is the "glue" into which the magnetic oxides are mixed for application to the film. But it also must have a lubricative quality, for ease in sliding past fixed surfaces—the magnetic heads on recorders. The "integrity" of a binder compound determines, among other things, how well the tape will last, avoiding rub-off or flake-off, or abrasive damage to recorder heads. The evenness of the coating is important for flat frequency response and the avoidance of drop-outs. And its reliability and

durability are as important as any other factor in determining the permanence of the tape over long periods of use and storage.

Magnetic Particles. The ultimate performance quality of any tape is dependent upon the magnetic particles applied to the binder—which at present are of the magnetic-oxide family.

It has long been known that ferric-oxide (in one form known as rust) is a stable and reliable material that can be crystallized to small particles, each one of which will act as a discrete magnet. The particular oxide formula, standardized since the early days of tape, has been gamma-ferric oxide. By adjusting the particle size and shape, different tape properties could be obtained from this one basic material.

Gamma-ferric oxide was unchallenged as the basic raw material of tape until about 1970 when DuPont unveiled magnetic tapes made with new magnetic particles—chromium-dioxide. The recording currents necessary to put magnetic imprints on chrome-dioxide tape had to be much stronger. Yet, once recorded, the new material was harder to erase for re-use of the tape. Therefore, stronger erase currents were needed.

Chromium-dioxide (or "Crolyn," DuPont's tradename) tape's potential for improved signal-to-noise ratios and extended frequency response are most useful with low-speed tape, where the greater packing density of the new tape is advantageous. At higher speeds, this edge disappears. Thus, there is no advantage in using chromium-dioxide tapes in preference to ferric-oxide at speeds of 7½ ips or higher.

If the machine will accommodate the chromium-dioxide tape with its higher bias needs (relative to ferric-oxide), a gain in performance at the high end of the frequency spectrum will be obtained. At the low end, however, a recorder's equalization must be changed to boost bass response for a flat playback response. A chromium-dioxide switch position generally takes care of these internal recorder changes.

The best of both worlds may now exist in the recent introduction of ferri-chrome tapes for the cassette market. These are tapes with a double coating on the base material: a gamma-ferric-oxide coating over which a thinner coating of chromium-dioxide is placed. The result offers the advantages of chrome without the need for excessive bias. Furthermore, it has the better bass of the ferric tape. The signal-to-noise ratio is excellent across the entire audio-frequency spectrum.

So, today's cassettes can use gamma-ferric-oxide, chromium-dioxide, or ferri-chrome tapes. Tapes with slower speeds are those for which chromium-dioxide or combinations are most effective. Eight-track cartridges and open-reel systems use only gamma.

Recently some technical papers have discussed a new type of magnetic particle. Not too much is known, except that instead of oxides, pure metal powder is used, with claims being made for improvement in high-frequency performance and S/N ratios in the cassette format.

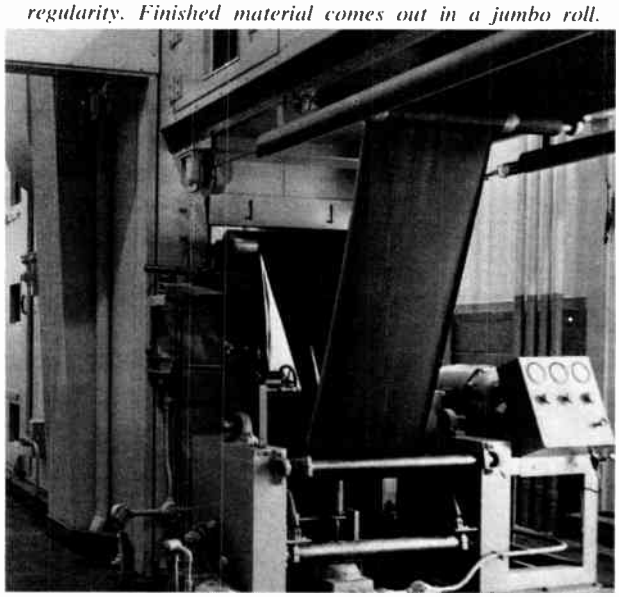
SPECIAL PROPERTIES OF TAPE

When tape is used in a particular application, a special property may be needed. The most important of these is the lubricity that is built into the tape when it is destined for a cartridge. Here the problem of re-entrant tape path (the tape is pulled from the center of the reel and returned to the outside of the same reel) requires a more friction-free tape than do other formats. The magnetic coating and tape's back surface must both be lubricative.

The most visible special property applied to some tapes is the backing configuration of the non-magnetic-coated side of the film. This backing has a slight texture, analogous to the tread in a tire, which

The baisc ingredient of tape's magnetic coating is iron oxide, a reddish-brown powder-like material. Such coatings

are applied by huge machines which control thickness and regularity. Finished material comes out in a jumbo roll.



results in smoother winding by allowing orderly dispersion of the air cushion between layers. The texture also gives a better surface for the recorder's drive capstan and pinch roller to grab. This means a slip-free tape motion past the recorder's heads.

Then, in high-quality, high-performance tapes, the magnetic-coated side is often treated to make it smoother. This often takes the form of compression or polishing. The smoothness enhances the contact between the magnetic particles and the record/playback head, which improves output levels and high-frequency response.

(As a result of these two developments, the old rule "shiny side away from the recording head" is no longer true with some tapes. There are tapes on the market with both sides equally shiny, and there are those with surface-treated magnetic sides that are shinier than the positive-traction backsides.)

TAPE FORMATS

Open-reel tape was the springboard for other formats. Open-reel tape is available in several widths. The home recordists need only be concerned with one, the ¼-inch width. However, professionals use ¼-, ½- 1-, and 2-inch widths. Tape comes on various size reels. The professional primarily uses reels of 10½-inch diameter, while consumer machines accept 10½- 7-, 5-inch, and even smaller diameter reels. All commonly used tape speeds from the professional's 30 down, are used on open reel. (Most machines offer only two speeds.) All open-reel speeds are fractions of 30: 15, 7½, 3¾, and 1⅞ ips.

The cassette format was developed as a home and portable system and high-fidelity sound was not part of the original concept. The cassette contains a tape slit to an approximate width of ⅛-inch (actually 0.150 in) and runs at a speed of 1⅞ ips. In many ways the cassette is a miniature open-reel system. The tape travels inside the cassette from one reel to the other. Therefore, it has the advantage of fast-forward and rewind capability.

The 8-track or endless-loop cartridge is another format altogether. The concept really came from the broadcast and point-of-sale fields, were high-quality cartridge systems have existed for a long time as short (commercial) message systems. They are easily cued. There is only one reel in a cartridge. Tape is pulled from the center of that reel, passed around the cartridge (and across the heads of the machine), and then returned to the outside.

Accordingly, the cartridge really contains a continuous loop of tape so that when the message is ended, it begins again. The familiar 8-track cartridge contains four pairs of stereo tracks; therefore, it has four programs. The machine will switch among these sets, going back to set one when it finishes with set four. But the tape is just going on and on.

Because of the re-entry characteristic, rewind is not possible; fast-forward is, although speed cannot approach that of other formats. As a consequence, the cartridge format is less convenient as a recording medium, but it certainly is easy to use. On most machines, you just push the cartridge into the unit and it will start playing. The 8-track cartridge system runs at 3¾ ips and uses ¼-inch tape.

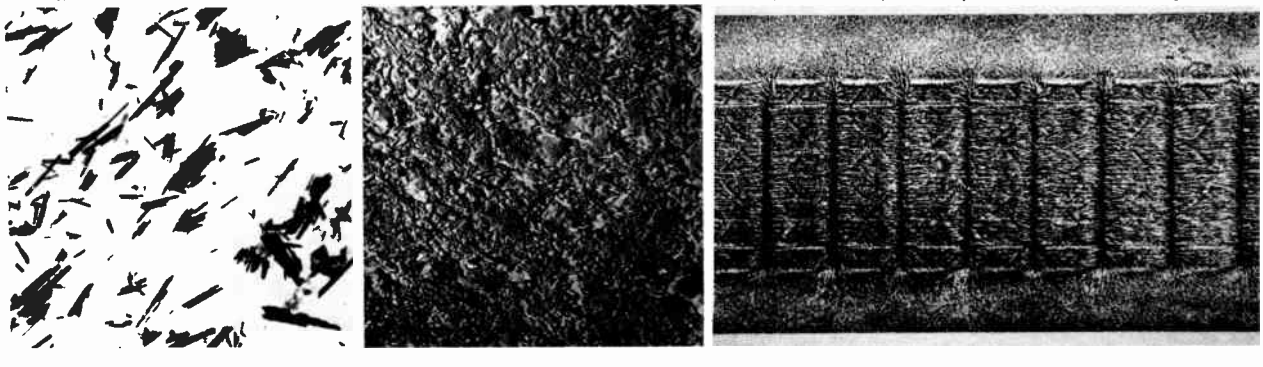
TAPE RECORDING LANGUAGE

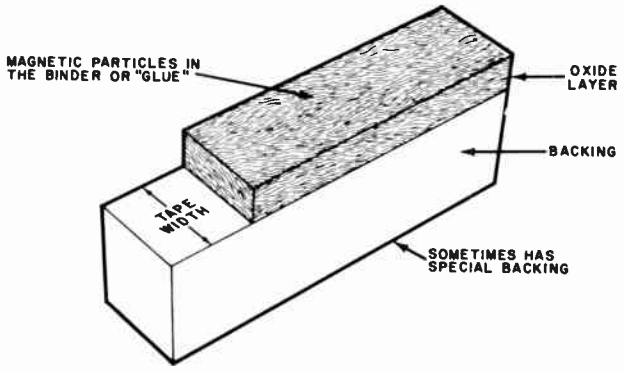
There is an apparent mystique involving tape. Mention bias, for example, and ask three "knowledgeable" people about it and you'll get three answers—and they'll all probably be wrong!

Data sheets generally contain three types of information. . . . on physical properties, intrinsic magnetic properties, and electromagnetic properties.

Physical properties are fairly easy to understand and self-explanatory. Information as to the backing material, width, thicknesses, and strength is generally compatible among data sheets of the various manufacturers, so that it is easy to compare, al-

Electron microscope photos of magnetic recording tape (left) Chromium-dioxide (CrO_2) particles enlarged 52,500 times. (Center) Magnetic tape surface (15,000X) showing iron-oxide particles. (Right) Recorded sound pattern made visible on a magnetic tape by magnifying iron filings sprinkled on oxide surface.

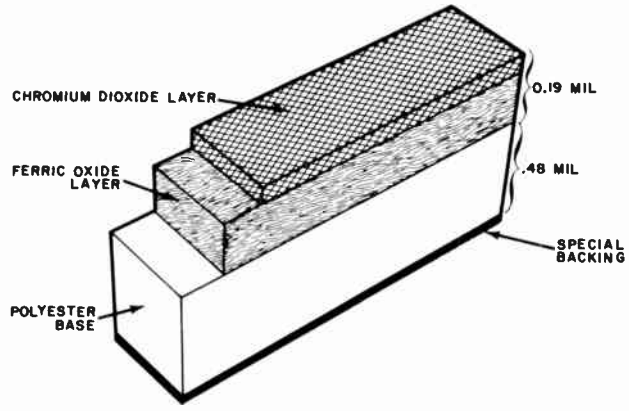




Single oxide tape for cassettes or open-reel.

though some sheets may give the figures in metric rather than English units. It would be difficult to calculate how well a tape would wear, however, because no standard industry test has been established for this parameter.

Intrinsic magnetic properties are the basic magnetic characteristics of each tape involved. Generally a user can compare tapes with confidence because of the well established industry standards for determining the magnetic properties of the tape. Perhaps, it would be helpful to review the main properties and suggest some guidelines.



Configuration of C-60 ferri-chrome cassette tape.

Bias. A signal added intentionally during recording to compensate for the inherent non-linearity of magnetic systems. It is an alternating current of high frequency (beyond audibility), linearly added to the signal.

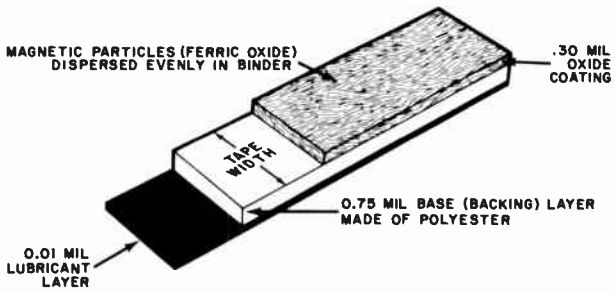
Usually, the bias frequency is designed to be about five times higher than any audio frequency you want to record. So if you want to record up to 20 kHz (assuming your machine can), the bias should be at least 100 kHz. Note that the frequency of bias is set at the factory and cannot be readily changed.

Bias adjustment refers to the amount of bias being added to the audio signal being recorded. Depending on the coating formulation of the tape being used, more or lesser amounts of bias will be required for optimum performance. It is always the amount of bias that is being adjusted, never the frequency. (It should be changed only by a person with skill and the proper instruments, unless the tape machine has external provisions for such adjustments—as a very few do.) By optimizing the bias, good performance (frequency response, distortion, and S/N) can be set.

Coercivity. The demagnetizing force or field intensity required to reduce the induction of a piece of tape from saturation to zero. Used as a figure of merit, expressed in oersteds for magnetic tape, it is useful for comparing relative bias and erase field requirements. It is the high coercivity of chromium-dioxide tapes that makes it hard for machines not designed for them to properly erase one's recordings.

Coercivity affects both bias and high-frequency distortion limitations. Tapes below 290 oersteds are characterized as non-low-noise tapes. Above this figure they are most likely low-noise tapes. The higher the coercivity, the more bias is required. Chrome tapes, for instance, are 450 to 500 oersteds and require special bias beyond that of conventional ferric-oxide tapes.

Retentivity. A tape design property which, from the user's standpoint, is not very meaningful. It indicates the amount of tape oxide versus the amount of binder applied to the tape's backing. In today's jargon, high density is really high retentivity, so tape designs of recent years have generally been in



General configuration of a cartridge tape. A lubricant layer is needed for this tape format.

the 1000-1500 gauss range as compared to 700-1000 for earlier designs.

Remanence. Not universally shown on data sheets because it is a calculated figure. The higher the remanence figure, the higher the tape's potential maximum output before you reach distortion at low frequencies.

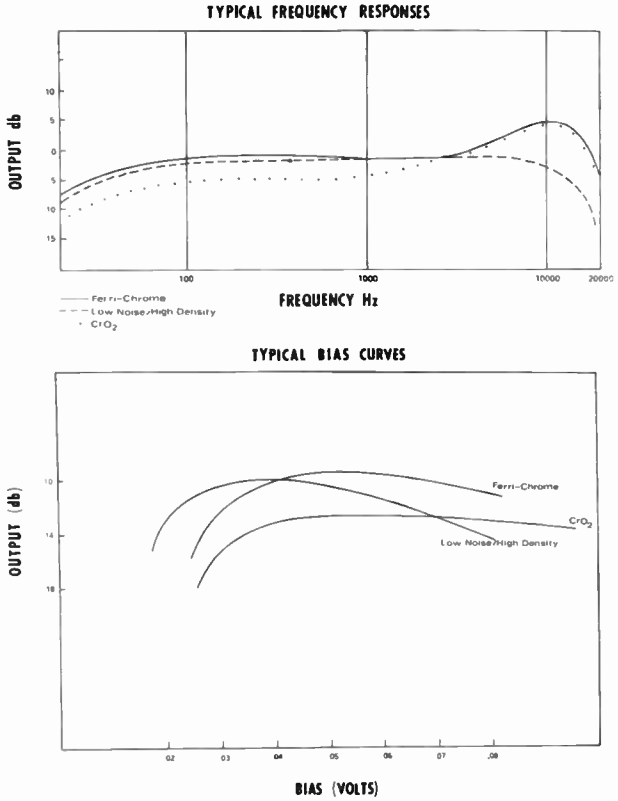
If remanence is not specified, it can easily be figured by multiplying the retentivity (given in gauss) by the coating caliper (given in mils), then dividing by 629.

For reel tapes, remanence for the standard output

tapes will be given in such figures are 0.5 to 0.7 and high-output tapes should have a range on the order of 0.8 to 1.2 lines per quarter inch. For cassettes, the spread among competitive tapes will be much less, because manufacturers are generally putting on the thickest coating with the highest retentivity possible. Most high-density/low-noise tapes will have a range of 0.3 to 0.4 flux lines per quarter inch and high-output tapes should be 0.4 to 0.5. If the reference is made to 150-mil tape rather than quarter-inch tape, it is convertible by multiplying the 0.150 mil by 1.67.

Electromagnetic Properties. Probably the most familiar to users, but difficult properties to compare on paper. This is because there is no one standard technique used to define electromagnetic properties and because the particular recorder used for the test is critical to all the parameters. How bias, recorder levels, and equalization are adjusted in a particular machine are critical to the numbers generated. Thus, if one machine is adjusted one way, another differently, the numbers will not correlate.

We think the following performance parameters are needed to best characterize the tape and mini-



mize the number of machine variables present. These include peak bias, maximum modulated level, weighted noise level, sensitivity, and uniformity. All these electromagnetic properties suffer, as there is no absolute number that can be defined. Each tape data sheet must compare the tape's electromagnetic properties with a reference tape and this makes comparison between brands A and B almost impossible because of the different reference tapes that may be used. In the area of cassettes, a reference has been generally accepted—a German standard reference tape (DIN Bezugsband).

There are two performance parameters you may find quoted on technical data sheets about which we feel you should be wary. They are signal-to-noise ratio and frequency response. Either of these is extremely dependent on the tape recorder's design and adjustment. To have a frequency response out to 20 kHz on recorder A with tape X does not mean that tape X will give the same response on another brand or model recorder. Similarly, to have a 70-dB S/N ratio on a tape in a specific machine will not necessarily give you the same signal-to-noise ratio on another model.

HOW IT ALL COMES TOGETHER

So you've got a super open-reel machine and you want to know what tape to buy. Or you've got a fine little cassette deck, and you also want an answer to that question.

In general, it can be said that you get what you pay for. At least it is true that the inexpensive "bargain" tapes offer little consistency of performance at best, and may be anywhere from pretty good to useless. In open-reel there are choices between the low-noise and the high-output/low-noise tapes. Those latter-named premium tapes will offer superior performance, providing the machine is biased and equalized for them.

In practice, most similar types of tape will perform similarly. So, if your machine was biased by the manufacturer for one brand of high-output/low-noise tape, it probably will work well with any of them. (This may not be true with some non-low-noise tapes.) The same is true of cassette machines. However, many are supplied with switches for different tape types—usually a choice between conventional oxides and chromium-dioxides. The instructions that come with the machine detail the type of tape to use, but not necessarily the brand. So pick the brand you trust.

Recording time is always a consideration in buying tape. (Longer time on the same size reel means the tape must be thinner!) But remember that the thinner tapes are more delicate. Buy no thinner tape than you actually require. A C-120 (120 minutes play/record time) cassette may be so thin that the magnetic coating suffers in quality; use it only for voice or "low-fi" applications. □

HOW WILL YOU USE YOUR TAPE RECORDER?

Before buying a tape recorder, take the time to critically examine your own personal requirements.

To play commercially recorded open-reel tapes, a two-speed ($3^3/_4$ and $7^1/_2$ ips), four-track recorder is necessary. Special sound recording facilities (sound-on-sound, microphone mixing, etc.) are not required. However, a simple accessory Dolby noise-reduction circuit might be advisable.

Most of these comments apply equally to cassette recorders, except that Dolby circuits are usually built into machines selling for more than $200. Many, if not most, current cassette releases are Dolbyized.

Many people—perhaps the largest group of tape recorder users—dub phonograph records and FM broadcasts to build up a tape library. As with the "listening-only" tape unit, no special recording flexibility is required for this, but a good overall record/playback frequency response is desirable. The tolerable limits of recorder flutter, distortion, and noise level depend somewhat on the quality of the associated record-playing equipment and FM tuner. An unweighted flutter of 0.2% or less, and a S/N ratio of 55 dB or better, combined with a useful frequency range from 30 Hz to 14 or 15 kHz, will usually result in a tape copy virtually indistinguishable from the original program. For certain types of music, such as piano, it's desirable to have less than 0.1% flutter.

If "live" recording is your goal, an open-reel recorder is most desirable since its tapes can be edited. The quality and price of the recorder you choose must be dictated by the specific nature of your recording needs. For example, no recorder can sound any better than the microphones will allow. One should be prepared to spend about half as much for the microphones as for the recorder, for comparable quality of sound.

For anything more than casual recording, even the most expensive recorders may lack the desired input flexibility and require an external mixer. Costs escalate rapidly—not so much in relation to audible performance as operating flexibility. Clearly each case must be evaluated individually.

DOES YOUR TAPE MACHINE MATCH YOUR TAPE?

By Ralph Hodges

I RECEIVED a crestfallen note from a reader in Illinois recently. He was upset because his tape deck (an older model) lacked the bias and equalization switches that have proliferated over the past couple of years. Therefore, he felt, he wouldn't be able to experiment with the many new types of tape now available—tapes that inspired the switch facilities to begin with.

Fortunately he was wrong. The absence of the switches would mean a certain inconvenience, to be sure, but a tape recorder's *internal* bias and EQ adjustments are still the best way of matching a machine, as closely as possible, to the particular tape being used. I often wonder when I see the legends NORMAL and SPECIAL (or similar nomenclature) on these switches, just what kind of tape is being referred to. Presumably SPECIAL means the so-called low-noise/high-output formulations, but to suggest that all of them, from their numerous different manufacturers, perform identically is being optimistic.

True, chromium-dioxide cassettes tend to be very similar because, with few exceptions, the oxide material all comes from the same source. But the iron oxides applied to open-reel tapes of the low-noise/high-output category are more diverse—so much so that there are evidently tape machines that *can't* be optimally set up for some of them.

Hotter Tapes. Does this mean that when you put a reel of the latest (and "greatest") 1-mil polyester on your machine and casually flip the bias and EQ switches to SPECIAL, you are perhaps not getting the flattest possible frequency response and the lowest noise and distortion. Yes indeed!

The SPECIAL position can only refer to optimum conditions for one particular tape—or at best two or three tapes with highly similar characteristics. For any other tape, it's an approximation, which may or may not be audibly satisfactory. In recognition of this and additional factors, some tape-deck manufacturers still refrain from providing the almost ubiquitous switches. The new $1800 Revox with which I've been amusing myself for the past several weeks, for example, lacks them; but the continuously variable trimmers that can set the bias and EQ much more precisely are accessible (and clearly marked) with the removal of two back panels.

How did these better, "hotter" tapes come about? In general, they started to appear with the high-fidelity boom of the late sixties. The object was to provide tape with better frequency response, less noise and lower distortion. Simplistically put, the reason tape has distortion is that magnetic materials do not really behave linearly, and can be made to do so only with the exercise of considerable ingenuity, and even then with serious limitations. The reason tape has noise (the familiar tape hiss, as well as other noises) is that its surface (the oxide coating) is composed of ground-up bits of magnetic material, and hence is not magnetically or physically smooth. And the reason it doesn't have infinite (for audio purposes) frequency response is that it can't hold onto the very short wavelengths of extremely high frequencies. These closely spaced magnetic poles are neutralized through a number of mechanisms, either right at the moment of recording or later, with the passage of time and use.

Hence, tape manufacturers began a multi-pronged attack on the problems of tape, particularly those of oxide coatings. They worked to make oxides magnetically tougher (higher coercivity), so that they'd be less inclined to relapse from any magnetic state they had been put into. They strove to get the separate oxide particles more uniform in shape and size, and to pack them more densely and smoothly on the tape. The result was tapes with better high-frequency response (in other words, hotter), less noise, and higher potential output (since they had a greater concentration of magnetic material per unit area). The result also was tapes that had to be used under somewhat different conditions than the prevailing ones if the most was to be gotten out of them.

Bias. Everyone talks about bias but few seem to truly know anything about it. Bias was discovered long ago in tape's antiquity, when it was learned that the application of a rather strong dc field along with the recording signal served to reduce the distortion of tape and increase its sensitivity. In due time the dc was replaced with ac of very high (ultrasonic) frequency, since the dc bias produced objectionable tape noise. After that, developments in bias were sporadic and concentrated on making it higher in frequency (the Revox's bias oscillator puts out above 1.5 Mhz), less distorted (for instance, an asymmetric bias suggests a dc component, and therefore more noise), and more accurately positioned relative to the point where the recording signal is applied to the tape (the cross-field head technique, for example).

There's still no general agreement as to what these innovations achieved. However, it's unmistakable that bias, pure and simple, does reduce distortion and greatly increase the tape's sensitivity to the recording signal. And at least we can say, with technical accuracy, that it does so by putting the tape into a high state of flux, apparently making it more malleable. Imagine yourself with a stout steel I-beam, intending to sculpt it into a graceful curve for exhibition at some art show. After fruitless efforts with a sledgehammer you resort to a pile driver, which kinks and tortures the metal, and which is difficult to modulate in the intensity of its blows. Finally, it occurs to you to heat the metal almost to the molten state. Then you can approach (in your asbestos suit) and mold it effortlessly into the shape you desire.

This is a very rough analogy, but to carry it a little further, the hotter tapes generally require somewhat more heat (more bias) to achieve "optimum" malleability, and they can usually profit from a stronger molding force (a stronger recording signal) And the hotter a tape gets, the more bias and recording signal it's likely to need, which means readjustment of the tape machine.

Bias and Equalization. Recording equalization (EQ) is merely a high-frequency level adjustment, and it is provided in most tape machines simply to complement the *playback* equalization (which should be fixed to conform to the standard NAB characteristics) and to touch up any frequency-response aberrations that things such as the bias adjustment might produce.

To illustrate: the bias signal can partially erase a tape even as it's helping to record it. (In fact, the bias oscillator also drives the erase head—with a much stronger signal.) This erasing potential is first exhibited at the high frequencies. If achieving the desired bias results in a moderate droop at the top end of the frequency response, EQ may then be able to flatten things out, with some cost in signal-to-noise ratio.

The important thing to realize about the EQ adjustment is that it *follows* the bias adjustment, and is in a sense subsidiary to it. Bias is not a fix-it for what you can't or prefer not to achieve with EQ. Certainly you can bring up the high-frequency response of a recording by reducing the bias, but you will also affect distortion and noise, as well as fail to make the most efficient use of the tape. The bias must be correct to begin with; then you can try to effect any repairs needed on frequency response with the EQ.

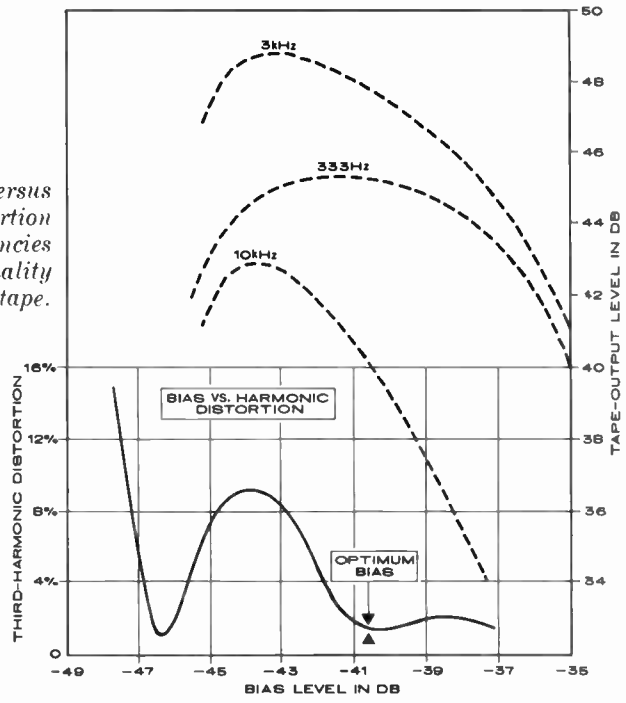
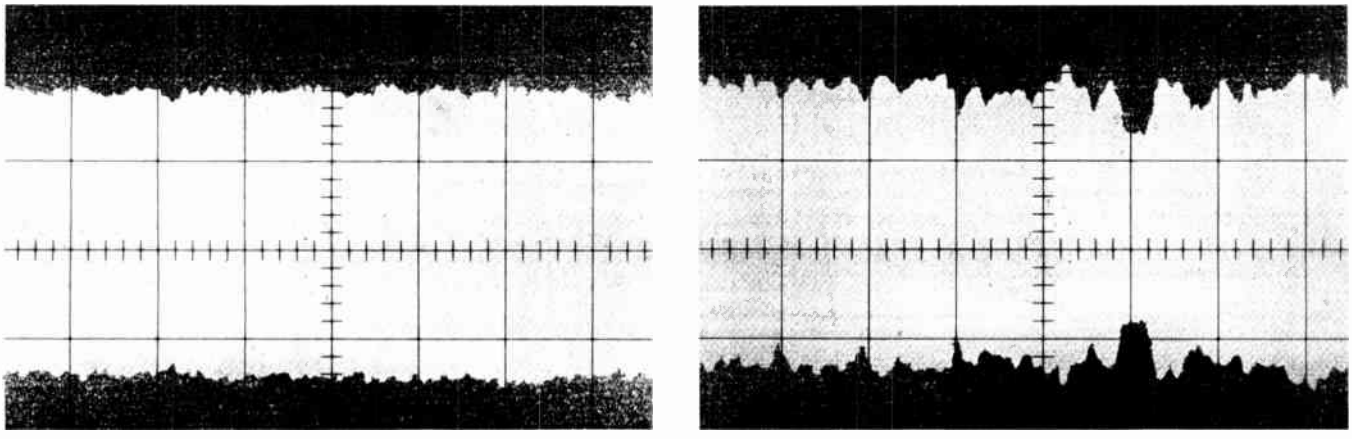


Fig. 1. Bias versus harmonic distortion at three frequencies for a high-quality iron-oxide tape.

Setting the Bias. Figure 1 (Memorex MRX_2 curves) shows the way a varying bias affects the sensitivity and distortion of a particular iron-oxide tape. The top of the figure gives the output levels obtained for recording signals of constant strength at three different frequencies. The solid curve near the bottom indicates total harmonic distortion for the 333-Hz signal. (Odd-order harmonic distortion is characteristic of tape, which means that distortion at the lower frequencies is of greatest concern. Any distortion products generated with the 10-kHz signal would all be at 30 kHz or above, and therefore inaudible.) The first thing that happens as bias increases is a precipitous drop in distortion. Then the output of the tape begins to climb—at the higher frequencies first—and so does distortion. Sensitivity nears a maximum at 333 Hz, as distortion meanwhile declines again, along with the tape's output at the higher frequencies. Ultimately an "optimum" bias point is achieved at just over −41 dB.

In this example, optimum bias occurs at a point very close to the conditions for highest output and lowest distortion at 333 Hz, but that is perhaps more by accident than design. There are other factors to consider, noise being an especially important one. Because a magnetic field obeys an inverse-square law, even a slight variation in distance between the recording-head gap and the tape can significantly affect the field strength impinging on it. And the word "slight" includes the minute surface roughness of a tape, with tiny troughs and bumps that pull and push the tape toward and away from the head face. Referring again to Figure 1, you'll note that optimum bias closely corresponds to the broad peak in the tape's sensitivity at 333 Hz. Small changes in bias strength (as would be caused by tape-surface roughness) will therefore

Fig. 2. Oscilloscope photo at left shows playback of a high frequency signal from tape with proper bias. At right is playback of same tape with improper bias. Momentary signal losses can be seen.



not affect the tape's output much at that frequency. But the 10-kHz curve's slope is quite steep at that bias value, meaning that small bias changes will produce much larger changes in output.

This is the mechanism—or one of them—responsible for drop-outs: momentary signal losses caused by tape-oxide irregularities (Fig. 2). If the tape's surface is consistently irregular and bias is not set at optimum, these drop-outs (or drops up and down) may become the steady susurrus known as modulation noise. The amplitude of the signal on the tape is then being constantly modulated by the tape's oxide-coating aberrations. Naturally, various other interesting types of distortion are also involved.

Drop-out and modulation effects are not as noticeable at 10 kHz as they are at 333 Hz, which is one good reason for biasing near the point where lower-frequency sensitivity changes least with bias. Another is that maximum low-frequency sensitivity implies that the bias field is penetrating down through the full thickness of the tape's oxide coating. (I should say that *particular* tape's oxide coating, since thicknesses vary.) Much low-frequency energy is recorded deep within the oxide layer, provided bias is also present at that depth to facilitate the process. If it is, then the full potential of the tape can theoretically be realized.

For the foregoing two reasons, optimum bias for a tape is not likely to be many decibels away from the value that yields greatest sensitivity at lower frequencies. But with that bit of wisdom, the hard-and-fast rules end. Unless you have a better-equipped lab and a fuller understanding of all the considerations involved than most, you're not going to be able to deduce much more than this about how to bias a tape properly on your own.

What are your other recourses? The tape machine's manufacturer is the first one. His service manual will give the procedure for biasing to the tape he recommends. Usually this involves recording a high-frequency tone, monitoring the playback-head output, and raising the bias to where the output peaks and then beyond, until output falls perhaps 3 or 4 dB (whatever is specified) from its maximum. Note that this is essentially a process of adjusting to a benchmark. Presumably the manufacturer has considered *all* the relevant factors in advance, chosen the best bias for the combination of his machine and his selected tape, and then provided an easy way to home in on it. He doesn't mean to imply (I trust) that a 3-dB or so falling off at 10 kHz results in optimum bias for *any* tape.

The machine's manufacturer may also have some idea of how to bias for other tapes you want to try. But if he doesn't, there's always the manufacturer of the tape himself. Unfortunately, unless you can make some sort of contact with the tape company's engineering staff, the information you get may not be particularly helpful. You might receive reams of literature on why the tape is superior without learning a bit about how to exploit its superiority. Its bias requirements could be identical to those of the tape you have been using, but you might never know. Furthermore, there are factors involving the machine itself. The way the bias field impinges on the tape depends on the configuration of the record head (or the cross-field head, if the machine has one). So another element of confusion is added to the mix.

Minimum-Noise Test. Through the good offices of the Boston Audio Society's newsletter, I recently became aware of a bias-adjusting procedure being used by dbx. It involves adjusting for minimum drop-out and modulation noise and forgetting about everything else. The rationale for this, I suppose, is that improvements in tape have rendered even distortion and frequency-response problems minor in comparison with tape noise. Also, according to dbx, the results achieved through this process typically differ only slightly from what you get with other bias-adjusting schemes.

The dbx approach goes like this. Start recording a 30-Hz steady tone on the tape and use appropriate filters to roll off the playback head's output below 400 Hz and above 4,000. Then just listen. The 30-Hz tone will be removed by the filter setup, so that all you will hear is noise—drop-out noise, which sounds like dull popcorn detonations, and hiss, which sounds more or less like the usual tape malady. Reportedly, by altering the bias, you should be able to locate a fairly precise point that minimizes both these noises. And that is optimum bias.

As soon as I could, I tried this technique on the Revox A700, starting with the 15-ips speed, since dbx advises that slower speeds are much more problematic with this test. I didn't know what recording level to use for the 30-Hz tone, so I opted for one that made the distortion and modulation effects of the tone (quite audible at low bias settings, even though the tone itself wasn't) effectively disappear at higher bias settings. Then to business, which proved even more difficult than I had expected. One of the problems was that drop-out noises are discrete and random in their occurrence, so that, as I manipulated the bias trimmer, I couldn't be sure if I had minimized them or just found a momentary quiet patch on the tape. Another was that the hiss I heard was composed both of tape and tape-machine noise, and noise from subsequent electronics in the chain (rather high gain settings were necessary for the test). Focussing in on the difference was exasperating.

At last I decided on a setting and, wonder of wonders, it turned out to be just a hair above Revox's recommended adjustment, which is essentially what dbx predicted. However, I'm not at all sure I could repeat it reliably. And when I tried the test at 7½ ips, I was utterly boggled. Even with electrostatic headphones, any decisive clues as to where the trimmer belonged simply eluded me. Perhaps my difficulties lay with the filters, which didn't precisely conform to dbx's specification. I can't say for sure until I try the test again.

Where does this leave us? For obvious reasons, I tend to favor the dbx technique whenever it proves workable. Barring that, you could try to compile the best information from tape and equipment manufacturers and attempt some kind of seat-of-the-pants interpolation. Of course, there's nothing wrong with taking a shot in the dark, aiming at the best compromise between frequency response (adjusted subsequently by EQ) and signal-to-noise ratio, for example. The point is to get results that satisfy your own special requirements, whether you be picky or easy-going. Do not, however, be over-hasty in blaming any new, highly touted tapes when their performance seems to fall short of your standards. It might just be that your machine and its recording environment fall short of *their* standards.

How to Check TAPE-HEAD ALIGNMENT At Home

By Ralph Hodges

WHEN it comes to aligning tape recorders, I favor the support-your-factory-serviceman approach. A practiced technician with a bench equipped for alignment can make short work of even a complicated machine; but an untrained amateur taking his first crack at the job is almost certain to find it tedious and outrageously time consuming. So there's no disgrace, as I see it, in saving the alignment (and other routine chores of maintenance) for a periodic factory return, where your machine can be fussed over by capable and sympathetic hands.

But how do you know *when* your recorder needs such care? And worse, once it's given, how do you know it was administered properly, or that it survived the trip back to your local freight depot, the ride home in the trunk of the car, or the fall from the coffee table that took place several days later?

Many experts suggest that, as a check on the day-to-day health of your recorder, you make and save a reference recording (a dubbing of a phonograph record, for example), and assure yourself periodically that the machine is still capable of recording the same disc with equal fidelity. This is actually a fairly sensitive test. But some people are reluctant to trust their ears that far, and others will have long since updated their phono cartridges or other components in the system, changing the reference point. Finally, the reference-recording test is not at all diagnostic; you may *hear* that something is wrong, but you won't necessarily know what. Clearly it would be good to have some additional techniques for isolating specific problems.

The alignment of a tape recorder refers to both electrical and mechanical adjustments, and these affect its frequency response (particularly *high*-frequency response), signal-to-noise ratio, distortion, and drop-out rate (drop-outs are brief signal losses caused by imperfect tape-to-head contact). Many of the adjustments are interdependent. Therefore, if you ever feel ambitious enough to make one, you may find yourself forced to make all the rest.

This is precisely what you're trying to *avoid*. So the idea behind recorder check-ups at home is to find out as much as possible about what's right and wrong with the machine without disturbing any of its adjustments too much. This is not easy, I assure you, but there are ways.

Mechanical Alignment. This refers to the orientation of the tape heads relative to the tape passing over their faces. Not only should each head be positioned properly, but, since most serious recordists' tape recorders have at least three interdependent heads (erase, record, and playback), they should all be positioned properly relative to one another. The *azimuth* adjustment—getting the record and playback head gaps precisely perpendicular to the edge of the passing tape—has been well publicized because it is critical for extended high-frequency response. However, there are other alignment factors (Fig. 1) that can affect audible performance much more. The *height* adjustment, for example, which determines how accurately the playback and erase heads line up with the tracks the record head lays down, is vital for a good signal-to-noise ratio, and can even affect the drop-out rate. The same is true of the *tilt* adjustment.

As a preliminary check on alignment, put a reel of tape on the machine and record a 1,000-Hz tone from your audio generator on both channels, watching the recorder's output on a scope. Use a fresh reel of good tape for this, since any deformation of the tape edges will grossly influence results. It's also a good idea, in this and subsequent tests, to run through the reel at least once beforehand at normal playing speed, so that the machine has had a chance to wind the tape the way it normally does on the take-up reel. Do not use a fast-wound tape for this test and watch out for any rubbing of the tape on the reel flanges.

Set the scope for a slow sweep so that you can observe the envelope of the signal rather than individual cycles. As you switch the scope from one channel to the other, small differences in level will be readily apparent, and you'll also see drop-outs as momentary gashes in the envelope. The ideal is for both channels to be equal in level and drop-out severity—an achievable goal for a half-track machine, but not always for a quarter-track recorder, which may have a consistently poorer left channel.

The level difference between the two channels should be well within one decibel. Otherwise, some electri-

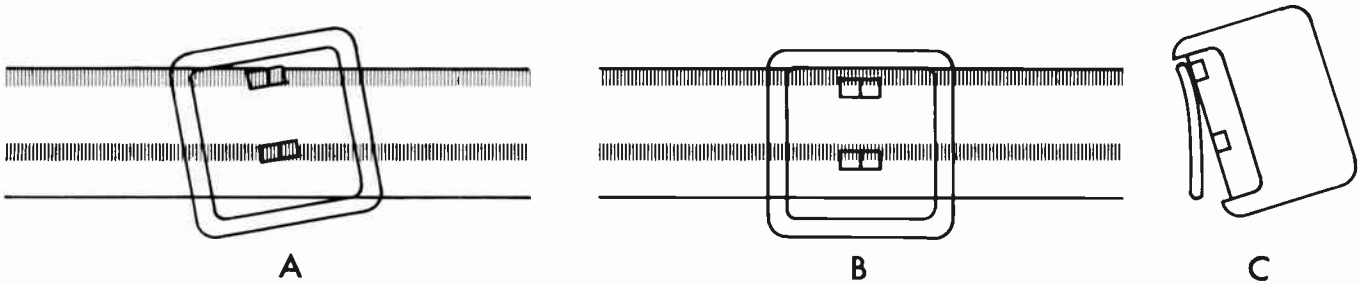


Fig. 1. An azimuth error, as indicated at (A) is a common cause of losses at the extreme high frequencies. A height error is shown at (B), with the head gaps missing the tracks somewhat. At (C) is a tilt error. All illustrations are exaggerated for clarity.

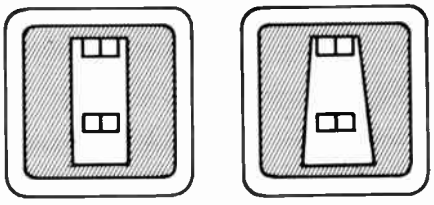


Fig. 2. A tilt error produces a trapezoidal wear pattern on the head. Correct pattern is at left.

cal portions of the machine—meters, or recording or playback electronics—are miscalibrated, or there is a tilt problem with one of the heads. If, on a quarter-track machine, the right channel is lower in level (and all other possible causes have been eliminated), the trouble is very likely tilt, which causes the top edge of the tape to press closer to a head than the bottom. A tilt error should also produce more drop-outs on the weaker channel.

A height misalignment is less likely to show up as a level difference between channels. What can happen, however, is a high drop-out rate on the left channel of a quarter-track machine, usually caused by a record or playback head that is too low (and therefore recording or playing right on the upper edge of the tape, which is the most irregular part).

The Magic Marker Test. To get an idea of the tilt situation, as well as a general picture of tape-to-head contact, try gently painting the head faces with dark-color ink from a felt-tip pen and running a few seconds worth of tape over them. Once the tape has worn away some of the ink, you'll be able to see a contact patch, which should be perfectly rectangular in shape and well centered on the head face (Fig. 2). If the patch is trapezoidal (i.e., wider at the top or bottom of the head), there is a tilt misalignment, although it may not be obvious which head is misaligned. Any head of the three can give the tape a little skew that will show up in the contact patterns of the other two. But probably the responsible head will have a patch that is larger in area. (As a general rule, you can expect patches of equal size on the record and playback heads of a properly aligned machine.)

On a brand new recorder, or an especially old one, the contact patches may be roughly rectangular, but irregular in shape or even streaky. In the new machine's case, this is caused by a slight roughness of the head faces that will disappear after a few reels of tape have polished them down. With an older machine, it may indicate severe and uneven head wear.

A tilt misalignment may be responsible for an error in height, since the tilt can bow the tape away from its proper path, or even cause it to "ride up" on the angled head surface. Conversely, if the machine was originally aligned with a tilted head, correcting the condition may cause a height error to appear. You can readily appreciate from this how head alignment tends to be an "all or nothing" task.

After you've completed the magic marker test, clean the heads according to the manufacturer's recommendations and, since it's probably not a good idea to reuse it, snip off and discard the length of tape used to develop the contact patch.

Looking at the Recording. When you suspect a height problem, the first questions is: which head is responsible, the record or playback head? About the only way you can determine this (short of buying an expensive test tape and fiddling with playback-head alignment) is to invest in the Soundcraft Magna-See kit, which costs about $7 and is not always easy to find. The main ingredient of the kit is a can of volatile (but not flammable) solvent in which is suspended a gray iron-oxide powder. Swirl a bit of recorded tape around in this fluid, let it dry, and Shazam! the recorded tracks appear in a dusty pattern on the tape surface. An alternative to the Magna-See, less messy and easier to obtain (through mail order) but more expensive, is 3M's Plastiform Magnetic Viewer Type BX-1022. With this device, the fluid is contained in a thin-wall plastic case that is placed directly on the tape surface. One drawback, according to a 3M spokesman, is that the case's seal, critically thin to ensure adequate sensitivity, must be maintained by storage in a moist environment (such as a sponge in the viewer's box). Order from 3M Industrial Electrical Products Div., P.O. Box 33365, 3M Center, St. Paul, MN 55101. Price is $24.95 plus 75 cents for postage.

For a half-track machine with both channels of the tape recorded, a height misalignment of the record head exists if the guard band between tracks is not perfectly centered on the tape (Fig. 3). A quarter-track tape, which should be recorded on both channels in both directions, shows a record-head height error when all three guard bands are not of the same width. A too-wide center guard band means the head is too low, which may actually give acceptable performance as long as the tracks don't touch or overlap. A too-narrow center band indicates a high head, which risks drop-outs of the tracks near the edge of the tape. (If your recorder is a *four-channel* machine, you'll find this test easier to interpret if you record only the two front channels, in both directions.)

So much for the record head. If it passes this test and you still suspect a height problem, you'll have to start thinking of the playback head, or possibly some misalignment of the tape guides.

Some Simple Adjustments. The only way you can learn much more about the alignment condition of your machine is to start fiddling with the head adjusting screws. This can be a tempting idea, particularly if you believe that only one head is at fault, and that fixing it might cause everything else to snap into place. Well, it doesn't always work that way. It may be, for example, that at one time the other heads were aligned to the incorrectly

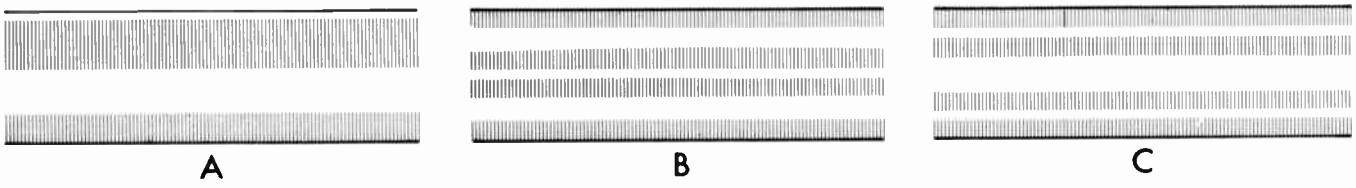


Fig. 3. A height error of the record head on a half-track machine creates an off-center guard band (A). Diagrams (B) and (C) show results of a quarter-track record head positioned too high and too low, respectively.

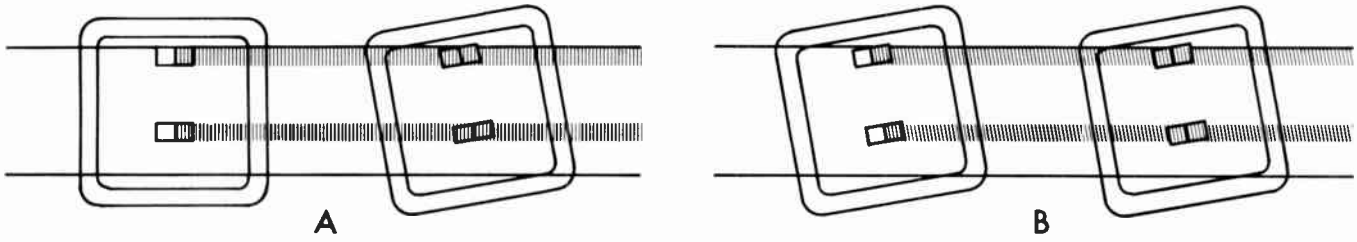


Fig. 4. Azimuth errors between record and playback heads produce high-freguency losses (A). Misalignment of both heads (B) causes no losses for tapes made on that machine.

positioned head, in which case a change in any one of them is likely to degrade the performance of the rest. Also, there's the problem of making sure that when you change one alignment factor—height, for example—you don't also change tilt or azimuth. (As far as I know there is no way to be sure of this, except by going back and checking tilt and azimuth after you've made the adjustment.) Finally, depending on the way the manufacturer has set up the machine, a readjustment of equalization or bias may be necessary.

Looking at the brighter side, however, it is true that you usually have the option of returning to the original adjustment if your attempted improvements do more harm than good—provided you have marked the original screw positions carefully! When you take off the cover to expose the heads, you'll probably find some or all of the alignment screws (protruding through the little platform on which each head is mounted) sealed with lacquer or whatever. If not, you can apply your own at this point, since the broken edges of the disturbed seal are a much better guide for returning to the starting point than a pencil mark.

Next, it's a great comfort to have on hand the recorder's service manual (frequently an expensive item), or at least some specific instructions from the manufacturer on head alignment. Sometimes the screws are readily identifiable as to their precise function, but there may be some sequence in setting them that will greatly simplify the whole business.

And now to proceed. With the simple checks described above and a few others, you're in a position to do a respectable alignment job on every parameter *except* the azimuth of the playback head. Playback azimuth must be set with a reproducer alignment test tape if it is to conform to tapes made on other, properly adjusted machines. If this is not a requirement, you can get by with a reasonable error in playback-head azimuth as long as the record head has exactly the same error (Fig. 4). But where possible, it's best to avoid touching the playback head at all, on the assumption that whatever its actual azimuth alignment, it is more accurate than you could achieve without a test tape.

In making height and tilt adjustments on the record head, you'll have to resort to the magic marker test on both the record and playback heads to make sure that what you're doing isn't adversely affecting either one. If one contact patch changes appreciably in size relative to the other, it means that one head is beginning to lose contact with the tape. Shifting the entire record head closer to or farther away from the tape will usually serve to equalize things again.

You'll also have to keep constant tabs on the playback head, making sure that what you do to the record head does not diminish its output (indicating that the tracks laid down by the record head are beginning to miss the playback-head gaps). To do this you must have tape running through the machine virtually at all times, and being recorded with a steady 1000-Hz tone. Monitoring the playback-head output on a scope or meter will alert you to any loss of level (an *increase* in level is a good sign, provided it takes place in both channels). There will be a short delay before any adjustment you make on the record head shows up in the playback-head output, and you'll simply have to get used to that. On the other hand, if the playback-head gaps are significantly longer than the width of the recorded tracks, you may be able to make minor height adjustments on the record head without observing any changes in playback level.

Assuming you can get the height and tilt of the record head squared away without introducing further problems, you can go on to matching the record head's azimuth to the playback head. For a test signal, I just use the audio generator to drive the record head, running it up in frequency until the playback-head output begins to drop. Then I tweak the record-head alignment to see if I can raise the output level at that point. (Note that the results may well be different for the two channels, necessitating an intermediate setting.) Usually I use the 7½-ips tape speed, although the other speeds should work as well on most machines. (The one exception I can think of had its response electronically rolled off above 20 kHz. Since the heads were presumably capable of going beyond that at 7½ ips, I probably would have chosen a slower tape speed to make sure I was seeing the effects of head alignment and not electronic filtering.) However, be sure to keep the recording level for the test tone down to -20 dB or lower. Otherwise, high-frequency tape losses are likely to occur at most speeds.

I've saved the erase head for last because it's easy. Azimuth doesn't really matter, and tilt can be handled through the magic marker test. The height adjustment is best accomplished by running a previously recorded tape with the machine in the record mode (record-level controls at minimum and no input signal being fed to the machine) and going for minimum playback output.

The Last Word. So it is possible to perform a good deal of recorder alignment with a minimum of specialized equipment. This is not to say, however, that all these tests will give you nice, neat, unambiguous results, or that you'll find satisfaction in devoting to them the time they require. Those seeking the last word in tape performance regularly go to greater lengths, and are often rewarded by audibly improved performance. For others, these tests can serve as indicators of something wrong.

TAPE Q&A

Answers to a selection of the most common tape-recording questions from Stereo Review readers

By Larry Klein

Cassette-deck Tape Switch

Q. *Please tell me, once and for all, whether it is okay to use the chromium-dioxide switch on a cassette deck for low-noise/high-output, superdynamic, or extra-dynamic tapes. The manual for my cassette deck says it's okay, but I read elsewhere that it should not be done.*

A. This letter has a note of desperation in it that is hard to understand. As with many other questions that come to me, the answer is: try it and see what happens. If some brands or types of cassettes sound better (in respect to noise, frequency response, sensitivity to overload, or output level) with the switch in one position rather than the other, then that's the position to use, no?

Adding a Tape Machine

Q. *I'm considering adding a tape machine to my system, but can't make up my mind whether to go cartridge, cassette, or open-reel. Can you spell out the relative advantages of each system?*

A. Briefly, choose open-reel if you are interested in editing the tape and monitoring while recording. The open-reel format also provides the lowest distortion, the best frequency response, the lowest wow, and the lowest noise levels, and it is much less likely to distort high-frequency signal peaks. Cassettes, on the other hand, have the virtues of compactness, convenience, and a performance level (in the top-quality machines) that will satisfy all but the most critical listeners. Off-the-tape monitoring *is* available with cassettes, but only in the very expensive decks.

Theoretically, eight-track cartridges *could* provide somewhat better performance than cassettes simply because they operate at 3¾ ips (twice the speed of the cassette). There are a few quality eight-track record/playback decks available that are designed for connection to a home audio system and will turn out tapes that are far superior to the commercial prerecorded product. But, in general, they have the same deficiencies as the cassette units when compared to open-reel machines. Prerecorded eight-track cartridges played at home—rather than in a car—have a hiss level that makes them unacceptable for critical listeners (road noise masks the hiss in automotive applications). I find the prerecorded cassettes marginally better in this regard. Although the commercial prerecorded releases of *both* formats usually suffer from a lack of high frequencies, there are some hopeful signs that things are getting better (see "Dolbyized Highs" below). Open-reel prerecorded tapes have slowly improved over the years, but to my ears they don't sound sufficiently superior to the best discs to justify their extra cost—there are also considerably fewer of them. And prerecorded tapes in *any* format certainly don't provide the easy location of selections that discs do.

Tape-recording Level

Q. *I have a high-quality machine that I use mostly for recording off the air. I have found that if I record with VU-meter readings of +2 or +3 on peaks, I get much less hiss than when I set for 0 level on peaks as recommended in the instruction booklet. I have been told, however, that when I go over 0 VU my recorder is distorting. On playback, my tapes sound perfectly fine. Am I recording distortion that I can't hear?*

A. You can be quite sure that you *are* recording distortion that you can't hear, since every time anyone tapes anything some distortion of the original material takes place. A good pragmatic test of permissible distortion is annoyance value. If your tapes sound fine to you and others when played on a variety of machines, then there is no point in suffering an audible loss of signal-to-noise ratio in order to minimize *in*audible distortion. Perhaps the manufacturer was conservative in establishing his 0-VU reference point, or it may be that the VU meters in your unit are out of calibration. In any case, some experimentation will tell you the VU levels your machine will take before the recording starts to "break up." Remember that the higher frequencies tend to distort before the lows, and that cassettes have less "headroom" before audible distortion occurs than open-reel units. In addition, some tape formulations will take more signal before overload than others. This too will determine the effective 0-VU reference point for your specific machine.

Cassette Drag

Q. *A few of my many cassette tapes get draggy in spots—I guess you could call it wow, except that it doesn't happen regularly and is far worse than anything I have heard on records or open-reel tapes. I own an expensive portable player. Is there any cure?*

A. We first have to determine whether the fault lies with the cassette itself, the machine on (or is it "in"?) which it is being played—or both. Since only a few of the cassettes suffer from speed irregularity, let us assume that the major part of the blame lies with them.

The better late-model cassette portables have electronic regulators built into their motor circuits that will maintain correct speed even when the battery voltage falls somewhat. However, when the batteries grow too weak, then the motor torque becomes inadequate, and any greater-than-normal frictional drag inside the cassette will tend to cause wow. In every case, the longer-length cassettes (C90's or 120's) will be more of a problem for a marginal drive mechanism to handle than the shorter lengths will. But, assuming that your battery voltage *and* the speed-regulation circuit in your machine are okay (and that there are no other mechanical slippage problems in the transport, such as are caused by glazed or oxide-coated rubber parts), the cassette itself is suspect.

I assume that you are using standard-brand, good-quality cassettes such as are advertised in the pages of the hi-fi magazines. Aside from the superior quality of the tape they contain, one of the big differences between the cheapies and the recognized standard brands is in their mechanical assemblies. It is obvious that irregularities in the tape path, in the operation of the internal guides, or in the hub area will offer enough resistance to tape flow to cause drag. Sometimes these problems occur even with good-quality cassettes because the tape has been shuttled back and forth with numerous stops and starts. This tends to cause pile-ups and tensions in the tape pack. If you look at the tape pack through the center window during play and it seems to be wobbling, bumping, or jerking, this may be the problem. It is sometimes helpful to slap the flat side of the tape cassette several times against a flat surface (but not hard enough to crack the case!) to loosen up the tape layers that may be binding. Then a run-through at normal playing speed may put things right.

Another procedure that is sometimes helpful is to add a spot of lubrication to the tape *hubs*. A silicone lubricant (available in either spray can or liquid dispenser) would be best. Be *very* careful to keep the silicone away from the tape itself, because if it gets on the tape and is subsequently transferred to the pressure roller, speed irregularities will almost surely develop because of slippage at the drive capstan. If you have a spray can, spray a bit of the fluid into a small container, extract a couple of drops with a toothpick and apply them *sparingly* to both sides of both tape hubs in the area where they touch the shell. Tape drag is frequently caused by an accumulation of several factors, and, to be effective, a

trouble-shooting procedure must take them all into account.

Record/Tape Overload

Q. *When I dub some of my records onto tape, my cassette unit acts very peculiarly. I get a sort of harshly distorted break-up in the sound perhaps once a second or so. This happens only with some records, and when I listen to those discs during dubbing or later they sound fine. What is wrong?*

A. The records you are trying to dub are probably warped sufficiently to cause severe vertical deflection of your phono stylus. The stylus deflection produces a very low frequency, high-amplitude signal that appears at the tape-output jacks of your amplifier and overloads (overdrives) the tape and/or your cassette decks' electronics. The reason the records sound okay when played through your system is that either the warp "signal" is handled without overload by the non-tape components in your setup or it undergoes normal subsonic attenuation (in the circuits *after* the tape-output jack) before it can cause trouble. You can check this hypothesis simply enough by watching the distorting discs while they are playing and noting whether the stylus is pushed back toward the cartridge body by the record warps and whether these warps coincide with the overload distortion.

New Sound from Old Tape

Q. *I recently came across a tape I had made many years ago using a Pentron machine and—would you believe—black-oxide paper-based tape. I wasn't even sure that the tape would play, but when I tried it on my new $600 recorder, I was startled by the high quality of the reproduction. In fact I'm sure the sound was far better than that heard originally from the tape. Do tapes, like wine, improve with age? Was 1959 a vintage year for oxide?*

A. I'm tempted to reply "Yes, but only if it can be proved that the oxide came from certain shafts in the Minnesota Mines." Although your tape *hasn't* improved as it aged, playback heads have certainly gotten better over the years. Recording heads, which do not require the ultra-narrow gaps of playback heads, have improved also—but mostly in the areas of better overload margin. A tape made with yesteryear's recording head would not therefore be that much inferior to one made with one of today's good heads. In other words, the old recording heads could put high frequencies on the tape that the old playback heads (because of their wide gaps) could not pick up. The new narrow-gap heads *can* recover the highs, and therefore your tape probably does sound better than it did in its youth, but only because it is being played by a machine with an improved playback head.

DIN Tape-jack Sensitivity

Q. *The test reports on various products with DIN connectors usually state that they are paralleled with the normal phono-jack connectors. However, when I attempted to use its DIN socket input, my tape recorder overloaded and distorted severely. What happened?*

A. The input pins of the DIN socket in some tape recorders are connected in parallel with the *microphone* jacks rather than the high-level "line" or "aux" inputs. Feeding a high-level signal of 0.5 volt into a mike input designed to accept perhaps a 0.005-volt signal is going to produce just what you got—severe overload distortion. So, either you'll have to rewire the DIN socket on your recorder or install some signal-attenuating resistors at the plug to reduce the tape-output signal voltage from your preamplifier to a suitable level. The exact values of the resistors will have to be determined by trial and error, or possibly your recorder manufacturer may have some recommendations. This strange state of affairs comes about because many DIN inputs have been designed to accommodate the very low signal levels provided by some European equipment.

Dolbyized Highs

Q. *I don't understand why you keep plugging the Dolby system in your column. The prerecorded cassettes I have been buying lately, which are marked (sometimes in very small print) as being mastered to the Dolby B standard, have highs only when the Dolby circuit is switched* off. *As soon as I switch in my deck's Dolby circuit the highs disappear. I think I would rather have the highs* and *the hiss than neither.*

A. I have had the same experience, but I interpret it differently. Most of the cassette duplicators in the United States, for one reason or another (mostly lack of care and/or inadequate equipment), don't record the higher frequencies on their prerecorded cassette products. Since the Dolby encoding process boosts the low-level high frequencies, when you play Dolbyized tapes without decoding them they sound somewhat brighter than non-Dolbyized tapes. However, when you flip the Dolby decoding switch, the extra boost is removed—as it should be—along with 5 or 6 db of hiss, and you are left with a tape that is reasonably hiss-free but then lacks the highs that were lost in the duplication process. It is obvious that the problem lies *not* with Dolby processing per se, but rather with the duplicators who, by and large, are doing such a rotten job.

Studio Sound Proofing

Q. *I would like to make live recordings in my home and need to build a soundproof area, both to keep from bothering my parents and to provide myself a distraction-free and acoustically correct place to work. Where can I obtain plans for building one or any information about them in general?*

A. There is a confusion in most people's minds between sound proofing and sound treatment. Most of the techniques used for sound treatment (that is, adjusting the acoustics of an area) are *not* suitable for sound *proofing* (preventing noise originating inside the room from getting out—or noise from outside getting in).

Let's look at sound proofing first. Think of sound as vibrations of (not in, *of*) the air which impinge on surfaces and cause them to vibrate. Therefore, to keep sound out—or in—one has to make sure that all possible pathways of vibration from one area to another are eliminated. First of all, this means that all *air* transmission paths must be totally blocked. This includes ventilation ducts, seams around door edges, etc. Measurements have shown that even small air leaks can defeat an otherwise effective approach.

Once the air-borne sound paths are eliminated—and that isn't always easy—then you have to minimize the vibrations in solids that also serve to carry sound from one area to another. One very effective technique is to increase the mass of the solids forming the transmission path. For example, you can use heavy wall panels instead of thin ones and/or you can brace the panels with 2 x 4 studs at more frequent intervals than is usual in normal construction practice. Or, instead of studs and panels, you can use brick, concrete, cinder blocks, etc., all of which are excellent acoustic barriers.

Another isolating technique is to build up a wall or a door using sandwiched layers of different types of material to take advantage of the fact that vibration tends to be "de-coupled" when traversing the interfaces of disparate substances. But it must be noted that even the screws or nails used to hold such an assemblage together can provide a transmission path. The mastic material commonly used to mount ceiling tiles is therefore preferred in this sort of application. The double glass windows (with spaces of 3 inches or more in between) used in the control rooms of recording studios also function on this principle. Another example: I recently sound-insulated a glass-paned door by using a layer of 1-inch glass-fiber wool pressed against the panes by a ¾-inch panel of dense Homasote wall board screwed to the door. (Foam rubber would have done as well as the glass fiber.) The door treatment actually represents a dual approach to the problem in that the compressed fiberglass damped the glass vibration, and the Homasote panel (which is relatively inert because of its softness and mass) served as a sound barrier. The door edges were also lined with adhesive-backed foam tape to inhibit the transmission of air-borne sound.

Now we come to the question of sound treatment—which is another ball game altogether. The two areas do overlap somewhat, in that a very reverberant room (highly reflective or hard surfaced) is going to be "noisier" internally and hence will tend to emphasize any noise that gets in from the outside. I have found that, for best music reproduction (and even best voice intelligibility), a room should tend toward "softness" acoustically—though, if it is *too* soft, much of the "live" quality will be lost in your recordings.

Through practice and training I can judge fairly well by ear how a room is affecting the sound in it. But I have not been able, unfortunately, to come up with an easy formula or test that will enable John Q. Audiophile to tell whether his room is "right" for music reproduction—or production. One very rough test of a room's acoustic qualities is to clap your hands, once and sharply, and listen carefully. In an anechoic chamber, the total lack of sound reflection will cause a handclap to have a dull "thud" rather than a "snap" quality. Conversely, a loud handclap in a reverberant test chamber will have a bright "bwan-n-g" quality and may take a second or so to die down. Is it helpful to say that an acoustically "good" room should be somewhere between these two extremes? I find that a room with a barely perceptible "bwan-n-g" to it seems just right, but I'm sure that taste is a factor here. In any case, heavy carpeting, wall hangings, heavy drapes, upholstered furniture, etc. can be used to damp high-frequency reverberation, and their absence will encourage it.

CHOOSING PORTABLE & MOBILE TAPE RECORDERS

Buying considerations for battery-operated tape machines.

By James R. Horstman

TAPE enthusiasts were truly freed from the tyranny of the a. c. wall socket about ten years ago when 8-track cartridge and cassette tapes and machines were introduced. It was the beginning of tape recording for an on-the-move generation.

Several developments in the mid-sixties spurred the portable and auto tape revolution: (1) transistorized design for smaller and lighter machines; (2) new batteries featuring longer life, smaller size, and recharging capability; (3) new raw tape formulations that improved fidelity; (4) prerecorded libraries; (5) and, in the case of battery-powered portables, built-in condenser (electret) microphones. As a result, the old portable rim-drive, open-reel tape machines quickly disappeared.

CASSETTE VS CARTRIDGE

The cassette and cartridge tape formats have grown and prospered side by side, each boasting its own unique advantages.

The cassette is actually a small, reel-to-reel tape housed in a self-contained plastic shell that measures only 4" long × 2½" high × 7/16" thick. Like open-reel tapes, with separate supply and feed reels, it may be rewound or turned over to play other tracks. When the loaded cassette machine is activated, a small pinch roller moves the tape smoothly at 1⅞ ips. Tape measures about ⅛" wide and is available in 20-minute to 120-minute play- or record-time formats.

The tape cartridge, on the other hand, is much different. Its tape is wound in a continuous loop that's fed from the center of a single reel and rewound on the outside of that same reel, permitting continuous play. When it reaches the end of one revolution, the playback head moves over a notch (manually or automatically) to play the next track. In stereo, this head-moving process occurs four times, while in 4-channel it's done twice. Compared to a cassette, a cartridge is bulky, being four times its size. Tape speed is 3¾ ips and tape width is ¼", which, theoretically should make the cartridge superior to the cassette in terms of potential hi-fi reproduction. Further, each tape cartridge contains its own pinch roller (which most experts feel is *not* an advantage).

Theory aside, however, the cassette system generally provides better fidelity. This is due, in part, to the special tape formulations available for cassettes. Additionally, the 8-track cartridge drive and head alignment systems are inherently less precise than a cassette's. But these differences are less noticeable in portables and auto units since Dolby noise-reduction circuitry, dual capstans, etc., are rarely incorporated in these cassette machines.

As a result, choice of format generally involves considerations other than high-fidelity sound. For example, if one were to choose a battery-powered portable, it's likely that the choice would be a cassette. Due to its much smaller size and lighter weight, it has essentially eliminated cartridges from this market. Further, cassettes can be rewound and have a fast-forward speed, making it much easier (and faster) to locate specific recorded sections on the tape. Additionally, most 8-track machines do not offer record facilities, while most cartridge machines do.

Selecting a car tape format, however, is an entire-

Craig Model 2625 ultra-miniature cassette recorder with built-in condenser mike, speaker, rechargeable battery pack.

ly different story. Here 8-track cartridges got the jump on cassettes when Lear Jet teamed up with RCA and Ford before Philips got up steam with its cassette format. Actually, the earlier introduction of the present 8-track format as an option in an automobile, coupled with RCA's release of prerecorded tapes of current "hits," virtually eliminated other systems vying for the customer's dollar. These were Fidelipak's 4-track cartridge and Orrtronics' 8-track cartridge, neither of which was compatible with Bill Lear's brainchild.

Aside from the auto tape lead enjoyed by 8-track (40% of Thunderbirds sold in 1966 were said to be equipped with this option), the no-fumble convenience of simply pushing a cartridge into a slot while driving and listening to commercial-free music played continuously attracted many people. It still does, thanks to the availability of a large library of prerecorded tapes and the easy transition from stereo to 4-channel sound made possible by the 8-track cartridge system. The latter is something cassette manufacturers are still struggling with. Moreover, fidelity in an auto environment is not as important as in the quiet of one's home.

Cassettes *are* challenging the 8-track machine in automobiles, though. Compact size is one reason. Another is the ability to locate portions of a recording very quickly. And, equally important, if a person owns a home cassette deck, the recording facility and interchangeability permits a cassette to do double duty.

Recently, however, 8-track home cartridge machines have demonstrated improvements in fidelity, more home cartridge recording machines are available (but it's a chore compared to cassette recording and many machines record a "clunk" when changing tracks), and the prerecorded library continues to grow like Topsy. (RCA, for example, releases 65 8-track tapes and about 15 cassettes for every 100 disc titles.)

Cassette auto machines haven't stood still, though. There are some auto-reversing cassettes now and the quadraphonics sound barrier will probably be broken one day (talk is that BASF is toying with an SQ-encoded prerecorded cassette to bypass Philips' objections to changing the direction format of the present-day cassette).

SHOPPING FOR PORTABLES

The way to start shopping for tape portables is to sit down with paper and pencil and assess the quantity and quality of portability you will require. Very often, these two go together, as extra dollars add desirable features you'll find you cannot do without.

Chances are that you'll opt for a battery-powered cassette unit, since there aren't many cartridge machines around. (One company, however, recently introduced a colorful portable cartridge player at $39.95, so fun-type cartridge machines are available; nonetheless, portable cartridge machines are a rare breed due to large size and absence of a record facility.) Most portable cassette machines are monophonic types, which is just as well since you wouldn't want to pack an extra speaker wherever you go. However, if you're willing to sacrifice small size and light weight, there are a handful of a.c.-d.c. portable cassette machines that record and play back in mono or stereo. Some do feature two built-in speakers and two microphones for stereo use.

You can purchase a portable cassette machine for $25 or one for $300. Costlier models offer a host of extra features you might want to check out. Here are some examples:

☐A.c. and d.c. operation to save batteries.
☐Built-in battery charger to charge batteries automatically when plugged into an a.c. outlet.
☐Larger speaker(s) for a more robust sound.
☐Automatic shutoff with mechanism disengage when tape play is ended.
☐Automatic level control to maintain relatively constant sound recording level. so that the recordist need not continually monitor a volume control.
☐Large VU/battery indicator for easy viewing.
☐Tone control to adjust playback to your liking.
☐Tape counter to permit quick location of a recorded portion of your tape.
☐Tape select switch to give you the flexibility of using premium tapes.

Clarion's 888 under-dash 8-track player.

☐Speedier fast-forward and rewind time for impatient users.
☐Dual flywheels for reduced wow and flutter.
☐Servo-control motor to maintain accurate speed when batteries weaken.
☐Interlocking pause control for stable recording speed when starting and stopping.
☐Remote microphone provisions to free you from the machine.
☐Variable pitch control for the critical music lover.
☐Peak limiter to automatically prevent distortion from overloading.
☐Subminiature size for handy carrying.
☐Stereo provisions.
☐More powerful amplifier(s).
☐Automatic voice activator so you don't miss a thing.

Clearly, there will have to be tradeoffs. Each "extra" chosen adds to the cost, weight, and/or size. The latter is sometimes offset by superb miniaturization with rugged construction, but the tradeoff here is higher cost.

How does one "test" a portable? There are a number of guidelines. ● Handle it to judge weight and size. ● Play cassette tapes that you've heard on a high-quality cassette deck (preferably a tape with plenty of highs and lows, and one with a solo piano recording). ● Record a tape for playback at home. ● Record a few minutes on a C-120 (two-hour) tape, which is ultra thin, to judge tape-handling quality. ● Jingle keys so you can determine recording and playback realism. ● Speak at the same level at different distances and with your back turned to evaluate how much the voice is obscured by the machine's noise (you'll be surprised at the substantial differences among machines). ● Try the push-buttons to be sure they're conveniently located and

Pioneer's KP-345 auto-reverse cassette player.

don't stick. ● Attach an external, high-efficiency speaker system to the portable's external speaker jack.

Above all, don't lose sight of your quest for *portability*. After all, you don't want to be a furniture mover every time you wish to take along your portable. But, if you're willing to accept greater size and weight, you might also consider a combination cassette/AM-FM receiver unit.

SHOPPING FOR AUTO TAPE PLAYERS

A major reason for the popularity of the automobile tape player is that even a relatively inexpensive system sounds better in the car than at home. The closed environment and masking of fidelity limitations by external noise (engine, wind, tires, etc.) makes listening a rewarding experience. The choice of music is yours, not the disc jockey's nor the broadcast station's advertising department. Equally important, there isn't much to distract you in the car.

You'll have to make a choice between 8-track cartridge and cassette machines. As discussed earlier, 8-track offers many more prerecorded selections, largely non-classical. The cartridges are bulkier, though, and it's difficult to locate portions of a recording with dispatch. However, they play continuously, so a cartridge doesn't stop when the recording ends, but continues 'round and 'round. When driving, this no-handling facility is advantageous. Consider, too, that 8-track offers 4-channel sound, which provides a unique sound sensation, especially in an auto environment.

The favorable attributes of cassette machines can be recapitulated as: smaller machine, which makes for easier car installation; smaller tape package so you can store more cassettes in a small space; fast-forward and rewind facility; and a convenient recording facility (at home). So take your choice.

8-TRACK PLAYERS

Features you may want to consider in 8-track machines are fast-forward operation, track indicators, bass boost, automatic track switching, and, for under-dash and floor-mount models, a built-in burglar alarm. Models with automatic play-through often feature a manual override switch so you can select channels if you wish.

Cartridge players, too, have been mated with AM-FM stereo radios, available for about $100 and up. Miniaturization and clever design have reduced the size of even these multi-mode machines so they can be mounted in the dashboard.

Despite the difficulty of recording 8-track at home, self-programming is not unusual. Tape manufacturers report that sales of blank cartridges are booming, especially in the longer lengths. Both Capitol and Columbia have 100-minute lengths on the market now (that's four 25-minute stereo tracks, about the length of four long-play albums, or two 25-minute four-channel tracks for a total of 50 minutes). And a 120-minute cartridge is expected to bow later this spring. Remember, however, that you'll

need another machine to do your recording on—either part of your home system, or one of the rare record/playback portable units.

Since 8-track is bulkier than its cassette counterpart this probably accounts for the fact that under-dash installations outnumber in-dash by about 3 to 1. A few units are readily adapted for installation under the seat or in the glove compartment, but the potential dangers of dirt and grime in the first case and summer heat in the second should be obvious.

Creation of the in-dash unit was prompted by the heavy theft rate of the past few years that made most 8-track models uninsurable. Dashboard installations have pretty much solved this problem, but at the expense of permanence—if you sell the car, chances are the cartridge player will have to go with it. Several snap-out models are available now which offer a nice compromise. When you're not using the car, simply take the entire unit out and store it indoors or in the trunk.

CASSETTE PLAYERS

Cassette car players are small enough to be mounted in the dashboard where the car radio goes or in the glove compartment—both major deterrents to theft—although many are still mounted under the dash. Whichever position you choose, practice loading the unit a few times before you try it on the road. With a glove-compartment mount, of course, you'll have to pull over to the side of the road to change tape.

If you have a cassette deck at home, you can get more from your mobile unit by making your own recordings. You can save money, too, since prerecorded tapes are costlier than discs by one or two dollars. Furthermore, a high-quality cassette deck and good source equipment and material can supply you with better-quality home recordings than you can buy (an exception here is the new, premium Advent prerecorded cassettes made on chromium-dioxide tape, and wholly in the classical field at this time).

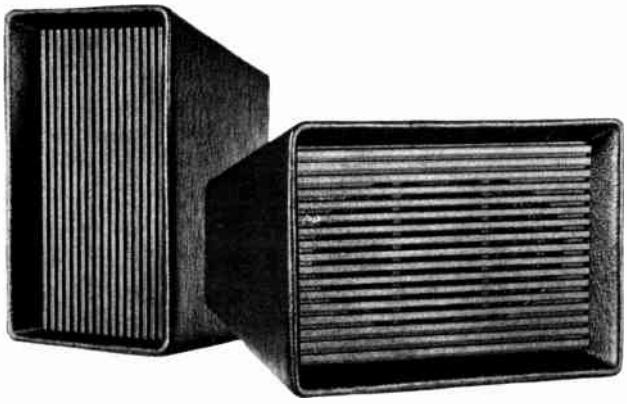
An increasingly popular option in car cassette units is a built-in AM-FM stereo radio, which gives the driver four program options. Many of these models have a clever "custom" look in which the radio tuning dial also serves as the cassette slot. Some are wired to record directly off the air (usually in mono, although the unit will play back in stereo), while others even have a hand-held microphone so you can dictate while you drive.

Other features to look for in an auto cassette machine (remembering they add to the cost) are: fast-forward and rewind, automatic reverse, multi-band radio, automatic stop and/or reject, and signal-seeking on the radio.

SPEAKER INSTALLATION

Installing speakers and positioning them properly generally presents a severe challenge to the do-it-yourselfer. Probably most people should turn the job over to a specialist, such as an auto dealer or auto radio/tape player installation outfit.

A popular speaker-mounting location is in the front doors. There are also kick-panel installations in case the thought of cutting into doors upsets you. The latter technique is less expensive to do, too. Under-dash installation of speakers is another possibility, but the overall stereo or quadraphonic effect is reduced considerably. As for rear speakers, you have a choice of rear doors, trunk ledge, or external speakers. You'll have to find the combination that pleases you, based on the interior configuration of your car.



Utah's SA53 mini stereo speakers (6" W × 3¾" D).

CONCLUSION

Before finalizing your buying decision—whether a portable or mobile tape machine in the cassette or 8-track format—listen to a unit a "price point" higher and lower to determine if you can hear the difference. Consider, too, whether or not your choice is a well-known brand, the reputation of the dealer, and what you have to do to obtain in-warranty and out-of-warranty repair. The latter is especially important with auto players since there is a removal/installation chore involved.

Don't expect to match the high-quality sound of your home hi-fi system in portables or mobile equipment—they rarely exceed 10,000 Hz response and are often well under that. But experienced travelers feel that fairly good mobile sound is every bit as rewarding as great sound that just sits there.

So whether your preference is for rock or Bach, boating or camping, or driving through the countryside this summer, there is no reason why your kind of music shouldn't be at your fingertips. Just slide in a cassette or cartridge and let the music roll. □

TAPE EQUIPMENT TEST REPORTS FROM HIRSCH-HOUCK LABORATORIES

Detailed test reports on tape machines and allied tape products from the most widely respected equipment reviewers in the field of high fidelity.

OPEN-REEL DECKS

HIRSCH-HOUCK LABS REPORT

Dokorder Model 7140 Four-Channel Tape Deck

● THE Dokorder Model 7140 tape deck has a host of features formerly available only on much more expensive machines. For example, it can record and play back simultaneously on either two channels or four channels, at speeds of 3¾ or 7½ ips. It has "Multi-Sync," which is Dokorder's term for multiple-track synchronization—any of the four tracks of the recording head can be switched to function in the playback mode while a recording is made simultaneously on any or all of the other tracks. This permits each track to be recorded separately (and at different times) while keeping all tracks perfectly synchronized with each other.

The microphone and line inputs for each of the four channels can be mixed with their separate, but concentric, gain controls. The four playback-level controls are also two concentric pairs. On the lower edge of the front panel are four

standard microphone phone jacks and two stereo headphone jacks (for front and rear channels). Above them are four meters that indicate both recording and playback levels. Tape monitoring is controlled by four pushbuttons that connect each of the recorder's four outputs to either the source or to the playback amplifier output for that channel. A fifth button shuts off the rear channels for two-channel stereo operation. Nearby are a small slide switch and level control for the special effects (sound-on-sound and echo), with the level of the signal fed from one channel to the other controlled by the SOS/Echo knob.

The three-motor transport has a hysteresis-synchronous capstan motor and is fully solenoid controlled. Toggle switches control power, tape speed, and the pause function, and there is a four-digit index counter. A two-position Tape Selector optimizes the recording bias for Normal and Special tapes. Individual pushbuttons (with indicator lights) can be used to place any or all channels in the recording mode (when the Rec button is pressed on the tape-transport control). The transport controls are mechanically latched pushbuttons which require an appreciable operating force. Above them are the four Multi-Sync levers. The tape transport has tensioning levers which provide an automatic shut-off action. The head assembly plugs in as a unit for each replacement.

The Dokorder Model 7140, with the wooden side panels supplied, is 16⅞ inches wide, 17¾ inches high, and 6¾ inches deep; it weighs 41 pounds. Although operation is claimed to be possible with either vertical or horizontal mounting, there are no mounting feet on the back panel and ventilation would probably be impaired in a horizontal position. Price: $629.95 (an optional dust cover is available for $23.00).

● *Laboratory Measurements.* Over the range of the Ampex NAB test tapes, the playback frequency response at 7½ ips was ±2 dB from 50 to 15,000 Hz, and at 3¾ ips it was ±1.25 dB from 50 to 7500 Hz. Record-playback response measurements were made with Maxell UD35 tape, using the Special bias setting. At 3¾ ips, the overall response was ±1.5 dB from 40 to 16,000 Hz. At 7½ ips, it was ±2 dB from 45 to 25,000 Hz. The low-frequency response fell off quite rapidly at 7½ ips, and less rapidly at 3¾ ips. All four channels had essentially the same frequency-response characteristics. We were able to measure only a very small difference between the two settings of the Tape Selector switch. However, the high-frequency response and overall output level was substantially better with the UD35 tape than with 3M 203, suggesting that the machine is set up to perform best with low-noise/high-output tapes.

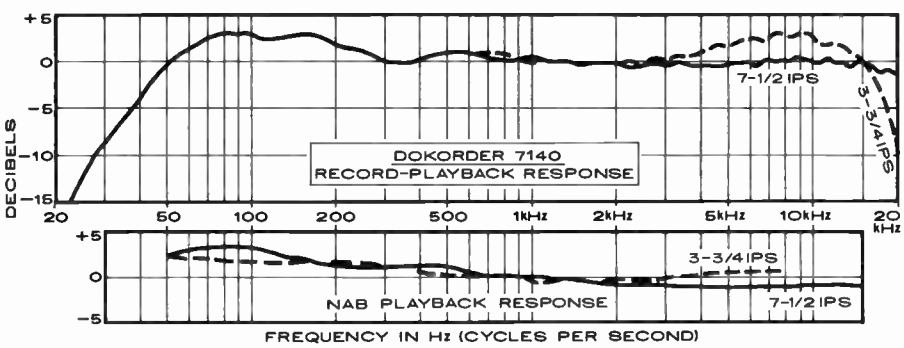
A line input of 60 millivolts (mV) or a microphone input of 0.7 mV produced a 0-dB recording level, which played back with an output of 0.65 volt. The 3 per cent reference distortion level was reached at +7 and +8 dB at 3¾ ips and 7½ ips, respectively. The unweighted signal-to-noise ratio (S/N) referred to this level was 55.7 dB at 3¾ ips and 59.5 dB at 7½ ips. Using the IEC standard weighting for better subjective correlation, the S/N measurements improved to 62 and 66 dB. Through the microphone inputs at the maximum gain setting, the noise increased only 1.5 dB. Crosstalk between the four channels, at 1000 Hz, was −43 to −46 dB.

The tape speeds were correct for both 7½- and 3¾-ips operation. Combined wow and flutter (with an unweighted r.m.s. measurement) was 0.1 per cent at 3¾ ips and 0.09 per cent at 7½ ips. In fast-forward and rewind, 1800 feet of tape was handled in 84 seconds. Headphone volume was good, tested with both 8-ohm and 200-ohm phones. The meter ballistics were somewhat slow compared to true VU meters, so that they read about half their steady-state value when driven with 0.3-second (300-millisecond) tone bursts.

● *Comment.* During our testing, every one of the Dokorder's many controls, modes, and features worked perfectly. Despite its rather imposing appearance, it is a very easy and "un-fussy" machine to operate. As can be inferred from the test results, its sound is first rate. The tape-overload margin is considerable, when referred to the meter's 0-dB indication, so that the recording-level settings are not at all critical. Its other characteristics, including S/N, flutter, and speed accuracy, come close to meeting the highest professional standards, and are certainly adequate for the critical home recordist for whom this machine is intended.

Listening to FM interstation hiss recorded and played back through the Model 7140, we could hear a moderate low- to mid-frequency coloration, apparently caused by a slight emphasis in response below 200 Hz. The highs were perfect at 7½ ips, and were reduced by a barely detectable amount at 3¾ ips. Needless to say, FM music broadcasts were recorded and played back with complete fidelity.

We enjoyed experimenting with the Multi-Sync feature. For anyone interested in doing live demo rock tapes, a track-synchronizing machine has become something of a must. Although it lacks some of the glitter and operational refinements of some other more expensive recorders, the Dokorder Model 7140 nevertheless manages to deliver more honest performance and total versatility than we have seen in any other comparably priced machine. At its current price, especially if you are interested in track-synced live recording, it is an outstanding value. □



Record/playback response of the Dokorder 7140 (top) using Maxell UD35 tape; (bottom) playback response with the Ampex NAB test tapes.

HIRSCH-HOUCK LABS REPORT

Pioneer Model RT-1011L Stereo Tape Recorder

● THE U.S. Pioneer Electronics' Model RT-1011L stereo tape recorder features three motors, three heads, solenoid-operated transport, and 7½ and 3¾ ips operating speeds. This quarter-track recorder is designed to accommodate tape reels measuring up to 10½ inches in diameter. The transport is "logic controlled" so that any operating mode or speed can be selected from any other without having to first press the Stop button. Yet, the tape is fully protected against breakage and spilling.

The recorder's tape loading procedure is simplified by a guide roller arm that locks out of the way when it is moved to its limit so that the tape takes a straight-line path across the heads, over the capstan, and over a tensioning arm as it goes to the take-up reel. The tensioning arm also serves as an automatic shut-off switch in the event of tape breakage and when the tape runs out.

Two large illuminated meters indicate both recording and playback levels. The meters monitor the line outputs so that the playback indications vary with the setting of the playback level controls. Located above the meters is a red light that comes on whenever one or both channels is set to the Record mode. Below each meter is a standard jack for 600- to 50,000-ohm dynamic microphones.

Locking pushbutton switches control a.c. power, tape tensioning for 7-inch and 10½-inch reels, and tape speed. Other pushbuttons are labeled Rec, Play, Rewind, Fast Forward, and Stop. For easy identification, the Rec button is red, while the Stop button is larger than the others. Although the pushbuttons energize solenoids, they are designed to mechanically lock into position to permit the recorder to be set up in advance for recording. When line power is later applied by an external clock timer, the deck goes directly into record mode.

Five lever switches supplement the pushbuttons. Two place the channels individually into the recording mode when the Rec button is pressed. This is a safety feature that prevents accidental tape erasure. It also serves as a means of recording on one channel while playing back through the other for echo and sound-on-sound (the later requiring external patching).

Two more levers provide exceptional flexibility in adapting the recorder to any type of tape. They separately control recording bias and equalization. Each has positions for Std (standard) and LH (low noise/high-output) tape formulations. A table in the comprehensive instruction manual provided with the recorder suggests switch setting combinations for many popular tapes. Alternatively, optimum conditions can be determined by recording and listening.

The last lever switch connects the line outputs to either the source (input) signal or to the playback amplifier's output.

Concentric control knobs are provided for independently adjusting the recording levels in the two channels. One pair of controls is for the microphone inputs, while the other is for the line inputs. A third pair of concentric controls permits the playback level to be adjusted in each channel.

A stereo headphone jack is located on the recorder's front panel. The line inputs and outputs and a DIN socket that repeats the two are located on the rear of the recorder.

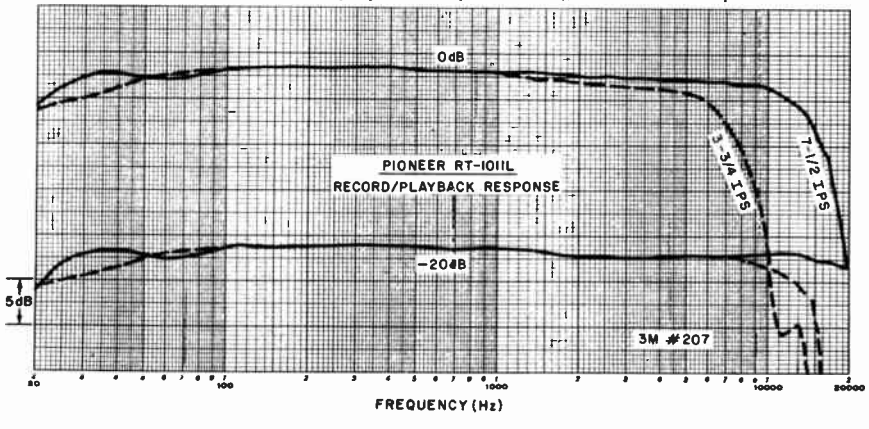
The recorder can be operated vertically or horizontally. It measures 17 inches high by 16⅞ inches wide by 8 15/16 inches deep and weighs 49 pounds. It comes with walnut side panels, a 10½-inch metal reel, and two reel-hub adapters for professional-size reels with large center holes. Price: $599.95.

● ***Laboratory Measurements.*** Using Ampex test tapes, we found the playback equalization of the tape recorder to be very accurate at both speeds. It was within ±0.5 dB from 50 Hz to 15,000 Hz at 7½ ips and within ±0.8 dB from 50 Hz to 7500 Hz at 3¾ ips. (These are the frequency limits of the test tapes.)

We used 3M No. 207 tape for the balance of our tests. We measured the record/playback response with all four combinations of switch settings. Although the differences were slight, we concluded that the LH bias and Std equalization settings yielded the flattest overall frequency response.

Using a −20 dB recording level at 3¾ ips, the overall response was within ±2.5 dB from 20 Hz to 13,500 Hz. At a 0-dB recording level, tape saturation (expected at this speed) caused a sharp drop-off in response beyond 7000 Hz. At 7½ ips, the response at the −20 dB level was a very flat 2.5 dB from 20 Hz to 24,500 Hz. It was within ±1 dB from

Pioneer RT-1011L record/playback response using 3M No. 207 tape.



25 Hz to 21,000 Hz. Saturation was less of a problem at higher recording levels at 7½ ips. Hence, the 0-dB response did not begin to fall off appreciably until we reached 12,000 Hz.

The line inputs required 43 mV for a 0-dB recording level. This produced a maximum playback output of 0.5 volt. The microphone sensitivity was 0.18 mV for 0 dB, while the amplifiers overloaded at 70 mV. This should be quite adequate for most recording situations.

A standard Dolby level tape played back with a full-scale +3-dB meter indication. The meters were somewhat slower in responding than are true VU meters. They indicated 65% of their steady-state values on 0.3-second tone bursts as compared to 99% for a true VU meter.

At a 0-dB recording level, the playback distortion was 1.0% at 7½ ips and 1.2% at 3¾ ips. To reach the standard 3% reference distortion level, it was necessary to record at +12 dB (far off the meter scales) at either tape speed. Referred to this level, the unweighted noise was −62 dB at 7½ ips. With IEC A-weighting for better correlation with subjective effects, the noise was −70.5 dB. It is interesting to note that the S/N ratio at 3¾ ips was only 0.5 dB lower than at 7½ ips. At maximum gain through the microphone inputs, the noise level increased by a negligible 3 dB.

The tape speeds were 0.4% fast at 7½ ips and 0.4% at 3¾ ips. In fast-forward and rewind, an 1800-foot tape passed in 84 seconds. The unweighted r.m.s. flutter was 0.12% at 7½ ips and 0.16% at 3¾ ips. To our surprise, the flutter was reduced when the guide roller arm was locked in its loading position. (It normally plays an important part in reducing flutter.) The flutter measurements were then 0.08% and 0.12%, respectively. Wow was the residual of the test tapes, measuring 0.01% to 0.02%.

The tape transport operated smoothly and appeared to be foolproof. When going from either fast speed to Play, the tape came to a stop in about a second and paused for 2 or 3 seconds before going into play. The manual explains how the Pause control can be used to eliminate even this small delay, if desired.

The headphone outputs have very good volume levels, even with 200-ohm high-impedance phones.

● *Comment.* Despite its ability to accommodate 10½-inch reels, this is very much a home tape recorder—an outstandingly fine one. In ease of loading and handling, it is about as simple and straightforward as any machine we have used. Its frequency response, distortion, and noise levels are among the best we have measured and would do justice in most respects to any professional recorder.

Due to the calibration of the deck's meters, it is practical to maintain average music recording levels near the 0-dB mark. The meter pointers can be permitted to swing to full-scale and beyond on peaks without serious risk of over-recording.

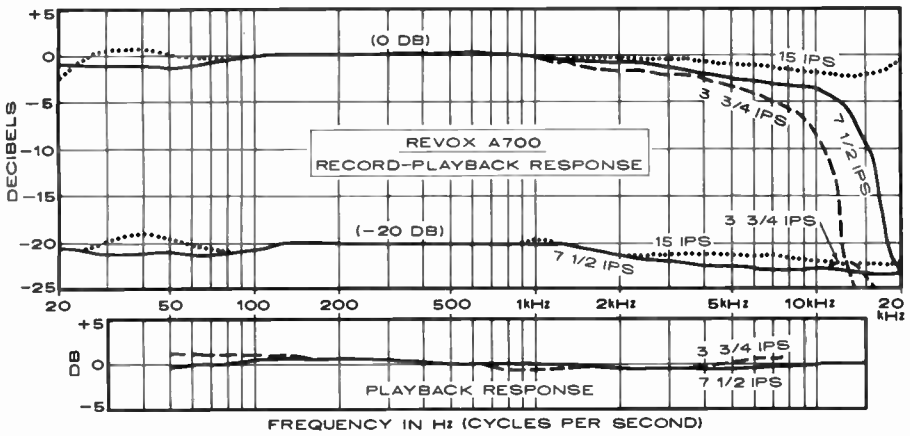
Needless to say, the deck did a flawless job of recording from phonograph and tuner sources as well as of playing back commercially recorded tapes. At a surprisingly reasonable price, the Pioneer RT-1011L offers an impressive combination of high performance and operating versatility. □

HIRSCH-HOUCK LABS REPORT

Revox A700 Stereo Tape Deck

● THE new top-of-the-line tape recorder from Revox (the A700) features the most sophisticated tape transport ever offered in a consumer product. As Revox points out, the A700 fills the gap between the highest-quality consumer recorders (such as its own A77) and professional recording-studio machines. This "intermediate" standing applies in most areas of its design, performance, construction, and price.

The Revox A700 is a three-motor, three-head, three-speed recorder operating at 3¾, 7½, and 15 ips. The machine's flexible input mixing facilities employ two sets of stereo inputs controlled by a pair of input-selector switches. Each selector can be set to microphones (either low- or high-output types) or to a variety of high-level sources. One set of inputs can also be used for a magnetic phono cartridge if desired. The selected input sources can be mixed and, since each channel has two vertical-slider recording-level controls, it is possible to mix four microphone or other program inputs. There is, in addition, a single master recording-level slider. The two VU meters are located behind a single window next to the master level control. The meters are equalized to register the high-frequency boost applied to the recording signal in order to give advance warning of possible high-frequency tape overload. On the face of each meter there is a red indicator (a light-emitting diode—LED) which flashes at a +6-dB recording level to warn of excessive short-term peak levels that might not register on the meters. Below each input selector are its two associated microphone inputs, which are balanced.



The excellent 0-dB curves illustrate the A700's freedom from tape-saturation effects.

The A700 includes, in effect, a high-quality stereo control preamplifier able to drive an external power amplifier. Its controls, grouped at the right side of the panel, include bass and treble tone controls with click stops; a stereo, mono, L, or R mode selector; and two vertical sliders for playback-volume adjustment (these do not affect the normal line-output levels when the preamplifier is not used). There are two stereo headphone jacks, one of which disconnects the A700's main output when phones are plugged in. The remaining knob, which is the only operative preamplifier control when the A700 is used strictly as a tape deck, connects either the source or the monitor-head playback program to the line outputs.

Most of the front panel of the Revox A700 is devoted to the tape transport and its controls. The unique tape-drive system is controlled by a quartz-crystal oscillator, operating at 1.6384 MHz, which feeds digital frequency dividers and phase-locked loops to provide the motor speed-control signal. When one of the speed-control buttons is pressed, it causes the capstan drive motor to "lock" to the correct speed with the full accuracy and stability of the crystal-controlled time base. When it is locked, the button lights up. A few seconds may be required to reach the locked condition, especially when changing from a higher speed to a slower one. Special effects are possible using an external speed control that operates by feeding in a square-wave signal (to a connector in the rear of the unit) which then replaces the fixed internal time base. Changing the square-wave control frequency between 1000 and 10,000 Hz will vary the tape speed from 6.5 centimeters per second (about 2½ ips) to 57 centimeters per second (about 22½ ips).

The A700 has a tape running-time indicator instead of an arbitrary index counter. It operates in fast-forward and rewind as well as at normal tape-operating speeds and reads directly in minutes and seconds at 7½ ips (the readings must be doubled for 3¾ ips and halved for 15 ips). The basic transport control buttons operate conventionally, providing fast-forward and rewind, play, recording interlock, and stop functions. Each button lights when engaged, and a logic-control system permits the buttons to be operated in any sequence and at any time with no risk to the tape.

The remaining buttons include the on-off switch, individual recording interlocks for the two channels, a nonlocking pause control, and two buttons for repeat and automatic operations. The former places the tape in rewind as long as it is held down, and returns the machine to normal playing speed when released. In the automatic mode, the tape rewinds to the beginning (or any other preselected point) and replays in its entirety. The rewind is initiated by a piece of clear leader spliced in at the desired point. This activates the photoelectric system, which also provides automatic shut-off when the tape runs out.

The tape transport can handle reels up to 10½ inches in diameter, and it automatically maintains proper tape tension for any effective reel diameter from 10½ to 1½ inches. Tape loading is along a relatively simple path—over a tension arm and roller on each side of the head assembly and straight across the heads. The lightweight plastic head cover pulls off to expose the heads and their adjustments for cleaning or alignment. At the rear of the A700 are the various inputs and outputs (except for the microphone and headphone jacks, which are on the front panel). The connections to an external amplifier, as well as inputs from a radio source, are through DIN sockets; all other signals are routed through phono jacks. There are switches to adapt the recorder for operation at line voltages from 110 to 250 volts, either 50 or 60 Hz.

The A700 is 19 inches wide, 18 inches high, and 7 inches deep; it weighs 50 pounds. It is supplied with walnut side panels, a head-cleaning kit, and a 10½-inch empty reel. It is available in either half-track or quarter-track stereo versions. Price: $1800.00.

● ***Laboratory Measurements.*** The unit supplied for test was a quarter-track machine. Its playback frequency response, over the range of the Ampex test tapes, was within +0.9 dB from 50 to 7500 Hz at 3¾ ips, and within +0.5 dB from 50 to 15,000 Hz at 7½ ips. Measurements involving the recording functions were made with 3M Type 207 tape, for which the machine was biased, at a −20-dB recording level. At 3¾ ips, the overall record-playback frequency response was +1.5 dB from 20 to 15,000 Hz. At 7½ ips and 15 ips, it was +2 dB from 20 to 21,000 Hz. We also tested all three speeds at a 0-dB recording level to observe any tape-saturation effects at high frequencies (see graph).

A line-input test signal of only 23 millivolts (mV) produced a 0-VU recording level, which played back at a level of 0.77 volt. The two microphone sensitivities (high- and low-gain inputs) were 0.06 mV and 1 mV, and the phono sensitivity was 1.35 mV, all for a 0-dB recording level. The microphone inputs overloaded at 26 mV and 310 mV, respectively, and the phono overload occurred at a very high 230 mV. The tone controls and other characteristics of the preamplifier not directly related to the recording function were not measured. The headphone volume, even with high-impedance phones, was very good.

With a 0-dB indicated recording level, the playback distortion was 1.1 per cent

at 3¾ ips, 0.66 per cent at 7½ ips, and 0.72 per cent at 15 ips. The reference distortion of 3 per cent was reached at the three speeds with inputs of +7, 10.5, and +8.5 dB. With IEC "A" weighting, the signal-to-noise ratio (S/N) referred to the 3 per cent distortion level at the three tape speeds was, respectively, 65.5, 72.2, and 69.3 dB. When set for maximum gain, the noise increased by 14.5 dB through the high-gain microphone inputs; there was no measurable increase through the low-gain microphone inputs. When the gain settings were reduced to more usual levels, neither microphone input contributed noticeable noise. The meters were slightly slower in their response than a standard VU meter, reaching 80 per cent of their steady-state readings (instead of the standard 99 per cent) on 0.3-second tone bursts. The peak warning lights flashed at +7 dB.

The tape transport operated smoothly, with the tape always under complete control, no matter in what sequence or how rapidly the control buttons were operated. By a stroboscope measurement, the tape speed appeared to be exact. The wow was unmeasurable, being less than the 0.01 per cent residual of the test tapes, and flutter (r.m.s. unweighted) was 0.05 to 0.055 per cent at all three speeds. In the fast mode, 1800 feet of tape was handled in 85 seconds.

● *Comment.* Compared with other fine home tape recorders, most of which are considerably less expensive, the Revox A700 offers some tangible immediate advantages and a potential (but difficult to evaluate precisely) long-term advantage.

It is clear from the measured performance of the A700 that its distortion and S/N characteristics are superior to those of most home tape recorders. This is one machine that could hardly benefit from the use of Dolby B noise reduction, for example. We also checked a half-track version of the A700, which proved to be essentially identical to the quarter-track model, except for the expected improvement (2 to 3 dB) in S/N. The feature of variable-speed operation, which we would normally expect to be of interest to professional users, gives the advanced amateur the opportunity to create special recording effects not possible with conventional tape recorders. And, for many users, the flexible input facilities will save the cost of an external mixer.

The transport of the A700, aside from its several novel features, is certainly one of the best basic designs we have encountered. Although it is capable of achieving extremely high speeds in fast-forward and rewind, the logic system and tension-controlling mechanism of the tape guides assured gentle handling of the tape under all conditions of use (and abuse), we could set up.

Overall, the rugged construction and sophisticated electronic transport control system suggest that the A700 should give exceptionally long and superior service with a minimum of maintenance. □

HIRSCH-HOUCK LABS REPORT

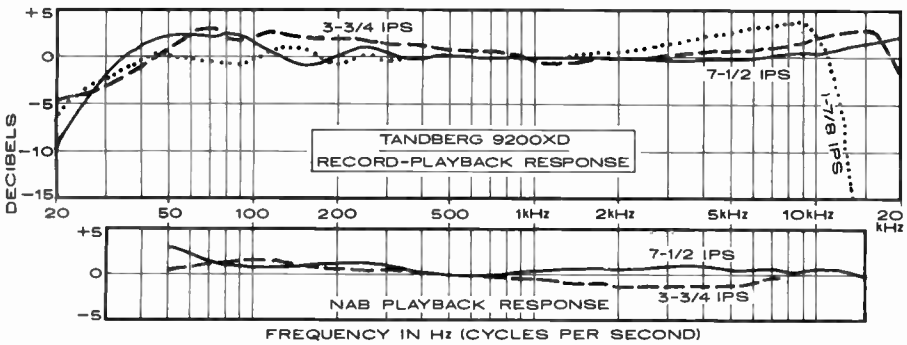
Tandberg 9200XD Stereo Tape Deck

● THE Tandberg 9200XD is a slightly improved version of the company's Model 9000X and, in addition, has built-in Dolby circuits. The 9200XD is a three-motor, three-head machine that can operate at 1⅞, 3¾, and 7½ ips. Its transport mechanism features the advanced logic-controlled, solenoid-operated system offered in the 9000X.

Like the other Tandberg tape recorders, the 9200XD uses cross-field biasing, with the recording bias signal applied to the base side of the tape by a special head located opposite the record head. The cross-field head extends the high-frequency response without the use of high levels of recording equalization. The tape follows a straight-line path across the heads, passing over tape-tensioning arms as it nears the 7-inch reels. The speeds are selected by a lever that also changes the recording and playback equalization. A new feature is the Edit/Cue button, which permits listening to the tape during fast-forward or rewind (to locate recorded sections), as well as when the reels are rotated by hand to zero-in on editing points. There is also a pushbutton-reset, four-digit index counter.

The tape-transport functions are controlled by a group of flat green buttons that operate with a very light finger touch. The logic system, which alone uses fifteen integrated circuits, makes it possible to operate the buttons in any sequence, or at any time, without risk of damaging or spilling the tape. A section of each button is illuminated when its function is selected. The Play button is spaced slightly from the fast-speed and Stop buttons, and the red Record button is still farther away. The Tandberg 9200XD does not require simultaneous operation of two controls to engage the recording mode. However, one or both of the Rec Select buttons under the meters must be depressed, and the tape stopped, before the Record mode can be engaged.

The lower portion of the panel, whose silver color contrasts with the black transport section, contains the re-



Record-playback response using the Maxell UD35-7 tape (top); NAB playback response (bottom) using Ampex test tapes.

corder's electronic controls. At the left are four vertical sliders that control the recording levels from two microphones and two line inputs (which can be mixed). At the far right are two more vertical sliders for playback-level control. The two large illuminated meters read the peak levels *after* the recording equalization has been applied, helping to insure against tape saturation at high frequencies (which can easily happen when the meters read the levels *before* equalization). The internal switching of recording and playback equalization when changing mode or speed, and of the metering circuits, is done by noiseless, solid-state diode switches. When the machine is at a stop, and the Rec Select buttons are pressed, the meters light up and indicate recording levels. This continues during recording, regardless of the position of the Source/Tape buttons, which can be operated to connect either the incoming signal or the playback-head outputs to the line outputs. However, when the machine is in the play mode, the meters are automatically switched to monitor the line-output levels, as they are affected by the playback-level controls.

Below the meters are two ¼-inch jacks for balanced microphone inputs (unbalanced sources can also be used). The preamplifier gain is controlled automatically by the microphone impedance to obtain optimum noise characteristics with dynamic microphones having impedances between 200 and 700 ohms. The headphone jack is designed to drive 8-ohm phones, but provides an adequate level for most high-impedance units.

Two small knob switches have signal lights above them to indicate that they are in use. The S-on-S switch cross-connects the recording and playback amplifiers for making sound-on-sound recordings (in mono) by copying one track onto the other, with new material added. The Dolby NR switch has several operating modes and it is the most distinctive new feature of this recorder. Its three positions are Norm, Filter, and Dolby FM. The first is for Dolby recording from any source other than stereo FM, and for playing back any Dolbyized tape. The Filter position introduces a 19-kHz notch filter to prevent the stereo-pilot carrier from interfering with the Dolby circuits when recording FM broadcasts. The Dolby FM mode has two distinctly different uses. When recording a Dolbyized FM broadcast, it bypasses the recording Dolby circuits but feeds the playback signal through the Dolby decoders. This avoids the need for "double Dolby" recording, while permitting the program to be heard with full quieting and correct frequency balance during recording. The second purpose of the Dolby FM mode is to listen to Dolby FM without making a recording.

The Tandberg 9200XD is 15¾ inches wide, 16¼ inches high, and 5½ inches deep; it weighs 34 pounds. It can be operated either vertically or horizontally. Price: $1049.00.

● ***Laboratory Measurements.*** The playback frequency response, with Ampex test tapes, was within ±1 dB over the 50- to 15,000-Hz range of the tape at 7½ ips, and within ±1.5 dB from 50 to 7500 Hz at 3¾ ips. The overall record-playback frequency response, with Maxell UD35-7 tape (for which the recorder was biased) was ±2 dB from 40 to 11,300 Hz at 1⅞ ips, ±2 dB from 32 to 20,000 Hz at 3¾ ips, and ±2 dB from 30 to 26,500 Hz at 7½ ips. The meters of the 9200XD are calibrated differently from most we have seen, so that a standard Dolby-level tape gives a meter reading of −10 dB and a 0.5-volt audio output. Since tape saturation begins rapidly at 0 dB or slightly above, peaks should be kept below that level as much as possible for best results.

We measured a reference 3 per cent distortion in the playback outputs with a recording level of 0 dB at 1⅞ ips, +3 dB at 3¾ ips, and +1.5 dB at 7½ ips. The unweighted noise levels referred to these levels were respectively −50.5 dB, −58 dB, and −61.5 dB. With IEC "A" weighting to attenuate the less audible low frequencies, these improved to −56.5 dB, −64.3 dB, and −68 dB. Finally, when we added the Dolby system, the noise levels became −64.7 dB, −71.5 dB, and −74 dB—all of them exceptionally good. The noise contributed by the microphone amplifiers (which are outside the Dolby system) was very small until the microphone gain controls were set to more than about 85 per cent of maximum. Considering the high gain of these circuits, that level will never be required with most microphones. At maximum gain, the noise increased by 5 to 14 dB depending on the impedance of the microphone used.

The line input for a 0-dB recording level was 0.1 volt (the microphone inputs required only 100 microvolts with a 600-ohm source), and the playback output was 1.23 volts at 7½ ips, decreasing to 0.78 volt at 1⅞ ips.

The tape speeds were exceptionally accurate, with errors of +0.13 per cent at 7½ ips and +0.5 per cent at 1⅞ ips (the 3¾-ips speed was exact). Wow was at the 0.01 per cent residual of our test tapes, and flutter was 0.06 per cent at 7½ ips, 0.07 per cent at 3¾ ips, and 0.15 per cent at 1⅞ ips. In fast-forward and rewind, an 1800-foot reel of tape was run through in 70 to 72 seconds. The meters read 100 per cent of their steady-state values on 300-millisecond tone bursts, with negligible overshoot and a visibly slower decay. The Dolby circuits tracked very accurately, affecting the overall frequency response by less than 1 dB at all frequencies up to 16,000 Hz. The multiplex filter had no effect up to 15,000 Hz, but reduced the 19-kHz response by more than 24 dB.

● ***Comment.*** If you do not become careless and let the recording levels climb too far into the red area of the meters, the 9200XD makes virtually perfect recordings at all three speeds from FM radio and discs. We did not use it for live recording, but would expect it to be equally outstanding for that purpose, especially at the two higher

speeds. The Dolby system, as expected, had its greatest subjective effect at the lower tape speeds, but nevertheless made a worthwhile contribution at 7½ ips. Obviously, when recording from microphones, it is desirable to keep the recording level controls at a reasonable setting to prevent microphone circuit noise from negating the effects of the Dolby system. We also found the Dolby FM mode very convenient for listening to Dolbyized FM broadcasts.

The 1⅞-ips performance of the 9200XD is, in all respects, comparable to that of a good Dolby-equipped cassette recorder—but with the numerous advantages of open-reel tape, such as longer playing time, easy editing, etc. This is not an insignificant achievement, since most open-reel decks fall well short of top-level cassette-deck performance at that speed.

Compared with the usual tape recorder, the Tandberg 9200XD is somewhat different in its operating characteristics. But, having previously tested and used the 9000X, we had no difficulty becoming accustomed to the 9200XD, and found it to be one of the most enjoyable recorders we have used. □

CASSETTE & CARTRIDGE DECKS

HIRSCH-HOUCK LABS REPORT

Sony (from Superscope) TC-127SD Cassette Deck

● THE Sony TC-137SD is a cassette deck designed for optimum performance with the new Ferri-Chrome tape, as well as conventional gamma-ferric-oxide and chromium-dioxide tapes. It has the features we have come to expect in today's top cassette recorders, including Dolby noise reduction, a ferrite record/playback head, and a "memory" counter that stops the tape automatically at any predetermined point during rewind. The Mic and Line inputs, which have separate slider-type recording-gain controls, can be mixed during recording. A separate knob adjusts the line-output level. The two illuminated meters read both the recording and playback levels, and a peak-level indicator light flashes when momentary excessive-signal overloads occur. A limiter circuit can be switched in to prevent such recording overloads without affecting normal program levels. The tape transport shuts off and disengages in any mode of operation if the tape breaks or jams.

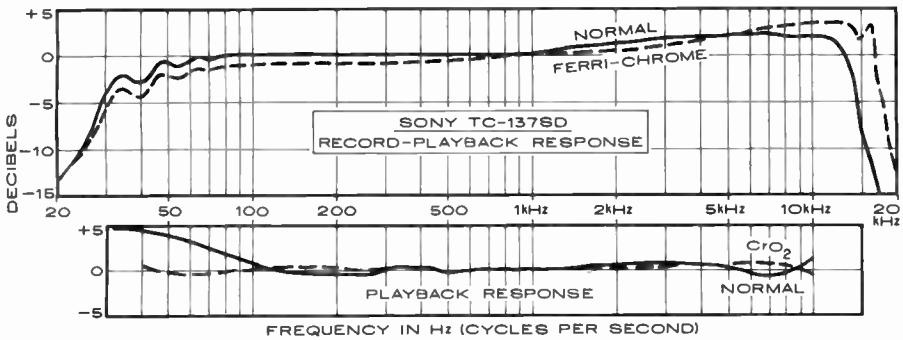
The new Ferri-Chrome tapes combine most of the advantages of ferric-oxide *and* chromium-dioxide tapes, apparently without incurring any compensating disadvantages (except possibly cost). The FeCr tape has two layers of magnetic coating—an inner layer of gamma ferric oxide and an outer layer of chromium dioxide (CrO_2). Compared to CrO_2 tape, Ferri-Chrome has higher sensitivity and lower distortion. Its general high-frequency characteristics and freedom from modulation noise are claimed to be superior to either Fe_2O_3 or CrO_2 tapes, and, in addition, the new tape operates with the same bias level—if not the same equalization—used for "normal" ferric-oxide tapes.

The Sony TC-137SD tape deck has a three-position Tape-Selector switch which optimizes bias, recording equalization, and playback equalization for each of the three tapes. Each has its own recording characteristic, while FeCr and CrO_2 share the playback equalization (70 microseconds) now in general use for playing CrO_2 tapes.

The tape transport mechanism uses conventional piano-key controls. The cassette is visible through a window in a hinged cover, and an adjacent plastic strip unsnaps for access to the heads. The rear of the recorder's top surface slopes upward for easy viewing of the meters, index counter, and memory switch, plus the four mode lights (Limiter, Dolby, Record, Pause). The two microphone inputs and a stereo headphone jack (for 8-ohm phones) are on the front edge of the wood base, and the line inputs and outputs are at the rear.

The performance specifications for the TC-137SD are comprehensive, and are representative of the best of today's cassette machines. The flutter specification of 0.07 per cent (r.m.s. weighted), however, is definitely state-of-the-art for the cassette medium. The TC-137SD is approximately 16¼ inches wide, 11⅝ inches deep, and 5⅜ inches high; it weighs 15½ pounds. Price: $399.95.

● ***Laboratory Measurements.*** The playback frequency response for standard test tapes was ±1 dB from 90 to 10,000 Hz, rising to +5 dB at 31.5 Hz. In the FeCr and CrO_2 tape-switch settings the playback response was within



Overall record-playback response using Sony UHF and ferri-chrome and TDK Krom-O_2 tapes. Playback-only response shown at bottom.

±0.7 dB from 40 to 10,000 Hz. We measured the overall record-playback response at a −20-dB level with three tapes: Sony UHF (normal), Sony Ferri-Chrome, and TDK Krom-O_2 (CrO_2). The normal tape had a response of ±2.5 dB from 31 to 14,500 Hz. With CrO_2 tape, the response was ±2.5 dB from 31 to 16,000 Hz. The Ferri-Chrome tape showed a slight reduction in low-frequency output, and some emphasis of the higher frequencies with an overall variation of ±4 dB from 31 to 16,800 Hz.

When we repeated these measurements at a 0-dB recording level, the high-frequency differences among these tapes were clearly revealed. The response at 12,000 Hz, relative to the 1000-Hz output was down 30 dB with normal tape, 13 dB with CrO_2, and only 10.5 dB with Ferri-Chrome tape. The relative immunity to high-frequency saturation (overload) evidenced by the latter two tapes can be expected to improve the "openness" of recordings made with them, since high-frequency tape saturation is a major cause of the "veiled" quality on some cassette recordings.

The Dolby-system tracking, at a −25-dB level, was within 3 dB, which meets Dolby's standards for high-quality cassette recorders. With the Dolby system on, the high frequencies were slightly emphasized in the record-playback process. As a result, the noise improvement afforded by the Dolby system was 4 to 6 dB instead of the usual 8 to 9 dB. The reference 3 per cent distortion level was reached at +3 dB with Fe_2O_3 tape, +2 dB with FeCr, and −2 dB with CrO_2. The corresponding unweighted noise levels were: −49 dB, −51 dB, and −45.5 dB. Applying IEC weighting, these improved to −56 dB, −59 dB, and −54.2 dB, respectively. Adding the Dolby system resulted in ultimate noise levels of −62.5 dB, −64.5 dB, and −58.8 dB.

The input sensitivity for a 0-dB recording level was 37 millivolts (Line) and 0.08 millivolt (Mic), with a corresponding playback output of 0.8 volt. At maximum microphone gain the noise increased by 20 dB, but most of this took place in the upper third of the control range. Under normal recording conditions, the microphone inputs added only a slight amount of noise. The microphone preamplifier overloaded at 60 millivolts. The Peak light began to glow at +7 dB. The limiter, which came into operation gradually at inputs from 0 dB to +3 dB, had a very fast attack and released slowly over a period of several seconds. It allowed only about a 1-dB increase in recorded level for each 10-dB increment of signal input, effectively preventing excessive recording levels.

The tape operating speed was about 1 per cent fast, and a C-60 cassette was wound in 63 seconds in fast-forward and 69 seconds in rewind. The flutter was as low as we have every measured on a cassette recorder—0.07 per cent unweighted.

● ***Comment.*** Despite its conventional external appearance, the Sony TC-137SD is a highly refined recorder that ranks with the very best we have tested. Although it is able to deliver excellent performance with Fe_2O_3 and CrO_2 tapes, its ultimate potential can best be realized with Ferri-Chrome tape. As we continue to use Ferri-Chrome tape with other cassette machines, we will be able to judge its overall effectiveness. In the meantime, it appears that, in the TC-137SD at least, it out-performs both CrO_2 and the best ferric-oxide cassette tapes in every important respect. □

HIRSCH-HOUCK LABS REPORT

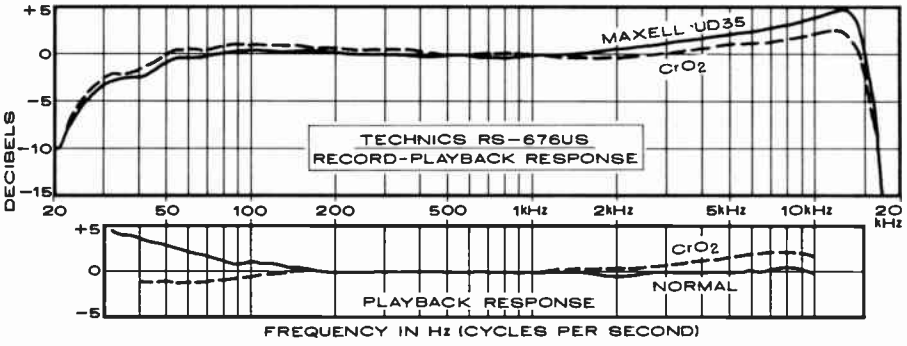
Technics RS-676US Stereo Cassette Deck

● A recent trend in cassette-deck design, exemplified by the new Technics RS-676US, is the front-loading deck. External dimensions, styling, and general appearance of a front-loading deck generally match those of the amplifiers and tuners in the same manufacturer's product line, so that the tape deck can be stacked on, or placed next to, the other components—even be panel-mounted—without creating aesthetic problems. The tape is loaded (in a more or less horizon-

tal plane) through a hinged front door, and is visible through a window in the door. In the case of the RS-676US, the cassette is tilted slightly forward in the lighted compartment and can be viewed either directly or via a built-in mirror. An "Eject" button opens the door partially and, if the transport is disengaged, ejects the cassette.

connects the recorder's Dolby circuits to decode a Dolbyized FM broadcast for listening. The circuits are so arranged that the program may also be simultaneously recorded in encoded form. The recording can then be played back later through the recorder's Dolby system and heard with full noise reduction and proper frequency balance. Recessed

playback-level screwdriver adjustments, and a Dolby FM de-emphasis switch. Dolby FM programs are now being transmitted with a 25-microsecond (μs) pre-emphasis, instead of the normal 75 μs, for better compatibility with non-Dolby FM reception. When a 25-μs transmission is received, the switch on the RS-676US can convert the output of



Record-playback response measured with Maxell and TDK tapes (top) and playback response checked with Nortronics AT-200 and Teac MT-116SP test tapes (bottom).

The Technics RS-676US is a two-motor machine with a solenoid-activated transport mechanism controlled by light-touch pushbuttons in the center of the front panel. Symbols on the "Play," "Rec," and "Pause" buttons light up when engaged. The "Play" and "Stop" buttons are long bars, easily distinguished from the other smaller controls. Pressing the "Rec" button turns on the recording circuits (for setting levels) and lights a red dot on the button, but does not start the tape. Recording begins when the "Play" button is touched, but if one wishes to disengage the recording mode after setting the levels, it is only necessary to touch the "Stop" button. The "Pause" control latches when pressed, and is released by a second touch.

Above the transport controls are a three-digit index counter and its reset button, plus a button to engage the "Memory Play," a feature exclusive to this machine. Several other deluxe recorders have a memory *stop*, which means that the counter can be set to zero at any part of a tape and the machine will rewind to that point and stop. The Technics system goes one step beyond this—the tape stops at the preset point, then automatically goes into the play mode. If you wish, it can also be used as a memory stop by pressing both the "Pause" and "Rewind" buttons.

The Dolby-system switch includes a third position for a filter that removes the pilot carrier and other ultrasonic signals from stereo-FM programs so that they do not affect the operation of the Dolby circuits. A second "Dolby FM" switch screwdriver controls on the panel set the Dolby-FM levels with the aid of test tones transmitted by FM stations.

A two-position "Tape Selector" optimizes recording and playback equalization and recording bias for normal ferric-oxide or chromium-dioxide (CrO_2) tapes. The now-standard 70-microsecond playback equalization is used for the CrO_2 tape. Some brands of CrO_2 cassettes are manufactured with a special notch next to the recording interlock tab, and when such a cassette is loaded into the RS-676US, the recorder automatically switches to the CrO_2 operating mode for recording and playback.

A single large knob adjusts recording level for both channels, and a smaller "Balance" control provides gain adjustment between channels. Two small concentric knobs adjust the microphone-input gain, which is independent of the setting of the master recording-level control and can be mixed with the high-level inputs. The "Input Selector" connects either the "Tuner" or the "Line" inputs, or disconnects both for microphone recording alone. The two quarter-inch microphone jacks and a stereo headphone jack are located on the front panel.

The two illuminated VU meters read both recording and playback levels. Normally, they have the ballistic characteristics of a standard VU meter, with a fast attack and decay and no significant overshoot. Pressing the "Peak Check" button below the meters converts them to very-fast-responding peak indicators, with a much slower decay time.

In the rear of the recorder are the input and output jacks, left- and right-channel a standard FM tuner to a 25-μs characteristic for optimum frequency response and noise reduction. There is also a "Remote Control" socket for use with an optional accessory ($34.95). The Technics RS-676US is 16¼ inches wide, 14⅜ inches deep, and 5½ inches high; it weighs 23 pounds. Price: $459.95.

● **Laboratory Measurements.** The playback-frequency response, tested with the Nortronics AT-200 tape (standard 120-μs equalization), was ±0.5 dB from 125 to 10,000 Hz, rising to +4.5 dB at 31.5 Hz. The response with the Teac MT-116SP test tape (employing the 70-μs equalization used with CrO_2) was within ±1.5 dB from 40 to 10,000 Hz.

We measured the overall record-playback frequency response with Maxell UD and TDK Krom-O_2 (CrO_2) tapes at a −20-dB recording level. The former had a slightly rising high end, and was within ±4 dB from 30 to 16,000 Hz. The CrO_2 response was somewhat flatter—within ±3 dB from 27 to 16,800 Hz. We also checked the RS-676US with the new Sony Ferri-Chrome tape, using the "Normal" bias setting recommended for this tape. As expected, the high end was strongly accentuated, with a smooth rise to +10 dB at 13,500 Hz. When we played the tape back with the 70-μs equalization used for CrO_2, the overall response was ±4 dB from 30 to 16,300 Hz. Using the same tapes, we also checked record-playback response at 0 dB to determine the machine's freedom from the effects of magnetic saturation. With the standard and CrO_2 tapes, response at 10,000 Hz was 2 to 3½ dB

below the mid-range level. With Ferri-Chrome tape, the 10,000-Hz level was actually 1½ dB above the 1000-Hz level.

With the Dolby system on, the overall record-playback response at a −25-dB level was accentuated slightly, by about 3 dB, above 1000 Hz. This tended to dilute the effectiveness of the noise reduction, although the Dolby system still achieved a very good 7- to 8-dB improvement in signal-to-noise ratio (S/N). The reference 3 per cent distortion level was reached with a recording input of +4 dB (Maxell UD), +2 dB (TDK Krom-O_2), and +3 dB (Sony Ferri-Chrome). The differences in the S/N numbers among the three tapes were insignificant. The unweighted S/N was about 50 dB, improving with IEC weighting to about 54 dB. Adding the Dolby system resulted in a 61.5-dB S/N with all tapes. When we used the Ferri-Chrome tape with normal recording bias and the 70-μs playback equalization, the S/N was about 1 to 2 dB better than with the other tapes.

The input sensitivity for a 0-dB recording level was 62 millivolts (mV) for "Line," 85 mV for "Tuner," and 0.24 mV for "Mic." The "Mic" input added about 11 dB of noise at maximum gain, but at any normal input-gain setting the noise increase was small enough to be inaudible. The playback output level from a 0-dB recording-level input was about 0.5 volt, varying somewhat with the tape used. A standard Dolby-level test tape gave a +6-dB meter reading, although the Dolby marks on the meter scale were at +3 dB. The headphone volume was good with 8-ohm phones, but rather low with higher-impedance (200-ohm) phones.

The performance of the tape transport was excellent, with a speed error or less than 0.1 per cent, and only 0.1 per cent unweighted r.m.s. flutter. In fast-forward or rewind, a C-60 cassette was wound in 64 to 65 seconds. The meters had an exceptionally fast and well-damped response, even in their normal mode of operation. Tone bursts of a 0.3-second duration gave exactly the same reading as a steady test signal, and the response of the meters was down only 3 dB with 0.1-second bursts. When we pushed the "Peak Check" button, a 0.05-second burst gave a reading 3 dB below a steady signal.

● ***Comment.*** While there are probably some installations that require a top-loading cassette deck, we found the design of the Technics RS-676US exceptionally convenient to use, and we suspect that many others will have the same reaction. The positive, light-touch controls give it the feel of a fine open-reel deck, and add much to the enjoyment of the unit.

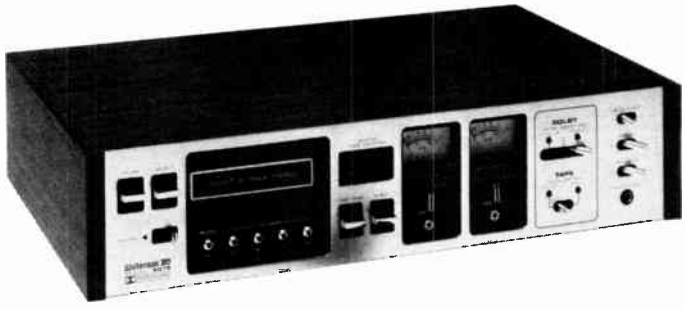
In respect to sound quality, the RS-676US is as good as any cassette recorder we have used. Its Dolby FM-decoding system worked perfectly, although we did not evaluate the 25-μs broadcast de-emphasis feature.

We did encounter a potential problem with recorded Dolbyized FM broadcasts while listening to them in decoded form, although it should be noted, however, that this exists with all recorders having this feature and is thus not peculiar to the RS-676US. With the "Dolby FM Cal" controls set so that a 50 per cent modulation level in the broadcast produced a Dolby calibration-level meter reading (+3 dB), high-level program passages regularly drove the meters to their limit (+6 dB) or beyond. This is apparently not enough to cause distortion in the recorder's electronic circuits, but is almost certain to cause tape saturation. One can switch to the normal "Tuner Input" mode, so that the proper recording level can be set, but this sacrifices the ability to listen to the decoded program while recording.

Having lived with the Technics RS-676US, we can say that anyone who has a chance to become accustomed to the conveniences of a high-quality solenoid-operated cassette deck such as this one will find it difficult to go back to a mechanically switched one. The front-loading feature should make this machine a natural choice for rack or panel mounting or for shelf installations at or near eye level. Best of all, the deck sounds as good as it looks. □

HIRSCH-HOUCK LABS REPORT

Wollensak Model 8075 8-Track Cartridge Deck



● UNTIL recently, manufacturers paid little attention to the "high-fidelity" possibilities of the 8-track cartridge tape format. In any event, it was reasoned, good hi-fi quality would be of no benefit in the normally noisy environment of a car, for which the cartridge format was first developed. The deficiencies of the 8-track format, however, are very apparent when the cartridges are played through a home music system of even modest quality. Hence, limited frequency range, high noise levels, and excessive wow and flutter have come to characterize the cartridge format.

Now, however, Wollensak is changing that picture. Its Model 8075 record/playback deck is perhaps the first of its kind to depart from traditional "mobile" design. Consequently, it can qualify as a true high-fidelity sound component. Its transport is rated for 0.1 per cent weighted r.m.s. flutter (several times less than the typical cartridge deck). A Dolby noise-reduction system

that can be used both in the tape recording and playback process and with Dolby-encoded FM broadcasts is built into the deck.

Although the 8075's frequency response is rated at ±3 dB from 30 Hz to 12,000 Hz with standard tapes—which is several times better than with most cartridge decks—3M's newly developed "Special" cartridge extends the rated upper-frequency to 15,000 Hz. This requires a special recording equalization characteristic, for which a switch is provided on the deck. The rated S/N ratio is also comparable to that of a good cassette recorder (60 dB with the Dolby circuits switched in and 50 dB when they are switched out).

The Wollensak Model 8075 cartridge deck is about as large as many stereo receivers, measuring 19¾ inches by 10¼ inches by 5 inches; it weighs 17 pounds. Price: $399.95.

The usual track-selection and recording interlocks are provided. In addition, there are Pause and Fast Wind levers. The index counter provide an indication in actual playing time (minutes and seconds) instead of the usual arbitrary units. The two VU meters indicate both recording and playback levels. Green lights under the tape-loading slot show which channel is in use, while a red light comes on when the deck is set to the recording mode.

The Dolby switch has three positions. Off disconnects the noise reducing circuits from the system; Rec/Play is used for encoding and decoding tapes; and FM Decode shuts off the transport's motor, connecting the Dolby playback circuits between the input and output terminals of the deck for decoding FM transmissions. Screwdriver adjustments are provided for setting the correct levels for FM Dolby decoding. Another switch permits selection of Regular or Special recording equalization. (Red lights identify settings of the Dolby and Tape switches.)

The Auto Eject and Repeat switches can be set to eject the cartridge from its slot after playing either one track or all four tracks, or to repeat one track or all four tracks indefinitely until the cartridge is manually ejected. An FM Listen switch turns on the electronics portions of the deck without a cartridge in the slot.

● *Laboratory Measurements.* We measured the playback frequency response of the deck with an Audiotex 30-213 test cartridge. The response was ±2 dB from 45 Hz to 8500 Hz and was down 4.5 dB at 40 Hz and 10,000 Hz. The overall record/playback response was measured with a "regular" tape (TDK SD) and the new Scotch Special tape, using the appropriate settings of the Equalization switch. Below about 500 Hz, there were irregularities caused by the head design in the response of both tapes. The response with TDK SD tape was ±4.5 dB from 20 Hz to 14,500 Hz; above 200 Hz, the variation was less than ±2.5 dB with a slight peak at 11,000 Hz. The Special tape produced a smoother and peakless high-frequency response that was ±2 dB from 200 Hz to 14,000 Hz and ±3 dB from 20 Hz to 14,000 Hz. The tracking of the Dolby noise-reduction circuit was good, with less than 1.5 dB variation in response at frequencies beyond 1000 Hz.

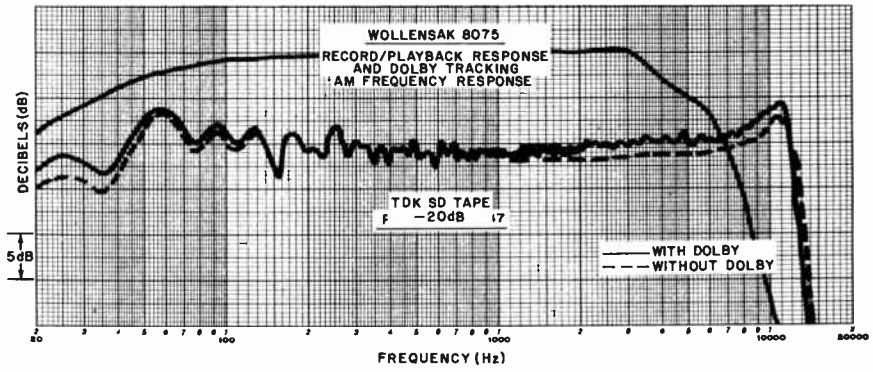
An output of 100 mV produced a 0-dB recording level (which played back at about 1-volt output level). The THD at 0 dB was 1 per cent to 1.5 per cent with either tape. The S/N ratio, relative to the 0-dB level, was measured with IEC weighting (similar to ANSI "A") for better correlation with subjective effects. It was 50.3 dB with Special and 53 dB with TDK SD tape. Using the noise-reduction system, the respective figures were 59.5 dB and 61 dB.

The wow and flutter were measured as a combined record/playback effect. There was a great variation with different tape cartridges, some of which produced intolerable wow. The best of them were very good, with 0.05 per cent wow and from 0.12 per cent to 0.15 per cent flutter. Our measurements were unweighted r.m.s.

● *Comment.* By dubbing high-quality discs onto the tape deck and comparing the playback with the original in an A-B test, we satisfied ourselves that this can honestly be described as a "high-fidelity" cartridge recorder. The differences we heard generally took the form of a slight "hardness" of the higher frequencies. The noise level contributed by the record/playback process was inaudible when the Dolby circuits were switched in.

The Fast Wind mode was about four times (rated 3.5 times) the normal 3¾-ips tape speed. The timer proved to be a convenient and generally accurate means of locating a specific portion of the recording. However, the tape does not instantly stop and start when the Pause and Fast Wind controls are operated; so, care is needed to insure that the deck's mechanism and tape have come to a full stop before removing the cartridge. Failure to follow this procedure may result in indexing errors.

Although this cartridge deck has many of the convenience and performance features of a cassette deck, it requires a very different operating technique for successful use as a recorder. Patience is the most important requirement, since even at the "fast" speed it may require five to six minutes to reach the starting poing of a 90-minute cartridge. Any error in recording will require a similar wait before it can be corrected, since you cannot "rewind" a cartridge. Fortunately, the listening quality of the end product can be excellent, justifying the care taken in its production. □



Overall record-playback response measured with TDK SD and the new Scotch Special tapes.

STEREO HEADPHONES

HIRSCH-HOUCK LABS REPORT

Koss Model HV-1 Stereo Headphones

● THE Koss Model HV-1 (the "HV" stands for High Velocity) stereo headphones are lightweight, weighing in at only 9½ ounces, exclusive of cord. Unlike most phones that depend on a tight seal around the ear for best bass performance, the HV-1 rests on porous foam pads that provide no isolation from ambient sound; one can hear external sounds as well with the phones on as with them off. By the same token, the phone sounds can be heard clearly in the room, especially when listening at high levels. In fact, the phones are designed to provide excellent sound quality and low distortion at high listening levels.

The HV-1 phones are comfortable to wear for extended periods of listening. Each earcup contains a 2-inch diaphragm made from 1-mil Mylar. The diaphragms are driven by a 1-inch diameter voice coil. The outside of the earcup is vented, and the compliant diaphragm suspension resonates at about 200 Hz—roughly an octave lower than the resonance of the stiff suspensions used in sealed phones. The resonance is damped by the acoustic resistance of the ear cushion and the internal structure of the earcup. The useful frequency response of the phones extends far below the resonance point.

The phones are relatively efficient, producing a 95-dB sound pressure level (SPL) in the wearer's ear with only 0.6 volt applied drive. They are capable of very high undistorted output, on the order of 132 dB in the 200-Hz region, where much musical energy is concentrated, without damage or serious distortion—to the phones, that is.

The Koss HV-1 phones are fitted with an integrated coiled cord that extends to 10 feet. They are designed to operate from any amplifier with an output impedance of from 3.2 ohms to 600 ohms. Price: $44.95.

● ***Laboratory Measurements.*** The measured frequency response of a headphone is critically dependent upon the dimensions and design of the coupler or "artificial ear" used to match the headset to the microphone. We tested the HV-1 phones in a Koss coupler, a slightly modified ANSI headphone coupler.

The response curve for the phones had a broad maximum centered at 200 Hz but spanning several octaves. There were the usual midrange irregularities, found in virtually all phones, but the overall frequency response was a very good ±7 dB from 20 Hz to beyond the 15,000-Hz upper limit of our microphone calibration.

With 1-volt signal applied, the acoustic output of the phones varied between 95 and 109 dB over the full frequency range. This level, which would be uncomfortably loud for many listeners, can easily be achieved when driving the phones from any amplifier known to us. At 1000 Hz, the distortion was only 2.6 per cent at a 120-dB sound pressure level. At 200 Hz, the distortion was less than 2 per cent for any output up to 132 dB SPL, at which point, we began to hear some buzzing. Of course, 132 dB would be an ear-splitting level to even the most dedicated rock-music enthusiast.

The electrical impedance of the HV-1 phones was a uniform 150 to 200 ohms from 20 Hz to 20,000 Hz.

● ***Comment.*** The Koss phones had an open, airy quality which most people find to their liking. Subjectively, this effect comes closer to that of loudspeaker listening than that of tightly sealed headphones.

The overall sound quality was so good that we compared it to the expensive Koss Model ESP-9 electrostatic phones which were the best we had previously tested and which are considered by some people to be a standard of headphone sound quality. Although the HV-1's did not match the sound provided by the ESP-9's, the differences were not great. The HV-1 had a fuller, warmer sound, easily explained by their response curve which emphasized the lower midrange and had somewhat less output at both extremes of the audio range. The HV-1's sound smooth and free from obvious coloration. For good sound, we feel that the HV-1's offer strong competition to far more expensive stereo headphones. On the whole, they rank at or near the top of all phones we have tested for output level capabilities. □

HIRSCH-HOUCK LABS REPORT

Pickering Model OA-3 Stereo Headphones

● THE Pickering Model OA-3 "open-air" stereo headphones provide little or no isolation from room sounds. Unlike conventional isolating-type phones that have air-tight seals between the earcups and the listener's head, the Model OA-3 phones are fitted with vinyl-covered foam rings that rest lightly over the ears. The lack of sound isolation works in both directions. The program being played through the phones can be audible to others in the immediate vicinity, as well as letting outside sounds in.

Open-air phones have a distinctly different sound quality than conventional phones. The quality might be described as "airy" or "light," perhaps because the normal room ambience is not excluded from the listener's ears (although it does not directly interact with the musical program as it does when listening through loudspeakers). This type of headphone is also exceptionally comfortable to wear, owing to its very light weight of only 8.5 ounces and the slight pressure it exerts on the ears and head of the person listening with them.

It is generally recognized that good low-bass response through headphones requires a tight phone-to-ear seal. While this statement appears to contradict accepted acoustical theory in the open-air design, it is not really so. The bass response of an open-air phone may extend down to 60 Hz or so, but subjectively appear to go to a much lower frequency. Since there is little music content in the lowest octave of hearing, one is not aware of any lack of deep bass sound when listening with good open-air headphones.

The published specifications on the Model OA-3 phones indicate that they are quite efficient, requiring only 0.1 volt across their nominal 15-ohm impedance to produce a 100-dB SPL at 1000 Hz. The maximum rated input power is 0.2 watt/channel, but the series resistors built into all amplifier headphone output circuits will provide adequate protection even with a high-powered amplifier. The distortion is specified at 0.5 per cent for a 110-dB SPL output.

The Pickering Model OA-3 headphones are supplied with an adapter plug to permit them to be used with small transistor radios and cassette decks. Price: $39.95.

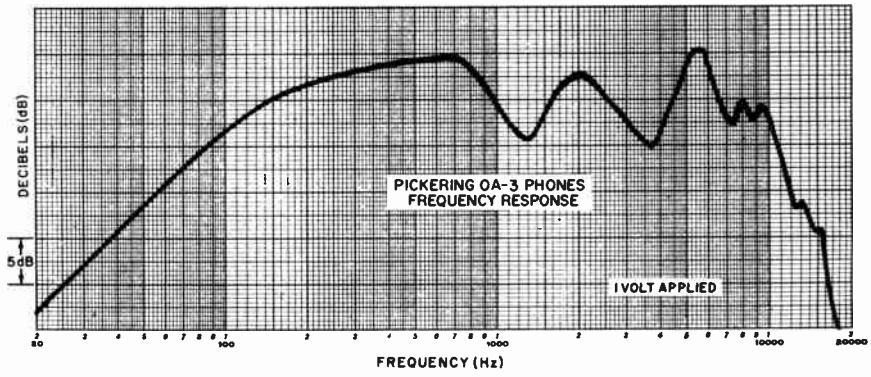
● ***Laboratory Measurements.*** We tested the frequency response of the phones on a Koss-designed coupler, which is a slightly modified version of an accepted standard earphone coupler. The measured frequency response of any headphone is closely connected with the dimensions of the coupler (or artificial ear) on which it is mounted so that it is virtually impossible to compare data on different coupler designs especially at the higher frequencies. However, one can obtain a reasonably valid picture of the headphone's overall response even though the specific peaks and dips on the response curve may be as much a property of the coupler as of the phone (and would certainly be still different through the ears of any individual wearing the phones).

The measured frequency response was relatively uniform from 100 Hz to 11,000 Hz, with a total variation of only ±5 dB over that range. The output fell rather quickly at frequencies beyond 11,000 Hz and a smooth 6 dB/octave at low frequencies. The response was measured with 1 volt applied to the phones, producing an average 120-dB SPL over the measurement range, which happens to agree exactly with the published specifications.

Normally, one would expect distortion to be a function of frequency, but the published specifications do not specify the test frequency. We measured the distortion at several frequencies between 200 Hz and 1000 Hz, where the output was both strong and smooth, at a 110-dB SPL. The distortion was typically between 1.2 and 1.6 per cent and was principally second harmonic. In view of the high SPL used, this amount of distortion cannot be considered serious, even if it does slightly exceed the published rating.

The electrical impedance of the phones was an almost constant 20 ohms across the audio range. It gently rose to 25 ohms at 150 Hz and underwent a

Frequency response curves run with a Koss-designed coupler.



slight drop to a 16-ohm minimum at 20 Hz.

● *Comment.* Since our first experience with open-air phones several years ago, we have enjoyed their special qualities—which eliminate many of the objections voiced about headphone listening (heavy weight and pressure exerted, inability to hear desired outside sounds, such as the ring of a telephone, etc.). The Model OA-3 phones embody all the virtues of a good open-air headphone and have a smooth response and the ability to handle high volume levels without objectionable distortion.

The vinyl-coated ear cushions make the Pickering phones a little less "open" to outside noises than are some other types that feature simple foam pads. In fact, in a quiet room, one might almost believe that the phones are the isolating type.

The low impedance and high efficiency of the phones make them exceptionally well suited for use with small radio receivers and tape recorders. □

HIRSCH-HOUCK LABS REPORT

Scintrex Model 98 Stereo Headphones

● THE Scintrex Model 98 stereo headphones feature a novel dual-cavity acoustic design in which the rear of the driver is fully isolated from the outside environment, but its rear radiation is admitted to the ear-cup cavity through a system of internal ports. The ports and the area surrounding the front of the driver are damped by plastic foam, which is also used behind the driver. This system is intended to sonically enlarge the cup volume at low frequencies while keeping the volume small at high frequencies.

The frequency response of the Scintrex Model 98 is designed to provide what might be called a built-in Fletcher-Munson loudness-compensation characteristic: both the bass and treble are somewhat accentuated relative to the mid-range response. The glycerin-filled earseals provide exceptionally high attenuation of external sound (claimed to be 40 dB at 1000 Hz), as well as extended low-frequency response.

The Model 98 has a 14-foot coiled cord, with a strain relief where it enters the earcup. The headphone specifications include: 6.5 milliwatts sensitivity to achieve a 100-dB sound-pressure level (SPL), 50 milliwatts maximum input (corresponding to a 110-dB SPL), and distortion of 1 per cent at 1000 Hz at an unspecified SPL. The headset weighs 16 ounces. Price: $39.95.

● *Laboratory Measurements.* The Scintrex Model 98 phones were tested using a Koss-designed test-measurement coupler that we have been using for all our headphone evaluations. The volume of the cavity presented to the earpiece by the coupler (and, of course, the possibly different volume of the individual user's ear cavity) can have a critical effect on the measured—or audible—frequency response of the phone. Therefore, one cannot necessarily expect to measure the "objective" response of a headphone when using a test coupler not specifically designed to take into account its *physical* characteristics. This is not unlike the situation with regard to testing loudspeakers in different acoustic environments.

As it happened, our measured response of the Scintrex Model 98 proved to be very good, and followed the general contours of a curve run by Scintrex on the same headset, using their coupler and test equipment. The response was within ±3.5 dB from 20 to 5300 Hz, with the average levels in the 400- to 1500-Hz area being about 5 dB below those of the lower frequencies. Above 5000 Hz, the output increased to about +10 dB in the 7000- to 10,000-Hz range (relative to the averaged lower frequency level) and remained strong all the way to 20,000 Hz. The Scintrex curve showed a stronger output between 50 and 100 Hz than ours, but the two curves were otherwise quite similar in shape.

An input of 2.8 volts at 1000 Hz produced a 100-dB SPL, and the rated maximum of 110 dB required about 9 volts of drive. (This is well within the capability of any amplifier rated at 10 watts or more into 8 ohms.) The total harmonic distortion at 1000 Hz was 1 per cent at a 90-dB SPL, reaching 10 per cent at a 110-dB output level. The sound isolation of the liquid-filled ear cushions was excellent (this has been a characteristic of the other Scintrex/Sharpe phones we have tested in the past). An external random-noise signal was reduced by 23 dB. The impedance of each earpiece was a uniform 300 ohms from 20 to 20,000 Hz. There is no compatibility problem with the standard headphone jacks found on current amplifiers and receivers.

● *Comment.* The subjective character of the Scintrex Model 98 was completely consistent with its measured performance. There was a slight but noticeable brightness, complemented by a powerful bass response. At the same time, there was no mid-range deficiency, and the overall sound, despite a distinct "punch" was well balanced. □

HIRSCH-HOUCK LABS REPORT

Superex EP-5 Stereo Headphones

● SUPEREX ELECTRONICS' EP-5 headphones employ both electrostatic and dynamic driver elements. Electrostatic phones are well known for wide frequency range and smooth response, but tend to be restricted, particularly at low frequencies, in the maximum volume levels they can produce without excessive distortion. Dynamic phones, on the other hand, can deliver extremely high acoustic outputs approaching the threshold of pain, but often have a relatively irregular upper mid-frequency and high-frequency response.

In the Superex EP-5, many of the best features of both types are combined. A 2¾-inch Mylar-diaphragm dynamic "woofer" handles the low and mid frequencies. Mounted coaxially with it is a 2¼-inch permanently charged electret electrostatic diaphragm. The crossover, in the 3000- to 4000-Hz region, is accomplished acoustically through backloading the tweeter and by tailoring the acoustic design of the woofer cavity.

Electrostatic elements, by their nature, require a high-voltage audio signal, and this is provided by a step-up transformer in the control "console" supplied with the EP-5 system. The console must be connected to the speaker outputs of a stereo amplifier (the usual headphone jacks cannot drive the transformer and phones), and the headset plugs into a five-pin socket on the console panel. Terminals are provided in the rear of the console for the displaced speaker connections, and a rocker switch on the panel selects either speaker or headphone listening.

Unlike full-range electrostatic headphones (including those made by Superex), the EP-5 tweeters operate as single-ended (non-push-pull) drivers. Apparently, the small diaphragm excursions needed for high-frequency operation also make it possible to use permanently polarized electret elements and eliminate the inconvenience and expense of a.c. line connections or polarizing supplies without incurring excessive distortion. The left and right inputs are electrically separate, except for a 440-ohm resistance between their grounded sides. Most amplifiers share a common ground between channels and present no connection problems, but Superex suggests caution in connecting the EP-5 console to any amplifier which does not have one side of each speaker output grounded.

The headset of the EP-5 is similar in styling to other current Superex models, with relatively large, but light, square-shaped earpieces and a padded headband. The cushioned ear seals do not exert an uncomfortable pressure on the wearer's head, yet are quite effective in excluding ambient noise. The headset weighs 16 ounces, and it has a 15-foot coiled cord. The console measures 7 × 4 × 2 inches. Price: $80.00.

● ***Laboratory Measurements.*** The frequency response of the Superex EP-5 phones was measured on a Koss-designed test coupler, with the phones driven at a constant 3-volt input. The output of the dynamic woofer was unusually smooth down to the lower test limit of 20 Hz. There was a broad dip in the 1000- to 3000-Hz region that was about 8 dB below the 100-Hz level. The tweeter output above the crossover frequency was almost as great as the average woofer output, and it remained strong all the way to the upper test limit of 20,000 Hz. The impedance of the EP-5 phones reached a maximum of about 90 ohms in the 500- to 2000-Hz range, falling off to 15 ohms at 20 Hz and to 8 ohms at 20,000 Hz.

Tone-burst measurements of headphones are difficult to interpret since the dimensions of the coupler and the inside of the earpieces interact in a somewhat unpredictable manner to modify the burst response, particularly at the higher frequencies. Our measurements at 100, 1000, and 5000 Hz showed generally good response, with some evidence of ringing at the higher frequencies. A 3-volt test signal input produced a sound-pressure level (SPL) of 105 to 107 dB at frequencies from 20 to 400 Hz, and between 100 and 105 dB at frequencies from 3000 to 18,000 Hz. These are all fairly high listening levels (they would rarely be used in loudspeaker listening), and the EP-5 phones can produce them with any amplifier rated at 10 watts per channel or more. The EP-5 has internal overload protection circuits to prevent excessive drive signals from reaching the phones. We verified their effectiveness by driving the phones at high levels from a 200-watt-per-channel amplifier with no ill effects.

● ***Comment.*** The EP-5, developed to provide high-quality listening for rock, modern, and synthesized music, has a slight bass boost incorporated in the phones to appeal to the taste of contemporary listeners and to compensate for possible air leaks between the ear cushions and the wearer's head.

Our subjective reaction conformed in every detail to Superex's own appraisal of its phones. The EP-5 had a slightly "heavy" sound by comparison with the reference phones, although the high-frequency responses of the two phones seemed to be quite similar. For those users who prefer a more conventional sound balance, most amplifier tone controls are capable of flattening the bass response to match the mid-range level.

We did not hear any distortion or similar effects that might have resulted from the use of single-ended drivers. This is not surprising in view of the high crossover frequency, since harmonics generated by the electrostatic tweeters would probably fall above the range of human hearing, and many intermodulation products would fall below the crossover frequency.

To summarize, we feel that the Superex EP-5 phones do provide the extended, smooth high-frequency response of an electrostatic phone together with the powerful bass of a dynamic phone, and at a price well below that of other electrostatic phones currently on the market. For the listener who favors low bass, the EP-5 phones are among the most potent that we have heard in the lowest octaves. And, when desired, they can easily be equalized with amplifier tone controls to suit more conventional listening tastes. □

TAPE MUSINGS

A series of thought-provoking ideas for tape hobbyists.

By Craig Stark

TAPE-RECORDER HYGIENE

APART from inquiries about specific product recommendations, the subject most readers ask about is how to care for their recorders and tapes.

In addition to routine household dusting, recorders need two kinds of periodic cleaning: physical and magnetic. The tape has yet to be made that does not shed *some* of its oxide particles with every playing, and unfortunately these tend to accumulate on tape heads and guides, pressure pads, and the capstan/pressure-roller drive system. If not removed, this debris can cause slippage in the drive mechanism. The resulting wow and flutter is heard as inconstancy or "graininess" in pitch. In addition, the oxide accumulations on the heads cause momentary "drop-outs" in the signal and loss of treble response.

Happily, the solution is as near as a bottle of isopropyl or rubbing alcohol and an ordinary cotton-tipped swab. If the tape you use has a brown surface, the chocolate-colored band that develops on the black pressure roller is an obvious warning that housekeeping is in order. If the tape you use has a black oxide, you will have to look more closely to see the shiny band that appears. In any case, the build-up of flaked-off oxide particles *must* be removed from *all* parts in the head assembly and anywhere else the moving tape contacts the recorder.

Though unseen, residual magnetism induced in heads, guides, and capstan represents an even greater potential danger to your tape collection, and preventive or therapeutic treatment is indicated at least as often as physical cleaning. Professional studios "degauss" their machines daily (every 8 to 20 hours of operating time is the usual recommended rule of thumb) to guard against this insidious force. A magnetized component anywhere in the tape path will create some hiss and permanent loss of high-frequency signal whether you're recording or simply playing back a tape.

Fortunately, head demagnetizers are inexpensive accessories available from all dealers, and using them properly takes less than a minute. Start by turning your recorder off and removing all tapes from the immediate vicinity. Remove the head covers (you should have done this already for the physical cleaning), and, holding the tape-head degausser at arm's length, plug it in, push its "on" button (if it has one), and bring it in close proximity to each of the surfaces that contact the flowing tape. Then, with the demagnetizer still on, withdraw it slowly and smoothly. Turn it off when it is at arm's length from the machine and the job is done. *Note*: to avoid any danger of scratching the tape heads, it is a good idea to put a piece of plastic tape over the tip(s) of the degausser. (Because of differences in physical design, not every tape-head demagnetizer will be able to get to the heads of every recorder. Check with your dealer to make sure that there is no potential problem.)

For most audiophiles, lubrication of a recorder is best left to a yearly visit to the service technician. Too much is as great a danger as too little! Obviously, though, bearings and sliding and rotating surfaces must have lubricants. If you want to do the job yourself, follow the manufacturer's instructions carefully.

Tape care is no less important. Always keep tapes in their containers when not in use, and put tape reels on edge—*not* piled atop one another. I recommend the professional practice of leaving tapes in a *played*, not a *fast-wound* condition, for the latter tends not only to create an unevenly wound tape "pack," but also to put internal stresses on the tape layers that may cause damage. For the same reason, it's a good idea to play—not rewind—a tape at least twice a year. Avoid storing tapes next to a radiator, in the immediate vicinity (within 2 to 3 feet) of strong magnetic fields (loudspeakers, motors, or power transformers in hi-fi equipment), or in a car trunk during warm weather. Given proper care, your tapes should outlast their owner!

Accidental erasure, especially of the high frequencies, *is* something to worry about. I once ruined a $35 test tape by using a screwdriver I didn't know was magnetized for some head adjustments, and a friend once tearfully played for me a master tape on which his five-year-old had momentarily placed a magnet from the kitchen memo board, "to see if it would stick." The magnet didn't, but the once-around blip did.

To assess the potential dangers, I consulted several experts and found they agreed that most fears about accidental damage from magnetic fields—generated by radar, house wiring, home appliances, power transformers, and even loudspeakers—are exaggerated.

The reasons are two formidable-sounding but relatively straightforward factors: "tape coercivity" and "the inverse square law." Coercivity is simply an index of the amount of magnetic energy necessary to erase a tape and is measured in oersteds (Oe). Tapes generally have a coercivity in the 280- to 450-Oe range, but this value is a kind of an average (some oxide particles require more field, some less, for erasure). The consensus among the experts was: a good rule for general tape safety is to keep the absolute peak level of stray fields to less than 10 per cent of the tape coercivity. For ferric-oxide tapes, this amounts to 25 to 30 Oe, and for chromium-dioxide tapes, 45 Oe. One gentleman reported measuring a magnetic field of only 10 Oe at the case of an electric drill, so it surely would be safe to use in the vicinity of most tapes. (In fact, home-appliance motors aren't that different in principle from those used in tape decks.) However, for really critical tapes, it was suggested that external fields should be kept below about 10 or 15 Oe, respectively, for iron and chrome tapes, since high frequencies tend to be more easily erased.

The other factor is a function of distance. Even a bulk tape eraser that may generate a powerful 1,000-Oe field measured at a distance of ½ inch measures only one fourth that field at one inch, and one sixteenth at two inches. That's the effect of the inverse square law, and it holds, generally, for magnetic recordings. Thus, even a few inches of separation from potentially damaging fields—magnetic latches on cabinets for example—can prevent signal damage.

You can measure *steady-state* or "permanent" fields (around a speaker cabinet or from magnetized tape heads, guides, and capstans) with an inexpensive ($6.80) magnetometer from R. B. Annis, 1101 N. Delaware St., Indianapolis, Ind. 46202. Multiply your readings by ten or even a bit more on recorder parts that touch the tape directly. You'll find with speakers that the magnetic "leakage" field varies from model to model and, of course, the point on the cabinet at which it is measured.

GETTING ORGANIZED

As the size of your home-recorded tape collection grows (mine seems always to be overflowing the last shelf, leaving a dozen or so reels lined up between bookends on the carpet), you're bound to encounter three problems. First, how do you *find* a selection you may have taped several years ago? Next, how do you ensure, when you may have half a dozen reels out at once, that they all get back into their proper boxes? Third, with "normal" wear and care (in the Stark household this includes an occasional empty box's being stepped on, which ruins the fragile hinge that holds the top and bottom halves together), how do you keep your collection from looking just plain ratty? Over the years, I've explored several possible answers, and if my solutions don't meet your individual requirements, perhaps they'll inspire a brainstorm that will.

The first necessity is a cataloguing system separate from the information you write on the box. I use a Royal-McBee Keysort setup (an inexpensive home data-processing scheme you might look into if your collection is rather large), but for ordinary purposes 3 x 5 index cards in a file box will certainly serve. Whether the system you adopt is basically alphabetical or straightforwardly sequential in order of recording or acquisition date, I think a *number* code of some kind is essential. When I first started recording, I kept two file indexes: one listing the reel number, composer, selection, performers, side, etc., and the other a kind of inverse index, showing how much time remained on each side of a tape for future recording.

Next, each of my reels gets an identifying, self-adhesive label ½ inch by 1¾. I've used the Dennison Pres-a-ply (S828 size) for years; they're available at any large stationery or art-supply store. Alternatively, you could simply use a short strip of Scotch "Magic" tape which you can write on with a ball-point or soft-tip pen. With any system of numbered reels, however, you must develop a consistent approach to make sure that the tape gets back onto its designated reel.

I do this in two steps, first by using a distinctive metal take-up reel (which warns me that any tape left on it should be elsewhere), and second, by always storing my tapes in a *played*, not a rewound condition. This means, of course, that if, like me, most of your collection is two-track stereo, you'll have to rewind the tape *before* playing, but it's really no harder than the usual, potentially harmful practice of rewinding after hearing. If you're playing both sides of a quarter-track stereo recording, it may not matter. If you care about the long-term quality of your tapes, the fact that they are stored wound on the reel under moderate and reasonably uniform tension is important. This guards against the excessive stresses on the tape that tend to arise from fast winding and from changes in temperature and humidity.

Cardboard tape boxes are often a headache, and the plastic counterparts supplied with some premium tapes are not uniform in shape, color, or the way they open up. To prevent torn hinges and to create an aesthetically pleasing appearance as well, I reinforce the spine of each box with a length of 1½-inch-wide Mystic Tape. I use a uniform shade, but you may find it convenient to color-code different kinds of recorded material. Either way, I prefer the cloth to the plastic-backed type, both because it won't stretch and because it will take *white* marking ink—an excellent way of identifying your tape boxes. For a real "finishing touch," however, use a Dymo Labelmaker, which prints raised white letters onto a transparent tape you simply press atop the cloth-reinforced spine of your tape boxes. I'm sure that once you get into overhauling your tape "housings," you'll probably discover lots of hidden—or at least forgotten—treasures among your miscellaneous reels. There's a bonus in the enterprise, for you can do your labeling and listening simultaneously.

DON'T JUST DUB

For many owners of tape-recording equipment, its primary use is to record live music or dub discs. But there are dozens of other ways to use tape, and perhaps it's time for you to pay some attention to them. What brings this to mind just now is the abundance of battery-operated cassette recorders, some with built-in microphones, that you can hold in your hand to record with.

The ease with which these units can be carried about and operated has led many students to record professors' lectures instead of taking written notes. As a college teacher, I am often approached by students requesting permission to tape my remarks. Done openly, with explicit permission, this is a high form of flattery. But except for very special lectures (or perhaps taping for a friend who may have to miss class), I do not think such tapes are very effective study aids. It is true that students' notes often bear no recognizable relationship to what was actually said in class, but it takes just as long to hear the lecture again on tape as it did to listen to it originally, and few students can afford to double their lecture-listening time in order to get more accurate notes.

Making recordings for "shut-ins," however, is an entirely different matter. Tapes of the religious services from the parish or synagogue where an ill or aged person has deep personal ties will mean far, far more than any basket of flowers from the Altar Guild or its equivalent. And "service" tapes are so easy to provide. In a small congregation all you need do is sit in the front row with a C-120 cassette in your machine, and you'll be amazed at how good a recording you can make, completely unobtrusively. And in any large church there will be a public-address system that you can almost always tap into to provide a feed to the high-level (line or aux) inputs of your recorder. You won't even need a mike.

What you want for this sort of work is a cassette machine with some sort of automatic volume-control circuit. On the machine's spec sheet this feature is called AVC or ALC (automatic loudness control), and most of the better cassette portables have it built in. With hanging microphones, a multi-input mixer, large-scale VU meters, and all the trappings, you could no doubt get a "better" recording. But for the purpose at hand all you want is to make a soft-spoken prayer audible and a large choral "Hallelujah!" undistorted, and that is precisely the function of an ALC circuit. It automatically raises the recording level of low-volume sounds and lowers that of high-level signals, keeping the range within the limits of machine and tape.

Another interesting project, perhaps closer to home, is to record your children's voices, year by year. The record becomes, as it were, a sonic photo album in which you can trace a youngster's progress in speech all the way from coo's to conversation. And, of course, a newborn's first sounds at home are as individual as his first steps. I've often thought of submitting my daughter's tapes to Bell Labs to prove she could hit a high C an octave above that of any known operatic soprano—a sound far more precious to me now than when first heard some years ago at 3:00 A.M.

Then there are the sightless. What could be more rewarding than to give the gift of education by reading onto tape for a blind student? You can make local arrangements, work through a tape club, or through a national organization. Although the American Foundation for the Blind uses only professionals, Recording for the Blind, Inc., has studios in eighteen cities nationwide for volunteer readers. Write to Mr. Gilbert Field, 215 East 58th St., New York, N.Y. 10022. And if you have good open-reel equipment and can pass a voice audition, you can even record at home on tape supplied under a program administered by the Library of Congress. Contact Mr. Bill West, Coordinator of Tape Volun-

teers, 1291 Taylor St. N.W., Washington, D.C. 20542, for information.

STANDARDS

THOUGH audiophiles often compare the published specifications of different recorders (I hope with a properly jaundiced eye!), they rarely consider the basic *standards* that really determine performance. Best known to most readers of this column are the standards set by the NAB (National Association of Broadcasters), which were last revised in 1965. However, when making copies of my own tapes for European broadcast, I've often had to change the equalization of my recorder from the NAB to the European curve; otherwise, the bass/treble balance would have been improper when they were aired. Other, often conflicting, recommendations are suggested by numerous other international groups. It's not that anyone wants to change the size of the spindle hole or the tape width of the reels you buy at your local dealer; it's simply that they are concerned with the standardizing of equalizations that will obtain the best possible results from the available tape formulations. The tape formulations and the machines keep improving, however, and therein lies the problem. The cassette format, because of its particularly rapid evolution, provides an especially good illustration of the problems involved in dealing with tape standards.

For example, the original Philips design called for a bass rolloff in playback of about 6 dB per octave starting at 100 Hz. This helped to prevent power-line hum from becoming audible. In order to provide a flat *overall* signal, a corresponding bass boost was built into the record section. However, the duplicators found that applying this much bass boost during recording produces considerable low-end distortion. So they simply omitted the mandated bass boost and permitted the low-frequency playback response to droop a bit.

In the meantime, however, the playback electronics in *good* cassette machines have improved to the point where the designers now lower (or altogether eliminate) the playback bass rolloff. Thus the bass boost during recording is no longer needed. With such machines, if a duplicator adhered strictly to standard, you'd have to turn *down* your bass control slightly to play his tapes "flat."

The situation is no less chaotic at the high-frequency end of the spectrum, where improvements in both heads and tapes have made the older "standards" unrepresentative of equipment actually in use. New oxides have greater high-frequency response, which requires changing the amount of treble boost, as well as the level of bias, during playback. Again, a new standard is lacking, and in its absence tapes made on one machine may not sound the same on another.

Quadraphonic sound presents still another challenge. When converting from mono to stereo, Philips wisely decided to put both left and right channels onto the same half of the tape (by reducing the track width, of course). This meant that a mono cassette player whose record/playback head spanned 0.56 inch would automatically combine and play *both* of the new 0.21-inch stereo channels. And, as in mono days, the cassette could be turned over for side two.

But Philips' demand that there be two program "sides" and complete compatibility has so far kept the cassette out of the discrete four-channel market. The Philips format involves making an eight-track cassette—putting four channels where there are now two, and cutting the channel width on the tape to about 0.07 inch each. Even prototype laboratory heads that can meet these dimensions are rare, and the technical and manufacturing problems of producing them are enormous. Four channels in *one* direction are relatively easy, so perhaps this is another standard that should give way.

THE LEGAL SIDE OF TAPE RECORDING

Guidelines for what you can and cannot record with legal impunity

By MARSHALL LINCOLN

THE tape recorder has given the world a handy, accurate recording service for both business and pleasure. Its versatility and usefulness, however, have given rise to a number of legal and ethical questions which ultimately influence how, where, and when it can be used.

Questions facing tape recorder owners include such gems as: May we use our recordings for anything we wish without limitations? To what other electronic equipment may we connect our recorders without causing the law to look our way? Are there any special limitations placed on private citizens on the manner in which we use our recorders (limitations which do not apply to certain privileged groups)?

For those of us who own them, tape recorders have become part of our everyday lives: so, it is easy to overlook the fact that their use can create legal pitfalls. Some of these pitfalls may seem trivial at times, but it is good policy for each of us to be aware of circumstances which can bring the unwary under the scrutiny of the law.

Recording Phone Conversations. Let us consider the case of a tape recorder being used as an "automatic notebook" for taking accurate notes of lectures, interviews, business calls, etc. When you are talking face to face with someone and openly using a tape recorder, there can be little doubt that the conversation is being taped. But in the absence of face-to-face confrontation, as in the case of a telephone conversation, are you free to record? As many tape recorder owners have learned, they are *not* free to arbitrarily record telephone conversations.

A private citizen may record his own telephone calls only if his phone is connected to his recorder via a "coupling arrangement" containing a beeper. (The beeper generates an audio tone every 15 seconds or so to alert anyone on the line to the fact that the conversation is being taped.) Direct connection requires paying your telephone company for installation and use of the coupling device.

A much simpler and superior way to record phone conversations is with an inductive coupler or telephone pickup coil, a low-cost item which can be purchased from any number of dealers. Inductive pickups have the advantage that they do not create interference on the telephone line since no physical connection is made to the phone wires. *But* when telephone recording methods were being considered by the FCC, Bell Telephone was categorically opposed to inductive pickups.

The FCC pointed out that inductive couplers would eliminate any need for recorder salesmen to make special arrangements with the phone company whenever they wished to demonstrate their equipment. The telephone company took the position that its opposition to the inductive pickup

was based on the fact that it wanted to ensure the privacy of its customers' calls. It insisted that some sort of signal must be put on the line to warn everyone that the call was being taped. The FCC finally yielded to the phone company's arguments.

Broadcasters were once required to use beepers because they were not permitted to connect their telephones to their transmitters. When FCC rules were amended to permit broadcasters to connect regular phone calls into their transmitters (a fringe benefit of the Carterfone case of a few years ago), it meant that stations might not actually record calls before broadcasting them. So, they did not use a beeper because the rule specifically applied to *recordings* made from telephone lines.

The FCC rule on this matter states that broadcasters may either record for broadcast or to directly broadcast telephone conversations with the only warning being a simple announcement at the beginning that the conversation may be taped or broadcast. In some cases, such as when the caller dials an "open-mike" number, the broadcasters are not even required to make the announcement. The FCC reasons that it may be assumed the public will know their voices may be recorded or broadcast because they dialed the number.

This convenience has been a great boon to broadcasters since they can dispense with the beep tone which they may consider annoying on the air. However, the FCC has not allowed individual citizens the same convenience of simply stating at the start of a call that it will be taped for their own use.

Recording from a Receiver. You can record anything you wish from a radio or TV receiver tuned to any frequency in the spectrum without first having to obtain permission from anyone. However, the nature of the transmission taped determines how you may use your recordings. Any radio or TV public information or entertainment broadcast is public domain and can be recorded and played back for a non-commercial purpose. But if you record from a commercial channel (police, fire, aircraft, mobile telephone, etc.), you are *forbidden* under the FCC's "Secrecy of Communications" regulation from playing the recording for anyone else. Furthermore, you are enjoined from even repeating the contents of any transmission heard.

Recording from Records or Tapes. You are probably violating the rights of performers or others if you tape discs or prerecorded tapes. One section of the Copyright act states, "Where any person knowingly distributes infringing copies of any work . . . . to affect prejudically the owner of the copyright, he is guilty of an offense under this Act." This might conceivably be construed to mean a person taping a record who then loans the recorded tape to another party for dubbing purposes. Another part of the act refers to "profit." Does this mean money saved? Needless to say, persons who tape record material on a hobby level for personal use can and are doing so with reasonable safety, for how could an enforcement agency ever cope with the problem? Although some of your tapes might be considered to be technical violations of the law, chances of penalty are extremely small. It all rests with your conscience.

Recording Live Performances. At live performances—especially concerts given by well-known performers—you can run into a whole series of prohibitions designed to prevent you from using your recorder. For one thing, instrumental and vocal performers nowadays are plagued by bootleg record companies which secretly tape performances and sell record copies to an unsuspecting public. The performers, needless to say, receive no compensation whatsoever from the bootleggers. (Some shady operators get in as members of the audience with a small, battery powered recorder hidden on their persons. They use the recorders to make their "master tapes." The quality of the recordings possible from these small tape recorders may not be first class, but it is passable for hard rock and other loud music. Too, if the buyer has never heard a live performance by a given soloist or group, he has no real way of determining whether or not the selection was pirated.)

The hard-nosed attitudes of performers' agents and theater managers toward anyone they see carrying a tape recorder into a live performance is understandable. They are protecting their interests and the interests of the performers. Additionally, managers face stern union rules which forbid any recordings to be made unless a whole gang of union electricians is on hand (always assuming, of course, that you have received permission to make recordings). These rules are in union contracts: so there is nothing a theater manager can do about the situation.

When you plan to take a recorder to a live performance, remember that you are treading on dangerous ground. If you are caught with a recorder at a performance, chances are good that you will be hustled out the nearest exit. It would be better (and safer) to check with the theater manager before walking in with a tape recorder. If you are convincing in the telling of why you want the recording, there is always the remote possibility that permission will be granted—but don't count on it. □

BEST OF RECORDED TAPES

A roundup of some of the most outstanding recordings issued in tape format during the past year.

ARTIST/COMPOSER	TITLE	LABEL	CAT. NO.	FOR-MAT
Airto	Virgin Land	Salvation	SA8-701	(8)
			SAC-701	(c)
Akkerman, Jan	Tabernakel	Atco	TP7032	(8)
			CS7032	(c)
Allman, Gregg	Laid Back	Capricorn	M80016	(8)
			M50116	(c)
Bee-Gees	Mr. Natural	RSO	TP4800	(8)
			ICS4800	(c)
Beethoven	Concerto No. 5	London	M95097	(8)
			M94097	(c)

Loggins & Messina

Bodacious, D. F.		RCA	APSI-0206	(8)
			APKI-0206	(c)
Bruch/Mendelssohn	Violin Concerto E Minor/Concerto No. 1	Angel	8XS36963	(8)
			4XS36963	(c)
Buffett, Jimmy	Living and Dying . . .	Dunhill	C8023-50132	(8)
Burton/Corea	Crystal Silence	ECM	8F1024	(8)
Canned Heat	One More River . . .	Atlantic	TP7289	(8)
			CS7289	(c)
Captain Beefheart	Unconditionally Guaranteed	Mercury	MC8-1-709	(8)
			MCR4-1-709	(c)
Carter	String Quartets #2 & #3	Columbia	MAQ32738	(4/8)
Cobham, Billy	Crosswinds	Atlantic	TP7300	(8)
			CS7300	(c)
Como, Perry	Perry	RCA	CPSI-0585	(8)
			CPKI-0585	(c)
Cooder, Ry	Paradise & Lunch	Reprise	M82179	(8)
			M52179	(c)
Cooper, Alice	Greatest Hits	Warner	L8W-2803	(8)
			L5W-2803	(c)
Croce, Jim	I Got a Name	ABC	M-8022-797	(8)
			M-5022-797	(c)

Cleo Laine

ARTIST/COMPOSER	TITLE	LABEL	CAT. NO.	FOR-MAT
Davis, Miles	Big Fun	Columbia	PGA-32866	(8)
			PGT-32866	(c)
Dee, Kiki	Loving and Free	Rocket	MCAT-395	(8)
			MCAC-395	(c)
Dr. John	Desitively Bonnaroo	Atco	TP7043	(8)
			CS7043	(c)
Dylan, Bob	Before the Flood	Asylum	8201	(8)
			8C520	(c)
Evans, Gil	Svengali	Atlantic	M81643	(8)
			M51643	(c)
Family	It's Only a Movie	UA	UA-EA-181-G	(8)
Faure	Requiem	Columbia	MAQ32883	(8)
Gypsy	Orig. London Cast	RCA	LBS1-5004	(8)
			LBK1-5004	(c)
Hollies	Hollies	Epic	EA32574	(8)
			ET32574	(c)
Holst	The Planets	Columbia	MAQ31125	(4/8)
			MA31125	(8)
			MT31125	(c)
Ian, Janis	Stars	Columbia	CA32857	(8)
Jackson, Milt	Goodbye	SKJ	CT8-6038	(8)
			CTC-6038	(c)
James, Bob	One	CTI	CT8-6043	(8)
			CTC-6043	(c)
Jefferson Airplane	Early Flight	Grunt	CYS1-0437	(8)
			CYK1-0437	(c)
King, Albert	I Wanna Get Funky	Stax	ST8-5505	(8)
Kinks, The	Preservation Act I	RCA	LPS1-5002	(8)
			LPK1-5002	(c)
Kottke, Leo	Ice Water	Capitol	8XT-11262	(8)
			4XT-11262	(c)
Laine, Cleo	I Am a Song	RCA	LPS1-5000	(8)
Laine, Cleo	Live at Carnegie Hall	RCA	LPS1-5015	(8)
			LPK1-5015	(c)
Laws, Hubert	In the Beginning	CTI	CT8-3+3	(8)
			CTC-3+3	(c)

The Bee-Gees

ARTIST/COMPOSER	TITLE	LABEL	CAT. NO.	FOR-MAT
Lightfoot, Gordon	Sundown	Reprise	M82177	(8)
			M52177	(c)
Loggins & Messina	Full Sail	Columbia	CA32540	(8)
			CT32540	(c)
Mahavishnu Orchestra	Between Nothingness . . .	Columbia	CA32766	(8)
			CT32766	(c)
Mahavishnu Orchestra	Apocalypse	Columbia	CA32967	(8)
			CT32967	(c)
Mason, Dave	It's Like You Never Left	Columbia	CA31721	(8)
			CT31721	(c)
Mott the Hoople	The Hoople	Columbia	PCA-32871	(8)
			PCT-32871	(c)
Messiaen	Visions de l'Amen	RCA	ARS1-0363	(8)
			ARK1-0363	(c)
Mingus, Charles	Mingus Moves	Atlantic	TP1653	(8)
			CS1653	(c)
Mitchell, Joni	Court and Spark	Asylum	TP-5072	(8)
			CS-5072	(c)
Mozart/Shubert	Symphony #41/ Symphony #8	DG	89468	(8)
			3300318	(c)
Newbury, Mickey	I Came to Hear . . .	Elektra	ET8-1007	(8)
			TC5-1007	(c)
Nitty Gritty Dirt Band	Stars and Stripes . . .	UA	EA184-J	(8)
Parkening, Christopher	Album	Angel	8XS-36069	(8)
			4XS-36069	(c)
Pickett, Wilson	Miz Lena's Boy	RCA	APS1-0312	(8)
			APK1-0312	(c)
Prine, John	Sweet Revenge	Atlantic	TP7274	(8)
			CS7274	(c)
Rachmaninoff	Sonata No. 2, etc.	RCA	ARS1-0352	(8)
			ARK1-0352	(c)
Rachmaninoff	Piano Transcriptions	RCA	ARS1-0357	(8)
			ARK1-0357	(c)
Raisin	Orig. Cast Album	Columbia	KSA32754	(8)
			KST32754	(c)
Raitt, Bonnie	Takin' My Time	Warner	M82729	(8)
			M52729	(c)
Ross, Diana	Last Time I Saw Him	Motown	M812T	(8)
			M812C	(c)
Ross, Diana	Live at Caesar's Palace	Motown	M801BT	(8)
			M801BC	(c)
Schumann	Faust	London	K-412100	(r)
			J-512100	(c)
Seals/Crofts	Unborn Child	Warner	T383	(8)
			C383	(c)
Siegel-Schwall Band	953 West	Wooden Nickel	BWS1-0121	(8)
			BWK1-0121	(c)
Siegel-Schwall Band	Last Summer	Wooden Nickel	BWS1-0288	(8)
			BWL1-0288	(c)
Simon, Carly	Hotcakes	Elektra	ET85075	(8)
			TC55075	(c)
Sir Douglas Band	Texas Tornado	Atlantic	TP7287	(8)
			CS7287	(c)
Sly & The Family Stone	Small Talk	Epic	EAQ32930	(4/8)
			PEA32930	(8)
			PET32930	(c)
Sopwith Camel	Miraculous Hump . . .	Warner	M82108	(8)
			M52108	(c)
Springsteen, Bruce	The Wild . . .	Columbia	CA32432	(8)
Taylor, James	Walking Man	Warner	L8W2794	(8)
			L5W2794	(c)
Temptations	1990	Gordy	BT966	(8)
			BC966	(c)
Three Dog Night	Hard Labor	ABC/ Dunhill	8023-50168C	(8)
			5023-50168C	(c)
Turner, Ike & Tina	Nutbush City Limits	UA	UA-EA180G	(8)
			UA-CA180G	(c)

Ike & Tina Turner

Tyner, McCoy	Song of the New World	Milestone	8-9049	(8)
			9049M	(c)
Velvet Underground	1969 Live	Mercury	MC8-1-7504	(8)
Vivaldi	Violin Concertos #5, #6, #7, #8	Columbia	MAQ32693	(4/8)
Walton/Stravinsky	Concerto Violin & Orch./ Concerto in D	London	M86819	(8)
			M56819	(c)
Weather Report	Mysterious Traveller	Columbia	CA32494	(8)
			CT32494	(c)
Williams, Andy	Solitaire	Columbia	CA32383	(8)
			CT32383	(c)
Winter, Edgar/Group	Shock Treatment	Epic	EAQ32461	(4/8)
			PEA32461	(8)
			PET32461	(c)
Young, Jesse Colin	Song for Jule	Warner	M82734	(8)
			M52734	(c)

(8) 8-track cartridge; (c) cassette; (r) open-reel; (4/8) 4-channel, 8-track cartridge

New Line of Classical Prerecorded Cassettes Introduced

THERE is good news for classical music buffs who have been frustrated by the relatively limited number of titles available on prerecorded cassettes. Advent, perhaps best known for its hi-fi speakers and Dolbyized cassette decks, has launched the CR/70 series which draws its material from the master tapes of Nonesuch Records and Connoisseur Society as well as from a limited library of original productions.

The things which set the CR/70 series apart from the run-of-the-mill prerecorded cassette is the screw-assembled tape housings (repairable); individual testing of each cassette; use of chromium-dioxide tape; Dolby "B" encoding; and use of the standard 70-μs playback characteristic for optimum signal-to-noise ratio.

The full current library was sampled: the average recording level varied widely depending on the particular selection, with maximum dynamic range being fully exploited in each case. On some of the tapes, crescendos drove the meters to their stops, but there was never any distortion from tape saturation or overloaded electronics.

The new CR/70 series releases are priced competitively with their disc counterparts (and may even undersell them as the price of vinyl climbs). In several of the cassettes a complete recording is impressed on side-one of the tape, leaving side-two blank for the user's own recordings. Each cassette comes with comprehensive annotation; in the form of a capsule program note which can be augmented by sending in a postage-paid card which brings the full set of program notes as printed for the original disc recording.

Another welcome "plus" is that any cassette which fails in a properly operating player can be returned to Advent for no-charge repair or replacement.

For the present, distribution is limited to some of the largest audio outlets from coast-to-coast, but it is anticipated that more stores will be handling the cassettes in the near future and more titles will be added to the current library.

How to keep the musical excellence you've already paid for:

Your tape system
The tape equipment of your system is your musical memory bank. It is the **one** area where only the best makes sense. Choose carefully, select a recording instrument that neither adds nor detracts from the sound you put into it. Few machines really meet this requirement. The Revox A77 does – and by a safe margin.

Your tape recorder and your money
A **truly** professional quality tape unit is your wisest audio investment. It will last for years and years.

Witness the number of Revox machines built more than 20 years ago that are still in service! It's hardly surprising then, that Revox recorders command very high prices second or third hand – if you can find them available!

Revox owners seldom change – other than to a later model Revox.

It's also interesting to note that our warranty records show that on average our users have bought 2 or 3 other makes before choosing Revox. Then we read the lament "I only wish I'd bought a Revox sooner."

When you play it later, will it still sound the same?
At first sight this could seem an unnecessary question. It's not though. In the course of time a high fidelity enthusiast upgrades one or more units in his system.

With time, rising affluence plus advancing technical innovation in all aspects of audio, will bring better reproduction within the scope of all.

The recordings that you make now could, therefore, sound even better in the future – when, as finances permit, you add a better amplifier or loudspeaker to your equipment.

Conversely, a poor recording made now will sound **really** inferior when exposed to more exacting playback.

With the Revox A77 you will **retain the excellence** of every recording to enjoy now – and perhaps appreciate **even more** in the future.

So visit your nearest Revox Dealer for full information and a demonstration.

Record it on a Revox A77

REVOX

Revox Corporation
155 Michael Drive
Syosset, N.Y. 11791

Revox Coproration
3637 Cahuenga Blvd West
Hollywood, CA 90068

Revox Canada Ltd.

Revox
C.E. Hammond Co. Ltd.
Lamb House
Church Street, London W4 2PB

Revox International
Regensdorf 8105 ZH
Althardstrass 146
Switzerland

Please tell me where I can see and buy Revox ☐ A77 Revox ☐ Good used machines*

Name _____ State _____

Address _____ City _____ Zip _____

*As and when available from our dealers.

CHE

The illustration contains optional extras.

CIRCLE NO. 15 ON READER SERVICE CARD

AKAI

GX-210D Stereo Tape Deck

Two-speed (7½ & 3¾ ips); 4-track, 2-channel stereo system. Response 30-25,000 Hz ±3 dB

(low-noise tape); 30-23,000 Hz ±3 dB (regular tape). 7" reels. Wow & flutter 0.08% rms at 7½ ips; distortion 1.5% (1000 Hz, 0 VU); (S + N)/N 50 dB. Three motors; two heads (one record/erase GX and one playback GX). Two mike and two line input jacks plus DIN jack. 14.5" × 14.6" × 8.9" $459.95

GX-600D Stereo Tape Deck

Two-speed (7½ & 3¾ ips); 4-track, 2-channel stereo/mono system. Will handle up to 10½"

reels. Response 30-23,000 Hz ±3 dB at 7½ ips; wow & flutter 0.07% rms; distortion less than 0.7%. (S + N)/N 56 dB. Has three heads and three motors; two mike and line input jacks; one DIN jack. 17.4" × 18.7" × 9" $599.95
GX-600DB. Same except with Dolby noise-reduction circuit. (S + N)/N 64 dB with Dolby $699.95

4400 Stereo "Convert-a-Deck"

Stereo design featuring front-panel converter switch which changes unit from recorder to deck. Has SOS, SWS, sound mixing, dual monitoring, output level control, pause control,

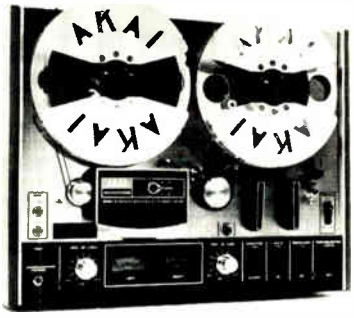
automatic shutoff. Two speeds (7½ & 3¾ ips). three heads, one motor. (S + N)/N 50 dB; wow & flutter 0.15%; distortion 1.5%, 7½ ips $369.95

1722W Tape Recorder

Two-speed (3¾ & 7½ ips), 4-track, 2-channel stereo. Wow & flutter 0.14% rms at 7½ ips. Response 30-21,000 Hz ±3 dB at 7½ ips. THD 2%. (S + N)/N −50 dB. Bias frequency 63 kHz. Has one record/playback & one erase head. Inputs: mike (0.5 mV) & line (150 mV). Two built-in 5" × 7" speakers. Features p.a. capability, automatic shut-off, equalizer preamp for direct phono input, selector switch for regular or low-noise tape. 14⅛" × 14½" × 9⅞" $319.95

4000DS Stereo Tape Deck

Two-speed (3¾ & 7½ ips), 4-track, 2-channel stereo. Wow & flutter 0.07% rms at 7½ ips. Response 30-26,000 Hz ±3 dB at 7½ ips. THD 1.5%. (S + N)/N −50 dB. Bias frequency 100 kHz. Has separate record, play, and erase heads. Line output 1.23 V. Inputs: mike (0.8 mV) & line (60 mV). Features selector switch for regular or low-noise tape; sound-on-sound;



sound-with-sound; mixing; automatic shut-off; pause control. 16" × 12½" × 7⅝" $299.95
4000DB. Same as 4000DS but with Dolby built in $379.95

CROWN INTERNATIONAL

CX722 Tape Recorder

Three-speed (15, 7½, 3¾ ips), 2-track, 3-motor design. Will handle up to 10½" reels. Has three

heads. Response 20-20,000 Hz ±2 dB. Wow & flutter 0.09% at 7½ ips. Features braking, automatic shut-off, two VU meters, pause control, and optional counter $1495.00
CX724. Same except 4-track version; response 20-25,000 Hz ±2 dB $1495.00

CX822 Tape Recorder

Three-speed (15, 7½, 3¾ ips), 2-track, 3-motor design. Will handle up to 10½" reels. Response 30-30,000 Hz ± 2.0 dB. Wow & flutter 0.06% at 15 ips. (S + N)/N 60 dB. Has braking, two VU meters, automatic shut-off, pause control, monitoring facilities, optional counter, and remote record. $1995.00
Four track version $1995.00
Four-channel in-line version $2995.00

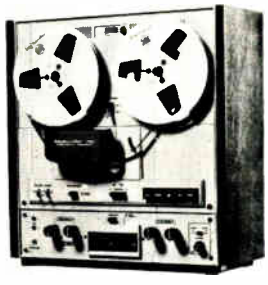
SX724 Tape Recorder

Two-speed (7½, 3¾ ips), 2-ch, ¼-track, 3-motor design. Will handle up to 10½" reels. Response 20-25,000 Hz ±2 dB. Wow & flutter 0.09% at 7½ ips. (S + N)/N 60 dB. Has braking, two VU meters, automatic shut-off, monitoring facilities, pause control, and optional counter. 15 and 1⅞ ips available $1095.00
SX724-P4C. 2- and 4-track version; plays 4-channel in-line $1495.00

DOKORDER

7100 Reel-to-Reel Tape Deck

Two-speed (7½ & 3¾ ips), 3-head, 4-track stereo tape deck. Features a four-pole induction



and 2 six-pole eddy-current type induction motors; automatic tape lifters; automatic shut-off; tape selector switch; echo & sound-on-sound; tape/source monitor. Wow & flutter 0.08% W rms at 7½ ips. (S + N)/N 55 dB. Re-

1 Open-Reel Tape Machines

sponse 40-21,000 Hz at 7½ ips $399.95

9200 Stereo Tape Deck
Two-speed (7½ & 3¾ ips) bi-directional record & playback for continuous recording of up to

1½ hours at 7½ ips on 1800-foot tape; automatic memory for programming order of selections for playback; adjustable recording bias; pause control; tape tension switch; computer-controlled transport; professional mixing; echo, sound-on-sound, sound-with-sound Has six heads for recording and monitoring in either direction; center capstan drive; built-in reel holders; quick-change head housing; turntable height adjustment; automatic tape lifters; remote-control operation (optional extra); built-in head demagnetizer. Features three motors; will handle 5" & 7" reels; response 25-26,000 Hz, S/N 58 dB. stereo channel separation 50 dB, crosstalk 55 dB, all at 7½ ips. 17" W × 16½" D × 20" H $949.95

1120 Stereo Tape Deck
Two-speed (15 & 7½ ips), three-motor deck; will handle 10½" reels. Can be used as 4-track,

2-channel deck or can be converted to a 2-track, 2-channel record/play deck; provides built-in circuitry for synthetic echo, sound-on-sound, sound-with-sound, and locking pause control for editing tape while recording or during playback. Wow & flutter 0.06%, S/N 60 dB, crosstalk 58 dB at 1 kHz, response 25-24,000 Hz, all at 7½ ips. 16⅞" W × 17¾" H × 6¾" D. $649.95

FERROGRAPH

Super Seven Series Tape Recorders
Three speeds (7½, 3¾, 1⅞ ips). Has three heads and three motors; braking; VU meters; electronics editing; sound-on-sound, sound-with-sound, echo, and re-record facilities; variable speed wind/rewind; 10½" reel capacity; solid-state FET front end at mike input; 4-digit counter. Has full range of inputs and outputs.

Response (record/play) 30-17,000 Hz ±2 dB at 7½ ips, 40-14,000 Hz ±3 dB at 3¾ ips, 50-7000 Hz ±3 dB at 1⅞ ips. Available in 2- and 4-track stereo models; with or without amplifiers and speakers; 15, 7½, 3¾ ips operation; optional Dolby-B noise reduction with every speed configuration. 117-V, 60-Hz operation ..... $1025 to $1200

JVC

RD-1696 Tape Recorder Deck
4-track, 3-speed (7½, 3¾ & 1⅞ ips), 2-channel stereo design. Response 30-18,000 Hz ±3 dB at

7½ ips; (S + N)/N −52 dB; wow & flutter 0.13% rms at 7½ ips. Has mike (0.5 mV) & aux. (80 mV) inputs. Line output 0-1 V. Has switch for either low-noise or standard tape; two heads (record/play and erase). 7½" × 15¾" W × 12¾" D. $249.95

OTARI

MX-5050-2S Tape Deck
Two-speed (15 & 7½ or 7½ & 3¾ ips); two-channel, four-head (two-track erase, record and

playback, four-track playback); three motors (hysteresis synchronous); will handle up to 10½" reels; pushbutton, remote controllable transport with full logic circuitry and motion sensing; edit & cue facilities; built-in splicing block on head cover; response 30-20,000 Hz, wow & flutter 0.04% peak weighted (both at 15 ips); S/N 65 dB; output level 0 VU into 600 ohms unbalanced line; features front-adjustable bias and two-speed equalization; built-in test oscillator; standard reference level calibrate switch; VU meter adjust; individual channel record select & synchronous reproduce select, with "punch-in" record from play mode; has separate mike/line level controls; source/tape monitor switch; stereo headphone jack; four-digit resettable tape counter; mahogany case with carrying handles. 17" W × 19" H × 7⅜" D. $1345.00
MX-5050-4S. Same except 4-track, 2-channel with two-track reproduce head; S/N 63 dB. $1345.00
MX-5050-2S-2. Same except with d.c. servo capstan with ±10% variable speed .. $1545.00

PIONEER

RT-1011L Stereo Tape Deck
Four-track, two-speed (7½ & 3¾ ips), three-motor, three-head stereo deck; 4/8 pole hysteresis synchronous motor; solenoid-operated direct-changeable function buttons; mechanically lockable function buttons for automatic recording facility; wow & flutter 0.07% W rms; S/N 55 dB; dist. 1%; response 40-20,000 Hz ±3 dB; crosstalk 50 dB; has full complement of inputs & outputs; will handle up to 10½" reels. 16⅞" W × 16⅞" H × 8⅞" D... $599.95

RT-1050 Stereo Tape Deck
Two-track, two-speed (15 & 7½ ips), three-motor, three-head stereo deck. Has 4/8 pole, two-speed hysteresis synchronous motor (cap-

stan drive) and 6-pole inner-rotor induction motor (reel drive). Response 30-22,000 Hz ±3 dB at 15 ips; 40-20,000 Hz ±3 dB at 7½ ips; wow & flutter 0.04% W rms at 15 ips; (S + N)/N 57 dB; stereo channel separation 53 dB at 1000 Hz; 125 kHz bias frequency. Features 3-step bias selector; 4-step EQ selector; dual-scale level meters; recording peak indicator; lockable electronic controls (including pause); two pairs of line inputs; full complement of inputs and outputs. 120-V, 60-Hz operation. 18⅛" W × 17⅞" H × 9⅝" D ... $699.95

RADIO SHACK

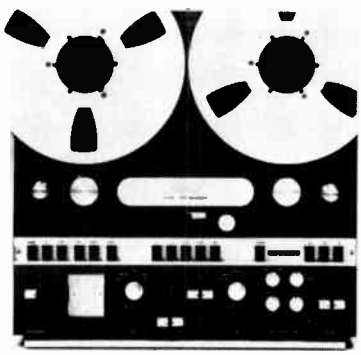
999B Stereo Tape Deck

Three speeds (7½, 3¾, 1⅞ ips); 4 tracks; 3 heads. Has two VU meters and level controls. Provisions for professional sound-on-sound recordings. Tape/source monitor. Response 40-20,000 Hz at 7½ ips; wow & flutter 0.2% rms at 7½ ips. Overall size 16" × 13¼" × 7⅜" $239.95

REVOX

A700 Stereo Tape Recorder

Three-motor, three-speed (15, 7½, 3¾ ips) recorder. Features computer-type digital control logic with memory circuits; quartz-crystal speed-control reference; frequency and phase servo system for capstan speed control; two tape-tension sensors governing servo-controlled reel motors. Has logic-controlled tape tension which is automatically maintained even with mixed reel sizes; electronic tape-motion sensor; minutes and seconds readout on tape counter. Plug-in head assembly (¼ or ½ track available); three heads with fourth control head (optional). Fail-safe auto stop logic to eliminate possibility of tape breakage; electronic pause control operating on all functions; instant repeat play control; continuous unattended re-



cord or play function; solid-state switching of audio circuits. Features built-in four-input mixer; switched selection of 12 input sources including four balanced hi/lo mike inputs; built-in magnetic phono preamp; master record-level slide fader; stereo echo; five independent stereo outputs; standard zero-level line outputs and level & tone-controlled outputs; VU meters with instantaneous over-modulation indicators; variable speed (+ or − 7 halftones with remote-control accessory); variable speed (2.5 to 21.5 ips with external oscillator); input or off-tape metering $1800.00

A77 MkIV 1102 Tape Deck

Two-speed (3¾ & 7½ ips or 7½ & 15 ips), 2-track, 3-motor, 3-head deck. Will handle up to

10½" reels. Response 30-20,000 Hz ±2.5 dB at 7½ ips. Wow & flutter 0.08% peak at 7½ ips. (S + N)/N 61 dB at 7½ ips. Has a servo braking system, VU meters, automatic shut-off, relay and solenoid operation, full remote control, and off-the-tape monitoring. Options include plug-in 10 W/ch continuous power amplifiers. a suitcase version with built-in speakers, metal cage for rack or custom mounting. 16⅜" H × 14³/₁₆" W × 7⅛" D $959.00

Model A77 MkIV 1104. A 4-track version of Model 1102. Same options available .. $959.00

A77 MkIV Dolby B Oeck. Same as 1102 or 1104 but with Dolby B noise-reduction system. Has separate compressors and expanders for each channel. (S + N)/N 70 dB (ASA A curve weighted) at 7½ ips, 2-track $1172.00

SONY from SUPERSCOPE

TC-270 Stereo Tape Recorder

Economy design featuring quarter-track stereo/mono play & record, three speeds (7½, 3¾

& 1⅞ ips), straight-line record & playback level controls, two VU meters, automatic end-of-tape shutoff, and sound-on-sound. 5 W/ch continuous power. Response 30-18,000 Hz ±3 dB at 7½ ips. (S + N)/N 50 dB; wow & flutter 0.12% at 7½ ips. Sensitivity: aux. 0.06 V; low-imp. mike −72 dB (can be used as phono input with optional RK-66 adapter). Has line output 0.43 V at 0 VU; two lid speakers. 8 ohms. 20¼" W × 10¼" H × 15¼" D. Comes with carrying case. $399.95

TC-280 Stereo Tape Recorder Deck

Economy quarter-track stereo/mono design featuring three speeds (7½, 3¾ & 1⅞ ips), tape select switch, sound-with-sound, dual VU

record meters, pause control. May be operated vertically or horizontally. Response 40-18,000 Hz ±3 dB at 7½ ips with regular tape (40-21,000 Hz ±3 dB with SLH-180 tape). (S + N)/N 52 dB with standard tape (55 dB with SLH-180 tape). Sensitivity: aux. 0.06V; mike (low-imp) −72 dB (mike input can be used as mag. phono input with RK-66 optional adapter). Line output 0.775 V at 0 VU. Wow & flutter 0.10% at 7½ ips. 15¾" W × 7⅜" H × 14⅛" D. Comes with walnut base. $279.95

TC-353-D Stereo Tape Deck

Features three speeds (7½, 3¾, 1⅞ ips) and three heads. Has line & mike mixing, pause control, automatic shutoff, VU meters. Sound-on-sound with optional Sony MX-6S mixer. 15⅜" W × 7⅞" H × 13⅜" D. $349.95

TC-377 Stereo Recorder Deck

Features 3-speed (1⅞, 3¾ & 7½ ips), 3-head, 4-track design. Response 30-20,000 Hz ±3 dB at 7½ ips. (S +N)/N 52 dB (standard tape) 55 dB (SLH-180 tape). Has aux. (0.06 V sensitivity) & mike (−72 dB sensitivity) inputs & line output (0.775 V). Bias frequency 160 kHz. Wow & flutter 0.09% at 7½ ips. Has two VU meters, one induction motor. Features mike-line record level mixing controls, tape select switch for Sony standard or low-noise, high-output tape. Has pause control and an automatic total mechanism shut-off. Reversible walnut base for vertical or horizontal operation. Sound-on-sound capability with the MX-6S mixer. 16½" W × 8⅜" H × 15½" D $399.95

TC-458 Stereo Tape Deck

Two-speed (7½ & 3¾ ips); automatic-reverse stereo deck with ferrite & ferrite roto bi-lateral

heads; response 30-20,000 Hz ±3 dB at 7½ ips (standard tape), 30-25,000 Hz ±3 dB (SLH-180 tape). (S + N)/N 53 dB (standard), 56 dB (SLH-180 tape). Wow & flutter 0.06% rms (NAB) weighted; four heads (2 erase, 1 record, 1 playback); induction a.c. servo motor; two illuminated VU meters. Includes tape-tension regulators, tape path adjuster, built-in reel locks, 4-digit tape counter; closed-loop dual-capstan tape drive. Can be adapted for sound-on-sound, echo. 120-V, 60-Hz operation. 15¹³/₁₆" W × 16³/₁₆" H × 7¹⁵/₁₆" D $499.95

TC-558 Stereo Tape Deck

Three-motor automatic reverse stereo deck with six heads (ferrite erase, ferrite and ferrite record & playback); features "Symphase" recording for taping 4-ch sound from any SQ or FM matrix source; two speed (7½ & 3¾ ips); will handle 7" reels; response 30-20,000 Hz ±3 dB (standard tape), 30-25,000 Hz ±3 dB (SLH-180 tape); S/N 53 dB (standard), 56 dB (SLH-180) all at 7½ ips; has two line, two mike, headphone, and phono inputs; two VU meters; two line & one phono outputs. 17⁹/₁₆" W × 6⁷/₁₆" H × 13⅛" D $769.95

TC-756 Stereo Tape Deck

Two-speed (15 & 7½ ips) stereo deck; will handle up to 10½" reels; frequency response 30-15,000 Hz at 7½ ips. 30-22,000 Hz at 15 ips, both ±3 dB with standard tape; 30-25,000 Hz at 7½ ips, 30-30,000 Hz at 15 ips, both ±3 dB with SLH-180 tape; S/N 56 dB (standard tape), 59 dB (SLH-180); features 4-digit tape counter; illuminated pause control with lock; reel-size selector switch; record timer lock; illuminated left & right record buttons; record & bias equalization selector switches; illuminated VU meters; stereo headphone monitor jack; ferrite and ferrite heads; three motors; logic-controlled transport functions. Comes with 10½" reel adapters, two stereo patchcords, 10½" plastic reel, and head cleaning ribbon. 17⅛" W × 17¾" H × 8¾" D ... $899.95

TC-570 Stereo Tape Recorder

Three-head stereo tape system with integral speaker systems; three speeds (7½, 3¾, 1⅞ ips); will handle up to 7" reels; response 30-20,000 Hz ±3 dB (standard tape), 30-25,000 Hz ±3 dB (SLH-180 tape), both at 7½ ips; features 4-digit tape counter; illuminated VU meters; provides full complement of inputs and outputs; comes with two F-25 mikes, two RK-74 patchcords, head-cleaning ribbon, empty 7" reel. 20³/₁₆" W × 15⅜" H × 10³/₁₆" D. weight 41 pounds, 4 ounces. $449.95

TC-755 Stereo Tape Deck

Two-speed (7½ & 3¾ ips), 3-head, 3-motor deck with 10½" reel capacity. Response 30-20,000 Hz ±3 dB (standard) and 30-25,000 Hz ±3 dB (SLH-180 tape); wow & flutter 0.05%. Provides mechanical memory capability with timer, bias select switch, ferrite heads, tape

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path adjustment, twin illuminated VU meters, 4-digit tape counter, -and built-in reel locks. (S + N)/N 53 dB (standard), 56 dB (SLH-180 tape). 120-V, 60-Hz operation. 17⅛" W × 17¾" H × 8½" D $699.95

TC-645 Stereo Tape Deck

Three-motor, three-head stereo deck with ferrite & ferrite heads; 7½ & 3¾ ips; will handle up to 7" reels; response 30-20,000 Hz ±3 dB (standard tape), 30-25,000 Hz (SLH-180 tape), both at 7½ ips; features 4-digit tape counter; illuminated VU meters; full complement of inputs and outputs; wow & flutter 0.07% at 7½ ips, 0.11% at 3¾ ips; comes with two RK-74 stereo patchcords, 7" plastic reel. 14⅞" W × 14⅝" H × 8⅞" D. $549.95

TC-758 Stereo Tape Deck

Three-motor, automatic-reverse stereo tape deck; 7½ & 3¾ ips speeds; will handle up to

10½" reels; response 30-20,000 Hz ±3 dB (standard tape), 30-25,000 Hz ±3 dB (SLH-180 tape), both at 7½ ips; features 4-digit counter; illuminated pause control with lock; illuminated VU meters; full complement of inputs & outputs; F & F heads; walnut base. 17¾" W × 17⅛" H × 8¾" D. $999.95

TANDBERG

Series 11 Tape Recorder

Portable (15 V, ten 1½-V cells), mono design. Three speeds (7½, 3¾, 1⅞ ips), and has three heads. Will handle up to 7" reels. Has automatic level-input controls, mike & line mixing, and built-in speaker. Response 40-16,000 Hz ±2 dB at 7½ ips, wow 0.1% at 7½ ips, (S + N)/N 58 dB unweighted. 13" W × 10" D × 4".

Model 11-1. Full-track $995.00
Model 11-2. Two-track $995.00
A.c. power supply $99.50

Series 15 Tape Recorder

Mono design with built-in 4" × 7" speaker. Three speeds (7½, 3¾, 1⅞ ips). Response 40- 16,000 Hz ±2 dB at 7½ ips, wow 0.1% at 7½ ips, (S + N)/N at max. record level 55 dB. 5 W/ch continuous output with both channels driven. Has 0.75 V preamp outputs, low-Z mike & high-and low-level inputs. 13⅜" W × 11⅞" D × 6¾".

Model 1541. Four-track $313.50
Model 1541F With foot remote control $418.00

Model 1521. Two-track $295.00
Model 1521F. With foot remote control $399.00

3300X Tape Recorder Deck

Three-speed (1⅞, 3¾ & 7½ ips) design featuring crossfield recording techniques; peak-reading record meters; four heads for sound-on-sound, sound-with-sound, and echo; input mixing; and photoelectric end stop. Has inputs for dynamic mike, receiver/tuner, and record

player. Supplied in half- or quarter-track versions. On request, can be equipped for 4-channel playback. Walnut cabinet (rosewood on special request). 15¾" × 7" × 16⅛" D. $499.90

3600XD. Same as 3300X except includes Dolby circuit $699.00

Series 14 Tape Recorder

Same as Series 15 except 2-speed (3¾ & 1⅞ ips) design.

Model 1441. Four-track without case $290.00
Model 1421. Two-track without case .. $270.00

9200XD Dolbyized Stereo Deck

Three-speed (7½, 3¾ & 1⅞ ips), Dolbyized deck; Max. wow 0.06% W rms at 7½ ips; response 25-24,000 Hz ±3 dB, 30-22,000 Hz ±2 dB at 7½ ips; crosstalk 50 dB stereo at 1000 Hz; max. tape dist. at 0 dB record level 2%.

Features one-hand tape threading; peak-reading dB meters; linear-motion input and output level controls; crossfield heads; (S + N)/N 73 dB at 7½ ips. $1049.00

9100X. Same as 9200XD but without the Dolby circuit $899.00

Series 10XD Stereo Tape Deck

Three-speed (15, 7½, 3¾ ips), three-motor deck with Dolby noise-reduction system; will

handle up to 10½" reels; 4/2 track; response 30-25,000 Hz ±2 dB, 25-27,000 Hz ±3 dB (both at 15 ips); speed tolerance ±0.3%; wow 0.04% max at 15 ips (weighted); crosstalk attenuation 50 dB in stereo at 1000 Hz; has full complement of inputs, outputs, controls; peak reading meters; crossfield heads; mike & line mixing facilities; logic circuit with memory; 45 cm × 43.5 cm × 18.5 cm. Comes with 10½" empty reel, NAB adapters, input-output connection cord. Remote control, pitch control kit, and rack mounting kit available as optional extras. $1299.00

TEAC

2300S Stereo Tape Deck

Two-speed (7½ & 3¾ ips) four-track, two-channel deck. Features push-button transport control with logic circuitry; dual VU meters; separate bias/equalization switches; record/pause lights; total remote-control capability. Has dual-speed hysteresis synchronous capstan motor and two eddy-current induction reel motors. Response 40-24,000 Hz at 7½ ips; 40-16,000 Hz at 3¾ ips; wow & flutter 0.08% at 7½ ips. (S + N)/N 58 dB. 17¹⁵⁄₁₆" × 15⁷⁄₁₆" × 8½" D. $499.50

3300S Stereo Tape Deck

Two-speed (7½ & 3¾ ips), four-track, two-channel deck. Will handle up to 10½" reels; offers remote-control capability; push-button transport control with logic circuitry; dual level bias oscillator for low-noise recording; d.c.-coupled equalization network. Features dual VU meters; pause control with indicator light; separate mike/line level controls; tape/source

monitor switch; stereo headphone jacks; 4-digit resettable tape counter. Response 40-24,000 Hz at 7½ ips; 40-16,000 Hz at 3¾ ips; wow & flutter 0.06% at 7½ ips; (S + N)/N 58 dB. 17⁵⁄₁₆" W × 17⁵⁄₁₆" H × 8⁵⁄₁₆" D. $699.50

3300S-2T. Same except two-track- two-channel with 15 or 7½ ips speeds. Response 30-26,000 Hz at 15 ips; 30-24,000 Hz at 7½ ips; wow & flutter 0.04% at 15 ips; (S + N)/N 60 dB. $739.50

4300 Auto-Reverse Stereo Deck

Two speed (7½ & 3¾ ips), three-motor, four-head stereo deck with automatic reverse. Features push-button transport control, pause control with indicator light, dual VU meters; separate bias/equalization switches; separate mike/line inputs; separate mike/line level controls. Will handle up to 7" reels; records in four-track, 2-channel stereo. Includes memory counter for automatic repeat and memory marker level guides; total remote-control capability.

Response 40-24,000 Hz; wow & flutter 0.06% both at 7½ ips. (S + N)/N 55 dB. 17⁵⁄₁₆" × 19¼" × 8½". $679.50

5300 Stereo Tape Deck

Two-speed (7½ & 3¾ ips), four-track, two-channel deck. Will handle 7" reels. Features direct-capstan drive servo-controlled motor; d.c. reel motors; automatic reverse; push-button transport control. Has separate bias & equalization switches; dual-scale VU meters; remote control for all functions including record & pause; memory marker level guides. Response 40-24,000 Hz; wow & flutter 0.08%, both at 7½ ips. (S + N)/N 60 dB. $769.50

5500 Auto-Reverse Stereo Deck

Two-speed (7½ & 3¾ ips), four-track, two-channel deck with automatic-reverse play. Direct-capstan drive servo-controlled motor, four high-density Permaflux heads, and dual-process Dolby noise-reduction system, permitting simultaneous Dolbyized recording with decoded tape monitoring; Dolby FM/Copy function; MPX filter switch; Dolby calibration oscillator; source/tape monitor switch. The 4-head machine with separate playback, reverse playback, record, and erase also has a "punch-in" feature which permits change from play to record mode without going through a stop; a four-digit resettable tape counter; memory marker level guides. Response 40-24,000 Hz; wow & flutter 0.08%, both at 7½ ips. (S + N)/N 65 dB (with Dolby). $899.50

4070G Stereo Tape Deck

Two-speed (7½ & 3¾ ips), 4-track, 3-motor stereo design; bi-directional record/playback. Will handle up to 7" reel. Response 30-20,000 Hz ±3 dB, wow & flutter 0.06% at 7½ ips, (S + N)/N 58 dB. Has braking, VU meters, automatic reverse and shutoff, pause control, bias adjustment, counter, separate bias & equalizer switches and monitoring facilities. 18" H × 17⅞" W × 9⁵⁄₁₆" D. $729.50

A-6100 Stereo Tape Deck

Two-speed (15 & 7½ ips), two-track, two-channel stereo with four heads (erase, record, playback, 4-track playback); 3 motors. Will handle 10½" & 7" reels. Features cue button & flip-up head cover for easy editing; auto stop counter; mike attenuation control; LED peak level indicators. Response 30-26,000 Hz at 15 ips; wow & flutter 0.05% at 15 ips; (S + N)/N 60 dB. 17⅜" W × 20½" H × 8¼" D. $999.50

A-7300 Stereo Tape Deck

Two-speed (7½ & 3¾ ips), four-track, two-channel deck. Features direct-drive d.c. capstan/servo control motor; two a.c. reel motors; built-in mixer to blend up to 4 mikes or lines; separate master input level control for all mike/line inputs; separate output level control. Has two sets of output jacks; dual VU meters; 3-position bias/equalization switches; pitch control; cue facility; push-button transport control; logic circuitry. Response 40-24,000 Hz; wow & flutter 0.04%, both at 7½ ips. (S + N)/N 60 dB $1399.50

A-7300-2T. Same except two-track, two-channel with 15 & 7½ ips operation; edit button; minutes/seconds counter. Response 30-28,000 Hz; wow & flutter 0.04%, both at 15 ips. (S + N)/N 60 dB $1449.50

TELEX

Lab Series 2001 Tape Deck

Two-speed (7½, 3¾ ips), 4-track, 3-head, 2-motor stereo design. Will handle up to 8¼" reels. Response 45-18,000 Hz ±2 dB, wow & flutter 0.18% at 7½ ips, (S + N)/N 52 dB. Has VU meters, automatic shutoff, pause control, counter, solenoid operation, and monitoring facilities. 14½" × 19⅜" × 8" D $725.00

2002W. Similar to 2001 except half-track. 3-motor design; solid-state preamps; walnut base. $725.00

TOSHIBA

PT-862D Stereo Tape Deck

Three-head system for either tape or source monitoring, echo recording; mechanical automatic shut-off; tape selector switch, recording bias control; sound-on-sound; 4-digit tape counter; three speeds (7½ , 3¾, 1⅞ ips); will handle up to 7" reels; 4-track, 2-channel stereo record & playback; universal power supply, 50-60 Hz; inputs: mike, line input, DIN; outputs: line-output, headphone, DIN; 4-pole condenser motor; controls: tape selector, speed change, power switch, volume control, mode selector; response 20-25,000 Hz; wow & flutter 0.09% W r.m.s.; crosstalk 60 dB; channel separation 55 dB; (S + N)/N 56 dB. 15⁵⁄₁₆" W × 12¼" H × 7⅜" D $269.95

UHER

4000 Report IC Recorder

Four-speed (7½, 3¾, 1⅞, ¹⁵⁄₁₆ ips), two-track portable recorder; can be powered by "C" cells, rechargeable battery, power pack, 12-V car battery (also power line with accessory unit); 5" max. reel dia.; frequency range 35-20,000 Hz; wow & flutter +0.20% (DIN), ±0.15% (rms); S/N (rms A curve) 64 dB, all at 7½ ips. Has 3-digit counter with reset button; direct tape monitoring with earphones or speaker; electronic start and stop with remote switch, manual, or foot operation. Inputs: (mike) 0.12 mV, 40 mV max. for mikes with 200-ohm source impedance; (radio) 2.4 mV, 700 mV max; (phono) 45 mV, 20 V max., input impedance 2 meg. $490.95

4200. Same as Model 4000 except stereo version; S/N 56 dB (weighted DIN), 64 dB (weighted rms A curve); 0.80 W/ch; two recording level meters $610.00

4400. Same as Model 4200 except four-track; S/N 54 dB (weighted DIN), 62 dB (weighted rms A curve) $610.00

An extensive line of accessories is available for use with all three models.

Royal SG-560 Tape Recorder

Four-track stereo (or optional 2-track stereo with plug-in head assembly modules), four-

speed (7½, 3¾, 1⅞, ¹⁵⁄₁₆ ips); response 20-22,000 Hz; wow & flutter ±0.02%; S/N (rms A curve) 68 dB, all at 7½ ips. Features reverberation and Concert-Hall effects; sound-on-sound; sound-with-sound; two integrated stereo input mixing facilities; integrated "Dia-Pilot" for slide and film projector synchronization. With tape drive system off, electronic section serves as stereo amplifier with 10 W/ch continuous power output. 7" max. reel; operates from 110-130, 220-240 V, 50-60 Hz. Will operate in horizontal or vertical position. 4-digit tape counter. $875.60

Universal 500 Tape Recorder

Three speed (3¾, 1⅞, ¹⁵⁄₁₆ ips), two-track mono; 5" reel dia.; frequency range 40-16,000 Hz; wow & flutter (rms) ±0.15%; S/N (rms A curve) 60 dB, all at 3¾ ips. Has four-digit counter; loudspeaker or earphone monitoring; VU meter; remote control for recording, playback, start, stop, rewind. Operates from 110-125-150-220-240 V, 50 Hz (can be modified for 60 Hz) $521.95

An extensive line of accessories is available for use with this model.

ADVENT

201 Dolbyized Cassette Deck

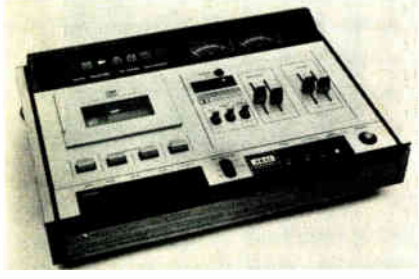
Play/record stereo design. Response 35-14,500 Hz at ±2 dB. THD less than 1½% with chromi-

um-dioxide tape; wow & flutter less than 0.15%; (S + N)/N 54 dB (Dolby off). Has VU meter, counter, automatic shutoff, pause control, and line inputs. 4⅞" H × 13¾" W × 9¼" D. Oiled-walnut cabinet $300.00

AKAI

GXC-75D Auto-Reverse Deck

Four-track, two-channel system; response 33-16,000 Hz (with chromium-dioxide tape), 30-14,000 Hz ±3 dB (low-noise tape); wow & flutter 0.08% Wrms; distortion 1.0% (1000 Hz, 0 VU). (S + N)/N 50 dB; 58 dB (with Dolby). Three



heads (one GX record/playback, two erase); hysteresis synchronous outer-rotor motor; two VU meters. Has full complement of controls. 18.1" W × 5.8" H × 11.9" D $429.95

CS-33D Dolbyized Cassette Deck

Features digital tape counter, tape selector switch, tape run lamp, and two VU meters. Response 40-15,000 Hz (chromium-dioxide tape),

wow & flutter 0.15% rms; distortion 2% at 1000 Hz (0 VU), (S + N)/N 56 dB with Dolby. 16.1" W × 5" H × 8.7" D..... $179.95

GXC-65D Dolbyized Cassette Recorder

Features glass and crystal ferrite head, automatic distortion-reduction system, Dolby, "Invert-O-Matic" reverse cassette, tape selector (chromium-dioxide or low-noise), pause control, and two VU meters. Frequency response 30-16,000 Hz; wow & flutter 0.2% rms. (S + N)/N 50 dB. Distortion 1%..... $319.95

GXC-38D Cassette Deck

Features glass and crystal ferrite head, induction motor, Dolby, automatic stop, OLS switch,

pause control, tape selector switch for low noise & chromium-dioxide tapes. (S + N)/N 50 dB; wow & flutter 0.30%; distortion 2.0%..... ..... $229.95

GXC-46D Dolbyized Cassette Recorder

Glass and crystal heads; automatic noise-reduction system. Response 30-16,000 Hz. Wow & flutter 0.12% weighted rms. (S + N)/N 50 dB (58 dB with Dolby). 16½" × 5⅜" × 12". $289.95

CHANNEL MASTER

6622 Cassette Play/Record Deck

Features Dolby noise-reduction circuit; memory

rewind; tape selector switch; automatic shut-off; piano key controls for stop/eject, fast-forward, rewind, play, record, pause; two illuminated level meters; digital counter with reset button; response 40-10,000 Hz- 40-12,000 Hz (CrO_2); S/N 45 dB (Dolby in); 58 dB (CrO_2); inputs: L/R mike, pair aux. jacks; wow & flutter 1.8%; outputs: headphones, one pair line outputs. 4" H × 13⅝" W × 9⅓" D.. $219.95

CONCORD

CD-1000 Stereo Cassette Deck

Plays/records 4-track, 2-channel stereo; two heads (erase and record/playback); will handle regular, low-noise, and chromium-dioxide tapes (via selector switch); Dolby noise-reduction system; response 30-13,000 Hz (30-16,000 Hz, CrO_2 tape); S/N 50 dB, 58 dB (with Dolby); solenoid-assisted piano-key switching; automatic tape shutoff; memory re-wind counter; two VU meters; 5⅞" H × 15¾" W × 12⅝" D $299.95

DOKORDER

MK-50 Dolbyized Cassette Deck

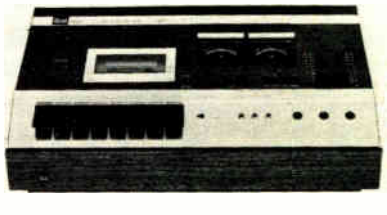
Features molybdenum record/play head; response 30-18,000 Hz (with CrO_2) tape; Dolby

noise-reduction system; S/N 60 dB (with Dolby); wow & flutter 0.10% rms; has cue & review switch; tape-scan indicator; 3-digit tape counter; separate left/right channel slide level controls; two VU meters; separate left/right mike inputs; line-in terminals; headphone jacks. 4" H × 16" W × 11¾" D $199.95

DUAL

901 Autoreverse Cassette Deck

Features automatic reverse, continuous play-



back, and bi-directional recording. Dolbyized, with test oscillator. Continuous-Pole/synchronous motor with double-capstan drive system. Slide-type controls; ballistically damped VU meters; automatic selector for ferrous and chromium-dioxide tapes; lighted indicators for all functions; ALC. Features complete automatic shut-off; two mike inputs. Response 20-16,500 Hz ±3 dB (to 17,000 Hz with CrO_2 tape); 20-14,000 Hz ±1.5 dB (to 15,500 Hz with CrO_2 tape); wow & flutter 0.07% W rms . . . $450.00

GENERAL ELECTRIC

TA700 Stereo Record/Playback Deck

Features dual lighted VU meters; sliding record-level controls; 3-digit counter; cassette eject pushbutton; bias select switch for standard or chromium-dioxide cassettes; noise filter; push-button function controls for record, rewind, fast-forward, play, stop, and pause; front-mounted mike jacks; input & output jacks for recording directly from stereo system; comes with two stereo mikes & stands, patch cords, storage compartment; response 125-8000 Hz; 3½" H × 12¼" W × 8¾" D $124.95

HARMAN/KARDON

HK1000 Dolbyized Cassette Deck

Stereo cassette recorder deck with built-in Dolby noise-reduction circuit. Has front-panel bias switch for standard, low-noise, and chromium-dioxide tapes. Features memory relay, peak-reading VU meters, sliding controls for playback & record level, and microphone input. Response 30-15,000 Hz ±1.5 dB; wow & flutter 0.15 (weighted); speed variation 1%. Constant-

current-drive record head $349.95

HEATH

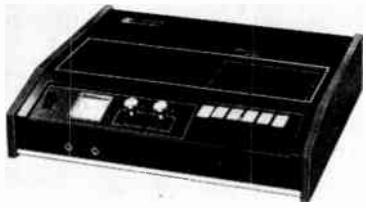
AD-1530 Deck with Dolby

Combines a pre-assembled tape transport, a

Dolby noise-reduction (B type) system, and necessary preamps to record or play stereo cassette tapes. Has built-in test circuit to adjust Dolby system; a bias & equalizing switch for chromium-dioxide or standard tapes; VU meters; and mike inputs; response to 40-14,000 Hz ±3 dB (CrO_2 tape); hum & noise −58 dB (with Dolby); wow & flutter 0.25% rms; dist. 0.2% (electronics only). Walnut cab. . . . . Kit (mail order). $259.95

AD-110 Cassette Deck

Play/record stereo design. Response 30-12,000 Hz ±3 dB, 0.25% distortion, wow & flutter



less than 0.25%, (S + N)/N 45 dB. Has VU meters, eject button, pause control, mike & line inputs, and adjustable bias. 11" H × 13⅜" W × 3⅛" D. Walnut cabinet.
Kit (mail order). $149.95

HITACHI

TRQ-252 Stereo Cassette Deck

Plays and records. Response 40-12,000 Hz, (S + N)/N 45 dB. Has VU meters, counter, eject button, mike inputs. 3⁹⁄₁₆" H × 7⅜" W × 10¹³⁄₁₆" D $119.95

TRQ-2020 Stereo Cassette Deck

Frequency response 40-16,000 Hz; wow & flutter 0.15%; S/N 45 dB; features push-button control; two VU meters; tape counter; automatic stop; fast-forward; pause switch; mike & aux. inputs. 15" W × 3⅝" H × 9⅛" D . . $149.95

TRQ-2040 Dolbyized Cassette Deck

Response 20-16,000 Hz; wow & flutter 0.12%; S/N 50 dB; push-button control; VU meters; tape counter; tape selector switch; automatic stop; fast-forward; pause switch; Dolby noise-reduction circuitry; slide volume controls; two mike and two aux. inputs. 16" W × 3⅞" H × 10¼" D $219.95

JVC

CD-1655 Cassette Deck

Stereo record/play design. Response 30-15,000 Hz ±3 dB. Ferrite record/play heads. Tape

selector switch for chromium-dioxide and standard tapes. Built-in noise-suppressor circuit, automatic stop, two VU meters, calibrated step recording-level controls. 4½" × 14¹¹⁄₁₆" × 9⁹⁄₁₆" D $149.95

CD-1656 Cassette Deck

Stereo record/play. Response 50-14,000 Hz ±3 dB (CrO_2), 50-12,000 Hz (standard tape); wow & flutter 0.22% rms; S/N 50 dB from peak level; built-in noise-reduction system (ANRS); features auto-stop mechanism; tape selector switch; two input mike & two line jacks; two line & headphone outputs; DIN jack. 4¾" H × 15⅛" W × 9¹³⁄₁₆" D. $229.95

CD-1669-2 Solenoid Cassette Deck

Response 30-19,000 Hz ±3 dB. (S + N)/N −60 dB; wow & flutter 0.13% rms. Ferrite record/play heads. Features both equalizer and tape bias switches; built-in automatic noise-reduction system; memory counter; dual motor drive mechanism; calibrated step recording-level and playback controls solenoid logic controls; remote control; automatic adjustable ANRS. 5⁹⁄₁₆" × 16½ W × 12¹⁄₁₆" D. . . . $499.95

CD-1667-2 Cassette Deck

Stereo record/play design. Response 30-16,000 Hz ±3 dB with chromium-dioxide tape (30-13,000 Hz with standard tape). (S + N)/N −50 dB; wow & flutter 0.15% rms; bias record &

erase 95 kHz. Has record/play and erase heads. Inputs: mike (0.7 mV) & line (80 mV). Line output 0 to 1 V. Features two VU meters and bias switch for chromium-dioxide and standard tape. Features ANRS (automatic noise-reduction system). 15" × 4⅝" × 10½" D $299.95

CD-1950 Stereo Cassette Deck

Front-loading unit; features ANRS noise-reduction circuitry; automatic stop; tape select switch; d.c. electronic governor motor; cronios-ferrite double-gap head; response 50-12,500 Hz; wow & flutter 0.15% $299.95

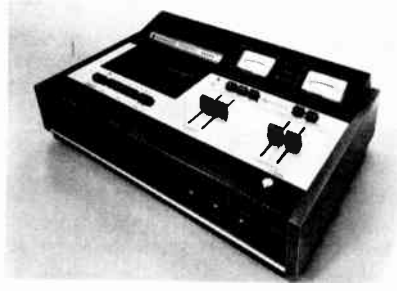
CD-1665 Cassette Deck

Economy stereo record/play design. Response 40-13,000 Hz ±3 dB. (S + N)/N −50 dB; wow & flutter 0.15% rms. Has record/play and erase heads. Inputs: mike (0.7 mV) & line (80 mV). Line output 0 to 0.6 V. 4½" × 11⅛" W × 9⅜" D $99.95

KENWOOD

KX-710 Cassette Deck with Dolby

Stereo cassette deck with Dolby noise-reduction circuit; d.c. servo motor plus high-mass



flywheel for speed accuracy and low wow & flutter; two heat-compressed ferrite heads (record/play & erase); response 30-16,000 Hz (with CrO_2) tape; S/N with Dolby 58 dB, without 50 dB, both with chromium-dioxide tape; has resettable automatic memory rewind system used with 3-digit tape location counter; automatic shut-off; automatic tape selector for optimizing equalization; cueing system; linear slide controls; piano-key controls; tape-running indicator; peak level indicators; two mike & line inputs; two line & stereo headphone outputs. 5¹⁄₁₆" W × 16³⁄₁₆" H × 10¹⁄₁₆" D. $249.95

KX-910 Cassette Deck with Dolby

Stereo cassette deck with Dolby noise-reduction circuit; hysteresis-synchronous motor for speed accuracy and low wow & flutter; two heat-compressed ferrite heads (record/play & erase); response 30-16,000 Hz, S/N with Dolby 58 dB, without 50 dB, all with CrO_2 tape; same features and controls as KX-710. 5¹⁄₁₆" W × 16³⁄₁₆" H × 10¹⁄₁₆" D. $299.95

2 Cassette Tape Machines

LAFAYETTE

RK-725 Record/Playback Deck
Deck featuring a low-impedance stereo amplifier for stereo headphone listening. Response 50-13,000 Hz; (S + N)/N 45 dB; channel separation 30 dB. Input sensitivity: mike 1 mV; aux. 100 mV. Wow & flutter 0.25% rms. Has standard/chromium-dioxide level control; illuminated VU record-level meters; 3-digit tape counter with reset button; front panel left- and right-channel mike and input jacks; six push-button tape functions including pause. Walnut wood case, brushed aluminum front panel. 12⅞" × 9 1/16" × 3 5/16" $109.95

RK-D50 Dolbyized Cassette Deck
Record/playback deck with Dolby. Has push-button tape selectors for standard, chromium-

dioxide, or UD tapes; memory rewind; sound-with-sound facilities; lockable pause control; two illuminated VU record-level meters; two peak record-level indicator lights; 3-digit tape counter with reset button; automatic shut-off. Has 4-pole hysteresis synchronous motor. Response 30-20,000 Hz ±3 dB; (S + N)/N 59 dB (Dolby in), 49 dB (Dolby out); channel separation 30 dB at 1 kHz. 14¾" W × 3¾" H × 10" D $259.95

RK-D750 Dolbyized Cassette Deck
Plays/records 4-track stereo & 2-track mono; response 50-13,000 Hz; S/N 55 dB (with Dolby), 45 dB (without Dolby); wow & flutter 0.25% rms; features front-panel left and right channel mike input jacks; 3-digit tape counter with reset button; standard/CrO_2 bias level control; tilt-up record-level meters; built-in amplifier for headphone monitoring; 12⅞" × 3 5/16" × 9 1/16" $159.95

MERITON

HD-540 Dolbyized Cassette Deck
Records/plays stereo; features Dolby noise-reduction system; response 30-16,000 Hz (chro-

mium-dioxide or ferri-chrome tape); built-in ferrite heads; tape bias/equalization control for all types of tape; servo motor control; automatic shut-off; left/right record level controls; review/cue button; two VU meters; 3-digit tape counter; pushbutton controls. Walnut veneer side panels, tinted dust cover. 15 15/16" W × 4 1/8" H × 10¼" D. $299.95

HD-500 Stereo Cassette Deck
Plays/records stereo; features tape selector for standard/chromium-dioxide tapes; response 30-15,000 Hz (CrO_2), 30-12,000 Hz (standard); illuminated VU meters; pause control; limiter switch; pushbutton keyboard controls. Walnut veneer hardwood cabinet with brushed aluminum. 14" W × 3½" H × 9⅝" D. $129.95

NAKAMICHI

1000 3-Head Cassette Deck
Stereo record/play deck has response of 35-20,000 Hz ±3 dB (CrO_2) tape. Wow & flutter less than 0.10% (weighted peak); (S + N)/N 60 dB (Dolby in); THD 2% at 1 kHz, 0 dB. Features three heads (erase, record, playback); record-head azimuth alignment beacon; Dolby noise-reduction circuit + DNL; closed-loop driven double capstans with staggered flywheels; two d.c. driving motors; two peak level meters; instantaneous spill-proof device; automatic shut-off, memory rewind, and automatic rewind;

variable pitch control, 3-point sound pickup for live recording; peak limiter; optional remote control. Inputs: mike 0.5 mV, 600 ohms; blend mike 0.5 mV, 600 ohms; line 100 mV, 100,000 ohms. Outputs: line 1.2 V (max.) variable; headphones 3 mW, 0 dB. 11 11/16" H × 20 11/16" W × 8 9/16" D. $1295.00

700 3-Head Cassette Deck
Same as the Model 1000 except does not have

automatic rewind or DNL. 10 11/16" H × 20½" W × 5⅛" D. $849.00

500 2-Head Cassette Deck
Four-track, 2-channel stereo model response 40-17,000 Hz ±3 dB; wow & flutter 0.13%

WTD peak; S/N 58 dB (CrO_2 tape with Dolby); THD 2% at 1000 Hz, 0 dB; inputs: mike & blend mike 600 ohm, 0.2 mV; line 150,000 ohm 70 mV; outputs: line 1.0 V (max.) variable; headphones 8 ohm 1 mW, 0 dB; features focused-gap head with crystal Permalloy core; full-range 45-dB peak-reading meters; Dolby noise reduction system; d.c. servomotor drive; automatic shut-off & memory rewind; 3-point sound pickup for live recording; peak limiter; 3-position tape selector; variable output level control. 15" W × 4½" H × 10" D $399.00

550. Similar to Model 500 except S/N 60 dB (CrO_2 tape with Dolby); outputs: line 580 mV;

headphones 300 mW (1 kHz at 0 dB); three-way power supply (117 V a.c., 12 V battery, car jack); tape end alarm with preset timer; 12¼" W × 3½" H × 13¾" D; 11¼ pounds without battery (battery life 15 hours continuous use). $499.00

Remote Control Box

Electronic touch control (duplicating control system on the 1000 & 700) Controls all tape motion, including record, within 15 feet $49.00

PANASONIC

SE-1040D Cassette/Stereo Receiver
Features AM-FM stereo receiver; midi-record changer; stereo cassette recorder; automatic stop & level meter; two air-suspension speaker systems with 6½" full-range speakers; push-button cassette tape controls. Walnut finish. $249.95

SE-21500. Similar to SE-1040D except with 3-speed record changer; recording level meter; digital counter; Quadruplex II circuitry; two air-suspension speaker systems with 6½" woofers & 2½" tweeters. $349.95

PIONEER

CT-4141A Dolbyized Cassette Deck
Stereo design featuring d.c. brushless motor. 85 kHz bias & a.c. erase. Bias change for standard & chromium-dioxide tape. Response 30-12,500 Hz with standard tape (30-15,000 Hz with chromium-dioxide tape). (S + N)/N 58 dB with Dolby. Wow & flutter 0.13%. Inputs: line

50 mV; mike 0.5 mV. Line output 0.775 V. 120 V, 60 Hz operation, 15⅝" W × 3¾" H × 9½" D $239.95

CT-3131A Cassette Deck
Stereo record/playback design featuring switch

for standard or chromium-dioxide tape; automatic stop; a level memory marker; dual record-level meters; tape running pilot; and skip button. Wow & flutter 0.13%; (S + N)/N −48 dB for standard tape (50 dB for chromium-dioxide tape). Response 30-12,500 Hz for standard tape (30-15,000 Hz for chromium-dioxide tape). Sensitivity: line input 50 mV; mike 0.5 mV; line output 0.775 V. 120V, 60 Hz operation. 15⅝" × 3¾" × 9½" D $179.95

CT-F7171 Dolbyized Cassette Deck

Stereo record/playback deck featuring front-access; a.c. bias recording system; a.c. push-pull erase; ferrite record/playback head; electronically controlled d.c. motor; wow & flutter 0.10% W rms; response (standard tape) 30-13,000 Hz (40-12,000 Hz ±3 dB); chromium-dioxide tape 30-16,000 Hz (40-13,000 Hz ±3 dB); S/N 48 dB (Dolby out), 58 dB (Dolby in); features tape selector with switchable bias & equalizer; full-auto stop mechanism; "skip" button for monitoring; recording LED peak indicators; recording limiter; memory rewind switch; cassette bed illumination light & switch; two pairs of input & output terminals; independent recording & playback level controls. Wood cabinet. 16¹⁵⁄₁₆" W × 5⁷⁄₁₆" H × 12¼"D. $369.95

CT-5151 Dolbyized Cassette Deck

Dolbyized cassette deck with independent bias and equalization circuit selection for regular, low-noise, or chromium-dioxide tapes. Features solid ferrite heads; twin VU meters; LED peak indicator (calibrated to light when level exceeds reference level by +4 dB); switchable level limiter; electronically controlled d.c. motor; electromagnetic automatic stop circuit; tape-motion pilot light; skip button for locating desired program material; three-digit tape counter and tape memory rewind button for preci-

sion cueing. Response 30-16,000 Hz (CrO_2); 30-13,000 Hz (standard) tape; (S + N)/N 58 (with Dolby), 48 dB (without); wow & flutter 0.12% Wrms; bias frequency 85 kHz. 120-V, 60-Hz operation. 15⅝" W × 3¾" H × 9½" D $269.95

CT-F6161 Dolbyized Cassette Deck

Front-access stereo cassette deck featuring angled illuminated tape compartment for direct visual confirmation of tape travel; built-in Dolby noise-reduction circuit; independent Bias/EQ tape selector circuit; two heads (record/playback & erase); electronically controlled d.c. motor; wow & flutter 0.12% Wrms; response 30-13,000 Hz (standard) and 30-16,000 Hz (chromium-dioxide); S/N 48 dB (Dolby off), 58 dB (Dolby on) with standard & LH tapes; has full complement of controls, inputs, and outputs; features Skip button which advances tape at twice normal speed for fast tape positioning; two VU meters; comes with two stereo cords and one head-cleaning kit. 17¹³⁄₃₂" W × 5⁷⁄₁₆" H × 13" D. $299.95

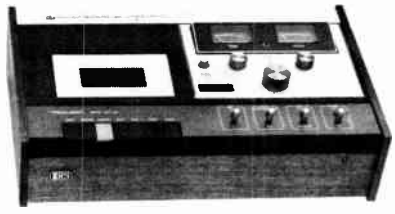
RADIO SHACK

SCT-7 Cassette Deck

Stereo record/play design; response (with chrominum-dioxide tape) 40-15,000 Hz ±3 dB; wow & flutter 0.09% rms; S/N (with Dolby) 52 dB; output level 1 V max; recording bias 100 kHz; features tape-travel lights; Dolby and record lights; automatic reverse; record "edit" button; dual VU meters; separate left & right channel record-level controls. Oiled walnut cabinet. 5⅛" × 16¾" × 11⅛" $319.95

SCT-6C Cassette Deck

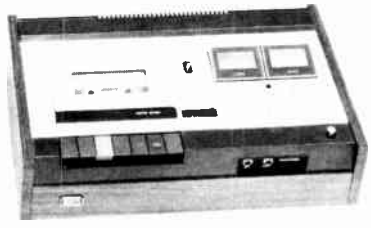
Stereo record/play design. Has individual channel record-level controls, VU meters, mike and auxiliary inputs, preamp outputs. Has Dolby noise-reduction circuit, tape bias switch for



recording chromium-dioxide cassettes. Capable of sound-on-sound recording. Has dual illuminated record-level meters, pause control, and automatic end-of-tape shut-off. Response 30-14,000 Hz (with chromium-dioxide tape) ±2 dB; wow & flutter 0.14% rms. Oiled walnut cabinet with brushed aluminum trim. 16½" × 10¼" × 4½" $249.95

SCT-5C Cassette Recorder

Stereo record/play design. Has dual VU meters. Response 50-12,000 Hz ±2 dB (playback-



only response 40-14,000 Hz ±2 dB). Wow & flutter 0.2%. Overall size 13⅜" × 9¾" × 3⅞" $159.95

SANSUI

SC-636 Cassette Recorder Deck

Stereo design with built-in Dolby circuits; provisions for chromium-dioxide tape; MC ferrite

heads; constant and peak-reading VU meters, three mike inputs. Response 30-13,000 Hz. (regular tape); 30-16,000 Hz (CrO_2); (S + N)/N 50 dB, Dolby out, but with chromium-dioxide tape. 16¹⁄₁₆" W × 4¹¹⁄₁₆" H × 11⅝" D ... $279.00

SANYO

RD-4350 Dolbyized Cassette Deck

Stereo design with built-in memory counter; separate record/playback level controls; adjustable recording equalization controls; mike/aux. input control; lighted VU meters with push-button tilt-up mechanisms for easy viewing; and mechanical automatic stop. Response 40-15,000 Hz ±3 dB; (S + N)/N 50 dB; wow & flutter 0.15%. Has two mike inputs and two stereo line outputs. Dolby noise suppression circuit. 17" × 9" × 5" $329.95

RD-4250 Dolbyized Cassette Deck

Features servo-controlled tape drive mechanism and ferrite heads; large VU meters; tape

counter; 7-button function control including both cue and pause functions; adjustable recording equalization; automatic stop. Has Dolby noise reduction circuit. Response 40-15,000 Hz ±3 dB; (S + N)/N 50 dB; wow & flutter 0.2%. Has two mike inputs and two stereo line outputs. 17" × 9" × 5" $289.95

SONY from SUPERSCOPE

TC-131SD Dolbyized Cassette Deck

Includes Dolby circuitry; has special tape select switch for chromium-dioxide or standard tapes; ferrite and ferrite head; built-in peak limiter. Has straightline record level controls, illuminated VU meters, automatic total mechanism shut-off (TMS); locking fast-forward and rewind; pause control with lock; 3-digit tape counter; record indicator pilot lamps; stereo headphone jack; non-magnetizing record head. Response 40-15,000 Hz, wow & flutter 0.22% (S + N)/N 48 dB. Overall size 15⁹⁄₁₆" W × 3¾" H × 9⁷⁄₁₆" D. Walnut base. $269.95

TC-137SD Stereo Cassette Deck

Features Dolby noise-reduction system; ferrite and ferrite heads; automatic total mechanism shut-off; response 20-15,000 Hz (standard tape), 20-17,000 Hz (FeCr and CrO_2) tape; has 3-digit tape counter; four function-indicator lamps; 3-pos. tape select switch; eject, rewind, fast-forward, forward, record, and stop push-buttons; sliding mike & line controls; illuminated VU meters; peak-level indicator; comes with two stereo patchcords, head-cleaning tips, dust cover. Walnut base. 16⁹⁄₁₆" W × 5⁷⁄₁₆" H × 11⁹⁄₁₆" D. $399.95

TC-203SD Stereo Cassette Deck

Front-loading deck with Dolby noise-reduction system; ferrite and ferrite heads; automatic total mechanism shut-off; response 20-15,000 Hz (standard tape); 20-17,000 Hz (FeCr and CrO_2); push-button control; two VU meters; record indicator lamp; peak level indicator; comes with two patchcords and head-cleaning tips. Walnut base. 17⁹⁄₁₆" W × 6⅛" H × 12⅝" D. $399.95

TC-177SD Stereo Cassette Deck

Features three ferrite heads; Dolby noise-reduction system; automatic total mechanism shut-off; response 20-17,000 Hz (standard tape); 20-20,000 Hz (CrO_2 and FeCr tape); has illuminated VU meters; peak-level indicator; 400-Hz calibration tone switch; push-button operation. Walnut base. 17⅛" W × 6⅛" H × 12⁹⁄₁₆" D. $749.95

TC-161SD Dolbyized Cassette Deck

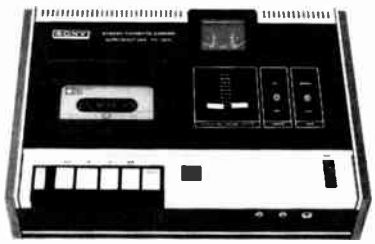
Features dual bias for standard or chromium-dioxide tape. Response 20-18,000 Hz with chromium-dioxide tape. (S + N)/N 54 dB at 1 kHz & 59 dB at 5 kHz. Wow & flutter 0.1%. Bias frequency 85 kHz. Has dual VU meters, illumi-

2 Cassette Tape Machines

nated cassette compartment, memory-type counter, headphone level switch. Has mike & line inputs (0.06 V sensitivity) and line output (0.775 V). Walnut base 15¾" W × 5" H × 10⅞" D. $299.95

TC-121A Stereo Cassette Deck

Records/plays. Response 40-13,000 Hz; wow & flutter 0.22% (S + N)/N 45. Has low-imp. mike



input; 560,000 ohm imp. aux. input. Output: phono 100,000 ohms. Level 0.775 V. Includes stereo headphone monitor jack, record level indicator, pause control, and automatic shut-off. 13" W × 3⅞" H × 8 15/16" D $129.95

TC-129 Stereo Cassette Deck

Records/plays. Response 40-14,000 Hz; wow & flutter 0.22%; (S + N)/N 45. Has low-imp. mike input; 560,000 ohm imp. aux. input. Output: phono 100,000 ohms imp. Level 0.775 V. Features straight-line record level controls; tape select switch; dual illuminated VU meter; three-digit tape counter; push-button operation; pause control with lock. Has stereo headphone jack; built-in dust cover; automatic shut-off; non-magnetizing record head. Walnut base. 13⅝" W × 4" H × 9¼" D $149.95

TC-203SD Dolbyized Cassette Deck

Front-load stereo cassette deck; Dolby noise-reduction circuit; F & F head; three separate tape select switches; uniphase recording for recording 4-channel sound from SQ or FM matrix sources for playback through decoder 4-channel amplifier; total mechanism shutoff; response 20-15,000 Hz (standard), 20-17,000 Hz (FeCr and CrO_2) tapes; has 3-digit tape counter; illuminated VU meters; peak level indicator; full complement of inputs & outputs; comes with two RK-74 patchcords, head-cleaning tips. 17 3/16" W × 6⅛" H × 12⅝" D. $399.95

SUPERSCOPE

CD-301 Stereo Cassette Deck

Record/play deck. Response 40-10,000 Hz (standard tape); 40-14,000 Hz (chromium-dioxide tape); (S + N)/N −48 dB standard/−51 dB CrO_2 tapes. Features two slanted VU meters; limiter switch to limit maximum recording level; illuminated function indicators; headphone monitor jack; left and right mike inputs and record-level controls; record mode light; 3-digit tape counter; interlocked piano-key type controls. Comes with walnut base and two audio patchcords. Overall size 12½" W × 3¼" H × 8⅞" D $139.95

CD-302 Stereo Cassette Deck

Similar to CD-301 except includes the Dolby noise reduction system. (S + N)/N −48 dB; Dol-

by in −60 dB; CrO_2 −51 dB. Has the same controls and features as the Model CD-301 ..... $189.95

CR-1000 Cassette Recorder/AM-FM

Lightweight cassette recorder with AM-FM radio; 120-V a.c. operation; response 63-10,000 Hz; S/N 50 dB (playback), 47 dB (record/play); 4" PM speaker; built-in electret condenser mike; full complement of inputs & outputs; supplied with metal carrying handle; 13" W × 8½" H × 3¾" D; 7 lbs, 5 ounces..... ..... $109.95

TANDBERG

TCD-310 Cassette Recorder Deck

Features Dolby noise-reduction system; three motors; two peak-reading record meters; chro-

mium-dioxide/low-noise, high-output tape switch; automatic endstop. Wow & flutter 0.15% (Wrms). Response 50-12,000 Hz ±2 dB. Has mike (0.1 mV), radio (5 mV), and line (40 mV) inputs. Output 0.775 V. Wall mountable. Walnut cabinet. 19" × 4¼" × 9⅛" D... $499.00

TEAC

360S Dolbyized Stereo Cassette Deck

Features Dolby noise reduction system; wow & flutter 0.07%. Has 400-Hz Dolby calibration tone generator; MPX filter switch; 8 external Dolby calibration controls; separate 3-position bias and equalization switches; memory rewind counter; total automatic shut-off in record and play mode; dual VU meters. Response 30-16,000 Hz (30-15,000 Hz ±3 dB with CrO_2 tape). (S + N)/N 60 dB (Dolby in); 50 dB (without Dolby). Overall size 17¾" W × 4¾" H × 10¼" D. $379.50

250S Dolbyized Stereo Cassette Deck

Features Dolby noise-reduction system; standard/chromium-dioxide tape selector switch;

straight-line record level control; dual VU meters; high-density "Permaflux" heads; automatic shut-off; and tape-run indicator light. Response 30-13,000 Hz; 30-16,000 Hz (with chromium-dioxide tape); (S + N)/N 58 dB (Dolby in). Wow & flutter 0.15%. 16 11/16" W × 4 1/16" H × 9⅞" D. $279.50

160 Dolbyized Cassette Deck

Features Dolby noise-reduction system; high-density "Permaflux" heads; separate bias and equalization switches; straight-line level controls (two record, two output); two VU meters; tape-run indicator light; and 3-digit resettable tape counter. Has left and right low-imp. mike jacks; stereo headphone jack; pause control; two heads. Response 30-10,000 Hz with standard tape (30-13,000 Hz with chromium-dioxide tape); wow & flutter 0.15%. (S + N)/N 58 dB (with Dolby). 16½" W × 4¾" H × 10⅛" D $259.50

450 Dolbyized Stereo Cassette Deck

Features Dolby-B type noise-reduction system. Has switchable controls for bias and equaliza-

tion for various tape types; mike/line inputs (mixable); two separate erase and record/playback heads. (S + N)/N 50 dB (60 dB with Dolby); wow & flutter 0.07%. Response 30-11,000 Hz with standard tape (30-14,000 Hz with low-noise tape; 30-15,000 Hz with chromium-dioxide tape). Inputs: mike 0.25 mV; line 0.1 V. Output: 0.3 V. 7" H × 17½" W × 10⅝" $449.50

140 Stereo Cassette Deck

Features dual VU meters; straight-line record-level controls; high-density "Permaflux" heads; separate equalization and bias switches; tape-run indicator; 3-digit resettable tape counter; left and right low-imp. mike jacks; 8-ohm stereo headphone jack; locking pause control; and automatic shut-off. Response 30-10,000 Hz (standard tape); 30-13,000 Hz (chromium-dioxide tape). (S + N)/N 50 dB; wow & flutter 0.15%. 16½" W × 4¾" H × 10⅛" D... $199.50

TECHNICS BY PANASONIC

RS-279US Cassette Recorder Deck

Dolbyized stereo design with standard and chromium-dioxide tape selection and HPF ultra-longlife heads. Three-head system permits off-tape monitoring. Wow & flutter 0.1%. (S+N)/N 60 dB (with Dolby), 50 dB (without). Response 20-17,000 Hz (chromium-dioxide tape), 20-15,000 Hz (standard tape). Has two motors including electronically controlled direct drive for capstan, optional remote control, memory rewind, pause control, electronic autostop. Mike/line input selection. 5⅜" H × 16⅝" W × 13½" D. $499.95

RS-263US Cassette Recorder Deck

Dolbyized stereo design with standard tape & chromium-dioxide selection. Wow & flutter 0.2%. Response 30-13,000 Hz (standard tape); 30-14,000 Hz (chromium-dioxide). (S + N)/N 45 dB (55 dB Dolby). Has mike & line inputs, automatic stop, memory rewind and pause control. 14" × 5" × 9⅝" D $199.95

RS-676US Cassette Recorder Deck

Vertical design with front-loading features Dolby circuit (including switch selector and calibrator for pre-encoded Dolby FM broadcasts); two motors including electronic control for capstan drive; solenoid operation; hot-pressed ferrite head; meter peak-check switch; selectable MPX filter; chromium-dioxide/normal tape selector (either manual or automatic). Has full auto stop in any mode; mechanical pause; single level control for record mode with aux. left/right balancer; digital counter; memory rewind with automatic replay; mike/line/tuner inputs with mike level control for mixing. Guaranteed minimum specifications: record/play frequency response 40-13,000 Hz ±3 dB (chromium-dioxide tape); 40-12,000 Hz ±3 dB (gamma ferric-oxide tape); wow & flutter 0.08% W rms; S/N 50 dB (Dolby out), 58 dB (Dolby in); dist. 2.0% with regular tape. 5½" H × 16⅜" W × 14⅜" D $459.95

RS-610US Cassette Recorder Deck

Vertical design with front-panel controls; top loading; Dolby noise-reduction circuit; chromium-dioxide/normal tape equalization and bias; auto-stop in record/play modes; hot-pressed ferrite (HPF) head; pause control; single level control for record mode with left/right balancer; digital counter; Guaranteed minimum specifications: record/play frequency response 50-12,000 Hz ±3 dB (CrO_2 tape), 50-10,000 Hz (gamma ferric-oxide tape); wow & flutter 0.15% W rms; S/N 50 dB (Dolby out), 57 dB (Dolby in); dist. 2.3% with normal tape. 4⅝" H × 13¼" W × 11½" D $249.95

RS-625US Cassette Recorder Deck

Dolbyized design with patented HPF (hot-pressed ferrite) head, guaranteed for 10 years; selector for ferric-oxide /CrO_2 (70 μs tapes; VU meters with pushbutton peak-reading function; tape counter with memory rewind; separate input/output level controls; lockable pause control; tape-run indicator lamps; full automatic stop in any mode with transport disengagement; Mic/headphone inputs; push-button controls; guaranteed minimum specs: wow & flutter 0.10% weighted rms or better; overall record/play frequency response +3, −5 dB at 40 Hz to ±3 dB at 11,000 Hz (ferric-oxide tape), +3, −5 dB at 40 Hz to ±3 dB at 12,000 Hz (CrO_2) tape; S/N 49 dB (without Dolby), 57 dB (with Dolby); dist. 2.3%; overall speed accuracy ±2%. $329.95

TOSHIBA

PT-415 Cassette Deck

Stereo design featuring a Dynamic Noise Limiter (DNL); tape selector (standard or chromium-dioxide). Output 0-1 V. Response 30-15,000 Hz, with chromium-dioxide tape. Wow & flutter 0.1% rms weighted; (S + N)/N 50 dB (unweighted). Sensitivity: line 80 mV; mike 0.56 mV. Fast-forward and rewind 100 sec. Has universal line inputs. 14½" × 4" × 10¼" $199.95

PT-490 Dolbyized Cassette Deck

Features stereo play/record; mechanical automatic shut-off; 3-step tape selector (adjusts bias and frequency response), two record-level meters, and automatic reverse. Output 0 to 1 V. Frequency response 30-15,000 Hz. Wow & flutter 0.1% weighted rms. (S + N)/N 50 dB (60 dB with Dolby). Input sensitivity: line 80 mV; mike 0.56 mV (10,000 ohms). 16⅞" × 5½" × 11½". $349.95

PT-470. Same as PT-490 except does not have automatic reverse $249.95

PT-406 Stereo Cassette Deck

Records/plays 4-track, 2-channel cassettes; six pushbuttons control fast-forward, record, play, rewind, stop/eject, and pause; pushbutton cassette loading; noise filter; S/N 45 dB; wow & flutter 0.15% W rms; output 0.775 V; response 50-10,000 Hz (CrO_2), 50-8000 Hz (Std.); stereo headphone, microphone, line-in, line-out jacks up front for easy access; walnut cabinet; 13⅛" W × 4⁵⁄₁₆" H × 9⅞" D. $159.95

UHER

CR134 Stereo Cassette Recorder

Will operate from six "C" cells, storage batteries, 12-volt car battery, or 100-130 V, 200-240 V, 50-60 Hz supplies; records and plays back in mono or stereo; features volume and recording level control; built-in condenser microphone; level indicator with dB scale for record, voltage scale for playback; pause control; microphone jack with interlocking facility for mike with remote-control "on/off" switch; built-in speaker switch; built-in mike switch; alc "on/off" switch; 3-digit index counter; tape-direction and operating-mode indicator; response 20-13,000 Hz; S/N (rms A curve) 56 dB; wow & flutter (rms) ±0.12%; automatic photosensitive electronic control of tape travel and playback tape direction switch. $378.00

CG360 Dolbyized Cassette Recorder

Features three-motor drive system (one hysteresis synchronous and two brushless dc for constant tape tension and high forward and rewind speeds); Dolby circuit (switchable in and out); slider controls (two level for two separate intermixable inputs, recording balance correction control, one volume, one treble, one bass, and one balance); headphone socket (with automatic muting of speaker final stage); re-recording socket; microphone socket; program switch; automatic cassette selection. Has special sintered 4-track record/playback head plus ferrite erase head; 3-digit counter. Frequency range (chromium-dioxide) 20-15,000 Hz; S/N 56 dB Dolby in; wow & flutter ±0.20%. Inputs for mike, radio, phono, recorder; outputs for line, re-recording, headphones. 40.0 × 10.4 × 29.5 cm. $1092.50

WOLLENSAK

4766 Cassette Recorder Deck

Dolbyized design featuring beltless, direct dual-drive system; mike & line mixer switch for sound-on-sound mixing; Dolby calibration oscillator; tape switch for standard, CrO_2, Scotch "Classic" tapes; end-of-tape sensing; dual VU meters. Wow & flutter 0.15% (DIN) weighted. Sensitivity: mike 0.65 mV for 0 VU; line 150 mV; Output 1 V; headphone output 0.2 mV at 8 ohms. Response 35-14,000 Hz ±2 dB with standard tape. (S + N)/N 50 dB with Dolby off (60 dB at 4000 Hz with Dolby). $429.95

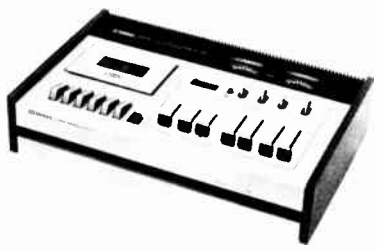
4775 Cassette Recorder Deck

Dolbyized design; hysteresis-synchronous motor; interlocking piano-key controls; end-of-tape shutoff; response 40-17,000 Hz (CrO_2), 40-13,000 Hz (standard); S/N 50 dB (Dolby off), 60 dB (Dolby on); channel separation 38 dB at 1000 Hz; wow & flutter 0.12 WTD rms; memory digital counter; two illuminated VU meters; 16" W × 10⅞" W × 5⅝" D; comes with removable dust cover. $314.95

YAMAHA

TB700 Dolbyized Cassette Deck

Stereo play/record deck with Dolby noise-reduction circuit and exclusive pitch control for adjustment of speed ±3% in the playback mode; wow & flutter 0.15% weighted rms; S/N 48 dB (Dolby out), 58 dB (Dolby in); THD 2.5%; frequency response 30-13,000 Hz (standard), 30-16,000 Hz (CrO_2 tape); hot-pressed ferrite record/play head, double-gap ferrite erase head; features two expanded VU meters; pause switch; auto-stop mechanism; OTL headphone amplifier; 3-digit tape counter. 4½" H × 15¾" W × 9¾" D $340.00



AKAI

CR-81D 8-Track Stereo Deck

Response 50-16,000 Hz ±3 dB; wow & flutter 0.25% rms; (S + N)/N 47 dB. Has line output

1.23 V. Inputs: mike 0.5 mV & line 50 mV. Has automatic stop and continuous playback, two VU meters. 13⅝" × 5½" × 10⅜" D.... $209.95

GXR-82D 8-Track Record/Play Deck

Response 40-17,000 Hz ±3 dB; (S + N)/N 47 dB; record/play & erase heads; wow & flutter

0.25% rms. Features pause switch; automatic stop and continuous playback; fast-forward; automatic and manual program selection; VU meters; headphone monitoring jack; DIN jack; line input and output jacks. 13.6" × 5.3" × 10.5" $249.95

BSR McDONALD

TD-8S 8-Track Playback Deck

Deck includes a 2-stage stereo preamp, 0.75 V

output. Comes with cabinet and connecting cables. 7⅜" W × 10½" × 3¾" $49.95

CHANNEL MASTER

6609 8-Track Player Deck

Features automatic track change; manual track selection; blackout track indicator lights; output jacks with connecting cables. Walnut-finish wood cabinet with smoked acrylic faceplate. 4¾" H × 8" W × 10½" D..... $49.95

6646 8-Track Record/Play Deck

Features push-button selectors for auto stop, pause, fast-forward, record, channel select; built-in automatic level control; aux. right & left input jacks; right & left mike input jacks; aux. output with connecting cable. Comes with two patchcords. Walnut-finish wood cabinet. 5" H × 8⅜" W × 10½" D..... $89.95

6647. Similar to 6646 except includes right & left illuminated record meters; stereo headphone output; four patchcords. 4¾" H × 12 3/16" W × 12⅜" D..... $139.95

FISHER

2081 "MusiCenter" System

Combines an AM-FM stereo receiver; built-in 8-track player; separate turntable; and two speaker systems (each with 6" woofer & 2" tweeter; 3000 Hz crossover); FM sensitivity 4 μV; selectivity 36 dB; Separation 30 dB at 1000 Hz; push-button controls; slide controls for volume, balance, bass & treble. 19½" W × 13¾" D × 5⅛" H..... $299.95

Also available with 3-way speaker systems (each with 8" woofer, 4½" mid-range, 2" tweeter, crossovers 800 & 3000 Hz) at additional cost.

2381. Same as 2081 except turntable is built-in. 19½" W × 17⅝" D × 5⅛" H..... $299.95

Same speaker option as 2081.

GENERAL ELECTRIC

TA560 8-Track Player Deck

Turns on automatically when cartridge is inserted; program indicator lights; manual or automatic channel selection; response 100-8000 Hz; wow & flutter 0.3%; 4½" H × 10" W × 9¼" D..... $59.95

TA600 8-Track Recorder/Player Deck

Features dual lighted VU meters; sliding record-level controls; one/all channel select switch for program sequencing; four separate program indicator lights; line output jacks for connecting to stereo system for playback; input jacks and patchcords; comes with two dynamic mikes; response 100-8000 Hz; wow & flutter 0.3%; 4¾" H × 13½" W × 10½" D.... $119.95

SC2305 Recorder/Player/AM-FM Stereo

Plays/records 8-track cartridges in stereo; AM-FM stereo radio reception; comes with two 5¼" full-range speakers (each in 14" × 10" × 5" enclosure); jacks for optional record changer or cassette tape deck; terminals for main/Quadra-Fi speaker systems; comes with two dynamic mikes; control center 20" W × 12½" D × 6½" H. $169.95

SC3300. Similar to SC2305 with addition of automatic 3-speed record changer, tubular aluminum tonearm, stereo ceramic cartridge with diamond stylus; 6½" dual-cone speakers (each in 17" × 11" × 7" enclosure); control center 21" W × 9" H × 15" D..... $289.95

SC2310. Similar to SC2305 except has two air-suspension speaker enclosures (each with 8" woofer & two 3" tweeters); four-channel decoder accessory jacks; jacks for phono input, line output, main, and QuadraFi speakers, mikes; speakers 21" × 12" × 8"; control center 21" W × 5" H × 11" D..... $349.95

GLENBURN

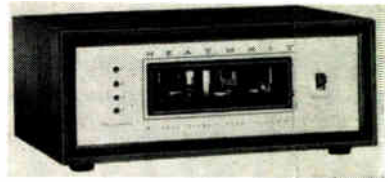
SP-12 8-Track Stereo Playback Deck

Solid-state, 3-stage preamplifier; straight-line head positioning system for precise track selection; heavy-duty four-pole synchronous motor; channel indicator light; positive automatic or manual channel selection; comes complete with connecting cables. Walnut-grain case..... $49.95

HEATH

GD-28 8-Track Stereo Deck

Home playback deck for use in component system. Response 50-10,000 Hz. Simulated



walnut-finished cabinet measures 10⅜" × 4½" × 8¼" (mail order)..... $64.95

HITACHI

SDP-2820 8-Track/Phono System

Combines a cartridge tape player, a BSR automatic record changer, and a pair of separately housed speaker systems. Supplied with dust cover..... $269.95

SP-2840 AM-FM/8-Track Player

Combines AM-FM stereo receiver and 8-track cartridge player; features a.f.c., LED FM stereo indicator, FET and tuned r.f. amplifier on FM, separate controls for bass, treble, and balance; equipped with headphone, Aux. In, Rec. Out jacks plus one unswitched a.c. outlet; push-button program selector; illuminated program indicators for 8-track player; comes with full-range air-suspension speakers (10⅞" × W × 18½" H × 6½" D); tuner 19 5/16" W × 4 5/16" H × 11 13/16" D..... $229.95

SP-2845 AM-FM/8-Track Recorder

Similar to SP-2840 except with 8-track recorder/player; features pushbutton control for record, fast-forward, program selection, and pause; variable monitor system; automatic stop. $299.95

SEE SECTION 4 FOR 4-CHANNEL

JVC

ED-1103 8-Track Tape Deck
Playback stereo design. Response 30-15,000 Hz; (S + N)/N −45 dB; wow & flutter 0.2% rms. Output 0.8 V. 3⅝" × 6¾" W × 9⅜" D .. $49.95

ED-1240 8-Track Tape Deck
Record/play stereo design. Response 30-15,000 Hz (40-12,000 Hz ±3 dB); (S + N)/N 50 dB from

peak level; wow & flutter 0.2% rms; crosstalk 50 dB & 40 dB channel separation, both at 1 kHz. Features automatic eject control, two VU meters, four front-mounted tape controls. 120-V, 60-Hz operation. 4¼" H × 13½" W × 9⅛" D..... $169.95

ED-1245 8-Track Play/Record Deck
Features three-in-one head; automatic or manual cartridge eject; fast-forward; two VU meters; two record-level controls; electronic governor d.c. motor; automatic noise-reduction system (ANRS) on both record & playback; response 40-12,000 Hz ±3 dB; wow & flutter 0.2% rms; S/N 60 dB; has 2 mike & 2 line input jacks; two line & headphone output jacks; DIN jack. 4⅝" H × 15 13/16" W × 9⅜" D.... $249.95

LAFAYETTE

RK-92 8-Track Playback Deck
For home playback of car 8-track tape collection; lighted program indicators; push-button program selection; hinged cartridge door for protection against dust & dirt; walnut-finish case. 8⅛" × 4¼" × 8¾"..... $34.95

RK-82 8-Track Playback Deck
Stereo playback deck designed to be used with audio systems. Response 50-8000 Hz. Has push-button track selector; illuminated track indicator lights; dust-proof cartridge slot door. 8⅞" W × 4¾" H × 8½" D $49.95

RK-885 8-Track Record/Playback Deck
Record/play deck designed to be used with any stereo receiver or amplifier with tape in/out jacks. Has mike input jacks for "live" stereo recording with optional microphones; dual VU meters; recording volume controls; mode switch; record indicator light; illuminated channel indicator lights. Comes with connecting cables. 13" W × 5⅝" H × 8⅝" D..... $119.95

RKD-985 8-Track Deck with Dolby
Features Dolby-B noise-reduction system in stereo record/playback; Autostop switch to

stop unit during playback or record mode at end of each program; mode switch for continuous operation or automatically stopping unit; S/N 55 dB (Dolby in), 45 dB (Dolby out); response 30-11,000 Hz; wow & flutter 0.25% rms; bias frequency 60 kHz; input sensitivity: mike 1 mV, aux. 100 mV; channel separation 30 dB..... $199.95

RK-990 8-Track Record/Play Deck
Features stop/eject after any program (1-4) or at end of cartridge; sound-with-sound; concen-

tric mike & aux. volume controls; record level meters for each channel; d.c.-type governor-controlled motor; response 30-12,000 Hz; bias & erase frequency 60 kHz; output level 1 V max.; input sensitivity: mike 1 μV, aux. 100 μV; channel separation 45 dB at 400 Hz; S/N 45 dB; Walnut side panels. 12" W × 3¾" H × 9⅛"D. $189.95

SR-80 8-Track/AM-FM Receiver
Combines an AM-FM stereo receiver, an 8-track cartridge recorder/player, with two acoustically matched wide-range speaker systems, each with 6½" speaker with multicellular diffuser. Has inputs for attaching a record changer or another tape recorder; microphones. Has full complement of controls and separate record-level meters for left and right channels. Speakers 14 3/16" × 9 7/16" × 5½" D. Control center 18" W × 10" D × 4½" H $199.95
Recording microphone for SR-80 ..... $19.95
SR-50. Same as SR-80 except comes with stereo cassette recorder/player instead of 8-track recorder/player $199.95
Recording microphone for SR-50 .... $19.95

SR-30-A Cartridge Player/Receiver
8-track cartridge player combined with an AM/FM stereo receiver and matching speaker systems (each containing multicellular diffuser). Has separate slide controls for bass, treble, and balance, a front-panel headphone jack, FM stereo light, black out and illuminated slide-rule tuning dials, plus a full complement of inputs and outputs..... $129.95

LSC-2000 8-Track/AM-FM/Phono
Complete system including 8-track recorder/player, AM-FM tuner, automatic Garrard turntable, four three-way speaker systems (each with 8" woofer, 5" midrange, 3" tweeter, and crossover); comes with dust cover, 45 rpm adapter, FM dipole antenna and speaker cable, two mikes, and one blank 8-track cartridge; control center 22¾" × 10" × 7¾"; each speaker 19 5/16" × 11 13/16" × 8¼"..... $319.95

MERITON

HD-830 8-Track Play/Record Deck
Response 40-13,000 Hz; wow & flutter 0.15% Wrms (playback), 0.25% Wrms (record/play-

back); S/N 45 dB; features pause control switch; two illuminated VU meters; eject button; program selector switch; vertical-slide record level controls for left/right channels; automatic shut-off or continuous play switch; fast-forward; stereo headphone & mike jacks. Walnut cabinet with brushed chrome face. 14¼" W × 5⅜" H × 9⅝" D..... $139.95

HD-800 8-Track Playback Deck
Designed to be used with any stereo system; features program selector button; repeat button; response 30-12,000 Hz; wow & flutter 0.17% Wrms; channel indicator lights. Walnut veneer cabinet with brushed chrome face. 10⅝" W × 5⅜" H × 8¾" D..... $54.95

PANASONIC

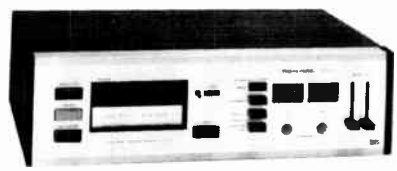
RS-828S 8-Track/Stereo Receiver
AM-FM stereo receiver with built-in twin-slot 8-track player/recorder; will record from original sources and pre-recorded tapes in lower slot, playback in upper slot; features auto-start and auto-stop; Quadruplex II circuitry for enhanced sound of stereo discs and tapes; mike mixing in playback mode with optional microphones; two 6½" air-suspension speaker systems; continuous tone, balance, and volume controls; tuning/VU meter; 3-pos. monitor sw.; Wood cabinets..... $329.95
RE-8174. Similar to RS-828S but 8-track player-only built-in and separate automatic record changer. Walnut finish..... $229.95
SE-2280. Similar to RE-8174 except automatic record changer is built-in..... $269.95
SE-3280. Similar to RS-828S except with built-in automatic record changer; speaker systems each with 6½" woofer and 2½" tweeter..... $299.95
RE-8134. Similar to RE-8174 but without record changer..... $169.95
RS-817AS. Similar to RS-828S with two-channel 8-track recorder..... $199.95

RADIO SHACK

TR-888 Automatic Tape Changer
8-track playback deck/automatic cartridge changer; can play three cartridges in sequence; play any program on any cartridge; replay an individual cartridge; lighted program indicators; plugs into stereo Aux. input. Comes with cables..... $99.95

TR-882 Record/Play Deck
Features dual VU meters; level controls; push-button fast-forward, pause, and record interlock; program select button; response 50-10,000 Hz; wow & flutter 0.2%; front-panel mike input for live recording. Walnut-finish wood-grain case. 3⅞" × 13¼" × 8⅜"... $99.95

TR-801 Record/Play Deck
Features digital timer; push-button control of continuous play, program repeat, auto-stop,



push-button eject, program change, fast-forward, and pause; response 50-12,000 Hz; wow & flutter 0.2%; front-panel mike input for live recording. Walnut wood cabinet. 4¾" × 16½" × 10"..... $149.95

SONY from SUPERSCOPE

TC-208 8-Track Playback Deck
Response 50-10,000 Hz; wow & flutter 0.25% rms weighted. Features program select and re-

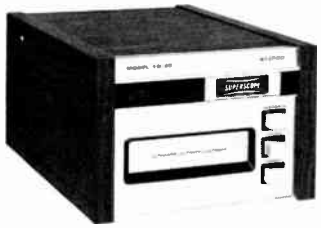
3 8-Track Tape Machines

peat buttons, fast-forward button, program indicating light, automatic track switching. 120-V, 60-Hz operation. 8¾" × 4¹/₁₆" H × 9½" D $89.95

TC-228 8-Track Recorder Deck
Stereo design. Response 30-13,000 Hz; (S + N)/N 45 dB. Bias frequency 95 kHz. Wow & flutter 0.17%. Has two VU meters, one d.c.-type motor. Aux. (70 mV sensitivity) & mike (−70 dB sensitivity) inputs & line output (0.5 V sensitivity). Features automatic total mechanism shut-off. Walnut case. 14⅜" × 4¾" × 8¾" D.... $199.95

SUPERSCOPE

TD-28 8-Track Player Deck
Has built-in automatic tape program selector which plays all four programs; illuminated pro-



gram indicators. Features a program selector push switch for selecting specific programs and a fast-forward for bypassing unwanted material; repeat switch for continuous replay. Response 50-10,000 Hz; (S + N)/N −48 dB; 117-V, 60 Hz operation. Walnut wood-grained cabinet with white gold-anodized faceplate. 7¼" W × 4⅞" H × 9¾" D $74.95

SYLVANIA

MST3736W Phono/8-Track/Receiver
Combines a Garrard automatic turntable with Pickering magnetic cartridge, viscous-damped cue/pause control, and anti-skating device; an AM-FM stereo receiver; an 8-track stereo tape player; and a pair of sealed air-suspension speaker systems (18¾" × 12" × 9" D) each with 8" woofer and a 3" tweeter. Has built-in Phase Q4 matrix to synthesize regular two-channel stereo program material. 20 W/ch dynamic power at 1% HD (12½ W/ch continuous). Power bandwidth 25-20,000 Hz; response 25-20,000 Hz ±1½ dB. FM sensitivity 2.5 μV for 30 dB quieting; capture ratio 5.5 dB. Walnut cabinets with dust cover. Control center 9¼" H × 23½" W × 15¾" D..... $349.95

MST3735W Phono/8-Track/Receiver
Features full-size BSR automatic turntable, AM-FM stereo receiver, 8-track play/record deck, pair of air-suspension speaker systems; has built-in Phase Q4 matrix; front-panel headphone jack; cut/boost bass & treble controls; response 55-22,000 Hz ±1.5 dB; FM sensitivity 4 μV; S/N 60 dB. Walnut-grained vinyl. Control center 9⅞" H × 25⅜" W × 15⅝" D; speakers 16¼" H × 10¾" W × 6¾" D..... $329.95
CS4720W. Same as 3735W but 8-track tape player; control center 9⅞" H × 18" W × 16⅝" D; speakers 15⅜" H × 9¾" W × 7¼" D... $199.95

ET3752W 8-Track Play/Record Deck
Features two VU meters; automatic and manual eject/shut off; two mike and one headphone jack; pause control; individual record/playback level controls; record safety interlock; frequency response 30-21,000 Hz (playback), 50-10,000 Hz (record/playback); wow & flutter 0.3% rms; S/N 40 dB; channel separation 40 dB. Walnut-grained vinyl cabinet. 4⅜" H × 15¾" W × 8½" D..... $179.95

TELEX

48-H 8-Track Changer
Four program modes for manual or automatic selection of twelve 8-track stereo cartridges for up to 16 hours of non-repetitive music; response 40-12,000 Hz; stereo power amp and preamp outputs; supplied with dust cover. 18¼" × 9" H × 16¼" D..... $319.95
48-D. Same as 48-D but without power amplifier..... $269.95

TOSHIBA

KT-84 8-Track Stereo Deck
Fully automatic operation; lighted channel lamp indicates program selection; manual pushbutton control for changing programs; built-in storage compartment for four 8-track cartridges; response 40-12,000 Hz; wow & flutter 0.3% rms; S/N 40 dB; channel separation 45 dB at 1000 Hz; 4-pole synchronous motor; walnut veneer wood cabinet. 13⅞" W × 8⅘" D × 4⅗" H..... $79.95

KT-805 8-Track Stereo Deck
Plays/records 2-ch stereo cartridges; response 50-10,000 Hz; S/N 40 dB; wow & flutter 0.3% rms; lighted program indicator; headphone jack for private listening; mike jack for recording; full complement of controls; walnut veneer cabinet; 15⅜" W × 5½" H × 10¼" D.. $139.95

PE-1150 8-Track Stereo Deck
Plays/records 2-ch stereo cartridges; automatic play operation; records from phono, radio, or

mike; response 100-10,000 Hz; S/N 40 dB; wow & flutter 0.3% rms; headphone & mike jacks; two VU meters; rotary-type controls operate left and right recording-level channels; full complement of controls; walnut veneer cabinet; 15¾" W × 4¼" H × 10¾" D..... $149.95

WOLLENSAK

8056 8-Track Recorder Deck
Features two-position tape selector switch (standard or Scotch "Classic"); response 30-

12,000 Hz (standard), 30-15,000 Hz (Classic); automatic recording level circuit; individual manual recording level controls for each mike input; digital time counter calibrated in minutes and seconds; special cueing system; features fast-forward mode; repeat switch for replay of one or all four pairs of tracks; switchable automatic cartridge ejection; pause switch; walnut shelf-style cabinet..... $269.95

8075 8-Track Recorder Deck
Features record/play of 8-track Dolbyized cartridges as well as cartridges using the new

3M ferric-oxide tape. Has minutes/seconds timer for precise timing of recordings; fast-forward mode 3½ times actual speed; special cueing system. Response 30-15,000 Hz ±3 dB with Scotch special high-performance tape (30-12,000 Hz with standard tape). (S + N)/N 60 dB at 4000 Hz and above (Dolby system on). Sensitivity: mike 0.25 mV; aux. 80 mV. 19¾" × 5" × 10¼"..... $399.95

ZENITH

F712 8-Track/Receiver
Combines an AM-FM stereo receiver with built-in 2-/4-channel 8-track tape player and four Allegro 1000 speaker systems; features separate bass & treble controls; loudness and balance controls; speaker system has 6½" woofer & treble horn; LC crossover network; response 60-15,000 Hz; 8 ohm imp.; grained-walnut enclosure (16½" H × 10½" W × 7½" D). Control center 5¼" H × 25¼" W × 15½" D..... $359.95

F736 Phono/8-Track/Receiver
Combines an AM-FM stereo receiver with built-in 2-/4-channel 8-track tape player, matrix 4-ch record player, and four Allegro 1000 speaker systems; same features as F712 plus record player with low-mass tonearm; cueing control; 0.7 mil × 3.0 mil stylus. Control center 9½" H × 25¼" W × 15½" D..... $419.95

F594W Phono/8-Track/Receiver
Combines AM-FM stereo receiver, built-in record changer, built-in 8-track player/recorder and a pair of Allegro 3000 speaker systems; cartridge unit features sequential program selector, fast-forward, record, pause, and slide level controls; slide mode switch; record-level meter for each channel; 4 illuminated program indicator lights; 3-speed automatic changer handles 7", 10" & 12" discs; each speaker has 10" woofer & 3½" horn tweeter, LC crossover network; response 40-15,000 Hz; 16 ohms; control unit 10⅛" H × 25½" W × 15¼" D; speakers 22¾" H × 14¼" W × 8¾" D..... $419.95

F685W 8-Track/Receiver
Combines an AM-FM stereo receiver with built-in 8-track player/recorder and pair of Allegro 1000 speaker systems; cartridge unit includes sequential program selector, record, fast-forward, pause, and slide recording-level controls; 4 illuminated program indicator lights; record-level meter for each channel; each speaker has 6½" woofer & 3½" horn tweeter, LC crossover network; comes complete with two mikes, two stands, one blank 40-minute cartridge; control unit: 5" H × 24¾" W × 10¾" D; speakers 16½" H × 10½" W × 7½" D..... $269.95

F587W Phono/8-Track/Receiver
Combines an AM-FM stereo receiver with built-in record changer, 8-track tape player and pair of Allegro 1000 speaker systems; tape player allows either automatic or manual sequential program change; four illuminated program indicators; 3-speed record player handles 7", 10" and 12" discs; each speaker has 6½" woofer & 3½" horn tweeter, LC crossover network; response 60-15,000 Hz; stereo headphone, tape in/out, and main speakers jacks; control unit: 9¾" H × 22⅜" W × 15¾" D; speakers 16½" H × 10½" W × 7½" D..... $279.95

4-CHANNEL EQUIPMENT

AKAI

GX-400DSS 4-Channel Tape Deck
Designed for 4-channel record/playback. Will handle up to 10½" reels. Has four GX glass and crystal heads; closed-loop dual-capstan drive system; ADRS; quadra-sync for synchronizing one track onto another; automatic and manual reverse in playback; three motors; separate input controls for front and rear channels for mike/line mixing; separate output controls for front and rear channels; standard or low-noise tape selector switch; four-digit tape counter; tape/source monitor switch; separate illuminated pause control with lock. Has three speeds (15, 7½ & 3¾ ips); four illuminated VU meters; front/rear mike inputs on front panel; front/rear headphone inputs on front panel; remote-control input socket on back panel. Oiled walnut cabinet $1495.00

1730D-SS 4-Channel Tape Deck
Four-track, 4 & 2 channel play and record. Features automatic shutoff, pause control, and

two speeds (7½, 3¾ ips). Response 30-22,000 Hz ±3 dB, wow & flutter 0.12% rms, dist. 1.5%, all at 7½ ips. Has mike (0.4 mV) and line (40 mV) inputs plus line (1.23 V) output. 16½" × 18" × 9½ $419.95

CR-80D-SS 4-Ch. 8-Track Deck
Features 2- or 4-channel play/record. Response 30-16,000 Hz ±3 dB. Wow & flutter 0.25% rms;

(S + N)/N 47 dB. Has four mike (0.5 mV) & line (50 mV) inputs; four record-level meters. $329.95

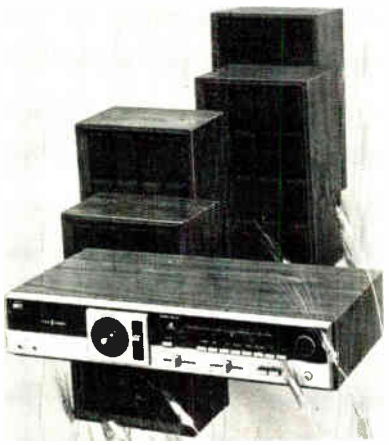
BSR McDONALD

TD-8QW 8-Track Stereo/4-Ch Deck
Deck automatically selects stereo or discrete 4-channel tapes. Includes 0.40 V stereo/4-ch

preamp. Comes with wood grain cabinet and connecting cables. $99.95

CHANNEL MASTER

6690 4-Ch 8-Track/Receiver
5 W rms/ch; 4-ch discrete 8-track and SQ 4-channel FM reception; features push-button



control of channel selection, loudness, FM muting, a.f.c., "on/off;" remote-control panel with 14-ft cord; automatic and manual track changing. Control center 5¼" H × 23¾" W × 12⅝" D. Air-suspension speakers (2 pairs) 18" H × 11" W × 7" D $349.95

CROWN INTERNATIONAL

CX844 Tape Recorder
Three-speed (15, 7½, 3¾ ips), 4-channel, 4-track, 3-motor design. Will handle up to 10½" reels. Has 3 heads. Response 20-25,000 Hz ±2 dB. Wow & flutter 0.09% at 7½ ips. Features braking, pause control, four VU meters, remote record, and automatic photocell shutoff $2995.00

SX744 Tape Recorder
Two-speed (7½ & 3¾ ips), 4-track, 4-channel, 3-motor design. Will handle up to 10½" reels. Has 3 heads. Response 20-25,000 Hz ±2 dB. Wow & flutter 0.09% at 7½ ips. Features braking, pause control, four VU meters, and automatic shut-off $1995.00

DOKORDER

7140 2/4 Ch Stereo Tape Deck
Provides complete 4-channel record & playback facilities. Has three motors (synchronous capstan and eddy-current induction reel), mechanical speed change; solenoid operation. Tape speeds 7½ & 3¾ ips; wow & flutter ±0.08%

max. at 7½ ips. Will handle 5" & 7" reels; operates horizontally or vertically. Has three separate heads; full tape/source monitoring; NAB equalization. Response 30-22,000 (±3 dB 40-20,000 Hz) at 7½ ips; (S + N)/N 55 dB at 7½ ips; crosstalk 55 dB at 1000 Hz; stereo channel separation 45 dB at 1000 Hz. Includes Multi-Sync function which permits recording separate tracks individually and re-recording of any individual track in perfect sync with other three tracks. Built-in sound-on-sound, sound-with-sound, and echo circuitry. Includes four VU meters, quick-change heads, turntable height adjustments, automatic end-of-reel shut-off, and easy-threading operation. 16⅞" W × 17¾" H × 6¾" D $629.95

1140 Four-Channel Tape Deck
A miniature recording studio with complete 2- and 4-channel recording and playback facilities. Mult-Sync function and full logic control, tape transport, and 15 & 7½ ips speeds. Fea-

4 Tape Machines

tures separate playback controls to balance 4-channel output for listening or mix-down dubbing; four illuminated VU meters; separate tape/source monitoring switches for each channel; 4-channel mike and line mixing. Multi-Sync feature permits recording of separate tracks and instruments individually and re-recording any individual track at any time in perfect sync with the other three tracks. Electronic echo, sound-on-sound, and sound-with-sound are switch selected. Response 25-26,000 Hz (30-23,000 Hz ±3 dB) at 15 ips; 25-24,000 Hz (30-20,000 Hz ±3 dB) at 7½ ips; S/N 60 dB; crosstalk 58 dB; wow & flutter 0.04% at 15 ips, 0.06% at 7½ ips. 17¾" W × 15¼" D × 20" H. $1199.95

8140 4-Channel Deck
Provides full discrete 4-channel recording & playback facilities; "Multi-Sync" permits any track to be recorded or re-recorded in perfect sync with others; solenoid-controlled tape transport; three motors (hysteresis synchronous capstan and two eddy current induction); response 20-25,000 Hz at 7½ ips; S/N 58 dB; crosstalk 60 dB; stereo channel separation 55 dB at 1 kHz; three heads (record, play, erase); full tape/source monitoring for all four channels; four VU meters; 4-ch/2-ch output controls. $749.95

FISHER

40 4-Channel System
Combines an AM/FM stereo receiver, a 4-speed automatic turntable with magnetic cartridge, and a 4- and 2-channel 8-track tape cartridge player. Includes matrixing circuit to provide 4-channel reproduction from conventional 2-channel programs. 25 W/ch (100 W total) dynamic (EIA) power at 5% HD. FM sensitivity 2.5 μV. 25" W × 8¾" H × 17½" D. $499.95

4081 "MusiCenter" System
System includes 5 W rms/ch strapped power amplifier; separate turntable; SQ circuit; four two-way speaker systems (each with 6" woofer & 2" tweeter, 3000 Hz crossover); built-in 8-track cartridge player. FM sensitivity 4.0 μV; selectivity 36 dB; S/N 60 dB; capture ratio 4 dB; has full complement of controls. 23¾" W × 14" D × 5" H $449.95

Also available with 3-way speaker systems (each with 8" woofer, 4½" mid-range, 2" tweeter, crossovers 800 & 3000 Hz) at additional cost.

GENERAL ELECTRIC

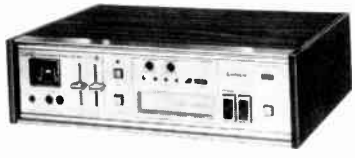
TA400 2- /4-Ch Player Deck
Automatic start when cartridge is inserted; auto or manual program selection; indicator lights; mixing switch for playing 4-ch tapes through stereo system; output jacks for connection to stereo or 4-ch system; patchcords. $89.95

TA-640 2- /4-Ch Deck
Provides 2-ch record and 2- /4-channel playback; automatic mode selection; pause control for editing or cueing; manual or auto eject; dual lighted VU meters; record-level controls; tape timer; fast-forward; front-panel mike jacks; comes with mikes and patchcords. $219.95

SC4210 4-Ch. /8-Track System
Combines a 4-ch AM-FM stereo receiver with 4-ch/2-ch 8-track cartridge player and four speaker systems; will play SQ and CD-4 records with accessory record changer; has 4-ch headphone jacks; matrix 4-ch decoder; four-position mode switch for SQ, synthesis, or stereo operation; lighted slide-rule dial; vernier tuning; 6½" dual-cone speaker in each 17" × 11" enclosure; formed grille cloths; full complement of inputs and outputs. $319.95

HITACHI

TRQ-154 4-Ch Play/2-Ch Record
8-track four-channel playback with two-channel recording facilities; features automatic stop; fast-forward; 3-digit tape timer; pause switch; two VU meters; response 40-12,000 Hz; wow & flutter 0.2%; S/N 55 dB; two mike & two aux. inputs; line & headphone outputs. 16 1/16" W × 4 13/16" H × 10 15/16" D. $199.95



SP-2980 4-Ch Receiver/8-Track
AM-FM stereo receiver combined with 8-track cartridge player and four speakers (rear speakers wireless); has four amps for discrete 4-ch tape reproduction; built-in SQ/regular matrix decoder; normal/reverse switch (front-rear programs); rear function switch for stereo (using 4 speakers), SQ and regular matrix, Aux., and tape. Tuner 20⅞" × 5 9/16" × 12 1/16" D; speakers 12 1/16" W × 20 7/16" H × 6⅝" D. $479.95

JULIETTE

C802-82 Four-Channel System
Combines a 4-channel AM-FM stereo receiver, 8-track cartridge player, built-in SQ circuit for FM broadcasts and 4-channel records, and four speaker systems; plus dual-programming to permit two simultaneous and independent stereo programs; features illuminated vernier tuning dial; omnidirectional single-lever joystick for speaker balance; rotary 4-ch mode switch; master volume; separate front & rear tone controls; 8-track pilot light; stereo indicator lamp; automatic and manual push-button program changers; headphone output jacks; four aux. inputs; four speaker jacks. Speakers 16¼" H × 10½" W × 6¼" D. Control center 5¼" H × 20" W × 12½" D. $299.95
C930-82. Same as C802-82 except includes a built-in automatic BSR changer with dust cover. Control center 9¾" H × 20" W × 6¼" D. $379.95

JVC

4RD-1406 4-Channel Tape Deck
Will play/record 2- and 4-channel reel-to-reel tape. Two speeds (3¾ & 7½ ips). Response 30-18,000 Hz ±3 dB at 7½ ips with low-noise tape. (S + N)/N −52 dB; wow & flutter 0.1% at 7½ ips. 57 kHz bias & erase. Has two heads (record/play & erase), mike (0.5 mV) & line (80 mV) inputs, and line output (0-1.2 V). Features low-noise or standard tape switch. 7⅝" × 16" × 13½" D. $429.95

LAFAYETTE

RK-94 2/4 Channel Tape Deck
Plays all pre-recorded 8-track cartridges: stereo, SQ and discrete Q8 4-channel; has program indicator lights; manual program selector; quadraphonic 4-channel indicator; hinged cartridge door. Walnut finish case with black & silver front panel. 8" × 4¼" × 8½". $59.95

SQR-40 4-Ch, 8-Track/Receiver System
Receiver features sensitive AM-FM stereo tuner, 4-channel "SQ-M" decoder, "Composer" derived 4-channel from 2-channel sources, discrete 4- & 2-channel 8-track tape player, and four separate amplifiers. Comes with four wide-range walnut speaker systems (8½" W × 14½" H × 5½" D). 21½"W × 11⅛" D × 4⅝" H. $189.95

OTARI

MX-5050 QX Tape Deck
Three-head, four-track, four-channel version of the company's MX-5050-2S tape deck; S/N 63 dB; 17" W × 23¼" H × 7⅜" D. $1945.00
MX-5050-QX-S. Same except with d.c. servo capstan with ±10% variable speed. $2145.00

PANASONIC

RS-862S 8-Track Recorder/Radio
Four-channel, 8-track player which will record in 2-channel. Has AM-FM stereo radio, four built-in amplifiers, two VU meters. With optional mike can be used for sound with sound. Features automatic stop, fast-forward, a stereo broadcast indicator light, continuous tone con-

trol, two headphone jacks, and a 4-channel MPX jack. Comes with four matching 2-way walnut speakers with latticework grilles $399.95

RE-8244 8-Track Deck/Receiver
Discrete 4-channel, 8-track system with AM-FM stereo receiver with "Quadruplex IV" 4-ch simulation from stereo sources; has four slide volume controls; continuous tone control; blackout & illuminated slide-rule tuning; FM stereo eye; program selector; speaker jacks; twin headphone jacks: remote 4-ch balancer. Comes with four separate air-suspension speakers. Can be used with optional CD-4 record changer for discrete 4-ch sound..... ..... $279.95
SE-4400. Similar to RE-8244 but includes 3-speed automatic CD-4 record changer as well; adaptable for discrete and matrix sound; 4-ch Aux. input for addition of any 2/4-ch accessory..... $349.95
RE-8860. Similar to RE-8244 but has built-in 4-channel balance scope..... $359.95
RE-8585. Similar to SE-4400 but with a 4-channel "radar" eye to indicate a CD-4 disc is being played..... $399.95
SE-5757. Similar to SE-4400 but with auto-sensor for 2/4-ch records and tapes; proper matrix or CD-4 circuitry selected automatically. $499.95

PIONEER

RT-1020L Stereo Tape Deck
Three-motor, 3-head stereo tape deck with 4-channel reproduction capability. Has 4/8 pole two-speed hysteresis synchronous motor (capstan drive) and 6-pole inner-rotor induction motor (reel drive). Operates at 7½ & 3¾ ips. Wow & flutter less than 0.08% (W rms) at 7½ ips. (S + N)/N 55 dB; dist. less than 1%. Re-

sponse 40-20,000 Hz ±3 dB at 7½ ips. Crosstalk 60 dB, stereo channel separation 50 dB both at 1000 Hz. Inputs: mike 0.25 to 80 mV; line 50 mV to 25 V; DIN 15 mV. Outputs:line 316 mV; DIN 316 mV; headphone 40 mV (4 to 16 ohms). Features 3-position bias selector, 2-position equalizer selector, lockable pause lever, 4-digit tape counter, independent left/right tape monitor switches, 4-ch./2-ch. playback mode selector, independent right/left recording mode selectors, 4-ch front, rear monitor mode selector, independent mike & line recording level controls, output level controls. Will accept up to 10½" reels. 17⁹/₁₆" W × 17" H × 8⅞" D..... $649.95
RT-1020H. Same as RT-1020L except 15 & 7½" ips; response 30-22,000 Hz ±3 dB at 15 ips; wow & flutter 0.04% W rms at 15 ips. 120-V, 60-Hz operation $649.95

RADIO SHACK

Q-800 4-Channel 8-Track Deck
Will play 2- or 4-channel programs. Has "Auto-Stop." Tape head automatically senses and

adjusts to either 2- or 4-channel tapes. Walnut-grain wood cabinet with aluminum front panel $99.95

494 4-Channel Deck
Three-speed (7½, 3¾ & 1⅞ ips), four-track, three-head design. Has four discrete channels, four VU meters, and level controls. Response 50-18,000 Hz; wow & flutter 0.13% rms at 7½ ips. Records discrete 4-channel and standard 2-channel stereo. Walnut wood cabinet with brushed aluminum front panel. 16" × 14⁹/₁₆" × 6⅝" $329.95

SANSUI

QD-5500 2/4 Ch Record/Play Deck
Two-speed (7½ & 3¾ ips) deck. Will record and play back 4-track stereo or 4-channel. Wow & flutter 0.07%. Response 15-25,000 Hz at 7½ ips. (S + N)/N 60 dB. Has three heads, three motors, three-way mixing. Features four mike &

four line inputs. Standby position for easy editing. Overall size 16⅝" W × 21⅞" H × 10⁹/₁₆" D $799.00

SANYO

RD-8200 8-Track 2/4 Ch Player Deck
Will play 2- or 4-channel 8-track cartridges. Features fast-forward, automatic sensing sys-

tem for 2- & 4-channel cartridges. Response 50-12,000 Hz. (S + N)/N 45 dB. Wow & flutter 0.2%. 13" × 12⅜" × 4¾" $149.95

DXL-5486P 2/4 Ch Music System
Combines an AM-FM stereo receiver, a 2/4-channel 8-track tape deck, SQ circuitry; four amplifiers; and four separately housed speaker systems (11⅞" W × 7⅜" D × 17⅜" H) each with an 8" full-range air-suspension speaker, a mid-range whizzer, and a directional tweeter. Four-channel discrete tapes or CD-4 records (with adapter) are played through the system's four power amplifiers. Features bass & treble slide controls, 4-ch headphone output jacks; phono inputs; output jacks for 2- or 4-ch tape recording..... $349.95

GXT-4831 2/4 Ch Music System
Combines an AM-FM stereo receiver; 4-ch matrix decoder circuit; four power amplifiers; 2/4 ch 8-track tape deck; automatic record changer; and four separately housed bookshelf speaker systems (9⅞" W × 7" D × 15⅜" H) each with a full-range speaker. Will handle SQ records or 4-ch discrete 8-track tapes. Has inputs for 4-ch stereo playback from reel-to-reel tape recorders and outputs for tape recording from radio, built-in 8-track deck, or from the phonograph. 19½" × 14½" × 9½"..... $299.95

GXT-4621 2/4 Ch Music System
Combines an AM-FM stereo receiver; four amplifiers; matrix decoder circuit; cassette tape

deck; automatic 3-speed record changer; and four separately housed speaker systems (9⅞" W × 7" D × 15⅜" H) each with full-range speaker. The cassette deck will record in 2-ch stereo at the same time 2-ch stereo or 4-ch SQ stereo discs are played; recorded cassettes may be played back in 4-ch stereo. 19½" × 14½" × 9½". $349.95

DXT-5489 2/4 Ch Music System
Combines AM-FM stereo receiver; four amplifiers; SQ circuitry; 2/4 ch 8-track tape deck; Garrard automatic record changer; four separately housed speaker systems (11⅞" W × 7⅜" D × 17⅜" H) each with an 8" full-range air-suspension speaker, a mid-range whizzer, and a directional tweeter $349.95

GXT-4652 2/4 Ch Music System
Combines AM-FM stereo receiver, four amplifiers; decoder matrix circuitry; cassette tape deck; Garrard automatic record changer; four separately housed speaker systems. Features two recording level meters; automatic stop; automatic eject on cassette deck. 21½" × 14½" × 9½"..... $479.95

DXL-5491P 2/4 Ch Music System
Combines AM-FM stereo receiver; four amplifiers; matrix circuitry; 8-track record deck; four

separately housed speaker systems (same as in DXT-5489). 20" × 12½" × 6"..... $479.95

GXT-4881 2/4 Ch Music System
Combines AM-FM stereo receiver; Garrard automatic record changer; 8-track tape deck; four amplifiers; decoder matrix circuitry; and four separately housed speaker systems (same as in DXT-5489). 21½" × 14½" × 9½"..... $479.95

RD-8010 8-Track 2/4 Ch Player Deck
Will play both 2- and 4-ch 8-track cartridges. Features include automatic selection of correct playback circuits; channel indicator lights; program selector switch. Response 50-12,000 Hz; (S + N)/N 42 dB; wow & flutter 0.2%. 9" × 8½" × 3¼" $69.95

4 Tape Machines

DXT-5342 2/4 Ch Music System
Combines AM-FM stereo receiver; cassette tape deck; 8-track tape player; automatic record

changer; decoder matrix circuitry; four amplifiers; and four separately housed speaker systems. 20" × 14" × 10". $579.95

SONY from SUPERSCOPE

TC-277-4 Quadradial Tape Deck
Reel-to-reel, 3-speed (7½, 3¾, 1⅞ ips), 4-channel, in-line design. Response 50-16,000 Hz ±3 dB at 7½ ips; S/N 52 dB; wow & flutter 0.12% at 7½ ips. Has two heads (4-channel erase & record/play), four inputs, and four line

outputs (1/ch). Input sensitivity 0.06 V. 15¾" W × 7¾" D × 15½" H. $469.95

TC-854-4S 4-Channel Tape Deck
Three-motor, 3-speed (3¾, 7½ & 15 ips) design with 10½" reel capacity. Will record/play 2 or 4 channel. Features vari-speed pitch control and Sony's "Synchro-Trak" for precise synchronization of each track. Response 30-18,000 Hz ±2 dB at 7½ ips (S + N)/N 56 dB with standard tape (59 dB with SLH-180 tape). Wow & flutter 0.04% at 7½ ips. Has four VU meters, sound-on-sound capabilities, record equalization switch for standard or low-noise, high-output tape. 17⅜" W × 22" H × 10" D. $2295.00

TC-258 Quadradial 8-Track Deck
Playback of 4/2 channel 8-track cartridges. Features program select button; repeat button for same program; fast-forward; program indicating lamps; 4 ch/2 ch indicating lamp; automatic 2 ch/4 ch switching. Response 40-12,000 Hz; wow & flutter 0.25%. 8¾" W × 4 1/16" H × 9 9/16" D.

120-V, 60-Hz operation $119.95

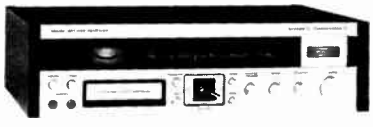
TC-388-4 Quadradial Tape Deck
Open reel, 2-speed (7½ & 3¾ ips) 2- and 4-channel recorder. Response 20-25,000 Hz

(standard tape) and 20-25,000 Hz ±3 dB (SLH-180 tape) at 7½ ips. (S + N)/N 52 dB standard tape; 55 dB SLH-180 tape. Has four auxiliary inputs; impedance 100,000 ohms; four mike inputs; sensitivity −72 dB. Three heads (erase, record, playback); four VU meters. Wow & flutter 0.09% at 7½ ips (rms (NAB) weighted). Features pan pot on-off switch; mike attenuator (−20 dB); built-in reel locks; line output level control. 16 7/16" W × 19¾" H × 8⅞" D. . $679.95

TC-788-4 Quadradial Tape Deck
Records/plays 4 channel; 15 & 7½ ips; will handle up to 10½" reels; 30-22,000 Hz ±3 dB (standard tape), 30-28,000 Hz ±3 dB (SLH-180 tape), both at 15 ips; features 4-digit tape counter; four illuminated VU meters; illuminated pause control with lock; pan pots with on-off switch; full complement of inputs & outputs; comes with two RAD-10 reel hub adapters, 10½" empty reel, four RK-74 audio cables, head-cleaning ribbon; walnut base. 17⅜" W × 22" H × 8¾" D. $1399.95

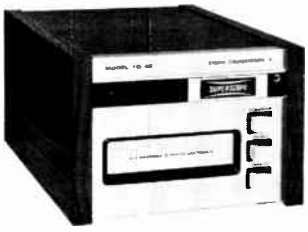
SUPERSCOPE

QRT-440 4-Ch Receiver/8-Track
Will reproduce SQ records, FM broadcasts or tapes; simulate 4-ch reproduction from stan-



dard stereo sources. Will play Q-8 cartridges through built-in 8-track 2/4-ch tape player. FM usable sensitivity 5 μV (IHF); stereo separation 32 dB at 1 kHz; response 20-12,000 Hz ±1.5 dB; THD 1.5% stereo; capture ratio 5 dB. Has complete set of controls; signal-strength tuning meter; four-channel FM output. 18¼" W × 5¼" H × 14½" D $329.95

TD-48 4/2 Ch Cartridge Player
Has automatic 2- and 4-channel switching that sets tape player for correct operation; illuminated 4-channel indicator; built-in automatic program selector; illuminated program indi-



cators; fast-forward, repeat, and program selector push switches; walnut wood-grained cabinet. Response 50-10,000 Hz; (S + N)/N −48 dB; 117-V, 60 Hz operation, 7⅛" × 4⅞" H × 9¾" D $99.95

SYLVANIA

CQ3733 4 Ch 8-Track/AM-FM Stereo
Features built-in 8-track four-channel player; AM-FM stereo receiver; built-in BSR automatic turntable with ceramic cartridge & diamond stylus; four full-range 6" speakers in sealed air-suspension enclosures; front-panel stereo or 4-channel headphone jacks; cut/boost bass & treble controls; provision for accommodation of CD-4 discrete phono demodulator; individual slide control for each channel; control unit 10½" H × 22½" W × 15¼" D; speakers 13⅜" H × 8⅜" W × 5½" D. $369.95
CQ3739. Similar to CQ3733 but with Garrard 6-300 automatic turntable; Pickering V15 magnetic cartridge; cue/pause control; anti-skate control; tape monitor function switch; four speakers with 6" woofer & 2½" tweeter (16¼" H × 10¾" W × 6¾" D); control center 10½" H × 25¾" W × 15" D. $499.95

TEAC

3340S 4-Channel Tape Deck
Multi-channel, three-motor, three-head stereo tape deck with 15 & 7½ ips speeds. Features "Simul-Sync" which allows recording four discrete but fully synchronized channels on each track of a 4-track tape; permits synchronized overdubbing, professional mix-down and special effect tapes. Up to eight inputs (four mike, four line) can be recorded simultaneously. Push-button transport control with logic circuitry. Has 4/8 pole dual-speed hysteresis synchronous motor and two eddy-current induction reel motors. Hyperbolic-shape Permaflux heads, shielded for max. channel separation and protection from leakage flux fields. Unit includes separate bias level and EQ switches; total remote capability; four expanded-scale VU

meters; 2-ch/4-ch play switch; front & rear stereo headphone jacks; pause control with indicator light; Quik-Lok reel holders. Response 30-26,000 Hz at 15 ips; 40-24,000 Hz at 7½ ips; wow & flutter 0.04% at 15 ips, 0.06% at 7½ ips. (S + N)/N 55 dB. 17 5/16" W × 20½" H × 8¾" D $1149.50
A-2340. Same as 3340S except 7" reels; 7½ & 3¾ ips; response 40-18,000 Hz at 7½ ips; wow & flutter 0.08% at 7½ ips; (S + N)/N 55 dB. 17 5/16" W × 18¾" H × 8¾" D. $739.50

2340R 4-Channel Tape Deck
Four-channel, three-motor, three-head deck which includes 2-ch play with automatic reverse. Has front-panel bias switch; 8 source mixing ability (4 line, 4 mike); four separate VU meters; tape/source monitor switches; mike inputs; mike/line level controls; output level controls. Records 7½ or 3¾ ips; will accept up

to 7" reels; wow & flutter 0.08% at 7½ ips; response 40-18,000 Hz at 7½ ips. (S + N)/N 55 dB. 17⁵⁄₁₆" W × 18¾" H × 8¾" D..... $899.50

TECHNICS BY PANASONIC

RS-858US 4-Channel 8-Track Deck
Will record/play all 2- or 4-channel cartridge programs. Has four separate input level con-

trols, four VU meters, mike & line inputs plus pause control and noise-suppressor switch. Response 30-12,000 Hz; wow & flutter 0.2%. 8¼" × 21⅛" × 11¼"..... $329.95

RS-1030US 2/4 Track Tape Deck
Two-speeds (15 & 7½ ips). Response 20-26,000 Hz at 15 ips (30-22,000 Hz ±3 dB); 20-23,000 Hz at 7½ ips (30-20,000 Hz ±3 dB). Two-track record/play, four-track (stereo) playback. Wow & flutter 0.12% W rms at 7½ ips. (S + N)/N 55 dB (2-track). Accepts 10" or smaller reels. Four heads including three HPF ultra-longlife types. Low-noise/normal tape selector. Three motors, one dual-speed hysteresis synchronous for capstan drive. Tape tension selector, optional remote. Features automatic stop, tape pause, and 4-digit counter..... $999.95

TOSHIBA

PT-884 2- and 4-Channel Tape Deck
Reel-to-reel type; 4 ch. record/playback. Three

speeds (1⅞, 3¾ & 7½ ips), 3 heads. Response 30-20,000 Hz ±3 dB with low-noise tape. (S + N)/N 50 dB. Wow & flutter 0.09% at 7½ ips. Has regular & low-noise tape switch. 15¾" × 17½" H × 8¾"D..... $499.95

PT-114 2/4 Ch. Cartridge Deck
Plays all 8-track 4-channel and 2-channel stereo tape cartridges; S/N 45 dB; wow & flutter 0.2% rms; output 0.2 V; features four line output jacks; lighted program indicator with separate lighted 4-ch mode indicator; push-button program selector; walnut veneer cabinet. 9⁷⁄₁₆" × 4" × 10¹⁄₁₆"..... $99.95

WOLLENSAK

8080 4-Ch Player/2-Ch Recorder
Will record & play stereo and play 4-channel tapes; features Dolby noise-reduction circuit which operates on both play & record and FM broadcasts; tape selector switch for standard

or company's Classic cartridge tapes; digital minute & second counter for timing recordings; fast-forward; end-of-tape shut-off; response 30-15,000 Hz (Classic tape), 30-12,000 Hz (standard); S/N 60 dB (Dolby in), 50 dB (Dolby out); wow & flutter 0.1% rms (weighted). 19¾" L × 10¼" W × 5" D..... $399.95

4 Headphones

BEYER/DYNAMIC

DT-204 4-Channel Headphones
Frequency range 20-20,000 Hz; impedance 4 × 200 ohms (4-channel), 2 × 100 ohms

(stereo); independent volume controls for each front channel built into right earcup; 4-ch./stereo slide switch on right earcup; two jack plugs color-coded for front & rear channels; 10-ft detachable cable. Weight 14 ounces..... $120.00

GENERAL ELECTRIC

H28 Quadraphones
For 4-ch or stereo use; max. input 800 mW; imp. 8 ohms; comes with coiled cord with two phone plugs; cushioned earcups & padded headband..... $24.95

HEAR-MUFFS

QM-440 "Quadramuffs"
Features a velour-covered curved polyurethane cushion worn around the back of the head while

reclining. Contains four 3½" dynamic drivers and is supplied with double stereo phone plugs. Response 20-18,000 Hz. Compatible with 4-16 ohm output impedance. THD unmeasurable at 95 dB SPL. 1.5 W/ch max. power handling capacity. 26 ounces..... $49.95

QM-5000. Same as QM-440 except has a 10-ft coiled cord with color-coded plugs for front and back channels; 27 ounces..... $54.95

JVC

5944 4-Channel Headphones

2- or 4-channel design. Response 20-20,000 Hz. HD 0.5% at 1 mV. Has a built-in phase changeover switch $49.95

KOSS

4-Channel Quadrafones
Both versions are designed to be used for either 2- or 4-channel operation. Each earpiece has dual 1½" dynamic drivers. These are connected in parallel for regular 2-channel stereo use. 3.2 to 600 ohm operation. Dist. 0.5% at 109 dB SPL. Capacity 5 V continuous with provision for 14 dB transient peaks. Has balance control on each earpiece. 22 ounces.
K/6LCQ. Response 20-17,000 Hz. Has foam-

filled vinyl ear cushions for ambient noise isolation averaging 18 dB..... $49.95
PRO/5Q. Response 20-20,000 Hz. Has fluid-filled ear cushions for 40 dB ambient noise isolation $75.00

K2+2 4-Channel Headphones
Dynamic type. Features four separate drive elements (2 in each phone) for 4-channel reproduction, arranged in conventional 4-channel format. Has switch for conventional stereo operation. Frequency response 10-20,000 Hz. Sensitivity −87 dB ±3 dB SPL from each cup with 1 V continuous signal at 1000 Hz. Imped-

ance 300 ohms each driver. For use with 3.2 to 600 ohm source impedances. Power input 5 V

4 Headphones

continuous maximum per phone. 10-ft. coiled cord. 26 ounces. Fluid-filled ear cushions. Comes with carrying case..... $90.00

Phase/2+2 Quadraphone
Incorporates one Decilite driver element and one high-velocity dynamic element in each

earcup; response 20-20,000 Hz; programmer permits 127 personal listening perspectives in 4-channel sound without adjusting amp controls; features comparator switch for normal 4-channel mode vs Phase/2 + 2 mode; soft acoustical sponge ear cushions; vinyl-covered headband with pivoting self-adjusting yokes. $145.00

LAFAYETTE

F-4400 4-Channel Headphones
Four separate 2¼" speakers, each in its own acoustically isolated chamber, deliver 4-channel sound from 4-channel amplifiers and receivers. Exclusive, patented baffle plate increases front-to-rear separation. Has 4-channel/2-channel switch. Built-in circuitry derives 4 channels from 2-channel sources. Frequency response 20-20,000 Hz. Impedance 4-16 ohms. Foam-filled vinyl leatherette earpieces and adjustable headband. With 9½-ft cable, connectors. $44.95

F-400 4-Channel Headphones
Open-acoustic type; lightweight foam ear cushions; adjustable headband; four wide-range 2" transducers with polyester film diaphragms; response 20-20,000 Hz; 8 ohms; 6½-ft cord; two ¼" phone plugs..... $29.95

MURA

QP-280N "Quadset" Headset
Has 4-channel/stereo switch; 10-ft coiled cord with dual plugs marked for easy identification. Response 20-20,000 Hz. Power rating 0.2 W; impedance 8-16 ohms. Custom leather-type padding on earcups and headband ... $24.95

QP-300N Deluxe "Quadset"
Features two woofers and two tweeters in each earcup for a total of eight dynamic speakers. Electronic crossover network. Impedance 8-16 ohms. Frequency response 20-20,000 Hz ±5 dB. Maximum allowable input 500 mW. Comes with 6-ft cable, plugs marked for easy identification, and zipper carrying case..... $49.95

PIONEER

SE-Q404 2/4 Ch Headphones
Features four matched driver elements; sensitivity 105 dB/0.3 V (4-ch, each channel), 111 dB/0.3 V (2-ch, each channel); frequency range 20-20,000 Hz; max. input power 500 mW/ch; has volume controls; 2/4 ch selector switch; adjustable headband; 8 ohms; matching imp. 4 to 16 ohms..... $69.95

RADIO SHACK

Nova-44 4-Channel Headphones
Quadraphonic/stereophonic dynamic design. Each earcup has separate speakers for two channels. Dual plugs provided for stereo or 4-channel use. Ported earcups. Frequency range 20-20,000 Hz; 8 ohms. 15-ft coiled cord $44.95

SCINTREX

HQ4 4-Channel Headphones
Has four separate drivers which will deliver

sound from any discrete or matrixed four-channel source. Has quad/stereo switch for maximum utilization of the four drivers in the 2-ch stereo mode. Response 20-20,000 Hz. Impedance 4-300 ohms. Sensitivity 100 dB SPL 1.1 mW. Max. input 14 mW; max. output 110 dB. HD at 1 kHz 0.7%. Ambient noise isolation 40 dB. Has liquid-filled ear cushions 14-ft coiled cord with dual jacks. Black with chrome-plated headband. 24 ounces..... $69.95

XQ-4 4-Channel Headphones
Features dual-driver cavity assembly with four separate acoustic-suspension drivers; response 15-20,000 Hz (20-15,000 Hz ±4 dB); HD 0.6% at 110 dB SPL 1000 Hz; impedance 4-1000 ohms; sensitivity 4.0 mW (95 dB SPL), 13.0 mW (100 dB SPL); max. input power (loaded) 45 mW; max. acoustical output (loaded) 110 dB; liquid earseals; padded head cushion; comes with 14-ft coiled cord with dual jacks; 19 ounces. $79.95

STANTON

Dynaphase Sixty-Five Four C
Has two speakers in each earpiece for 20-20,000 Hz response. Equipped with two plugs

(blue for front, black for rear); earpieces marked "L" and "R" for accurate listening orientation. Sensitivity: 100 dB SPL (at 0.1 V input at 1 kHz each channel). Maximum power input 1.25 V rms continuous with provision for 10 dB SPL transient peaks. Dist. ½% at 110 dB SPL. Input imp. (at 1 kHz) 15 ohms ±20%. Vinyl-covered foam ear cushions; adjustable headband. 11-ft coiled cord with four-channel/stereo switch, front & rear plugs. 19 ounces. $69.95

SUPEREX

QT-4 "Quad-Tette" Headphones
Has four identical reproducers (two to an earcup) with frequency response of 25-17,000 Hz. 15-ft. cord. Ivory/Cordovan $50.00

QT-4B "Quad-Tette" Headphones
Has four identical reproducers (two to an earpiece) with frequency response of 20-18,000

Hz. 15-ft. cord and 2-4 ch. sw $65.00

TECHNICS BY PANASONIC

EAH-420 4-Channel Headphones
Dynamic type using six drivers; each earpiece has center-mounted 3" woofer with two iso-

lated front-back 1¾" tweeters; high efficiency; independent tone & volume controls on each earpiece; 4-ch/2-ch selector switch; input imp. 4-16 ohms; response 20-20,000 Hz; max. input 1000 mW; sensitivity (1 mW, 200 Hz)=104 dB; 9.1-ft cord. 23.8 ounces..... $79.95

TELEPHONICS

TEL-101F "Fixler Effect" Phones
Patented design involving specially designed drivers positioned in front of and behind ear for

realistic spatial distribution of sound; two dynamic drivers per phone; response 20-20,000 Hz; sensitivity 100 dB SPL at 1000 Hz for 1 mW; dist. 0.2% max; features "Quadrablend" control to adjust ambience; open-cell foam ear cushions. 23 ounces..... $59.95

TEL-101A "Quadramate"
Designed to be used with the TEL-101F to

create 4-ch effect from 2-ch program sources; max. power 1 W; input impedance compatible with all hi-fi system phone jacks; no power required; has focus and perspective controls; 6-ft cord. $26.95

TOSHIBA

HR-40 2-Ch/4-Ch Headphones

Features 4-channe /2-channel changeover system with two plugs (front & rear). Dynamic driv-

er 3" × 4". Frequency range 20-20,000 Hz; rated input power 1 mW/ch; imp. 4-16 ohms. Comes with 6.6-ft. cord. Total weight 27½ ounces $54.95

ZENITH

839-35 2/4 Ch Headphones

Has 2-ch or 4-ch compatible slide switch; separate volume controls on each earpiece; frequency response 20-20,000 Hz; 8 ohms imp.; 10-ft coiled cord. Weight 11 ounces.... $75.00

839-34. Same as 839-35 except frequency response 20-19,500 Hz. Weight 17 ounces..... ..... $59.95

839-44 2/4 Ch Headphones

Has 2-ch or 4-ch compatible switch, 2-4 channel mode selector switch; volume/balance control; response 20-19,000 Hz; 8 ohms; 10-ft coiled cord. Weight 16 ounces..... $49.95

4 Decoders & Miscellaneous

ELECTRO-VOICE

EVX-44 Universal 4-Channel Decoder

Automatically provides correct decoding of all matrixed four-channel records, tapes, and FM broadcasts. Provides optional front-to-rear separation enhancement. Connects into hi-fi system between preamp & power amp or through tape jacks. Has inputs for 2- and 4-channel tape sources. (S + N)/N 70 dB below ¼ V. Gain is unity. Maximum input 4 V rms. Response 20-20,000 Hz ±1 dB. 2¾" H × 8" W × 7" D..... $99.95

SONY

SQD-2020 4-Channel Decoder

Designed as a control center for 4-channel discrete tapes and has built-in SQ full-logic (gain-riding) matrix decoder. Features four VU monitor level/balance meters. (S + N)/N 80 dB. HD 0.1%. Sensitivity: input & 4-ch. 1, 2 250 mV; Rec/PB 2 & 4-ch. tapes 750 mV. Output: front 500 mV, back 550 mV & 2 V. SQ separation LF/RF, LF/LB, RF/RB 20 dB; CF/CB 15 dB. 5⅞" × 15¾" × 12⅞" $229.50

TEAC

AN-300 Dolby Noise Reduction Unit

Has four separate Dolby-B type noise-reducing systems within a single housing. Features four VU meters. With channels operated in pairs the unit affords simultaneous decoded stereo monitoring or full 4-channel Dolby encoding. Has a standard 400-Hz recording calibration tone on all four channels and a 420-Hz pulse circuit for easy identification of the calibration tone. Increased (S + N)/N of 10 dB at 10,000 Hz (5 dB at 1000 Hz). Sensitivity: tape and line 0.1 V. Outputs: record and monitor 0.3 V. Has multiplex filter. Response 20-20,000 Hz ±1.5 dB. 6¾" H × 16⅛" W × 10⅛" $399.50

AX-300 Multi-Channel Mike/Line Mixer

Has a preamplifier and features inputs for six

low-impedance microphones (four circuits mike/line switchable and two circuits mike only). Has a six in and four out format. Noise level is −62 dB (−72 dB line); mike (600 ohms unbalanced) input 0.1 V max.; line output 0.3 V (7 V max.). 6⅛" × 16⅛" W × 10⅜" D... $429.50

Model 2 Audio Mixer

Features six input, six mike, or six line sources (or any combination of mike/line inputs), four outputs; level controls for each input channel; master output level control; cue out jack on each input channel; accessory send/receive patch points on each output bus for reverb units, graphic equalizers, limiters, compressors, noise-reduction units, other signal processing equipment; four aux. outputs in parallel with four line outputs; selectable high-cut filters at 5 kHz or 10 kHz; low-cut filters at 100 Hz or 200 Hz; color-coded push-push channel assignment buttons with pan on each input channel; 3¼" H × 13¼" W × 10½" D..... ..... $299.50

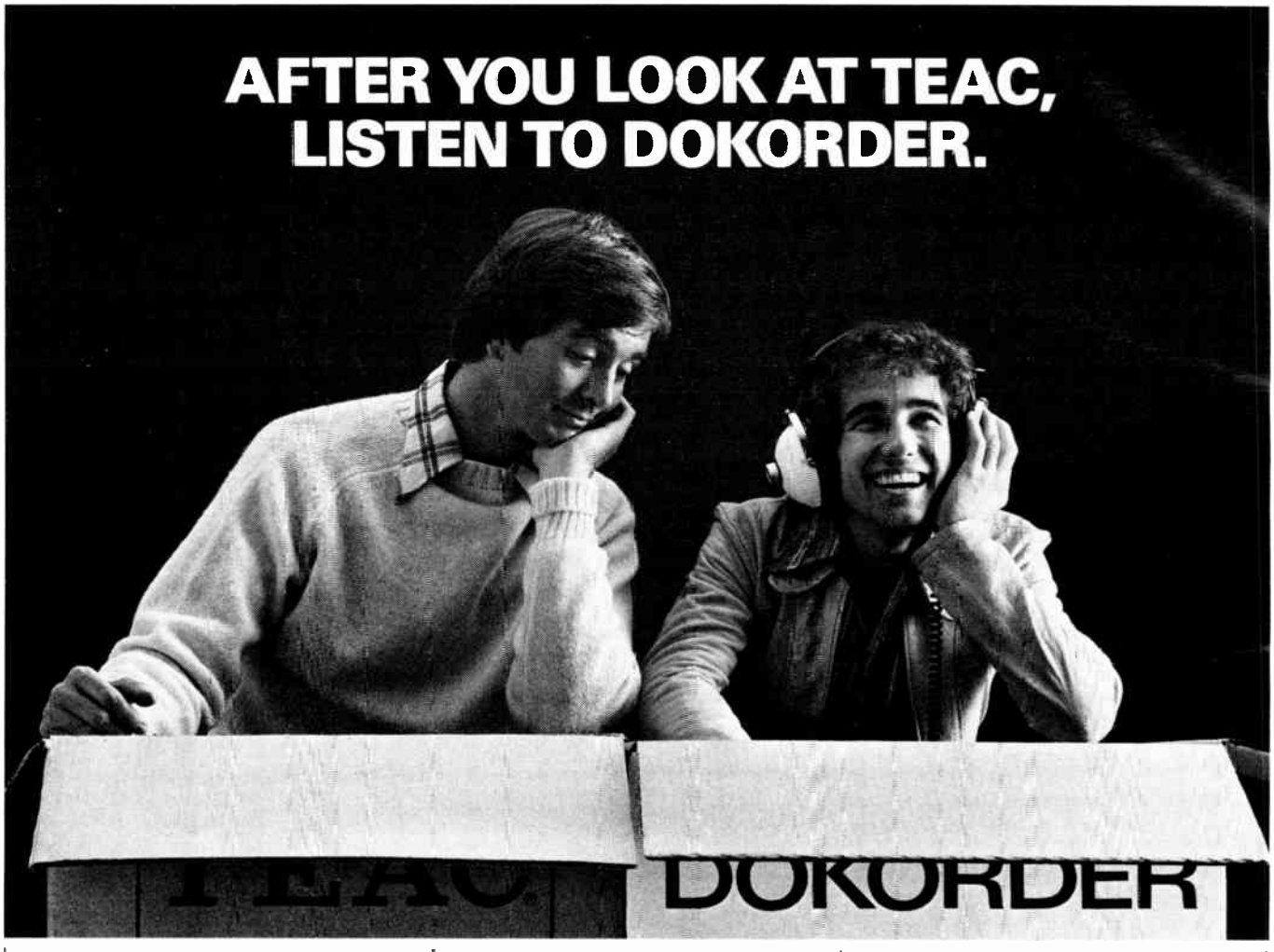
NOTICE TO READERS

We consider it a valuable service to our readers to continue, as we have in previous editions of this guide, to print the price set by the manufacturer or distributor for each item described as available at presstime. However, almost all manufacturers and distributors provide that prices are subject to change without notice.

We would like to call our readers' attention to the fact that during recent years the Federal Trade Commission of the U.S. Government has conducted investigations of the practices of certain industries, in fixing and advertising list prices. It is the position of the Federal Trade Commission that it is deceptive to the public, and against the law, for list prices of any product to be specified or advertised in a trade area, if the majority of sales of that product in that trade area are made at less than the list prices.

It is obvious that our publication cannot quote the sales price applicable to each trading area in the United States. Accordingly, prices are listed as furnished to us by the manufacturer or distributor. It may be possible to purchase some items in your trading area at a price that differs from the price that is reported in this edition. The Publisher

AFTER YOU LOOK AT TEAC, LISTEN TO DOKORDER.



We're one of two major companies seriously and exclusively into the manufacture of high performance tape recorders. The smaller one.

When you work with a tape recorder the only thing that counts is how well it works with you, not the size of the company that made it.

For sure they sell more tape recorders than we do. But you're only interested in the one you buy. They spend more on advertising, too. But you're buying a tape recorder, not an ad.

They have a sophisticated assembly line and so do we. Theirs is just longer. They have a big quality control department and ours is smaller. But only one man can check one machine at a time and it's the commitment to quality that matters.

They're continually working on new products...we are, too. And good ideas have nothing to do with size.

So if you compare specs, features and functions you'll find yourself comparing two excellent tape recorders. One of them, however, takes significantly fewer dollars to buy. Ours. And that's the difference.

You won't always find TEAC and DOKORDER at the same store; we're too much alike. Naturally they have more dealers, so you may have to look around a little.

But that's the only price you'll have to pay for paying a lower price.

TEAC 2340	
Motors	3
Heads	3
4-Channel Record and Playback	Yes
Built-in S-O-S/Echo	No
Overdub	Yes
Frequency Response at 7½ ips	±3 dB, 40-18,000 Hz
S/N	55 dB
Wow and Flutter at 7½ ips	0.08%
Manufacturer's suggested retail price	**$739.50**

DOKORDER 7140	
Motors	3
Heads	3
4-Channel Record and Playback	Yes
Built-in S-O-S/Echo	Yes
Overdub	Yes
Frequency Response at 7½ ips	±3 dB, 30-23,000 Hz
S/N	58 dB
Wow and Flutter at 7½ ips	0.08%
Manufacturer's suggested retail price	**$629.95**

Features and specifications as published by respective manufacturers in currently available literature.

DOKORDER 7140

5430 Rosecrans Avenue, Lawndale, California 90260

CIRCLE NO. 8 ON READER SERVICE CARD

AIKO

ACS-215 Cassette Player
Designed for underdash mounting; features patented "Slot-in" system; cassette eject & fast-forward buttons; electronic governor for constant speed; volume, tone, and balance controls; on-off indicator light; cassette door to keep out dust; comes with mounting bracket and necessary hardware. $79.95
ACS-251. Similar to ACS-215 but with the addition of FM-stereo radio with two FET's. $119.95
ACS-217. Similar to ACS-251 but with addition of AM tuner. $129.95
ACS-310. Similar to ACS-217 but designed for in-dash mounting. $139.95
ACS-312. Similar to ACS-310 but designed for compact cars; 7" wide (5" shaft-to-shaft); automatic shut-off. $149.95

AUDIOVOX

C-902 8-Track Stereo Player
Features slide volume, tone, and balance controls; automatic & manual channel selectors; channel indicator lights; response 50-10,000 Hz; separation & crosstalk 40 dB; speaker imp. 4 or 8 ohms each channel; comes with underdash mounting bracket. 5¼" W × 6½" D × 2" H $45.85

C-905 8-Track Stereo Player
Compact unit (4¾" W × 6½" D × 2⅝" H) to fit most vehicles; response 50-10,000 Hz; has slide volume, balance, and tone controls for left/right speakers; automatic track indicator light; S/N & crosstalk 40 dB; separation 30 dB $56.00

C-910 8-Track Quad Matrix Player
Simulated four-channel reception from standard 8-track cartridges; response 50-10,000 Hz; features fast-forward; slide volume control; thumbwheel balance control; slide tone control; automatic or manual track switching; 12-V negative-ground operation; comes with mounting bracket, screw kit, and speaker wires. 6¼" W × 7¼" D × 2½" H $69.95

C-988 Cassette Player
Compact stereo unit; features fast-forward; automatic or manual eject; balance & rewind controls; response 50-10,000 Hz; output imp. 4 or 8 ohms; 12-V negative-ground operation; comes with underdash mounting hardware. 5¼" W × 6⅜" D × 1⅞" H $79.95

C-980 8-Track/FM-Stereo Radio
Features a "channel-repeat" control; automatic start; channel selector; FM stereo indicator light; FM sensitivity 2 μV (per 500 mW output); separation 20 dB at 1 kHz; local/distance switch; response 50-10,000 Hz; 12-V negative-ground operation. 7¾" W × 7¾" D × 2¼" H $129.95

C-990 4-Channel 8-Track Player
Features automatic start & manual pushbutton control; automatic track switching; individual slide volume controls for front pair of speakers, individual control for rear speakers; left/right balancing control; power, volume, bass/treble controls; lighted program indicator; response 50-10,000 Hz; 11-16 V negative-ground operation; comes with mounting bracket, screw kit, speaker wires, spare fuse. 7⅛" W × 7¼" D × 2¼" H $149.95

ID-400 8-Track/AM-FM Stereo
In-dash 8-track stereo player with AM-FM stereo radio; response 50-10,000 Hz; wow & flutter 0.25%; FM sensitivity 5 μV for 30 dB S/N; stereo separation 20 dB; SCA rejection ratio 40 dB; has full complement of controls. 7" W × 6⅛" D × 2½" H $149.95
ID-500. Similar to ID-400 but with pushbutton radio controls; 7⅛" W × 6" D × 2¾" H. $199.95
ID-600. Similar to ID-400 but with cassette player instead of 8-track system. $169.95

AUTOMATIC RADIO

SPA-5000 8-Track Player
Plays all 8-track cartridges; slide-bar controls; pushbutton channel selector with lights; easy access control panel; cartridge ejector; 5½" W × 8" D × 2" H. $70.95

SPB-5001 8-Track Stereo Player
Features fine tuning; "Theft-Control" slip-out mounting bracket; pushbutton cartridge ejector; program repeat circuit; pushbutton channel selector with lights; slide-bar controls. $79.50

SPC-5002 8-Track Stereo Player
Features fine tuning; fast-forward control; "Theft-Control" mounting bracket; digital channel indicator; program repeat circuit pushbutton cartridge ejector; slide-bar controls. $89.50

SPD-5003 8-Track/FM-Stereo Radio
Same features as SPC-5002 with addition of FM-stereo receiver; FM local/distance reception controls; FM stereo indicator; illuminated slide-rule dial. $127.95

SPE-5004 8-Track/FM-Stereo Radio
Same features as SPD-5003 with addition of four individual speaker balance controls; designed for 12-V negative-ground cars; 7¾" × 8½" W × 2⅞"; comes with mounting hardware but less speakers. $142.95

SPF-5005 8-Track Stereo/AM
Similar to Model SPB-5001 with addition of AM broadcast receiver; thumbwheel radio tuning. $106.50

Home Power Converters
Designed to permit auto tape players to be used in the home; walnut-grained wooden cabinets house converters; 11" W × 11" D × 4½" H.
HCS-5103. For Model SPB-5001. . . . . $77.95
HCS-5104. For Models SPC-5002 & SPE-5004. . . . . $86.50

SPG-5006 Cassette Stereo Player
Slide-bar controls for volume, tone, and balance; fast-forward tape control; tape eject; pilot light; "Theft-Control" bracket. . . . $73.50
SPH-5007. Identical to SPG-5006 but with addition of AM radio. $91.50
SPK-5008. Similar to SPG-5006 but with addition of FM-stereo radio; local/distance switch; end-of-tape signal. $127.50

QME-2445 4-Channel Tape Player
Plays stereo & 4-channel tapes; slide-bar controls; tape program repeat button; fine tuning control to eliminate crosstalk; program selector with lights; four individual speaker balance controls; 12-V negative-ground operation; 7¾" D × 8½" W × 2⅞" H; comes with mounting hardware but without speakers. $134.95

CLARION

430 8-Track Player
Compact in-dash or under-dash 8-track player; vertical head tracking; four program selector lights; automatic and manual track changing. $49.95

431 8-Track Player
Designed for boats, trucks, and trailers as well as cars; features integrated circuitry; loudness control; radio-tape bypass switch to permit unit to be connected to existing car radio; same basic features as Model 430. . . . . $74.95

888 8-Track Player
Same basic features as Model 430; special loudness control for proper tonal balance; automatic repeat control; accepts the company's FM stereo tuner and cassette adapter for future system expansion. $109.95

434 4-Channel Stereo Player
Offers both discrete 4-channel and stereo 8-track; features front and rear slide volume controls; slide balance control; repeat switch; automatic-manual track changer; vertical head tracking. $159.95

884 8-Track/FM Stereo Radio
Designed for in-dash or under-dash mounting; features integrated circuitry; stereo indicator light; local/distant switch. $129.95
616. Same as Model 884 but with AM-FM stereo receiver· a.f.c.; stereo/mono switch. . . $149.95
617. Same as Model 616 but with radio dial as

cartridge slot; LED's for band, program, and stereo indicators. $164.95

810 Cassette Player
Front-load system with slide controls; features

5 Auto Tape Machines

integrated circuitry; end-of-tape warning signal. $89.95

811 Cassette Player
Incorporates automatic tape reverse for continuous play; slide volume & tone controls; program indicator lights; automatic or manual program switching; fast-forward and rewind. $119.95
940. Same as Model 811 but without fast-forward and rewind feature. $109.90

812 Cassette Recorder/Player
Has all playing features of Model 811 plus recording mike with "on-off" switch for dictating; spring-tension cord for in-car recording. $154.95

653 Cassette/AM-FM Stereo
Includes adjustable shafts for in-dash adaptability; features automatic reverse; stereo/mono switch; automatic/manual program switching; front-panel eject button; FM stereo light. $179.95
657. Same as Model 653 but with fast forward/rewind; local/distant switch; tape function light; end-of-tape warning signal. $179.95
659. Same as Model 657 except includes auto-

matic reverse function. $199.95

CRAIG

3147 8-Track Stereo Player
Features slide volume controls for left- and right-channels; illuminated program indicators; automatic and manual program change; automatic operation when cartridge is inserted; response 80-8000 Hz; stereo separation 30 dB; operates from 12-V negative-ground system; 5½" W × 2⅞" H × 7½" D. $47.95
3144A. Similar to 3147 except response 40-8000 Hz; quick-mount feature; automatic program selection with repeat mode; 6" W × 2¼" H × 6¾" D. $59.95

3515 Cassette Stereo Player
Features one-hand slot loading; fast-forward; LED tape-running indicator; eject button; two-position tone control; response 50-10,000 Hz; stereo separation 40 dB; 12-V negative-ground operation; 5⅝" W × 1⅝" H × 5⅞" D. . . . $59.95

3135 8-Track Stereo Player
Features illuminated program indicators; fast-forward; slide volume & tone controls; plug-in quick-release mounting; response 50-8000 Hz; stereo separation 35 dB; operates from 12-V negative-ground system; 4¾" W × 2⅛" H × 6½" D. $69.95
3143. Similar to 3135 except response 70-10,000 Hz; power-eject cartridge removal; 7" W × 2½" H × 8" D. $84.95

3511 Stereo-Matrix Cassette Player
Features slot loading; end-of-tape indicator light; locking fast-forward & rewind; pushbutton operation; matrix circuit for 4-channel effect from stereo tapes; response 40-10,000 Hz; stereo separation 35 dB; operates from 12-V negative-ground system; 5⅞" W × 2¼" H × 7½" D. $84.95

3136 8-Track/FM-Stereo Radio
Combines 8-track stereo player with FM-stereo receiver; features automatic FM-stereo switching; illuminated program indicators; fast-forward & stereo/mono switches; response 100-8000 Hz; stereo separation 35 dB (tape); operates from 12-V negative-ground system; 7½" W × 2¼" H × 7⅛" D. $104.95
3137. Similar to 3136 except includes three pre-select FM stereo tuning buttons with individual dial pointers; 7½" W × 2¾" H × 7¾" D. $119.95

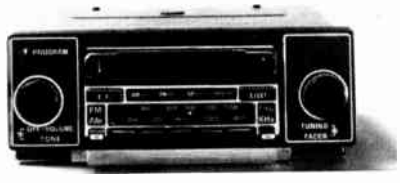
3512 Cassette Player/FM-Stereo
Features a stereo-matrix circuit to simulate 4-channel sound from stereo cassettes; response 40-10,000 Hz; stereo separation 35 dB; operates from 12-V negative-ground system; includes quick-mount feature; 7⅜" W × 2¼" H × 7½" D. $119.95

3141 8-Track Player
Floor-mount player with high-power amplifiers; response 70-10,000 Hz; separation 40 dB; power bandwidth 100-14,000 Hz; features fast-forward cueing; automatic program selection with repeat mode; 12-V negative-ground operation; 6.3" W × 8" H × 9.6" D. $129.95

3148 8-Track/AM-FM Stereo Radio
Features stereo-matrix output for four speakers; matrix, repeat, and eject pushbuttons; response 70-10,000 Hz; stereo separation 35 dB; operates from 12-V negative-ground system; designed for in-dash mounting, will fit most foreign & domestic cars; mounting centers 5.6" × 5.8" × 6" or 6.3"; comes with trim plate for use with 148, 152, and 160 mm shaft spacings and underdash mounting kit. $144.95

3140 4-Ch 8-Track Player
Will play any Q-8 or stereo cartridge; automatic 2-/4-ch switching; master volume & tone controls with L-R, F-B balance controls; fast-forward & repeat pushbuttons; four amplifiers; response 70-10,000 Hz; stereo separation 35 dB (tape); operates from 12-V negative-ground system; 7¾" W × 3" H × 8½" D. $144.95

3149 8-Track/AM-FM-WB Radio
Features 5-button pre-set FM tuning plus weather pushbutton; stereo-matrix output for four speakers; matrix, repeat, eject pushbuttons; response 70-10,000 Hz; stereo separation 35 dB; designed for in-dash mounting (compatible with existing customized mounting kits); operates from 12-V negative-ground system; comes with trim plate for use with 148, 152, and 160 mm shaft spacings. $189.95
3516. Similar to 3149 except has cassette



player instead of 8-track; comes with trim plate, gasket, and mounting hardware. $199.95

HITACHI

CS-2400 8-Track Stereo
Slide lever control for volume, tone, and balance; illuminated program indicator; response 50-10,000 Hz; operates from 12-V negative-ground battery; comes with mounting bracket & extra fuse. 4¾" W × 1⅝" H × 7" D. . . $59.95

CS-2440 8-Track Stereo
Features matrix 4-channel stereo with 2-channel cartridge; matrix mode switch; illuminated cartridge slot; automatic repeat button; slide lever control for volume, tone, and balance; illuminated program indicator; response 50-10,000 Hz; operates from 12-V negative ground battery; comes with theft-proof lock, mounting bracket, connecting cord, and extra fuse. 4¾" W × 1⅝" H × 7" D. $69.95

CS-1750 8-Track Stereo
Features fast-forward, cartridge eject, and automatic repeat button; slide lever control for volume, tone, and balance; illuminated program indicator; response 30-12,000 Hz; operates from 12-V negative-ground battery; comes with theft-proof lock, lockable mounting bracket, connecting cord, and extra fuse; 7⅛" W × 2 13/16" H × 7½" D $79.95
CS-1700. Similar to CS-1750 but featuring one-touch channel selector button with remote-control switch; one-touch cartridge ejection button. 7⅞" W × 2 15/16" H × 8 1/16" D. $79.95

CS-400 8-Track Stereo
Features discrete/matrix 4-channel sound; sound balance control for front/rear, left/right speaker systems; illuminated program indicator; response 30-12,000 Hz; operates from 12-V negative-ground battery; comes with mounting bracket, theft-proof lock and key, connection cord, extra fuse. 6 9/16" W × 2¾" H × 2⅛" D. $119.95

CSK-1300 FM Stereo/8-Track
Combines FM stereo tuner with 8-track player; features automatic FM-FM stereo changeover; program indicator and FM stereo indicator lamp; control knobs for volume, balance, and tone; response 30-12,000 Hz; operates from 12-V negative-ground battery; comes with mounting bracket; connecting cord, head cleaner, and extra fuse. 5⅛" W × 3⅜" H × 7⅞" D. $119.95

CS-214 Cassette Player
Features one-hand cassette loading; fast-forward; rewind; dustproof door; for built-in or underdash mounting. 7 1/16" W × 1 15/16" H × 5⅛" D $109.95

CS-200 Cassette Player
Features automatic start, automatic reverse; lever controls; cassette eject button; illuminated program indicator; response 50-10,000 Hz; operates from 12-V negative-ground battery; comes with mounting bracket, connecting cord, and extra fuse. 5½" W × 2 3/16" W × 4⅜" D. $129.95

CSK-2300 FM Radio/Cassette Player
For built-in dashboard installation; Philips-type cassette player; fast-forward & rewind; automatic or manual eject; built-in a.f.c. 7 1/16" W × 1 15/16" H × 5⅛" D $169.95

J.I.L.

828-P 8-Track Stereo Player
Compact, underdash unit; response 50-10,000 Hz; S/N 45 dB; features automatic start & track selection; slide-controls for volume, balance, and tone. 1 15/16" H × 6 5/16" D × 4 11/16" W. $37.95
828. Same as 828-P but with slightly higher power output. $49.95

528 Mini 8-Track Stereo Player
Compact, functional design; features slide volume and tone controls; illuminated program indicator; left/right balance control; manual track selector. 2" H × 4⅞" W × 6½" D. . . $49.95

515 8-Track Stereo Player
Designed to be installed in any handy location; features fast-forward switch; illuminated program indicator; repeat switch with indicator; volume, balance, and tone controls. 2" H × 6¾" W × 6¾" D. $59.95

815-M 4-Ch Matrix 8-Track Stereo
Plays 4-ch tapes; response 70-10,000 Hz; S/N 30 dB; separation 30 dB; operates from 12-V negative-ground system; features fine-tuning head adjustment; fast-forward; program repeat; left/right stereo balance control; push-button channel selectors; tape lamp. 5" W × 1⅞" H × 8¼" D. $59.95

817 8-Track/FM-Stereo Radio

Response 50-10,000 Hz; S/N 45 dB; features channel indicator; FM-stereo lamp; left/right volume controls; illuminated dial scale; automatic start & track selection; 6 11/16" W × 2" H × 7 1/2" D. $89.95

517. Similar to 817 but with different styling; local/repeat switch. 2" H × 6 3/4" W × 6 3/4" D. $99.95

822 8-Track/FM-Stereo Radio

Combines 8-track player with FM-stereo receiver; designed for underdash mounting; response 50-10,000 Hz; S/N 45 dB; 4 or 8 ohm speaker imp.; features loudness, balance, and tone controls; manual track selection; digital program indicator; lighted dial pointer for stereo; built-in alarm; automatic start and automatic track selection. 6 5/8" W × 2" H × 7 1/8" D. $109.95

851 8-Track/AM-FM-Stereo Radio

Designed for in-dash mounting; features IC's; stereo indicator light; stereo/mono switch; power polarity protection; has volume, balance, tone controls; manual track selector; automatic start and automatic track selection; response 50-10,000 Hz; S/N 45 dB; 1 3/4" H × 4 3/4" D × 6 3/4" W; adjustable shafts to fit most domestic and foreign cars. $119.95

841. Similar to 851 but slightly different styling; 1 3/4" H × 5 1/2" D × 7 1/4" W. $119.95

842. Similar to 841 but with 4-channel matrix, front-end head alignment, antenna trimmer, front-to-rear fader control. $139.95

604 Cassette/AM-FM Stereo Radio

Designed for in-dash mounting; stereo cassette playback; response 50-10,000 Hz; S/N 45 dB; features automatic tone control; power polarity protection; IC's; eject and fast-forward buttons; adjustable shafts. 1 3/4" H × 4 3/4" D × 6 3/4" W. $159.95

605. Similar to 604 but with automatic tuning; color running lamp; 1 3/4" H × 5 1/2" D × 7 1/8" W. $212.12

843 8-Track/AM-FM Stereo Radio

Designed for in-dash mounting; pushbutton radio; IC's; front-end head alignment; antenna trimmer; response 50-10,000 Hz; adjustable shafts; convertible nosepiece gasket; 2 5/8" H × 5 1/2" D × 7 1/4" W. $169.95

846. Similar to 843 except slightly different styling with reversible walnut grain/leather faceplate; automatic tone control; 2 5/8" H × 5 1/4" D × 7 1/4" W. $179.95

848. Similar to 843 but with automatic tuning; stereo and channel indicator; remote control for auto tune/program select; styling similar to 846; 1 3/4" H × 5 1/2" D × 7 1/8" W. $199.95

832-Q 4-Ch 8-Track/AM-FM Stereo

Plays stereo and 4-channel cartridges; manual AM-FM stereo receiver; has volume, balance, and tone control; manual track selector; automatic start and automatic track selection; 2 1/8" H × 7" D × 7" W. $239.95

LAFAYETTE

"Auto-Mate II" Cassette Player

Can mount in glove box; has slide-volume, balance, and tone controls; push-in cassette loading; power-on indicator light; 12-V negative-ground operation; comes with metal case, mobile mounting bracket, cable. 6" × 1 7/8" × 6 3/4". $39.95
Pair of 3" × 5" speakers. $7.95

RK-300 Auto-Reverse Player

Features solid-state stereo amplifier; fast-forward, rewind, and cassette eject buttons; slide-type tone, volume, and balance controls; 12-V negative-ground operation; mounts under dash; comes with mounting bracket and connecting cable; 7" × 2 1/8" × 7". $89.95
Pair deluxe car speakers. $15.95

CP-88 8-Track Stereo Player

Solid-state circuit; automatic play plus manual program selector; individual program lights; volume, balance, and tone controls; underdash mounting bracket & hardware supplied; 12-V negative-ground operation; 4 3/4" × 2 5/8" × 6 1/2". $39.95
Pair of speakers. $7.95

2-/4-Ch Cartridge Player

Plays 2-channel & discrete 4-channel 8-track cartridges; has front-rear-left-right balance; pushbutton program selector; underdash mounting bracket; 12-V negative-ground operation; 8" × 2" × 8 1/8"; less speakers. $99.95

4-Channel Adapter for Cars

Derives 4-channel sound from present 2-channel car stereo tape system or FM radio. Front panel contains rear-level speaker control, 2- or 4-channel mode switch, and front (L & R) speaker-level controls. If present system has four speakers, only adapter is required; if two speakers, two more speakers must be added. For 12-V negative ground systems. Includes two 3-ft., two 6-ft., and two 15-ft. connecting cables. 5 1/2" W × 1 3/4" H × 2 1/2" D. #99-85128 ..... $5.95
99-62994. Pair of 3" × 5" matching rear deck speaker systems $7.95

PANASONIC

CX-375 8-Track Player

Super-compact, 8-track player; slide-rule volume & tone controls; thumbwheel balance control; pushbutton program change; illuminated program indicator. $49.95

CX-475 8-Track Player

Features dynamically boosted sound: slide-rule volume, tone, and balance controls; other features similar to CX-375. ..... $69.95

CX-675 8-Track Player

Features four-speaker matrix giving 4-channel or reverb effect from 8-track stereo tapes; output terminals for four speakers; other features similar to CX-375. ..... $89.95

CX-567 8-Track Player

Features lock-tight car bracket which permits player to be removed for safe keeping; slide-rule volume and tone controls; thumbwheel balance control; program-change & program-repeat pushbuttons; illuminated program indicator. $89.95

CQ-252 8-Track Player/Radio

Features 8-track tape player & AM radio; in-dash mounting; adjustable control shafts for easy installation $119.95

CQ-898 Car/Home Player/Radio

Features 8-track tape player plus FM/FM stereo receiver; slides from locking car bracket to optional home cabinet; mono/stereo and distant/local switches; separate volume, tone, and balance controls; program-change & program-repeat pushbuttons. $139.95

CX-601 4-Channel Car/Home Player

Plays regular stereo cartridges as well as 4-channel tapes; slides from car mounting to optional home cabinet; converts to stereo radio with optional FM stereo pack; slide-rule volume, balance, and tone controls; program-change, program-repeat, and eject pushbuttons; illuminated program indicator, comes with lock-tight underdash mounting bracket. $149.95

CQ-959 8-Track Player/Radio

Features in-dash mounting; 8-track stereo player; AM-FM stereo receiver; adjustable control shafts for easy installation; separate volume, tone, and balance controls; distant/local switch; stereo indicator light; program-change pushbutton. $169.95

CX-232 Stereo Cassette Player

Designed for 12-V d.c. negative-ground cars; response 60-10,000 Hz (at 4 ohms, 0.5 W less than 10% THD); wow & flutter 0.4% W rms; S/N 40 dB; tone, volume, balance, fast-forward, and eject controls; for underdash mounting. $79.95

CX-141 Stereo Cassette Player

Features automatic reverse for playing both sides of the cassette; manual reverse; indicator lamp for tape direction; fast-forward & rewind pushbuttons; loudness circuit; pushbutton tape ejector which turns power off; underdash installation. $119.95

PIONEER

TP-828 8-Track Player

Underdash player with illuminated volume indicator; balance, tone, and volume controls; fast-forward, repeat, automatic/manual program change; response 30-10,000 Hz; wow & flutter 0.25%; 7 3/4" W × 3 3/4" H × 8 1/2" D. $89.95

TP-232 Mini 8-Track Player

Small enough to be installed in car's ashtray; features automatic/manual program change; separate tone, balance, and volume controls; track indicator lights; response 40-10,000 Hz; wow & flutter 0.3%; 4 3/4" W × 2" H × 6 1/8" D. $49.95

QP-424 4-Channel 8-Track Player

Plays 4-channel tapes; features left/right balance control; separate front/rear channel volume control; automatic/manual program change; fast-forward, repeat button, tone control; response 40-10,000 Hz; wow & flutter 0.3%; comes with quick-release bracket; 6" W × 2 1/2" H × 7 1/8" D. $119.95

TP-6000 8-Track/AM-FM Stereo Radio

In-dash unit with AM-FM stereo receiver & 8-track tape player; features mono/stereo switch; automatic/manual program change; volume, balance, tone, and manual tuning controls; response 40-10,000 Hz; wow & flutter 0.3%; 7 1/8" W × 2" H × 6 1/4" D. $139.95

KP-212 Cassette Player

Underdash player with lighted play indicator; program lights; fast-forward & rewind; automatic eject at end of play; has volume, balance, tone controls; response 40-10,000 Hz; wow & flutter 0.3%; S/N 45 dB; channel separation 35 dB; 5 7/8" W × 2" H × 6 1/8" D. $79.95

KP-301 Cassette/FM Stereo Receiver

Underdash cassette player plus FM-stereo receiver; has Dolby noise-reduction system; FET front-end for FM; manual direction change; automatic reverse; mono/stereo switch; Dolby in/out; volume, balance, and tone controls; response 40-10,000 Hz; wow & flutter 0.3%; 7 1/2" W × 2 1/8" H × 8 1/2" D. $199.95

RADIO SHACK

12-1819 "Stereo 8" Player

Designed for compact and subcompact cars; thumbwheel controls for volume, balance, and tone; IC audio output; program lights. 2 1/4" × 5 1/2" × 6 7/8". $49.95

12-1817 "Stereo 8" Player

Features sliding volume, balance, and tone controls; pushbutton program selector; 1 3/4" × 5" × 6 1/2". $59.95

12-2024 "Stereo 8" Player

Features "Quatravox" circuit for providing 4-channel effect from stereo tapes; thumbwheel switches for volume, tone, and balance; speaker switch for 2- or 4-ch operation; pushbutton program selector; program indicator lights. 2 5/8" × 6" × 6 1/4". $69.95

5 Auto Tape Machines

12-1822 Cassette Player
Designed for subcompact cars; accepts cassette sidways; eject bar; volume, balance, and tone slide controls; locking fast-forward button. 2" × 6" × 6¾". $64.95

12-1814 Cassette Player
Features two ICs and transformerless audio output; fast-forward and rewind; slide controls for volume, balance, and tone; pushbutton eject. 2⅛" × 5⅞" × 7½". $79.95

12-1818 "Stereo 8" Player/FM Stereo
Features FM stereo tuner; FM stereo beacon; dial light; rotary controls for tuning, volume, and tone; lighted tape program indicators; automatic or pushbutton program change. 2¾" × 8" × 7½". $99.95

12-1813 Auto Reverse Cassette Player
Provides up to two hours of program with automatic reverse feature; pushbutton direction controls; thumbwheel volume, balance, and tone controls; locking fast-forward and rewind; pushbutton eject turns off player. 2¾" × 7" × 6⅞" $99.95

12-1815 Cassette Player/FM Stereo
Provides tape playback or FM/FM stereo reception; sliding volume, balance, and tone controls;

pushbutton fast-forward, rewind, and eject; tuner has stereo indicator light, mono/stereo switch, lighted dial. 2⅜" × 7½" × 8". . . $109.95

RCA

12R490 "Stereo-8" Player
Features front-load with dust cover; automatic operation when cartridge is inserted or removed; left/right volume controls; tone-control knob; program selection button; power indicator light; response 50-10,000 Hz; wow & flutter 0.44% rms; operates from 12-V negative-ground source; imp. 3 to 8 ohms each channel; 5½" W × 2⅛" H × 7" D. $39.95

12R500. Similar to Model 12R490 except has four IC's, wow & flutter 0.4% rms; push-button program selector; sliding tone & volume controls. $54.95

12R301. Similar to Model 12R490 except has recessed volume & tone controls; sliding speaker balance control; program indicator lights; higher output power. 2⅞" H × 7¼" W × 7¾" D. $69.95

12R150 Cassette Player
Compact size; continuous operation with automatic shutoff when cassette is removed; thumbwheel balance control; high-speed fast-forward and fast rewind; tape direction indicator lights; push-button program selector; eject button; operates from 12 V negative-ground source. 5½" W × 2⅛" H × 6⅝" D. $112.95

12R800 4-Channel 8-Track Player
Will play both Q-8 and Stereo-8 cartridges; response 40-10,000 Hz ±3 dB; wow & flutter 0.4% rms; features two sliding volume controls, two sliding tone controls, pushbutton program selector; program & mode indicator lights; sliding speaker balance control; uses 8 integrated circuits; operates from 12-V negative-ground source. 2⅝" H × 10⅛" W × 7½" D (including mounting bracket). $119.95

12R600 8-Track/FM-Stereo Receiver
Combines 8-track player with FM-stereo receiver; response 40-10,000 Hz ±3 dB; wow & flutter 0.4% rms; distant/local select button; FM stereo signal indicator light; a.f.c.; operates from 12-V negative-ground source; 3⅝" × 7⅝" W × 8⅜" D. $129.95

12R703 8-Track/AM-FM Stereo
Similar to 12R600 but with AM radio included;

response 50-10,000 Hz; wow & flutter 0.3% rms; S/N 45 dB; adjustable shafts for installation flexibility; 7¹⁵⁄₁₆" W × 2⁹⁄₁₆" H × 7¹⁵⁄₁₆" D. $159.95

SANYO

FT819 8-Track Cartridge Player
Features repeat pushbutton for replay; fast-forward; 4-channel matrix circuit for simulating 4-channel reception from stereo tapes; comes with all mounting hardware for underdash or floor mounting. $49.95

FT401 Stereo Cassette Player
Designed to withstand temperature, humidity extremes; features latching-type fast-forward; cassette eject system. $59.95

SONY from SUPERSCOPE

TC-10 Car Cassette Player
Stereo design. 12-V negative ground operation. 6 W/ch continuous. Response 50-10,000 Hz. Wow & flutter 0.25%; (S + N)/N 45 dB. 3.2 ohms impedance. 7¼" W × 2⅞" H × 7⅛" D. With mounting hardware but less speakers. $129.95

TC-30. Same as TC-10 except has automatic reverse. (S + N)/N 50 dB. 7¼" W × 2⅞" H × 9⅜" D. $179.95

TEAC

AC-5 Car Cassette Player
Features continuous stereo playback; automatic reverse; universal mounting; and servo-controlled motor. Wow & flutter 0.25%. Frequency range 40-10,000 Hz. Output 6 W/ch dynamic (EIA) power at 5% THD. 12 V d.c. negative-ground operation. 2⅝" × 7" × 8⅜" D. Speaker optional $159.50

AC-9 Car Cassette Player
Similar to AC-5 except higher fidelity. Has tone controls; fast-wind in both directions; automatic reverse; tape-travel indicating lamps. Speaker optional $199.50

ALWAYS . . . . . .

take along your copy of this Guide when shopping for hi-fi components. It is a comprehensive reference to complete technical details and prices.

PORTABLE TAPE MACHINES

AIKO

ATP-706 Cassette Recorder

Operates from four "C" cells or a.c.; pushbutton operation; eject button; automatic level control for recording; automatic stop at end of tape; built-in electret condenser mike; comes with remote-control mike, batteries, a.c. cord, C-30 cassette, adjustable strap, earphone. . $49.95

ATP-704. Deluxe version of ATP-706 with higher power output; retractable metal handle; does not include remote-control mike. . $54.95

ATP-707. Similar to ATP-704 but with battery-condition meter; powered by four "D" cells; comes with batteries, a.c. cord, C-30 cassette, remote-control mike, earphone. $59.95

ATPR-406 Cassette Recorder/AM-FM

Operates from four "C" cells or a.c.; pushbutton operation; simultaneous mike & radio mixing; built-in condenser mike; 3-position monitor switch; slide volume & tone controls; comes with four "C" cells, a.c. cord, C-30 cassette. $99.95

ATPR-401R. Similar to ATPR-406 but with the addition of SW1 & SW2 short-wave bands; VU meter; direct speaker monitoring..... $129.95

ATPR-401U. Same as ATPR-401R except covers aviation and public-service bands instead of SW1 & SW2..... $119.95

ATPR-407. Similar to ATPR-401R except includes woofer & tweeter; 9-section telescoping antenna; digital tape counter; comes with four "D" cells, a.c. cord, C 30 cassette, wireless FM mike, headphones, telephone pickup. $149.95

ATPR-412 Cassette/AM-FM Stereo/SW

Cassette recorder, AM-FM stereo receiver with short-wave (SW1 & SW2) bands; operates from nine "D" cells or a.c.; four built-in speakers; stereo headphone jack & indicator light; two VU meters for recording; 9-section telescoping antenna; two built-in condenser mikes; digital tape counter; comes with batteries, FM wireless mike, a.c. cord, demo tape, headphones. $239.95

CRAIG

2630 Portable Cassette Recorder

Operates from five "C" cells or 120-V a.c. (adapter included); response 100-8000 Hz; S/N 35 dB; features mike input; earphone/external speaker outputs; built-in condenser mike; 2¾" speaker; automatic shut-off; automatic level control. 4¾" W × 2½" H × 8¾" D.. $41.95

2619 Portable Cassette Recorder

Features single-control operation; built-in condenser mike; 3½" speaker; response 100-7000 Hz; operates from six "C" cells or 120-V a.c.; built-in battery recharging circuit; illuminated battery condition/recording indicator; fast-forward cueing; automatic shut-off at end of tape; comes with power cord & accessory pouch; 11¼" W × 6¾" H × 3" D; 4½ pounds (including battery)..... $59.95

2623 Portable Cassette Recorder

Features automatic shut-off; automatic level control; built-in battery recharging circuit; battery condition meter; operates from five "C" cells or 120-V a.c.; response 100-7000 Hz; comes with mike, accessory pouch, a.c. adapter; 5¼" W × 2¾" H × 9" D; 3.4 pounds (including battery) $59.95

2626 Portable Cassette Recorder

Features automatic shut-off; built-in condenser mike; automatic battery charging; operates from four "C" cells, 6 V d.c., or 120-V a.c.; has snap-action pause control; automatic level control; comes with a.c. cord; 5¾" W × 2½" H × 10¼" D; 4 pounds (including battery).. $59.95

2627 Portable Cassette Recorder

Features cue/review functions; automatic shut-off; built-in condenser mike; combination record/battery level indicator; automatic battery charging; operates from four "C" cells, 6-V d.c., or 120-V a.c.; response 100-8000 Hz; comes with a.c. cord; 5¾" W × 2½" H × 10¼" D; 4 pounds (including battery)..... $67.95

2628. Similar to 2627 but includes 3-digit tape counter..... $79.95

2629 Hand-Held Recorder

Features automatic shut-off; built-in condenser mike; digital tape counter; LED battery/record level indicator; pause button; response 50-7000 Hz; 2" speaker; earphone/external speaker jack; operates from four "AA" cells or a.c. adapter; comes with carrying case and a.c. adapter; 6⅞" W × 4⅝" H × 2" D; 1.1 lb. $84.95

2620 Cassette Recorder/AM-FM

Features single-control operation; automatic level control; built-in battery recharging circuit illuminated battery/recording/tuning indicator; built-in condenser mike; automatic shut-off; provision for optional stereo headphone adapter; operates from six "C" cells or 120-V a.c., response 100-7000 Hz; 3½" speaker; comes with power cord and accessory pouch; 12⅛" W × 7" H × 3" D; 6 lbs (including battery). $104.95

3403 8-Track Portable Player

Operates from eight "D" cells, 120-V a.c. or external 12-V supply; features automatic battery charger; stereo headphone jacks; two 4" speakers (one separable); response 100-8000 Hz; 11¾" W × 7¾" H × 6¼" D; 7½ lbs (including battery)..... $84.95

3404. Similar to 3403 except incluces an AM-FM stereo receiver; stereo indicator lamp; a.f.c.; slide-rule tuning dial; 8½ lbs (including battery)..... $119.95

GENERAL ELECTRIC

3-5501 8-Track Player

Features two-speaker (6" dyanamic woofer & 2" tweeter) system; stereo tape head with mono amplifier; three-way power (8 "D" cells, a.c., or optional auto-boat adapter); automatic a.c.-d.c. switching; continuous tone control; mike input jack for sing-along or p.a. (mike optional extra); automatic or manual program sequencing; program indicator lights; earphone jack; adjustable, removable carrying strap; 3½" D × 8½" H × 12" W. Bass blue..... $56.95

3-5502. Same except case in Treble red. $56.95

3-5503. Same except case in Gunmetal grey. $56.95

M8525 Cassette Recorder/AM-FM

Combines cassette recorder, built-in condenser mike, and AM-FM radio; features push-to-play/stop control for tape operation; three-position monitor switch; built-in guard to prevent accidental erasure of pre-recorded cassettes; automatic end-of-tape shut-off; a.c. bias, d.c. erase; cassette eject; jacks for earphone, remote mike, and auto/boat adapter; operates from six "C" cells, a.c., or optional auto/boat cigarette-lighter adapter; black and silver high-impact polystyrene cabinet. 7¼" H × 11¼" W × 3½" D. $69.95

M8617 8-Track Player/AM-FM Stereo

Features two 4" dynamic speakers (one detachable with 7 ft separation for stereo); AM-FM stereo receiver; 8-track cartridge player; three-way power capability; automatic or manual channel sequencing; jacks for stereo headphones and accessory record changer; black and silver high-impact polystyrene cabinet. 10" H × 9¼" W × 7" D (closed)..... $129.95

MERITON

CT-665 Cassette Recorder

Mini-size (3⅞" W × 6" H × 1⅞" D) unit; features anti-rolling mechanism for constant speed even on the move; automatic shut-off; built-in electret mike; automatic level control; pushbutton operation; tape counter with reset button; battery-check meter; will operate from four "AA" cells or 120-V a.c. (with adapter); 2⅝" PM speaker; response 50-10,000 Hz; S/N 40 dB; comes with a.c. adapter, earphone, C-30 cassette. 1 lb, 10 ounces..... $109.95

PANASONIC

RQ-711S "Take-n-Tape"

Operates from a.c. or batteries (four "C" cells); built-in condenser mike; pushbutton controls; fast-forward and rewind; 3" PM dynamic speaker; available in red, yellow, white, gray, or blue plastic cases..... $32.88

RQ-309AS Cassette Recorder

Operates from a.c. or batteries (four "C" cells) or with optional car adapter; built-in condenser mike; automatic stop; piano-key operation; fast-forward and rewind; cassette eject button; 3½" PM dynamic speaker..... $39.95

6 Portable Tape Machines

RQ-410S Cassette Recorder
Upright styling; a.c. or battery operation or with optional car adapter; digital tape counter; automatic stop; built-in condenser mike; push-button operation; continuous tone control; LED battery-strength indicator; cassette eject button. $54.95

RQ-413S Cassette Recorder
Features built-in condenser mike; digital tape counter; LED battery-condition indicator; automatic stop; cue and review buttons; one-touch recording; pause control; fast-forward and rewind; continuous tone control; three-way power (with optional car adapter); rechargeable with optional battery pack. $79.95

RQ-212DS Cassette Recorder
Features integrated circuits; automatic stop; recording level control; built-in condenser mike; one-touch recording; VU/battery meter; pause control; fast-forward and rewind; tape counter; rechargeable capability with optional battery pack; three-way power (with optional car adapter). $79.95

RQ-320S Cassette Recorder
Features record/playback mike mixing with volume control; d.c. servo motor for constant tape speed; mike has pause & volume control; chromium-dioxide tape selector; automatic stop; digital tape counter; cue & review functions; VU meter; three-way power (with optional car adapter); rechargeable capability with optional battery pack; detachable condenser mike. $129.95

RS-264S Stereo Cassette Recorder
Features two built-in condenser mikes; stereo spacer system; a.c. bias & erase; automatic stop; continuous tone, balance, and volume controls; fast-forward & rewind; two VU meters; 3-digit tape counter; two 4" PM dynamic speakers; three-way power with optional car adapter. $129.95

RQ-432S Cassette Recorder/Radio
Features AM-FM radio; built-in condenser mike; automatic/sleep switch; automatic stop; fast-forward & rewind; pushbutton operation; three-way power (with optional car adapter); eject button. $79.95

RQ-444S Cassette Recorder/Radio
Features AM-FM radio; built-in condenser mike; record/playback mike mixing with volume control; automatic rewind; automatic/sleep switch; automatic stop; VU/battery/tuning meter; digital tape counter; three-way power (with optional car adapter); comes with dynamic mike; mike stand, windscreen. $129.95

RQ-446S Cassette Recorder/Radio
Features AM-FM radio; built-in condenser mike; automatic stop; mike mixing in playback mode with optional mike; fast-forward & rewind; LED battery/condition indicator; digital tape counter; tone & volume controls; 3-position monitoring; pushbutton operation. $99.95

RQ-448S Cassette Recorder/Radio
Features AM-FM radio; record/playback mike mixing with volume control; detachable built-in condenser mike; variable sound monitor; cue & review functions; VU/battery/tuning meter; volume & tone controls; digital tape counter; rechargeable capability with optional battery pack. $149.95

RS-451S Stereo Recorder/Radio
Stereo cassette recorder with AM-FM stereo receiver; two built-in condenser mikes; stereo spacer to enhance speaker separation; record/playback mike mixing; full automatic stop; chromium-dioxide/standard tape selector; automatic/sleep switch; variable sound monitoring; digital tape counter; continuous tone, balance, and volume controls; two dynamic stereo speakers. $199.95

RF-7100 8-Track Player/Radio
Features a.c. or battery operation; AM-FM stereo receiver; stereo 8-track player; lighted 8-track program indicator; stereo indicator light; stereo spacer for sound dispersion; two-step tone control; two separate 4" PM dynamic speakers; jacks for headphones, external power, and record output. $129.95

RADIO SHACK

CTR-16 Cassette Recorder
Operates from four "C" cells or a.c. power line; built-in condenser mike plus remote-control mike; Aux. input for recording direct from radio or TV; auto-level control; auto-stop; high/low tone switch; digital counter; comes with earphone, carrying strap, a.c. cord. $2\frac{1}{2}" \times 4\frac{3}{4}" \times 9\frac{1}{4}"$. $59.95

CTR-25 Cassette Recorder
Features built-in condenser mike; pushbutton controls with separate eject button; auto-level control; digital counter; auto-stop; battery-level meter; jacks for a.c. and d.c. adapters; remote-control mike; earphone; comes with carrying case, wrist strap, four "AA" cells, earphone. 4" × 7" × 2". $69.95

CTR-20B Cassette Recorder
Features built-in condenser mike; auto-level control; auto-stop preserves batteries, tapes, heads; jacks for taping off-the-air, monitoring, external remote-control mike; d.c. adapter; pushbutton controls for eject, digital counter, level/battery meter, tone control; operates from four "C" cells; comes with earphone, a.c. cord. $2\frac{3}{8}" \times 7" \times 9\frac{1}{4}"$. $69.95

CTR-18C Cassette Recorder/AM-FM
Records off-the-air or live from built-in condenser mike; features auto-level control; auto-stop; pushbutton control of stop/eject, battery/tuning; slide-type tone & volume controls; slide-rule AM-FM dial; jacks for earphone, external mike, and power; operates from four "C" cells. $11\frac{7}{8}" \times 8\frac{3}{4}" \times 3\frac{1}{4}"$. $89.95

CTR-30 Cassette Recorder
Features end-of-cassette shut-off; auto-level control; input for off-the-air recording; battery/

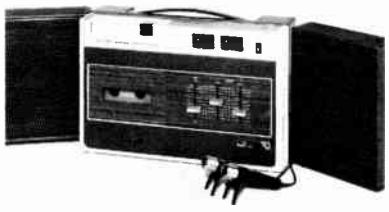
record level meter; 3-digit counter; separate tone & volume controls; eject button; built-in condenser mike; operates from four "C" cells; comes with earphone, carrying case, and a.c. cord. $7\frac{3}{4}" \times 10\frac{1}{2}" \times 3"$. $89.95

Minisette-II Cassette Recorder
Pocket-sized recorder; built-in condenser mike; auto-level control; locking pushbutton controls include fast-forward & rewind; battery meter; jacks for external mike and power, earphone; operates from four "AA" cells; comes with case, wrist strap, batteries. $89.95

CTR-32 Cassette Recorder
Features IC chip built into erase head; built-in condenser mike; line input for recording directly from radio or phono; monitor switch; remote-control mike input; auto-level control; auto-stop; pushbuttons for pause and stop/eject; tone & volume slide controls; battery/record meter; digital counter; external speaker/headphone jack; comes with earphone and a.c. cord; operates from four "D" cells. $7\frac{1}{2}" \times 11\frac{1}{4}" \times 3\frac{1}{8}"$. $99.95

Minisette-III Cassette Recorder/AM-FM
Plays/records cassettes; built-in condenser mike; built-in AM-FM radio; monitor switch; record interlock; record level/battery meter; pushbutton control of cassette eject, tone & volume; slide-rule dial with log scale; jacks for earphone, external power, speaker, mike; operates from four "C" cells; comes with carrying strap. $6\frac{3}{4}" \times 8" \times 2\frac{1}{4}"$. $119.95

SCT-2C Cassette Recorder
Portable stereo design. Has dual VU meters, monitor switch, slide controls. Operates from



117-volt power source or six "D" cells. Supplied with two mikes (one with remote-control switch). Has two removable wing speaker systems. $11" \times 8\frac{1}{2}" \times 6\frac{1}{2}"$. $159.95

SANYO

M2522 Cassette Recorder
Compact design; operates from batteries or a.c. (with optional adapter); has built-in condenser mike; automatic record-level circuit; automatic shut-off; built-in tape counter. $44.95

SONY

TC-67 Cassette-Corder
Compact record/play unit; features built-in electret condenser mike; Sonymatic system to maintain optimum recording level; automatic shut-off for tape transport and power; battery (four "C" cells) or 120-V, 60-Hz operation; response 70-8000 Hz; S/N 48 dB; wow & flutter 0.42%; $3\frac{1}{16}"$ speaker; comes with a.c. cord, earphone, shorting plug, demo tape, accessory case. $2\frac{5}{8}"$ H × $5\frac{1}{2}"$ W × $10\frac{5}{8}"$ D. 2 lbs, 2 ounces (without batteries). $70.00

TC-110B Cassette-Corder
Features built-in electret mike; Sonymatic system; record level/battery meter; 3-digit tape counter; 4-way power supply; response 50-10,000 Hz; S/N 46 dB; wow & flutter 0.28%; comes with carrying case, a.c. cord, earphone, shorting plug, demo tape, external mike F-27S, RK-69 patchcord, RM-15 remote-control switch. $2\frac{1}{2}"$ H × $5\frac{3}{4}"$ W × $9\frac{1}{2}"$ D. 3 lbs, 6 ounces (without batteries). $140.00

TC-92. Similar to TC-110B except features a variable-level recording monitor system; cue & review functions; special telephone input jack. $2\frac{13}{16}"$ H × $7\frac{1}{8}"$ W × $9\frac{11}{16}"$ D. 4 lbs, 7 ounces $150.00

TC-142 Cassette-Corder
Features 3-head system for instant tape monitoring; ferrite and ferrite record/playback head; built-in condenser mike; Sonymatic, plus manual recording adj.; counter-inertial flywheel system for tape transport stability when unit is carried; d.c. servo-controlled motor; pre-end alarm system for no-gap recordings; tape selector switch; 3-digit tape counter; record-level/battery meter; 4-way power supply; response 70-10,000 Hz (standard) and 70-12,000 Hz (CrO_2); S/N 45 dB; wow & flutter 0.26%; $2\frac{1}{2}" \times 4"$ speaker; comes with carrying case, a.c. cord, earphone, shorting plug, demo tape, RK-69

patch cord. 2⅞" H × 9¾" W × 7⅝" D. 5 lbs, 5 ounces (without batteries)..... $230.00

TC-244. Stereo version of TC-142 with two built-in condenser mikes; separate record-level meters; separate volume controls for left & right channels; stereo headphone jack; response 50-10,000 Hz; S/N 48 dB; two 5" × 3½" speakers; comes with carrying case, a.c. cord, demo tape. 8¼" H × 12⁹⁄₁₆" W × 3¼ D. 7 lbs, 1 ounce (without batteries)..... $230.00

TC-126CS Stereo Cassette-Corder

Features one-point stereo mike; counter-inertial flywheel system; pause switch; tape selector sw.; preset record function; built-in speaker plus two detachable speakers; stereo balance control; jack for stereo headphones; 3-digit tape counter; 4-way power supply; response 50-10,000 Hz (standard), 50-13,000 Hz (CrO_2); S/N 45 dB; wow & flutter 0.26%; 4" × 3" built-in speaker; two 4" dia. external speaker systems; comes with carrying case, a.c. cord, earphone, demo tape, F-99S external mike, RK-74 patch cord, SS-16 external speakers. 3¹⁄₁₆" H × 10⅞" W × 7⅜" D. 6 lbs, 3 ounces (without batteries) $270.00

TC-92 Cassette-Corder

Features built-in condenser mike; Sonymatic system; automatic shut-off for transport & power; counter-inertial flywheel system for transport stability; cue function; pause switch; 3-digit tape counter; 4-way power supply; response 50-10,000 Hz; S/N 45 dB; wow & flutter 0.38%; comes with carrying case, earphone, shorting plug, demo tape, RK-64A patch cord, four "AA" batteries. 7¼" H × 2" W × 4⅜" D. 2 lbs, 2 ounces..... $140.00

TC-55. Similar to TC-92 but response 90-10,000 Hz; wow & flutter 0.35%; a.g.c. with selector for music or speech recording; 5⅞" H × 1½" W × 3⅞" D. 1 lb, 14 ounces..... $170.00

SONY from SUPERSCOPE

TC-152SD Cassette-Corder Deck

Operates from four "D" cells or 117 V a.c. line. Records/plays stereo. Has built-in mono amplifier and single speaker for monitoring (both channels simultaneously). Features a Dolby circuit for either record or playback. Response 30-15,000 Hz; wow & flutter 0.15% (S + N)/N 48 dB. Has tape select switch; automatic shut-off; battery check switch; line in/line out for deck operation; separate monitor/playback volume and tone controls; 3-digit tape counter; built-in peak limiter. Comes with two patch cords, four "D" cells, shoulder strap..... $349.95

SUPERSCOPE

C-101 Portable Cassette Recorder

Operates from four "C" cells or 120-V a.c.; features playback volume control; cassette compartment; record, rewind, fast-forward, play, stop/eject buttons; built-in electret condenser mike; remote stop/start jack; response 100-8000 Hz; S/N 46 dB; built-in 3½" speaker; 5½" W × 2½" H × 9½" D..... $59.95

C-102. Similar to C-101 but with addition of 3-digit tape counter with reset; four-way power; automatic shut-off; automatic record level; cue/fast-forward and review/rewind buttons. $79.95

C-103. Similar to C-102 but with built-in recharging circuit; optional NiCad battery pack; response 90-10,000 Hz; built-in 3½" × 3½" speaker; record level/battery condition meter; 5⅞" W × 2¹³⁄₁₆" H × 10¹⁄₁₆" D..... $89.95

C-104. Similar to C-103 but with dual flywheel drive; automatic total mechanism shut-off (TMS); Vari-Speed pitch control (adj. ±20%); response 60-10,000 Hz; S/N 48 dB; 3¾" speaker; 6" W × 2½" H × 11" D..... $119.95

C-105. Similar to C-103 but with three heads for tape/source monitoring; manual & automatic record-level control; peak limiter..... $169.95

C-106 Miniature Portable Recorder

Operates from four "AA" batteries; response 120-8000 Hz; S/N 46 dB; built-in 2" speaker; built-in condenser mike; features external remote start/stop jack; momentary/locking pause control; record level/battery condition indicator; review/rewind, stop, play, record, cue/fast-forward buttons; 1¹⁵⁄₁₆" W × 7" H × 4⅜" D; 1 lb, 14 ounces..... $119.95

C-108. Similar to C-106 but with 3-digit tape counter with reset; will accommodate special NiCad battery pack; 1½" W × 5⅞" H × 3⅞" D; 1 lb, 12 ounces $159.95

CS-200S Cassette Recorder System

Operates from four "C" cells, 120-V a.c., 6-V d.c. or rechargeable NiCad battery pack; provides full complement of inputs & outputs; response 40-12,000 Hz (standard tape), 60-14,000 Hz (chromium-dioxide tape); built-in 4" speaker; lid-integrated full-range speaker systems; S/N 54 dB (CrO_2); 6³⁄₁₆" W × 3⅜" H × 10⅞" D; 9 lbs, 12 ounces..... $199.95

CRS-152 Cassette Recorder/AM-FM

Operates from 6-V d.c. or 120-V a.c.; combines stereo cassette recording system with AM-FM stereo radio and two detachable speaker systems; built-in condenser mike in each speaker for maximum separation in live recording; response 100-15,000 Hz −3 dB; S/N 45 dB (standard tape); full complement of inputs & outputs; 13" W × 6¼" D × 8⅜" H; 13.2 lbs. $219.95

TOSHIBA

KT-225 Cassette Tape Recorder

Records/plays in 2-track mono; features built-in condenser mike; LED power indicator; speaker monitor; a.c.-d.c. versatility; has fast-forward, rewind, record, play, stop/cassette open, volume/tone controls; 11½" × 7⅛" × 3"; 3 lbs, 12 oz..... $59.95

KT-270 Cassette Tape Recorder

Records/plays in 2-track mono; features "quick-select" slide control for preview/review with automatic playback; play/stop switch; record-lock button; volume control; hi/lo tone control; pushbutton cassette loading; record level/battery indicator; built-in condenser mike; IC erase tape head; earphone for private playback; monitor record facilities; 3" speaker; operates from 120 V a.c., d.c., four "AA" batteries or 6-V external power supply; high-impact polystyrene case; tooled vinyl carrying case; 8½" × 4½" × 2"; weight 2 pounds, 7 ounces..... ..... $74.95

RT-293FC Cassette Recorder/Radio

Records/plays in 2-track mono; features AM-FM radio; 3⅝" dynamic speaker; built-in condenser mike; 3-digit tape counter; has full complement of controls; operates from 120-V a.c., d.c., four "C" cells, or 6-V external supply; 11¹⁄₁₆" W × 6½" H × 2¾" D; weight 5 pounds. $89.95

KT-216C Cassette Tape Recorder

Plays/records in 2-track mono; operates from 120 V a.c., d.c., four "D" cells or external 6-V supply; built-in condenser IC mike; remote-control mike jacks; 4" dynamic speaker; external speaker jack; 3-position speaker monitor switch; 3-digit tape counter; full complement of controls; black/silver/chrome high-impact polystyrene case; tooled vinyl carrying case; 8½" × 4½" × 2"; weight 2 pounds, 7 oz. $94.95

RT-333F Cassette Recorder/AM-FM-SW

Plays/records 2-track mono cassettes; features 3-band AM-FM-SW (3.8-12 MHz) receiver; multi-mixing system for simultaneous recording of tape, mike inputs, and radio; full complement of controls; built-in IC condenser mike; 3-digit tape counter; 4" dynamic speaker; operates from 120 V a.c., d.c., four "D" cells, or 6-V external supply; has cueing and auto play features; 12¾" W × 8⅛" H × 3⁵⁄₁₆" D; 7 lbs, 7 oz..... $159.95

AKAI

ASE-22 Dynamic Headphones

Moving-coil type. Response 20-20,000 Hz. Sensitivity 1.0 mW, distortion 1% at 1.0 mW. 8 ohms impedance. ½ W maximum input per phone. Has individual earphone volume controls. 6-ft. coiled cord. Weight 20 ounces $31.95

AKG

K-180 Dynamic Headphones

Has adjustable drivers for subjectively controllable sound. Response characteristics vary due to change in volume. Response 16-20,000 Hz. Efficiency: 1 mW for 112 dB SPL. Distortion less than 1% at 125 dB SPL. Impedance: 600 ohms each driver for multi-impedance matching 4 to 1000 ohms. 21 ounces $69.00

AUDIO-TECHNICA

AT-701 Dynamic Headphones

Uses a 47-mm dynamic driver; non-resonant, thermo-formed polymer diaphragm; copper-plated aluminum wire voice coil for minimum mass; response 30-20,000 Hz; impedance 4 to 16 ohms; sensitivity 97 dB SPL at 1000 Hz. Comes with coiled cord. Ear pads may be removed for replacement. 9 ounces $39.95

AT-702. Same as AT-701 except response 25-20,000 Hz; sensitivity 97 dB/SPL at 1000 Hz $49.95

AT-703. Same as AT-701 except response 20-20,000 Hz; sensitivity 94 dB/SPL at 1000 Hz $69.95

AT-706 Electret Condenser Phones

Condenser-type drivers with permanently charged diaphragm in push-pull configuration; diaphragm 58 mm dia. × 3 microns thick; accessory adapter matches high impedance of condenser element to any standard amplifier output and includes headphone/speaker switch; response 10-22,000 Hz; impedance 4-16 ohms; 94 dB SPL at 1000 Hz. 10.8 ounces Impedance matching adapter 3¼" H × 3⅛" W × 8½" D. $129.95

AT-707 Electret Condenser Phones

Plugs into any headphone jack without adapter or power supply; features permanently polarized diaphragms; built-in impedance-matching circuit; response 20-20,000 Hz; sensitivity: 89 dB SPL at 1000 Hz; imp. 4-16 ohms; 10 ounces (less cord); 10-ft coiled cord. $79.95

AUDIOTEX

Marquis Stereo Headphones

Open-air, lightweight design. Response 20-20,000 Hz; 8 ohms imped. matches all amplifier 4-16 ohm outputs 6-ft cord and plug. Cushioned earpieces and adjustable padded headband. 30-5205 ..... $39.95

Mark IV Stereo Headphones

Wide-range dynamic type. Frequency range to above audibility at 1% distortion between 10-18,000 Hz. Removable, soft cushions; padded headband. 10-ft coiled cord with stereo plug. Imp. 8 ohms. Matches all 4-16 ohm outputs. 30-5206 ..... $59.95

Mark III Stereo Headphones

Slide-type volume control on each earpiece; response 20-18,000 Hz. 12-ft coiled cord with stereo plug. 8 ohms. Matches all 4-16 ohm outputs. 30-5204 ..... $38.95

Mark II Stereo Headphones

Response 20-20,000 Hz; 8 ohms. Comes with 6-ft flexible cord and stereo plug. 30-5202 ..... $22.50

Mark I Stereo Headphones

Response 30-15,000 Hz; 8 ohms. Comes with 10-ft coiled cord and stereo plug. 30-5200 ..... $18.95

Headphone Remote Control

Plugs directly into amplifier to control volume and balance of headphones; noise-free slide controls for each earpiece permit adjustment of volume and balance. Special switch allows for mono/stereo selection. Has 5-ft cord and 3-conductor stereo phone plug. 30-5250 ..... $12.95

BEYER/DYNAMIC

DT-48 Dynamic Headphones

Moving-coil type. Originally designed as an audiometry instrument for measuring human hearing in lab research. Range 16-20,000 Hz +2 dB. Response virtually flat. Comes with 10-ft cord. $130.00

DT48-K. Same as DT-48 except with plug-in coiled cable. $140.00

DT900 Dynamic Headphones

Moving coil type. Response 30-18,000 Hz. 5-2000 ohms impedance. 200 mW maximum input per phone. 6-ft. cord. $35.00

DT96A Dynamic Headphones

Moving coil type. Response 30-17,000 Hz. Sensitivity 1.0 mW at 400 Hz produces 110 dB (re 2×10^{-4} μbar). 50-200 ohms impedance. 100 mW maximum input per phone. 5-ft. cord. 8 ounces. $52.50

DT100 Dynamic Headphones

Moving coil type. Response 30-18,000 Hz. Sensitivity 1 mW at 400 Hz produces 110 dB (re 2×10^{-4} μbar). 5-100-400-2000 ohms impedance. 1 W maximum input per phone $70.00

SEE SECTION 4 FOR 4-CHANNEL

DT480 Dynamic Headphones

Moving coil type. Response 20-18,000 Hz. Sensitivity 1 mW at 400 Hz produces 115 dB (re 2×10^{-4} μbar). 25-200 ohms impedance. 1 W maximum input per phone. $95.00

DT302 Lightweight Phones

Designed to be connected directly to either high- or low-impedance outputs; response 20-

20,000 Hz; rated power approx. 7 mW = 2.1 V for 600 ohms; equipped with sponge ear cushions, stereo phone jack plug; 2.3 ounces without cord. $29.95

BEYER/GOTHAM

DT-48S Stereo Headphones

Dynamic design extending from 20-18,000 Hz ±2 dB. Dist. 0.3% below 100 Hz & 0.1% above. Peak power demand 200 mW or 1 V max. per phone. Input 10 mV. Impedance: 5 ohms each for stereo (10 ohms total for mono) ... $120.00

DT-48SN. 50-ohm mono design $120.00

DT-48SP. Stereo design with separate plugs on each phone $120.00

DT-48KS. With coiled cord $123.00

TR-48. Plug-in transformer for 600-ohm input $22.00

TR-48. Pair for stereo use $40.48

UG-8. Speaker/phone switcher box $11.33

HEAR-MUFFS

HM-1A Headphones

Stereo headphones; washable cotton velour cover; 10-ft coiled cord; 3½" dynamic drivers; compatible with 4-16 ohm output impedance; response 20-18,000 Hz; THD 1% at 115 dB SPL; 1.5 W/ch max. $29.95

HM-4000 "Supermuffs"

Stereo headphones; washable high-pile acrylic cover; 10-ft coiled cord; 4" dynamic drivers; compatible with 4-16 ohm output impedance; response 20-20,000 Hz; THD unmeasurable at 95 dB SPL; 1.5 W/ch continuous power handling capability; 21 ounces. $37.95

KOSS

ESP-9 Electrostatic Headphones
Frequency response 15-15,000 Hz ±2 dB. Sensitivity 80 dB SPL (reference 0.0002 dyne/cm²). Distortion less than 0.2% at 110 dB SPL. 4 to 16 ohms impedance. 6-ft. coiled cord. 19 ounces. Black, fluid-filled earcups for ambient noise isolation. Designed for critical studio monitoring $175.00

ESP-6 Electrostatic Headphones
Frequency response 30-19,000 Hz ±5 dB. Sensitivity 80 dB SPL (reference 0.0002 dyne/cm²). Distortion less than 0.2% at 110 dB SPL. 4 to 16 ohms impedance. 10-ft. coiled cord. 27 ounces. Black, fluid-filled earcups for ambient noise isolation. Self-contained polarizer $130.00

PRO-4AA Dynamic Headphones
Frequency response 10-20,000 Hz. Distortion is negligible at 95 dB SPL. 3.2 to 600 ohms impedance. 10-ft. coiled cord. 19 ounces. Fluid-filled earcups for ambient noise isolation $65.00

PRO-600AA Dynamic Headphones
Same as PRO-4AA except nominally 600 ohms voice-coil impedance for matching audio transmission lines. 600 ohms characteristic impedance. Available on special order $70.00

KO-727B Dynamic Headphones
Frequency response 10-16,000 Hz. Distortion unmeasurable at 95 dB SPL. 3.2 to 600 ohms impedance. 10-ft. coiled cord. 19 ounces. Dark green finish $34.95

K-6LC Dynamic Headphones
Frequency response 10-16,000 Hz. Distortion unmeasurable at 95 dB SPL. 3.2 to 600 ohms impedance. 10-ft. coiled cord. Individual earphone volume controls. Brown/beige .. $29.95
Model K-6. Same except without volume controls $19.95

SP-3XC Headphones
Frequency response 10-14,000 Hz. 3.2 to 600 ohms impedance. 10-ft. coiled cord. Brown $15.95

HV-1 Dynamic Headphones
Has 2" dia. driver & will operate from 3.2 to 600 ohm outputs. Response 20-20,000 Hz; capacity 5 V continuous with provision for 14 dB-SPL transient peaks. 9.3 ounces. 10-ft coiled cord $44.95

T-4A Connector Box
Accepts up to five sets of stereophones. 14-ft. cord with 3-conductor phone plug fits standard headphone jack. Private listening for five persons at one time. Unit measures 6" diameter and has walnut-like base combined with black trim and aluminum plug-in panel. $12.95

T-10A Chairside Listening Station
Offers remote control for two sets of stereophones. Features separate volume controls for each stereophone and a speaker "on-off" switch. Wires directly to amplifier or receiver. Unit measures 6" diameter and has a walnut-like base $19.95

T-5A Remote Control Station
Similar to T-10A. Has jacks for two sets of stereophones. Left- and right-channel volume controls and speaker "on-off" switch. Has walnut-like base combined with black trim. $9.95

T-3 Speaker/Headphone Transfer Switch
Provides a speaker "on-off" switch and stereophone jack. Connects to speaker terminals of amplifier or receiver. Adds low-impedance jack to system for wide-range performance of stereophones $7.95

HV/1a Stereophones
Features low-mass "Decilite" driver elements for coverage 15-20,000 Hz; will operate from outputs of 3.2 to 600 ohms; dist. 0.5% at 109 dB SPL; will handle 5 V rms continuous with provision for 14-dB SPL transient peaks; acoustical sponge ear cushions; extendable headband with self-adjusting, pivoting yokes and soft padded vinyl cover; 3-conductor coiled cord (10-ft extended); 9.3 ounces $49.95
HV/1LC. Same except response 20-20,000 Hz; miniature volume/balance control per earcup. 9.9 ounces $54.95

"Phase/2" Stereophones
Frequency response 10-20,000 Hz; will operate from outputs of 3.2 to 600 ohms; dist. 1% at 100 dB SPL; 100 dB SPL/2.5 V rms; will handle 5 V rms continuous with provision for 14-dB SPL transient peaks; fluid-filled ear cushions for high-ambient noise isolation; two rotary panoramic source controls on each earcup; slide-type ambience expander on right earcup; comparator switch on left earcup; extendable stainless steel headband with self-adjusting pivoting yokes and sponge cushion cover. 24 ounces $75.00

LAFAYETTE

F-600 Open-Acoustic Headphones
Open-acoustic stereo design. Response 20-20,000 Hz. Lightweight open-air foam ear cushions with adjustable headband. Imp. 200 ohms. Comes with 5-ft cord and plug $24.95

F-990 Stereo Headphones
Response 20-20,000 Hz. Has two 3½" wide-range transducers; air-tight earphone cushions; fully adjustable cushioned headband. Imp. 8 ohms. Comes with 6½-ft cable and standard stereo phone plug $29.95

F-1000 Stereo Headphones
Features full-range 2½" woofer/tweeter transducer in each earpiece; individual left/right channel volume controls; foam-filled ear cushions; response 20-20,000 Hz; 8 ohms; 6-ft coiled cord; standard ¼" plug..... $34.95

MARANTZ

SE-1S Electrostatic Headphones
Response 20-20,000 Hz ±3 dB; dist. 0.5% 40-20,000 Hz at 100 dB SPL, 1.5% at 20 Hz; im-

pedance 30 ohms; energizer has built-in headphone/speaker switching; facilities for additional set of phones; protective circuit for regulating extremely loud passages; overload protection; 14 ounces $129.95

SD-5 Dynamic Headphones
Response 30-15,000 Hz; THD 1% at 30 Hz, 0.18% at 1000 Hz, 0.25% at 10,000 Hz (all at 100 dB SPL); 8 ohms imp.; sensitivity: 0.15 V rms for 200 dB SPL; Mylar diaphragm dynamic transducers; soft ear cushions with tailored acoustical seal; 16 ounces..... $39.95

MURA

SP-100 Stereo Headset
Lightweight headset. Frequency response 30-15,000 Hz. Comes equipped with 8-ft cord..... $9.95.

SP-202 Stereo Headset
Features slide volume controls for each earpiece. Response 30-18,000 Hz. Imp. 8 ohms. Comes with 10-ft coiled cord..... $11.50

SP-402 Stereo Headset
Features fully padded headband and oversized ear cushions. Individual slide volume and tone controls and stereo/mono switch included. Response 30-18,000 Hz. 8 ohms imp. 10-ft coiled cord..... $19.95

SP-606 Stereo Headset
Open-air design to accommodate surrounding sounds while listening. Mylar speakers for improved response. Response 20-20,000 Hz. 1 mW power required. 8 ohms impedance. Comes with 10-ft coiled cord & fitted case.... $19.95

SP-103A Stereo Headset
Features tone and volume controls on each earcup. Response 20-20,000 Hz. Has stereo/mono switch, 8 ohms impedance. 10-ft coiled cord..... $24.95

SP-205 Stereo Headset
Features slide-type volume and tone controls; Mylar speakers; stereo/mono switch. Impedance 8 ohms. Response 30-20,000 Hz ±5 dB. Includes 16-ft coiled cord and zippered storage case. $37.50

SP-206 Stereo Headset
Features Mylar speakers and vented housing with bass-reflex-type enclosure. Has individual volume and tone controls. Response 20-20,000 Hz ±4 dB. Impedance 8 ohms. Stereo/mono switch. Comes with 25-ft coiled cord and zippered storage case..... $37.50

PICKERING

OA-1 Headphones
Lightweight, open-audio design. 8 ohms. Max. input 300 mW. Sensitivity: 100 dB at 600 Hz. Response 30-19,000 Hz. Is equipped with 7-ft cord $19.95

OA-2 Headphones
Lightweight, open-audio design with special adapter for use with portable radios, tape recorders, and TV sets. 8 ohms. Max. input power 300 mW; sensitivity 100 dB at 600 Hz; response 30-19,000 Hz; dist. 1% (100 dB SPL). 7-ft cord. 10.9 ounces..... $22.95

OA-3 Headphones
Lightweight, open-audio design. 15 ohms ±10% at 1000 Hz; max. power input 0.2 Wrms/ch; response 20-20,000 Hz; dist. ½% at 100 dB SPL; sensitivity 100 dB SPL at 0.10 V input at 1000 Hz each channel. 1½" Mylar diaphragm dynamic transducer. Extend-adjust. headband with full pivot yoke and padded vinyl cover; soft vinyl foam ear cushions; 10-ft, 3-cond. coiled cord. Weighs 7.5 ounces (without cord) $39.95

4955 Headphones
Dynamic type. 8 ohms impedance; response 40-11,000 Hz ±3 dB; 30-18,000 Hz ±6 dB; sensitivity 100 dB SPL; max. input 0.5 W rms; distortion 1% at 115 dB SPL; 10-ft coiled cord. 28 ounces. $64.95

PIONEER

SE-205 Stereo Headphones
Dynamic type covering a frequency range of 20-20,000 Hz. Cone-type speaker in each earpiece. Matching imp. 4 to 16 ohms. Max. input power 500 mW each channel. Comes with 8.2-ft cable. 16 ounces $24.95

SE-305 Stereo Headphones
Dynamic type covering a frequency range of 20-20,000 Hz. 8 ohms imp. each channel; matching imp. 4 to 16 ohms. Max. input power 500 mW each channel. Comes with 16-ft, 5-in coiled cord. 15 ounces $34.95

7 Headphones

SE-405 Stereo Headphones
Dynamic type covering a frequency range of 20-20,000 Hz. 8 ohms imp.; input power 500 mW each channel. Unit features polyester-film diaphragm; special ear pads with sliding-type adjusting headband and clickstops for easy listening; volume controls for both left and right channels. 16½-ft coiled cord $44.95

SE-500 Stereo Headphones
Incorporates high-polymer film diaphragm; frequency range 20-20,000 Hz; sensitivity 100 dB/3V; max. input power 30 V/ch; resistant to temperature/humidity changes; plugs directly into headphone jack of any amplifier or receiver. $49.95

SE-505 Headphones
Two-way stereo dynamic design with a woofer & tweeter in each phone; 8 ohms each channel. Response 20-20,000 Hz. Sensitivity 108 dB/0.3 V; Features both tone & volume controls on each phone; maximum input 500 mW each phone. With 16-ft coiled cord $59.95

SE-700 Stereo Headphones
Features high-polymer driver elements; frequency range 20-20,000 Hz; matching im-

pedance 4 to 16 ohms; sensitivity 100 dB/3 V..... $79.95

SE-L401 Stereo Headphones
Lightweight, open-air stereo headphones; polyester film driver elements; frequency range 20-20,000 Hz; matching impedance 4 to 16 ohms; sensitivity 111 dB/0.3 V; max. input power 200 mW/ch. 10 ounces..... $39.95
SE-L201. Same as SE-L401 except 9 ounces. $29.95

RADIO SHACK

Nova-15 Headphones
Dynamic type. Ported open-back earcups. Response 20-20,000 Hz. 10-ft cord. 4 to 16 ohms impedance $21.95

Pro-1 Headphones
Dynamic type. Ported open-back earcups. Response 20-20,000 Hz. 10-ft cord. 4 to 16 ohms ear cushions. Has individual earphone volume controls. $54.95

Custom Pro Headphones
Dynamic type. Response 20-20,000 Hz. Impedance 4 to 16 ohms; bass port $24.95

Nova Pro Headphones
Stereo dynamic design with volume controls on each earcup. Response 20-20,000 Hz; 8 ohms impedance. 10-ft. coiled cord $34.95

LV-10 High-Velocity Phones
Features electro-acoustical design plus 2" dynamic elements; response 20-20,000 Hz; 0.5% dist.; acoustical sponge earpieces; soft vinyl-covered headband with self-adjusting yokes; 4-16 ohms imp.; 10-ft coiled cord; plug. $39.95

SCINTREX

Mark IV Stereophones
Features flat response 15-20,000 Hz; response 20-15,000 Hz ±3 dB. Sensitivity (100 dB SPL) 10 mW. Maximum input 2 W; max. output 120 dB. HD 0.3% at 1000 Hz at max. dB. Ambient noise isolation 40 dB at 1000 Hz. 4-8 ohms impedance. ABS ear cups and fluid-filled ear cushions. Features patented dual-driver cavity assembly. Comes with 14-ft coiled cord with special strain-relief feature. Black with chrome-plated headband. 18 oz $50.00

PRO-500 Stereophones
Response 15-20,000 Hz; 20-18,000 Hz ±3.5 dB. HD 0.9% at 1000 Hz at max. dB. Sensitivity (100 dB SPL) 6.3 mW; max. input 1 W; max. output 110 dB. 4-300 ohms impedance. Ambient noise isolation 40 dB at 1000 Hz. Equipped with patented dual-driver cavity assembly. Liquid-filled ear cushions. Individual volume controls in each earcup. 14-ft coiled cord with strain-relief feature. 18 oz $65.00

"Supra" Lightweight Stereophones
Open-air design with "Supraform" acoustics and high velocity drivers. Weighs only 6.5 oz,

including cord. Response 20-20,000 Hz; 20-12,000 Hz ± 6 dB. Impedance 4-200 ohms. HD at max. dB less than 1%. Sensitivity 0.5 mW at 100 dB SPL. Max. input 4 mW; max. output 110 dB. Foam plastic ear cushions, 10-ft coiled cord with strain-relief feature. Chrome-plated headband $29.95

88 Stereophones
Lightweight (9 oz) circumaural design which will withstand rugged use. Impedance 4-300 ohms. Sensitivity (100 dB SPL) 4 mW. Maximum input 1 W; max. output 110 dB. Response 15-20,000 Hz. HD 0.9% at 1000 Hz at max. dB. Ambient noise isolation 20 dB at 1000 Hz. Cycolac ear cups with foam ear cushions. Has automatic frequency compensation. Black with Polypropylene headband. 14-ft coiled cord with strain-relief feature $24.95

SX-4 Stereo Headphones
Incorporates four separate drivers for spacial and dimensional effect of 4-ch sound in stereo mode; response 15-20,000 Hz (20-15,000 Hz ±4 dB); HD at 110 dB SPL, 1000 Hz: 0.8% stereo, 0.6% "Experiential"; impedance 4-1000 ohms; max. input power (loaded) 43 mW; max. acoustic output (loaded) 110 dB; ambient attenuation 40 dB; liquid earseals; padded head cushion; 14-ft coiled cord; 19 ounces.... ..... $49.95

98 Stereophones
Features patented dual-cavity design and contoured response for accented bass and treble to match hearing characteristics. 4-300 ohms impedance. Sensitivity 6 mW; max. input 1 W; max. output 110 dB. Response 15-20,000 Hz. HD 1% at 1000 Hz at max. dB. Ambient noise isolation 40 dB at 1000 Hz. ABS ear cups and liquid-filled ear cushions. Chrome-plated headband. Comes with 14-ft coiled cord with strain-relief feature. 16 oz $39.95

SENNHEISER

HD414 Headphone
Patented dynamic "open-aire" design. 2000 ohms/ch. Response 20-20,000 Hz. Sensitivity 17.7 μbar/V. Normal power 1 mW/ch (1.41V) for sound pressure of 102 dB. HD 1% at 22 V & 1000 Hz. Can be connected to any preamp output. 5 ounces without cord. 10-ft. cable $49.75

HD424 Headphone
Deluxe dynamic headphone with patented "open-aire" design. 2000 ohms/ch. Response 15-20,000 Hz. Sensitivity 17.7 μbar/V. Normal power 1 mW/ch (1.41 V) for sound pressure of 102 dB; HD less than 1% at 22 V and 1000 Hz. Can be connected to many preamp outputs. 6.5 ounces without cord. Removable head and ear cushions. 10-ft cable..... $79.75

HD44 Headphone
Lightweight stereo headphone (1.2 ounces without cable). Patented dynamic "open-aire" system with under-the-chin configuration. 600 ohms/ch. Response 52-10,000 Hz. Normal power 1 mW/ch (1.41 V) for average listening level. Comes equipped with a 10-foot cable..... ..... $29.75

STANTON

Dynaphase Sixty Headphones
Dynamic design; two-way system—woofer & tweeter with individual LC crossover. Response 40-11,000 Hz ±3 dB. Sensitivity 95 dB for 1 mW at 1000 Hz (100 dB sound pressure level). Distortion 1% at 115 dB SPL. Impedance 8 ohms. Power input 0.5 W rms max. per phone. 10-ft. coiled cord. 28 ounces. Blue and black $64.95

Dynaphase Forty Headphones
Dynamic design. Response 60-10,000 Hz ±3 dB. Distortion 1% at 115 dB SPL. 8 ohms impedance at 1000 Hz; Power input 0.5 W rms max. per phone. 10-ft cord. 21 ounces. Blue-black/chrome $44.95

Dynaphase Fifty Headphones
Same as Dynaphase Forty except has volume control on each earpiece..... $54.95

Dynaphase Twenty-Eight Headphones
Open audio headphone with plug for AM-FM, tape recorder listening; response 30-19,000 Hz; 8 ohms impedance; distortion less than 1% at 100 dB SPL; 10-ft coiled cord; weight 11 ounces. $27.95

SUPEREX

PRO-B-VI Headphones
Has acoustic-suspension woofer and ceramic tweeter. Response 15-22,500 Hz. 4 to 16 ohms impedance. 2 W maximum input per phone. 15-ft. coiled cord. Cordovan, ivory, or transparent $60.00

ST-V Headphones
Moving-coil dynamic type. Response 20-18,000 Hz. 4 to 16 ohms impedance. 2 W maximum input per phone. Individual earphone volume controls. 15-ft. coiled cord $30.00

SST Headphones
Response 20-20,000 Hz. Maximum music power 2 watts. Has volume and tweeter controls at each earpiece. Supplied with 15-ft coiled cord. Cordovan or ivory. 4—16 ohms. .. $40.00

ST-F-2 "Feather-Fone"
Weighs only 8 ounces (excluding 15-ft coiled cord) with a 25-17,500 Hz response. Maximum power 0.5 watt. Ivory/Cordovan $30.00

ST-N "Newport"
Contemporary design dynamic stereophones with post and yoke headband. Response 30-15,000 Hz. Cordovan S19.95

930 Headphones
Moving-coil dynamic type. Response 40-14,500 Hz. Adjustable stainless headband. 7-ft cord $14.95

SW-IV Headphones
Dynamic element. Response 30-15,000 Hz. Adjustable headband. 10-ft coiled cord. Black with red trim $24.95

927 Headphones
Woofer/tweeter headphone. Response 25-19,000 Hz. Dynamic woofer, ceramic tweeter, L-R crossover. Fully adjustable stainless headband. 10-ft coiled cord $35.00

PEP-79E Electrostatic Headphones
Electrostatic system consisting of PEP-74 stereophones and CC-79 control console; response 10-22,000 Hz ±5 dB; acommodates one set of stereophones; designed to use level controls of main amp or receiver; no connection to a.c. power line; source impedance matched for 4-16 ohm termination; for bookshelf or table-top installation. Wood-grain vinyl over steel case. 7" W × 2½" H × 4" D $90.00
PEP-74. Extra set of stereophones $70.00
STEX-15-P. 15-ft extension cord for PEP-74.... ..... $9.95

PEP-77E Electrostatic Headphones
Same listening characteristics and sound quality as 79E but has self-energized console; two phone jacks; volume controls for both stereo channels (20 dB range); acommodates two sets of stereophones; nominal impedance 4-16 ohms; speaker/phone selector rocker & illuminated "on-off" rocker switches; incorporates PEP-74 "Trans-aire" headset with fully adjustable headband; 12 ounces. Cabinet walnut veneer. 11" × 3¼" × 6½" $125.00

EP-5 Electrostatic Headphones
Combines a Mylar woofer with an electrostatic tweeter for heavier bass capability; separate

energizer which can be driven from any power amp or receiver; response 10-24,000 Hz; crossover 4000 Hz; energizer has speaker/phones switch, internal overload protection; fully adjustable headband; 15-ft coiled cord. Wood-grained vinyl finish cabinet..... $80.00

PRO-VII Headphones
Features Mylar woofer/tweeter combination; response 15-23,000 Hz; fully adjustable padded headband; 15-ft coiled cord with molded plugs & strain reliefs. 18 ounces..... $65.00

Uni-Pro Headphones
Features wide-range Mylar element; response 15-20,000 Hz; fully adjustable headband, soft replaceable cushions; 15-ft cord. $50.00

TL-3 Trans-linear Headphones
Features Trans-aire principle; response 25-20,000 Hz; fully adjustable steel & aluminum headband; snap-on soft-foam replaceable cushions; coiled cord with molded plug and strain relief..... $40.00

SYLVANIA

SP25 Stereo Phones
Full-frequency phones with foam-filled earcups to reduce room noise and increase comfort. Lightweight construction and with adjustable headband. Has 14-ft coiled cord. Black vinyl finish $19.95

SP40 Stereo Phones
Response 20-20,000 Hz. Distortion less than 1% at 120 dB. Features foam-filled earcups for good coupling to ear for extended bass response. Lightweight construction and with adjustable headband. 8-ft coiled cord. Black and white vinyl finish with chrome trim ... $39.95

TEAC

HP-101 Dynamic Headphones
Stereo design. Frequency response 18-20,000 Hz. 8 ohms. Input sensitivity 1 mW, maximum power 500 mW. 6-ft. cable $39.00
HP-102. Same as HP-101 except 10,000 ohms impedance $39.00

HP-100 Stereo Headphones
High-velocity stereo headphones which permit listening to ambient sounds as well as music. Response 25-20,000 Hz; 8-16 ohms impedance (each channel); sensitivity 115 dB at 1 kHz, 1 mW; max. input 0.5 W. Has 2¼" Mylar cone drive for each channel. Comes with 13½-ft coiled cord $29.50

TECHNICS BY PANASONIC

EAH-80A Electret Headphones
Electret element supplies advantages of electrostatic without its drawbacks. Distortion-canceling design. Adapter/control box included for direct connection to speaker output and control of speaker and headphone output. Lightweight headset (12.5 oz) with self-adjusting assembly. 6-ft, 7-in cord to control box plus 6-ft, 7-in coiled cord to headphone. Max. input (to adapter) 5 V; input imp. to adapter 4 to 16 ohms. Sensitivity (1 V, 500 Hz) 101 dB. Max. sound pressure level output 115 dB. Distortion (101 dB, 500 Hz) 0.8%. Response 20-20,000 Hz $79.95

TELEPHONICS

TEL-26 Dynamic Headphones
Sensitivity 102 dB-SPL at 1 kHz for 1 mW; dist. 0.2% max. Volume and tone controls on each earpiece; stereo/mono switch. Black and chrome finish; coiled cord. 16 ounces. $36.95

TEL-111 Electret Headphones
Response 18-24,000 Hz; sensitivity 104 dB; dist. 0.2% at 115 dB SPL. Separate power pack

requires no external a. c. power. Black and chrome finish. Designed for studio monitoring. 17 ounces $87.50

TEL-14 Dynamic "Two-Way" Headphones
Moving coil woofer and tweeter in each earpiece. Response 20-20,000 Hz; dist. 0.2% max. at 95 dB-SPL. 17 ounces $29.95

TEL-29 Dynamic Headphones
Lightweight. Has individual volume controls; coiled cord; response 30-18,500 Hz; chrome finish. 7 ounces $19.95

TELEX

Studio 1 Headphones
Dynamic design. Response 20-22,000 Hz. Sensitivity 105 dB SPL/mW. Distortion 1.0% at 122 dB SPL. 3 to 16 ohms impedance. 1.0 W maximum input per phone. Has volume controls on each earphone. 15-ft. coiled cord. 24 ounces. $74.95
Studio 2. Same but without volume controls $64.95

300 Stereo Headphones
Dynamic design. Has 15-ft coiled cord. 8 ohms.

Gold with cinnamon brown trim..... $39.95
400. Designed for additional convenience. Has volume control on each earpiece; audio metric driver. $49.95
200. Features two volume controls; 15-ft coiled cord..... $29.95
100. Designed for youth market; 8-ft cord; molded plug; choice of blue, yellow, or orange. $14.95

TOSHIBA

HR-80 Dynamic Headphones
Dynamic headphones; response 20-20,000 Hz; rated input power 15 mW/ch. Imp. 4-50 ohms. Comes with 6.6-ft cord $17.95

HR-50 Stereo Headphones
Two-way dynamic headphones with stereo effect changeover switch (stereo/binaural); rated power 1 mW/ch; response 20-20,000 Hz; crossover 400 Hz; imp. 4-16 ohms. Comes with 6.6-ft. cord $29.95

7 Microphones

ADVENT

MDC-1 Microphones
Matched pair of low-impedance microphones. Cardioid pickup pattern. Frequency response

50-16,000 Hz. Balanced output. Has 20-ft cables and stands. Pair $99.95

7 Microphones

AKG

D-109 Dynamic Microphone
Sensitivity −56 dB ASA. Response 50-15,000 Hz ±3.5 dB. 200 ohms impedance. Omnidirectional pattern. Use for speech. Has lavalier, dust filter or windscreen, 30-ft. cable, and chrome finish. Connector not included . $49.00

D-160E Dynamic Microphone
Sensitivity −55 dB ASA. Response 50-15,000 Hz ±3 dB. 200 ohms impedance. Omnidirectional pattern. Use for tape recording. Has slip-in stand attachment, dust filter or windscreen, with detachable windscreen. With windscreen presence rise, without windscreen linear response. Comes with 15-ft. cable, XLR connector, and chrome finish $69.00

D-190E Dynamic Microphone
Sensitivity −53 dB ASA. Response 40-15,000 Hz ±3 dB. 200 ohms impedance. Cardioid pattern. Use for music. Has slip-in stand attachment, dust filter or windscreen, XLR connector. Comes with 15-ft. cable $59.00
Model D-190TS. Same as D-190E except high impedance operation with "on-off" switch. Has 24-ft. cable and phone plug $79.00

D-200E Dynamic Microphone
Sensitivity −55 dB ASA. Response 30-15,000 Hz ±3 dB. 200 ohms impedance. Cardioid pattern. Use for music and tape recording. Has slip-in stand attachment, dust filter or windscreen. Comes with 15-ft. cable, XLR connector, matte grey finish $79.00
Model D-200TS. Same as D-200E except for high impedance operation with "on-off" switch, 24-ft. cable, and phone plug ... $99.00

D-707E Dynamic Microphone
Sensitivity −52 dB ASA. Response 50-15,000 Hz ±3.5 dB. 200 ohms impedance. Cardioid pattern. Use for tape recording. Comes with slip-in stand attachment, pop or blast filter, chrome finish, 15-ft. cable, and XLR connector $49.00
Model D-707TS. Same as D-707E but for high impedance operation with "on-off" switch, 24-ft. cable, phone jack $69.00

D-1000E Dynamic Microphone
Sensitivity −53 dB ASA. Response 40-16,000 Hz ±3 dB. 200 ohms impedance. Cardioid pattern. Use for rock vocals. Has slip-in stand attachment, pop or blast filter, chrome finish, 15-ft cable, and XLR connector $69.00
Model D-1000TS. Same as D-1000E but for high impedance operation with "on-off" switch, 24-ft. cable, and phone plug .. $89.00

D-140E Dynamic Microphone
Sensitivity −51 dB; 0.23 mV/μbar; response 30-17,000 Hz ±2.5 dB; cardioid pattern; 200 ohms impedance; use for on-stage requirements; will handle up to 128 dB with less than 1% dist. System internally suspended and encapsulated with wire mesh windscreen, lined with polyurethane foam. Has −10 dB bass-attenuation switch, XLR-3 connector, SA-25 stand adapter. 6" long × 1¾" dia. 6.2 oz. $150.00

Electret Condenser Mike System
Modular system consisting of one basic powering module, four interchangeable capsules, and accessories. Powering module has battery compartment for 5.6-volt battery, "on-off" switch for shifting battery to clean contact points, 550-hour continuous operation, and adaptability for phantom powering off d.c. supply. Interchangeable capsules include: CE-1 cardioid capsule plus condenser mike preamp; CE-2 omnidirectional capsule with preamp; CE-5/1 cardioid capsule with integral suspension and

wire mesh screen plus preamp; CE-10 miniature lavalier attachment with integrated FET preamp.
SE-5E. Powering module $60.00
CE-1 ..... $45.00
CE-2 ..... $45.00
CE-5/1 ..... $55.00
CE-10 ..... $85.00
CE-501. For cardioid operation; consists of CE-1 capsule, SE-5E powering module, SA-11/1 stand adapter, W-3 windscreen $119.00
CE-505. For cardioid operation; consists of integral suspension and windscreen, CE-5/1 capsule, SE-5E powering module, and SA-11/1 stand adapter $129.00
CE-510. For lavalier operation; consists of CE-10 lavalier element and SE-5E powering module $145.00

AUDIOTEX

Low-Impedance Microphone
Designed as a replacement unit for many tape recorders built prior to 1969 as well as some later models. Cord terminated in miniature and subminiature plugs to fit most tape recorders; adapter for recorders using concentric jack included. 200 ohms. 30-2300 ..... $8.95
30-2302. Same except 50,000 ohms impedance $9.75
30-2304. Same except equipped with 5-pin and 3-pin DIN plugs found on all European and some American and Japanese recorders. 200 ohms $9.75

Dynamic Microphone
For recording groups and soloists; cardioid pattern. Wide, flat frequency response. 50-13,000 Hz; output −58 dB (on high impedance). Rugged construction, built-in windscreen. 20-ft cable with standard phone plug and adapter for floor or desk stand. Built-in volume control with on-off switch. Dual (hi/lo) impedance. 30-2314 ..... $39.95

Omnidirectional Microphone
Response 55-13,000 Hz; output −62 dB (on high impedance). Rugged construction. Comes with 15-ft cable, standard phone plug, swivel holder, on-off slide switch, and windscreen for outdoor use. Dual (hi/lo) impedance. 30-2312 ..... $36.95

Omnidirectional Microphone
Response 80-13,000 Hz. High impedance. Comes with 10-ft cable with standard phone plug, on-off slide switch, desk stand. Sensitivity: −58 dB. 30-2310 ..... $32.95

Microphone Mixer
Allows combination of up to four mikes mono or two mikes to each stereo channel; separate control for each mike; on-off switch; stereo/mono selector switch; 9-volt battery operated. Standard ¼" phone jack inputs, phono pin jack outputs. 30-2320 ..... $27.95

Microphone Boom
Fits all standard mike floor stands. Has adjustable counterweight; movable clamp and hinge design for any desired position. Standard ⅝-27 thread. 31" long. 30-2370 .. $14.95

Floor-Type Stand
Heavy cast-iron, self-leveling base with polished chrome-plated telescoping tubing. Adjusts from 34" to 64". Top of tubing has standard ⅝-27 thread to fit all standard mikes. 30-2360 ..... $16.95

Folding Microphone Stand
Folds and unfolds in seconds; weight 3½ pounds; chrome-plated tubing extends to 60"; folded size 33". Legs have rubber tips to prevent skidding and scratching. 30-2362 ..... $21.00

BEYER/DYNAMIC

M-500 Dynamic Ribbon Microphone
Super-cardioid; response 40-18,000 Hz ±2.5 dB. Sensitivity: −153 dBm (EIA); 200 ohms imp. Has four-stage integral blast filter and Cannon XLR termination. Especially designed for rock vocals; low pop and breath noise even when singer's lips touch microphone $140.00

M-160 Double-Ribbon Microphone
Super-cardioid dynamic type. Response 40-18,000 Hz ±2.5 dB. Sensitivity: −152 dBm (EIA); 200 ohms impedance. Low sensitivity at 120 degrees to axis. Suitable for stereo recording. Cannon XLR termination $230.00

M-260 Dynamic Ribbon Microphone
Super-cardioid design. Response 50-18,000 Hz ±2.5 dB. Sensitivity −153 dBm (EIA). High-energy ribbon. 200 ohms imp. Suitable for speech, music, or vocals 1¾" mesh head ×6" long. Cannon XLR termination $110.00

M-260SM. Same as M-260 except with "on-off" and bass-cut switch. $130.00

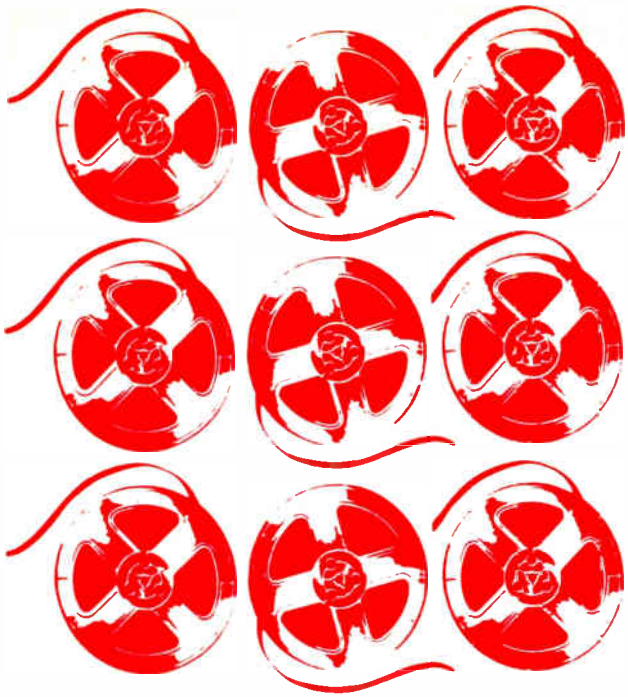
M-550S Moving-Coil Microphone
Omnidirectional dynamic type. Response 70-18,000 Hz. For tape recording and general applications. Sensitivity: −152 dBm (EIA); will work with all impedances. Suitable for use indoors and outdoors. Comes with clamp, table stand, cable with jack plug, "on-off" switch, and presentation case. $42.50

M-810-N Moving-Coil Microphone
Dynamic cardioid design. Response 50-16,000 Hz. Sensitivity: −148 dBm. Suits all impedances. Designed for tape recording applications. Comes with windshield, clamp, and detachable 16-ft cable with jack, all housed in lined case. $70.00

"Soundstar" X1N Dynamic Microphone
Dynamic cardioid design. Response 30-18,000 Hz ±2.3 dB. Sensitivity: −146 dBm (EIA); 200 ohms imp. Front-to-back attenuation greater than 20 dB. For tape recording, music, and vocals. Has built-in pop screen and hum compensation coil. Cannon XLR termination .. $80.00
"Soundstar" X1HL. Same as X1N except with high/low imp. switch $90.00

M-69 Moving-Coil Microphone
Dynamic cardioid design. Response 50-16,000 Hz ±3 dB. Sensitivity: −144 dBm (EIA); 200 ohms imp. For indoor/outdoor applications; unaffected by temperature or humidity .. $95.00
M-69-SM. Same as M-69 but with "on-off" and bass-cut switch. $115.00

M-101 Moving-Coil Microphone
Omnidirectional type. Response 40-20,000 Hz. Sensitivity: −150 dBm (EIA); 200 ohms imp. Withstands pressures associated with modern music (modulated voltages up to 2V). Low handling noise. 4½" × ⅞". Cannon XLR termination $120.00



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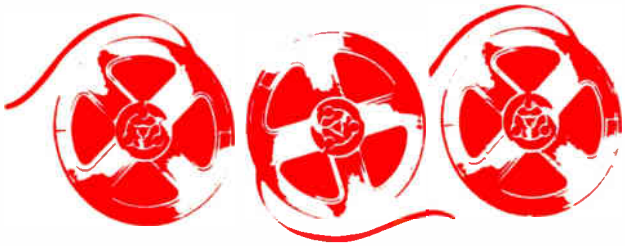

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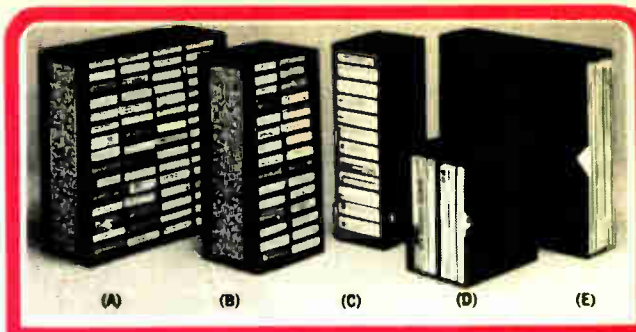


A COMPLETE SET OF MATCHED STORAGE CASES

Here's the ideal solution to the problem of keeping all your records and tapes stored neatly, safely, conveniently and attractively. A complete set of matched storage cases, designed by the editors of STEREO REVIEW magazine, for your records and all your tapes: cassette, cartridge and 7" reel. Now you can keep them side-by-side on your bookshelf or cabinet, easy to identify and readily available.

These cases are sturdily constructed and covered in a handsome leatherette. The outer case is elegantly embossed in gold and comes in your choice of three popular decorator colors—black, brown and green—so that they lend themselves readily to the decor of any room.

STEREO REVIEW large capacity storage cases are just what you've been looking for—they're the ideal solution to keeping your records and tapes neatly stored for easy use.

(A) 60-unit cassette case 13½" high x 12⅝" deep x 5½" wide. $17.95 each; 3 for $49.95.

(B) 30-unit cassette case. 13½" high x 6½" deep x 5½" wide. $12.95 each; 3 for $34.95.

(C) 12-unit 8-track cartridge case. 13¼" high x 6½" deep x 4½" wide. $9.50 each; 3 for $24.95.

Units A, B and C have tilted compartments to prevent spillage and include pressure sensitive labels for titling.

(D) 6-unit 7" reel case. 8" high x 7½" deep x 5" wide. Holds reels in original boxes. $6.95 each; 3 for $18.50.

(E) 20-unit 12" record case. 13¼" high x 12½" deep x 3½" wide. Holds records in original jackets. $7.50 each; 3 for $19.95.

HERE'S HOW TO ORDER

CASH: Mail your order along with your name, address and remittance in the amounts indicated above for the units being ordered. PRICES INCLUDE ALL POSTAGE AND HANDLING CHARGES. OUTSIDE U.S.A. ADD $1 PER UNIT ORDERED.

CHARGE: Your American Express, BankAmericard, Master Charge or Diners Club account. Mail your order, name, address, credit card number and expiration date (Master Charge customers include four-digit Interbank #). Be sure your signature is on your order. You will be billed in the amounts indicated above

Identify the type of case ordered and indicate your color choice for the back of the case—black, green or brown (sides in black only).

Residents of Calif., Col., Fla., Ill., Mich., Mo., N.Y. State, D.C. and Tex. add applicable sales tax.

MAIL ALL ORDERS TO ZIFF-DAVIS SERVICE DIVISION, DEPT. JJ, 595 BROADWAY, NEW YORK, N.Y. 10012.

M-67 Moving-Coil Microphone
For tape recording, interviewing, and general outdoor/indoor work. Cardioid type. Response 40-18,000 Hz ±2.5 dB. Sensitivity: −148 dBm

(EIA); 200 ohms imp. Special transducer mounting minimizes handling noise. Has built-in "on-off" bass-cut switch. 7¾" × 1½". Cannon XLR termination. $130.00

M-201 Moving-Coil Microphone
Super-cardioid dynamic type. Response 40-18,000 Hz. Sensitivity: −149 dBm (EIA); 200 ohms imp. 6" × 1⅝". Cannon XLR termination. Comes with clamp and presentation case $165.00

M-88 Moving-Coil Microphone
Super-cardioid dynamic type. Response 30-20,000 Hz ±2.5 dB. Sensitivity: −144 dBm (EIA). Special transducer mounting eliminates body noise. Will withstand rough handling, humidity and temperature changes. For studio work, recording artists, and instrumentalists $218.00

ELECTRO-VOICE

CS15 Electret Condenser Microphone
Remotely powered electret condenser mike with cardioid pickup pattern; greatest rejection at 180 degrees off-axis; single-D cardioid design emphasizes bass when used close-up; response 40-18,000 Hz; low imp. output −45 dB; dist. 1% THD (open circuit) at 141 dB SPL; dynamic range 119 dB; operating voltage 8 to 48 volts, accepts standard 48-V remote powering; EIA sensitivity −137 dB. Comes with 15-ft cable, A3-type cable-to-mike connector, and stand mounting clamp; weight 8 ounces. 7" long × 1" max. dia. Fawn beige finish.. $198.00

635A Dynamic Microphone
Sensitivity −149 dB EIA. Response 80-13,000 Hz ±3 dB. 150 ohms impedance. Omnidirectional pattern. Hand-held with slip-in stand attachment and lavalier neckcord assembly. Use for tape recording and broadcasting. Has a four-stage pop or blast filter, 15-ft. cable, Switchcraft A3F connector. Fawn beige matte finish..... $60.00

670 Dynamic Microphone
Sensitivity −152 dB EIA. Response 60-14,000 Hz. User selects high or low impedance. Single-D cardioid. Hand-held with slip-in stand attachment. Use for speech, rock vocals, music, and tape recording. Has built-in "Acoustifoam" pop or blast filter, "on-off' switch, 15-ft. cable, and Switchcraft A3F connector. Frequency response varies with distance from microphone (maximum bass response is ¼" from source). Features an anodized brass finish..... $55.50

670V Dynamic Microphone
Sensitivity −152 dB EIA. Response 60-14,000 Hz. User selects high or low impedance. Single-D cardioid. Hand-held with slip-in stand attachment. Use for speech, rock vocals, music, and tape recording. Has built-in "Acoustifoam" pop or blast filter, "on-off" switch, 15-ft. cable and Switchcraft A3F connector. Features a special thumb-actuated volume control for user convenience. Bass response varies with distance from sound source. Anodized finish..... $59.40

RE10 Dynamic Microphone
Response 90-13,000 Hz. Super-cardioid polar pattern. 150 ohms impedance. Output −56 dB (0 dB = 1 mW/10 dynes/cm²). Sensitivity −150 dB EIA. Has 18-ft. cable. 6¾" × 1⅜" with carrying case. $110.10

RE55 Dynamic Microphone
Response 40-20,000 Hz. Omnidirectional pattern. 150 ohms impedance. Output −55 dB (0 dB = 1 mV/10 dynes/cm²). Sensitivity −149 dB EIA. 18-ft. cable. 10½" × 1 7/32" with carrying case. $172.20

671 Dynamic Microphone
Sensitivity −154 dB (EIA) low-Z; −156 dB (EIA) hi-Z. Response 60-14,000 Hz. User selects high or low imp. Cardioid pattern. Features hand-held design with slip-in stand clamp, integral Acoustifoam pop or blast filter, "on-off" switch, 15-ft cable, and A3F connector. Directional single-D emphasizes low-frequencies when used close-up. Satin chrome finish.... $60.00

660 Dynamic Microphone
Sensitivity −150 dB (EIA) low-Z; −150.5 dB (EIA) hi-Z. Response 90-13,000 Hz. User selects high or low imp. Super-cardioid pattern. Can be used hand-held or in stand clamp. Variable-D for smooth response on or off-axis with no proximity effect. Professional-style 15-ft cable and mike-end connector. Satin chrome finish..... $69.80
661. Same as Model 660 except with "on-off" switch..... $71.30

631A Dynamic Microphone
Sensitivity −149 dB EIA. Response 80-13,000 Hz. May be ordered hi or lo impedance. Omnidirectional pattern. Hand-held with slip-in stand attachment. Use for speech, vocals, music, and tape recording. Has silent, magnetic "on-off" switch with removable actuator button; 15-ft cable; Switchcraft A3F connector. Satin chrome finish..... $45.55
All of the above prices are "Net." Slightly higher in Western states.

GROUP 128

SD-140Z Professional Electret Mike
Omnidirectional; response 40-16,000 Hz ±3 dB; 0.2% dist. at 100 dB; SPL capability to 150 dB; output 200 ohms balanced from standard XLR-3 connector located on separate miniature level-control power module; system includes mike with windscreen, cable, remote gain control, power module, and mike stand adapter; black with blue windscreen; weight 2 ounces. $174.50
SD-140. Same except has high-imp. output from standard phone jack..... $144.20

Ext 14 Extension Boom
Lightweight extension boom option for either model SD mike; adds 14 inch reach to mike; several can be used for long-reach applications. $4.95

P800 Contact Pickup Mike
Contact pickup for acoustic guitar and other acoustic instruments; can be attached or removed in seconds using adhesive tabs supplied; complete with miniature belt-worn preamp and gain-control unit, connecting cable, complete instructions; hi-Z phone jack output; available with XLR/Cannon output as P800-Z for low-Z preamps..... $99.50

HITACHI

NDM-32 Dynamic Microphone
Sensitivity −78 dB. Response 70-12,000 Hz ±4 dB. Impedance 600 ohms. Omnidirectional with desk stand. Use for speech and recording applications. Supplied with plug connector and windscreen. 16-ft. cable. Black..... $35.00

LAFAYETTE

Deluxe Ball Dynamic Microphone
General-purpose, omnidirectional, dual-impedance (50,000 & 250 ohms), selectable at cable end. Output at high impedance −59 dB. Frequency response 100-10,000 Hz. Has "on-off" switch. Includes ball screen, 20-ft cable, phone plug, black metal desk stand, and floor-stand adapter. Die-cast case finished in satin aluminum, Case is 6¼" long × 2⅛" max, dia. of ball. $24.25

Electret Condenser Microphone
Unidirectional cardioid pattern with high front-to-back rejection ratio and flat frequency response from 30-16,000 Hz. Impedance 600 ohms but can be used with inputs up to 20,000 ohms. FET circuitry. Powered by one "AA" penlite cell. Foam windscreen, 20-ft shielded cable, standard ¼" phone plug, metal tripod-type desk stand, floor-stand adapter, and battery are included..... $34.95

Cardioid Dynamic Microphone
Dual-impedance, general-purpose microphone; unidirectional pickup; response 100-10,000 Hz; output level −57 dB; dual impedance switch selected; on/off switch; chrome finish; pop-proof wire mesh grille; 20-ft detachable cable; stand swivel adapter. 8" long × 1" dia. $24.50

MU-100 Dynamic Microphone
Unidirectional pickup; output −56 dB; response 200-10,000 Hz; user selects high or low impedance; hand-held with Switchcraft connector to body; "on/off" switch; shock-mounted transducer and Mylar diaphragm for rugged use; use for speech, rock vocals, and tape recording; cable end free; die-cast case; non-glare finish..... $39.75
MU-101. Same as MU-100 except increased maximum working distance and rejection of unwanted background sound. 1.65" dia. head; 7¼" × 1" body..... $39.75
M0-102. Same as MU-100 except response 50-13,000 Hz; −58 dB output; for use where feedback or background noise is not a problem. $39.75

ML-1 Lavalier Condenser Mike
Response 50-15,000 Hz; −80 dB output; tie-clasp holder; noise-reducing cable to FET preamp & power supply; 600-ohm output imp.; 1½" × ⅔" dia.; comes with "AA" battery, shielded cable, phone plug..... $19.50
ML-2 Same except response 50-13,000 Hz; 800-ohm imp.; −66 dB output; 1" × ⅝" dia..... $24.50

MERITON

CNM-70 Condenser Microphone
Omnidirectional electret unit; frequency range 40-20,000 Hz with tone separation; FET circuitry; sensitivity −73 dB ±3 dB (0 dB = −1 V/μ bar at 1 kHz); imp. 600 ohms; comes with stand adapter, 16-ft, 5-in cable, ¼" dia. plug. 1 3/32" dia. × 6 9/32" H. $79.95

CNM-75 Condenser Microphone
Unidirectional electret unit; frequency range 50-15,000 Hz; has built-in bass roll-off switch to attenuate low-end response during close miking; sensitivity −73 dB ±3 dB; imp. 600 ohms; FET circuitry; comes with stand adapter, 16-ft, 5-in cable, ¼" dia. plug. ⅞" dia. × 6 3/16" H $99.95

DNM-40 Dynamic Microphone
Unidirectional dynamic unit; features three windscreens; dual-impedance matching; flat response, film diaphragm; standard connectors for studio or home recorders; built-in on-off switch; comes with holder for stand use, 16-ft, 5-in cord, ¼" dia. plug. 1 1/16" dia. × 6 9/16" H.... ..... $39.95

DNM-25 Dynamic Microphone
Unidirectional dynamic unit; response 150-10,000 Hz; sensitivity −78 dB ±3 dB; imp. 250 ohms (unbalanced); built-in on-off switch;

7 Microphones

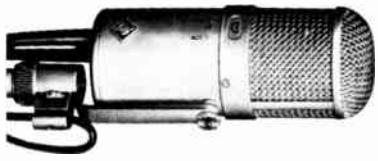
comes with table stand with mini plug. 1⅜" dia. × 6⅜" H. $14.95

DNM-20 Dynamic Microphone
Omnidirectional dynamic unit; features polyester film diaphragm; built-in on-off switch; response 70-12,000 Hz; imp. 250 ohms (unbalanced) comes with table stand. 1 1/32" dia. × 5 11/16" H. $19.95

DNM-10 Dynamic Microphone
Omnidirectional replacement unit for use with cassette recorders; response 100-10,000 Hz; imp. 250 ohms (unbalanced); comes with table stand, windscreen, mini plug. 1" dia. × 4 15/16" H $9.95

NEUMANN

FET-80 Condenser Microphones
A line of studio microphones that come in many configurations from omni, figure-8, cardioid,



multiple pattern to multiple pattern stereo. All can be either battery or phantom (separate power supplies) powered.
U-47FET $530.00
Other FET-80 models ..... from $230.00

PIONEER

CM-2S Electret Microphone
Dual-element electret condenser unit; hypercardioid pattern; response 20-20,000 Hz; output impedance 1000 ohms; sensitivity −68 dB at 1 kHz (0 dB = 1 V/μ bar); maximum SPL 126 dB; S/N 46 dB; 1.5-V "AA" cell power supply; 6.06" H × 4.33" W; weight 11.2 ounces; 21-ft cable; pair comes mounted on desk stand. $59.95

CM-2 Electret Microphone
High molecular diaphragm electret condenser element; selectable omni- or uni-directional μattern; response 40-20,000 Hz (uni), 20-20,000 Hz (omni); output impedance 600 ohms unbalanced; sensitivity −69 dB (uni), −74 dB (omni) (both 0 dB = 1 V/μ bar); 126 dB maximum SPL; 1.5-V "AA" cell power supply; 1.42" dia. × 8.37" long; weight 10.56 ounces; comes with 18-ft cable. $99.95

PML

DC-20 Condenser Microphone
Omnidirectional pattern. Response 30-20,000 Hz. Sensitivity −56 (1.5 mV); noise 23 dB; impedance 200 ohms. Comes with stand adapter and connecting cable $122.95
DC-21. Same except cardioid pattern. $122.95

DC-73 Condenser Microphone
Cardioid pattern. Has electrical pop filter. Response 30-20,000 Hz (100-20,000 Hz); Sensitivity −60 dB. (1.0 mV); noise 21 dB; impedance 200 ohms. Comes with stand adapter and connecting cable $160.95

DC-96 Condenser Microphone
Cardioid pattern. Response 30-18,000 Hz. Sensitivity −61 dB (0.9 mV); noise 17 dB; impedance 200 ohms. Comes with stand adapter and connecting cable $242.95

EK-71 Condenser Microphone
Omnidirectional pattern. Response 80-18,000 Hz. Sensitivity (hi-Z) −38 dB (2.5 mV); impedance hi-Z. Comes with stand adapter and connecting cable $97.95
EC-71. Same except cardioid pattern .. $97.95

FP-92K Electret Microphone
Omnidirectional pattern. Pre-polarized with built-in 6 V battery. Response 30-20,000 Hz. Sensitivity −66 dB (0.5 mV); noise 23 dB; impedance 200 ohms. Comes with stand adapter and connecting cable $146.95
FP-92C. Same except cardioid pattern $146.95
FP-92C+. Same except has windscreen and shockmount $183.95
FP-92K+. Same as FP-92K except has windscreen and shockmount $183.95

S/BE CL3 Electret Microphone
Tie-bar design. Omnidirectional pattern. Response 80-17,000 Hz. Sensitivity −30 dB; noise 23 dB; impedance 200 ohms. Requires 22½ V battery $163.95

Power Supplies
Battery supply for DC-20, DC-21, DC-73, DC-96. 48 V d. c. output. Impedance 50,200, 600, and hi-Z.
7320-M. Mono $49.95
7320-S. Stereo $55.95
110 V. a. c. supply for DC-20, DC-21, DC-73, DC-96.
6320-M. Mono $74.95
6320-S. Stereo $102.95
Battery supply for EC-71 and EK71.
7140-M. Mono $45.95
7140-S. Stereo $53.95

RADIO SHACK

Pro-100 Microphone Kit
Supplied as a pair with 13-piece accessory package including wind screens, table stands, floor stand adapters, lavalier cords, and cables. Response 10-10,000 Hz. Switchable 250 and 10,000 ohm impedance $39.95

Highball Dynamic Microphone
Cardioid design. Response 50-15,000 Hz. Features "on-off" switch and internal push-on impedance change 50/250 ohms or 50,000 ohms. Has pop filter and 15-ft. cable .. $39.95

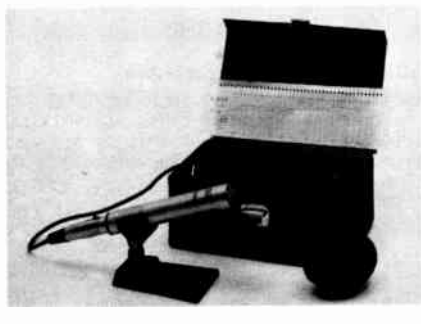
Highball 5 Dynamic Microphone
Cardioid design. Response 70-13,000 Hz. Has change plug for 600 to 20,000 ohm impedance. Stand adapter and 15-ft. cable .. $34.95

Electret-1045 Condenser Microphone
Cardioid design. Response 30-15,000 Hz. Can be switched from low imp. (600 ohms) to high imp. (20,000 ohms). Has windscreen and desk stand. Powered by single penlight. $34.95

Electret-1044 Condenser Microphone
Omnidirectional pattern. Response 30-15,000 Hz. Can be switched from 600 to 20,000 ohm impedance. Has foil diaphragm, windscreen, and mike stand. Powered by single penlight battery. $29.95

REVOX

3500 Dynamic Microphone



Dynamic unidirectional moving-coil type; cardiod pattern; response 40-18,000 Hz; impedance 600 ohms; comes with windscreen, clamp, table stand, and case; Cannon XLR connector; each unit supplied with own frequency-response curve. $165.00

SENNHEISER

MD-211U Dynamic Microphone
Omnidirectional unit. Response 40-20,000 Hz. Sensitivity −58 dBm (0.13 mV/μbar) ±2.5 dB. Has extremely wide, flat response unusual in a moving-coil microphone. 4¾" × 1" dia. Fitted with Cannon XLR connector and cable. $195.00

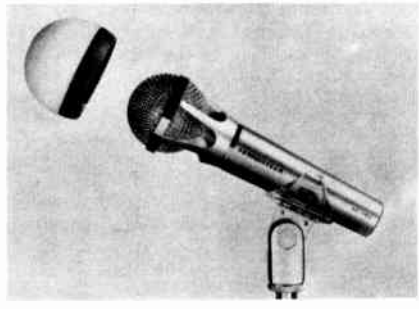
MD21N Dynamic Microphone
Omnidirectional, 200-ohm impedance design. Response 50-15,000 Hz ±3 dB. Sensitivity 0.2 mV/μbar at 1000 Hz. EIA rating −145.8 dB. Output level −53 dBm (1 mW/10 dynes/cm²). Fitted with small Tuchel connector. Has balanced output. 10 ounces. 4¾" × 1⅞" × 1⅞". $105.00

MD421U Dynamic Microphone
Cardioid, 200-ohm impedance design. Response 30-17,000 Hz ±5 dB. Sensitivity 0.2 mV/μbar ±3 dB at 1 kHz. EIA rating −145.8 dB. Output level −53 dBm (1 mW/10 dynes/cm²). Has front-to-back ratio 18 dB, −2 dB and a variable bass attenuator. Fitted with XLR connector and cable. 7" × 1⅞" × 1 13/16". $176.00

MD412HLM Dynamic Microphone
Super-cardioid. Features a built-in triple-impedance transformer to permit mike to be con-

nected directly to any tape recorder. High impedance is 25,000 ohms for tube units; 800 ohms medium impedance for transistor recorders; 200 ohms low impedance for recorders of either type fitted with low-impedance input transformers. Response 50-12,000 Hz. Side attenuation 20 dB at 120 degrees. Sensitivity 1.25 mV/μbar at 1 kHz: EIA rating − 154 dB; output level − 58.1 dBm (1 mW/10 dynes/cm²) all at high-imp. setting. Comes with table stand, floor stand adapter, and zippered case. 8 ounces $61.00

MD416 Dynamic Microphone
Cardioid type especially designed for close miking. Response 50-15,000 Hz; sensitivity 0.13



mV/μbar ±3 dB; impedance 200 ohms; Cannon XLR connector. Has built-in isolation system to eliminate handling noise; built-in pop filter;

outdoor pop filter; threaded stand mount with quick-release clip and cable..... $159.00

MD441 Dynamic Microphone
Super-cardioid design. Response 40-20,000 Hz; sensitivity 0.2 mV/μbar ±3 dB. Has brilliance switch for nominal 5 dB boost at 5 kHz; 5-position bass attenator. Front-to-back ratio is 20 dB, −3 dB. Comes with cable and quick-release mount that fits on floor stand or accessory table stand MZT-441. Windscreen for microphone is Model MZW441. 1.3" H × 1.4" W × 9.6" long..... $247.00

SHURE

300 Ribbon Microphone
Sensitivity −153 dB (EIA). Response 40-15,000 Hz. User selects high or low impedance. Bi-directional. Hinge mount to stand. Use for speech and music. Has 20-ft. cable and connector. Gray..... $115.20

515SA "Unidyne B" Microphone
Dynamic type. Sensitivity −154 dB (EIA). Response 80-13,000 Hz. High impedance. Cardioid pattern. Hand-held with slip-in stand attachment. Use for speech, rock vocals, and music. Has "on-off" switch and 15-ft. cable. Chrome finish..... $30.30
Model 515SB. Same as Model 515SA except low impedance..... $30.30

545 "Unidyne III" Microphone
Dynamic type. Sensitivity −149 dB (EIA). Response 50-15,000 Hz. User selects high or low impedance. Cardioid pattern. With slip-in stand attachment and hinge mount to stand. Designed specifically for speech, music, and tape recording. Supplied with 15-ft. cable and Amphenol-type MC4M connector. Chrome finish..... $64.20
Model 545S. Similar to Model 545 but has cable connection through hinge and "on-off" switch in upright..... $68.40
Model 545SO. Same as Model 545 but has "on-off" switch on microphone barrel.. $68.40
Model 545L. Similar to Model 545 but has lavalier cord and clip..... $53.85

546 "Unidyne III" Microphone
Dynamic type. Sensitivity −154 dB (EIA). Response 50-15,000 Hz. User selects high or low impedance. Cardioid pattern. Hinge mount to stand. Use for speech, rock vocals, and music. Comes with 20-ft. cable and connector. Chrome finish..... $103.80

548SD "Unidyne IV" Microphone
Dynamic type. Sensitivity −141 dB (EIA). Response 40-15,000 Hz. User selects high or low impedance. Cardioid pattern. Hand-held with slip-in stand attachment. Use for speech and music. Has "on-off" switch, 15-ft. cable, and connector. Chrome finish..... $80.40

55S "Unidyne II" Microphone
Sensitivity −148 dB (EIA). Response 50-15,000 Hz. User selects high or low impedance. Cardioid pattern. Hinge mount to stand. Use for speech and music. Supplied with Amphenol-type MC3M connector and 15-ft. cable. Chrome finish..... $64.20
Model 55SW. Same as Model 55S except has built-in "on-off" switch..... $65.40

565 "Unisphere 1" Microphone
Dynamic type. Sensitivity −148.5 dB (EIA). Response 50-15,000 Hz. User selects high or low impedance. Cardioid pattern. Hinge mount to stand. Use for speech, rock vocals, and music. Has pop or blast filter, 15-ft. cable, and connector. Chrome finish..... $72.60
Model 565SO. Same as Model 565 except has "on-off" switch..... $75.60
Model 566. Similar to Model 565 except with shock mount..... $110.40

578 "Omnidyne" Microphone
Sensitivity −154 dB (EIA). Response 50-15,000 Hz. User selects high or low impedance. Omnidirectional pattern. Hand-held. Use for speech and music. Has "on-off" switch, a 15-foot cable, and connector. Supplied with chrome finish..... $60.00
Model 578S. Similar to Model 578 except has swivel assembly..... $67.20

579SB "Vocal Sphere" Mike
Sensitivity – 151 dB (EIA). Response 50-15,000 Hz. Low impedance, omnidirectional pattern. Has slip-in stand attachment, "on-off" switch, pop or blast filter. Use for speech, rock vocals, and music. Supplied with 20-ft. cable and connector. Chrome finish..... $50.85

580SA(B) "Unidyne A" Mike
Sensitivity −151 dB (EIA). Response 50-13,000 Hz. User specifies high or low impedance. Cardioid pattern. Hand-held with slip-in stand attachment. Use for speech and music. Comes with "on-off" switch, 15-ft. cable, and connector. Chrome finish..... $46.65

585SA(B) "Unisphere A" Mike
Sensitivity −151 dB (EIA). Response 50-13,000 Hz. User specifies high or low impedance. Cardioid pattern. Hand-held with slip-in stand attachment. Use for speech, rock vocals, and music. Has pop or blast filter, "on-off" switch. Supplied with 15-ft. cable and connector. Chrome finish..... $50.85
Model 585SAV. Similar to Model 585SA(B) but has volume control on microphone barrel..... $55.65

588SA(B) "Unisphere B" Mike
Sensitivity −155 dB (EIA). Response 80-13,000 Hz. User specifies high or low impedance. Cardioid pattern. Hand-held with slip-in stand attachment. Use for speech, rock vocals, and music. Has pop or blast filter, "on-off" switch. Comes with 15-ft. cable and connector. Chrome finish..... $43.65

589S "Unidyne C" Mike
Unidirectional dynamic type; response 90-13,000 Hz; 150 ohm imp. to match any input from 20-200 ohms, also high impedance; built-in "on-off" switch with lockplate; internal rubber vibration-isolator shockmount; 15-ft two-conductor shielded with 3-pin female connector on mike end; zinc die-casting housing with silver-metallic finish, stainless steel grille; 7" × 1 9/16"; weight 12 ounces less cable..... $51.00

SONY from SUPERSCOPE

ECM.16 Tie Clasp/Lapel Mike
Sensitivity −57.8 dB (0 dB = 1 V/10 μbar). Response 50-13,000 Hz. Low impedance, omnidirectional pattern. Lavalier-type for speech and tape recording. Supplied with mini connector. Internal battery operation. 6-ft. cable. 9/16" dia. × 1 9/16" long. Silver $34.95

ECM-18 Condenser Microphone
Sensitivity −56.8 dB (0 dB = 1 V/10 μbar). Response 50-12,000 Hz. Low impedance, cardioid pattern. Hand-held type for speech, music, and tape recording. Supplied with mini connector, dust filter or windscreen. 6.5-ft. cable. Internal battery operation. Silver gray and black..... $27.95

ECM-33P Condenser Microphone
Sensitivity −54.8 dB (0 dB = 1 V/10 μbar). Response 40-15,000 Hz: Low impedance, balanced 250/600 ohms. Cardioid pattern. Hand-held with "slip-in" stand attachment. Use for speech, rock, vocals, music, and tape recording. Comes with dust filter or windscreen and 20-ft. cable. Connector not included. Internal battery/phantom powering..... $129.95

ECM-99 Condenser Microphone
Sensitivity −53 dB (0 dB = 1 V/10 μbar). Response 50-12,000 Hz. Low impedance. Cardioid (dual) pattern. Hand-held with "slip-in" stand attachment. Use for music and tape recording. Comes with dust filter or windscreen, 10-ft. cable, mini (2) connector, one-point stereo pickup. Internal battery operation. Nickel satin finish..... $49.95

F-27 Dynamic Microphone
Sensitivity −58 dB (0 dB = 1 V/10 μbar). Low impedance. Cardioid pattern. Hand-held. Use for speech and tape recording. Supplied with mini connector and 6.5-ft. cable..... $14.95

ECM-170 Condenser Microphone
Sensitivity −56 dB. Response 20-16,000 Hz. Low impedance. Omnidirectional pattern. Use for live recording of large ensembles. Has voice/music switch for adjusting frequency response. Comes with two-conductor shielded cable, accessory windscreen, and microphone holder..... $79.95

ECM-220 Condenser Microphone
Sensitivity −57/−41 dB. Response 50-12,000 Hz. Impedance 200/10,000 ohms. Unidirectional pattern. Use for live music pickup. Has "on-off" switch; dual-impedance switch; built-in windscreen. Comes with microphone holder, battery, and audio cable..... $49.95

ECM-250 Condenser Microphone
Sensitivity −57 dB. Response 50-14,000 Hz. Low impedance. Cardioid pattern. For all types of recording. Has built-in windscreen, making it suitable for outdoor recording. Comes with battery, mike stand adapter, cable, and carrying case..... $59.95

ECM-270 Condenser Microphone
Sensitivity −56 dB. Response 40-16,000 Hz. Low impedance. Unidirectional pattern. Use for recording live musical performances. Lightweight for stage, nightclub, and other situations where performer holds mike. Comes with accessory windscreen, microphone holder, and cable..... $79.95

ECM-280 Condenser Microphone
Sensitivity: −56 dB. Response 30-18,000 Hz. Low impedance. Cardioid pattern. Has bass roll-off switch and a built-in windscreen. An additional removable windscreen works in conjunction with the unidirectional pickup pattern for outdoor recordings free from wind and background noise. Incorporates FET electronics. Comes with battery, mike stand adapter, cable, and carrying case..... $99.95

TEAC

MC-201 Microphone
Electret. Response 50-15,000 Hz. Balanced

600 ohms. Has slip-in stand attachment, windscreen, and 10-ft. cable..... $80.00

ME-120 Microphone
Electret. Cardioid or omni; two-position response switch; balanced 200 ohms; response 40-18,000 Hz (cardioid), 30-16,000 Hz (omni). Comes with stand attachment, two windscreens, 15-ft cable..... $120.00
ME-80. Same except response 50-16,000 Hz.

7 Microphones

..... $80.00

ME-50. Same except cardioid; unbalanced or balanced 10,000 or 200 ohms; response 50-14,000 Hz..... $50.00

109-A Mike Input Transformer
Designed to match low-impedance mikes to high-impedance inputs; will terminate low-impedance, balanced signal to allow interfacing with most consumer tape recorders & mixers..... $20.00

TECHNICS BY PANASONIC

RP-3850 Electret Condenser Mike
Cardioid pattern; FET head amplifier; tone-adjust switch; PAD 10-dB sensitivity switch; detachable windscreen; response 20-16,000 Hz; sensitivity −72 dB at 1000 Hz; 0 dB = 1 V/μ bar; output Z 600 ohms balanced; S/N 46 dB; max. input = 128 dB SPL. Operates 5000 hrs on single AA cell. Comes with Cannon cable connector..... $149.95

RP-3830E. Similar to 3850 except response 50-15,000 Hz; sensitivity −74 dB; Switchcraft cable connector..... $99.95

RP-3550E. Similar to RP-3830E except fixed windscreen; Switchcraft cable connector..... $79.95

TURNER

500 Microphone
Dynamic type. Sensitivity −151 dB (EIA), response 40-12,000 Hz. User selects high or low impedance. Cardioid pattern. Hand-held with "slip-in" stand attachment. For use in recording speech, rock vocals, and music. Pop or blast filter. Detachable 20-ft. cable. Supplied with XLR connector. Satin chrome finish... $105.00
Model S-500. Same except with rotary "on-off" switch..... $120.00

700 Microphone
Dynamic type. Sensitivity −151 dB (EIA), response 40-15,000 Hz. User selects high or low impedance. Cardioid pattern. Hand-held with "slip-in" stand attachment. For speech, rock vocals, and music. Pop or blast filter, "on-off" switch. Detachable 20-ft. cable. Comes with Switchcraft A4F connector. Satin chrome finish $120.00

2300 Microphone
Dynamic type. Sensitivity −151 dB (EIA), response 50-15,000 Hz. High-impedance, omnidirectional. Hand-held with "slip-in" stand attachment. For speech, rock vocals, music, and tape recording. Has 20-ft cable, "on-off" switch, and phone plug. Satin chrome finish $100.00
Model 2302. Same except low-impedance version..... $100.00

S-2850 Microphone
Dynamic type. Sensitivity −161 dB (EIA), response 70-12,000 Hz. User selects high or low impedance. Cardioid pattern. Hand-held with "slip-in" stand attachment, lavalier clip. Use for speech and tape recording. Does not include connector but does have "on-off" switch and 12-ft. cable. Black..... $60.00

45 Cardioid Microphone
Dynamic design. Sensitivity −155 dB (EIA), response 100-13,000 Hz. High impedance. Use for speech, group singing, and music. Supplied with 20-ft. cable, phone plug, stand adapter, and "on-off" switch..... $50.00
Model 45A. Same except low-impedance version..... $50.00

603H Microphone
Dynamic type. Sensitivity −151 dB (EIA), response 50-15,000 Hz. High impedance. Cardioid pattern. Hand-held with "slip-in" stand attachment. For speech, rock vocals, and music. Pop or blast filter, "on-off" switch. Detachable 20-ft. cable. Satin chrome finish..... $100.00
Model 603L. Same except low-impedance version..... $100.00

UNIVERSITY

1655 Omnidirectional Microphone
Dynamic design; 200 ohms balanced. Response 50-15,000 Hz. Output −56 dBm (re: 10 dynes/cm²). Has built-in wind/pop filters; standard mounting swivel adapter. Supplied with 18 ft. cable. 6½" long × 1½" diam. tapering to ¾". 6¾ ounces $106.00

1656 Dynamic Microphone
Cardioid pattern; 200 ohms balanced. Response 60-15,000 Hz. Output −56 dBm (re: 10 dynes/cm²); SPL 0.5% at 126 dB (400 μbar at 1000 Hz); integral pop and breath-blast filter; extra rugged swedge steel case for applications involving rough handling; supplied with 18-ft, 2-cond. shielded cable with standard 3-pin female connector; standard 3-pin male audio receptacle on base; matte nickel finish. 1¾" dia. tapering to ¾" × 6½" overall length. 8 ounces $116.00
1656G. Same as 1656 but without switch; has threaded handle for flexible gooseneck stands or special boom adapters; 8-ft cable, 2-cond. shielded cable lead..... $106.00

BLANK TAPE & ACCESSORIES

ADVENT

Chromium-Dioxide Cassettes

Comes in screw-type housing with special lead-

er tape that cleans heads. In lots of six, comes with free optional storage album.

C-60	$2.25
C-90	$2.99
C-120	$3.99

AMPEX

364 Series 20/20+ Cassettes

364-C42. 42 min	$3.19
364-C60. 60 min	$3.49
364-C90. 90 min	$5.29
364-C120. 120 min	$6.79

363 Series Chromium-Dioxide Cassettes

363-C40. 42 min	$3.19
363-C60. 60 min	$3.49
363-C90. 90 min	$5.29

370 Series Cassettes

Low-noise/high-output type.

370-C42. 42 min	$2.09
370-C60. 60 min	$2.29
370-C90. 90 min	$3.49
370-C120. 120 min	$4.79

350 Series "Super" Cassettes

350-C42. 42 min	$1.19
350-C60. 60 min	$1.49
350-C90. 90 min	$2.29
350-C120. 120 min	$3.59

381 Series 8-Track Cartridges

381-42E. 42 min	$2.49
381-84E. 84 min	$2.99

388 Series 20/20+ Cartridges

388-42E. 42 min	$3.29
388-84E. 84 min	$3.89

20/20+ Series Open-Reel Tapes

Back-coated professional mastering tape.

372-15. 1200 ft, 7" reel, 1.5-mil	$6.59
373-15. 1800 ft, 7" reel, 1.0-mil	$8.09
373-17. 3600 ft, 10½" NAB reel, 1.0-mil	$23.39

PRT Series Open-Reel Tapes

High-frequency polyester.

331-13. 600 ft, 5" reel, 1.5-mil	$2.89
341-13. 900 ft, 5" reel, 1.0-mil	$3.89
331-15. 1200 ft, 7" reel, 1.5-mil	$4.29
341-15. 1800 ft, 7" reel, 1.0-mil	$6.59
351-15. 2400 ft, 7" reel, 0.5-mil	$10.69
361-15. 3600 ft, 7" reel, 0.5-mil	$11.59

Demagnetizer/Head Cleaner

E3220BL. For cassette players/recorders	$5.99
E3228. For 8-track players/recorders	$6.99

BASF

TP-18LH Recording Tape

Polyester base, tensilized, ½-mil., triple play.

1800 ft., 5" reel	$9.35
3600 ft., 7" reel	$18.75

LP-35LH Long-Play Tape

1-mil polyester base. Low-noise, high-output.

900 ft., 5" reel	$5.10
1800 ft., 7" reel	$9.35

DP-26LH Double-Play Tape

¾-mil polyester base. Low noise, high-output.

1200 ft., 5" reel	$6.85
2400 ft., 7" reel	$12.50

LH Super

Low noise, high-output. Tensilized base.

1800 ft., 7" reel	$12.10
2400 ft., 7" reel	$16.10

"Chromdioxid" SM Cassettes

Plastic box.

30 min/side C-60	$3.75
45 min/side C-90	$5.60
60 min/side C-120	$7.50

LHSM Cassettes

Plastic box.

C-60	$3.75
C-90	$5.60
C-120	$7.50

SKLH Cassettes

Mailer box

C-60	$3.25
C-90	$4.60
C-120	$6.00

Album Snap Pack

C-45DK (SP)	$2.50
C-60SK (SP)	$3.00
C-90SK (SP)	$4.35
C-120SK (SP)	$5.75

"Sound Loop 8" Cartridges

45 minutes	$3.10
64 minutes	$3.35
90 minutes	$3.75

"Sound Loop 8+" Cartridges

Low-noise, high-output cartridges.

45 min	$3.75
64 min	$4.10
90 min	$4.35

CAPITOL

Capitol 1 Cassettes

C-30, 15 min/side	$0.89
C-60, 30 min/side	$1.09
C-90, 45 min/side	$1.79
C-120, 60 min/side	$2.49
C-30, Three pack	$2.52
C-60, Three pack	$3.09
Cassette head cleaner	$1.09
Cassette saver	$2.19

Capitol 1 8-Track Cartridges

32 min/150 ft	$1.69
40 min/190 ft	$1.99
64 min/300 ft	$2.19
80 min/380 ft	$2.29
100 min/470 ft	$2.49
4 pk of 40 min	$5.79
4 pk of 80 min	$6.98
Cartridge head cleaner	$1.19

Capitol 1 Open-Reel Tape

Standard play, 1.5-mil polyester

600 ft., 5" reel	$2.39
1200 ft., 7" reel	$2.79

Extra play, 1.0-mil polyester

900 ft., 5" reel	$2.79
1800 ft., 7" reel	$3.79

0.5-mil polyester, tensilized

1800 ft., 5" reel	$4.29
2400 ft., 7" reel	$4.79

"the music tape" Cassettes

High-output/low noise with "cushion-aire" backing.

C-45. 45 min.	$2.69
C-60. 60 min.	$2.98
C-90. 90 min.	$4.49
C-120. 120 min.	$5.98
C-45. Stak-pak (2 paks).	$5.38
C-60. Stak-pak (2 paks).	$5.96
C-90. Stak-pak (2 paks).	$8.98
C-120. Stak-pak (2 paks).	$11.96

"the music tape" Cartridges

High-output/low noise.

8T-45. 45 min.	$2.98
8T-60. 60 min.	$3.19
8T-90. 90 min.	$3.59
8T-100. 100 min.	$3.79

"the music tape" Open-Reel

High-output/low noise with "cushion-aire" backing

FDS-1200. 1200 ft, 7" reel	$5.98
FDS-1800. 1800 ft, 7" reel	$7.59
FDS-2500. 2500 ft, 10½" reel	$11.98
FDS-3600. 3600 ft, 10½" reel	$16.68

COLUMBIA

Cassette Tapes

8 Blank Tape

Each side color-coded for easy identification. High-output/low-noise gamma-ferric oxide. Response 20-20,000 Hz. Tensilized polyester base. Delrin rollers; constant-tension pressure pad for consistent tape-to-head contact; mounted in three-sided Mumetal shield to prevent pickup of hum and noise; two re-recording labels included.

2CB-80040. 40 min. $2.29
2CB-80060. 60 min. $2.79
2CB-80090. 90 min. $3.49
2CB-80012. 120 min. $4.49
2CB-800HC. Head cleaner. $1.79

8-Track Tapes with "ConvertaQuad"

Back-lubricated high-output/low-noise gamma-ferric oxide tape. Response 20-20,000 Hz. Three-point Delrin tape suspension; silicone/rubber pinch roller; foam pressure pad; one-piece hub; features "ConvertaQuad" plastic slug for activating sensing device on 4-ch tape deck.

8CB-80740. 40 min. $2.69
8CB-80750. 50 min. $2.79
8CB-80780. 80 min. $2.99
8CB-80710. 100 min. $3.49
8CB-807HC. Head cleaner. $1.69

Open-Reel Tapes

High-output/low-noise gamma-ferric oxide tape. Index and timing chart included with all packages.

4CB-80412. 7" × 1200 ft, 1.5-mil polyester. $4.79
4CB-80418. 7" × 1800 ft, 1.0-mil polyester. $5.98
4CB-80424. 7" × 2400 ft, 0.5-mil polyester. $7.99
4CB-80436. 7" × 3600 ft, 0.5-mil polyester. $9.99

HITACHI

"Ultra-Dynamic" Cassettes

UDC-60, 60 min $3.70
UDC-90, 90 min $4.80
UDC-120, 120 min $6.70

Low-Noise Cassettes

C-30, 30 min $1.65
C-60, 60 min $2.25
C-90, 90 min $3.20
C-120, 120 min $4.30

All "suggested list" prices

IRISH

200 Series Professional Tape

Standard, 1½-mil, polyester base, ¼"
231-131, 600 ft., 5" reel $4.00
231-151, 1200 ft., 7" reel $6.10
Extra-length, 1-mil, polyester base, ¼"
241-131, 900 ft., 5" reel $4.55
241-151, 1800 ft., 7" reel $7.70
Double-length, ½-mil polyester tensilized base.
251-151, 2400 ft., 7" reel $13.35
0.5-mil, polyester tensilized base, ¼"
261-151, 3600 ft., 7" reel $13.60

270 Series Tape

Low-noise, high-output, back coated.
276-151, 1200 ft, 7" reel $9.75
276-173, 2500 ft, 10½" NAB aluminum reel $20.45
276-273, 2500 ft, 10½" NAB aluminum reel $41.00
277-151, 1800 ft, 7" reel $12.40

Professional-Series Cassettes

In album/mailer
261-C40, 20 min/side $1.70
261-C60, 30 min/side $1.90
261-C90, 45 min/side $2.90
261-C120 60 min/side $4.55

Low-Noise, Extended-Range Cassettes

Flip-top plastic box
262-C40, 20 min/side $2.65
262-C60, 30 min/side $3.00
262-C90, 45 min/side $4.45

Chromium-Dioxide Cassettes

Flip-top plastic box
263-C60, 30 min/side $5.00
263-C90, 45 min/side $7.55

"3-in-a-Bag"

261-C60-3PA $4.95

"2-in-a-Bag"

261-C90-2PA $5.40

8-Track Cartridges

8T42, 42 min. $3.20
8T84, 84 min. $3.85

8-Track Cartridge Package

Four 40-minute, 8-track cartridges, one head cleaner, plus storage tray.
8T-160-P $12.90

8-Track Cartridge Package

Four 80-minute, 8-track cartridges, one head cleaner, plus storage tray.
8T-320-P $14.50

LAFAYETTE

Tensilized Reel-to-Reel Tapes

Tensilized Mylar. 0.5-mil.
300 ft, 3" reel, double-play $0.79
600 ft, 3¼" reel, double-play $1.09
3600 ft, 7" reel, triple-play $5.29

Mylar-Base Reel-to-Reel Tapes

On clear plastic reels.
1200 ft, 5" reel, 0.5-mil $1.89
1800 ft, 7" reel, 1.0-mil $2.49
2400 ft, 7" reel, 0.5-mil $3.49

Chromium-Dioxide Cassettes

Chromium-based coating to provide low distortion, increased high-frequency levels, and reduced inherent tape noise. For recorders with chromium-dioxide bias switches.
60 min $2.29
90 min $2.99

Criterion Dynamic-Range Cassettes

Low-noise, high-output. Wide dynamic range with high-frequency response of 30-20,000 Hz. Head cleaner section at one end, sensing foils at each end to activate machines having reversing mechanism, but may be used on all cassette recorders. Hard, clear plastic storage box.
C-60. 60 min $2.40
C-90. 90 min $3.60
C-120. 120 min $4.75

Criterion Deluxe Cassettes

C-45 45 min $1.15
C-60 60 min $1.29
C-90 90 min $1.99
C-120 120 min $2.99

Voice-Grade Cassettes

C-45. 45 min $0.89
C-60. 60 min $0.99
C-90. 90 min $1.49
C-120. 120 min $2.19

8-Track Mylar Cartridges

40 min $1.69
70 min $1.95
80 min $2.25

LONGINES SYMPHONETTE

Music-Grade Cassettes

M40. C-40, 40 min $1.85
M60. C-60, 60 min $2.15
M90. C-90, 90 min $2.79
M120. C-120, 120 min $3.29

All-Purpose Cassettes

AP60. C-60, 60 min $0.99
AP90. C-90, 90 min $1.49
APS60. C-60 three-pack $2.89
APS90. C-90 three-pack $4.39

8-Track Cartridges

8M40. 40 min. single in sleeve $2.35
8M80. 80 min. single in sleeve $2.85

Cassette Tote Box

2AP60C (2-C60's) $2.19
2AP90C (2-C90's) $2.89

Head Cleaners

CMS-2 Cassette Maintenance Kit ... $2.05
8HCS-4 8-track (4-way head cleaner kit & demagnetizer) $2.55

MAXELL

Ultra-Dynamic Cassettes (High Bias)

UDC-46, 23 min/side $3.05
UDC-60, 30 min/side $3.50
UDC-90, 45 min/side $4.99
UDC-120, 60 min/side $6.80

Low-Noise Cassettes (Normal Bias)

LNC-30, 15 min/side $1.99
LNC-60, 30 min/side $2.29
LNC-90, 45 min/side $3.50
LNC-120, 60 min/side $4.70

Low-Noise Tape (Normal Bias)

1.5-mil polyester
LNE-50-7, 1200 ft., 7" reel $6.88
LNE-50-10R, 2500 ft., 10½" reel ... $15.20
1-mil polyester
LNE-35-7, 1800 ft., 7" reel $8.25
LNE-35-10R, 3600 ft., 10½" reel ... $20.00
0.5-mil polyester
LNE-25-7, 2400 ft., 7" reel $11.70
0.5-mil polyester
LNE-18-7, 3600 ft., 7" reel $14.40

Back-Treated Extended-Range

Back-treated, ultra-dynamic, high-energy, high-bias type..
1.5-mil polyester
UD50-60B, 1200 ft, 7" reel. $9.20
UD50-120B, 2500 ft, 10½" reel. $26.20
1-mil polyester
UD35-90B, 1800 ft, 7" reel. $11.35
UD35-180B, 3600 ft, 10½" reel. $31.00

Extended-Range Tape (High Bias)

Ultra-dynamic, high-energy type.
1.5-mil polyester
UD50-7, 1200 ft., 7" reel $7.65
UD50-10R, 2500 ft., 10½" reel $20.40
1-mil polyester
UD35-7, 1800 ft., 7" reel $8.70
UD35-10R, 3600 ft., 10½" reel $21.90

8-Track Cartridges (Normal Bias)

8T-200, 40 minutes $2.85
8T-300, 60 minutes $3.25
8T-400, 80 minutes $3.45

MEMOREX

Low-Noise, High-Output Tape

Standard play. 1.5-mil polyester, ¼"
600 ft, 5" reel $2.99
1200 ft, 7" reel $5.29
2500 ft, 10½" reel $12.99
Long-play, 1-mil polyester, ¼"
900 ft, 5" reel $3.89
1800 ft, 7" reel $6.39
3600 ft, 10½" reel $15.99
Double-play, tensilized polyester, ¼".
1200 ft, 5" reel $5.29
2400 ft, 7" reel $8.69

MRX₂ Oxide Cassettes

C-30. 15 min/side $1.89
C-45. 22½ min/side $2.09

C-60. 30 min/side $2.29
C-90. 45 min/side $3.39
C-120. 60 min/side $4.59

Chromium-Dioxide Cassettes

C-45. 22½ min/side $2.79
C-60. 30 min/side $2.99
C-90. 45 min/side $4.49

8-Track Cartridges

45 min $2.59
60 min $2.79
90 min $2.99

Accessories

Library (6 empty cassette albums) .. $3.59
8-track head cleaner $1.79
Cassette head cleaner $1.79
Empty 7" album $1.79

MERITON

Ferri-Chrome Cassette

FeCr C-60. 31 min./side $3.79

Chromium-Dioxide Cassette

CrO_2 C-60. 31 min./side $3.19

Low-Noise, High-Output Cassettes

LH C-60. 31 min./side $2.49
LH C-90. 46 min./side $3.59

Low-Noise Cassettes

LN C-60. 31 min./side $1.49
LN C-90. 46 min./side $2.29
LN C-120. 61 min./side $3.49

NAKAMICHI

"EX" Cassette Tapes

Specially formulated ferrocrystal tape for improved frequency response, S/N ratio, and dynamic range; special binder for even particle distribution and reduced head wear.

C-60 ..... $3.69
C-90 ..... $4.79

Chrome Cassette Tapes

Chromium-dioxide tape for improved frequency response, S/N ratio, and extended high-frequency output.

C-60 ..... $4.59
C-90 ..... $5.99

PAGEANT/MILLER

8-Track Cartridges

PTB-835. 35 min $2.98
PTB-840. 40 min $3.25
PTB-870. 70 min $3.95
PTB-880. 80 min $4.50

SCOTCH

Cassettes

High Energy
Features "High Energy" tape for quality sound; fully compatible with all cassette recorders. Has "Posi-Trak" back treatment. Album package.

45 min $3.10
60 min $3.75
90 min $5.60

Low-Noise/High-Density
Multi-purpose cassette featuring full dynamic range throughout the audible sound spectrum. "Posi-Trak" back treatment. Album package.

45 min $2.50
60 min $3.00
90 min $4.50
120 min $6.00

Highlander/Low-Noise
For all-purpose cassette use. Polyester base.

45 min $1.60
60 min $1.85
90 min $2.85
120 min $4.35

"Classic" Cassettes

Features layers of chromium-dioxide and low-noise ferric-oxide to produce high-frequency performance equal to "chrome," but an additional 5 dB increase over CrO_2 in low-frequency range; fully compatible with all recorders; "Posi-Trak" back treatment. Album package.

45 min $3.75
60 min $4.35
90 min $6.25

Chrome Cassettes

Features chromium-dioxide tape for extended high-frequency range; designed specifically for tape decks equipped to handle CrO_2; "Posi-Trak" back treatment. Album.

45 min $3.10
60 min $3.75
90 min $5.60
120 min $7.50

Open-Reel Tapes

High-Output/Low-Noise
Provides 50% increase in signal output and additional 3 dB in dynamic range over conventional low-noise tapes.

No. 206. Polyester base, "Posi-Trak" backing, leader, and trailer. 1.5-mil. 60 min at 7½ ips; 7" reel $7.50
2 hrs (2400') at 7½ ips, 10½" reel ... $20.00
No. 207. Polyester base, "Posi-Trak" backing, leader, and trailer, 1-mil. 90 min at 7½ ips; 7" reel $9.35
3 hrs (3600') at 7½ ips, 10½" reel ... $23.75

Low-Noise/Dynarange
Provides high-fidelity recording even at 3¾ ips. Multi-purpose tape providing full dynamic range throughout audible spectrum. S/N is 4 to 6 dB better than standard tapes.

No. 211. Polyester backing, white yellow trailers. 1.5-mil. 30 min at 7½ ips (5" reel); 60 min (7" reel). 30 min $3.75
60 min $5.60
2 hrs (2400') at 7½ ips, 10½" reel ... $17.50
No. 212. 1.0-mil. 45 min at 7½ ips (5" reel); $4.35
90 min (7" reel) $7.50
3 hrs (3600') at 7½ ips, 10½" reel ... $21.25
No. 213. 0.5-mil tensilized. 120 min at 7½ ips (7" reel) $11.25
4 hrs (4800') at 7½ ips, 10½" reel ... $32.50
No. 214. 0.5-mil tensilized. 90 min at 7½ ips (5" reel); $7.50
180 min (7" reel) $15.00

Highlander/Low-Noise
All-purpose economy tape for vocals as well as speech.

No. 228. 1-5 mil. 60 min at 7½ ips (7" reel) $4.35
No. 229. 1-mil. 90 min at 7½ ips (7" reel) $6.25

"Classic" Open-Reel Tapes

High-frequency performance 3 dB higher than No. 206-207; S/N 8 dB higher than standard recording tape; polyester base; "Posi-Trak" backing; leader, trailer. Padded book-style box.

CL.7R60. 1.5-mil, 60 min. at 7½ ips (7" reel) $9.95
CL-7R90. 1.0-mil, 90 min. at 7½ ips (7" reel) $12.45
CL-7R120. 0.5-mil, 120 min. at 7½ ips (7" reel) $16.20
CL-10R120. 1.5-mil, 120 min. at 7½ ips (10" reel) $23.70
CL-10R180. 1.0-mil, 180 min at 7½ ips (10" reel) $28.70
CL-10R240. 0.5-mil, 240 min at 7½ ips (10" reel) $37.45

"Classic" 8-Track Cartridges

Features special low-noise ferric-oxide coating for high-frequency sensitivity of 7 dB higher;

S/N at low frequencies 6 dB higher than standard cartridges; fully compatible, oxide coating heavy-duty lubricated polyester backing.

8TR-45. 45 min $3.75
8TR-90. 90 min $5.00

8-Track Cartridges

Features low-noise oxide coating on heavy-duty lubricated polyester backing.

High-Output/Low-Noise
Full 2-dB increase in output over premium tapes. Captures full balanced sound.

8TR-45 HO/LN. 45 min $3.75
8TR-90 HO/LN. 90 min $4.35

Low-Noise/Dynarange
All-purpose cartridge

8TR-45. 45 min $3.10
8TR-90. 90 min $4.35

SONY from SUPERSCOPE

Professional Recording Tape

Extra-heavy-formula Oxi-coat homogenized oxide coating; polyester back, "lubri-cushion" impregnated lubricant.

PR-150-3. 300 ft, 3¼" reel, 1 mil $1.99
PR-150-9. 900 ft, 5" reel, 1 mil $3.49
PR-150-18. 1800 ft, 7" reel, 1 mil $4.99
PR-150-36. 3600 ft, 7" reel, 1 mil ... $14.95

Low-Noise, High-Output Tape

On 1-mil polyester base.

SLH-180-18. 1800 ft, 7" reel $6.49
SLH-180-36. 3600 ft, 7" reel $19.95

Auto-Sensor Cassette Tape

C-45 Plus 2. 23 min/side $1.59
C-60 Plus 2. 31 min/side $1.69
C-90 Plus 2. 46 min/side $2.49
C-120 Plus 2.61 min/side $3.69

Ultra-High-Fidelity Cassette Tape

With Auto-Sensor

8 Blank Tape

UHFC-60 Plus 2.31 min/side $2.69
UHFC-90 Plus 2.46 min/side $3.79
UHFC-120 Plus 2. 61 min/side $4.99

Chromium-Dioxide Cassettes

CRO-60. 60 min $3.29
CRO-90. 90 min $4.29

Ferri-Chrome Cassettes

FeCr-60 Plus 2. 31 min/side..... $3.99

8-Track Cartridges

8T-40 Plus 2. 21 min/side $3.49
8T-60 Plus 2. 31 min/side $3.99
8T-80 Plus 2. 41 min/side $4.49

Empty Tape Reels

Computer-styled tape reels, with box.
MTRB-7. 7" $1.29
MTRB-5. 5" $0.99
MTRB-3. 3¼" $0.69

SOUNDCRAFT

Cassette Tapes

2SR-80130. 30 min..... $0.79
2SR-80140. 40 min..... $0.89
2SR-80160. 60 min..... $1.39
2SR-80190. 90 min..... $1.69
2SR-80112. 120 min..... $1.99
2SR-801HC. Head cleaner..... $1.39

8-Track Tapes

8SR-80340. 40 min..... $1.69
8SR-80380. 80 min..... $1.99
8SR-803HC. Head cleaner..... $1.29

Open-Reel Tapes

4SR-80512. 7" × 1200 ft..... $2.79
4SR-80518. 7" × 1800 ft..... $3.58
4SR-80524. 7" × 2400 ft..... $4.79
4SR-80536. 7" × 3600 ft..... $6.64

TDK

"Extra Dynamic" Cassettes

Exclusive "stagnetite" coating for highest MOL (maximum output level), wide dynamic range,

high S/N. Response 20-23,000 Hz. Includes new 45-min. "record-album-length." Polyester base.
ED-C45, 45 min $3.35
ED-C60, 60 min $3.75
ED-C90, 90 min $5.60

"Super Dynamic" Cassettes

High-performance gamma ferric oxide for wide dynamic range, low-noise, and distortion-free output. Response 30-20,000 Hz. Polyester back.
SD-C45, 45 min $2.75
SD-C60, 60 min $3.00
SD-C90, 90 min $4.50
SD-C120, 120 min $6.00

"Dynamic" Cassettes

Features company's new M-400 gamma ferric-oxide coating. Includes new 3-hour "4-record-album-length" cassette plus new single-album-length cassette. Polyester back.
D-C45, 45 min $2.25
D-C60, 60 min $2.50
D-C90, 90 min $3.75
D-C120, 120 min $5.00
D-C180, 180 min $6.85

"Krom" Chromium-Dioxide Cassettes

Outstanding linearity at very high frequencies. Use on machines with CrO_2 bias. Polyester back. Packed in plastic boxes.
KR-C60, 60 min $3.75
KR-C90, 90 min $5.60

"Endless" Cassettes

Endless-loop design with safety feature against accidental reversal. Usable in conventional cassette machines. Polyester backing. Packaged in plastic boxes.
EC-20S, 20 sec $5.00
EC-30S, 30 sec $5.00
EC-1,1 min $5.00
EC-3, 3 min $5.25
EC-6, 6 min $5.75
EC-12, 12 min $6.85

Head Cleaner Cassette

Chromium trioxide removes deposits, laps and polishes pitted heads. Unique check-off chart on box keeps record of cleaner life.
HC-1 ..... $1.50

"Super Dynamic" 8-Track Cartridges

Full-fidelity 8-track cartridges with gamma ferric oxide. Response 20-23,000 Hz. High saturation and output level (MOL). Has broad dynamic range, high S/N, and minimum distortion.
8TR-40SD, 40 min $3.75
8TR-80SD, 80 min $5.00

"Audua" Open-Reel Tape

High-density ferric-oxide coating for high output, low noise, stability and durability.
L1200. 1200 ft, 7" low-torque reel ... $8.00
L-1800. 1800 ft, 7" reel..... $10.50
L-3600 3600 ft, 10½" NAB reel $31.50

8 Accessories

ADVENT

MPR-1 Microphone Preamplifier

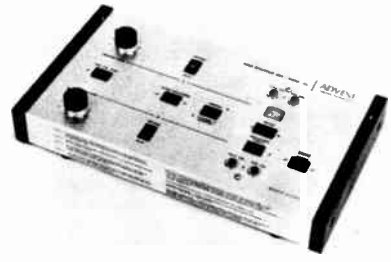
For use with low-impedance balanced or unbalanced microphones. Switchable gain for either 40 or 60 dB. Operated by power supply of Advent 201 cassette deck. 5¾" × 2¾" × 1" D $34.95

100A Dolby System

Noise-reduction unit with Dolby system for home tape recording/playback. Also plays Dolby-encoded pre-recorded commercial tapes and FM broadcasts. Provides four-input mixing (two on each channel), headphone monitoring, and sound-on-sound recording. Harmonic and IM distortion 0.1%. 5" × 12⅞" × 8¾" D. Cabinet extra..... $300.00

101 Dolby System

Similar in principle to Model 100A, but can only be used in record or playback mode (uses same



circuitry), but not simultaneously for two operational modes. $150.00

SEE SECTION 4 FOR 4-CHANNEL

AUDIOTEX

The company carries a complete line of tape accessories for use with open-reel, cassette, and 8-track equipment.
30-2150. Cleaning pen for tape heads $1.95
30-126. Kleentape for open-reel recorder heads $2.25
30-026. Tape cleaning cloth $0.90
30-129. Tape Care Kit, Jr. contains head cleaner, cotton swabs, and cleaning cloth $1.60
30-630. "Blast-off" tape head cleaner, 3-oz. aerosol can $1.95
30-128. Same except in 6-oz aerosol can $2.75
30-124-1. Recording head cleaner, 2-oz bottle $1.00
30-124-2. Recording head lubricant, 2-oz bottle $1.00
30-636. Tape player care kit contains cleaner and head lubricant, two 6" brushes, 10 plastic pouches to protect tape reels, cassettes, or cartridges..... $3.25

BSR-ELECTRONICS

FEW-3 Frequency Equalizer

Stereo frequency equalizer provides 12 zones

of control for each channel. Has two VU meters, defeat switch, and switch back control for both playback and recording. Distortion 0.007%. $199.95

FEW-2 Frequency Equalizer

Two-channel, five-zone per channel, frequency equalizer. Response: flat setting 5-100,000 Hz ±1 dB; tone control range ±12 dB at 60, 240, 1000, 3500, and 10,000 Hz. IM dist. 0.05% at 2 V output; HD 0.05% at 2 V output (20-20,000 Hz); max. output 9 V $99.95
FEW-4. Similar to FEW-2 but 4-channel version $199.95

BURWEN

DNF 1201 Dynamic Noise Filter

Will work on any 2-channel or matrix encoded source; provides 14 dB noise reduction; does not require pre-encoding. Push-button controls to select proper mode of noise reduction: Phono position for any 33 or 45 record played directly or recorded on FM; Phono 78 is for 78 rpm discs; Tape/FM is for cassette, open-reel, cartridge, or FM broadcasts. Includes sensitivity control. Frequency response (minimum bandwidth) −3 dB at 500 Hz, −10 dB at 1000 Hz, −20 dB at 2500 Hz; (maximum bandwidth) ±0.5 dB max. 10-20,000 Hz. HD 0.2% max. 20-10,000 Hz at 3 V input, sensitivity max.; 0.0 dB gain at 1 kHz, adjustable via rear-panel controls; internal noise 100 μV rms 20-20,000 Hz. Has six phono pin jacks, extra parallel input jacks for connection to tape deck. 11⅜" W × 3¾" H × 8⅞" D. 115 V ±10%, 50-60 Hz (8 W, 230 V version available)..... $299.95

CHEMTRONICS

Tape Head Cleaner

Aerosol cleaner formulated for cassette, reel-to-reel, and 8-track recorders and players. Removes dirt, film, and oxides from heads, tape

guides, capstan rollers, and other critical parts. Furnished with spray extender for pinpoint application. #THC-6 ..... $2.65
504-3. Same except 2-oz. bottle with special felt applicator $1.70
THC-4 Same, except 4-oz. spray can ... $1.95

Non-Slip Drive/Belt Restorer
Restores hardened and glazed rubber drives and belts. Fast drying. Prevents slippage and insures uniform speed. 2 ounces. #507-7. $1.75

Cassette Head Cleaner
Non-abrasive buffing tape. Cleans graphite deposits from tape head. To be used the same as regular cartridge. #CHC $1.98

Cassette Maintenance Kit
Performs double cleaning function of tape head and capstan shaft cleaner. Uses special cleaning liquid applied directly to non-abrasive buffing tape. #CHC-Kit $2.98

8-Track Head Cleaner
Cleans graphite deposits from tape heads with gentle wiping action. In use it is inserted in tape player and run for 30 seconds for every 50 hours of operation. #TR-8 ..... $1.98

8-Track Maintenance Kit
Cleans player head and capstan shaft with special cleaning liquid applied to tape. Prepared cartridge is inserted in player and job is done in seconds. Designed to be used weekly. #TR-8 Kit $3.05

Cassette Test Cartridge
Three-in-one action tests & cleans; removes iron oxide deposits from heads; provides crosstalk test for proper head alignment; equalization test for optimum response. #C-3.... $2.69

8-Track Test Cartridge
Three-in-one action tests & cleans; removes iron oxide deposits from heads; provides crosstalk test for head alignment; equalization test for optimum response. #8T-3..... $2.69

8-Track Head/Capstan Cleaner
Removes ferrite deposits from head and capstan shaft; prevents build-up; designed to be used after every 40 hours of play; double-head cleaner works without chemicals, one side for head, one for capstan. #DH-8..... $3.49

dbx

117 Dynamic Range Enhancer
A compressor/expander that permits listener to restore up to 20 dB of the dynamic range missing from records, tapes, or FM broadcasts. As a classical compressor/expander, allows the recordist to make full dynamic range tapes on moderately priced recorders and obtain 20 dB or more improvement (S + N)/N..... $175.00
119. Same features as 117, plus peak limiting/

unlimiting above user-selected threshold; LED indicator light..... $198.00

120 Series Noise Reduction Systems
Provides 30 dB noise reduction and 10 dB additional headroom when recording with open-reel, cartridge, or cassette recorders; eliminates tape hiss and noise in live recording; prevents additional noise build-up in tape duplicating or recording off-the-air; also decodes dbx encoded discs.

Model 122. Two-channel switchable record or play..... $259.00
Model 124. Four-channel switchable record or play..... $379.00

150 Series Noise Reduction Systems
Allows recordists to make noise-reduced tapes to studio standards on better-grade audiophile recorders. Fully compatible with company's studio professional models but with single-ended inputs/outputs and RCA-type phono connectors to facilitate connections to audiophile recorders, amplifiers, etc. Provides 30 dB noise reduction with 10 dB more headroom. Extruded aluminum and solid walnut cabinet. 3½" H × 9" W × 10½" D.
Model 157. Two-channel simultaneous record and play..... $600.00
Model 152. Two-channel switchable record or play..... $475.00
Model 154. Four-channel switchable record or play (may also be used as two-channel simultaneous record and play)..... $750.00

EDITALL

KP-2 Editing Kit
Complete kit includes splicing block, 30 splicing tapes, demagnetized razor blade, and grease pencil for ¼" audio tape $4.50

KS-2 Editing Kit
For ¼" tape, includes a 4" × ¾" × 1¼" block, marking pencil, roll of splicing tape, and cutting blade $11.50

KS-3 Editing Kit
Same as KS-2 except includes larger block (5¾" × 1" × ⅜") $13.50

FERROGRAPH

RTS-2 Recorder Test Set
Will test wow & flutter, frequency response, (S + N)/N ratio, gain, distortion, crosstalk, erasure, input sensitivity, output power, and drift. Input required 35 mV to 5 V. Has output for oscilloscope. 17⅜" × 10" × 5⅝" H..... $1500.00

JVC

SEA-10 Sound Effects Amplifier
Five-zone sound-effects amplifier/equalizer circuit, switchable to 40, 60, 250, 1000, 5000, 10,000 and 15,000 Hz. Permits sound equalization during recording as well as playback. 5¼" × 7½" × 10" D..... $129.95

NR-1020 ANRS Noise-Reduction Unit
Automatic noise-reduction unit for use with reel-to-reel, cassette, and cartridge tape decks. Improves (S + N)/N by 5 dB at 1000 Hz and 10 dB at 10,000 Hz. Includes built-in 400-Hz oscillator, two meters, two recording-level and two playback-level controls, reel-to-reel and cassette calibration tapes. 3⅝" × 13⅛" × 7½"D $149.95

LAFAYETTE

Bulk Tape Eraser
Tape degausser for erasing ¼" tapes or smaller and demagnetizing tape, magnetically striped film, tools, and watches. Hand-held custom-finished plastic case, "on-off" switch, power cord. $12.95

Tape Head Demagnetizer
Pencil-shaped with one extending probe which allows for reaching all heads in all positions. With "on-off" switch..... $3.99

Telephone Pickup Coil
Designed to feed into the microphone input of tape recorder of any high-gain amplifier. Easily fastened to the telephone by rubber suction-type attachment. Has 4¼-ft shielded cable with ⅛" miniature plug..... $1.39

DNR-50 Noise-Reduction Unit
Can be used with any tape deck or self-contained tape recorder having audio inputs and outputs. Increases S/N 10 dB at 10,000 Hz; 5 dB at 1 kHz. Has built-in Dolby reference meter with three-position function switch; separate slide lever record level controls, play/record push-button switch. Response 20-15,000 Hz ±2 dB. Must be used with separate Dolby calibration tape. 9" × 7⅜" × 3⅛"..... $89.95
Dolby cassette calibration tape..... $5.79
Dolby reel calibration tape..... $4.95
Dolby 8-track calibration tape..... $4.95

LAMB

PML422 Mixer
Four-channel input; stereo or mono output with provision for 4-ch output upon interconnection of a second unit; individual faders for each channel; separate high-, medium-, and low-frequency equalization; two-channel & four-channel; pan pots & echo send controls; group faders for each output channel; limiters with adjustable threshold and release; two VU meters monitor output; Cannon XLR input termination; jack sockets at outputs..... $675.00

MAGNESONICS

Erase-Sure Tape Eraser
Will erase a cassette or 8-track cartridge to –65 dB from 0 reference. Battery operated (four "A" cells, included). 4" × 3½" × 2¾.... $19.95

MURA

A-10 Stereo Volume Control
Stereo/mono switch enables headset to be used with radio, TV, electronic organ, or other mono program sources. Features electronic slide controls and 15-ft extension cord..... $7.50

NAKAMICHI

Head Demagnetizer
Slim-line, easy-to-use recorder head demagnetizer, specially designed for the company's Models 1000 and 700 cassette decks.. $15.80

NORTRONICS

5600 Quadrasonic Record/Play Heads
Four-track, four-channel, laminated core heads with all-metal hyperbolic face construction. #5601. Special record-only head, low imp., 50 mH, 500 μin gap spacer. For use with vacuum-tube or transistor circuits. No-mount type $109.95
#5602. Low imp., 90 mH, 100 μin gap spacer. For use with vacuum-tube or transistor circuits. No-mount type..... $109.95
#5603. Medium imp., 370 mH. 100 μin gap spacer. For use with vacuum-tube or transistor circuits. No-mount type..... $109.95

8 Accessories

Replacement Tape Heads
Replacement heads are available for 4100 models of recorders. Universal head #5800 for 8-track players; #5130 and#5230 for cassette recorders.
8-Track $12.00
2-track mono cassette $21.60
4-track stereo cassette $20.60

The company has prepared a 31-page "Recorder Care Manual" which is available without charge from local Nortronics distributors.

PANASONIC

RP-966 Outboard Dolby Unit
Has built-in oscillator for proper recording level meter, Dolby level meter for proper Dolby level adjustment, recording level control for matching program source levels to tape deck levels, and Dolby for FM broadcasts in both playback and record $69.95

PIONEER

SR-202W Reverberation Amp
Double-scatter system blends direct signals from source with reverb effect. Reverb time 0-2.5 seconds at 1 kHz. HD less than 0.2% at 1 kHz reverb time. Minimum output level 330 mV. Response 20-35,000 Hz ±2 dB (min. reverb time) and 20-50,000 Hz ±10 dB (max. reverb time). (S + N)/N 65 dB at 330 mV output. Universal power supply $139.95

SD-1100 Stereo Display
Designed for measurement and scoping of all audio components and stereo characteristics. Will show any waveform and measure voltage level and phase shift. Has built-in audio oscillator 20-20,000 Hz with automatic or manual sweep. Can also be used for 4-channel analysis. With universal power supply..... $599.95

MA-62 6-Channel Mixing Amp
Has input facilities for up to six mikes; each channel has alternative terminal for line or phono inputs; two channels equipped with pan pots; four with location switches; mike attenuators for each channel; low-cut filters for mike input; portable design; has two stereo output terminals; pointer-index markers for each of the six long-throw faders (plus master volume faders). 15¾" W × 5 3/16" H × 10⅜" D... $249.95

ROBINS

Cassette Head Demagnetizer
Removes excessive magnetic build-up. Designed to be used every 15-20 hours of player/recorder use. 110 V, 50-60 Hz operation. #TD-10 ..... $10.00

Test/Clean Cassette
Performs three functions to help maintain optimum recorder/player performance: cleans heads, tests for correct head alignment, and tests stereo balance equalization between channels. #THC-6 ..... $2.95

Bulk Tape Eraser
Erases cassettes, cartridges, open-reel, and magnetic-striped film; has momentary contact switch; reduces background noise levels below normal erase-head levels; 110-120 V a.c. #24017 ..... $26.00

Head Demagnetizer
Reduces residual magnetism which causes noise build-up; interchangeable tips accommodate all open-reel, cassette, and cartridge equipment; built-in switch; 110-120 V a.c. #25011 ..... $15.00

Cassette Maintenance Kit
Demagnetizes tape heads of home and auto cassette players/recorders; employs rotary magnet; includes non-abrasive head-cleaning tape; designed to be used after every 15-20 hours of player/recorder use; cordless. #36008 ..... $6.50

RUSSOUND

TMS-1W Tape Recorder Selector
Allows up to three tape recorders or other signal sources to be interfaced through the tape input/output of a single receiver or amplifier. Record or play any or all, at the same time, in any combination. Use for tape duplicating, editing, mixing, program production. Also interconnects graphic equalizers, Dolby and dbx devices, sound-effects generators, echo chambers, delay lines, and synthesizers. Walnut cabinet..... $34.95
TMS-1. Same but in utility steel cabinet. $29.95

SAE

Mark XXVII Octave Equalizer
Dual-control active equalizer for altering frequency response, octave-by-octave, of a stereo sound system; has 22 frequency level controls; 22 toroidal bandpass filters; level control range of ±16 or ±8 dB; zero dB center detent position; EQ defeat switch; tape monitor switch; frequency response 20-20,000 Hz ±0.25%, 3 dB down to 600,000 Hz; HD 0.05% at rated output 2.5 V rms (20-20,000 Hz); IM 60 & 7000 Hz 4/1; 60 & 12,000 Hz 4/1; 60 & 2000 Hz 4/1 less than 0.05%; S/N 90 dB; max. output 7 V into high imp.; input imp. 10,000 ohms; equalizer control range 40, 80, 160, 320, 640, 1280, 2500, 10,000, 15,000 & 20,000 Hz. 17" W × 7" D × 8¾" H..... $550.00
Walnut cabinet available optional extra.
Rack panel (19") version with 600 ohm output impedance available at extra cost.

SCOTT INSTRUMENT

451C Sound-Level Meter
Features "C" weighting for flat response; measures sound levels from 45 dB (below background noise level for most rooms) up to 130 dB; useful for balancing output of stereo or 4-channel systems, setting A-B levels of speakers; reads out directly in dBC; momentary "on" switch conserves battery life; uses 9-V transistor radio-type battery. Meets or exceeds ANSI standards..... $115.00

SHURE

SA-1 "Solo-Phone"
Stereo amplifier for headphones. Permits two sets of phones to be used simultaneously. Has balance control, dual input for tape/tuner or phono. Inputs: phono 47,000 ohms equalized for magnetic cartridge, tuner 250,000 ohms. Output 8 ohms, 100 mV. 10¼" × 3½" × 3⅞" D $33.33
Model SA-1F. Same as SA-1 except panel-mounting version..... $39.33

M68 Microphone Mixer
Five channels. A transistorized portable mixer for p.a. and tape recorders. Has four mike inputs for high- or low-impedance microphones, one high-level auxiliary input for tape, tuner & accessories, individual volume control to balance each of five inputs, and a master volume control to simultaneously control level of all inputs. Has high-impedance mike and auxiliary outputs. 105-130 V, 50/60 Hz $93.60

M67 Microphone Mixer
Four low-impedance balanced mike inputs & one line input. Has built-in tone oscillator for calibration. Response 20-20,000 Hz ±2 dB. Has automatic switchover to battery if power fails. Gain 90 dB max. (150-ohm mike into 600-ohm line). Battery power supply $25.00 extra. 11⅜" × 7½" × 2½" $181.20

SIGNAL SCIENCE

WS-10 Ultrasonic Control
Wireless, remote control for switching TV and audio equipment on or off; receiver plugs into 110-V outlet and controlled equipment plugs into receiver outlet; remote control is a soft rubber bulb which activates receiver. 2½" W × 4¼" H × 2" D (plug-in unit); 1½" dia. × 4" long (transmitter)..... $18.95
WS-20. Same as WS-10 but transmitter is hand-held and push-button operated; 1¾" W × 4¾" L × 2" D..... $19.95

SONY from SUPERSCOPE

MX-14 Stereo/Mono Mixer
Active six-channel mixer for mixing down six channels of input into two of output. Operates on 8 "C" cells. Straight-line volume controls for each input. Has reference tabs and two VU meters..... $229.95

NR-115 Dolby Adapter
Designed to be used with any two- or three-head open reel, cassette, or 8-track cartridge tape recorder. Has line-input facility; built-in 400-Hz oscillator for input/output balancing; record/playback mode switch; illuminated meter with right/left channel switching; two playback semi-fixed controls; and two input level controls. $129.95

NR-335 Dual-Process Dolby Adapter
Specifically designed for three-head machines. Permits simultaneous operation in both record and playback modes. Features built-in headphone jack; two mike input jacks; two professional VU meters; a two-position mike attenuator switch; tape/source monitor switch. Has built-in 19-kHz filter switch; two playback volume controls, two record-level controls; built-in 400-Hz oscillator for input/output balancing $299.95

SOUNDCRAFTSMEN

RP2212 Record/Playback Equalizer
Stereo audio frequency equalizer using four LED's to provide front-panel display for balancing input-to-output signal ratios; plugs into any receiver or preamp with tape monitor inputs and outputs; includes tape monitor inputs and outputs with push-button selection for tape monitor, equalized or unequalized output for speakers/room equalization, or equalized tape recording separate outputs for tape recorder and amplifier hookup; features two separate ten-octave equalization panels with plus or minus 12 dB boost & cut; separate equalized signal zero-gain controls. Walnut vinyl case. $349.50

PE2217 Preamp-Equalizer
Provides continuous visual monitoring of input-to-output balance as well as overload warning using LED's; discrete ten-octave equalizers for each channel; push-button patching for control flexibility with interlocked push-buttons to prevent inadvertent program destruction; has 39 separate front-panel control functions permitting simultaneous tape-dubbing into two recorders with output equalized or unequalized while monitoring either input or output; full-spectrum gain controls for each channel; automatic equalizer-defeat when line or tape equali-

zation is not in use; six a.c. outlets; dual outputs for scope, bi-amp, 4-ch hookup, or other special applications; response 5-100,000 Hz ±0.25 dB; THD & IM 0.01%. Walnut grained cabinet. 7¼" × 20" × 11¼" $499.50

SWITCHCRAFT

"Mini-Mix" Mike Mixer
Has two high-impedance inputs each with own level control; single output available with variety of connectors. 2" × 1¾" × 1" ... $10.45

306 Stereo Mike Mixer
Stereo/mono mixer; will handle four sound sources (mikes, electric instruments, etc.); through one amplifier; accepts up to two high-impedance inputs in stereo mode, four high-impedance inputs in mono mode. 2" H × 6 W × 3" D $29.00

306TR. Same as 306 except has two built-in transistorized amplifiers. $49.00
301. Similar to 306 except mono; mixes four mono sound sources. $27.00
301TR. Same as 301 except has one built-in transistorized amplifier. $39.00

308TR Mixer/Preamp
Individual controls for four inputs; master output gain control; mono/stereo and phono equalization switches on back panel; a.c. powered. $190.00

676 Listening Station
Compact audio junction box that provides four auxiliary outputs for multiple headphone use; has four 2-conductor phone jacks wired in parallel, two side-panel grommets for multiple wiring. $4.90
The company also carries a comprehensive line of adapters, interconnect cables, and audio accessory kits.

TEAC

AN-180 Outboard Dolby System
Record/playback control center with Dolby noise-reduction system. Recording section contains microphone & line preamps plus Dolby recording circuitry. Playback section has playback line preamps & Dolby playback circuitry. Can be used with any good tape deck. Has separate input level controls for mike and line inputs for each stereo channel, two VU meters, internal test-tone oscillator, Dolby level standard tapes, source/tape monitor switch. A multiplex filter prevents recording interference from pilot tone frequencies or unsuppressed multiplex carrier by the FM tuner $329.50

AN-80 Outboard Dolby System
Less elaborate version of AN-180. Input mixing feature omitted and only one Dolby circuit per

Directory Of Manufacturers

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PANASONIC, Matsushita Electric Corp. of America 82, 87, 90, 99, 101, 120
200 Park Ave., New York, N.Y. 10017

PICKERING & CO., INC. 105
101 Sunnyside Blvd., Plainview, N.Y. 11803

PIONEER, U.S. Pioneer Electronics Corp. 76, 82, 91, 94, 105, 112, 120
75 Oxford Dr., Moonachie, N.J. 07074

PIONEER ELECTRONICS OF AMERICA 99
1555 E. Del Amo Blvd., Carson, Calif. 90746

PML, Hervic Electronics, Inc. 112
1508 Cotner Ave., Los Angeles, Calif. 90025

RADIO SHACK, Div. of Tandy Corp. 76, 83, 87, 91, 94, 99, 102, 106, 112
2615 W. 7th St., Fort Worth, Tex. 76107

RCA CORP., Parts and Accessories 100
2000 Clements Bridge Rd., Deptford, N.J. 08096

REVOX CORPORATION 77, 112
155 Michael Dr., Syosset, N.Y. 11791

ROBINS INDUSTRIES CORP. 120
75 Austin Blvd., Commack, N.Y. 11725

RUSSOUND/FMP, INC. 120
Foot of Canal St., North Berwick, Maine 03906

SAE, Scientific Audio Electronics, Inc. 120
P.O. Box 60271 Terminal Annex, Los Angeles, Calif. 90060

SANSUI ELECTRONICS CORP. 83, 91
55-11 Queens Blvd., Woodside, N.Y. 11377

SANYO ELECTRIC INC. 83, 91, 100, 102
1200 W. Artesia Blvd., Compton, Calif. 90220

SCINTREX, INC. 94, 106
400 Creekside Dr., Tonawanda, N.Y. 14150

SCOTCH, 3M Co. Magnetic Products Div. 117
3M Center, St. Paul, Minn. 55101

SCOTT INSTRUMENT LABORATORIES 120
30 Cross St., Cambridge, Mass. 02139

SENNHEISER ELECTRONIC CORP. 106, 112
10 W. 37th St., New York, N.Y. 10018

SHURE BROTHERS, INC. 113, 120
222 Hartrey Ave., Evanston, Ill. 60204

SIGNAL SCIENCE, INC. 120
140 Lowland St., Holliston, Mass. 01746

SONY CORP. OF AMERICA 95, 102
9 W. 57th St., New York, N.Y. 10019

SONY FROM SUPERSCOPE, Superscope, Inc. 77, 83, 87, 92, 100, 103, 113, 117, 120
8150 Vineland Ave., Sun Valley, Calif. 91352

SOUNDCRAFT, Columbia Magnetics, CBS, Inc. 118
51 W. 52nd St., New York, N.Y. 10019

SOUNDCRAFTSMEN 120
P.O. Box 2361, Santa Ana, Calif. 92707

STANTON MAGNETICS, INC. 94, 106
Terminal Dr., Plainview, N.Y. 11803

SUPEREX ELECTRONICS CORP. 94, 106
151 Ludlow St., Yonkers, N.Y. 10705

SUPERSCOPE INC. 84, 88, 92, 103
8150 Vineland Ave., Sun Valley, Calif. 91352

SWITCHCRAFT INC. 121
5555 N. Elston Ave., Chicago, Ill. 60630

SYLVANIA INCORPORATED, Entertainment Products Group 88, 92, 107
700 Ellicott St., Batavia, N.Y. 14020

TANDBERG OF AMERICA INC. 78, 84
Labriola Court, Armonk, N.Y. 10504

TDK ELECTRONICS CORP. 118
755 Eastgate Blvd., Garden City, N.Y. 11530

TEAC CORPORATION OF AMERICA 78, 84, 92, 95, 100, 107, 113, 121
7733 Telegraph Rd., Montebello, Calif. 90640

TECHNICS BY PANASONIC, Matsushita Electric Corp. of America 85, 93, 94, 107, 114
200 Park Ave., New York, N.Y. 10017

TELEPHONICS, Div. of ISC 94, 107
770 Park Ave., Huntington, N.Y. 11743

TELEX COMMUNICATIONS, INC. 79, 88, 107
9600 Aldrich Ave. S., Minneapolis, Minn. 55420

TOSHIBA AMERICA, INC. 79, 85, 88, 93, 95, 103, 107
280 Park Ave., New York, N.Y. 10017

TURNER DIVISION, Conrac Corporation 114
909 17th St. N.E., Cedar Rapids, Iowa 52402

UHER OF AMERICA INC. 79, 85, 122
621 S. Hindry Ave., Inglewood, Calif. 90301

UNIVERSITY SOUND, Altec Sound Products Div. 114
9500 W. Reno, Oklahoma City, Okla. 73126

WOLLENSAK, 3M Co. 85, 88, 93
3M Center, St. Paul, Minn. 55101

YAMAHA INTERNATIONAL CORP. 85
Box 6600, Buena Park, Calif. 90620

ZENITH RADIO CORPORATION 88, 95
1900 N. Austin Ave., Chicago, Ill. 60639

8 Accessories

channel. Circuit operates for recording, then playback, but not together. Increased (S + N)/N 10 dB at 10,000 Hz. $169.50

AN-60 Outboard Dolby System
Frequency response 20-15,000 Hz ±2 dB. Increased (S + N)/N 10 dB at 10,000 Hz & 5 dB at 1000 Hz. Input sensitivity 0.1 V. Output to tape deck 0.3 V & line 0.58 V. Has 400-Hz tone oscillator & a reference meter for calibration. Dolby calibration tape for both open reel & cassettes supplied. Overall size 3¾" H × 6⅜" W × 10⅝" D $99.50

UHER

Stereo Mix 500 Mixing Console
Will handle up to five sound sources simultaneously in mono mode (five mikes or radio, tuner, record player, tape recorder, mikes) or two stereo sound sources and one mono. Each input has separate all-transistor amplifier channel. Has five studio-type slider controls calibrated for accurate cross-fading; built-in level tone generator. Frequency range 20-20,000 Hz; dynamic range 60 dB; output voltage 2 × 30 mV + 2 × 500 mV. Powered by 9-volt battery. $179.95

TAPE RECORDER GUIDE ADVERTISERS INDEX

The 360S ...following the leader.

When we introduced the 450, it became the leader in cassette technology. (It still is.) We followed up with a less expensive version, the 360S, and it became a leader in its price category. Now, you're going to be in for a round of so-called "revolutionary" new cassette machines two years behind the 450. There will be claims of advanced new drive mechanisms, a few new gadgets and gimmicks, and, of course, mighty hefty prices. But there won't be claims of better *overall* performance, assuming the claims are truthful. One of the last remaining cassette problems is wow and flutter. The 360S has remarkably little—less than 0.07% WRMS. Oddly, that's the same figure all these "revolutionary" machines are skirting. Naturally, the 360S features Dolby* noise reduction...separate 3-position bias and equalization switches... a dual function metering system including VU meters and a peak indicator light...a memory digital counter and automatic shut-off. If you're looking for a quality cassette deck, your nearby TEAC retailer is an excellent place to start (after all, he's had experience with the machines that started it all). You'll find that our retailers are well informed and helpful in general. Rare qualities, so there can't be many of them. You can find the one nearest you by calling (800) 447-4700.* We'll pay for the call.

*In Illinois, call (800) 322-4400

*Dolby is a trademark of Dolby Laboratories, Inc.

TEAC

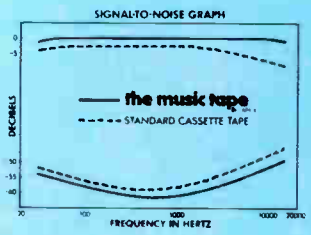
The leader. Always has been.

TEAC Corporation of America, 7733 Telegraph Road, Montebello, California 90640.

If you record music, this is the tape to buy

Now it's simple to select the correct blank tape. If you record music, buy the premium tape that's formulated to record music, The Music Tape by Capitol. An extra high output/low noise magnetic oxide formula makes The Music Tape more sound-sensitive than ordinary tapes. Music recording requires it.

Ordinary tapes round off an instrument's unique characteristics—its "color." They distort when the pitch (frequency) is high. Or create noise when the sound level (amplitude) is low.



Engineers plot these performance limits on a signal-to-noise ratio (S/N) graph like the one below. The greater the distance between the top and bottom lines, the better the tape's S/N. The wider the area covered, the better the frequency response.

This S/N graph shows the superiority of The Music Tape over conventional recording tape. It's another reason we think The Music Tape is best for recording music. You might say The Music Tape is the blank tape with an ear for music.

When you record ordinary things, use an ordinary tape. But when you record music, record on the music tape™ BY CAPITOL

cassette • cartridge • open reel

CIRCLE NO. 3 ON READER SERVICE CARD