RCA

BROADCAST AND COMMUNICATIONS PRODUCTS

TR-70 Television Tape Recorder Description and Installation

RADIO CORPORATION OF AMERICA

IB-31855

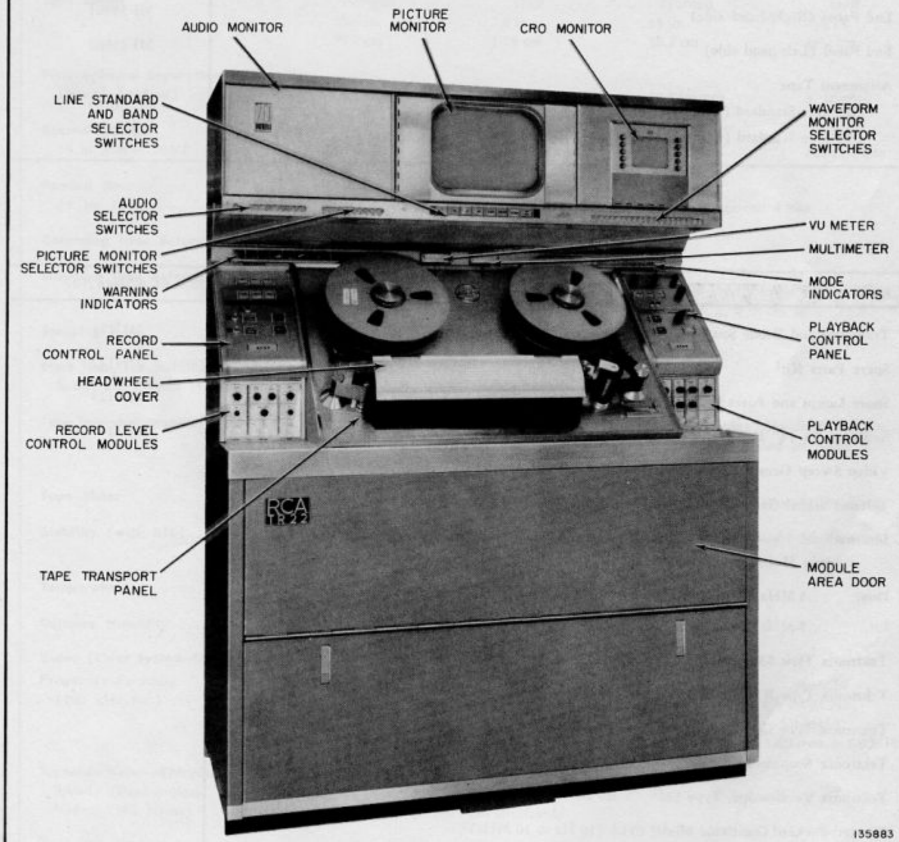


Figure 1—TR-70 TV Tape Recorder

EQUIPMENT SUPPLIED

Description	*MI-Number*
TR-70 TV Tape Recorder, color equipped, 117 v, 60 Hz power, 525 Line Standard	MI-35895
or	
TR-70 TV Tape Recorder, color equipped, 234 v, 50 Hz power, 405/525/625 Line Standards	MI-35897
Headwheel Panel (Air-bearing Type)	MI-40899
End Panel (Right-hand side)	MI-35901
End Panel (Left-hand side)	MI-35902
Alignment Tape	
525 Line Standard (with MI-35895)	MI-40793
625 Line Standard (with MI-35897)	MI-40797

SPARES AND RECOMMENDED TEST EQUIPMENT

Description	*RCA Stock No.*
Transistor and Diode Spare Parts Kit[1]	21H121
Spare Parts Kit[1]	21H122
Spare Lamps and Fuses Kit[1]	21H123
Replacement 14" Kinescope (14PDPA)[1]	21H107
Video Sweep Generator, Marconi TF1099[2]	
Telemet Signal Generator, 525 Line Standard, Telechrome Model 3501[3]	
International Use—Telemet Signal Generator, 625 Line Standard Telechrome Model 3501[3] Telemet Multiburst Frequencies:	
Dom. .5 MHz 1.5 MHz 2.0 MHz 3.0 MHz 3.6 MHz 4.2 MHz	
Int. .5 MHz 1.5 MHz 2.0 MHz 3.0 MHz 4.4 MHz 5.5 MHz	
Tektronix Type 535-A Oscilloscope (or 547 Width, 1A1 Plugin)[4]	
Tektronix Type B Wide Band Plugin Amplifier[4]	
Tektronix Type C-A Dual Trace Plugin Amplifier[4]	
Tektronix Scopemobile, 500/53-A[4]	
Tektronix Vectorscope, Type 526[4]	
Hewlett-Packard Oscillator Model 651A (10 Hz to 10 MHz)[5]	
Hewlett-Packard VTVM, Model 3400A[5]	

1. May be purchased from RCA
2. Not stocked by RCA: place order with Marconi Co., Chelmsford, Essex, England
3. Not stocked by RCA: place order with Telmet Co., 185 Dixon Ave., Amityville, N.Y.
4. Not stocked by RCA: place order with Tektronix Inc., P.O. Box 831, Portland, Oregon
5. Not stocked by RCA: place order with Hewlett-Packard Co., 275 Page Mill Rd., Paolo Alto, Calif.

TECHNICAL DATA

OVERALL PERFORMANCE

Recording Medium	[1]Magnetic Tape, 2 inches wide			
	50 Fields/Sec (Int'l)		*60 Fields/Sec (Dom.)*	
Tape Speed	[2]Normal 15.6 in. 39.7 cm	Half 7.8 in. 19.8 cm	Normal 15 in. 38.2 cm	Half 7½ in. 19.1 cm
Picture/Sound Separation[3] (Sound Leading)	14.8 frames	29.6 frames	18.5 frames	37 frames
Recording Time 14 in. reel—7200 ft.	92 minutes	184 minutes	96 minutes	192 minutes
Rewind Time 14 in. reel	approx. 5 min.		approx. 4 min.	
Recording Time Reference	To incoming video signal or an external reference			
Playback Time Reference	To an external reference or an internal precision oscillator 300 cps ±.05%			
Stopping Time	Less than .2 seconds from RECORD or PLAY mode			
Start Time, for Stabilized Sound and Picture (Color)	5 seconds from standby mode; 6 seconds from stop mode			
Tape Interchangeability	Tapes made on any machine may be played back on any other machine providing they are made in accordance with all applicable proposed SMPTE recommended practices and proposed ASA standards.			
Tape Timer	Accumulated time measured in minutes and seconds. Accuracy within 3 seconds per hour.			
Stability (with ATC)	Total jitter and geometric distortion including drift over a 30 second period—50 microsec. peak-to-peak.			
Temperature	0°C to 45°C			
Relative Humidity	20%-90%			

Video (Color System Characteristics)	*Lowband*		*Highband*	
	525/60	*625/50*	*525/60*	*625/50*
Frequency Response (100 kHz ref.)	±1 dB 30 Hz —3.8 MHz −3 dB max. at 4.2 MHz	±1 dB 25 Hz —4.5 MHz −3 dB max. at 5.0 MHz	±0.5 dB 30 Hz —4.1 MHz −3 dB max. at 4.5 MHz	±0.5 dB 25 Hz —5.5 MHz −3 dB max. at 6.0 MHz
Signal-to-Noise—(Normal Speed) (Peak-to-peak Video/RMS Noise)	43 dB (Mono) 40 dB (Color)	42 dB (Mono) (Color) not applicable	46 dB	43 dB
Transient Response (2 T sine² input)	2%	2%	Less than 1.5%	Less than 1.5%
Rise Time or Fall Time (20 ns or less on input)	120 ns max.	100 ns max.	120 ns	80 ns
Low Frequency Linearity (Blanking to White)	2% max.	2% max.	1% max.	1% max.
Differential Gain (Blanking to White)	Less than 4%	not applicable	Less than 4%	Less than 5%

TECHNICAL DATA (Continued)

Video (Color System Characteristics) (Cont'd)

		Lowband		Highband	
Differential Phase	5° at 3.58 MHz	not applicable	Less than 5° at 3.58 MHz	Less than 5° at 4.43 MHz
Moire (Color bars, 75% modulation)	24 dB	not applicable	40 dB or better	34 dB or better
FM Limiting[7]	50 dB	50 dB	50 dB	50 dB

Audio ....
50/60 Hertz (Hz)

	Program	Cue
Frequency Response		
15 IPS	±2 dB 50 Hz, 15kHz	±2 dB, 50 Hz, 12kHz
7.5 IPS	60 Hz, 10kHz	±3 dB, 60 Hz to 10kHz (except 36 dB notch at 240/250 Hz)
Flutter and WOW (for Components from 0.5 to 250 Hz)		
15 IPS	.1% RMS	.1% RMS
7.5 IPS	.15% RMS	.15% RMS
Signal-to-Noise	55 dB[5]	40 dB[6]

INPUT SPECIFICATIONS

Power Required

60 cycle, single phase	at J30, 117V ±10%, 16 amps	1.3 KW
	at J31, 117V ±10%, 16 amps	1.6 KW

Power Required

60 cycle	(Auxiliary circuit provides 20 amps at AC facility outlets; 30 amp input circuits are recommended to above inputs)
50 cycle	234 volts ±10%, AC single phase 3KW approx.
Video Input Impedance	Terminated in 75 ohms
Video Input Signal (A or B) (Switchable Inputs)	Input signal level may be between 0.5 volt p/p and 1.4 volts p/p composite signal:
Audio Line Input (A or B)	
Channel A	Line input level between 0 and 36 dBm 15,000 Ohm bridging input. 600 Ohm termination available. May be reconnected for 600 or 150 Ohm matching input, balanced or unbalanced
Channel B	Same as Channel A
Cue Line Input	Same as AUDIO Channel A
Sync (A & B)	3.0 to 5.0 v p/p, negative polarity can be looped through or terminated.
Color Subcarrier (For Color Playback)	1.5 to 2.5 v p/p bridging or 75 ohm termination
RF Copy Input	1 volt p/p, 75 ohm termination

OUTPUT SPECIFICATIONS

Video Line Outputs[9]

Type of Signal	Composite monochrome or color
Video Level	Black to White: 0.5 to 1.0v p/p
Sync Level	0.2 to 0.4 p/p
Pedestal Level	±20% of video level
Burst Level	0.2 to 0.4 v p/p (Color only)
Chroma Level	±20% of nominal level (Color only)
Source Impedance	75 ohms
Load Impedance	75 ohms

TECHNICAL DATA (Continued)

Tape Sync Output	Standard sync signals, 3.5 to 5 volts p/p
Color Monitor Output	1 volt peak-to-peak composite video waveform follows monochrome Picture Monitor switcher.
Audio Line Output	8 VU at 0 meter reading corresponds to 18 dbm peak output level into 600/150 ohms.
Cue Line Output	8 VU at 0 meter reading corresponds to 18 dbm peak output level into 600/150 ohms.
Audio Monitoring	5 watts into an 8-ohm speaker (+37 dbm maximum).
RF Copy Output	
Level	1.0 v p/p
Load Impedance	75 ohms

MECHANICAL SPECIFICATIONS

Transport	Centrally located at 45 degree angle and at reel height of 48" (122 cm)
Cooling	Filtered, forced air
Dimensions	
Width (overall)	55" (140 cm)
Width (Less End Panels)	53" (134 cm)
Height	71¼" (181 cm)
Depth	26½" (67 cm)
Shipping Information	
Width	61¼" (155.5 cm)
Depth	35" (88.8 cm)
Height	84" (213 cm)
Volume	125 cu. ft. (3.75 cm^3)
Gross Weight	1800 lbs. (816 Kg)

1. SMPTE standard PH-22.123
2. SMPTE standard PH-22.122
3. SMPTE standard PH-22.121
4. Edit pulses must be present on tape.
5. Measured between recorded signal at level producing 3% total rms distortion at 1000 cycles and noise on erased, unmodulated tape moving at standard speed.
6. Measured between recorded signal at level producing 5% total rms distortion at 1000 cycles and noise on erased, unmodulated tape moving at standard speed.
7. Decrease in rf level at demodulator input producing a 10% decrease in video output level.
8. Under these conditions the equipment will meet all specifications within 5 minutes from a cold start.
9. Three video outputs are provided, having either a composite or non-composite signal as determined by switch inside the video output module, 433.

DESCRIPTION

The RCA Type TR-70 Television Tape Recorder (see figure 1) is a quadruplex machine designed to record and playback television signals and accompanying sound in broadcast applications. Two versions of the equipment are available, one designed for domestic use and one for international use. The units are basically similar but differ as to power supply and line scanning standards. Refer to the listing in *EQUIPMENT SUPPLIED.*

Functional Description

The RCA TR-70 TV Tape Recorder is designed to produce in monochrome and in color reliable television tapes. The TR-70 is a complete system within itself. See figure 1. With a new highband, air-bearing headwheel, all standards of operation, domestic or world wide are possible, as indicated in the two separate MI-listings in the chart, either line standard 525 only at 117 volts for domestic use or line standards 405/525/625 at 234 volts for international applications. All circuitry relating to the basic requirements of the system are built-in; no extra modules are required to operate on different standards in the international machines.

Special features have been incorporated into the TR-70 equipment. A new recording and playback mode, HIGHBAND, utilizes higher FM deviation frequencies for both color and monochrome. This features makes possible multiple generation copies of good quality. Pixlock completely synchronizes

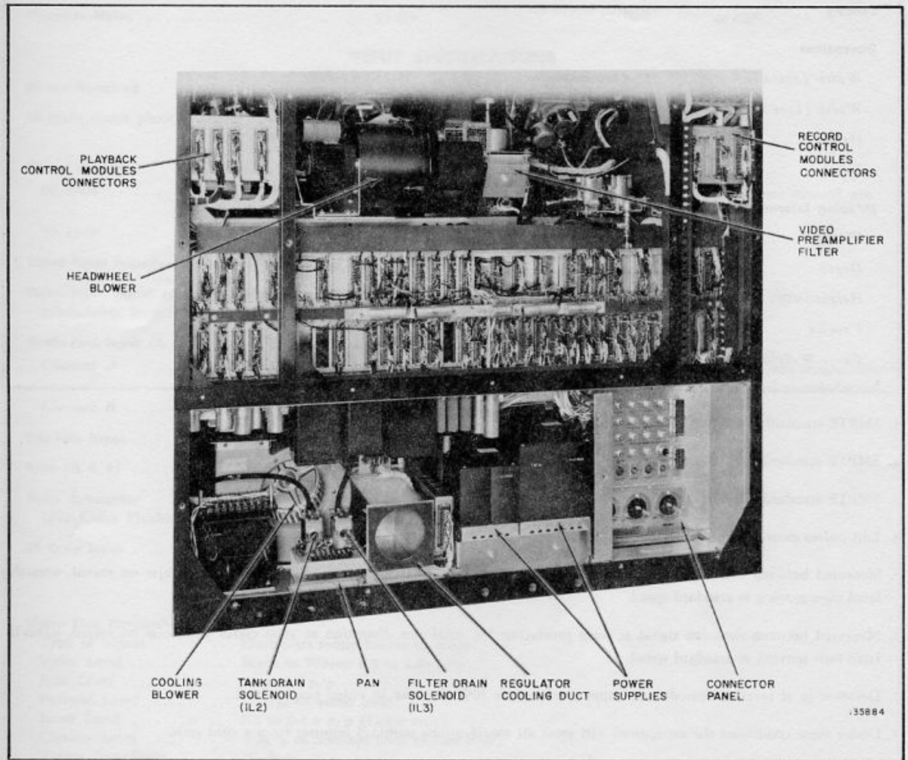


Figure 2—Rear View of Recorder, Covers Removed

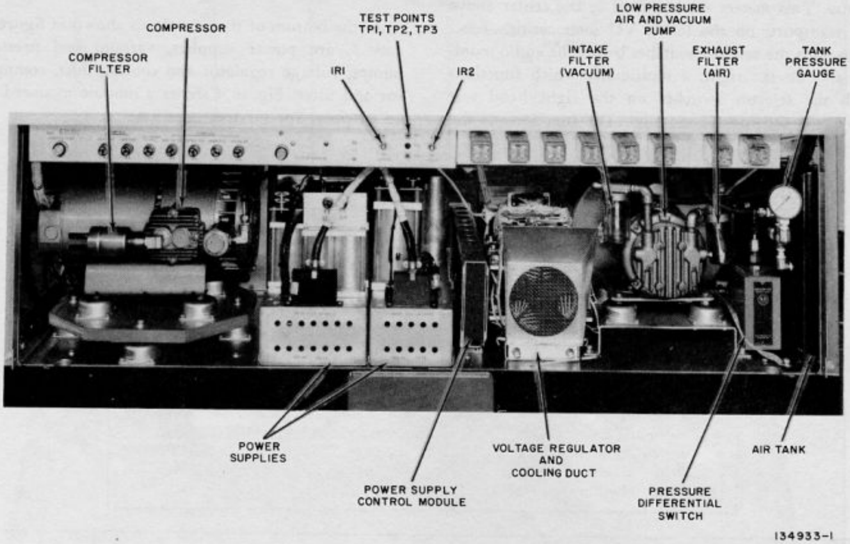


Figure 3—Partial Front View, Bottom Panel Removed

switching between tapes, studio signals and other sources and permits fade out and special effects; line-lock permits color operation with rapid recovery from disturbances. The automatic timing correctors achieve a high degree of stability. A selective erase head has been provided to allow for the simple addition of electronic splicing. A completely self-contained FM Test Facility allows the performance of several special tests in headwheel optimization, eliminating the need for external test equipment for this operation.

Physical Description

At the top of the TR-70 TV Tape Recorder unit, as shown in figure 1, are three transistorized monitors, audio, picture and waveform monitors. All three monitors are mounted on slides allowing them to be tilted forward for easy access to fine adjustments. Directly below the monitors is the panel for all the selector switches. Under the audio monitor are pushbuttons for selecting the functions to be monitored by the audio monitor and the VU meter and for selecting the signal to be viewed on the picture monitor. Directly under the picture monitor, the illuminated pushbuttons select the desired combination of operating mode: LBM, LBC and HB, tape speed, local or remote operations. Under the CRO monitor is a set of pushbuttons for selecting the signal to be viewed.

In the center, the tape transport panel is slanted at a 45-degree angle for ease in loading reels and threading tape. Tape threading is simple with its path guided by cone-shaped posts and tension arms. The control panels, on either side, and all the indicator lights and selector switches are visible and reachable from this central area.

At the left of the transport panel is the Record control panel, at the right, the PLAY control panel. The Record and Play functions are separated to eliminate the chance of error or accidental erasures. The modules for the input amplifiers for video, program audio and cue channels are mounted just below the record panel and the modules for the output amplifiers for these channels are mounted just below the Play control panel. Above the Record control panel a row of warning indicators provide a visual check of many functions. Above the Play control panel, a row of mode indicators show the mode of operation in use. Two meters are mounted in the center above the transport; on the left a VU meter which functions with the selector switches below the audio monitor and on the right, a multimeter which functions with the selector switches on the right hand just above the top row of modules. The functions of the modules are covered in the instruction book IB-31856 together with the operating procedures.

At the bottom of the console, as shown in figures 2 and 3, are power supplies, vacuum and pressure pumps, voltage regulator and cooling duct, compressor and filter. Figure 4 shows a module mounted on an extender for service.

INSTRUCTION BOOKS FOR TR-70 TV TAPE RECORDER

Title	*IB-Number*
Diagrams	31853
Parts List	31854
Description and Installation	31855
Operation Manual	31856
Video Processing	31857
Servo Systems	31858
Control and Power Supply Systems	31859
Tape Transport and Air Systems	31860
Audio System	31861
Video and FM	32113
Waveform Monitor	31825
Picture Monitor 525/625	32103
Picture Monitor 405/525/625	32107

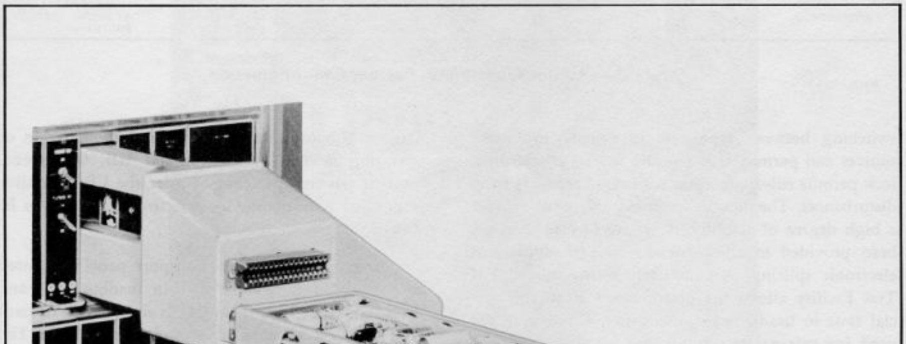


Figure 4—Module on Extender for Servicing

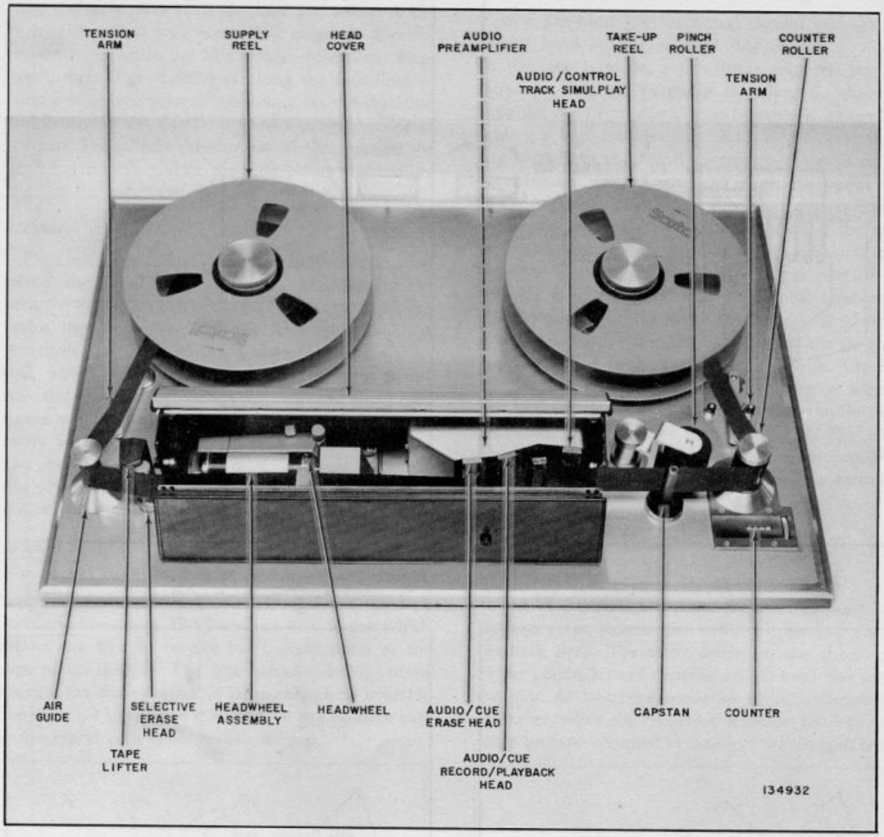


Figure 5—Tape Transport Panel, Head Cover Open to Show Threading

FUNDAMENTALS OF TV TAPE RECORDING

The following is a summary of the important concepts required for a general understanding of magnetic tape recording.

Magnetic Recording Principles

Recording

Magnetic tape consists of a thin plastic backing coated with a binder containing iron oxide particles. Signals are recorded on the tape with an electromagnet called a record head. (See figure 6.) The iron core of the record head is U-shaped and the small gap between the poles is filled with a non-magnetic material. The core and gap form a complete magnetic circuit for the lines of magnetic flux which appear whenever a signal current is fed into the coil.

The flux density through a cross-section of the magnetic circuit depends on the signal current and the medium through which the flux is passing. Since the flux density in the gap is lower than in the core the flux lines spread out at the gap to form a fringing field. (See figure 7.) When the magnetic tape is

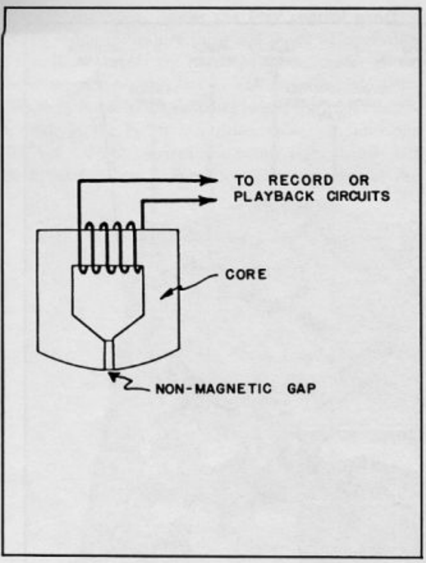


Figure 6—Typical Magnetic Head

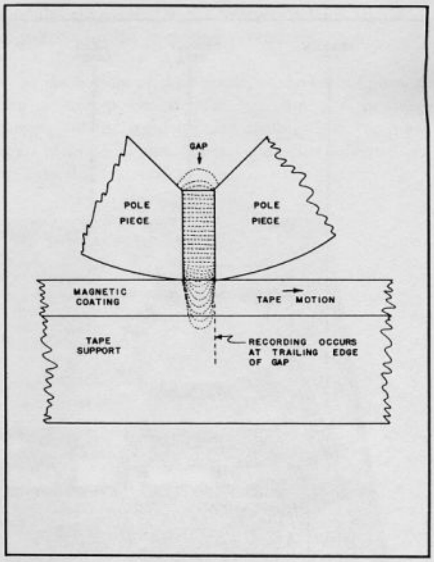


Figure 7—Simplified Sketch of Flux Lines in a Recording Gap

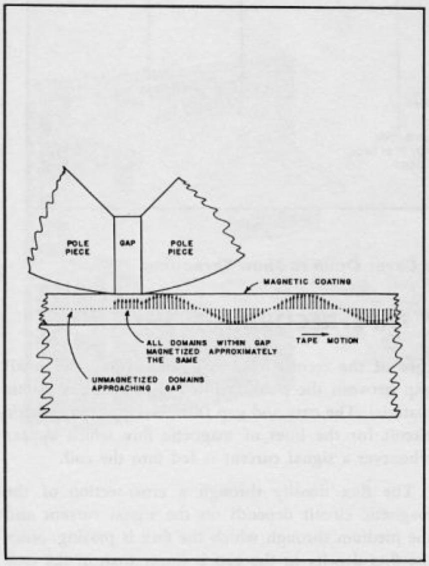


Figure 8—Direct Recording Process

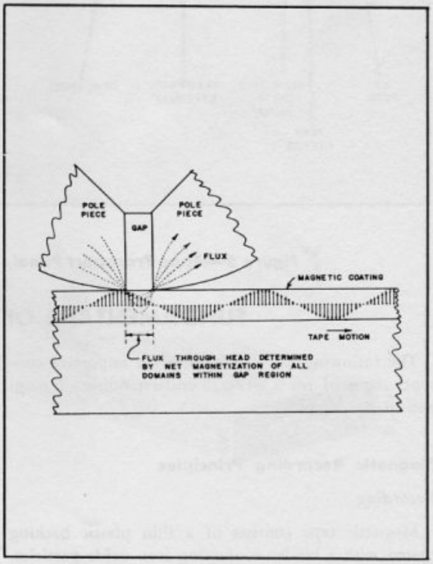


Figure 9—Playback Process

placed against the head, bridging the gap, flux lines from one pole piece enter the tape and return to the core at the other pole piece. The magnetic domains on the tape, which act like minute permanent magnets, then align themselves along the flux lines to form a magnetic pattern depending on the direction and density of the flux lines when the tape just leaves the gap. The pattern remains on the tape because the head has no effect after the tape passes the trailing edge of the gap. (See figure 8.)

Playback

Playback is accomplished by relative motion between the tape and a playback head similar or identical to the record head. As the magnetic pattern across the gap varies, the flux lines from the tape enter the core and induce a signal voltage in the coil, which depends on the number of turns in the coil and the rate of change of magnetic flux. (See figure 9.) In turn, the rate of change increases directly with frequency. If the tape speed is constant and the effects of head resonance and gap width are neglected the induced voltage rises with frequency at a rate of 6 db per octave.

Erasure

Erasure is accomplished by applying a high-frequency, constant-amplitude a-c signal to the tape with an erase head. This head has a wide gap which allows the flux to reverse itself many times as the tape passes the gap. The tape becomes demagnetized because the erase current is large enough to override the recorded signal and the negative and positive half cycles cancel each other across the gap.

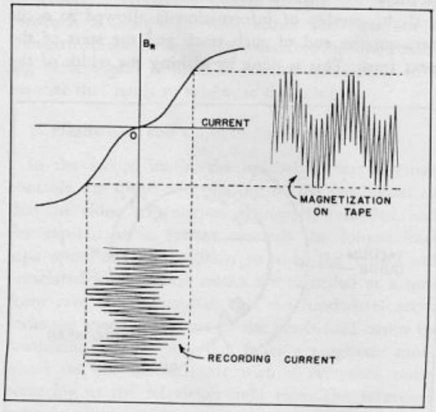


Figure 10—Use of High Frequency Bias in Recording

High Frequency Bias In Audio Recording

If a graphical plot of signal current through the record head against residual flux density produced in the tape is made, a non-linear magnetic transfer curve is obtained. In audio recording on magnetic tape the distortion due to non-linearity is reduced by adding a high-frequency constant-amplitude alternating current to the signal current in the coils of the record head. (See figure 10.) Both the upper and lower peaks of the envelope then trace out replicas of the signal current. The combined effect is the same as if two signals were applied to the tape, one confined to a linear segment in the upper part of the transfer curve, and the other to a linear segment in the lower part of the curve. Each segment provides a separate output but the two signals are in phase and are added to each other on the tape. The bias frequency is generally at least five times as high as the highest signal frequency and the amplitude is about ten times greater than the signal. The effect of the bias on the reproduced signal is negligible because it has too high a frequency to be recorded.

Limitations of Magnetic Recording

High Frequency Response

One of the most important factors that limit high frequency response is the width of the gap in the playback head. The effect arises because the output of the playback head depends on the total flux across the gap. At low frequencies no effect is discernible. However, when the frequency increases until the distance on tape occupied by one half wavelength is less

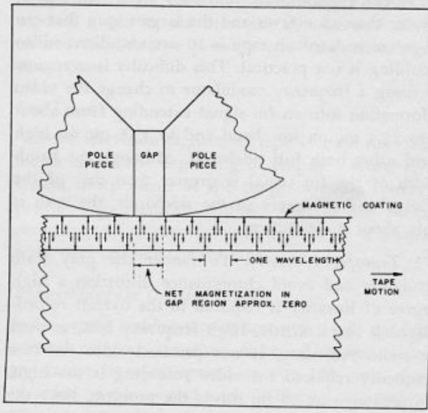


Figure 11—Wavelength Limitation in Tape Playback

than the gap width parts of both positive and negative half cycles appear across the gap simultaneously and start to cancel each other. (See figure 11.) When the wavelength equals the gap width the cancellation is complete and the output is zero. Thus, for a given gap width the highest frequency that can be played back without cancellation has an equivalent wavelength of twice the gap width. The limit can be extended by reducing the gap width, increasing the recording speed or both.

Octave Span

During playback tape noise is present in the output at about 60 db below saturation level. At sufficiently high signal levels the noise is unnoticeable. However, as the signal frequency is reduced, the response falls and the signal to noise ratio decreases. This effect limits the relative bandwidth, or the number of octaves between the highest and lowest frequencies. If the highest frequency is recorded at saturation the signal level 10 octaves below is 60 db down or equal to the noise level. As a result the largest frequency spread that can be accommodated in a magnetic tape system is about 10 octaves.

Television Recording Techniques

Frequency Modulation

In television recording the video information is placed on the tape in the form of a frequency modulated signal. This solves a number of problems simultaneously as follows:

1. *Octave Span.* Since the video signal has a span greater than 18 octaves and the largest span that can be accommodated on tape is 10 octaves, direct video recording is not practical. This difficulty is overcome by using a frequency modulator to change the video information into an fm signal extending from about 1 to 11.4 mc on low band and to 13.6 mc on high band using both full sidebands. Although the bandwidth of the fm signal is greater than that of the original video because of the sidebands, the span is only about three octaves.

2. *Transfer Linearity.* To render the gray scale accurately and avoid chrominance distortion a high degree of linearity is required in the overall record-playback characteristic. High frequency bias, as used in audio recording, is not practical since the bias frequency required for video recording is too high. Fortunately, use of fm solves the problem, since the symmetrical amplitude non-linearity produced by the tape characteristic does not change the time between successive crossings of the zero axis, and preservation of these time relations permits demodulating the signal without distortion.

3. *Signal-To-Noise Ratio.* In addition to the preceding benefits use of fm permits increasing the signal-to-noise ratio by recording the signal at a constant level high enough to saturate the tape.

Transverse Recording With Rotating Headwheel

As previously explained (under *Limitations of Magnetic Recording*) high frequencies can be recorded by moving the tape longitudinally at high speed past a head with a narrow gap. This method, however, is not feasible for television recording because of the excessive length of tape required.

The difficulty is overcome by moving the head at high speed across the tape while the tape itself moves at a much lower speed between the supply and takeup reels. This is accomplished by scanning the width of the tape with a rotating wheel, or headwheel, containing four tiny heads mounted at 90 degree intervals around the circumference. (See figure 12.) Each head starts across the left-hand edge as the preceding head approaches the right-hand edge. Since the tape moves slowly at right angles to the wheel motion, the signal is recorded on a series of parallel transverse tracks with a slight pitch, or angle from the horizontal.

With a headwheel speed of 240 revolutions per second and tape speed of 15 inches per second, a one-hour program requires only 4800 feet of tape, or a reel only 12½ inches in diameter.

To permit reassembling the information recorded in the series of tracks into a smooth continuous signal a slight overlap of information is allowed to occur between the end of each track and the start of the next track. This is done by making the width of the

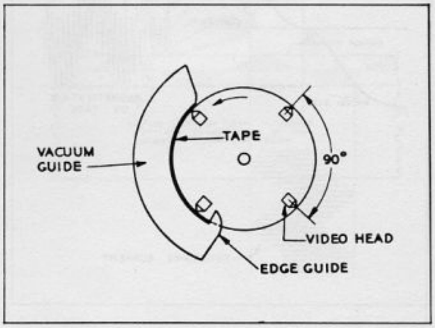


Figure 12—Video Headwheel

tape greater than the length of a 90 degree arc on the headwheel. In the playback process the overlap is eliminated by an electronic switcher which makes the transfer between head signals during horizontal blanking so that switching transients will be invisible.

Use of four video heads introduces other problems such as quadrature errors and differences in sensitivity and frequency response between heads. Quadrature errors consist of slight deviations in spacing of two adjacent heads from a true 90-degree arc. If uncorrected the errors cause the band of (16 or 17) tv lines scanned by a given head to be recorded or reproduced either too soon or too late in relation to the preceding or following headbands, resulting in breakup of vertical lines in the picture into a series of horizontally displaced steps. These timing errors are corrected electrically by adjustable delay lines in the recording and playback system. Differences in sensitivity and response of the heads are minimized by individual gain adjustments in the record amplifier system and individual equalization controls in the playback system.

Servo Systems

One of the major requirements of a TV tape recorder is precise timing. Even small timing errors cause picture distortion, flutter and loss of synchronization in the reproduced picture. To minimize these errors, closed-loop servo systems are used to control the motors that drive the headwheel, and the capstan, and position the curved guide which determines pressure of the video heads against the tape. In a closed-loop servo system automatic control is achieved by feedback from the output of the system. The feedback is compared with either the input or a standard reference in an error detector and the resulting error signal is used to control the output in a manner that tends to minimize the error.

1. Headwheel and Capstan Servo Systems

In the record mode, the headwheel servo system controls the speed and phasing of the headwheel so that the video information is properly recorded, and the capstan servo system controls the longitudinal tape speed via the capstan so that the video and associated longitudinal tracks are recorded at a uniform rate. To accomplish this the headwheel servo locks the speed and phase of the headwheel motor by comparing a pulse derived from a magnetic tonewheel on the motor shaft with a reference pulse occurring at the television field rate. The reference pulse is phased with respect to the vertical interval of the video input signal so that vertical sync is recorded in the center of the video track. The capstan motor is driven synchronously by a signal at the field rate, which is derived from the tonewheel pulse generated by rotation of the headwheel shaft. Thus, the headwheel and capstan motor rotations are closely locked during recording. To maintain a record of the tonewheel motion, for use by the capstan servo system during playback, the tonewheel pulse is converted to a sine wave and recorded longitudinally on a separate track near one edge of the tape.

During playback, the functions of the headwheel and capstan servo system are more complex. The ultimate objective, Pixlock, is exact synchronism between the recorder video output and the sync signal from a local synchronizing generator. The capstan servo controls the longitudinal tape speed and phasing so that the video heads track properly on the recorded video tracks and the vertical sync signal from the tape occurs at approximately the same time as the local vertical sync. Once this is accomplished, the headwheel servo phases the headwheel so that the tape vertical and horizontal sync pulses are exactly synchronized with the corresponding local sync pulses.

NOTE: In the PLAY mode a selector switch permits a choice of four degrees of servo control called Tonewheel lock, Switchlock, Linelock, and Pixlock. *See Simplified Functional Description of TR-70 TV Tape Recorder* for details, p. 19.

2. Vacuum Guide Servo System

In the vacuum guide servo system feedback from the tape is obtained from horizontal sync in the video being played back, which contains timing errors caused by incorrect positioning of the vacuum guide. An error detector controls a motor which moves the vacuum guide in the direction of increased or decreased head-to-tape pressure until the error signal disappears.

Cue Track

Since television signals on tape contain no visible indication of the beginning or end of a scene, a cue system independent of the program audio system is provided to facilitate editing. This system permits recording voice cues or tone signals on a separate track near one edge of the tape.

Frame Pulse On Control Track

To permit making tape splices which will not cause vertical rollover a narrow pulse which occurs once per frame is superimposed on the 240 cycle signal recorded on the control track. When a tape developer solution is applied to the control track the frame pulses become visible and serve as reference marks to permit identifying the correct places to cut the tape.

STANDARDIZATION OF RECORDINGS

Tapes made on any quadruplex machine may be played back on any other quadruplex machine if they are made to all SMPTE Standards, SMPTE Recommended Practices, and ASA Standards. On the domestic (525 line) video tape recorder the signals are recorded on the tape in accordance with the following SMPTE Standards:

1. Tape Reels Dimensions	PH22.116
2. Tape Dimensions	PH22.123
3. Tape Leader Spec.	PH22.115
4. Patch Splices	RP-5
5. Audio Recording	PH22.121
6. Track Dimensions	PH22.120
7. Modulation Levels	RP-6
8. Tape Speed	PH22.122
9. Vacuum Guide Radius	RP-11
10. Control Track	RP-16
11. Signal Specs.	RP-10
12. Video Post Emphasis	(To be published)

Recording standards for the international machine follow the current recommendations or proposals. The 405 line system conforms to the current ITA and BBC specifications. The 625 line system conforms to the CCIR Document Doc. X/27-E set forth by the EBU.

FM Standards

To obtain the best signal-to-noise figures and general overall best response, new pre- and post-emphasis curves have been used in the modulation and demodulation paths. They vary from standard to standard and are consistent with the SMPTE RP10 recommendations. It is worth noting that the new curves for low band mono and color do not match the curves used on previous machines and that the high band pre- and post-emphasis starts at a lower frequency than the other standards.

Modulation Limits

The following modulator limits chart shows the carrier and deviation frequency for all standards of operation.

Line Standard	*FM Standard*	*Sync*	*Black*	*White*
525/405	LB Mono	4.28	5.0	6.8
625	LB Mono	5.0	5.54	6.8
525	LB Color	5.5	5.79	6.5
525/405	HB Mono/Color	7.06	7.9	10.0
625	HB Mono/Color	7.16	7.8	9.3

TV Standards

On international machines, switching is provided to accomplish the changes required when the various standards are desired.

Description of Tracks on TV Tape

Figure 13 shows the location and dimensions of the tracks on television tape. Four types of tracks are recorded: the video, audio, cue and control tracks. The video tracks are transverse and the others are longitudinal. The control and cue tracks are adjacent to each other near one edge of the tape and the audio track is at the opposite edge. Guard bands are provided between the tracks to prevent crosstalk.

The geometry of the video tracks is determined by the speed of the rotating headwheel, the longitudinal tape speed, the length of the gap in the video head, and the length of the arc into which the tape is

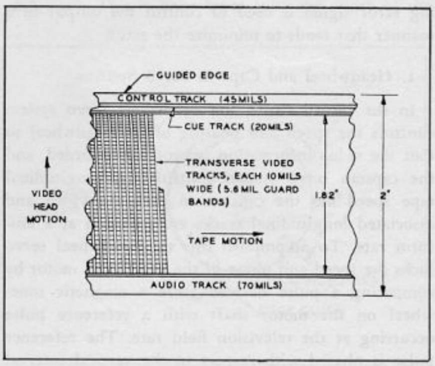


Figure 13—Tracks on Television Tape (Not to Scale)

curved by the vacuum guide. For 525 line standards, the gap width is ten mils, and the resultant of the vertical and horizontal motions causes the tape to move 15.6 mils fo reach head scan, or quarter revolution. Thus the tracks are 10 mils wide and the displacement between the beginning and end of a track is 15.6 mils. This leaves a guard band of 5.6 mils between tracks. Approximately 18.4 horizontal TV lines are recorded per track, and each horizontal line occupies 5.5 degrees of arc of 0.1 inch. Since each head starts across the tape when the preceding head reaches the 90 degree point the last two lines of each track contain the same video information as the first two lines of the next track. During playback, this overlap is eliminated by a switching circuit so that the average of slightly more than 16 lines per track is used. Thus one frame occupies 32 tracks or ½ inch of tape length.

SIMPLIFIED FUNCTIONAL DESCRIPTION OF TR-70 TV TAPE RECORDER

General

A simplified overall block diagram illustrating the main features of the TR-70 Tape Recorder are shown in figures 14 and 15. The large blocks are further broken down into systems and modules, and the main circuit paths are shown in the *Functional Block Diagram,* figure 29.

The video record and video playback systems include FM and RF circuits, as well as video circuits, since the signal recorded on the tape is a frequency modulated radio frequency carrier. Because four video heads are used, portions of this circuitry are present in quadruplicate. The audio record and playback circuits perform functions very similar to those well-known for audio tape recorders. The three servo mechanism which control the headwheel speed of rotation, the vacuum guide positioning and the capstan speed and phase are associated in application and performance. In addition, control circuits are required to perform the many functions required for operational modes.

Record Mode

The following is a summary of the action of the machine during recording.

Tape Path

Tape motion is controlled by three independent motors which drive the supply reel, the capstan and the takeup reel. (See figure 5.) During recording (or playback) the tape speed is governed by the capstan, and the reels merely provide constant torque. In the WIND mode, the tape is pulled by the winding reel, while the unwinding reel provides tension by pulling in the opposite direction. The reel brakes are automatically applied whenever the machine is placed in the STOP mode. However, a foot-operated switch at the bottom and center of the recorder permits releasing the brakes so that the reels can be turned manually during tape threading.

To remove speed variations and to take up excess tape if erratic motion occurs, a swinging tension arm is provided just below each reel. Tape breakage switches operated by both arms automatically stop the machine if the tape breaks or the supply reel runs out of tape. A stationary air-lubricated tape guide is provided below the tension arm of the supply reel which positions the tape for its approach to the video headwheel. The guide consists of a post perforated with tiny air holes and provided with flanges at the edges. Air forced through the holes lifts the tape slightly off the surface, and the flanges provide the guiding action.

Tape from the supply reel proceeds under the tension arm, over the air guide to a 2-inch wide master erase head, and then to the headwheel which rotates at right angles to the tape motion. Below the headwheel, a vacuum guide establishes suction which curves the tape transversely to fit the wheel and presses the tape tightly so that the heads penetrate the tape. The guide position, which determines the head-to-tape pressure is controlled by a motor behind the tape transport panel. The motor is driven by the guide servo system which, in the record mode, merely fixes the position of the guide in accordance with the setting of a manual potentiometer on the record control panel. The automatic positioning circuits of the vacuum guide servo are not active in the record mode.

After leaving the headwheel, the tape passes under the control-track head, which records a 240-cycle sine wave mixed with a narrow 30-cycle frame pulse. The 240-cycle signal is used during playback to establish the timing of the capstan servo system so that the video heads scan along the recorded tracks. The frame pulses permit locating the correct places to cut the tape during splicing.

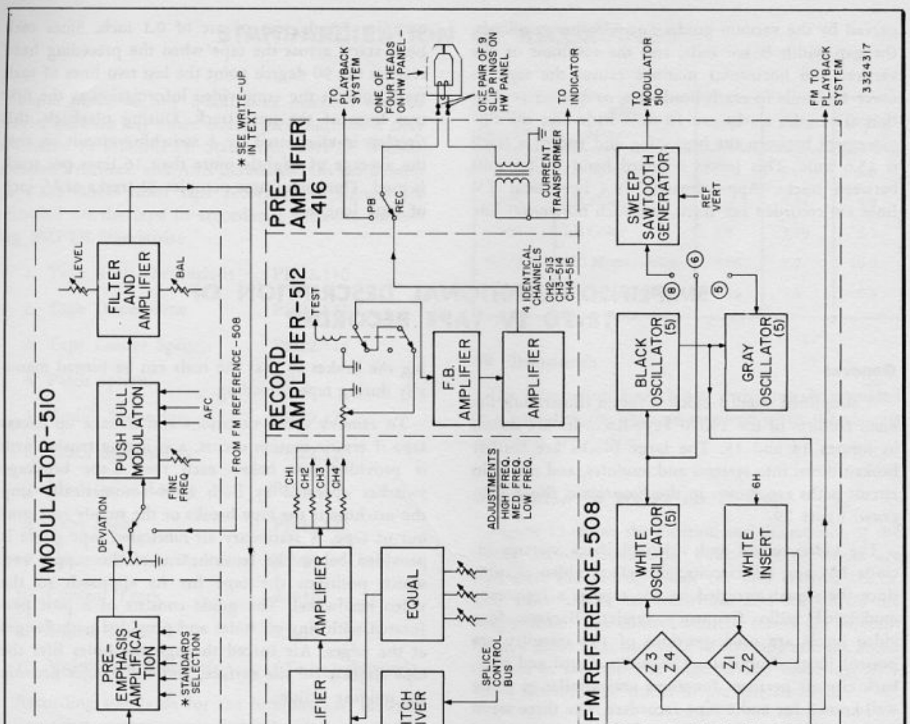


Figure 14—Block Diagram Showing Video Recording System

The tape next passes under three supports in sequence, each containing two heads concerned with tracks at opposite edges of the tape. The first support contains the erase heads which remove excess video to provide space for recording the audio and cue tracks. The second support holds the cue and audio record/playback heads. The third support holds the simultaneous playback heads which permit monitoring the audio and control tracks during recording. Because of the distance between the headwheel and the audio and cue heads, the two sound tracks are recorded 9 inches ahead of the corresponding video tracks.

The tape next proceeds to the capstan and pinch roller. The pinch roller which is actuated by a rotary solenoid during recording and playback, provides friction which enables the capstan to pull the tape. The capstan motor is driven synchronously by the capstan servo system so that the tape motion is related to the headwheel motion and the tape speed is 15 inches per second in 60 cycle machines. (The speed is 15.625 ips in 50-cycle machines.)

After leaving the capstan the tape passes under the counting roller and the takeup tension arm to the takeup reel. The counting capstan is geared to a four-digit resettable counter which indicates elapsed time during recording and playback and permits locating desired portions of the tape during rewind. The counter indicates minutes and seconds and has a capacity of 99 minutes and 59 seconds.

Video Recording Process

In the record mode (see figure 14) the incoming video signal is amplified, pre-emphasized, and converted to a double sideband fm signal extending from 1 mc to 11.4 mc lowband and to 13.6 mc high-band using both full sidebands. This signal is applied simultaneously to four individual recording amplifier channels, and then through transfer relay contacts and slip rings, to the four video heads in the headwheel. The level controls permit individual adjustment of the current supplied to each head so that the tape is just saturated.

Eight illuminated pushbuttons located directly under the picture monitor select the desired line standard and FM standard, low band or high band, monochrome or color system. Refer to the chart under *FM Standards*. As shown in figure 14, these switches simultaneously select carrier frequency, deviation, pre-emphasis and post-emphasis and crystal reference circuits for checking carrier frequency and deviation. A clamp circuit in the modulator clamps the video input at blanking level so that the modulator output frequency bears a definite relationship to picture brightness. The maximum deviation from this blanking level frequency is determined by the amplitude of the video signal at the white peaks.

To permit monitoring during recording, the modulator output is fed to the playback system where it is subjected to limiting, demodulation, deemphasis, amplification, and signal processing. The processed video signal is fed to the selector switches for the CRO and picture monitors.

A selector switch is provided to permit making rf copies of tapes being played back on another machine. When this switch is in the RF COPY position the modulator is disconnected and the incoming rf is fed to the four record amplifier channels. An rf copy playback circuit is also provided. See the playback functions block diagram, figure 15.

Audio Recording Process

Separate recording channels are provided for the audio and cue tracks. In each channel the input signal is amplified, high-frequency bias is added, and the combined signal is fed to the corresponding record/playback head through contacts of a transfer relay. There are two audio line inputs to the audio record channel. Refer to figure 16. Approximately one tenth of a second after the audio is recorded, the audio simultaneous playback head picks up the tape signal and feeds it to a pushbutton switch which permits monitoring the signal on the VU meter and speaker. A built-in audio oscillator operated by a push-button on the record control panel permits adding a 400 cycle tone to the cue track at desired locations.

To permit adding commentary to the audio or cue tracks a microphone and a three-position selector switch are provided on the microphone module 504. When the switch is OFF the microphone is disconnected and the incoming lines are connected to each channel. In the AUDIO or CUE positions a relay connects the microphone to the selected channel, disconnects the corresponding line input and causes a red warning lamp above the record control panel to light.

Timing

Both the headwheel and capstan are controlled by servo systems which establish the precise timing required for television recording and playback.

To provide a feedback signal for these servo systems, a tonewheel containing a small notch is mounted on the same shaft as the headwheel. As the wheel

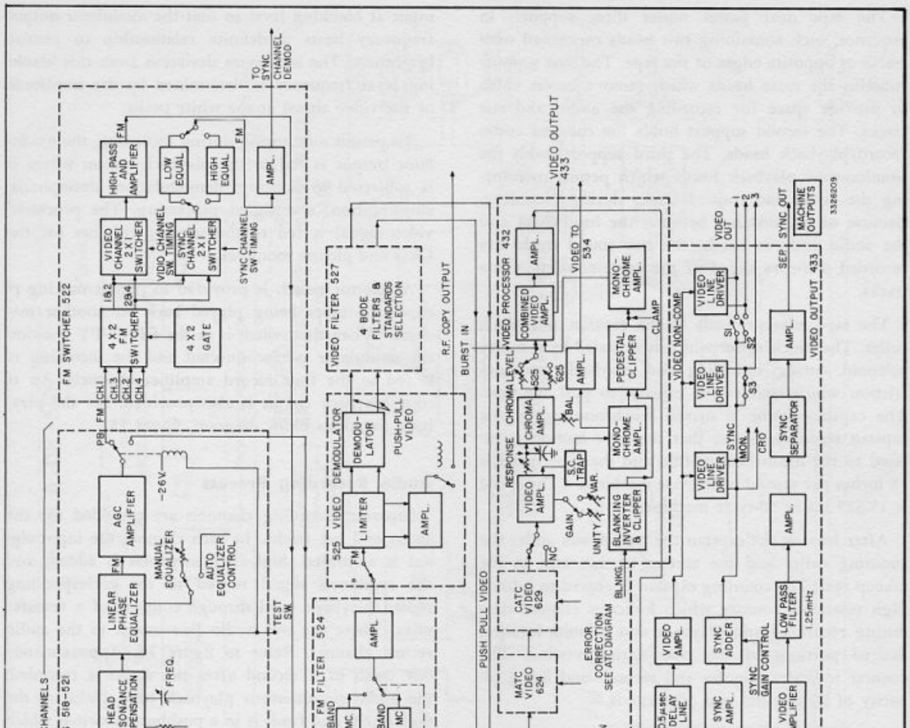


Figure 15—Block Diagram Showing Video Playback System

turns, the notch repeatedly passes through the field of a reluctance pickup and thus generates one narrow output pulse per revolution. Since the angular position of the tonewheel notch is fixed with respect to the headwheel, the tonewheel pulse provides a periodic indication of both the speed and angular position of the headwheel.

NOTE: For convenience, the frequencies and speeds used in the following explanation pertain to 525 line standards since they are common to all machines. For all other standards the numbers should be changed as follows: 50 for 60; 250 for 240; 1000 for 960; 15.625 for 15; 1/10 for 1/8; 40 for 32.

In the headwheel servo system, the tonewheel pulses are compared with a precisely timed 60 cycle reference pulse to produce an error signal. A two-position switch on module 613 permits the operator to select either the incoming video or house sync as the primary timing signal for developing the reference pulse.

When the headwheel speed is correct and the tonewheel pulse bears the correct phase relationship to the reference pulse the change in error signal is zero and the system is in equilibrium. Under these conditions, because of the fixed angular position of the tonewheel with respect to the headwheel, vertical sync is always recorded by head number one at a precisely determined spot near the center of the scanning interval. If the speed or position is incorrect, the error signal causes the headwheel motor to speed up or slow down until equilibrium is re-established.

Once the headwheel is rotating at the desired speed the 240 cycle tonewheel pulse serves as the timing reference for the capstan servo system. This pulse merely triggers a 240 cycle multivibrator. The multivibrator frequency is then divided by four and the resulting output is a 60-cycle signal. This signal is fed to a power amplifier which drives the single-phase capstan motor. The motor, in turn, drives the capstan, which pulls the tape at exactly 15 inches per second. Since the capstan motor is locked to the headwheel motor, both servo systems are controlled by the primary timing reference.

To provide a continuous record of the angular position and speed of the headwheel during recording, the tonewheel pulse is converted to a 240 cycle sine wave which is recorded longitudinally on the control track near one edge of the tape. This control track aids in controlling tape motion during playback, and is analogous to the sprocket holes in motion picture film. To assist in tape editing, a 30 cycle rectangular frame pulse derived from the primary timing source is added to the control track.

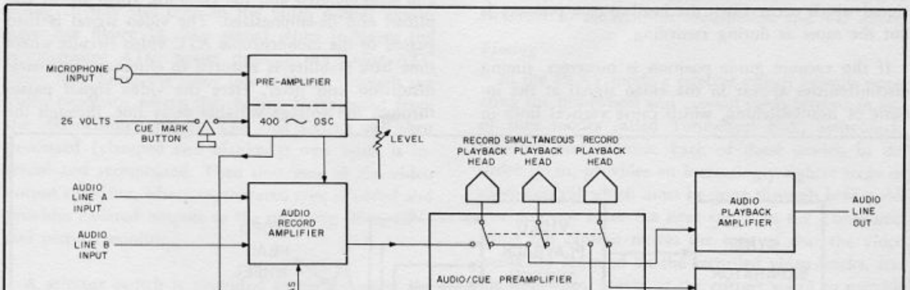


Figure 16—Simplified Block Diagram of Audio and Cue Facilities

The overall timing of the machine in the record mode can be summarized as follows:

1. The main timing reference is either the incoming video signal or a signal from an external source.

2. Pulses from the tonewheel synchronize the headwheel motor with the main timing reference, and the capstan motor with the headwheel motor.

3. The servo systems cause the headwheel to rotate at 240 revolutions per second and the tape to move at 15 inches per second. Thus one revolution of the headwheel takes $\frac{1}{240}$ second or $\frac{1}{8}$ of a frame period. Since one frame is recorded in 8 revolutions and each revolution produces four recorded tracks, one frame occupies 32 transverse tracks on the tape.

Playback Mode

In the playback mode, the tape recorder operates as follows:

Tape Path

The tape path is the same as in the record mode, but the video, audio, cue and control track heads function as playback heads, and the master, audio, and cue erase heads are de-energized. In addition, the vacuum guide servo (see figure 17) system automatically corrects timing errors in the reproduced video signal which occur when the head-to-tape pressure is not the same as during recording.

If the vacuum guide position is incorrect, timing discontinuities appear in the video signal at the instant of headswitching, which cause vertical lines in the picture to break into sloping segments known as "jogs". Since these variations occur at the headswitching rate or 960-cycles they introduce a 960-cycle timing error in the horizontal sync. The vacuum guide servo system then automatically causes the vacuum guide to move away from or towards the headwheel until the error disappears. To permit tests and adjustments, facilities are provided for disabling the automatic circuit and adjusting the guide position manually, with a potentiometer.

Video Path

In the playback mode (see figure 15) the tracks are read sequentially by the four video heads and the fm signals are fed through the slip rings and transfer relay contacts to four fm amplifier channels, and gain and equalization controls to compensate for variations in response of the individual heads. The four fm signals are then reassembled into a continuous signal by an electronic switcher. An overlap of about three TV lines exists between the end of each track and the start of the next track. The overlap is eliminated by performing the switching operation during the first horizontal sync period in the overlap interval.

The continuous fm signal is then equalized, limited and demodulated and the resulting video signal amplified and de-emphasized. The video signal is then passed to the monochrome ATC video circuits where time base stability is restored to eliminate geometric distortion and jitter. Here the video signal passes through the voltage variable delay line, through the

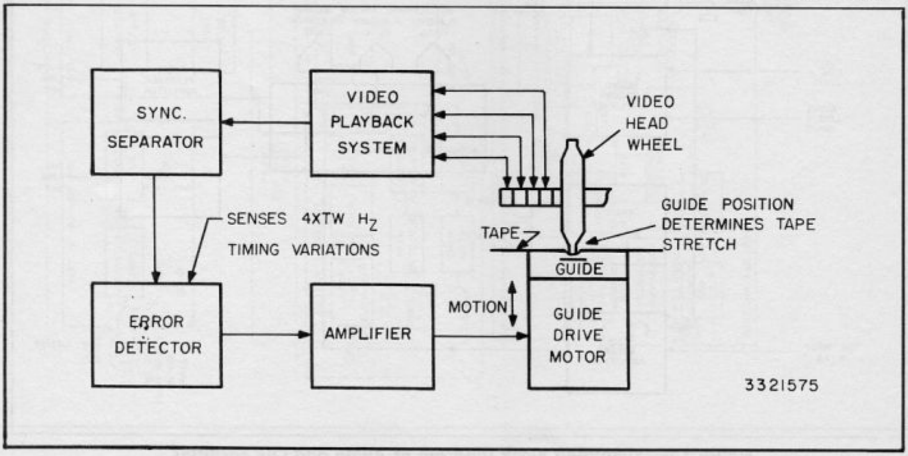


Figure 17—Simplified Block Diagram of Guide Servo System

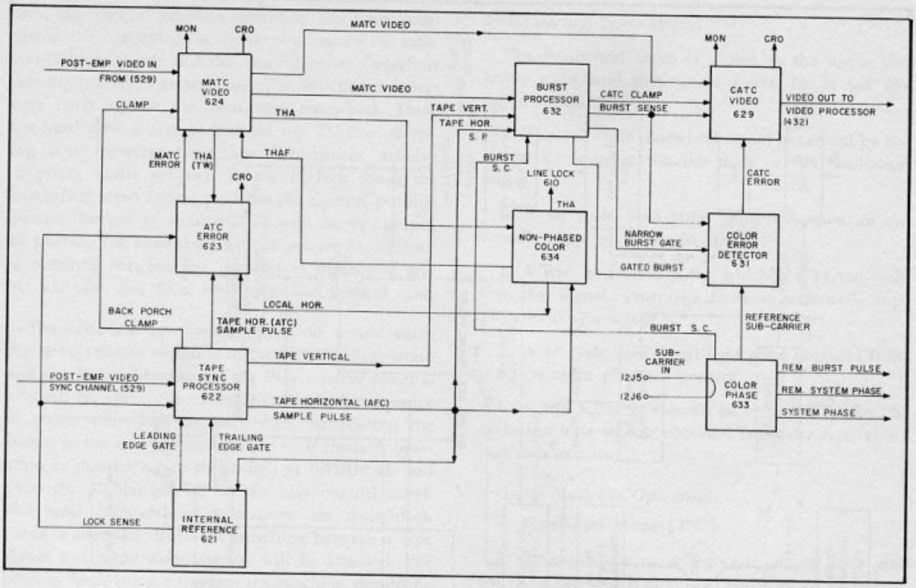


Figure 18—Simplified Block Diagram of ATC

amplifier circuits to the color ATC, the video processing circuits and then to the video output amplifiers. See figure 18. The signal when it leaves the monochrome ATC, passes through the Color ATC delay line. From the delay line it passes through the video processor where the chroma is separated from the monochrome signal. The two signals are then processed (clamped and blanked); new burst is inserted and recombined. Then they pass to the video output amplifier, where regenerated sync is added and provides isolated outputs to the outgoing lines, CRO and picture monitor.

A selector switch is provided to permit using the recorder as the master (playback) machine for making rf copies of pre-recorded tapes. When this switch is in the RF COPY position it feeds the rf signal originating on the tape being played back, after limiting and amplification, to the rf copy output jack, which is connected to the rf copy input of the slave (recording) machine.

Audio Path

The signals picked up by the audio and cue heads are fed by transfer relays to separate preamplifiers and then through line amplifiers to the outgoing lines. The signals are also fed to pushbutton switches which permit connecting them through the monitor amplifier to the monitor loudspeaker and VU meter.

Timing

In the PLAY mode a selector switch permits operating the headwheel and capstan servo systems in any of four modes called Tonewheel lock, Switchlock, Linelock and Pixlock. Each of these modes, in the order given, provides an increasingly tighter stage of servo control which must be gone through before the machine can enter the next stage. In the Tonewheel mode the capstan moves the tape so that the video heads are centered on the recorded video tracks, and the headwheel moves at the correct speed to provide a stable picture with accurately reproduced sync and video frequencies; however, there is no relationship between the phasing of the reproduced sync and local sync. In the Switchlock mode, the capstan servo controls the tape position so that when the vertical interval of incoming local sync occurs, the video track containing recorded vertical sync is being scanned, but the headwheel servo continues to operate in the tonewheel mode. This coarse vertical framing provides the closest possible approximation to coincidence between tape and local sync that can be accomplished by the capstan servo but it does not compensate for errors in placement of the vertical sync on its track during recording. In the Linelock mode,

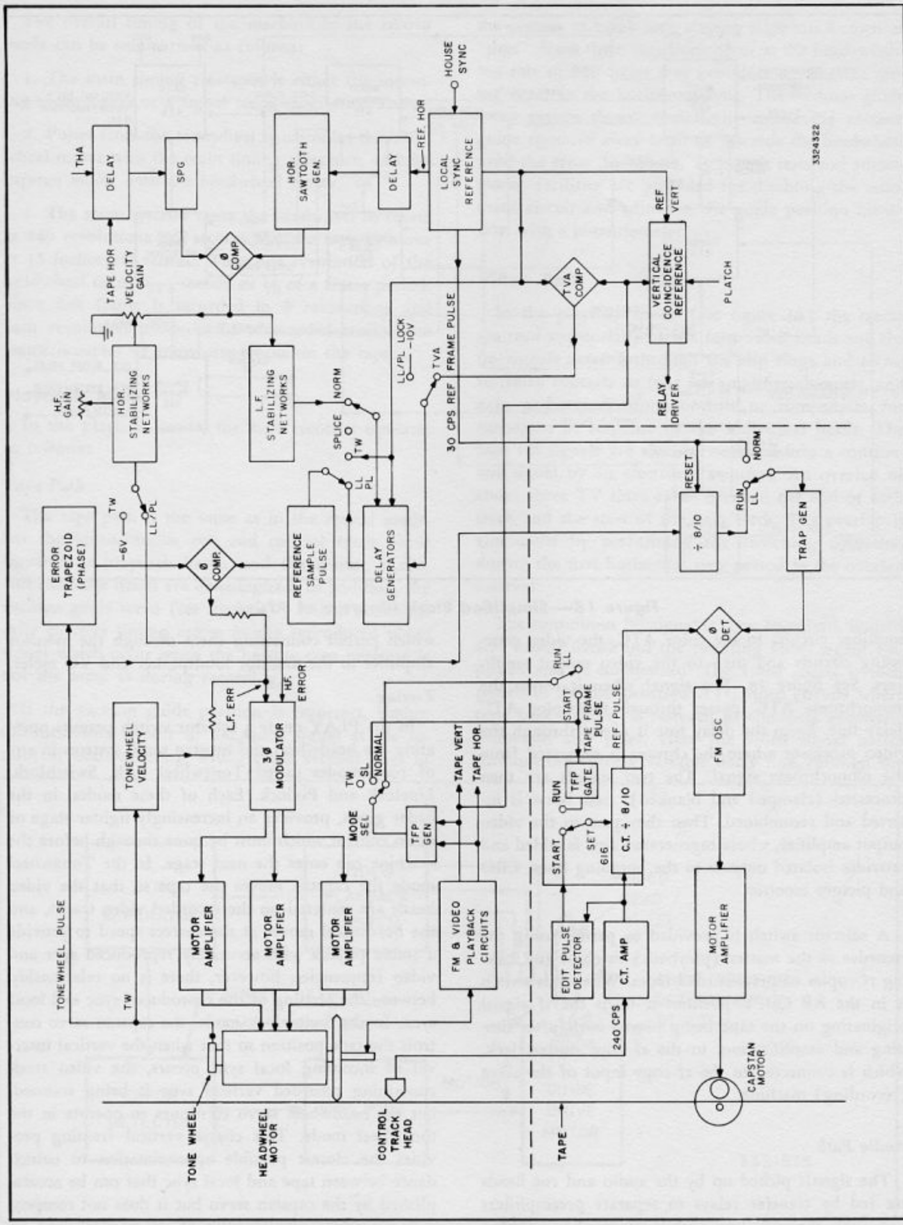


Figure 19—Functional Block Diagram of Headwheel and Capstan Servos Pixlock System

once the vertical framing operation has been completed the vertical coincidence requirement is automatically dropped, and the capstan servo (which is initially locked to external sync) is switched to reference itself against the headwheel tonewheel. Thus, the headwheel is free to lock on any TV line, allowing rapid recovery from tape disturbances, massive dropouts, faulty splices). In the Pixlock mode the headwheel servo system provides the tightest possible control that can be accomplished with the equipment, by phasing the headwheel so that precise coincidence is obtained between the reproduced horizontal and vertical sync and local horizontal and vertical sync.

The complete squence of operation occurs when the servo selector switch is in the NORMAL position and the PL pushbutton on the Play control panel is pressed. However, the operator can halt the sequence at either tonewheel or switchlock by placing the switch in the appropriate position or if linelock operation is desired, place the switch at NORMAL and press the pushbutton LL on the play control panel. For most Monochrome operations the Switchlock mode is adequate. Roll-free switching between a tape signal and other video signals will be attained. For playing back color programs the machine should be in the linelock mode, with the selector switch at NORMAL and the LL pushbutton pressed. For playing back non-interlaced color tapes, the NPC pushbutton on the Play control panel is pressed which automatically puts machine in LL. When it is desired to introduce special effects between tape signals and other video signals, Pixlock is required.

NOTE: For Color operation the CATC switch on 628 module must be in Normal posiiton. See the *Operation Manual*, IB-31856.

A block diagram illustrating the main features of the headwheel and capstan servo systems during playback is shown in figure 19.

Capstan/Headwheel Servo System

1. *Capstan Servo System*

The capstan servo is shown in the lower left corner of the diagram. It has three input signals:

a. The 240 cycle control track signal from the tape.

b. A 30 cycle frame pulse generated from an externally supplied local sync signal.

c. A 30 cycle tape signal frame pulse obtained from the tape video playback circuits.

2. *Headwheel Servo System*

The headwheel servo is shown in the upper and lower right-hand sections of figure 19. It has five input signals:

a. The 240 cycle tonewheel signal generated by the magnetic tonewheel on the shaft of the headwheel motor.

b. A 60 cycle field pulse generated from an externally supplied local sync signal.

c. A Ref. horizontal pulse, which is a 15,750 cycle line rate signal, generated from an externally supplied local sync signal.

d. A 60 cycle tape signal field pulse obtained from the tape video playback circuits.

e. A tape signal horizontal pulse, which is a 15,750 cycle line rate signal, obtained from the tape video playback circuits.

3. *Servo Modes of Operation*

a. Tonewheel Mode (TW)

In the capstan servo, a 240 cycle control track signal from the tape is amplified and divided by binary counters to 30 cycles per second. This 30 cycle pulse is compared with the 30 cycle frame pulse derived from local sync. The resulting error signal is used to frequency modulate a 240 cycle oscillator. The output of this oscillator is divided by four and a 60 cycle signal is generated. The 60 cycle signal is then amplified in a power amplifier to drive the capstan motor. The lock-up between the control track signal and the 30 cycle frame pulse is accomplished very quickly and before the vacuum guide solenoid causes video head contact with the tape.

Additional information is provided to the control track counters by the presence of the edit pulse reset during the initial lock up cycle. If edit pulses are present on the tape, the counters will be reset as soon as the tape begins to move, causing the capstan to lockup with the picture framed vertically as in the Switchlock mode described below. However, framing is not a requirement in the TW mode and cannot be relied on if edit pulses are absent from the control track or following an incorrect mechanical splice in the tape.

When the recorder is started in the playback mode, the headwheel servo is connected so that the tonewheel loop is active. This loop compares the tonewheel signal with the field pulse derived from local sync. The headwheel motor is driven by power amplifiers which are fed a 480 cycle signal that is amplitude modulated to control the motor speed. When the motor reaches a speed of 240 revolutions per second, the output of the phase detector circuit that compares the tonewheel pulse to the reference 60 cycle signal reaches a stabilized condition. This loop of the servo brings the headwheel motor to the correct nominal speed. This circuitry is also used in this manner in the switchlock mode.

b. Switchlock Mode (SL)

In the switchlock mode additional actions occur in the capstan servo:

As in the TW mode described above, the Edit Pulse Detector resets the control track counters as soon as the tape starts to move so that the capstan locks up with the picture vertically framed. In the Switchlock mode, however, framing is a requirement and must be relied on even if edit pulses are not recorded on the tape, or have been incorrectly recorded, or following incorrectly made splices. Therefore, after the guide pulls in making tape video information available, the reset is switched to tape frame pulse assuring that switchlocking is maintained under all conditions.

Since the control track edit pulse and tape frame pulse occur at the same time no visible effects can be seen at the switchover point. The use of the edit pulse results in a Fast Lockup Capstan (FLUC) system for normally recorded tapes.

For the condition where edit pulses are absent from the tape, the phase of the counters will be random at the beginning of the lock-up cycle. When the guide pulls in, the reset action of the tape frame pulse causes the counted down control track pulse (30 cps) to be shifted in phase. The resulting error from the phase detector causes the modulated oscillator to apply speed change information to the capstan motor. The speed change of the capstan causes "slipping" of the tape until framing is achieved.

In this mode the headwheel servo operates basically the same as in the tonewheel mode.

c. Pixlock (PL)

In pixlock operation, when the PLAY and the PL pushbuttons are depressed, and the servo selector switch is at the NORMAL position, the headwheel starts up in tonewheel/tape vertical alignment mode TW/TVA. The capstan goes to switchlock as described above, *Switchlock Mode.* During the time the capstan achieves switchlocking the headwheel has reached velocity lock, and begins the tape vertical alignment phase (TVA). This temporary mode aligns the tape signal more accurately than can be achieved by switchlock, which is required for pixlocking. (Within less than one horizontal line.)

The variable delay generator, inserted in the TW servo reference path, and having a nominal delay of one headwheel revolution (4166 microseconds, Domestic Standards; 4000 microseconds, International Standards) is modulated by the TVA error voltage in such a manner as to cause the TW servo to align tape vertical with reference vertical.

Once the TVA phase of startup has been completed, a vertical coincidence sense gate and lock control logic, switches out the TVA error signal and connects low-passed (phase information) from the Linelock sampler to the same variable delay generator. Thus, linelock error acts through the tonewheel servo to phase tape horizontal with reference horizontal, in much the same fashion TVA error was able to establish vertical alignment. At the same time (upper right corner of diagram) high frequency or velocity information, also derived from the Linelock sampler, is applied directly to the headwheel modulator. Separate low-frequency and high-frequency path anti-hunt stabilizing networks and gain controls have been incorporated which optimize loop gain phase characteristics in each path, as well as provide the special error bus dynamic characteristics required for rapid recovery during system disturbances.

After TVA is complete and the switch-over to horizontal lock has occurred, both the TW and LL servo loops operate simultaneously whereas in earlier systems either one loop or the other was in use. This compound loop arrangement yields significant improvements in overall headwheel stability, jitter, and recovery characteristics.

d. Linelock Mode (LL)

During the startup sequence with the PLAY button and LL button depressed, operation is similar to pixlock in that switchlocking and TVA functions are performed as in the pixlock mode. However, the system logic has arranged for the headwheel servo to attempt pixlock operation.

If pixlock operation is achieved the system will then switch to actual linelock operation. In this condition, the vertical coincidence sense and control circuits are disabled, the capstan reference is switched to tonewheel, and the servo is now free to recover on any TV line subsequent to tape disturbance.

If the headwheel servo is unable to go into pixlock for some reason, after an eight second* time delay interval the servo logic automatically switches the headwheel servo into linelock operation. When switchover to linelock operation has actually occurred, the servos then continue to operate in linelock mode regardless of subsequent system disturbances.

The capstan servo operation also changes somewhat when operating in the LL mode. After lockup, when switched to actual linelock operation, the reference for the capstan servo is switched from Reference Frame Pulse to TW divided by 8 (or 10, in 50 cycle systems). Therefore, the capstan servo will follow changes in phase of the headwheel if it locks up on different lines following disturbances. This assures that the tracking adjustment made with the CT Phase Control will be maintained regardless of the phase of the headwheel.

Recorder Control Circuits

The recorder control circuits use transistors and semiconductor diodes for the logic and memory functions but relays are used for ac power switching. Figure 20 is a simplified diagram of the logic and memory circuits. The blocks labeled WIND, STANDBY, PLAY, SET UP, CUE RECORD, AUDIO RECORD, and MASTER RECORD represent transistor bi-stable flip-flops. These circuits remember the mode of operation selected after the momentary contact pushbuttons are released. When a pushbutton such as the WIND button is depressed, a trigger signal is passed to the WIND flip-flop memory which cause the WIND flip-flop to be turned on. It remains in this condition until one of the other pushbuttons is depressed or power is removed from the machine. In the ON condition, the bus at the lower right of the block is energized and supplies a sensing signal to the unlatch circuits shown in the block at the right of the diagram. If any pushbutton other than STOP is depressed, so that a second memory flip-flop is triggered, the signal on the sense bus is increased to the point where the unlatch circuits send a release signal back to all memory flip-flops and thus restore them all to the OFF condition. This clearing action occurs in a matter of microseconds. Thus, the memory flip-flop associated with the depressed pushbutton restores itself to the ON condition before the button is released. Once the WIND memory flip-flop is in the ON condition, its output bus energizes the diode logic matrix shown in the lower area of the diagram. The reel motors WIND circuit and the reel brake sole-

*This is a safety feature which permits proper Linelock mode operation even though the operator may inadvertently have set Cap Phase to the wrong track. In this case the initial lock will not be completely phased, vertically and horizontally, but will lock horizontally to the nearest line.

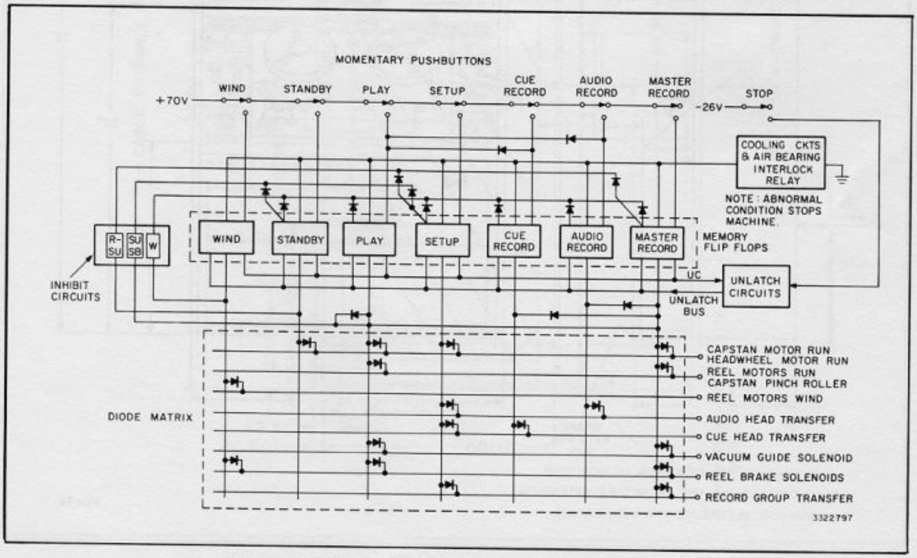


Figure 20—Basic Control System of TR-70 Recorder

noids will then be energized. Inhibit circuits are used to make it necessary to push the STOP pushbutton switch before any other mode of operation. These circuits are shown in the block at the left of the diagram. The WIND output bus energizes inhibit circuits that, in turn, prevent any other memory flip-flop from being triggered until the STOP switch is depressed to restore all memory flip-flops to the OFF condition. As a further guard against damage which might occur if buttons are pressed simultaneously, the power to the pushbutton switches is connected in series with the normally closed side of the switches. Thus, the lowest ranking mode always takes precedence.

The output busses from the diode logic matrix energize transistor driver circuits when solenoids are used to perform the mechanical control function. In the other cases, the output busses energize control relays or transistor switches.

INSTALLATION

Suggested Floor Plan

Since the recorder is a single, compact unit with front accessibility for maintenance, a variety of floor plans are possible. Clearance should be adequate for the extension of monitors and for the use of module extenders. Adequate clearance of the rear from the wall (a minimum of six inches) is also essential for adequate ventilation. Since the input-output connector board is mounted at the rear, left hand corner, bottom shelf, of the recorder, the consideration of additional space for easy access to the panel is also important. Refer to figure 21 for these dimensions.

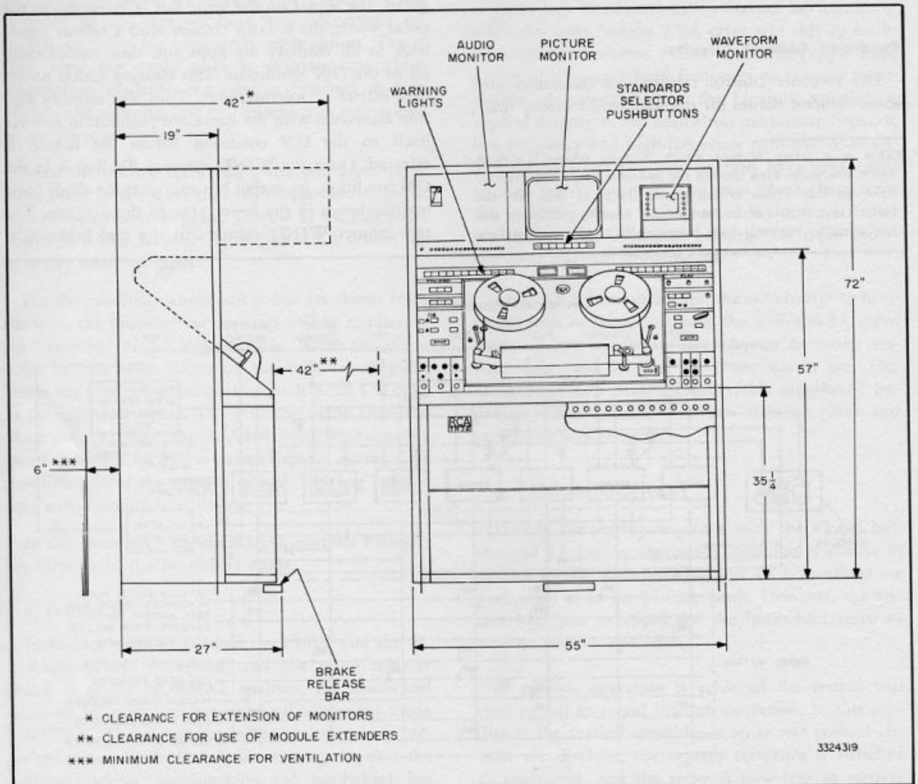


Figure 21—Outline Drawing Showing Overall Dimensions of TR-70 Recorder

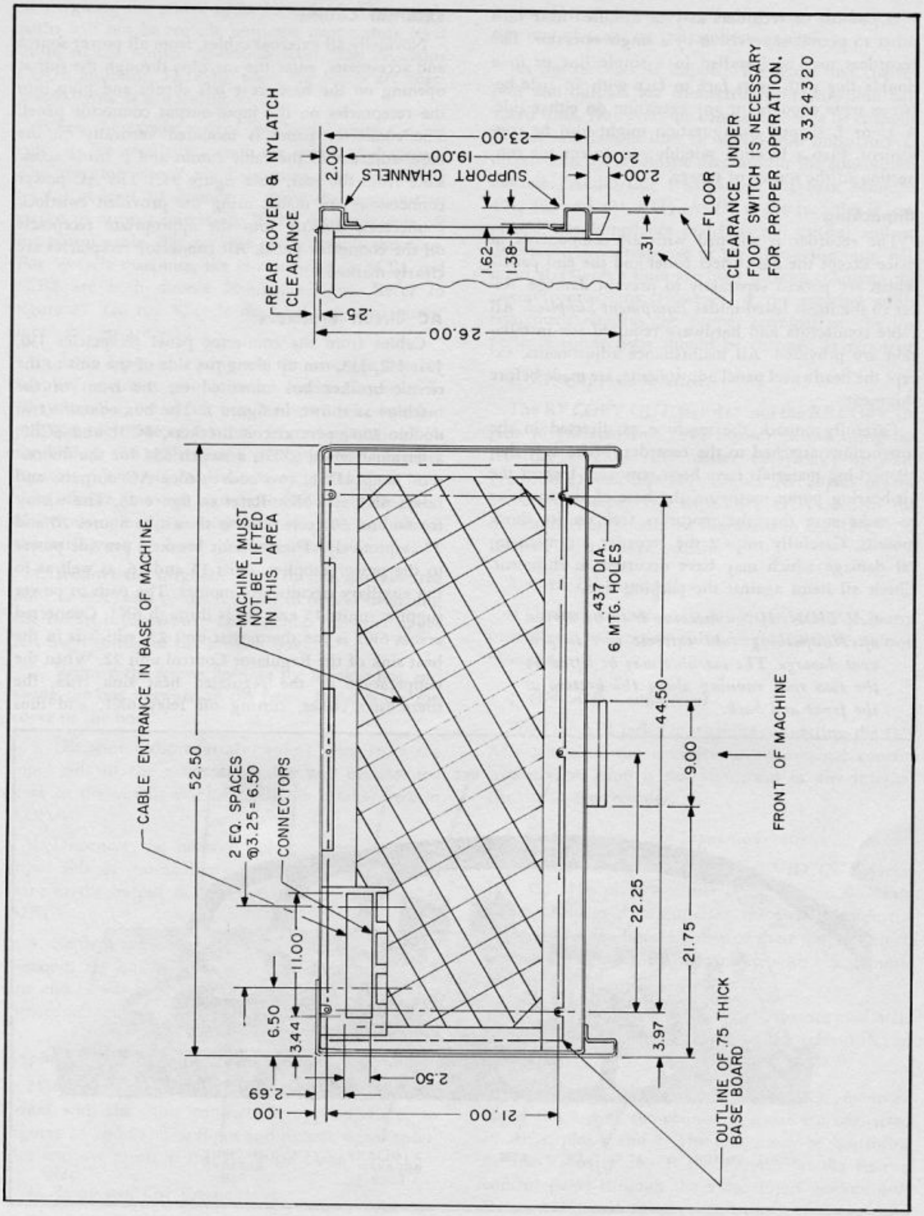


Figure 22—Base Mounting Dimensions

A number of recorders may be installed near each other to permit supervision by a single operator. The recorders may be installed in a single line or in a double line with units face to face with an aisle between wide enough for any extension on either side. A U or L shaped configuration might also be convenient. Plan a location suitably convenient for connection to the source of power.

Unpacking

The recorder is shipped with all components in place except the headwheel panel and the end panels which are packed separately to prevent damage. Refer to the items listed under *Equipment Supplied.* All cable connectors and hardware required for installation are provided. All maintenance adjustments, except the headwheel panel adjustments, are made before shipment.

Carefully unpack the machine as directed in the instructions attached to the recorder. Make sure that all packing materials have been removed. Inspect the air-bearing pump motor on the base of the machine to make sure that the motor is free on its shock mounts. Carefully inspect the recorder for mechanical damage which may have occurred in shipment. Check all items against the packing lists.

CAUTION: If the machine is to be moved after unpacking, take extreme care to prevent damage. The machine may be lifted by the two rails running along the bottom at the front and back.

External Cables

Normally all external cables, from all power source and accessories, enter the machine through the cutout opening on the base, rear left corner and plug into the receptacles on the input-output connector panel. The connector panel is mounted vertically on the base, adjacent to the cable cutout and is made accessible from the rear. (See figure 24.) The AC power connections are made, using the provided twistlock connectors, directly into the appropriate receptacle on the connector panel. All connector receptacles are clearly marked.

AC Circuit Breakers

Cables from the connector panel receptacles J30, J31, J32, J33, run up along the side of the unit to the circuit breaker box mounted on the front of the machine as shown in figure 1. The box contains two double 20-ampere circuit breakers, 6CB1 and 6CB2, a terminal board 6TB1, a switch 6S4 for the fluorescent lamp 1DS1, two convenience AC outputs, and relays 6K1 and 6K2. Refer to figure 23. The wiring for 60 and 50 cycle units is shown in figures 26 and 27 respectively. These circuit breakers provide power to the power supplies, units 15 and 16, as well as to the auxiliary circuits and motors. The path to power supplies, units 15 and 16, is through 6K1. Connected across 6K1 is the thermostat unit 23, which is in the heat sink of the Regulator Control unit 22. When the temperature of the regulated heat sink rises, the thermostat closes, cutting off relay 6K1, and thus

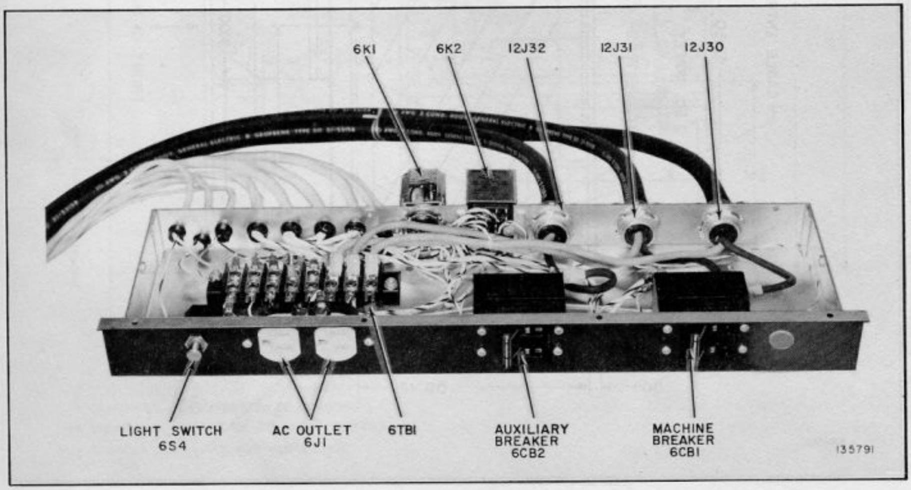


Figure 23—Circuit Breaker (Pulled Out)

deenergizing the power units 15 and 16. The supply paths will not be remade until the temperature level drops to the normal operating level. The regulator COOL indicator, 5XDS10, when the relays are energized, lights as a warning.

When the power system overloads, protector circuits in the regulator cutoff the overloaded circuit. The machine circuit breakers must then be turned off for at least 10 seconds to allow the regulator to return to normal operation. If the regulator cuts off the power again, the machine needs trouble shooting. For 50-cycle machines, the circuit breakers 6CB1 and 6CB2 are both double 20-ampere units. Refer to figure 27. On the 50-cycle machine only two power input sockets are used.

In both types of equipment the machine breaker supplies power to two recorder loads. However, in 60-cycle units, the circuit breaker box is wired so that only the high side of the lines from the junction box are broken and each section of the machine breaker controls a separate load. In 50-cycle machines both sides of the line are broken; however, if the local electrical code requires that only one side be broken, the wiring can be easily changed as follows:

1. Remove the magnetic catch for the module area door on the front of the machine to permit detaching the circuit breaker box. The catch is near the upper left hand corner of the breaker box.

2. Remove the screws holding the breaker box and swing the box outward to the front. Remove the top cover of the box.

3. Disconnect the neutral (white) wire from the input side of the machine breaker and connect the wire to the output side of the same breaker section 6TB1-1.

4. Disconect the neutral (white) wire from the input side of the auxiliary breaker and connect the wire to the output side of the same breaker section 62B1-3.

5. Replace the cover of the breaker box. Do not remount the box and the magnetic door catch until the end panels have been installed. (See page 35 for procedure.)

Input-Output Connector Panel

Make the connections to the input-output connector panel with the cable connectors supplied. Refer to figures 24 and 25. The input and output signal specifications are given in the *Technical Data.*

1. *Audio and Cue Connections*

The audio inputs, J21, J22, and output, J23, cue input, J24, and output, J25, are aligned along the top row of jacks on the connector panel.

As the recorder is shipped, the audio and cue inputs and outputs are connected for 15,000-ohm balanced lines. However, the connections may be changed for an unbalanced line, or a 600-ohm impedance as directed on the schematic diagram for the appropriate module (Audio/Cue Record and Playback Modules 401, 403 and 431, 434). As far as the recorder is concerned, the impedance match is not critical and no deterioration in response or signal-to-noise ratio will occur if 150-ohm lines are used without changing the circuit connections. However, if the external audio equipment requires the proper termination, the impedance connections should be changed as required.

2. *RF Copy Connections*

The RF COPY OUT Jack J17 and the RF COPY IN jack J6 (located two rows below) permit using the recorder as either the master (playback) or slave (recording) machine for making RF copies of the prerecorded tape. The RF COPY OUT jack of the master machine should be connected to the RF COPY IN jack of the slave machine.

3. *CAL IN Connection*

If desired, connect jack J19 to an external source providing a calibration pulse for the CRO Waveform Monitor.

4. *ON AIR Connections*

The ON AIR jack J20, permits connecting the ON AIR lamps of the recorder to an external control system. The lamp is not connected to any internal circuits of the recorder.

5. *Video Output and Input Connections*

Any one of the three isolated VID OUT jacks, J11, J12, J13 provide either composite or non-composite video as determined by the switch inside the video output module 433. Any of these outputs which are not used should be terminated with the termination supplied.

Two rows below these output jacks are two VID IN jacks, J1, J2, connected across the relay 12K1 at pins 1 and 5.

The three relays, 12K1, 12K2, 12K3, mounted along the top of the cônnector panel are connected in series, pins 3 and 7. The relays may be controlled by the Video A and B pushbutotns on the Record control panel through the video input module 402. Relays 12K2 and 12K3 control the sync output connections.

6. *Sync Input and Output Connections*

Two SYNC LOOP jacks, J8, J9, and two SYNC IN jacks, J3, J4, are provided in parallel rows. The sync inputs each consist of parallel connected jacks, one for actual input connections and the other for looping through to other equipment or for termination. Jacks J3 and J4 are connected to pins 2 and 6 respectively on relay 12K2. Loop jacks J8 and J9 are connected across pins 2 and 6 respectively on relay 12K3. Sub-carrier jack J5 feeds S.C. to the color phase module 633; J10 is the sub-carrier loop jack. TAPE SYNC OUT jack J14 supplies tape sync feed for external use.

7. *Color Monitor Output Connection*

The COLOR MON OUT jack J15 is used to connect a color monitor to the system.

8. *Remote Control Connections*

For remote control connections, two multiple contact jacks are provided. MODE REMOTE 12J26 for the MI-40691 Remote Control Panel and SIGNAL REMOTE, 12J28 for MI-40692 Remote Control Panel. Refer to figure 24 for identification of the connection points and then to the instruction book supplied with the remote control panels.

NOTE: As shipped, the recorder is wired for LOCAL operation in the LOCAL/REMOTE button button on the selector switch panel under the picture monitor. However, when the required changes are made to the control system, the button will permit choice of LOCAL or REMOTE operation.

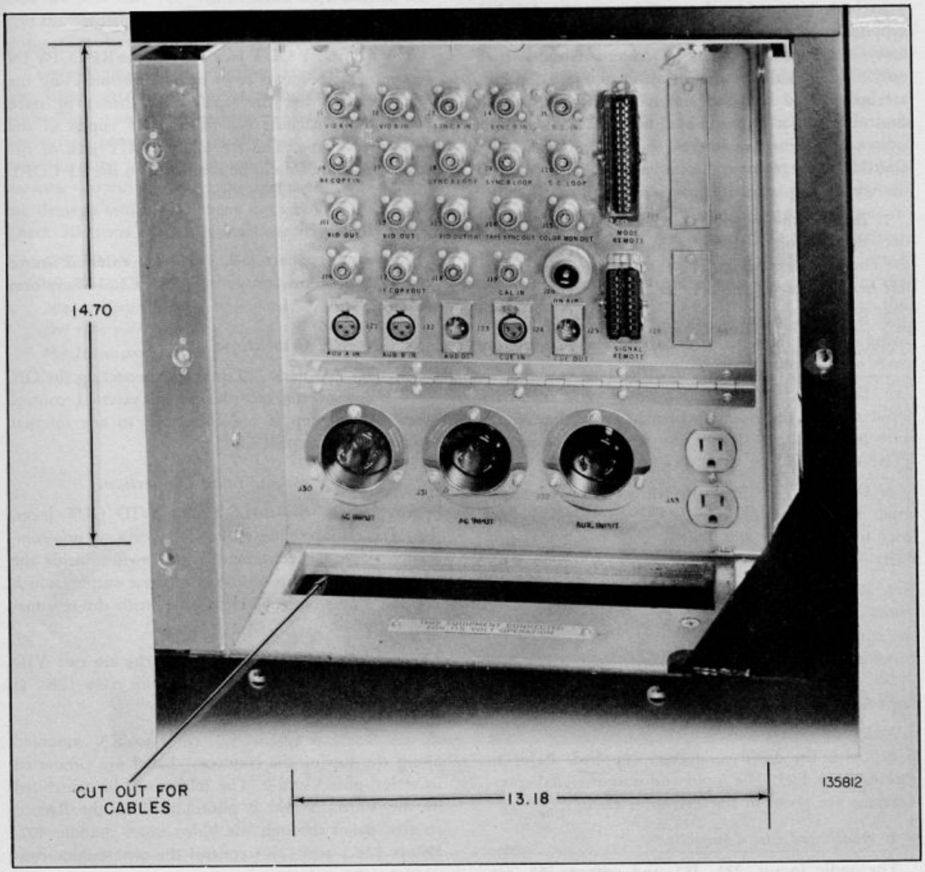


Figure 24—Signal Input-Output Connector Panel (Front View)

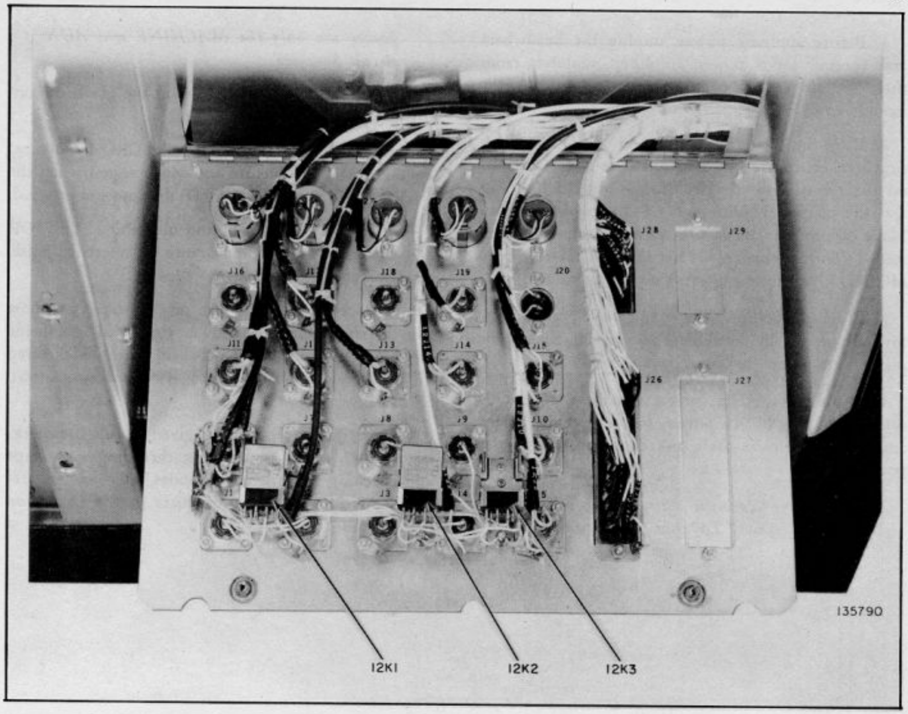


Figure 25—Signal Input-Output Connector Panel (Rear View)

9. *Spare Jacks*

Spare jacks J7, J16 and J18 are provided for future use when accessories are added to the machine or modifications are made.

HW Blower Motor Connections

The HW blower motor connections are also shown in figures 26 and 27, for 115-volt and 230-volt connections respectively. Note the color coding of the wiring for both plug and motor. The headwheel blower and motor are mounted back of the transport panel, a little to the left of the headwheel assembly as shown in the rear view, figure 2.

System Ground Connection

If an external ground connection is desired in addition to those provided by the bare leads in the power cables, run a heavy ground lead (braid) into the machine through the cutout in the base and connect it to the recorder frame at the connector panel with a heavy ground lug (not supplied).

Installation of End Panels

The end panels are shipped separately wrapped to prevent damage. After all connections are completed, install the panels with studs and press-in connectors supplied. The installation procedure is as follows: Install panel STUDS into holes in the machine. Snap the two fasteners in place by applying slight pressure to the panel. When it is secured proceed to apply the hardware (nuts and lockwashers) to the STUDS. Access to the STUDS is made by pulling the audio monitor assembly and CRO forward on their slides, and through the rear of the machine with the covers removed.

Initial Application of Power

Complete the installation by making the following checks and adjustments. If trouble is encountered, first check the installation, and then, if required, refer to the Maintenance manuals for servicing information. For details on operating the machine refer to the *Operation Manual,* IB-31856.

1. Before applying power, unplug the headwheel and capstan servo power amplifier modules, from their sockets (605, 606, 607, 608 left side, lower module row).

2. Place the −20 volt MACHINE AND AUX circuit breakers in the ON position. The STOP buttons on the record and playback panels should light up and the picture monitor and CRO should come on. Make certain that the COOL warning lamp above the record control panel is OFF (only the GUIDE and MODULE warning indicators should come on).

3. Check the ac line voltage and the dc power supply voltages on the multimeter by pressing the appropriate buttons on the meter selector.

4. If the voltages are correct and the COOL indicator is off, shut off AC power, and replace the power amplifier modules in their sockets. Then turn on the power.

CAUTION: Leave the −20 v circuit breaker on at all times. To shut off or turn on power use only the MACHINE and AUX circuit breakers.

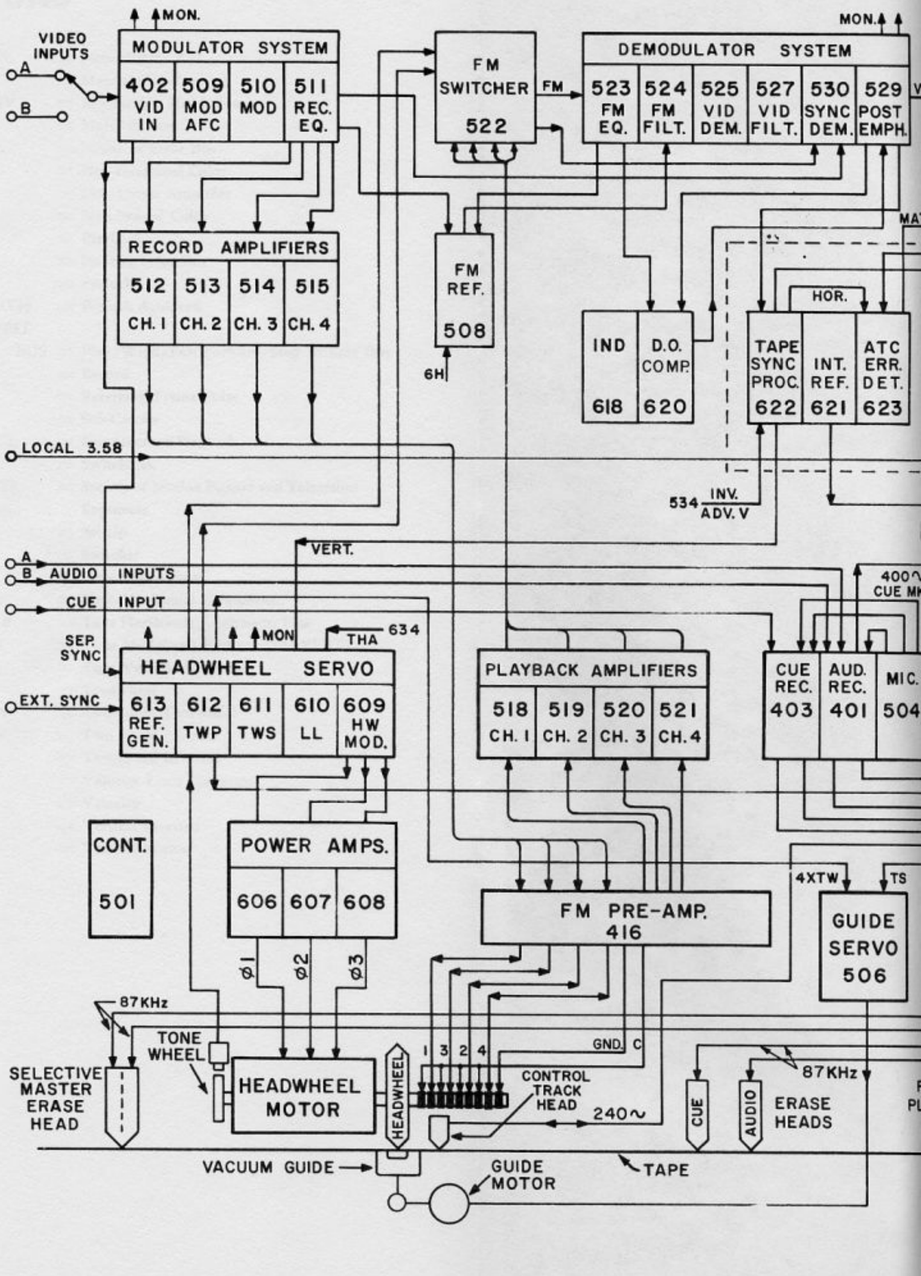
5. Place the DEMOD button on the playback control panel in the MOD condition.

6. Check the picture monitor and CRO for normal appearance of the picture and video signal when the DEMOD OUT and VID OUT displays are selected.

7. Press REF PULSE button on CRO SELECTOR and check for normal appearance of reference pulse. (See waveform in *Operation Manual.*)

8. Detach the head cover on the tape transport panel (release latches at lower right and left inside cover) and mount the headwheel panel as directed in the *Tape Transport and Air Systems* manual, IB-31860.

9. Refer to the procedures given in full for checking the headwheel adjustments, threading a test tape and checking the operation modes, playback and record, according to the procedures in the *Operation Manual,* IB-31856.


MON.
VIDEO INPUTS
A
B
MODULATOR SYSTEM
402 VID IN
509 MOD AFC
510 MOD
511 REC. EQ.
FM SWITCHER
522
FM
DEMODULATOR SYSTEM
523 FM EQ.
524 FM FILT.
525 VID DEM.
527 VID FILT.
530 SYNC DEM.
529 POST EMPH.
RECORD AMPLIFIERS
512 CH. 1
513 CH. 2
514 CH. 3
515 CH. 4
FM REF.
508
6H
IND
618
D.O. COMP.
620
HOR.
TAPE SYNC PROC.
622
INT. REF.
621
ATC ERR. DET.
623
LOCAL 3.58
534
INV.
ADV. V
VERT.
AUDIO INPUTS
CUE INPUT
400~
SEP. SYNC
MON
THA
634
HEADWHEEL SERVO
613 REF. GEN.
612 TWP
611 TWS
610 LL
609 HW MOD.
EXT. SYNC
PLAYBACK AMPLIFIERS
518 CH. 1
519 CH. 2
520 CH. 3
521 CH. 4
CUE REC.
403
AUD. REC.
401
MIC.
CONT.
501
POWER AMPS.
606
607
608
4XTW
TS
FM PRE-AMP.
416
GUIDE SERVO
506
ø1
ø2
ø3
87KHz
TONE WHEEL
SELECTIVE MASTER ERASE HEAD
HEADWHEEL MOTOR
HEADWHEEL
1
3
2
4
GND.
C
CONTROL TRACK HEAD
240~
CUE
AUDIO
ERASE HEADS
87KHz
VACUUM GUIDE
GUIDE MOTOR
TAPE

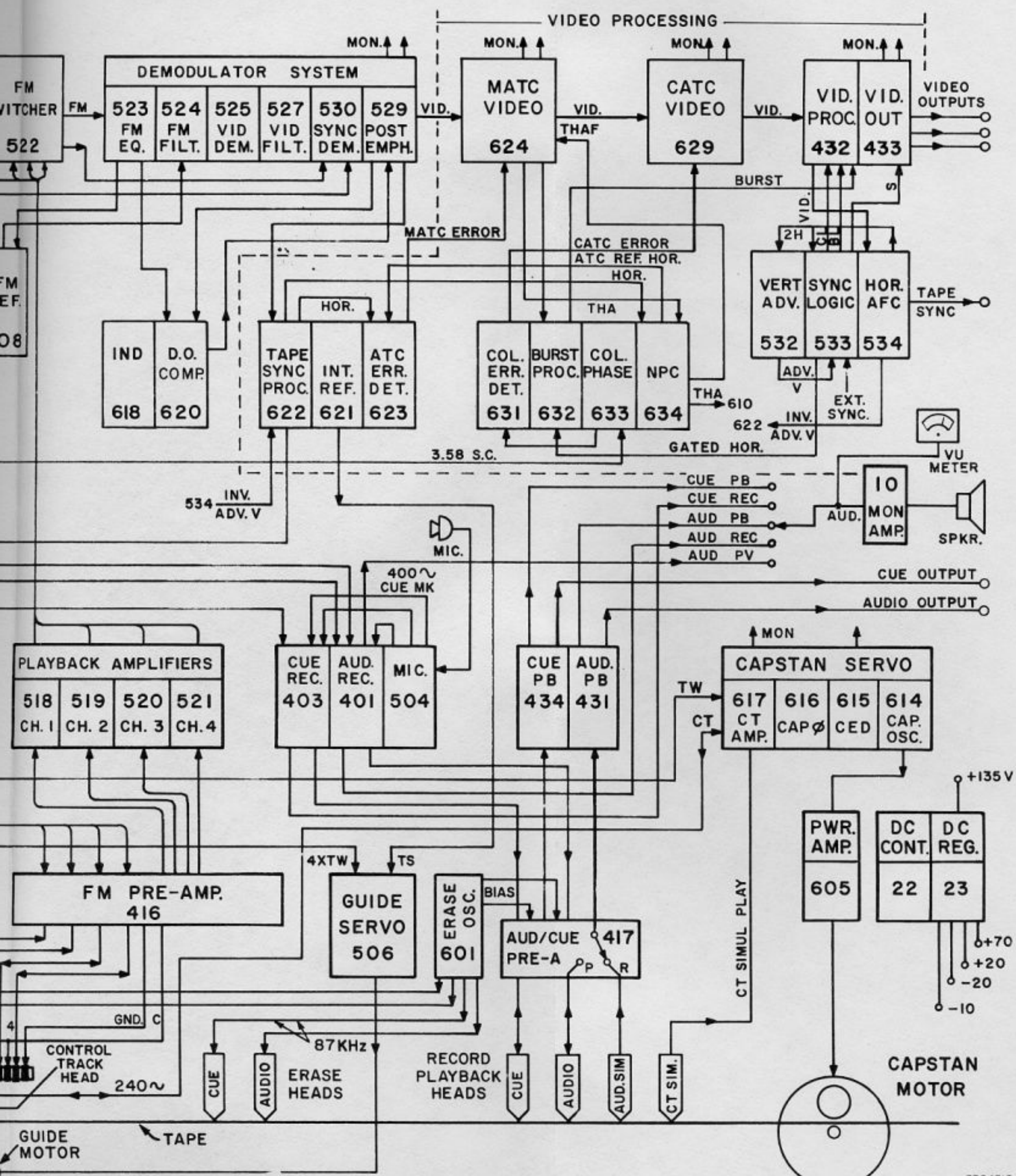


Figure 29—Overall Functional Diagram of TR-70 TV Tape Recorder

RADIO CORPORATION OF AMERICA

BROADCAST AND COMMUNICATIONS PRODUCTS DIVISION

CAMDEN, NEW JERSEY