



AMPEX AR-200

AIRBORNE AND MOBILE MAGNETIC TAPE RECORDER



*Maximum reliability with
Minimum size and weight*

*... precise performance under the most extreme environmental
conditions for airborne or mobile data acquisition ...*

In the laboratory or in the air...

MAGNETIC TAPE *provides the utmost capacity
and precision in the most versatile and easy-to-use form*

In airborne data acquisition, undersea research, or surface-vehicle analysis, today's technological advances shrink time and distance into insignificance. A scientific instrumentation package can become part of outer space in seven minutes, undergoing accelerations, pressures, speeds and changes in temperature that even Jules Verne would have thought fantastic.

In this era of change, the rate of advance is often determined by our ability to gather and make use of new information. Magnetic tape, alone among devices for acquiring and processing this information, provides the inherent capabilities, the range and scope necessary to cope with the data problems of the Space Age.

But tape's uses aren't limited to recording a rocket thrust or counting micrometeorite impacts on a satellite's shell. Its abilities are equally important in shedding new light on age-old variables—in capturing the sounds of a beating heart or the rumble of an earthquake, in analyzing an ocean wave or a bolt of lightning.

There is no limit to the number and type of variables which can be recorded on magnetic tape. Whatever can be expressed as an electrical voltage—whether it happens only occasionally or more than 100,000 times a second—can be stored within the memory of tape.

Hundreds of simultaneous variables can be recorded, providing precise time correlation between events. And upon reproduction, each signal is a faithful image of the original.

Other recording methods present information in a static form—a point on a chart or a reading on a dial. But data from tape appears as the same "live" electrical voltage you first recorded. It can be reproduced numberless times without degradation, for such purposes as repetitive analysis, providing control action, or re-creating the original phenomena.

Taped information can be compressed or stretched. Low-frequency information may be speeded up until it is within the range of electronic wave analyzers, or high-frequency information may be slowed down for visual readout and inspection.

Magnetic tape provides many economies—in time, effort, storage and cost. To locate specific information from vast quantities of data, it can compress into minutes what might require months of visual scanning. In automatically processing data, it bypasses tedious reproduction methods and helps eliminate human error.

Bringing the advantages of magnetic tape to bear on the problems of airborne data acquisition...

The Ampex AR-200 AIRBORNE AND MOBILE MAGNETIC TAPE RECORDER



Complete 7-track AR-200 recording system

RELIABLE

The AR-200 is a giant step forward in laboratory-quality data gathering. It functions with a maximum of reliability to gather dynamic, on-the-spot data under conditions of airborne, shipboard and vehicular use. Solid-state components and printed circuitry are used throughout, allowing the volume and weight of the AR-200 to be less than that of any other commercially available recorder.

RUGGED

Dust proof and sturdy, the AR-200 is designed to withstand and keep operating under the actual conditions encountered in rugged testing setups. Operating at altitudes to 100,000 feet, temperature to 95°C and shock to 15 g's—all part of a day's work!

MOBILE

A complete 7-track AR-200 system with shock-mount, reels and tape weighs 90½ pounds (less cables) and occupies a mere 1.6 cubic feet. The electronic assemblies need no shockmounts and can be mounted in any position.

OPERATIONAL CONVENIENCE

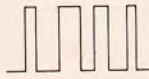
Unique alternate-hinged cover provides access to the transport from either side. All operational controls are duplicated at the transport and at the Remote-Control Unit. A full six-speed range is offered, plus fast-forward operation which shuttles a 2500-foot reel of tape in 1½ minutes, permitting the operator to run remaining tape off the reel while aircraft power is still available. New, easy-to-use reel holddowns provide quick, positive locking and release. Electronic amplifier housings are designed so that all types of amplifiers can be interchanged. The special test unit requires only one cable connection for complete system checkout.

The whole recorder system can be released from its mountings almost instantaneously; the entire package of amplifiers, housing shell and cable connectors can be released by four knurled screws. This means that the whole system or any part of it can be released fully cabled and ready for operation to facilitate maintenance or bench repairs.

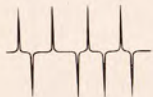
CAPABILITIES

Versatility is enhanced by a wide selection of recording techniques...

PCM



Square-wave pulses as received by recorder from keyer.

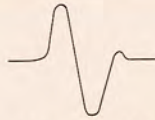


Pulses transformed to "spikes" which define beginnings and ends of pulses.

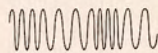


Positive and negative spikes are recorded on the tape.

FM CARRIER



DC to medium-high-frequency data as received by the recorder.

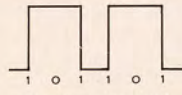


Carrier signal is frequency modulated by the data.



Modulated carrier is recorded directly on tape at near-saturation level.

DIGITAL



Digitally-coded level-change signal from Analog-to-Digital Converter or from Computer.



Record-current polarity changes each time a "one" is to be recorded. This is non-return-to-zero recording.



Signals are recorded at tape-saturation level.

DIRECT



Low- to high-frequency data received by the recorder.



No coding or modulation are used.



Data is recorded directly as a magnetic signal on the tape.

for highest frequency response

DIRECT RECORDING

In Direct recording, the incoming electrical signal is recorded without alteration, preserving its original time/amplitude relationships. Frequency response of the reproduced information is from 50 to 100,000 cycles per second at a tape speed of 60 inches per second, and is proportional at other speeds. Data recorded on any direct-record track may be a single broad-band channel of information, or made up of a number of data-bearing subcarrier frequencies.

for greatest amplitude accuracy

FM-CARRIER RECORDING

FM-Carrier recording is unexcelled for accurately preserving signal amplitudes over a frequency range from DC to 10,000 cycles per second. The incoming signal frequency-modulates a carrier, which is recorded on the tape. The reproduced data is unaffected by amplitude variations in the signal on the tape, and the effects of tape variations or tape-coating inconsistencies are eliminated. FM-Carrier recording is recommended for vibration data, transients, control signals, low-frequency phenomena, and

similar data where instantaneous amplitude accuracy is of primary importance.

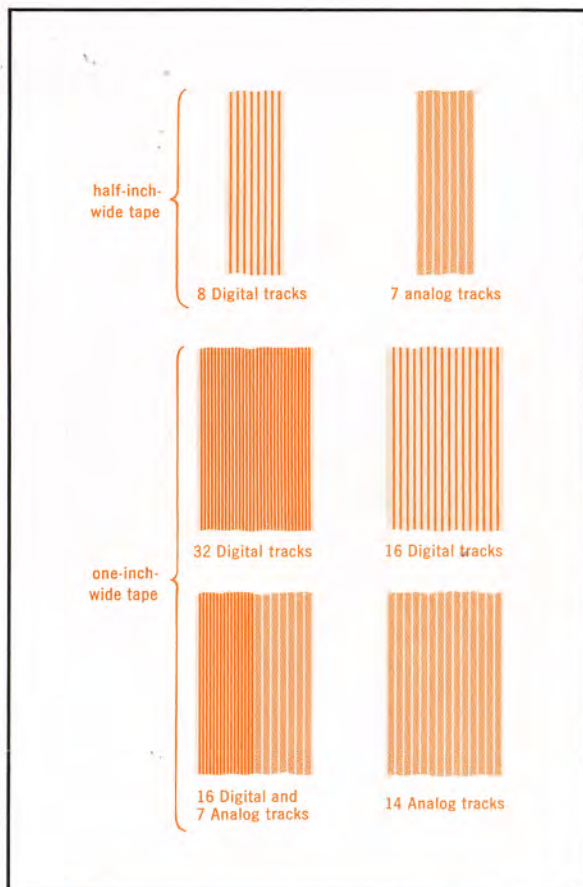
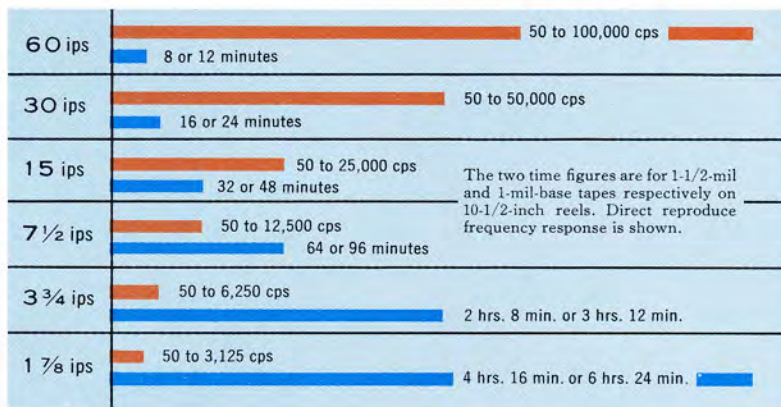
for recording the maximum number of data samples

DIGITAL (PCM) RECORDING

The AR-200 can be used to record binary-coded digital information. NRZ (non-return-to-zero) recording is used, which handles input rates up to 18,000 bits per second for each track. For instance, up to 3600 11-bit characters can be recorded per second, assuming two characters recorded side-by-side across the tape, with 10 additional auxiliary-channels for time-code, parity, block-marker signals, etc. For more information on head configurations, see the section on magnetic heads, page 8. Pulses may be recorded in:

Serial form—for example, as a binary time code on one track of an analog tape where automatic search and control equipment is to be used, or in

Parallel form—for data acquisition—each tape track represents a binary "bit" and the full width of the tape represents one or more alpha-numeric characters.



The AR-200 provides a variety of tape-track configurations, insuring versatility for data-recording needs and compatibility with standard reproducers

an alternative for high data-sampling rates

PDM RECORDING

PDM (Pulse Duration Modulation) is particularly useful for tests where large numbers of temperatures, pressures, positions, flow rates and other quasi-static variables are to be recorded. As many as 85 instantaneous values can be recorded on a single track several times per second. Signals recorded are in the form of rectangular pulses of meaningful duration.

... a full range of tape speeds...

The AR-200's wide selection of speeds serves these important needs: (1) providing maximum recording time for any particular data-bandwidth requirement (see bar graph), and (2) matching the tape speed of any standard reproducer in use. Standard tape speeds are 1⅞, 3¾, 7½, 15, 30 and 60 ips (others available to order). Speed change is simple, requiring only the change of a selector-switch position with the simple repositioning of a drive belt. This is accomplished at the bottom of the tape transport—a purposeful design feature. By this means, any accidental change of tape speed is positively avoided.

... from seven to thirty-two recording tracks...

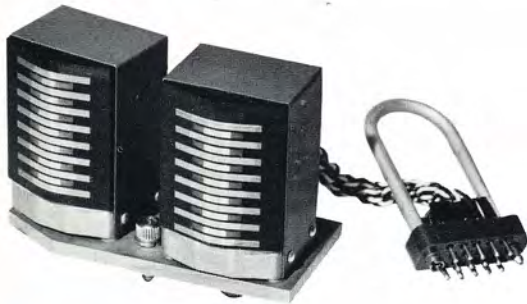
Two tape widths are available—½-inch or 1-inch. The ½-inch-wide tape will accommodate either 7 analog-recording tracks or 8 digital-recording tracks. One-inch tape will provide 14 tracks of analog recording, 16 or 32 digital recording tracks, or a combination of 16 digital and 7 analog tracks. Each analog track will accommodate many channels of multiplexed data, providing the means, where necessary, for recording more than 1,000 channels at one time.

... and servo tape speed control!

Where precise time base is required, a 60-cps signal (accurate to ±0.02%) is recorded on any track of the tape. This becomes the Servo Control Track signal when the tape is reproduced, allowing a continuous comparison with a precision 60-cps source. By means of this comparison the tape is servo controlled to keep the two signals in phase. Thus, effects of tape stretch, power variations and tape-speed inaccuracies are eliminated. Timing is kept accurate to the reproduce time base standard within ±0.75 millisecond, affording accuracies of 2 parts in 10⁵ per week (with Ampex High-Accuracy Servo System).

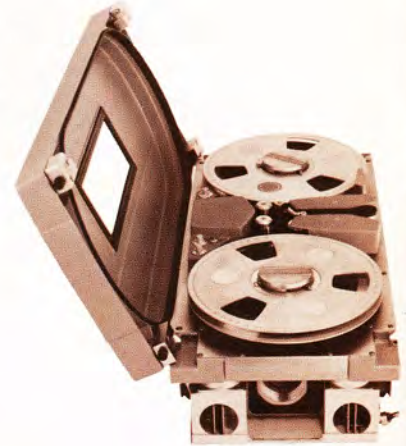
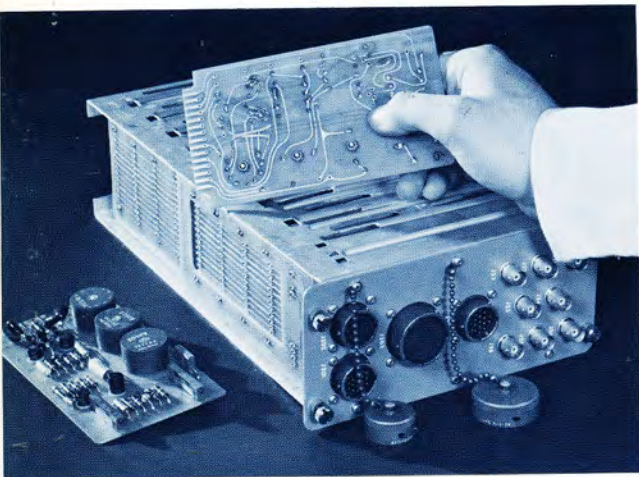
FEATURES

From experience gained with hundreds of users of earlier mobile recorders Ampex has provided a wide range of features which are realistic and practical for airborne applications...



Typical headstack assembly

Printed-circuit amplifiers fit into card rack containing all signal and power connectors



...accuracy...

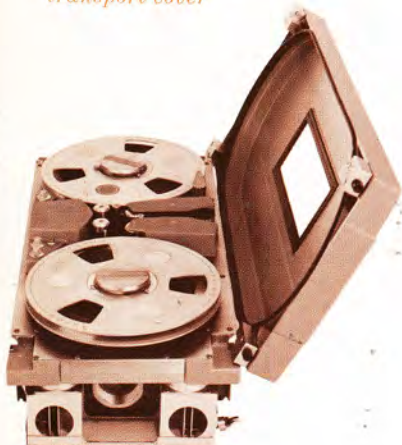
Minimum flutter. The AR-200's minimum flutter makes it the obvious choice for instrumenting such demanding applications as FM-multiplexed data and other tasks where maximum instantaneous signal accuracy is vital and superior flutter characteristics are required.

Ampex-developed magnetic heads. Plug-in heads with the exclusive Ampex positive-contact surface represent the most startling advances in the magnetic-head field. These heads provide significant improvement over older designs such as the first cast epoxy heads and the original Ampex all-metal-head design. The inter-track relief areas heighten tape-to-head contact and provide efficient disposal of the inevitable tape-oxide accumulation. Tape abrasion—which never has been a serious problem on an Ampex machine—and head wear are not affected. Head cleaning procedures, necessary on any machine, are still required for proper operational maintenance. For track-to-track phase relationships, simultaneity of parallel digits, or concurrence of events, these heads hold time displacement error among all tracks on one headstack to approximately 10 microseconds at 60 ips. Between adjacent tracks it can be as little as 5 microseconds. This high order of precision is achieved by holding total gap scatter among all heads in one stack to 1/10,000th inch *or better* and azimuth of gap axis to $90^{\circ}00' \pm 1'$. Latest track configurations are available, featuring up to 32 digital recording tracks, or 16 digital and 7 analog tracks on 1-inch tape. Compatibility with past, present and future Ampex recorders is guaranteed.

...versatility...

Modularity of design means that you get the benefits of instantaneous change or substitution when you need it. Recording methods can be changed between tests merely by pulling out one amplifier and plugging in another. If a part is suspect, you can immediately replace it with a perfect one while you bench check the first.

Alternate-opening transport cover



Remote control assembly duplicates all tape-transport controls, plus providing a meter which indicates amount of tape remaining on reel



Quick-turn holddown secures reel in place or releases it with only a quarter turn of the handle

...ease of operation...

Easy-access transport cover opens from front or back to allow operation from any position. Both cover and transport case provide unparalleled strength for weight—a 200-pound man can stand directly on the transport cover with absolutely no damage to the instrument.

Local and remote controls are provided, with all operational controls duplicated on both. The Remote-Control Unit is designed to mount in a standard 3 1/8-inch aircraft instrument panel "knock-out" hole. It features a meter showing the amount of tape remaining on the reel, and indicator lamps to show POWER ON and RECORDING mode operation. When the tape has reached its proper recording speed, the RECORDING lamp blinks, showing the operator that (1) power is supplied to the transport, and (2) the tape is moving past the magnetic heads at the proper speed.

Quick-twist reel holddowns provide quick, positive locking and release of standard NAB-hub tape reels (Ampex Precision Reels are supplied with the recorder and recommended for use). A quarter-turn of the handle releases the reel or clamps it firmly in position.

...and ease of maintenance!

Maximum accessibility of all modules and components has been realized in the AR-200. Speed-change facilities, working parts and subassemblies are reached at the bottom of the tape transport by

removing eleven 1/4-turn screws and setting the bottom plate aside. The whole transport assembly is securely fastened to its shockmount by only two wing nuts. To gain complete access to all amplifiers and electronic-housing wiring, merely release four knurled screws on the face of the connector plate and pull all the working units free. Plug-in amplifiers are instantly replaceable.

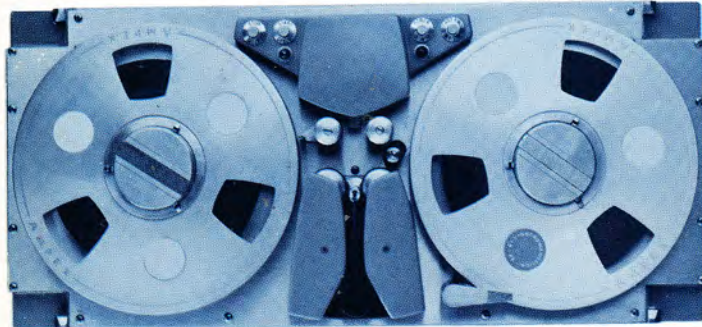
Dustproof compartment for heads, tape and all operating controls is insured by the gasketed cover. Electronic and mechanical components throughout the system are securely sealed from dust during normal operation.

No lubrication required for any of the parts of the AR-200 system means that Ampex has removed any possibility of troubles from excessive or indiscriminate oiling by inexperienced personnel. The transport uses sealed ball-bearing assemblies factory-lubricated for the life of the recorder. Precision bearings have been incorporated in a specially developed design that decreases flutter to a minimum.

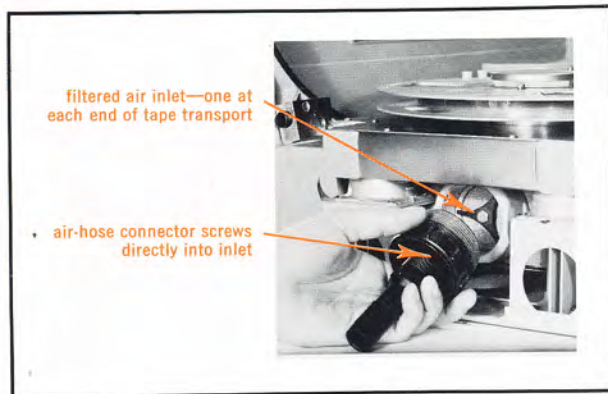
Instantaneous checkout of the whole AR-200 recording system with a single cable connection is provided by the special test unit. It is completely portable, with clearly labeled switches, indicator lamps and a meter providing a "go/no-go" indication.

All solid-state circuitry throughout—no tubes—gives the utmost possible dividends in reliability, size and ease of maintenance. Heat problems are nullified by the elimination of vacuum-tube heaters and high-voltage supplies. Power consumption is a mere 150 watts for a complete 14-track system.

MODULE DESCRIPTIONS



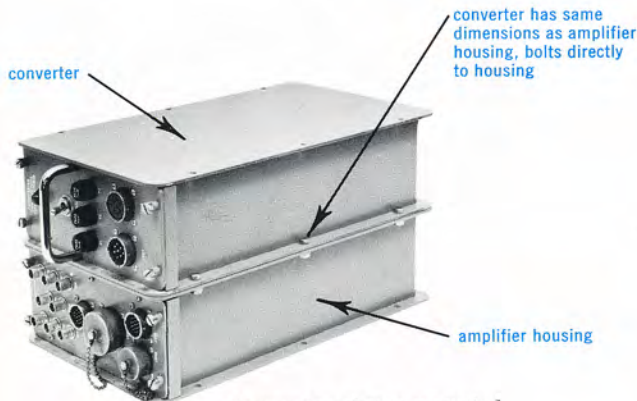
AR-200 tape transport



filtered air inlet—one at each end of tape transport

air-hose connector screws directly into inlet

End of transport showing filtered air inlet



converter

converter has same dimensions as amplifier housing, bolts directly to housing

amplifier housing

Converter shown mounted directly to amplifier housing

TAPE TRANSPORT

Reliability...the prime consideration in the design of the AR-200 transport, from the single rugged precision-cast frame to the exclusive use of low-heat, solid-state components.

The entire transport is mounted to withstand shocks to 15 g's and vibration to 10 g's. It supplies six standard tape speeds (1 $\frac{1}{8}$, 3 $\frac{3}{4}$, 7 $\frac{1}{2}$, 15, 30 and 60 ips \pm 0.25%) with cumulative flutter held to less than 0.1% (60 ips, at a cutoff frequency of 300 cps).

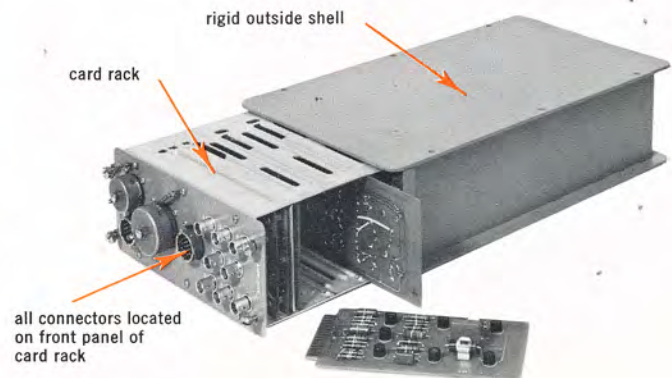
Models are available for either $\frac{1}{2}$ - or 1-inch-wide tape. Operating pushbuttons on the transport provide START, STOP, POWER and FAST FORWARD control, with indicator lamps, one glowing to show power on and the other flashing to show tape movement during recording-mode operation.

Connectors and fuse posts are all available at the front of the transport, clearly marked for convenience. For maximum economy of cabling space, Bendix "PT Pygmy" receptacles have been selected for signal and power connectors.

Intake connections on both ends of the transport are provided for the introduction of an external source of cooling air for operation above 71°C. These openings (both "in" and "out") are filtered and provided with caps to seal them off when they are not used. Hose connectors are available for use with a blower.

MAGNETIC HEADS

The extraordinary precision and uniformity with which Ampex heads are manufactured determines frequency response, signal characteristics and recorder-to-recorder tape compatibility. Their design contributes to overall versatility of the recorder. The Ampex AR-200 is usually purchased with record heads only, but space is also provided for monitor (reproduce) heads.



rigid outside shell

card rack

all connectors located on front panel of card rack

Typical amplifier housing

To provide extreme accuracy of interchannel timing, total gap scatter in each headstack is not more than 0.0001 inch. Gap spacing between the two stacks in a pair is fixed by the base plate at 1.5 ± 0.0005 inches. Gap azimuth alignments are within ± 1 minute of arc. To allow interchangeable amplifiers, analog record heads are universal to Direct, FM and PDM recording characteristics. Digital heads are available in a variety of track configurations. All heads are easily interchangeable since their precision base plates determine alignment; no azimuth adjustment is required.

For minimizing of crosstalk, seven and fourteen-track analog recorders, and 32-track digital recorders have two interleaved head stacks. Adjacent tracks are recorded from alternate stacks. A special configuration with 16 digital and 7 analog tracks is available.

Newest features of these heads are the exclusive positive-contact surface in which the head-to-tape contact and disposal of oxide deposit is increased by the recessed inter-track relief areas.

RECORD AMPLIFIER ASSEMBLIES

Record amplifiers have been designed for analog or digital recording on any track of the tape. All amplifiers are constructed on plug-in etched-circuit cards utilizing solid-state components exclusively. All cards are interchangeable and are contained in housings for seven (analog) or eight (digital) amplifiers.

Direct Record Amplifiers provide frequency response from 50 cps to 200 Kc, with an input level requirement of 1 volt rms for normal-level recording. The constant-current recording utilized in the AR-200 needs no special equalization, hence one amplifier serves equally well for all tape speeds. A special junction connector allows you to multi-

plex the Control-Track-Generator signal through any Direct Amplifier onto the tape.

Digital Write Amplifiers are used to record data information coded in binary digital form. Up to 8 or 32 recording tracks are provided on $\frac{1}{2}$ - or 1-inch tape, respectively. The amplifier is a voltage-level sensitive circuit, with input requirements of +5-volt pulses. This amplifier is capable of transferring up to 75,000 bits per second utilizing NRZ (non-return-to-zero) recording.

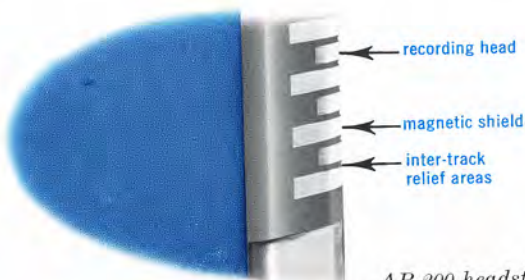
FM-Carrier and PDM Record Amplifiers. FM recording provides accurate amplitude reproduction from DC to 10 Kc, while PDM recording is used for large numbers of data channels time-multiplexed onto one tape track.

Amplifier Housings contain seven analog or eight digital amplifiers. The outside shell is rigidly constructed of welded $\frac{1}{8}$ -inch plate, with mounting holes for bolting it firmly in place. Sliding into this is the card rack which actually holds the amplifiers plus all necessary connectors and interconnecting wiring. The front panel of this unit is fastened in place with four knurled screws, and contains all cable connectors for the amplifiers.

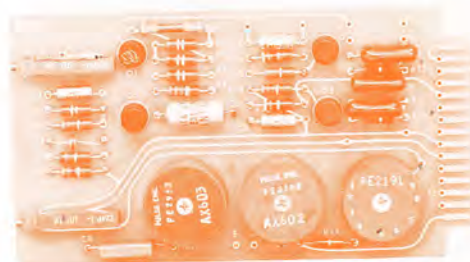
POWER CONVERTERS

Operation of all units of an AR-200 system is accomplished on 28-volt DC input power, available in almost all modern aircraft. A 14-track system requires 150 watts of power.

If the power available should be other than the necessary 28 volts, Ampex furnishes power converters. For 208 volts, 400 cps, 3 phases, a converter is available weighing 12 pounds. A 22-pound converter is supplied for 115 volts, 400 cps, single phase; and for 115 volts, 60 cps, single phase, the converter weighs 44 pounds. Size of the two 400-cps converters is the same as that of the Amplifier Housing. The 60-cps converter is equivalent in size to two Amplifier Housings.



AR-200 headstack showing positive-contact surface



Typical printed-circuit amplifier card

ACCESSORIES



Remote control unit for AR-200

SERVO TAPE SPEED CONTROL

Where precise time base is required, an accurate 60-cps signal is recorded on one track of the tape. Two alternate types of servo control-track amplifiers are available:

The **AM Control-Track Generator** is used wherever a direct-record servo system will be used for reproducing the tape. The Generator produces and amplitude modulates an 18.24-Kc or a 17-Kc* control-track subcarrier. Data may be concurrently recorded through a common Direct amplifier onto the same track provided none falls in the frequency band between 16.5 to 20 Kc.

*Other frequencies available on special order.

The **FM-Carrier Control-Track Generator** also fits into the space normally occupied by a regular amplifier. It generates and frequency modulates a carrier at the 60-cps reference frequency. This amplifier is usable for any tape speed, and is required where the tapes will be reproduced on an FM system, especially where servo-controlled time base expansion or contraction is to be utilized.

REMOTE CONTROL UNIT

The Remote Control Unit for the AR-200 reproduces all the operational controls on the tape transport, and includes a tape-remaining meter. The unit is designed to fit into a standard 3½-inch

knockout hole in an aircraft instrument panel. Fast-forward pushbutton lets the pilot run off remaining tape before de-energizing aircraft.

TEST UNIT

This lightweight and totally self-contained unit has been designed to afford complete alignment and checkout of the whole AR-200 recording system with only one cable connection. All necessary power is supplied through the test-unit cable. Proper operating conditions are indicated on the "go/no-go" meter. Convenient test points allow connection to an oscilloscope, VTVM or digital counter, if desired. The following items can be checked:

- FM-carrier rms head current
- Record bias head current
- Record signal head current
- Signal-to-noise ratio
- Standard deviations of the FM carrier
- External input
- System power

TWO-TRANSPORT SYSTEM

Where uninterrupted long-term recording is desired, Ampex can furnish pairs of modified AR-200 transports and accessory controls for recording sequentially. Each tape transport starts recording automatically as the end of the tape reel is sensed by the other. Reloading of the idle transport can extend recording time indefinitely.



Test unit

SPECIFICATIONS

This recorder is designed to be qualified under Mil-specification E-5400-C and will meet MIL-I-26600 for radio interference. Ampex reserves the right to change specifications without notice and without obligation. These are minimum design specifications, derived from data available on 1 April 1959.

General

Environmental specifications: Operating temperature — Recording system operates between -54°C and $+95^{\circ}\text{C}$ with sufficient cooling air introduced into the transport to keep the tape and internal portions at or below $+71^{\circ}\text{C}$. Without cooling air the transport operates between -54°C and $+71^{\circ}\text{C}$. No cooling air needed for electronic assemblies.

Non-operating temperature — Transport, -54°C to $+85^{\circ}\text{C}$ (without tape). Electronic assemblies, -54°C to $+125^{\circ}\text{C}$.

Humidity — 0 to 100% RH with condensation.

Vibration — (With transport shockmount in place) Continuous at 10 to 55 cps, 0.060 inches double amplitude; continuous at 55 to 500 cps, 10 g's.

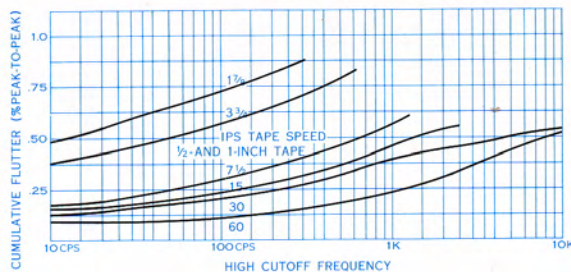
Shock — 18 impact shocks of 15 g's, duration 11 milliseconds ± 1 ms. (Three shocks in each direction along the three mutually perpendicular axes.)

Tape Transport

Tape speeds: Speeds of 1 $\frac{7}{8}$, 3 $\frac{3}{4}$, 7 $\frac{1}{2}$, 15, 30 and 60 ips (standard).

Reels and tape: 10 $\frac{1}{2}$ -inch Ampex Precision Reels (standard NAB hubs), either $\frac{1}{2}$ - or 1-inch tape.

Flutter: MAXIMUM CUMULATIVE FLUTTER



Tape speed deviation: $\pm 0.25\%$ maximum.

Start, stop and fast-mode times: Start time less than 0.5 seconds to achieve stable tape motion at any tape speed.

Stop time less than 0.5 seconds at any tape speed.

Below -20°C , up to $\frac{1}{2}$ -hour warmup in "standby" mode required before power is supplied to the capstan drive motor.

When power is first turned on, approximately 30 seconds required for the tape capstan to achieve stable rotational speed at 60 ips.

Fast-forward time is $\frac{1}{2}$ minutes for 2,500 feet of tape.

Recording Heads

Head geometry: Gap scatter — Trailing edges within a band 100 microinches wide (0.0001 inch).

Gap azimuth — All stacks within ± 1 minute of perpendicular to head base plate.

Track dimensions: Analog — Track width is 0.050 inches; track spacing is 0.070 inches on center.

Digital (16 tracks per inch) — Track width is 0.032 inches; track spacing is 0.0625 inches on center.

Digital (32 tracks per inch) — Track width is 0.020 inches; track spacing is 0.030 inches on center.

Number of tracks: Analog — $\frac{1}{2}$ -inch head assembly: 7 tracks

1-inch head assembly: 14 tracks

Digital — $\frac{1}{2}$ -inch head assembly: 8 tracks

1-inch head assembly: 16 or 32 tracks

Digital and Analog — 1-inch head assembly: 16 digital, 7 analog tracks

Monitor heads: Standard reproduce heads as required to match record-head configuration.

Direct Record Amplifier

Frequency response (of Direct Record Amplifier output): $\pm \frac{1}{2}$ db from 50 to 80,000 cps; $\pm 1\frac{1}{2}$ db from 50 to 200,000 cps at a constant ambient of 20°C . From 50 to 200,000 cps $\pm 3\frac{1}{2}$ db throughout an ambient temperature range of 0°C to $+75^{\circ}\text{C}$.

Signal-to-Noise Ratio: 35 db down at normal operating level (for 500-cps signal).

Input impedance: 10K ohms, unbalanced to ground.

Input level: 1 volt for normal record level; from 0.6 to 50 volts RMS accepted without significant performance change.

Harmonic distortion: 1% at 500 cps at 30 ips.

System crosstalk: Down 25 db between any two adjacent tracks.

FM-Carrier Record Amplifier

Frequency response: $\pm \frac{1}{2}$ db from DC to 10,000 cps at 60 ips.

Noise: Minimum 45 db down at normal operating level.

Harmonic Distortion: Less than 2%.

DC drift: Long-term less than 1% per week peak-to-peak of center frequency.

Input impedance: 10K ohms, unbalanced to ground.

Input level: 0.7 volts RMS (minimum) for 40% deviation of FM carrier signal.

PDM Record Amplifier

Pulse accuracy: ± 2 microseconds at 30 ips.

Pulse length: 50 to 700 microseconds at 30 ips.

Input impedance: 10K ohms, unbalanced to ground.

Input signal: Nominal +5 volts RMS (rise and decay time no more than 5 microseconds) +2 to +20 volts RMS (decay time 1 microsecond per volt).

Digital Write Amplifier

Input impedance: 10K ohms, unbalanced to ground.

Input level: +5 volts minimum, direct-coupled, referred to zero. 10K ohms input DC resistance, (but has low impedance to wave front) 0 to 75 ma peak-to-peak, 10-microsecond rise time.

Transfer rate: Up to 75,000 bits/second.

AM Control Track Generator

Subcarrier frequency: 17 Kc or 18.24 Kc $\pm 1.0\%$ with quick-change provision.

Modulating frequency: 60 cps $\pm 0.02\%$.

Modulation: 50% $\pm 5\%$.

Power

Input voltage (transport and electronic assemblies): +28 volts DC (+5 or -3 volts tolerance).

Converters: 115 volts, 60 cps, single phase to 28 volts DC.

115 volts, 400 cps, single phase to 28 volts DC.

208 volts, 400 cps, three phase to 28 volts DC.

Power consumption: 150 watts for 14-track system. Operation below -20°C requires 500 watts.

Physical Characteristics

Size and Weight (including handles)	Tape Transport with tape and shockmount:	Weight (lbs) (approx.)	Size (cu. inches)
		80	2370
	Remote Control Unit:	$\frac{3}{4}$	42
	Record Amplifiers and Housing (7 tracks):	10 $\frac{1}{2}$	390
	Test Unit:	7 $\frac{1}{4}$	720
	Power Converter (115 volts, 400 cps, single phase):	22	420
	Power Converter (208 volts, 400 cps, three phase):	12	420
	Power Converter (115 volts, 60 cps, single phase):	44	840



Amperex MR-100 Missile Recorders are actively contributing to this nation's missile program. Recorder shown here has been recovered from the sea after being ejected from the nose cone of a test missile.



FR-300 high-speed Digital Tape Handler selected by Philco Corporation for use with new transistorized TRANSAC S-2000 data-processing computer.*

**Trademark Philco Corporation*



Seven-track FR-100A Recorder/Reproducer used for production-line testing of Jupiter missiles at Army Ballistic Missile Agency, Huntsville, Alabama. Photo courtesy Electrical Manufacturing Magazine

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