SUBCOURSE SS0604 | EDITION 7

MAINTENANCE FUNDAMENTALS OF 3/4-INCH VIDEO CASSETTE RECORDERS

(DEVELOPMENT DATE: 30 JUNE 1987)

PRO PATRIA VIGILANS

THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT

ARMY CORRESPONDENCE COURSE PROGRAM

AIPD

READINESS / PROFESSIONALISM THRU GROWTH

US ARMY RADIO/TELEVISION SYSTEMS SPECIALIST
MOS 26T AND MOS 41E SKILL LEVELS 1 AND 2 COURSES

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MAINTENANCE FUNDAMENTALS OF 3/4-INCH VIDEO CASSETTE RECORDERS

SUBCOURSE NO. SS 0604-7
(Developmental Date: 30 June 1987

US Army Signal Center and Fort Gordon
Fort Gordon, Georgia

Four Credit Hours

GENERAL

The Maintenance Fundamentals of 3/4-Inch Video Cassette Recorders subcourse is part of the Radio/Television Systems Specialists, MOS 26T Skill Level 1 course, and is designed to teach the knowledge necessary for performing tasks related to maintenance and or repair of video cassette recorders (VCRs). Information is provided on several tasks which are performed at increasing levels of difficulty of Skill Levels 1, 2, and 3. The subcourse is presented in five lessons, each lesson corresponding to a terminal objective as indicated below. This subcourse will also assist personnel in MOS 41E to merge into MOS 26T.

Lesson 1: FUNDAMENTALS OF VIDEO RECORDERS

TASK: Describe the theory and terminology of video recorders.

CONDITIONS: Given information, illustrations, and schematic diagrams relating to the theory and terminology of video recorders.

STANDARDS: Demonstrate competency of the task skills and knowledge by correctly responding to 80 percent of the multiple-choice test questions covering theory and terminology of the fundamentals of video recorders.

Lesson 2: FUNDAMENTALS OF HELICAL SCAN VIDEO RECORDERS

TASK: Describe the principles of helical scan recording.

CONDITIONS: Given information on the fundamentals of helical scan recorders and on tape construction.

STANDARDS: Demonstrate competency of the task skills and knowledge by correctly responding to 80 percent of the multiple-choice test questions covering fundamentals of helical scan video recorders.

Lesson 3: PRINCIPLES OF HELICAL SCAN VCR CIRCUITS IN RECORD MODE

TASK: Describe the principles of the record mode of helical scan video recorders.

CONDITIONS: Given information and illustrations on the operation and circuitry of the helical scan record mode of VCRs.

STANDARDS: Demonstrate competency of the task skills and knowledge by correctly responding to 80 percent of the multiple-choice test questions covering playback circuits of a helical scan VCR in the record mode.

Lesson 4: FUNDAMENTALS OF THE VCR PLAYBACK CIRCUITS

TASK: Describe the fundamentals of the VCR playback circuits.

CONDITIONS: Given information and illustrations about terms relating to the fundamentals of the radio frequency (RF) playback amplifier.

STANDARDS: Demonstrates competency of task skills and knowledge by correctly responding to 80 percent of the multiple-choice test questions, covering terms relating to the fundamentals of the VCR playback circuits.

Lesson 5: FUNDAMENTALS OF THE AUDIO AND SERVO SYSTEMS OF A HELICAL SCAN VCR

TASK: Describe the operation and fundamentals of the audio and servo circuits of a helical scan VCR.

CONDITIONS: Given information and illustrations on the fundamentals and circuits of the audio and servo systems of a helical scan VCR.

STANDARDS: Demonstrate competency of the task skill and knowledge by correctly responding to 80 percent of the multiple-choice test questions covering the audio and servo systems of a helical scan VCR.

The objectives of this subcourse support tasks:

113-575-3028	Degauss VCR Heads or Guides
113-575-3029	Perform Daily Maintenance on a 3/4-inch Video Cassette Recorder/Reproducer
113-575-2044	Perform Functional Check of a Small Format Television Recording System, Using a 3/4-inch Video Cassette Recorder/Reproducer

TABLE OF CONTENTS

Section	Page

Whenever pronouns or other references denoting gender appear in this document, they are written to refer to either male or female unless otherwise indicated.

***** IMPORTANT NOTICE *****

THE PASSING SCORE FOR ALL ACCP MATERIAL IS NOW 70%.

PLEASE DISREGARD ALL REFERENCES TO THE 75% REQUIREMENT.

INTRODUCTION TO MAINTENANCE FUNDAMENTALS OF 3/4-INCH VIDEO CASSETTE RECORDER

The density and complexity of today's military television activities require a technician capable of performing his job using knowledge, experience, and proper techniques in the successful completion of the mission. The purpose of this subcourse is to provide the soldier with an overall view of the critical area he will work in using helical scan video cassette machines. It is also meant to assist MOS 41E personnel to merge into MOS 26T and provide entry-level training information for any soldier desiring to cross-train into MOS 26T.

LESSON 1
FUNDAMENTALS OF VIDEO RECORDERS

TASK

Describe the theory and terminology of video recorders.

CONDITIONS

Given information, illustrations, and schematic diagrams about terms relating to the theory and terminology of video recorders.

STANDARDS

Demonstrate competency of the task skills and knowledge by correctly responding to 80 percent of the multiple-choice test questions covering theory and terminology of the fundamentals of video recorders.

REFERENCES

None

Learning Event 1:
FUNDAMENTALS OF MAGNETIC RECORDING

1. Magnetic tape consists of thin plastic backing coated with a binder containing iron oxide particles. Signals are recorded on the tape with an electromagnet called a record head (fig 1-1). The iron core of the record head is U-shaped and the small gap between the poles is filled with a nonmagnetic 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.

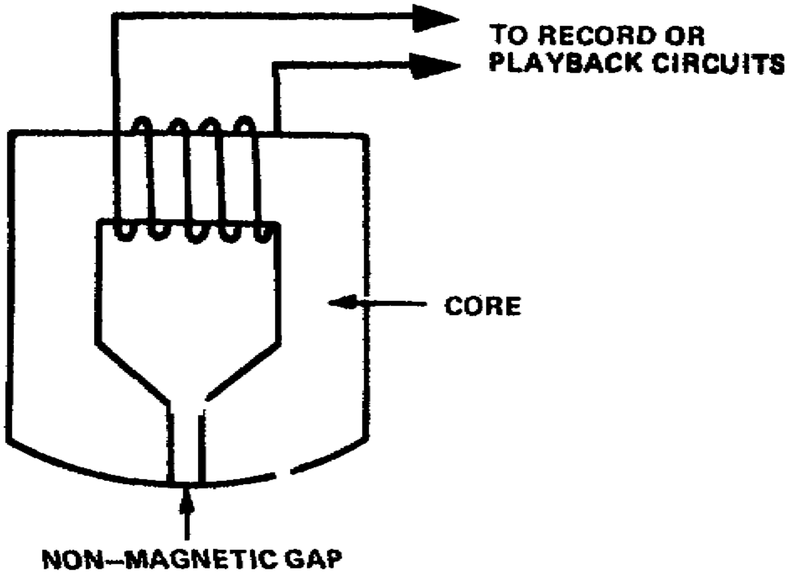


Figure 1-1. Typical magnetic head

2. 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 bridging field (fig 1-2). When the magnetic tape is 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 small 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 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 (fig 1-3).

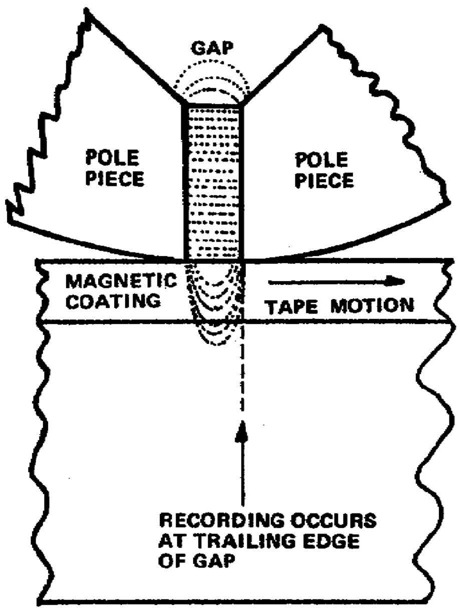


Figure 1-2. Simplified sketch of flux lines in a recording gap

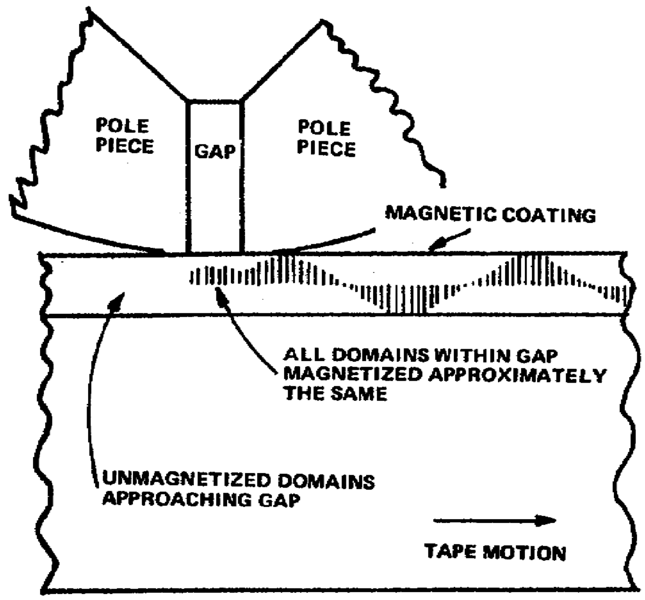


Figure 1-3. Direct recording process

3. The 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 (fig 1-4). In turn, the rate of change increases directly with the increase of frequency. If the tape speed is constant and the effects of head resonance and width are neglected, the induced voltage rises with frequency at a rate of 6db per octave.

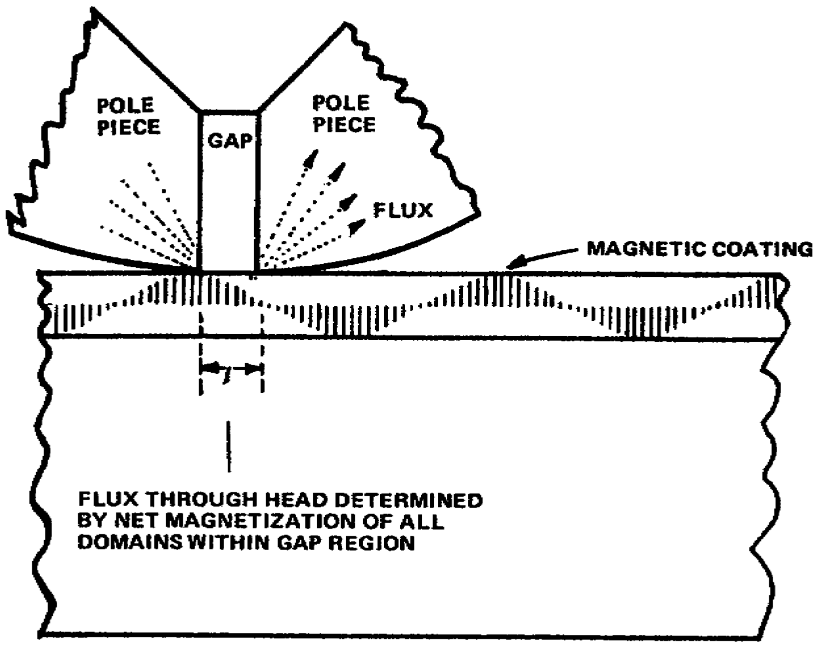


Figure 1-4. Playback process

4. Erasure is accomplished by applying a high-frequency, constant-amplitude AC 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.

Learning Event 2:
HIGH FREQUENCY BIAS IN AUDIO RECORDING

1. If a graphical plot of a signal current through the record head against residual flux density produced in the tape is made, a nonlinear magnetic transfer curve is obtained. In audio recording on magnetic tape, the distortion due to nonlinearity is reduced by adding a high-frequency, constant-amplitude alternating current to the signal current in the coils of the record head (fig 1-5). 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.

2. Each segment provides a separate output but the two signal currents are in phase and are added to each other on the tape. The audio 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 to be recorded. The effect of the bias on the reproduced signal is negligible because it has too high a frequency to be reproduced.

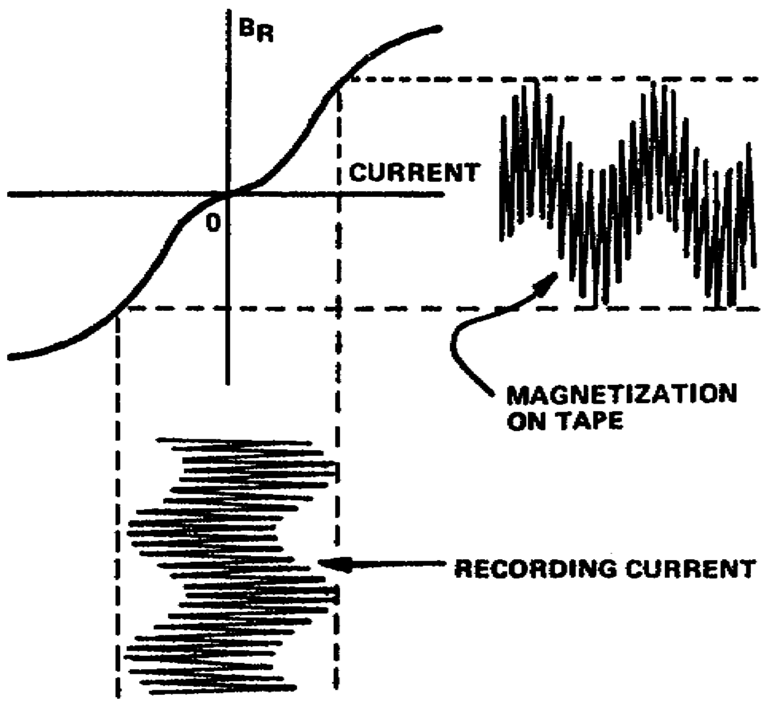


Figure 1-5. Use of high frequency bias recording

Learning Event 3:
LIMITATIONS OF MAGNETIC RECORDING

1. 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 than the gap width, parts of both positive and negative half cycles appear across the gap simultaneously and start to cancel each other (fig 1-6).

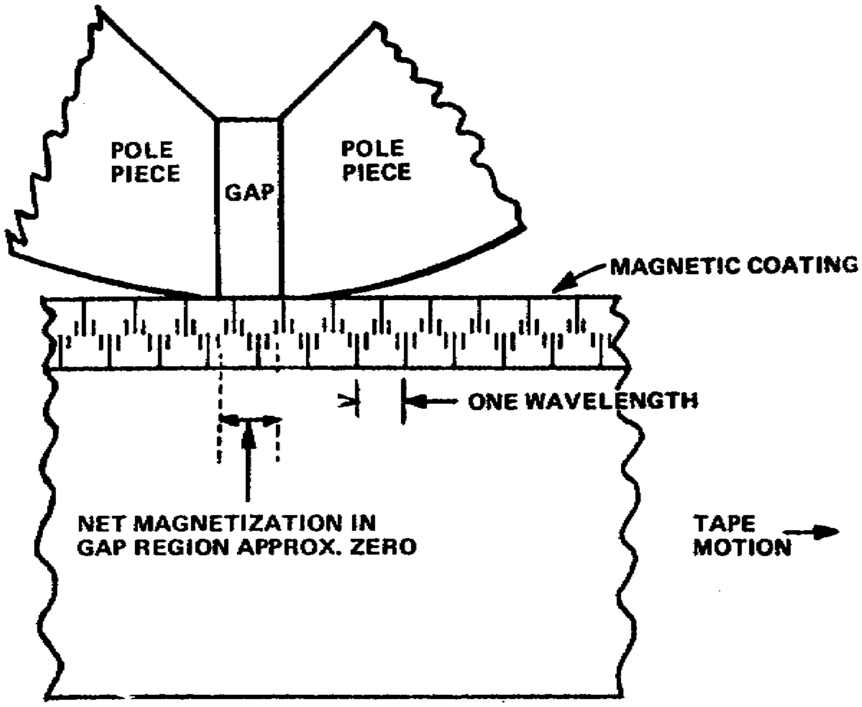


Figure 1-6. Wavelength limitations in tape playback

2. 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 may 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.

3. During playback, tape noise is present in the output at about 60db 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 at 10 octaves is 60db 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.

Learning Event 4:
SOLVING PROBLEMS IN TELEVISION RECORDING

1. Frequency modulation, in television recording, is the video information that is placed on the tape in the form of a frequency-modulated signal. This solves a number of problems as follows:

a. 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. Although the bandwidth of the FM signal is greater than that of the original video because of the side bands, the span is less than one octave.

b. 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, the use of FM solves the problem, since the symmetrical non-linearity of the tape does not change the time between crossing of the zero axis and this permits demodulating the signal without distortion.

2. In addition to the preceding benefits, use of FM permits increases to the signal-to-noise ratio by recording the signal at a constant level high enough to saturate the tape.

Learning Event 5:
PRINCIPLES OF LONGITUDINAL RECORDING WITH ROTATING HEADWHEEL

1. 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.

2. 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 take-up reels. This is accomplished by scanning the width of the tape with a rotating wheel, or headwheel, containing two tiny heads, mounted at 180 degrees apart. Each head starts across the bottom edge as the preceding head approaches the top edge. Since the tape moves slowly at small angles to the wheel motion, the signal is recorded on a series of parallel longitudinal tracks.

3. To permit the reassembling of 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. In the playback process, the overlap is eliminated by an electronic switcher which makes the transfer between head signals invisible in the video information.

4. Use of two video heads introduces other problems such as dihedral errors and differences in sensitivity and frequency response between heads.

a. Dihedral errors consist of slight deviations in spacing of two adjacent heads from a true 180-degree arc. If uncorrected, the errors cause a breakup of the vertical lines in the picture. These timing errors are corrected by mechanically adjusting the heads in the playback system.

b. 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.

5. 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 drumwheel and the capstan. 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.

6. In the recorder the drum assembly servo system controls the speed and phasing of the drumwheel so that the video information is properly recorded and the capstan servo system controls the longitudinal tape speed via the capstan; hence, the video and associated longitudinal tracks are recorded at a uniform rate. To accomplish this, the drumwheel servo locks the speed and phase of the drumwheel motor by comparing a pulse derived from a pulse generator coil on the headwheel shaft with a reference pulse occurring at the television field rate.

Lesson 1
PRACTICE EXERCISE

1. What is the shape of the iron core in the record head?

   a. J-shaped
   b. C-shaped
   c. U-shaped
   d. V-shaped

2. How is erasure accomplished with a constant amplitude AC signal?

   a. Applying a high-frequency
   b. Applying a low-frequency
   c. Applying a DC voltage
   d. Applying a sinewave

3. Why is the effect of the bias on the reproduced signal negligible in audio recording?

   a. It is too low a frequency
   b. It is too high a frequency
   c. There is forward bias
   d. There is thermal shutoff

4. What is the output when the wavelength equals the gap width?

   a. Twice the signal
   b. Half the signal
   c. Equals the signal
   d. Zero

5. What method of tape recording is not feasible for TV recording, because of the excessive length of tape required?

   a. Longitudinal
   b. Helical
   c. Quad
   d. Omega wrap

LESSON 2
FUNDAMENTALS OF HELICAL SCAN VIDEO RECORDERS

TASK

Describe the principles of helical scan recording.

CONDITIONS

Given information on the fundamentals of helical scan recorders and tape construction.

STANDARDS

Demonstrate competency of the task skills and knowledge by correctly responding to 80 percent of the multiple-choice test questions covering fundamentals of helical scan video recorders.

REFERENCES

None

Learning Event 1:
IDENTIFY AND DEFINE THE PRINCIPLES OF HELICAL SCAN RECORDING

1. Helical scan means "in a spiral formation," a line around a cylinder at an angle other than parallel with the axis. This should give you a mental picture of the tape path around the head drum assembly.

2. The basic design features for helical scan magnetic recorders must satisfy the requirements of a very wide market. They must have a frequency response wide enough to handle the standard television signals, specialized closed circuit video, high-bit-rate digital, radar type signals, and high frequency PCM. They must be portable to provide easy handling. They must also be simple to operate with a minimum of maintenance.

3. Dual head recorders (fig 2-1) use two rotating heads spaced 180 degrees apart, each sweeping the same arc repetitively. In this case, the tape need not be wrapped in a complete loop around the head drum assembly. It should be noted that one head will be in contact with the tape at all times. The heads are electrically switched so the head that is in contact with the tape is continuously active during its pass. The long signal dropout that was present in the previous example is eliminated. This type of scanning is referred to as the half-helical or two-head helix method of video recording. When the two heads are used, extreme care must be taken to place the heads accurately with respect to each other. Mechanical tolerances are critical, and placement errors are easily introduced.

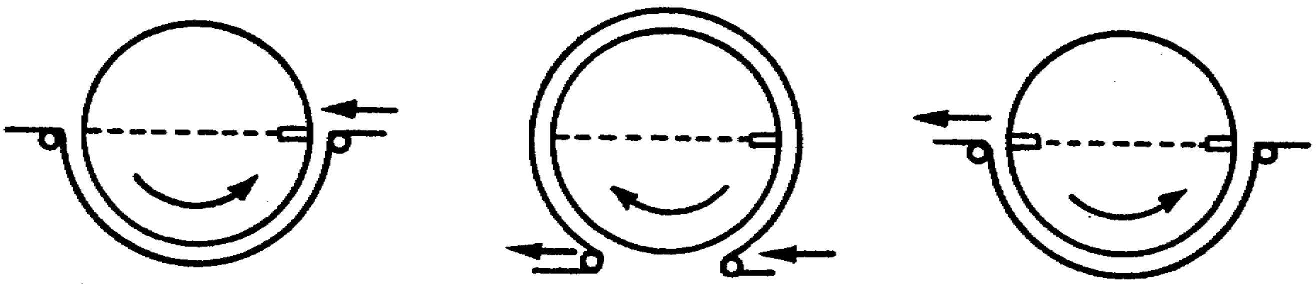


Figure 2-1. Tape wraps

Learning Event 2:
FUNDAMENTALS OF TAPE CONSTRUCTION AND REPAIR OF THE VIDEO TAPE

1. Because the video signal is much more sensitive to dropout than audio, it is desirable to have a tape designed for video recording. There is also a difference in the way tape is manufactured for helical scan video recordings as compared with that of quadruplex recording. The oxide particles are oriented longitudinally for helical scan video and transversely for quadruplex recording. It was found that if the oxide material is bonded to the film base in a pattern similar to the video recording pattern, the signal-to-noise ratio of the tape would be increased. Do not use helical scan recording tape on quadruplex recording equipment.

2. If it becomes necessary to repair a tape that is broken or crumpled, which requires cutting and splicing, it is very important that the tape be spliced precisely. Theoretically, if the tape is cut at a 90-degree angle and all tracks are aligned, the effect is vertical wipe with no roll or tear visible in the picture. If the tape is cut at the angle at which the video signal is recorded, an instantaneous transition from one scene to another will occur. Either method is acceptable. However, do not splice a video tape unless there is no other way of correcting the problem.

3. In most audio tape recorders, the tape is always wound on the reels with the oxide coating on the inside. The video recorders may wind the tape with the oxide to the inside or outside. Audio tape may be recorded in both directions while video tape is recorded across the entire width of the tape in only one direction. This means that the video tape must be rewound onto the supply reel after each playing to prepare it for replay.

Learning Event 3:
FUNDAMENTALS OF VIDEO TAPE TRACKS

1. Normally, there are four signals recorded on the tape; two audio tracks, a video track, and control track. The primary audio track is used to record the program audio, and the auxiliary audio track is used for cue information

or narration. Guard bands are provided between the tracks to prevent cross-talk. The two audio tracks are sometimes used for stereo recordings and in many cases today the second track is used to record, in a different language, the same information that is recorded on the first track. This type of recording is used more today because of the bilingual method of instruction.

2. The video track, as the name implies, is used for recording all video information. These tracks are recorded at an angle between 30 degrees and 90 degrees. The exact angle will depend on the manufacturer and the design of the recorder.

3. There are 262 1/2 lines of picture information in one television field. Two fields equal one frame and one frame is equal to one television picture. The quadruplex recorder requires 16 transverse tracks to record one field or 32 transverse to record one frame, which is one complete television picture. The helical recorder uses one diagonal track to record one field or two tracks to record a complete picture. Where the quadruplex recorder uses a track of less than 2 inches in length, the helical recorder uses a track which may be up to 10 inches long. With the helical putting the entire television frame on two diagonal lines, you can see how even a slight misalignment or improper spacing of tracks at the various points of the tape could cause a pronounced effect on the picture when it is displayed on a monitor.

4. The signal recorded on the control track is normally a 30 Hz signal; however, on some early machines, this signal was recorded at 60 Hz. This signal, when used in comparison with a signal from the head drum, is used to control the speed of the head drum assembly during the playback mode.

5. Magnetic tape is a strong permanent recording medium and is unaffected by normal handling. Avoid contact with the oxide surface of the tape since fingerprints may cause dust buildup and the possible loss of signal (dropout). When not in use, video tape should be stored away from stray magnetic fields and under temperature and humidity conditions recommended by the manufacturer.

6. Helical scan recorders are used in many areas in the civilian community as well as the military. They are used in the medical field, education, security and surveillance, industrial monitoring, as well as for entertainment.

Lesson 2
PRACTICE EXERCISE

1. What type of scanning is referred to dual head recorders, using two rotating heads spaced 180 degrees apart?

   a. 180-degree scanning
   b. Full helix
   c. Two-head helix
   d. Head drum scanning

2. In which direction are oxide particles bonded on video tape made for helical scan video recorders?

   a. Longitudinally
   b. Transversely
   c. Angular
   d. Reverse angular

3. Besides the two audio tracks and the video track, what other track is recorded on the tape?

   a. Sinewave
   b. Picture track
   c. Control track
   d. Framing track

4. How many tracks does a helical recorder need to record to get one field of information laid?

   a. 16 tracks
   b. 11 tracks
   c. 6 tracks
   d. 1 track

5. What is the frequency recorded on the control track?

   a. 15 Hz
   b. 30 Hz
   c. 45 Hz
   d. 60 Hz

LESSON 3
PRINCIPLES OF HELICAN SCAN VCR CIRCUITS IN RECORD MODE

TASK

Describe the principles of the record mode of helical scan video recorders.

CONDITIONS

Given information and illustration on the operation and circuitry of the helical scan record mode of VCRs.

STANDARDS

Demonstrate competency of the task skills and knowledge by correctly responding to 80 percent of the multiple-choice test questions covering playback circuits of a helical scan VCR in the playback mode.

REFERENCES

Overall block diagram (Figure 3-1, foldout (fo) at end of lessons).

Learning Event 1:
FUNCTION AND OPERATIONAL CHARACTERISTICS OF A VCR

1. The video signal processing is fundamentally the same as in all VCRs. In the record electronics, the luminance signal is separated from composite color video input signal. The amplitude of the luminance signal is then adjusted either manually or automatically by the AGC circuit. The luminance signal is then frequency modulated and recorded on the tape via video heads.

2. When the 3.58 MHz chroma signal is separated from the incoming video signal, it is passed through the ACC circuit where its amplitude is regulated to a constant value. Following the ACC circuit the chroma signal is frequency down converted to 688 KHz and recorded on tape by the video heads along with the Y-FM signal.

3. In the playback, the video head output signal is first amplified by a high gain preamplifier (CH-A and CH-B HEAD AMP) and the output signals from the two heads are mixed by switching circuit to form a continuous signal. The luminance FM and 688 KHz chroma signals are then separated by high and low pass filters, respectively. The separated luminance FM carrier is then passed through a limiter and dropout compensator which eliminates short duration noise components caused by tape dropout. The signal then passes through a sideband equalizer, another limiter stage and to the original AM luminance signal. It then passes through deemphasis and noise-cancelling circuits.

4. The separated 688 KHz chroma signal component is passed through an ACC circuit which removes any signal amplitude variation between the two channels. The signal is then frequency converted from 688 KHz back to 3.58 MHz. In the frequency conversion process, the phase instabilities in the playback chroma signal caused by mechanical jitter are corrected by an APC loop. The playback and chrominance are then mixed to provide a National Television Standards Committee (NTSC) output signal.

Learning Event 2:
FUNDAMENTALS OF THE LUMINANCE SIGNAL RECORD SYSTEM (MD-4 BOARD)

1. Refer to Figure 3-2 (fo) at end of lessons. The VCR has three video inputs. One input is a BNC connector, another input is part of the 8-pin connector and the third input is part of the 7-pin DUB IN connector. Selection between the three inputs is controlled by the INPUT SELECTOR switch located on the control panel. The INPUT SELECTOR controls the switching of electronic switches, IC-2 and IC-1, located on the MD-4 board. IC-2 has two inputs, the VIDEO IN signal from the BNC connector is applied to pin 3 and the TV IN signal from the 8-pin connector goes to pin 5. The selected output is supplied from IC-2 at pin 1. IC-2 selects between the two inputs by means of a DC control voltage applied to pin 6. The DC control voltage is switched by the INPUT SELECTOR switch on the control panel.

2. IC-1 also has two inputs; the selected output of IC-2, either LINE or TV, is applied to pin 5, and the DUB IN signal from the 7-pin connector goes to pin 2. The DUB IN signal will be luminance only video signal from another VCR equipped with DUB IN/OUT connectors. The selected output is supplied from IC-1 at pin 1. IC-1 selects between its two inputs again by means of a DC control voltage applied at pin 6. The DC control voltage is switched by transistor gate Q201. Two conditions must exist before IC-1 will select the DUB signal; the INPUT SELECTOR switch must be in the DUB position, and there must be a DUB Y signal present at pin 1 of the 7-pin DUB IN connector.

3. The output signal from IC-1 is supplied to three circuits: the Y-FM modulator and AGC circuit on the MD-4 board, the chroma signal record process circuit on the MD-4 board, and the SYNC SELECT circuit on the CS-8 board. Under certain conditions, the servo system will lock to the IC-1, pin 1, signal in both the record and playback modes.

Learning Event 3:
DESCRIBE THE FUNCTION OF Y-AGC CIRCUIT (MD-4 BOARD, RS-2 BOARD)

1. Refer to Figures 3-2 (fo) and 3-3 (fo) at the end of lessons. All active elements of the Y-AGC system are contained within IC-4 on the MD-4 board. The input video signal, selected by IC-1, is applied to the AGC amplifier in IC-4 (1/4) at pin 13. The gain of the AGC amplifier is controlled by a DC control voltage (also developed within (IC-4) so that its output level is constant). The AGC amplifier's output signal at pin 15 of IC-4 (1/4) takes one of the two possible paths depending upon whether the VCR is in the color or monochrome mode of operation. In monochrome it goes through a low pass filter consisting

of L1, C11, and C12. In the color mode, the signal goes through low pass filter FL1 and through a comb filter circuit contained in IC-3 (2/4). The path taken is selected by an electronic switch inside IC-4 (2/4). The monochrome mode signal goes to pin 19 and the color mode signal is applied to pin 17. The electronic switch, actuated by a DC control signal applied to pin 18, selects between them.

2. The output signal from the electronic switch passes through a Y-AMP stage, whose output appears at TP-2. This signal takes two paths, one path reenters IC-4 (3/4) at pin 22 and the other path is through the Y high frequency preemphasis circuit whose output appears at TP-3. The pin 22 signal path is through a sync separator and separated composite sync is supplied from pin 24. The H sync component passes through a delay network composed of R54 and C32 whose output is reapplied to IC-4 (3/4) at pin 1, the Y/SYNC MIX input.

3. The luminance signal from TP-3 which enters IC-4 (3/4) at pin 4 goes through a clamper stage and is then applied to the Y/SYNC MIX stage inside the IC. The delayed sync pulse added to the luminance signal is the AGC reference pulse. The AGC reference pulse which is formed by delaying the horizontal sync pulse is phase inverted and added-to the clamped luminance signal on the back porch of the horizontal interval. The added pulse is at an amplitude equal to 100 percent peak white in the luminance signal. The luminance signal, with reference pulse added, is supplied to a detector stage inside IC-4. The detector detects amplitude variations in signal level by comparing the H sync pulse amplitude against the fixed reference pulse amplitude. Any change in the input signal level is reflected by a change in sync pulse amplitude relationship of the sync to the reference pulse.

4. The DC output signal from the detector, filtered by C34, is the AGC control signal applied across deviation control R23. It is also supplied to the RS2 board as the video level meter drive. The DC control signal from the deviation control is reapplied to IC-4 (1/4) at pin 16 where it goes through a DC amplifier and is used to control the gain of the AGC amplifier stage.

5. The DC control signal from the detector in the Y-AGC circuit is supplied to the VIDEO LEVEL meter circuit on the RS-2 board. Since the DC control signal varies with the sync level of the input signal, it can be applied to the meter circuit as in indication of input sync signal level. R-4 on the RS-2 board is the calibration control for the meter. This type of Y-AGC system is insensitive to change in the brightness level of the scene, so the VIDEO LEVEL meter is conveniently effective in monitoring the record level. Since the AGC system can operate only in the record and E-E modes, the video meter has no deflection in the playback mode.

Learning Event 4:
FUNCTIONS OF COMB FILTER CIRCUIT

1. As stated in the description of the Y-AGC system, the signal path taken by the luminance signal at the output of the AGC amplifier is different, depending on whether the machine is in the color or monochrome operating mode.

2. In the color operating mode, the luminance signal output from the AGC amplifier contains the color signal information at 3.58 MHz. This must be removed since the color and luminance signals are processed separately. The signal is applied to IC-3 (2/4), where the luminance and chrominance signals are separated by means of a comb filter. This technique allows the two signals to be separated without loss of the high frequency video components which occupy the same band as the chroma signal.

3. DL1 is a tuned delay line which has a bandwidth limited to about 1 MHz, centered on the 3.58 MHz chroma frequency. The output signal from the delay line is of course delayed by one horizontal line (1H)(about 63.5 microseconds).

4. In the NTSC system, the phase of the color subcarrier is shifted by 180 degrees during each horizontal interval. The chroma signal in any given line of video is therefore 180 degrees out of phase with the chroma signal in the line immediately preceding or following it. For this reason, the chroma components are cancelled by mixing the 1H delayed chroma signal and the nondelayed full NTSC color video signal. It is this fact which forms the principle of operation of the comb filter.

Learning Event 5:
FUNDAMENTALS OF Y HIGH FREQUENCY PREEMPHASIS AND FM MODULATION

1. The output from the Y-AMP stage in IC-4 (2/4) which appears at TP-2 is rerouted to two places. One path to the sync separator in IC-4 (3/4) has already been described. The other path is through a Y HIGH frequency pre-emphasis circuit. From TP-2, the main signal goes directly to mixer Q3 while high frequency components of the signal go through high pass filter C22. The high frequency components are amplified by Q2 with low and high excursions of the signal being clipped by diodes D7 and D8. The effect of this stage is to sharpen rise and fall time (edge enhancement) of the high frequency component.

2. The high frequency components rejoin the signal at mixer Q3. The output of limiter Q2, D7, and D8 is cut off during the back porch of the horizontal interval by means of a delayed sync signal applied to Q6. This is done to remove any color burst information remaining on the signal amplified by Q2. Q6 will also mute the limiter output when VTR is placed in the DUB mode. The output of mixer Q3 is passed on to Y-BUFFER, Q4, and Q5, and appears at TP-3.

3. The FM modulator, preemphasis circuit (4/4) and clamp circuit (3/4) are all contained within IC-4 (1/4) along with the Y-AGC and sync separator. The clamp stage is also within a part of the AGC loop, as described previously. The clamped luminance signal passes through the preemphasis stage and is then supplied to the white and dark clipper. A 3.58 MHz trap circuit is included as part of the preemphasis stage. This trap is used only when the machine is operating in the color mode and is switched in and out by Q7. The trap is needed to remove 3.58 MHz stray pickup occurring within IC-4 (4/4). Transistor Q8 and diode D12 perform these functions and R63 is the white clip adjust control. The output of the white and dark clipper stage re-enters IC-4 (4/4) at pin 6, the input to the FM modulator. In the FM modulator, the luminance signal is converted into an FM signal deviating between 3.8 and 5.4 MHz.

4. The Y-FM output signal from the FM modulator takes one of two paths depending on whether the machine is in the monochrome or color mode of operation. In the monochrome mode, the luminance signal is applied to pin 3 of IC-6. In the color mode, the signal then goes through a 1 MHz trap, C51 and L12, which is used to provide space for the sidebands of the down-converted color signal. After going through high pass filter C52 and R85, the signal is applied to pin 5 of IC-6.

5. IC-6, an electronic switch, will select either the pin 3 or pin 5 signal depending on the mode selected (AUTO or B/W) and the type of input video signal being recorded (monochrome of full NTSC color). The power supply for IC-6, at pin 4, is provided only in the RECORD or EE operating mode. The output at pin 1, is therefore muted in all other operating modes. The output of IC-6 takes two paths to the Y record amplifier on the RA-2 board and to the PS-ID board for Y demodulation feeding video out.

Learning Event 6:
FUNDAMENTALS OF Y RECORD AMPLIFIER CIRCUIT (RA-2 BOARD) AND CHROMA SIGNAL RECORD SYSTEM

1. Refer to Figure 3-4 (fo) at end of lessons. The Y-FM signal from the output of the MD-4 board is applied to the Y record amplifier circuit on the RA-2 board. The Y record amplifier is discrete, consisting of transistors Q6 through Q12. Pot R22, a gain control at the Y record amplifier input, adjusts the record current level. Transistor Q7 is a muting switch that is driven by the Blanking switcher output. Pot R32 is used to adjust the frequency response of the Y record amplifier input, adjust the record current level. Transistor Q7 is a muting switch that is driven by the Blanking switcher output. There is only one Y record amplifier for both video heads. During recording, the two video heads are series-connected to the secondary of transformer T1, the record amplifier output transformer. The chroma record signal at 688 KHz is mixed with the Y-FM record signal in the primary of T1.

2. Almost all the chroma signal record circuitry is connected within IC-5 on the MD-4 board. The full NTSC color video signal, selected by electronic input selector switches IC-2 and IC-1, is applied to a 3.58 MHz bandpass filter. The filter consisting of L13, C58, and T1 has a 1 MHz wide passband centered on 3.58 MHz. Only the chroma signal passes through the filter; the luminance signal components are rejected.

3. After separation from the luminance signal, the chroma signal is applied at IC-5 at pin 13 where it passes through the ACC amplifier. The ACC amplifier is an automatic gain-controlled amplifier which performs the same function for the color signal as does the Y-AGC amplifier circuits as described previously. The ACC amplifier is controlled by a DC control signal derived by sampling and detecting the amplitude of the color burst in the output signal from the ACC amplifier.

4. The burst signal is separated from the rest of the chroma signal by a burst gate also located inside IC-5. The burst gate is a switching circuit that is actuated by a burst flag pulse supplied from the luminance channel. The burst flag pulses, which are applied to the burst gate at pin 10 of IC-5, unlock the burst gate only during the duration of the pulse. Only the burst portion of the color signal is therefore supplied as output from the burst gate at pin 8 of IC-5.

5. The gated burst signal is supplied to a crystal ringing filter consisting of transformer T2 and crystal X1. T2 adjusts the filter so that it is resonant at the 3.58 MHz color frequency. The successive string of burst signals occurring every 63.5 microseconds causes the circuit to ring and oscillation is sustained between the bursts due to the circuit resonance. The output signal from the crystal filter circuit is therefore a continuous wave 3.58 MHz signal, the amplitude of which follows the amplitude of the burst signal.

6. The 3.58 MHz continuous wave (CW) signal, with amplitude proportional to burst amplitude, is fed back into IC5 at pin 6. This signal is amplified in a 3.58 MHz CW amplifier and supplied to a detector. The detector produces a DC output signal proportional to burst amplitude and it is filtered by C67 and supplied to a DC amplifier inside the IC. The gain of the DC amplifier is adjusted by R97 which controls the ACC settings. The output from this DC amplifier is the control signal that controls the gain of the ACC amplifier.

7. The DC amplifier output signal also controls the Automatic Color Killer operation, which is an electronic switch inside IC-5. Whenever the incoming burst signal drops more than 23 db below its normal level, which the killer actuates, it places the system in the monochrome mode. When the automatic color killer actuates, the frequency converter which down-converts the chroma signal to 688 KHz is turned off. The electronic switch inside IC-4, which selects the Y signal filter path, is also switched to the monochrome mode.

Learning Event 7:
CHROMA SIGNAL FREQUENCY DOWN-CONVERTER CIRCUIT AND CHROMA RECORD AMPLIFIER CIRCUIT

1. The color signal amplitude regulated by the ACC amplifier in IC-5, is down-converted to 688 KHz from 3.58 MHz. The frequency down converter consists of a balanced modulator and a low pass filter. The balance modulator, also located inside IC-5, modulates a 4.27 MHz CW signal with the 3.58 MHz color signal. The 4.27 MHz signal is supplied from a crystal-controlled local oscillator. The output signal from the balanced modulator, at 4.27 MHz ±3.58 MHz, is supplied to the low pass filter, consisting of C77-80, and L15 and L16 from IC-5 at pin 15. Only the low frequency components, 4.27 MHz minus 3.58 MHz = 688 KHz, pass through the low pass filter. The down converter chroma signal at 688 KHz is supplied to delay line DL2 which maintains the proper timing relationship between the chroma and luminance signals.

2. The delayed chroma signal from DL2 is fed to pin 3 of IC-7, an electronic switch. IC-7 will select either the line/TV 688 KHz chroma at pin 3 or the

DUB 688 KHz chroma from another VCR at pin 5. The power supply for IC-7 at pin 4 is supplied from the Video REC/EE 12V line which is powered only in the RECORD or E-E mode so it supplied no output in any other mode. The selected output IC-7 takes two paths to the chroma record amplifier on the RA-2 board, and to the PS-10 board.

3. The 688 KHz output signal from the MD-4 board is supplied to the chroma record amplifier on the RA-2 board. Pot R1 is a gain control for the chroma record amplifier and is used to set the chroma record current level.

4. The transistors Q1, Q3, Q4, and Q5 form the actual chroma record amplifier. Q2 is a muting switch that is actuated by the blanking interval switcher circuit. When Q2 is turned on the chroma record signal is muted.

Lesson 3
PRACTICE EXERCISE

1. What happens to the chroma signal after going through the ACC circuit?

    a. Up converted
    b. Down converted
    c. Phase split
    d. Phase inverted

2. What takes care of the instabilities of the playback chroma signal caused by mechanical jitter?

    a. APC loop
    b. ACC circuit
    c. NTSC signal
    d. None of the above

3. Which signal causes IC-2 to select between its two input signals?

    a. Sinewave
    b. Frequency modulator
    c. DC control voltage
    d. Amplitude modulator

4. Which IC on the MD-4 board (fig 3-2 (fo)) contains the Y-AGC?

    a. IC-1
    b. IC-2
    c. IC-3
    d. IC-4

5. Which component filters out the DC output signal from the Y-AGC detector?

    a. C 34
    b. C 46
    c. C 54
    d. C 64

6. In the color mode, the signal applied to IC-3 is separated by what filter?

    a. Halstead filter
    b. Line filter
    c. Comb filter
    d. Cosine filter

7. Which transistor in the Y High Frequency preemphasis circuit amplifies the high frequency?

   a. Q1
   b. Q2
   c. Q3
   d. Q4

8. What IC is the chroma signal applied to, after it is separated from the luminance signal?

   a. IC-2 pin 13
   b. IC-3 pin 13
   c. IC-4 pin 13
   d. IC-5 pin 13

9. T2 adjusts the burst gate to resonate at what frequency?

   a. 3.58 MHz
   b. 1 MHz
   c. 3.8 MHz
   d. 5.35 MHz

10. The color signal is amplitude regulated by the ACC amplifier in IC-5 and down-converted to what frequency?

    a. 200 KHz
    b. 688 KHz
    c. 3.58 MHz
    d. None of the above

LESSON 4
FUNDAMENTALS OF THE VCR PLAYBACK CIRCUITS

TASK

Describe the fundamentals of the VCR playback circuits.

CONDITIONS

Given information and illustrations about terms relating to the fundamentals of the radio frequency playback (RF) amplifier.

STANDARDS

Demonstrates competency of task skills and knowledge by correctly responding to 80 percent of the multiple-choice test questions, covering terms relating to the fundamentals of the VCR playback circuits.

REFERENCES

None

Learning Event 1:
FUNDAMENTALS OF RF PLAYBACK AMPLIFIER (PS-10)

1. Refer to Figure 3-4 (fo) at end of lessons. The signals from the A and B rotary video heads are coupled through the rotary transformers in the head drum assembly to relays RY-1 and RY-2. In the playback mode, RY-2 connects head A to the primary of transformer T2 and RY-1 connects head B to T1. The playback RF signal from each head is coupled through the transformers to FET Q1 and Q2. Due to the low signal levels involved, Q1 and Q2 are connected to IC-1 as cascade amplifiers because of their low noise characteristics. The input circuits of the two FETs are tuned by C2-R3 and C3-R4, which tune the high frequency (5 MHz) response. All the remaining amplifier circuitry for the two playback amplifiers are inside IC-1, except for tuned circuits connected at pins 20 and 21 which adjust the mid-band (4.7 MHz) frequency response equalization. The A and B preamplifiers inside IC-1 are divided into two sections, a head amplifier stage and a RF OUT stage.

2. Between the two stages, there is an electronic switch that is actuated by a field pulse supplied from the servo circuits. The switch alternately switches the two preamp channels on and off, so that only the channel corresponding to the head in contact with the tape is turned on. Switched RF output from the two channels is supplied from pins 16 and 17 of IC-1. Pots R20 and R21, connected across pins 16 and 17, are used to balance the Y and chroma RF signals between and A and B channels. Transistor Q3 is a power

supply regulator which reduces the -12V supply voltage to -6V for IC-1. Transistor Q4 provides muting for the preamp during the REC/EE mode to prevent distortion from entering the playback circuits.

3. The RF signal from the preamplifier is applied across Y-RF playback level Pot R20. The output from R27 is in turn applied to pin 3 of IC-2 across a trap formed by C24 and L8. The trap removes audio bias interference during the AUDIO INSERT mode. Electronic switch IC-2 selects between playback RF and RECORD/E-E RF, supplying the selected signal to the succeeding stages. IC-2 is controlled by the VIDEO REC/EE 12V line, which goes high in the RECORD/E-E mode. When the line is high, IC-2 supplies the RECORD/E-E RF signals as output.

Learning Event 2:
FUNDAMENTALS OF THE TRACKING METER AND DROPOUT COMPENSATOR CIRCUITS (PS-10)

1. Refer to Figure 3-4 (fo). The PB RF signal at TP-6 is supplied to PB Y-RF AMF Q10 and buffer Q11. Q10 and Q11 provide an off-tape RF output that can be used by a Time Base Corrector for dropout compensation. The signal is also supplied to another PB Y-RF AMP, Q5, and to the tracking meter driver, Q6. The RF signal is than rectified by diodes D3 and D4 so that the tracking meter reads the average luminance level.

2. In the color mode, the Y-RF signal at TP-6 passes through a high pass filter consisting of C29, C30, and L10. The high pass filter eliminates the 688 KHz chroma signal to prevent interference with the luminance. Phase lag introduced by this filter is compensated by a phase equalizer circuit, C28 and L9. In monochrome operation, this filter is bypassed for improved picture resolution. The signal path selection is made by an electronic switch inside IC-1.

3. The Y-RF signal selected by the color monochrome RF switch, passes through the RF amplifier stage and is applied to the inputs of two limiter stages, all within IC-1. The limiter in the main route provides about 20db of limiting to remove AM components from the RF signal. The output of this limiter goes to the normally closed input of an electronic switch. The output of the other limiter is applied to a dropout detector stage. The dropout detector has two outputs, one of which actuates the dropout compensator electronic switch, and the other actuates the switching transistor Q8. The sensitivity of the dropout detector is controlled by the setting of pot R56. When a dropout is detected, Q8 is switched by the output signal from the dropout detector. This keeps the dropout detector switches on until the dropout ends.

4. Normally, when there is no dropout, the Y-RF signal passes through the normally closed side of the dropout compensator electronic switch. This signal goes through an RF output amplifier and passes out IC-1 at pin 4. This signal is buffered by Y-RF OUT BUFFER Q7, which supplies the signal as Y-RF OUT. The output from Q7 also feeds the input for DL1, a 1H delay line. DL1 delays the Y-RF signal by an amount equal to the period of one horizontal line (63.5 microseconds). The delayed Y-RF signal is applied to the normally open side of the dropout compensator electronic switch at pin 6 of IC-1.

5. Normally the Y-RF signal at pin 1 of IC-2 (CX-130) is 0.7 Vp. If this signal level drops to 0.05 Vpp or below, a dropout is considered to have occurred. A dropout is a momentary loss of playback signal that may be caused by discontinuities in tape-to-head contact or by a small imperfection in the tape coating. When a dropout is detected, the dropout detector actuates the electronic switch (all inside IC-1) and the switch replaces the portion of the signal during which the dropout occurs with Y-RF signal from the previous line.

Learning Event 3:
FUNDAMENTALS OF THE COSINE EQUALIZER (HF-3 BOARD)

1. Refer to Figure 3-4 (fo) at end of lessons. The output of Y-RF OUT BUFFER Q7 (PS-10 Board) is applied to a cosine equalizer circuit on the HF-3 board (fig 4-1). The incoming Y-RF signal is buffered by transistor Q1 and follows two paths, one to the base of Q2 with a delay of 60 nanoseconds and the other undelayed path to the base of Q3. Q2 and Q3 form a differential amplifier that compares the delayed luminance RF with the undelayed fundamental.

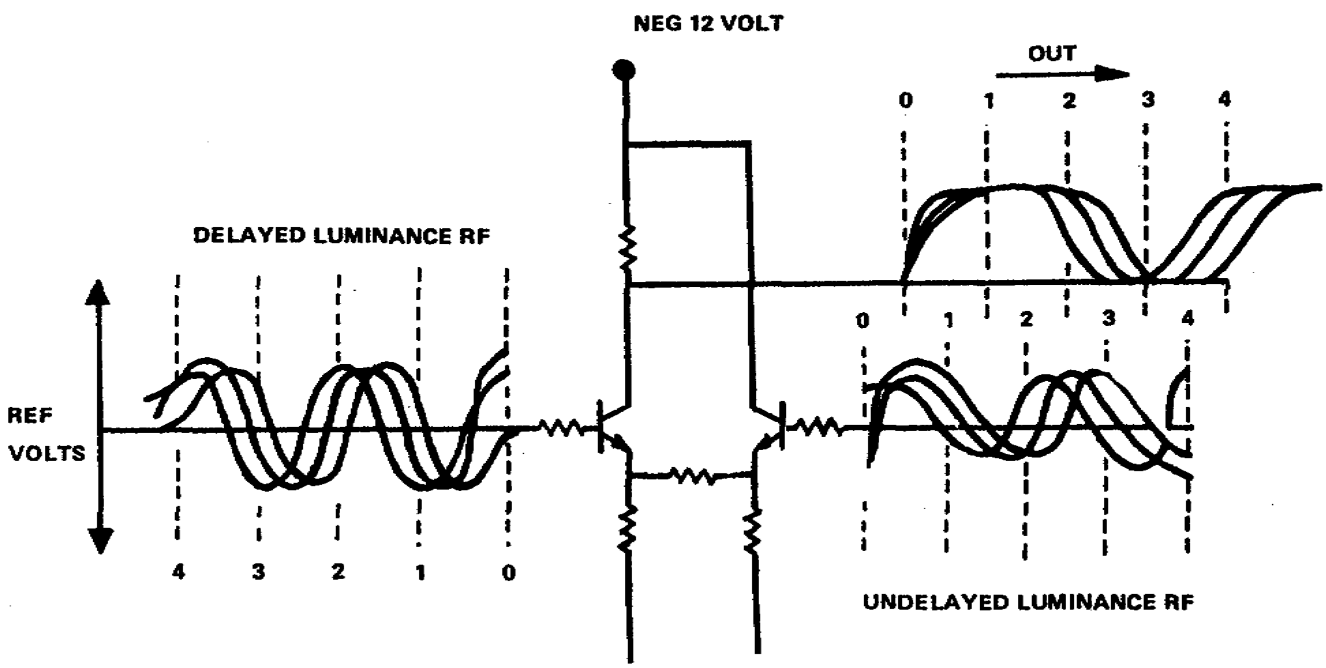


Figure 4-1. Cosine equalizer

2. The delay line has full-wave resonance at 4.1 MHz so that the output will vary around this center frequency from sync tip at 3.58 MHz to peak white at 5.4 MHz. The differential output will be the addition of the two sides. At 4.1 MHz, the two sides will be equal and the differential amplifier will have a minimum output. AT 8.3 MHz, the output will be minimum since the delayed input will equal the undelayed input. This will also be true at the lower 2 MHz frequency. At the middle frequencies from 2 MHz to 4.1 MHz and from 4.1

to 8.3 MHz, the two waves will be less than 180 degrees out of phase. The output will be an almost square pulse whose width from center positive edge to the next center positive edge would be equivalent to the period of the luminance frequency being differentiated. The placement of this center on reference would give inaccurate measurement of the period and an inaccurate reading when the RF is demodulated. Resistor R2 on the DM-7 board sets this reference level. The luminance FM signal, which leaves the cosine equalizer through buffer Q5, is a series of almost square waves whose period represents the particular luminance frequency. The cosine equalizer emphasizes the higher frequencies to give a sharper rise time to the square waves going to IC-1 pin 1 on the DM-7 board.

Learning Event 4:
FUNDAMENTALS OF Y DEMODULATION (DM-7 BOARD) CIRCUITS

1. Refer to Figure 4-2 (fo) at end of lessons. The Y-RF signal from the HF-3 board (fig 4-3) is supplied to pin 1 of IC-I on the DM-7 board. Pin 1 is the input to a limiter stage that is necessary to eliminate amplitude variations in the Y-RF signal prior to demodulation. The output of the limiter is split into two paths in the Y demodulator. One path goes directly to the phase comparator. The other path delays the pulse-coded luminance before it reaches the phase comparator. This delay is constant for all frequencies. These two signals are then mixed to produce a series of pulses whose period is one-half the input luminance frequency. These pulses are then integrated by the low-pass filters, FL1 and FL2, to the luminance DC levels found in the video signal.

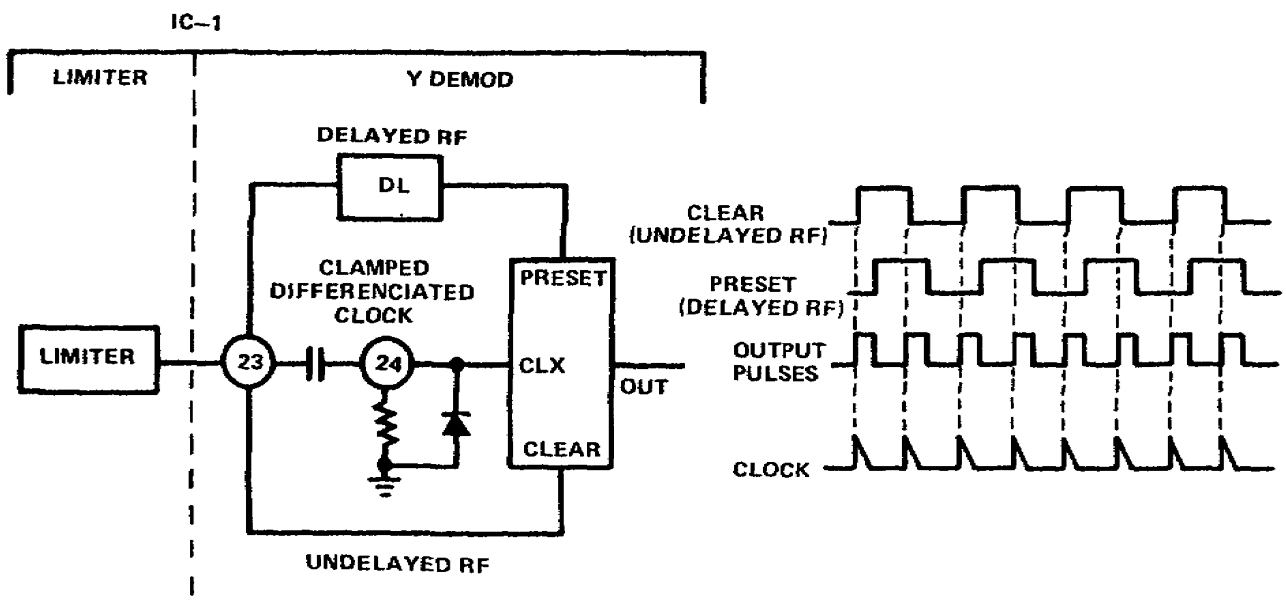


Figure 4-3. Y-FM demodulator

2. In the monochrome mode, the output of FL1 splits two ways; one path is amplified and goes to the sync separator; the second path is across R9. R9 sets the maximum output level of the luminance. This level is then amplified, filtered, peaked, de-emphasized and smear-corrected before passing to the YE-2 board. The Y signal luminance is not processed for chrome frequency inter-modulation and distortion as is the color mode output of FL2. After color video levels are determined by FL2, this output is buffered by Q3. The higher frequencies are preemphasized by a parallel RC network (C9 and R16) and the luminance is again buffered by Q4. Then L2 and C11 (at the base of Q5), whose series resonant frequency is slightly over 2 MHz, attenuate the higher and lower frequencies and give emphasis to the midband of the luminance signal. The output of Q5 is then tuned by a passive equalizer (transformer T1, L3, and C12). The center frequency of this tuner is determined by the adjustment of T1. R23, at the output of this equalizer, sets the maximum output level of the color luminance. Q10 will ground whenever the broadcast address track is used. The video heads will see the time code track as 200 KHz information. Q10 will receive a pulse if time code is present and will then take capacitor C22 to ground. The time constant of C22 is such that only the 200 KHz information will be filtered.

3. The primary purpose of the next section of IC-1 is to mute the luminance. There is a switch (on the output of the color/luminance amplifier and the B&W/luminance amplifier) that will open whenever a video mute condition exists. The filter at the input to peaking amplifier Q6 removes any residual luminance carrier and provides series attenuation at 3.58 MHz. Q6, a common base amplifier, drives the smear correction circuit, composed of Q7, Q25, and Q8. The luminance output of the DM-7 board now passes to the YE-2 board, a noise eliminator.

Learning Event 5:
FUNDAMENTALS OF THE NOISE ELIMINATOR CIRCUIT AND Y/C MIXER (YE-2 BOARD)

1. Refer to Figure 4-4 (fo) at end of lessons. The luminance video signal from the DM-7 board enters the YE-2 board at connector 1 pin 2 and splits two ways. One goes through Q9, the dub luminance buffer, which bypasses the noise eliminator. The output of Q9 goes directly to pin 1 of the dub connector on the rear panel. This output contains the luminance signal plus a 6VDC level used to control the dub luminance input switch in the recorder. The second path enters two delay lines, DL1 and DL2. DL1 is a fixed delay of 300 nanoseconds and DL2 is adjustable in 100 nanosecond increments, up to 300 nanoseconds maximum. This delay ensures that the luminance and chrome will arrive in phase at the mixer.

2. Q1 is a buffer with an output that feeds the base of Q2 and Q5. Low frequency noise passes through the IC filter, C22 and K2, to the emitter of Q5. High frequency noises pass through the RC filter, C7 and R10, and is amplified by Q3. Q4 then buffers the signal and diodes D1 and D2 clip the positive and negative spikes. R33 sets the amount of high frequency noise seen at the emitter of Q5. Here the processed high and low noise signals and the chroma signal are mixed with the luminance signal on the base of Q5.

The processed high and low noise signal is out of phase with noise in the unprocessed signal so they cancel each other out. Thus, if this part of the circuit is misaligned or has a problem, the picture will lose resolution and appear to be smeared.

3. The output of Q5 is buffered by Q6 and this drives a complimentary pair of amplifiers which feed the luminance signal to pin 2 of the 8-pin TV connector and the video out connector.

Learning Event 6:
FUNDAMENTALS OF THE CHROMA DEMODULATOR (PS-10)

1. Refer to Figure 4-5 (fo) at end of lessons. The RF signal is picked up as the video heads scan the tape field to field, and is amplified on the PS-10 board by Q1, Q2, and IC-1, respectively. R21 across the output of IC-1 controls the field to field chroma balance. The chroma output of IC-1 passes through L6 and C18, low-pass filter. Adjusting R26 sets the overall playback level of the chroma signal. The RF signal from R26 is applied across a second trap formed by C20 and L7. This is an audio bias trap designed to prevent the audio bias signal from interfering with the 688 KHz chroma signal in the Audio Insert mode. The chroma playback signal is applied to pin 3 of IC-3 on the PS-10 board, a type CX130 electronic switch. The other input to IC-3 at pin 5 is the E to E CHROMA signal supplied from the MD-4 board. IC-3 is switched by the video REC/EE 12V line and supplies playback RF signal in the playback mode and E-E chroma at 688 KHz in the Record and E to E modes. The output signal is supplied to the DM-7 board.

2. The output signal from the PS-10 board is supplied to a low pass LC filter that removes all frequencies above the chroma signal frequency. The signal thus filtered is buffered by Q11 and splits two ways; one path feeds the time code track detector circuit and the other feeds chroma amplifier Q12.

3. As stated in the description of the luminance demodulator, the video heads will see the time code track, if present on the tape, as 200 KHz information. This signal must be removed from the video circuits because it may create instabilities in the Automatic Color Control and Automatic Phase Control circuits, as well as produce video hash and chroma flicker during vertical blanking. Thus, a 200 KHz low-pass filter at the output of Q11, draws the 200 KHz time code signal away from the 688 KHz amplifier Q12. This signal is then amplified (Q41 and Q42), shaped (Q43 and Q44), and inverted (Q45), before being fed to IC-6. IC-6 contains two flip-flops whose time delays differ from each other. Also, feeding IC-6 at pin 1 is a Vertical Blanking pulse from the servo section. The flip-flops in IC-6 are tied in such a way that pin 13, at the output, will go high during vertical blanking whenever time code is present. This high is seen at the base of Q15 which turns it on and the output of the chroma amplifier, Q12, will go to ground. Q10 is also turned on taking the luminance signal to ground. There should be no chroma flicker during vertical blanking whenever a time code is present.

Learning Event 7:
FUNDAMENTALS OF PLAYBACK ACC AND ACK CIRCUITS

1. In the chroma demodulation process, once the 688 KHz chroma signal passes through the low pass filter at the base of Q11, the signal is amplified by Q12. Transistor Q14 controls the level of chrominance signal during slow, (reverse and pinch roller) off modes of operation. The gain of the chrominance signal is increased as the SLOW/REV/PINCH OFF 5 VDC is seen at the base of Q14. When the collector of Q14 goes to ground, the gain of transistor Q12 increases. This ensures that the amplitude of the chroma signal remains essentially the same as the machine changes speed through FORWARD, 1/20th speed, REVERSE X1, and REVERSE 1/20th speed. Also when the machine is in the PAUSE mode, and the pinch roller is off the tape, the track angle will change. The amplitude of the recovered 688 KHz signal will decrease and the gain at TP-2 will increase. This will happen in all modes except FORWARD X1. Q14 offsets the effect of this change.

2. Q12 amplified the 688 KHz signal which is then shaped by a phase equalizer, C30, L8, C31, L9, and C32. This filter removes amplitude and phase errors that may still be present in the signal. Q13 buffers the signal and is then further shaped by transformer T2, a tank circuit tuned by C10 and C34. IC-2 is the playback Automatic Chroma Control amplifier. It controls the gain of the chroma line by line and field by field. This circuit takes care of head-to-tape contact problems caused as the tape moves around the video head drum. These errors occur at the horizontal rate, thus line-by-line correction is necessary. Field-by-field amplitude errors occur when the record amplifiers do not have the same gain or when the playback head balance is not matched. Remember, the chroma information is amplitude modulation and is recorded directly on the tape at 688 KHz. Therefore, if any field-to-field or head-to-head differences did exist, they would be seen on a color monitor as flicker and would disappear when the chroma was turned off.

3. IC-2 has six sections: (1) the Playback Automatic Chroma Control amplifier, (2) a Frequency Converter, (3) a Chroma Amplifier, (4) the Automatic Chroma Control, (5) Automatic Chroma Control Detector, and (6) the ACC DC Amplifier.

4. After the signal has been phase-equalized by T2, section 1 of IC-2 amplifies the signal. After the signal leaves the ACC amplifier, if the machine is in the Dub mode, there will be no need for a 3.58 MHz subcarrier output and the signal will pass directly to Q21. R96 adjusts the level of the 688 KHz.
The second section of IC-2 contains a Frequency Converter. In this section, the 688 KHz signal is heterodyned with 4.27 MHz. Band pass filter FL3 allows the passage of only the difference frequency.

5. The third section of IC-2, a chroma amplifier, tow amplifies the 3.58 MHz chroma signal. R86 has been labeled the playback color killer because it determines the output level of the chroma amplifier. Section four of IC-2 contains a chroma amplifier and burst gate. The 3.58 MHz chroma signal is amplified again. The burst gate extracts only the burst portion of the 3.58 MHz chroma signal. This chroma information will then ring transformer T3 which is tuned to 3.58 MHz. The level of the signal, field to field or head

to head, is adjusted by a DC level generated by the PB ACC Field Memory. A field pulse from the servo section is inverted by transistor Q16; the same pulse is also seen at the base of Q18. Inverter Q16 drives Q17 so that when Q18 is off, Q17 is on, and vice versa. Capacitors C38 and C39 will alternately charge and discharge accordingly. The DC level produced should be continuous and equal field to field. The ACC Detector, section 5 of IC-2, detects the presence of chroma and when there is no chroma present, takes the output of Q18 and Q17 to ground. When a chroma signal is present, a DC bias is maintained by the detector. In the pause mode, Q18 and Q17 remain locked to the state which existed before movement of the tape path is stopped. The last field pulse will set the field memory until another field pulse changes the state of this transistor flip-flop. The chroma signal response of the coil will remain as it was when the pause mode was initiated. The output of T3 is detected by transistor Q19, an emitter follower. The DC output of T3, when chroma is present, will be 5.5 VDC. Q19 will be turned on and 5.5 V will be seen at TP-3. The color switch in section 6 of IC-2 will be switched away from ground. Thus, when chroma is present, TP-4 will be a plus 4 VDC and the collector of Q23, the 3.58 MHz chroma out buffer will not be grounded. In the B&W mode, the switch will be closed and 0 VDC will be seen at TP-4.

6. The ACC DC AMP amplified the DC output of Q19. This DC correction voltage is then fed back to the PB ACC amplifier. The DC reference level of the incoming chroma is set by the level of the previous field.

7. To convert the 688 KHz color under subcarrier to 3.58 MHz cleanly and without jitter, the demodulation system must be able to compensate for temperature changes and differences in chroma signal produced when the linear tape speed varies. In addition, frequency phase errors that occur as a function of head-to-tape contact and raw time base error must be removed. As in the modulator, the demodulator will use the difference of two frequencies to produce the demodulated signal. As mentioned previously, this will occur in section two of IC-2 and a 3.58 MHz signal will result when 4.27 MHz and 688 KHz chroma signal from the tape are heterodyned. The frequency and phase error in the 688 KHz incoming signal will not be present in the 3.58 MHz output of the demodulator. This is done by giving identical phase variations to the 4.27 MHz signal as are present in the 688 KHz signal itself.

8. After the 4.27 MHz signal is heterodyned with the 688 KHz recorded color signal, band pass filter FL3 selects the 3.58 MHz difference frequency for amplification by the chroma amplifier in section 3 of IC-2. This signal is again amplified in section 4 of IC-2. The output of this amplifier will go to the burst gate described previously to generate the DC correction voltage and to pin 21 of IC-3. When the 3.58 MHz signal arrives with the burst flag pulse generated by IC-7, the APC burst gate allows the chroma signal to pass to the phase detector. The phase detector compares the converted 3.58 MHz signal with the output of a 3.58 MHz reference oscillator. The DC voltage generated by the phase error, if any, speeds up or slows down a 688 KHz voltage controlled oscillator (VCO), causing the output of the 688 KHz signal. This 688 KHz will then be heterodyned with the output of the 3.58 MHz reference oscillator. The additive result of this mix will leave the frequency converter on IC-5, pass through the ceramic filter, and be fed to the 3.58 converter on section 2 of IC-2. Thus, the 4.27 MHz signal will have phase coincidence

with the off tape 688 KHz signal. R184 sets the level of the 4.27 MHz carrier. A differential amplifier, Q28 and Q27, filters and tunes the 4.27 MHz. T4 should be tuned to the maximum output from the amplifier at 4.27 MHz.

9. The amplitude of the chroma subcarrier during burst is one half of the chroma level during the video portion of the recorded signal. Thus, the 688 KHz color under subcarriers amplitude will drop during the burst period. The amplitude of the 4.27 MHz signal should also drop to ensure field to field uniformity of the 3.58 MHz chroma subcarrier. The 4,27 MHz carrier gate, Q53 and the voltage divider capacitors, C170 and C79, operate to prevent the difference in amplitude of the 4.27 MHz signal and the 688 KHz signal during burst. A pulse from sync inverter, Q49, turns Q53 on during the sync interval. C170, part of a 50-50 voltage divider (C170 and C79), discharges to ground through Q53. At this point, one-half of the 4.27 MHz signal goes through C170 to ground and the other half arrives coincident with the incoming 688 KHz signal at the frequency converter in IC-2. Correct phase and amplitude relationship will be maintained during this interval. R80, at the input to the frequency converter, may be adjusted to maintain the correct level of 688 KHz chroma. Noise is kept to a minimum by the voltage divider gate and the adjustment of R80 if the incoming burst varies greatly in level.

10. Burst samples do not exist for nine lines during the vertical blanking. The phase detector will have no reference during this interval and the 688 KHz VCO will try to move off frequency. To prevent this from happening, Q30 and Q31 are turned on during the vertical blanking interval. Capacitors C69 and C71 are charged through the transistor to ground. The time constants of these two RC networks at TP-16 and TP-18 are such that the networks will remember the last charge throughout the blanking interval. During vertical sync, the difference between TP-18 and TP-16 will remain stable and the VCO will remain on frequency. At line 10 of the video signal, Q30 and Q31 will be turned off and once again the phase difference between the 3.58 MHz reference oscillator and the generated 3.58 MHz signal will drive the 688 KHz VCO.

11. Another means of controlling this oscillator is to turn the color lock control at the rear panel of the machine. This varies the DC bias reference level to the 688 KHz voltage-controlled oscillator. R126 in series with the color lock control is a calibration potentiometer. It should be set when the color lock control is in its center detent position.

Learning Event 8:
FUNCTIONS OF THE AUTOMATIC FREQUENCY CONTROL CIRCUIT

1. The Automatic Frequency Control (AFC) circuit allows the APC circuit to track during the forward 1/20th, stop, and reverse 1/20th and reverse X1 modes. The sync separator triggers a multivibrator in IC-7 which produces a square wave having the same period as horizontal sync. This is the square wave gates transistor Q50. The output of this transistor is tuned by T8 and produces a sine wave at the horizontal rate of TP-25. This sine wave rings a high Q phase center tank, T9, C161, and C162. The phase difference between the incoming generated horizontal sync and the frequency of the tuner, T9, is seen as a DC level at the input to the AFC error buffer IC-7, pin 1. This

sampling is then buffered to ensure no signal loss and used to offset the loss in level at burst gate. A good example of how this circuit compensates for changes in tracking is the STILL mode condition. In the STILL mode, the head varies off the track as the tape comes to a halt. This would mean a definite loss of video signal. However, as long as horizontal sync is present, the chroma level will be maintained.

2. The video hash that may be noticed on the screen only occurs during the time when the head actually pulls away from the track. As long as the head is sweeping the track, chroma signal will remain uniform line by line. Changes in speed from the normal tape path speed, such as the use of the forward 1/20th mode, should not be used to adjust for signal line loss or capacitance errors.

Lesson 4
PRACTICE EXERCISE

1. What is supplied from the servo circuits to actuate the switch between the RF out stage and the head amplifier stage?

   a. Frame pulse
   b. Field pulse
   c. Fullwave signal
   d. Halfwave signal

2. Transistor Q3 is a power supply regulator which reduces the -12V supply voltage to what voltage level?

   a. -10.5V
   b. -8V
   c. -6V
   d. -4.5V

3. What amount of limiting is provided by the limiter to remove AM components from the RF signal?

   a. 20 dB
   b. 15 dB
   c. 10 dB
   d. 5 dB

4. On the HF-3 board (fig 3-4 (fo), Transistors Q2 and Q3 are what type of amplifier?

   a. Class A
   b. Class C
   c. Push-pull
   d. Differential

5. What resistor on the DM-7 board (fig 4-2 (fo)) sets the reference level of the demodulated RF?

   a. R2
   b. R6
   c. R12
   d. R15

6. Which IC on board DM-7 (fig 4-2 (fo)), is the Y-RF signal supplied?

   a. IC-1
   b. IC-2
   c. IC-3
   d. IC-4

7. On the Y/C mixer (YE-2 BOARD (fig 4-4 (fo)), the high frequency noises pass through the RC filter that is composed of what two components?

   a. C22 and R2
   b. R21 and C22
   c. C7 and R10
   d. C4 and R11

8. To which IC on the PS-10 board (fig 4-5 (fo)) is the chroma playback signal applied?

   a. IC-6
   b. IC-5
   c. IC-4
   d. IC-3

9. At what rate must line-by-line corrections be made?

   a. Vertical rate
   b. Horizontal rate
   c. 688 KHz rate
   d. 1/20 speed rate

10. On the DM-7 board (fig 4-2 (fo)) during vertical blanking, what two transistors must be turned on to maintain the 688 KHz VCO frequency?

   a. Q49 and Q53
   b. Q41 and Q43
   c. Q33 and Q41
   d. Q30 and Q31

11. What forward speed should you NOT use to adjust the signal line loss or capacitance errors?

   a. Forward 1/20th
   b. Forward 1/2
   c. Reverse 1/20th
   d. None of the above

LESSON 5
FUNDAMENTALS OF THE AUDIO AND SERVO SYSTEMS OF A HELICAL SCAN VCR

TASK

Describe the operation and fundamentals of the audio and servo circuits of a helical scan VCR.

CONDITIONS

Given information and illustrations on the fundamentals and circuits of the audio and servo systems of a helical scan VCR.

STANDARDS

Demonstrate competency of the task skill and knowledge by correctly responding to 80 percent of the multiple-choice test questions covering the audio and servo systems of a helical scan VCR.

REFERENCE

None.

Learning Event 1:
FUNDAMENTALS OF THE SERVO SYSTEM AND SYNC SELECTOR CIRCUITS (DC-4, GH-1, DS-6, PS-10, ED-7, and CS-8)

1. Refer to Figures 3-1, 4-5, and 5-1 (fo) at end of lessons. The servo system consists of three major circuits: (1) the 30 Hz reference signal generating circuit, (2) the drum servo circuit, and (3) the capstan servo circuit.

2. The sync selector on the CS-8 board selects the external reference, video, or external sync, from which vertical drive will evolve. The source control for the electronic switch, IC-2, is the SYNC SELECT on the front control panel of the machine. In the VIDEO position, a +12 VDC signal disables transistor switch, Q16 and Q17. With no control voltage on pin 6, IC-2 remains in the NORM position allowing Reference Video at pin 3 to pass through. When the switch is placed in the external position, the +12 VDC signal is removed, allowing operation of transistor switch Q16 and Q17. The incoming sync is applied to IC-2 pin 5 and transistor switch Q16 and Q17. The transistor switch turns on and supplies control voltage to IC-2 pin 4, opening the switch. The external sync now passes through the switch. The output of IC-2 is either external sync or reference video as determined by the SYNC SELECT switch.

3. An AC hysteresis motor powers the revolving head drum. An application of a brake on the head drum rotor affects the speed of the head drum. The servo PG coil, inside the revolving head drum, provides the servo PG pulse. The reference signal automatic selector circuit selects the reference 30 Hz to phase-compare to the servo PG pulse. To drive the brake coil, this phase-comparator output is amplified. Servo control is effective in both the record and playback modes.

4. An AC hysteresis motor generates the head drum rotational torque and transmits it to the head drum by a rubber belt. The servo PG output and the 30 Hz reference are phase-compared and the phase error, a DC signal, controls the braking of the rotary head drum. The same servo operation occurs in both the record and the playback modes. The rotary head drum has two PG coils, the SERVO PG coil and the EDIT PG coil. The servo PG pulse sets the flip-flop while the edit PG pulse resets the flip-flop. The flip-flop output is integrated and produces the 30 Hz ramp waveform. The 30 Hz reference signal samples the positive slope of the ramp waveform. The output of the sampling circuit is converted to a DC voltage. The DC voltage is held by the hold circuit which is sent to the brake coil to regulate the head drum rotation. When the FWD button is off, the brake current mutes so that the head drum spins with no braking.

Learning Event 2:
FUNDAMENTALS OF THE CAPSTAN SERVO AND CAPSTAN SPEED SERVO CIRCUITS

1. The capstan servo system controls the capstan DC motor. This system consists of two servo loops: (1) The capstan speed servo loop, and (2) the capstan phase servo loop. A frequency generator (FG) inside the DC motor supplies the FG signal. The FG signal of 360 Hz, varying with the speed variation, goes to the capstan speed servo which functions to maintain constant capstan speed. The capstan phase servo operates in the record mode and in the playback mode. In the record mode, a 30 Hz derived from the 360 Hz signal is at the same time recorded onto the video tape as the CTL signal. In the playback mode, the PB CTL signal is phase-compared with the reference 30 Hz. The capstan speed servo output and the phase-compared output go to dual inputs of a differential operational amplifier. This output goes to the capstan DC motor.

2. The servo system goes into the RECORD operating mode during both the normal record mode and ASSEMBLE editing mode. The servo systems are put into playback mode during both normal playback mode and the insert editing mode.

3. The FG output is amplified and shaped into a series of positive-going pulses. Q4 and Q3, C1 convert the FG pulse to a sawtooth waveform, having a positive-going slope. The same FG pulse samples the positive peak of the saw-tooth signal. The output converts to a DC signal by a HOLD capacitor, whose stored charge is amplified to drive the capstan motor. When the capstan motor speed decreases, the time period of one cycle of the FG signal becomes longer. This produces a higher peak saw-tooth signal voltage and a higher DC voltage from the sampling output. This increases the voltage across the capstan motor and increases its speed.

Learning Event 3:
FUNCTIONS OF THE CAPSTAN PHASE SERVO/RECORD AND CAPSTAN PHASE SERVO/PLAYBACK CIRCUITS

1. The phase servo has different loops in the record mode and playback mode. In the record mode, the phase loop adds to the speed servo in order to eliminate drift in the speed servo system. The positive-going 360 Hz FG pulse is doubled twice and divided by 48 which provides a 30 Hz pulse which is then integrated to form the 30 Hz ramp waveform. The 30 Hz reference signal samples the positive slope of the 30 Hz ramp. The output of the sampling circuit goes to the HOLD capacitor to produce the DC output. The DC output is phase-inverted, amplified and goes to the capstan motor. IC-1 has an operational differential amplifier in its final stage. The sampled DC outputs of both the capstan speed servo and phase servo go to the differential amplifier inputs. If the capstan motor speed decreases, the FG signal phase retards with respect to the other 30 Hz reference signal. This produces a reduced sampling DC output, which increases the differential amplifier output and accelerates the motor.

2. The phase of the 30 Hz reference signal changes in order to change the phase relationship between the playback CTL signal and the 30 Hz reference signal. The TRACKING one shot performs phase adjustment which is controlled by the TRACKING CONTROL on the front panel. When the FWD button is off, the capstan motor driver mutes so that the motor stops.

3. The FG dividing counter is reset by the CTL signal in the playback mode so that the 30 Hz FG signal will be positioned very close to the CTL SIGNAL. This is necessary since the servo reference signal changed from the CTL signal to the 30 Hz FG signal in the ASSEMBLY edit mode and the servo system is put into the record mode from the playback mode. The 30 Hz FG is close to the CTL signal in order to minimize the lockup time in the servo loop.

4. There are two rotary erase heads, one for each of the two video heads, each just ahead of the video head on the drum. In the Insert mode of operation, these rotary erase heads pre-erase the recorded track on the tape just ahead of the new recording. This permits erasure and recording of only the exact number of previously recorded slant tracks corresponding to the length of the edited segment. In the assemble mode of operation the rotary erase heads turn on but only work during the initial five seconds after the assemble mode starts. This is to erase the video information in the segment of the tape between the fixed, full-track erase head and the head drum.

Learning Event 4:
FUNDAMENTALS OF THE AUDIO (AU-8) AND POWER SUPPLY CIRCUITS (PW-1A)

1. Refer to Figures 5-2 and 5-3 (fo) at end of lessons. There are two identical audio record and playback channels to accommodate stereo or bilingual audio. In playback, both channels are operational and supply outputs are at the Ch-1 (left) and Ch-2 (right) jacks on the rear panel. In addition, the

selection of either left, right, or both outputs is made by the AUDIO MONITOR switch, S2, on the IS-4 board. It then goes to the MONITOR OUT and TV CONNECTOR.

2. Broadcast television is monoaural. When the input select switch is set to TV, you use only one audio channel, Ch-2 (r). Since the two audio circuits are identical in most sections, the description that follows deals with the right channel.

3. Playback signal from the audio head feeds through the normally closed contacts of RY-1 to IC-2 (PB Amp). A bias trap made up of L1 and C23 removes the AC BIAS (70 KHz) after equalization of the signal using R42. The audio signal then goes across the emitter of Q10 (muting) and collector of Q9 (20 KHz trap) to R47 (PB level). The signal then routes through the bias trap, L3 and C26 to IC-3 amp.

4. The output of IC-3 splits into several paths, one to the line out jack on the rear of the machine, to R68 and through Q16 to the audio monitor switch and the audio meter. The headphone jack provides two output levels selectable with the phone level switch. Muting for the audio playback comes from the system control board to Q11 during threading and unthreading.

5. Audio may be recorded from the TV, MIC, or LINE IN connectors. TV audio goes past Q1, which turns on only when TV is not recording, to Q3. The output of Q3 goes through the audio level control on the front panel to pin 2 of IC-3. The output of IC-3 follows the same path as the playback audio. In addition the output of R68 goes to the record amplifier, Q13, past Q13, with no muting in the record mode, to the audio head for recording on the tape. C52 L5 make up a bias trap to prevent the 70 kHz AC bias from feeding back into the record circuits.

6. The power supply (PW-1A) will accept 100V or 120V, 50 or 60 Hz. It supplies all regulated and unregulated voltages required for proper operation of the machine. There are three regulated voltages and three unregulated voltages. Only the regulated +6.5, +12, and 24 volts lines are adjustable.

7. Since all the regulators operate basically the same, we will discuss only the regulated +12V supply. The 18 VAC enters the power board at pin 7. D4 and D5 rectify this voltage to provide a DC voltage. The rectified and filtered voltage goes to Q30005. The output of Q30005 at the emitter goes to pin 1-5 of CN-2.

8. Q5 (error detector), Q4 and Q30005 (series regulator) accomplish regulation. When the regulator +12 volts increase because of a change in load, the voltage at the base of Q5 also increases because of the voltage divider network. Q5 will conduct more, causing its collector voltage to decrease, thereby decreasing the emitter current and the forward bias of Q4. Q4 conducts less, decreasing the emitter current and the forward bias on Q30005. Q30005 conducts less, increasing its internal resistance. When the resistance increases, the voltage at the output will return to +12 VDC. The three stages will operate in the opposite manner if the output should decrease.

Lesson 5
PRACTICE EXERCISE

1. The FG output is amplified and shaped into a series of positive-going pulses. What is the function of Q3, Q4, and C1?

   a. Convert the FG pulse to a sawtooth waveform
   b. Convert the FG pulse to a square waveform
   c. Convert the FG pulse to a trapezoidal waveform
   d. Convert the FG pulse to a triangular waveform

2. What controls the capstan DC motor?

   a. The flip-flop output
   b. The servo PG coil
   c. The capstan servo system
   d. The PB control signal

3. The capstan phase servo operates in which of the following modes?

   a. Erase and still mode
   b. Record and playback mode
   c. Audio and video mode
   d. Phase loop and amplifier mode

4. The sampled DC outputs of both the capstan servo and phase servo provide inputs to which of the following?

   a. Capstan servo
   b. Hold capacitor
   c. Differential amplifier
   d. Speed servo

5. What are the three regulated voltages supplied by the power supply?

   a. +6.5, +18, and +24
   b. +6.5, +12, and +24
   c. 12, +12, and +18
   d. +5, 12, and +18

Foldout Diagrams for Lessons 3, 4, and 5

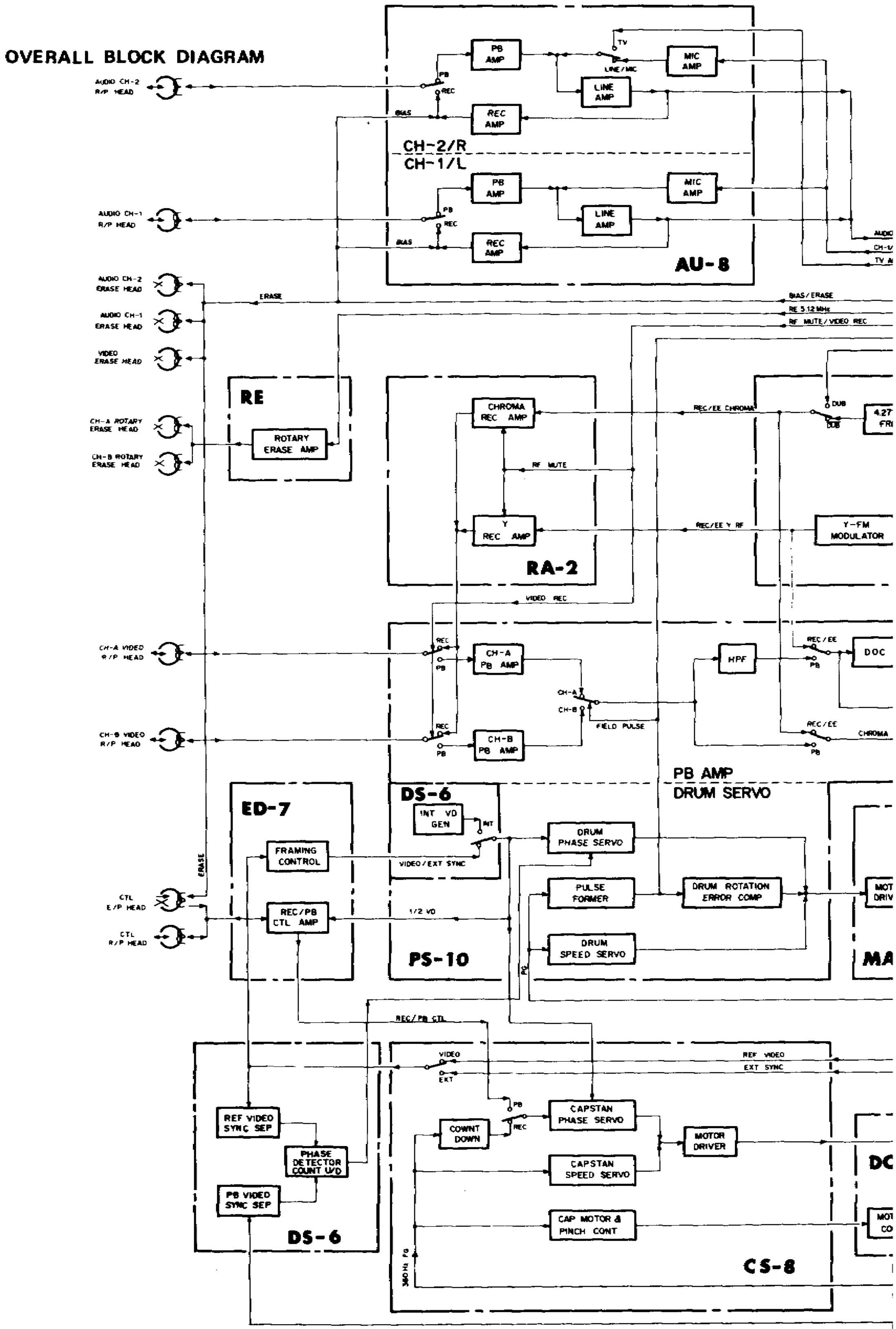


Figure (fo) 3-1. Overall block diagram.

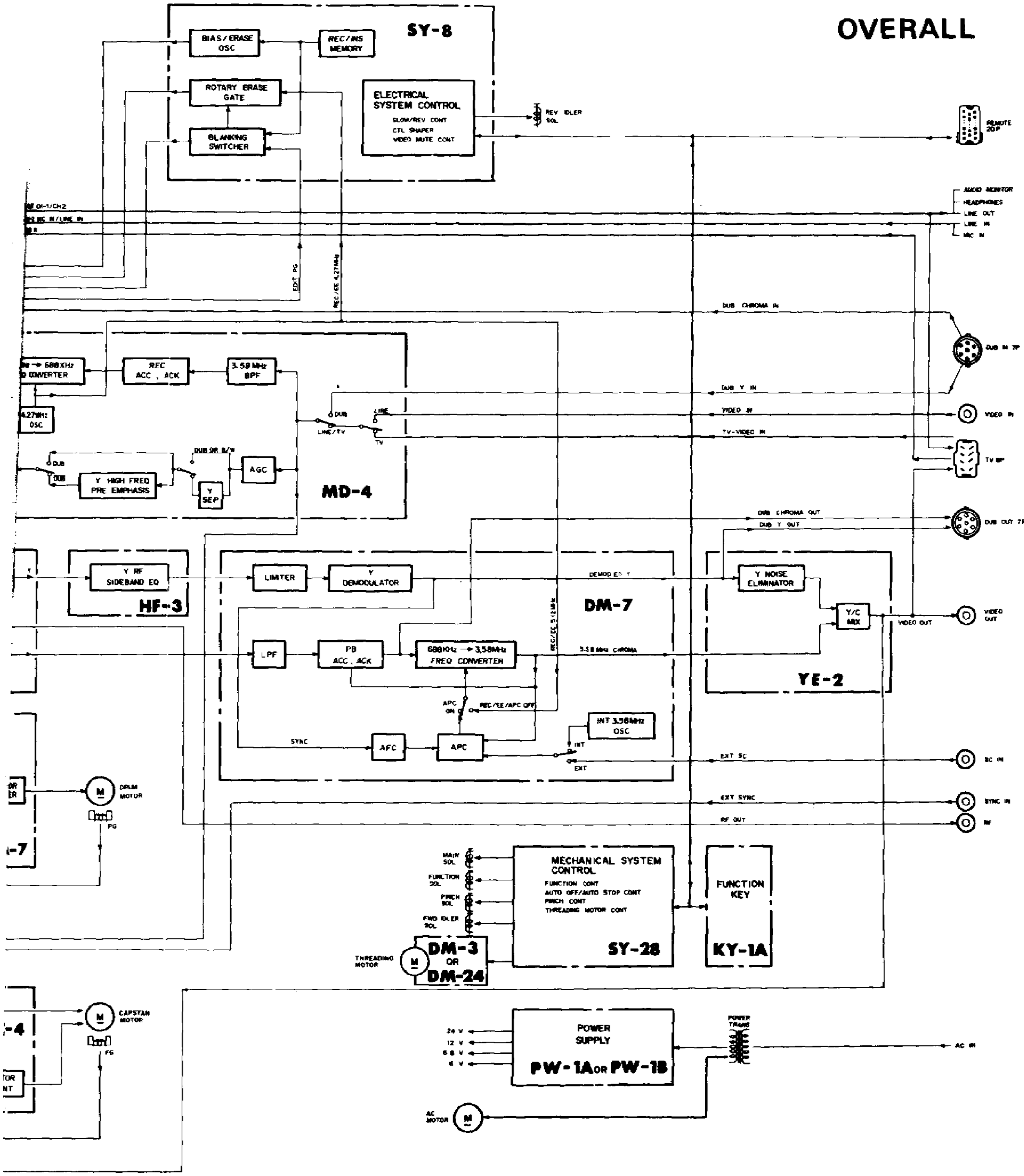


Figure (fo) 3-1. Overall block diagram - continued.

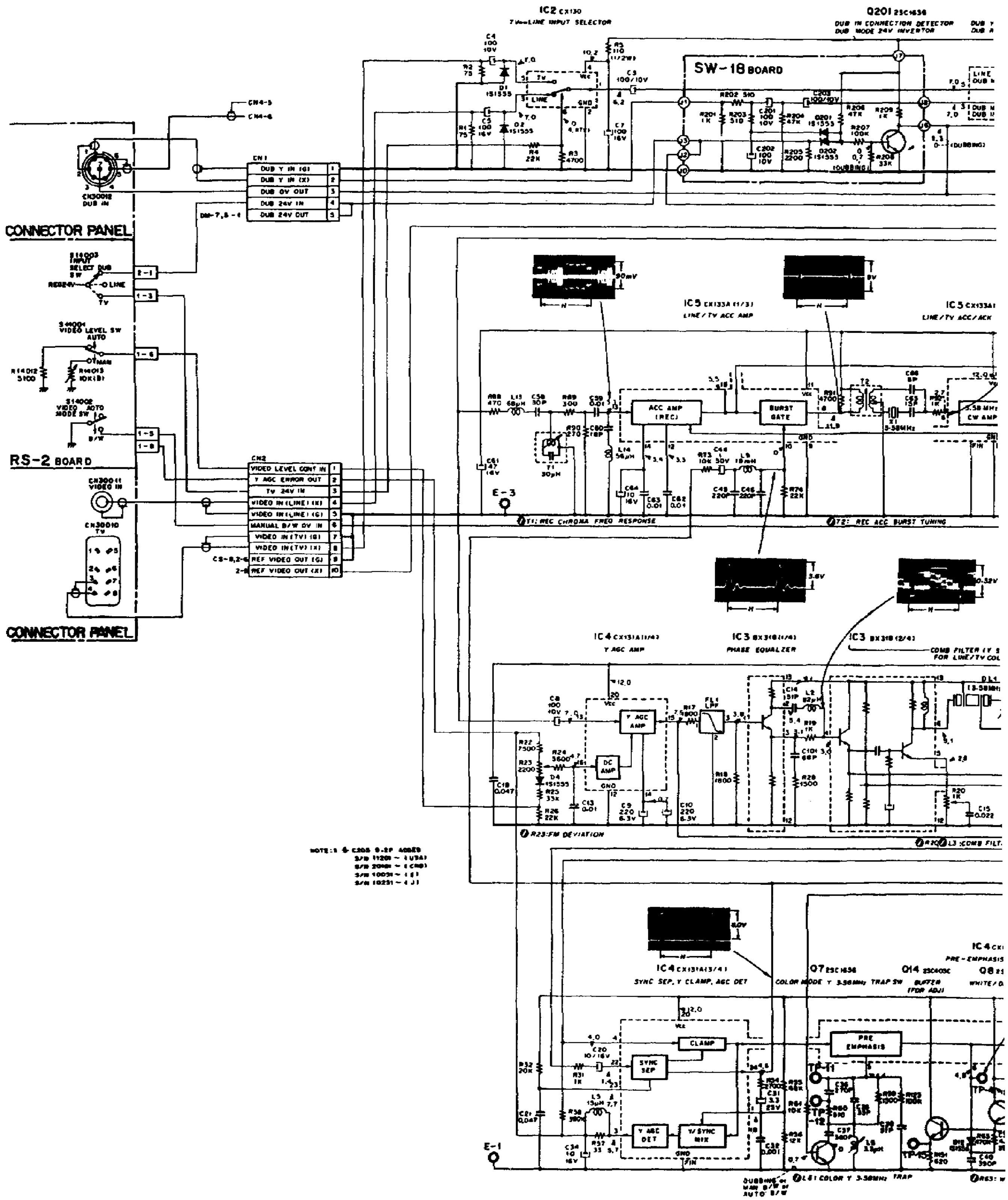


Figure (fo) 3-2. (MD-4) Y/C modulator

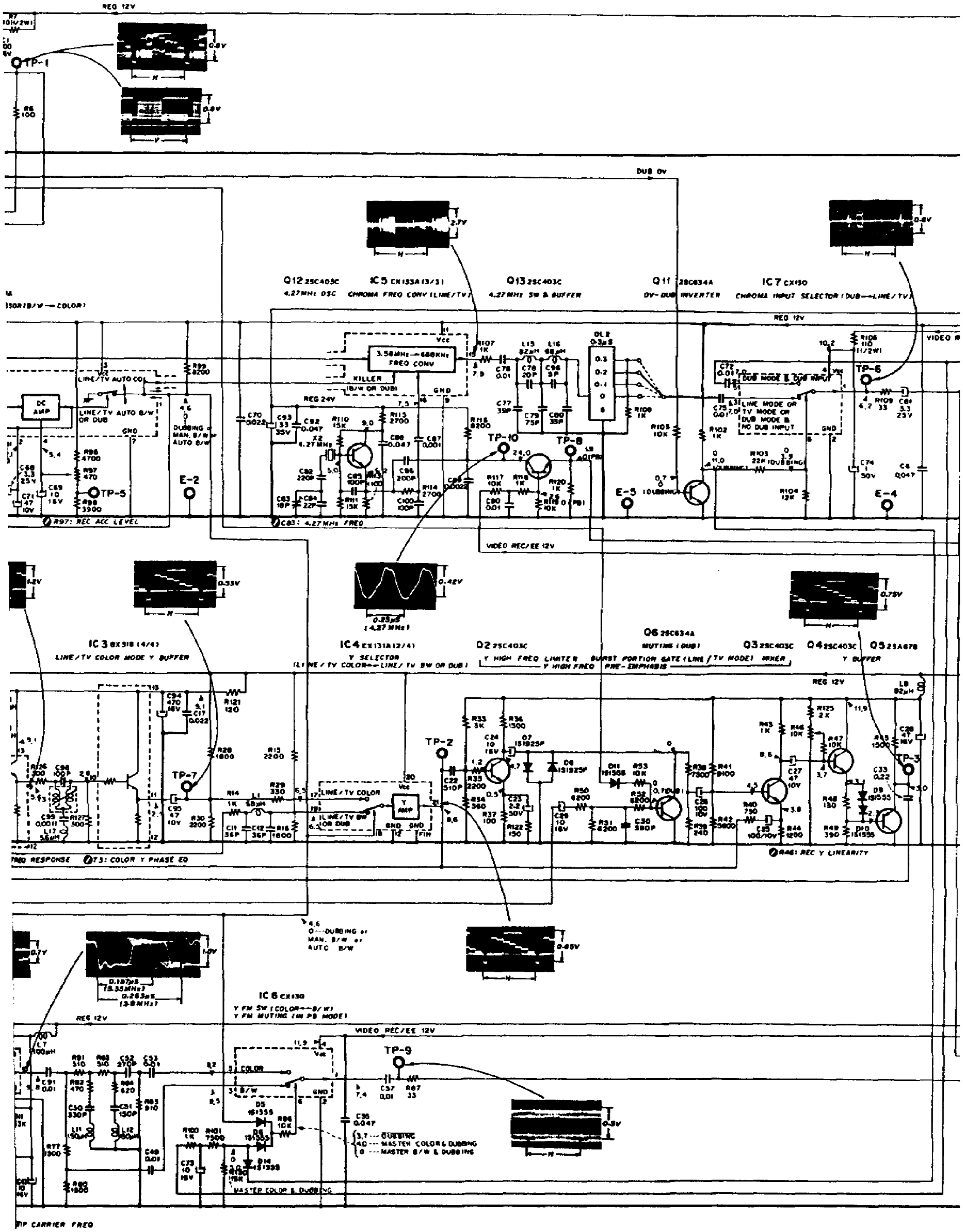


Figure (fo) 3-2. (MD-4) Y/C modulator - continued

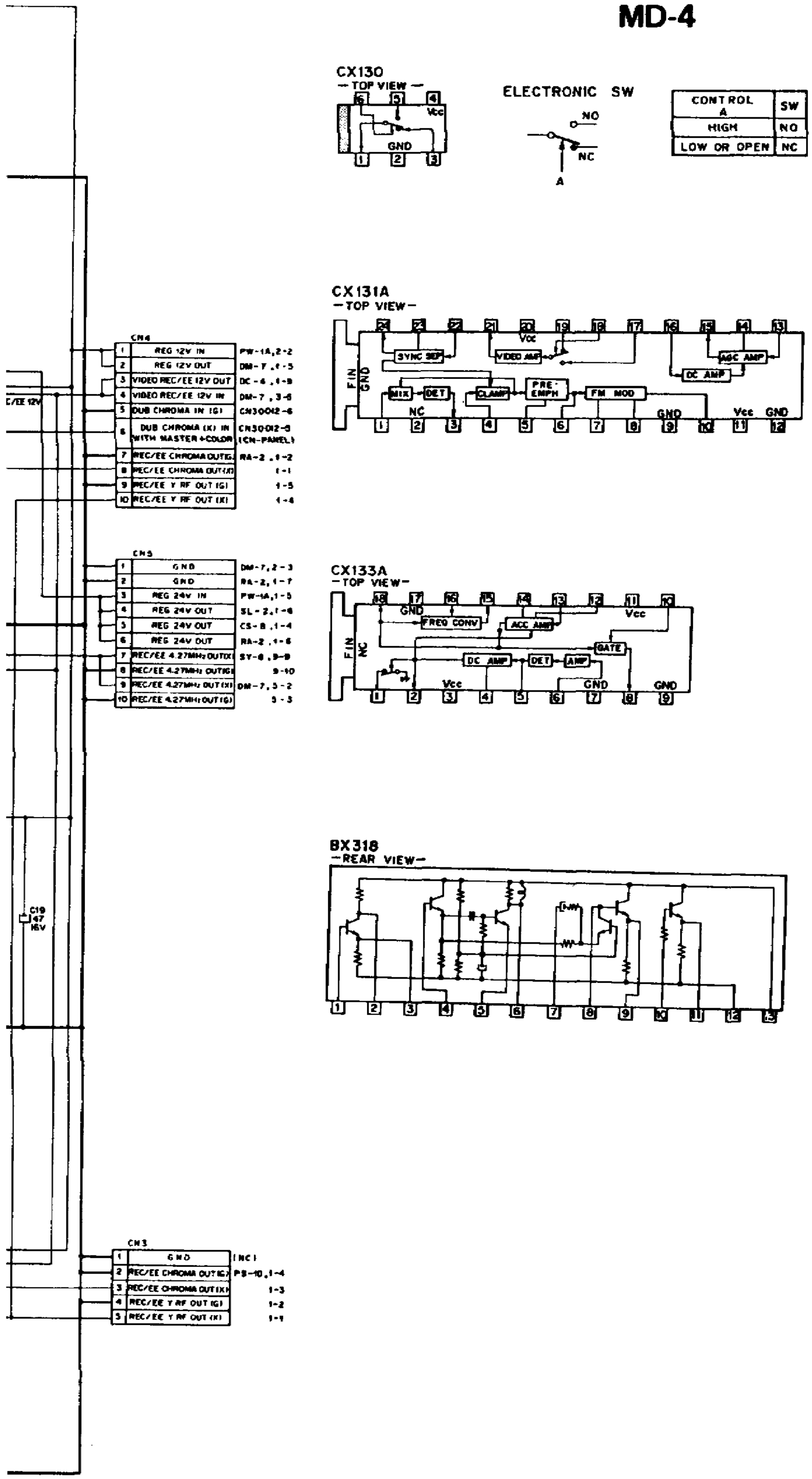


Figure (fo) 3-2. (MD-4) Y/C modulator - continued

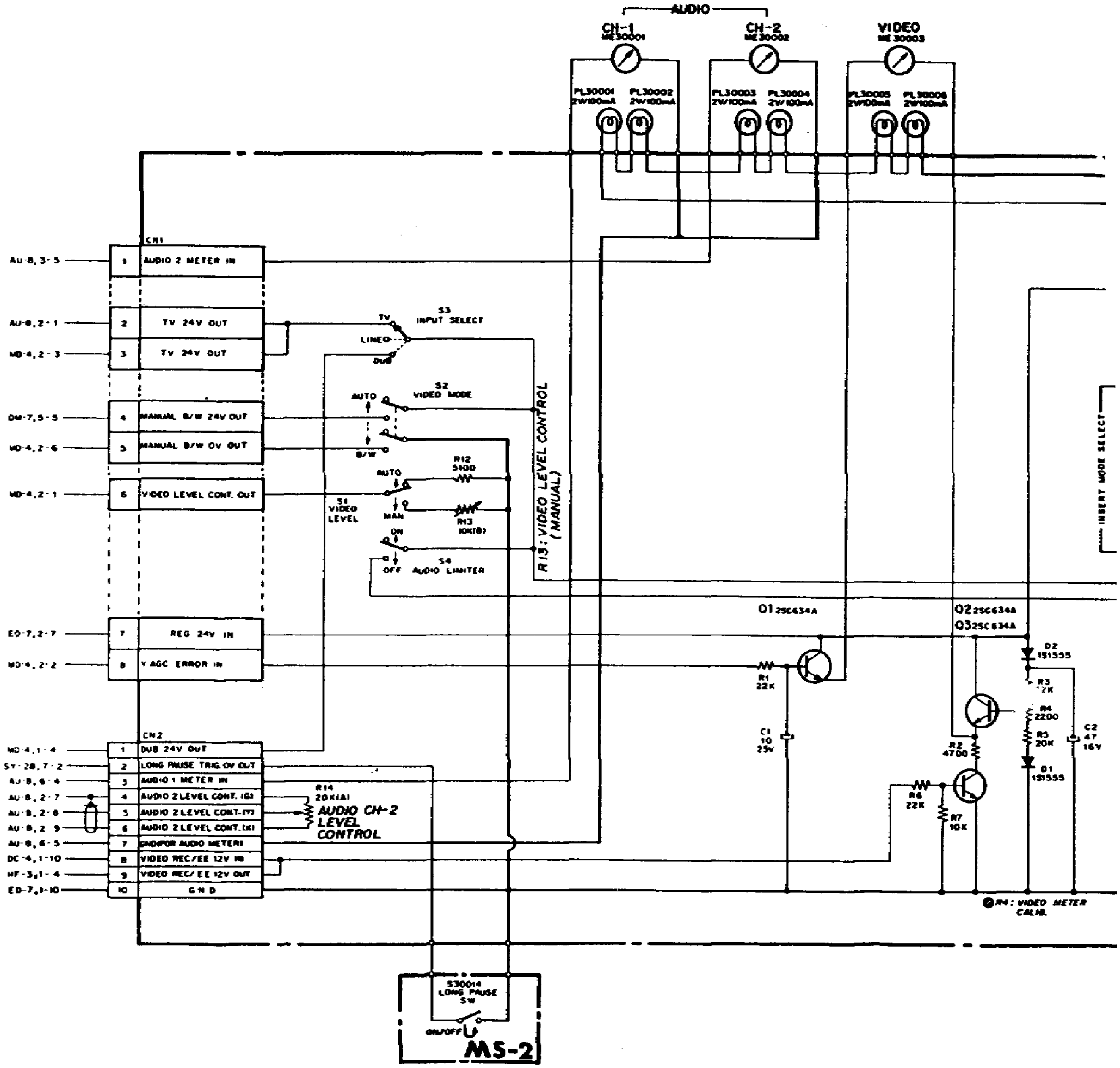


Figure (fo) 3-3. (RS-2) Right switch block

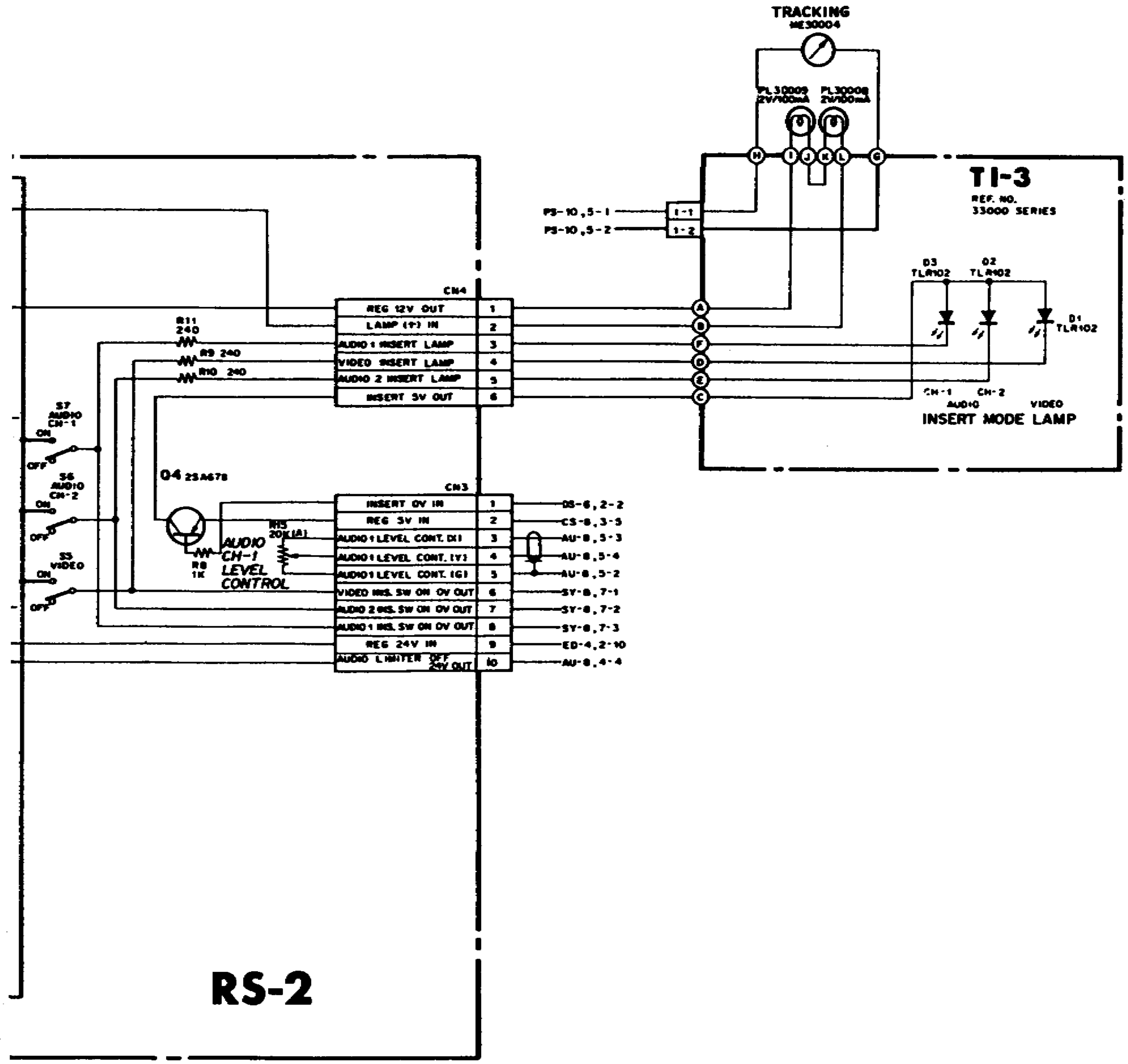


Figure (fo) 3-3. (RS-2) Right switch block - continued

The shaded and ⚠-marked components are critical to safety.
Replace only with same components as specified.

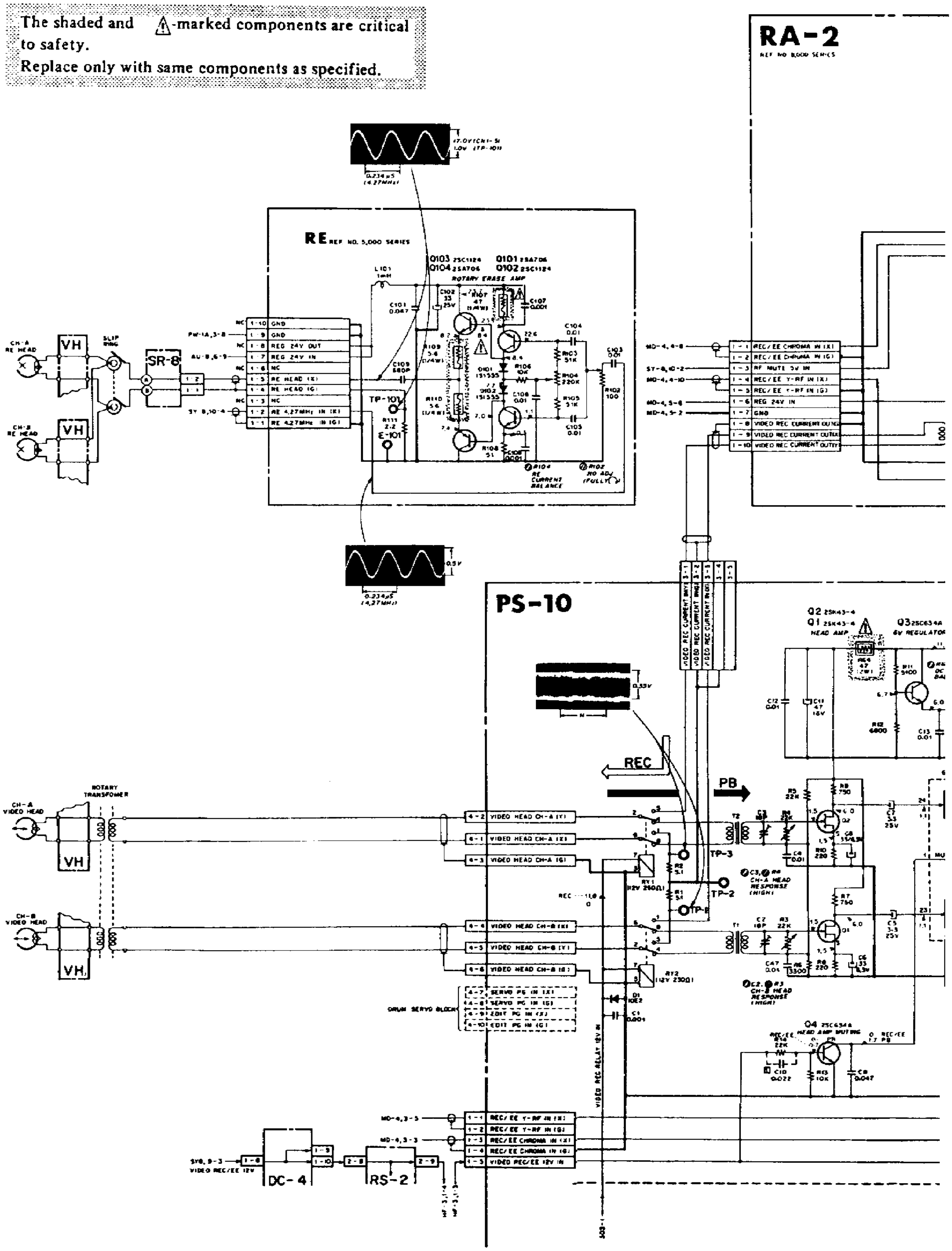


Figure (fo) 3-4. (RA-2) Y/C record amplifier, (PS-10) playback RF amplifier, (HF-3) PB Y RF sideband equalizer

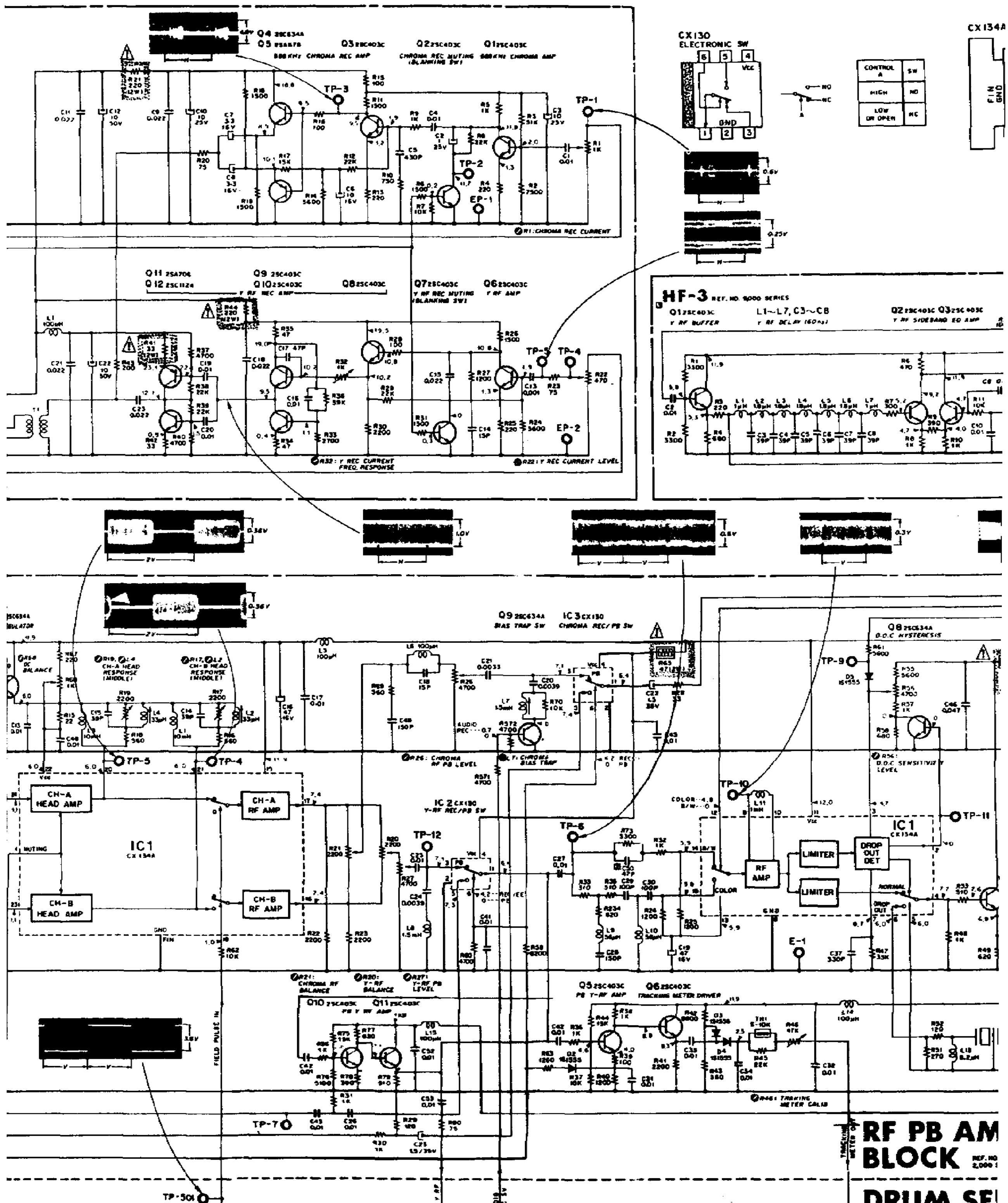
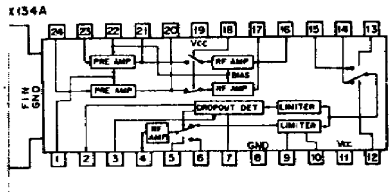
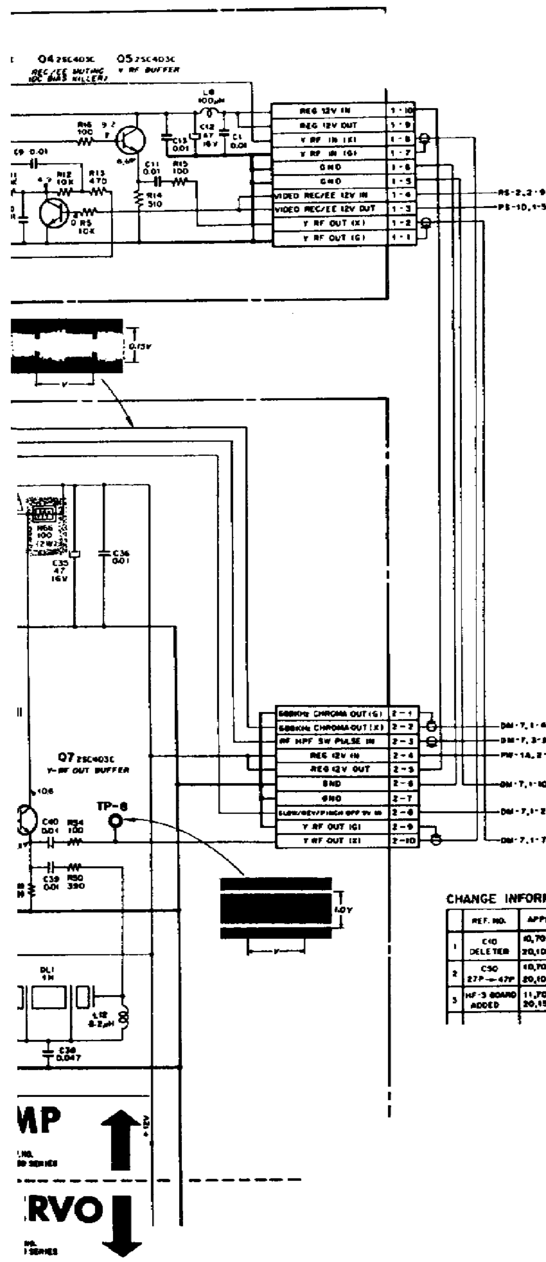


Figure (fo) 3-4. (RA-2) Y/C record amplifier, (PS-10) playback RF amplifier, (HF-3) PB Y RF sideband equalizer - continued





CHANGE INFORMATION

	REF. NO.	APPLIED SERIAL NO.		REASON
1	C10 DELETED	10,701~ / 20,101~	USA / CND	COUNTERMEASURE FOR NOISE
2	C50 27P→47P	10,701~ / 20,101~	USA / CND	IMPROVEMENT IN Y-F-RESPONSE
3	HF-3 BOARD ADDED	11,701~ / 20,151~	USA / CND	TO "EXPAND" Y-RF FREQ. BAND WIDTH

Figure (fo) 3-4. (RA-2) Y/C record amplifier, (PS-10) playback RF amplifier, (HF-3) PB Y RF sideband equalizer - continued

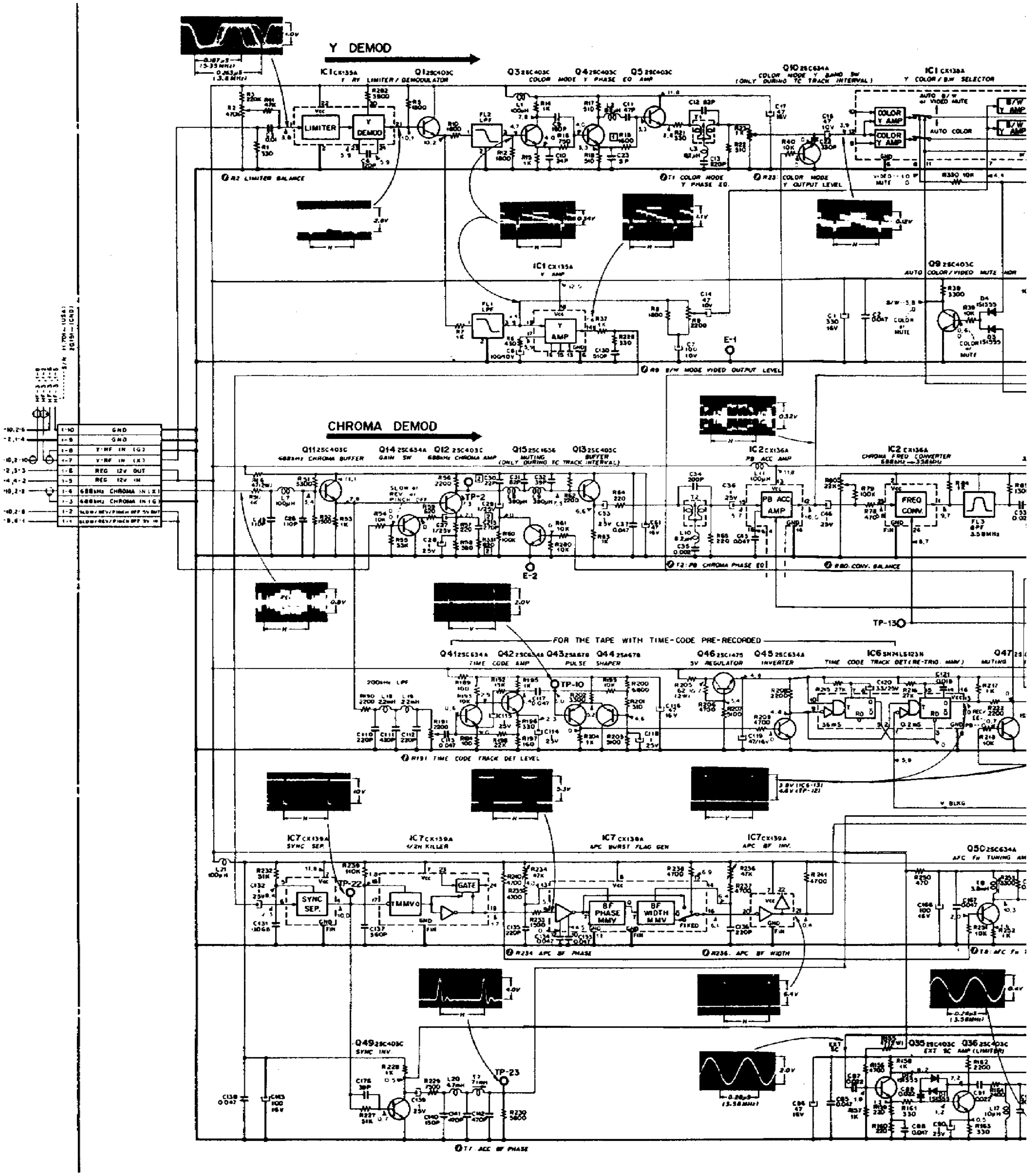


Figure (fo) 4-2. (DM-7) Y/C demodulator

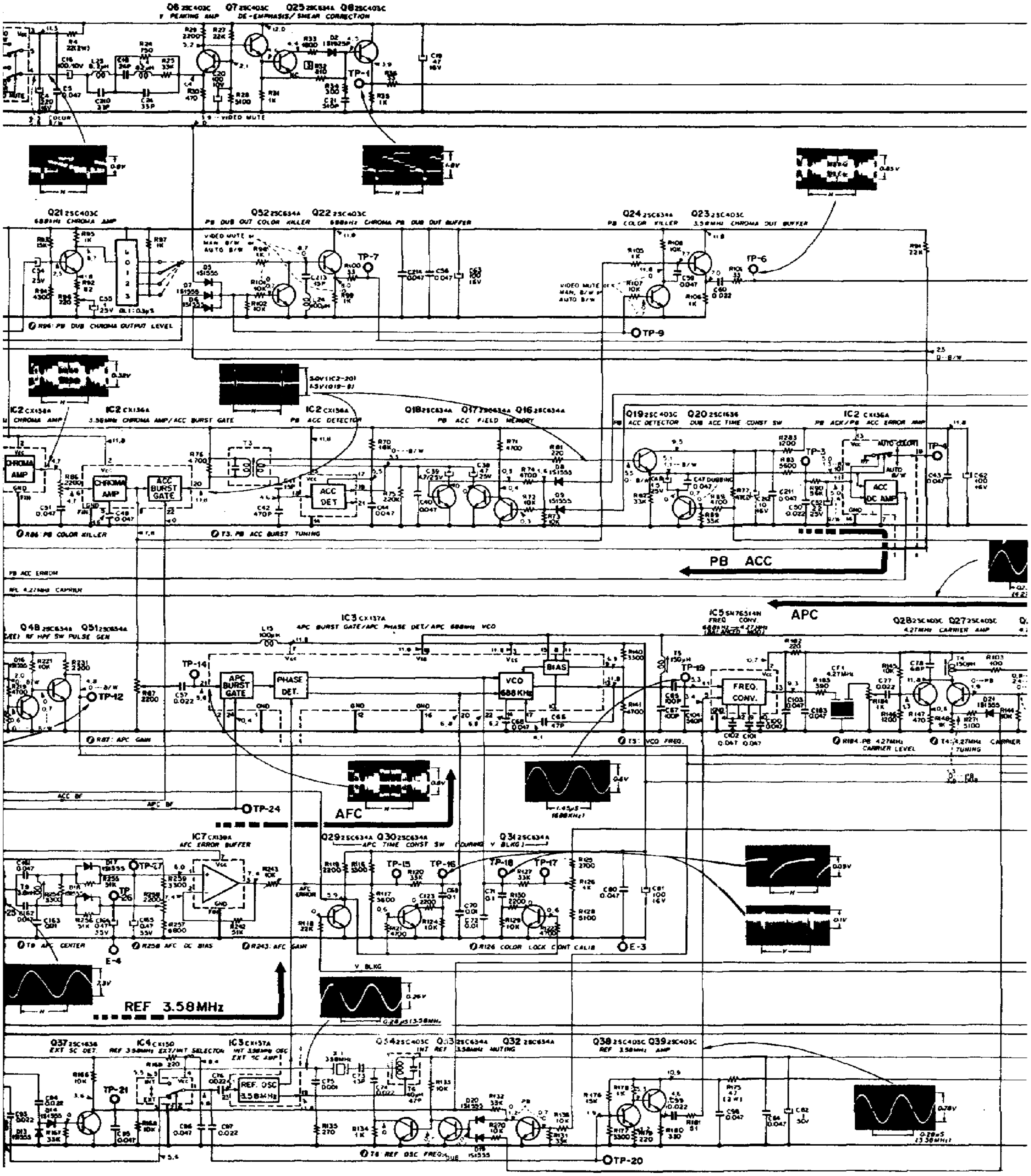


Figure (fo) 4-2. (DM-7) Y/C demodulator - continued

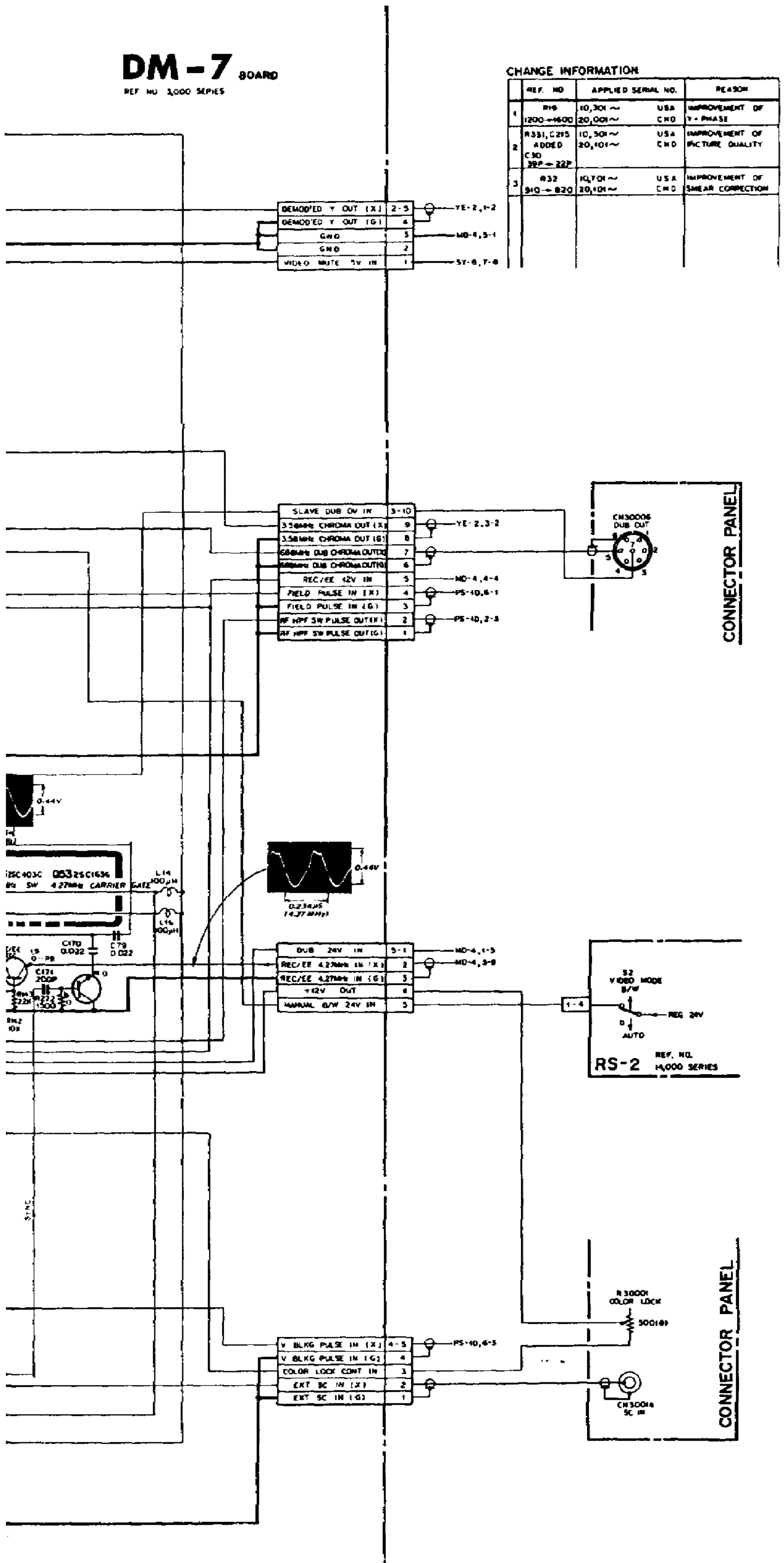


Figure (fo) 4-2. (DM-7) Y/C demodulator - continued

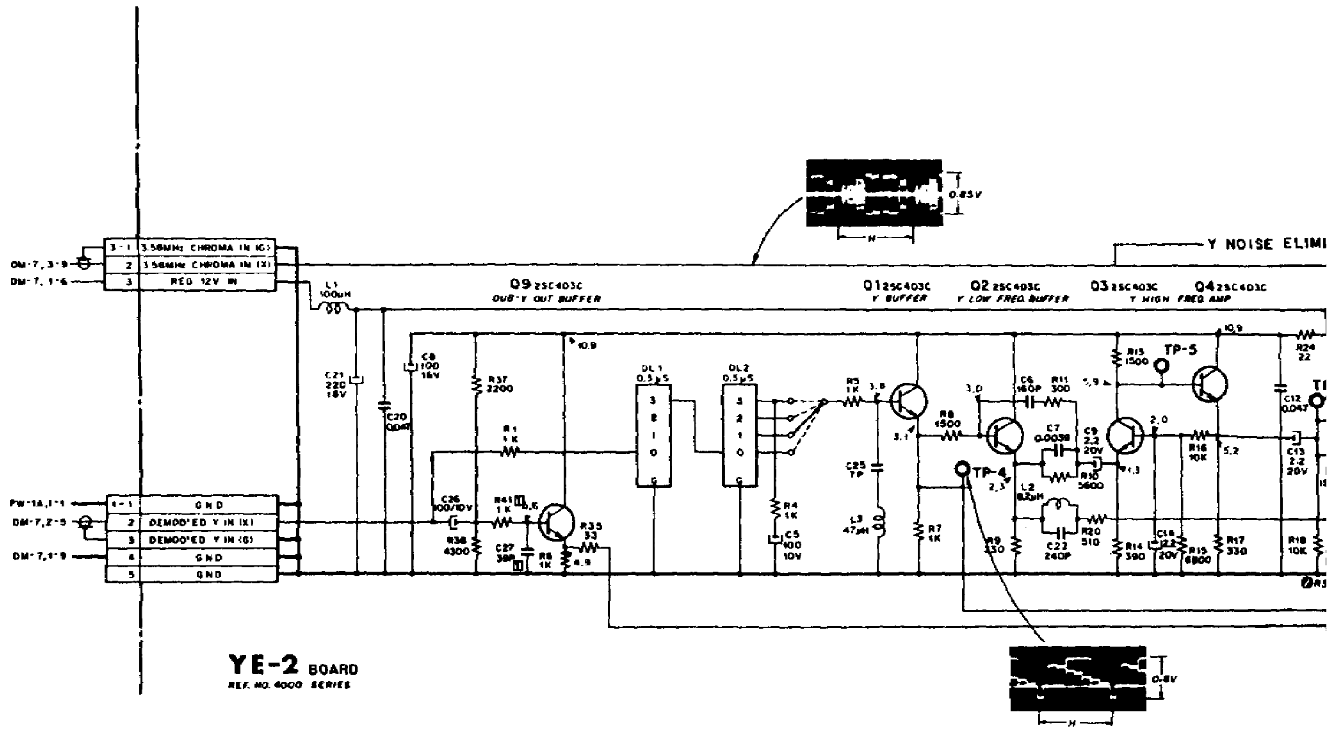


Figure (fo) 4-4. (YE-2) Y noise eliminator, Y/C mixer, and video output amplifier

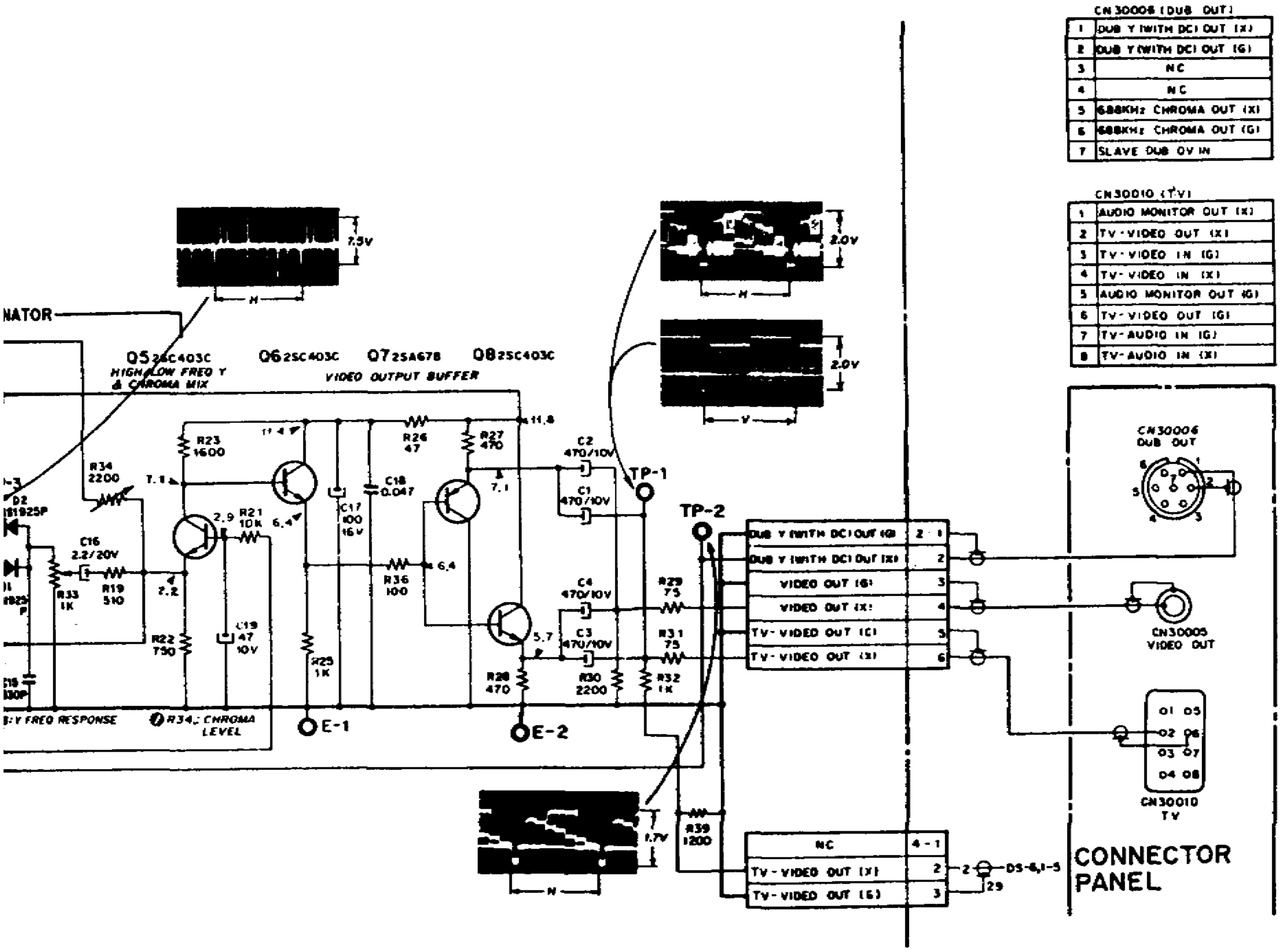


Figure (fo) 4-4. (YE-2) Y noise eliminator, Y/C mixer, and video output amplifier - continued

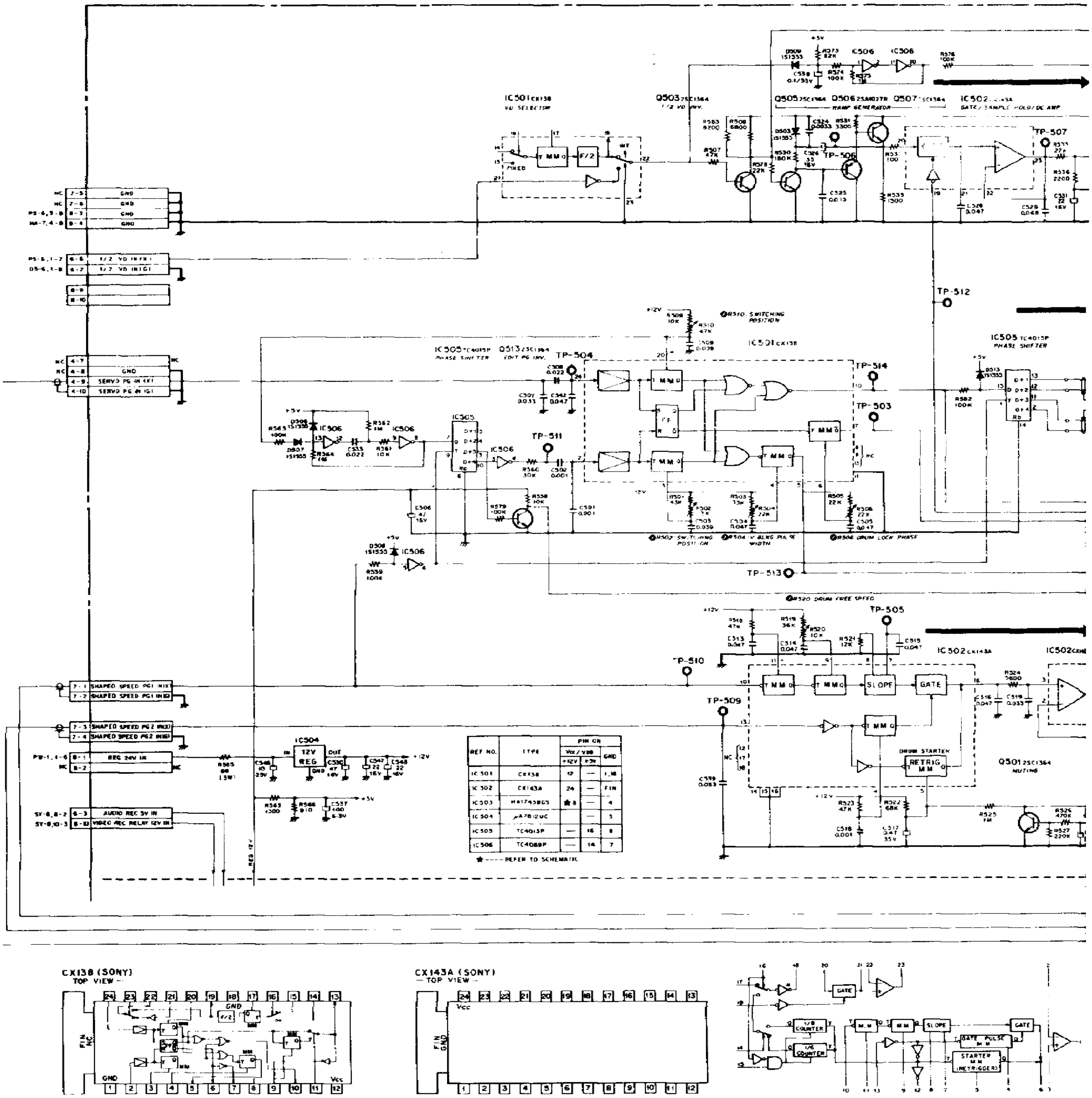
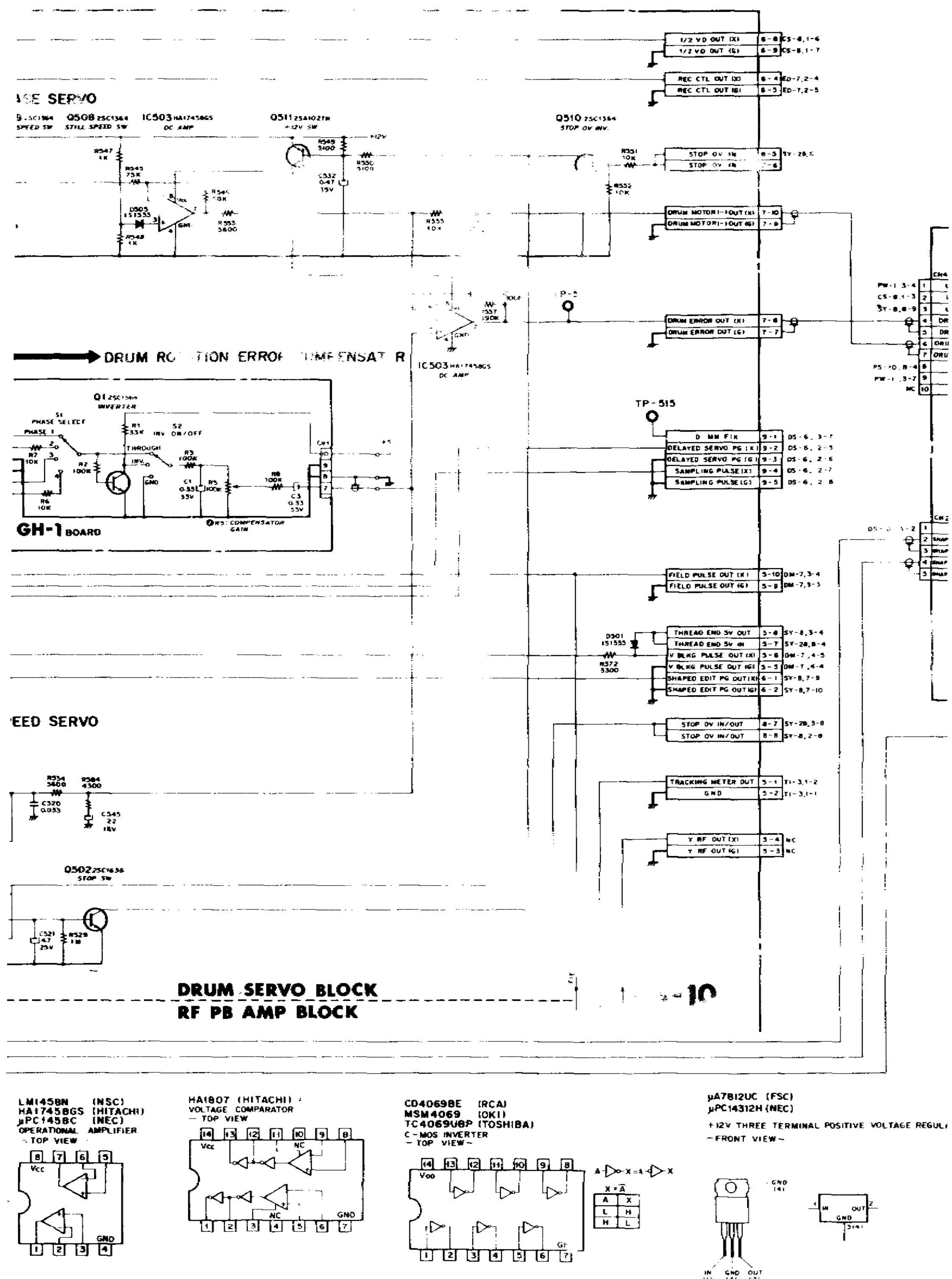


Figure (fo) 4-5. (PS-10, MA-7, and GH-1) drum servo, and chroma demodulator



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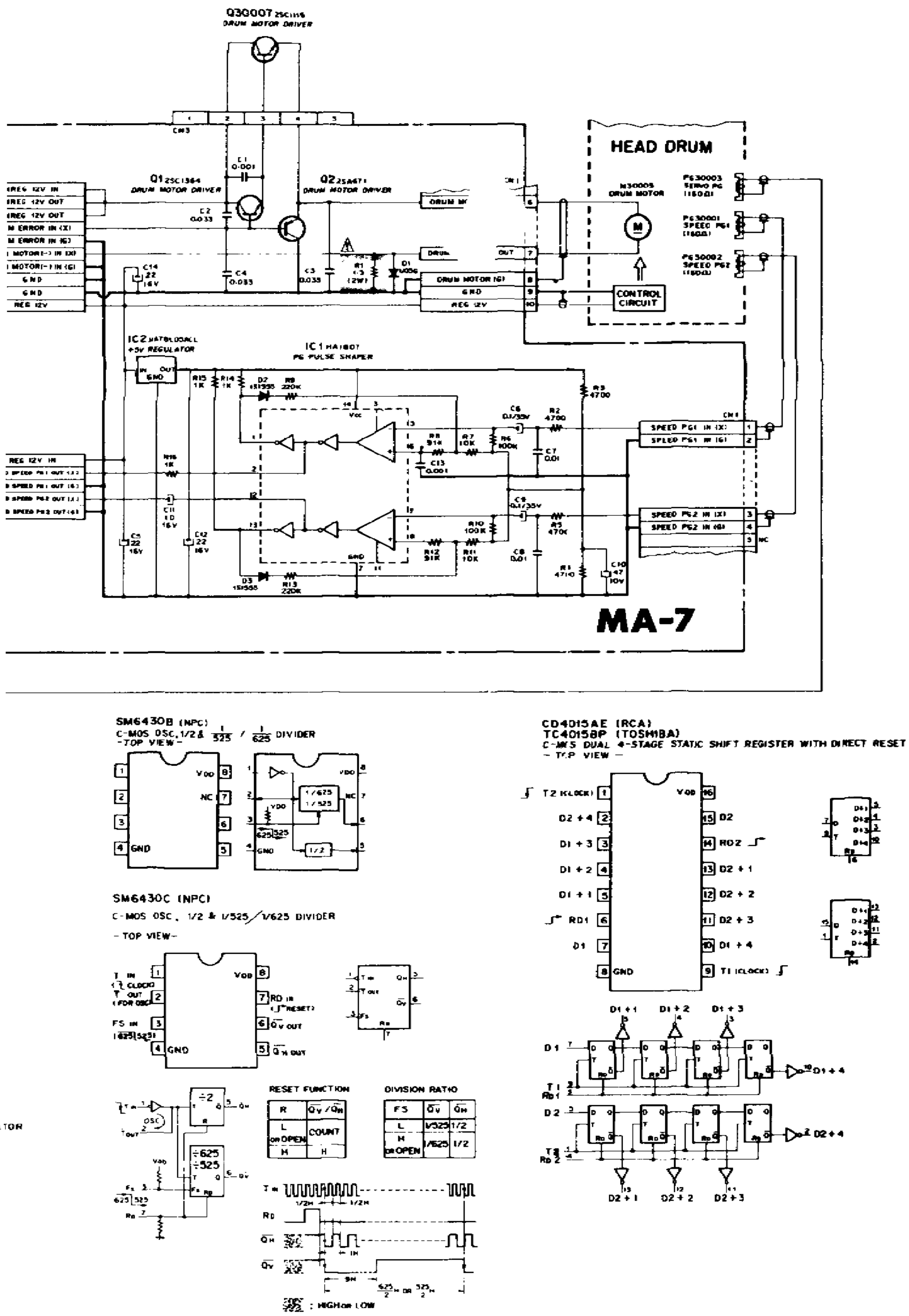
to safety.
Replace only with same component

Figure (fo) 4-5. (PS-10, MA-7, and GH-1) drum servo, and chroma demodulator - continued



nents are critical

as specified.

Figure (fo) 4-5. (PS-10, MA-7, and GH-1) drum servo, and chroma demodulator - continued

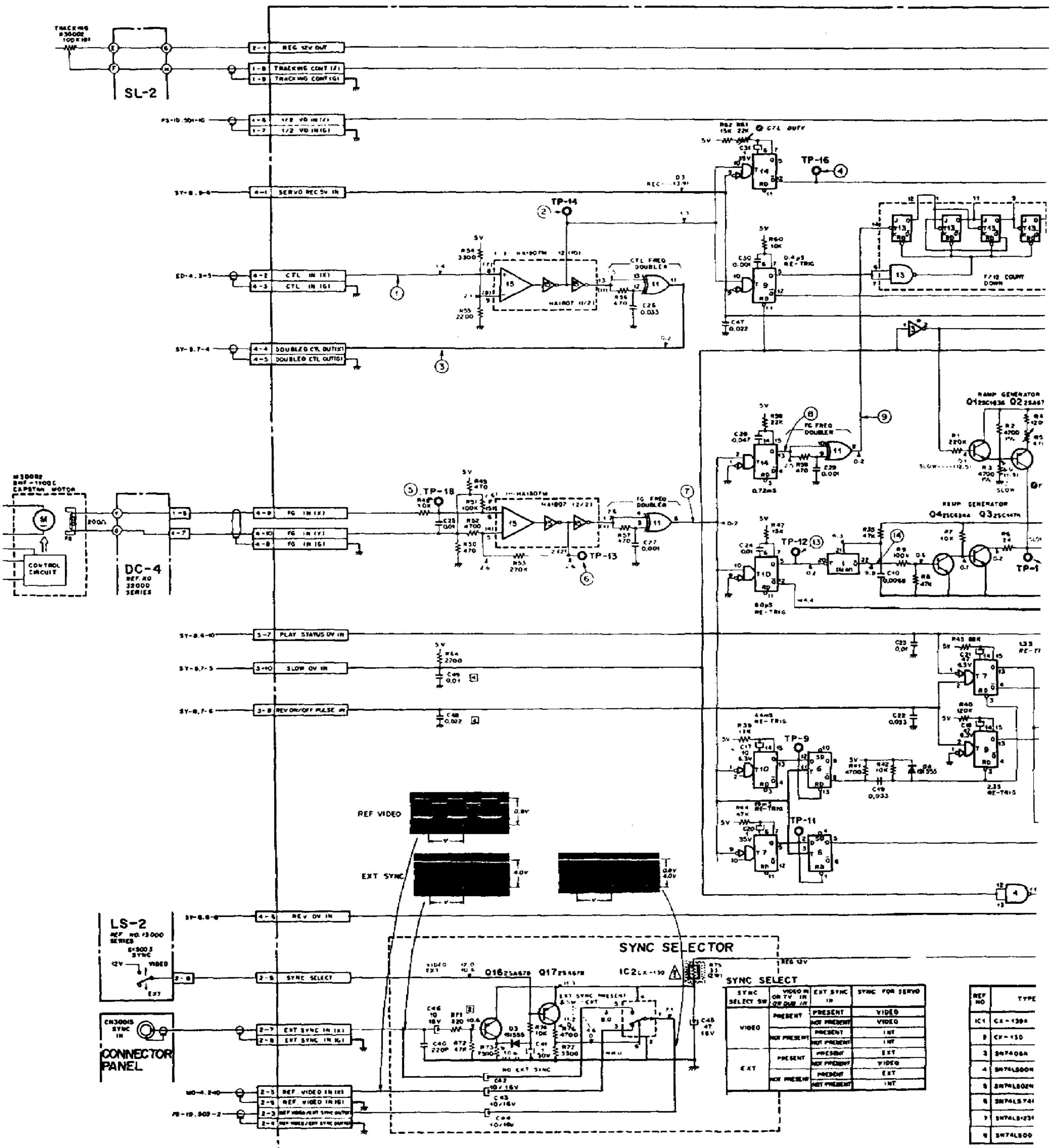


Figure (fo) 5-1. (CS-8) capstan servo

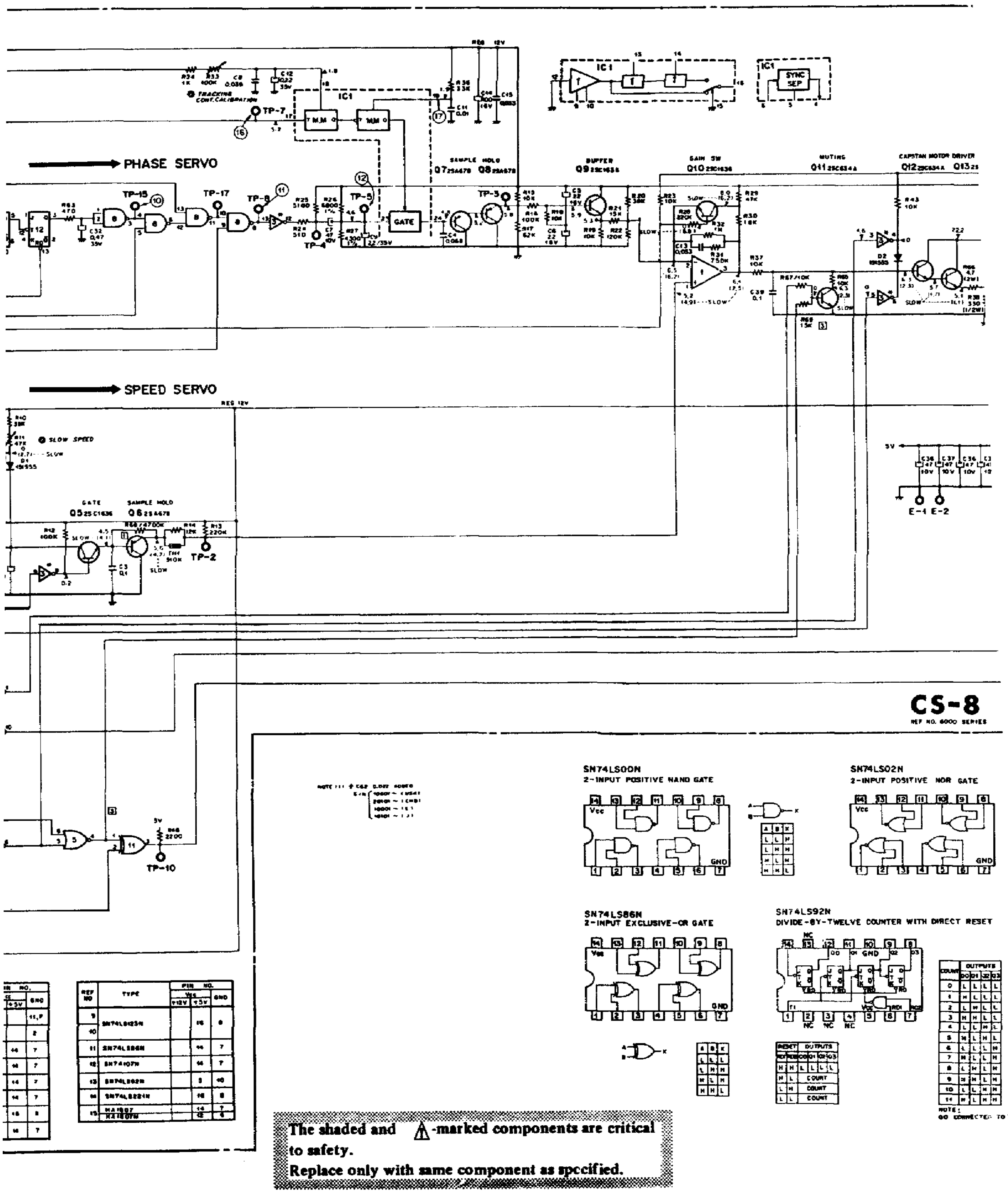


Figure (fo) 5-1. (CS-8) capstan servo - continued

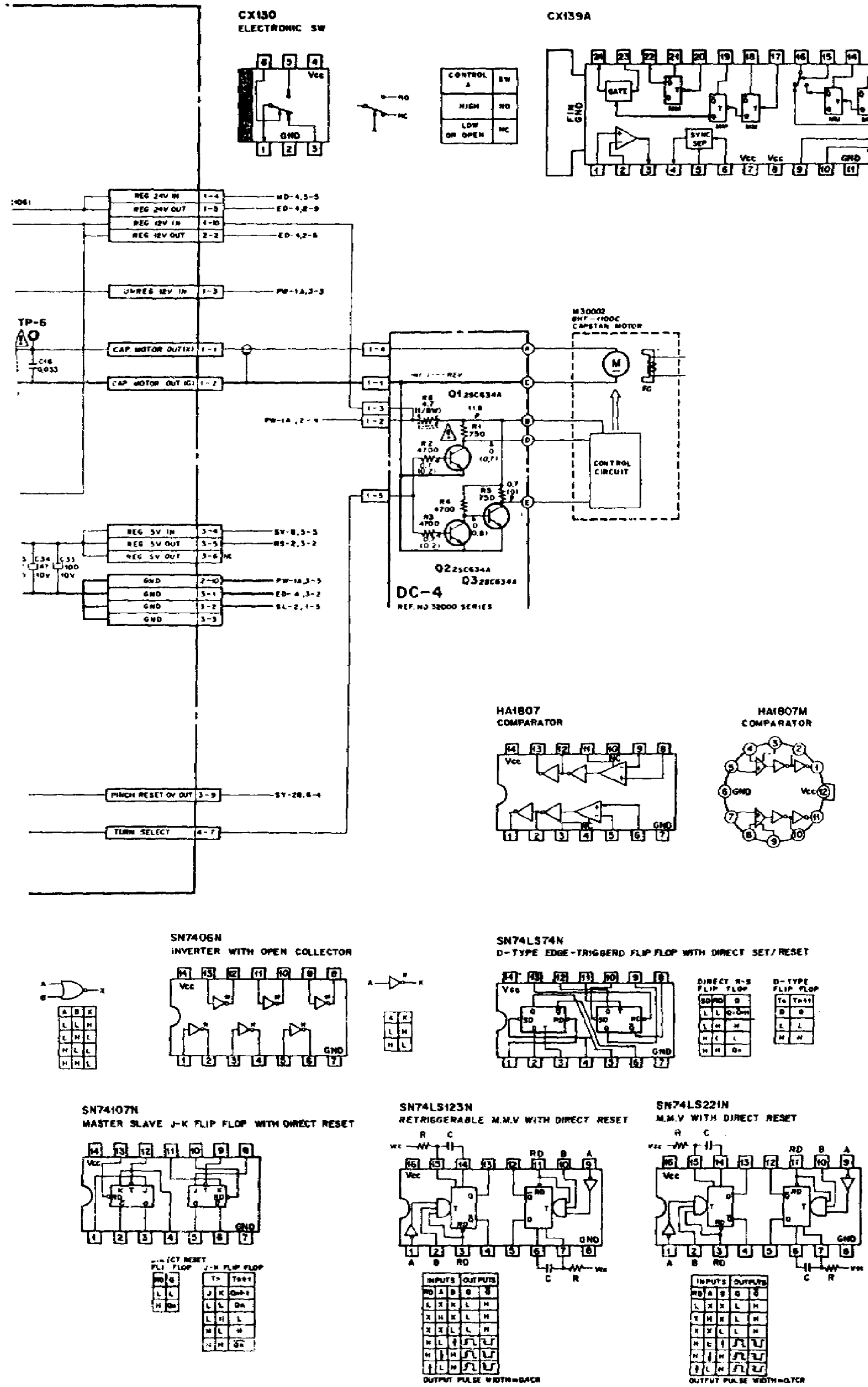
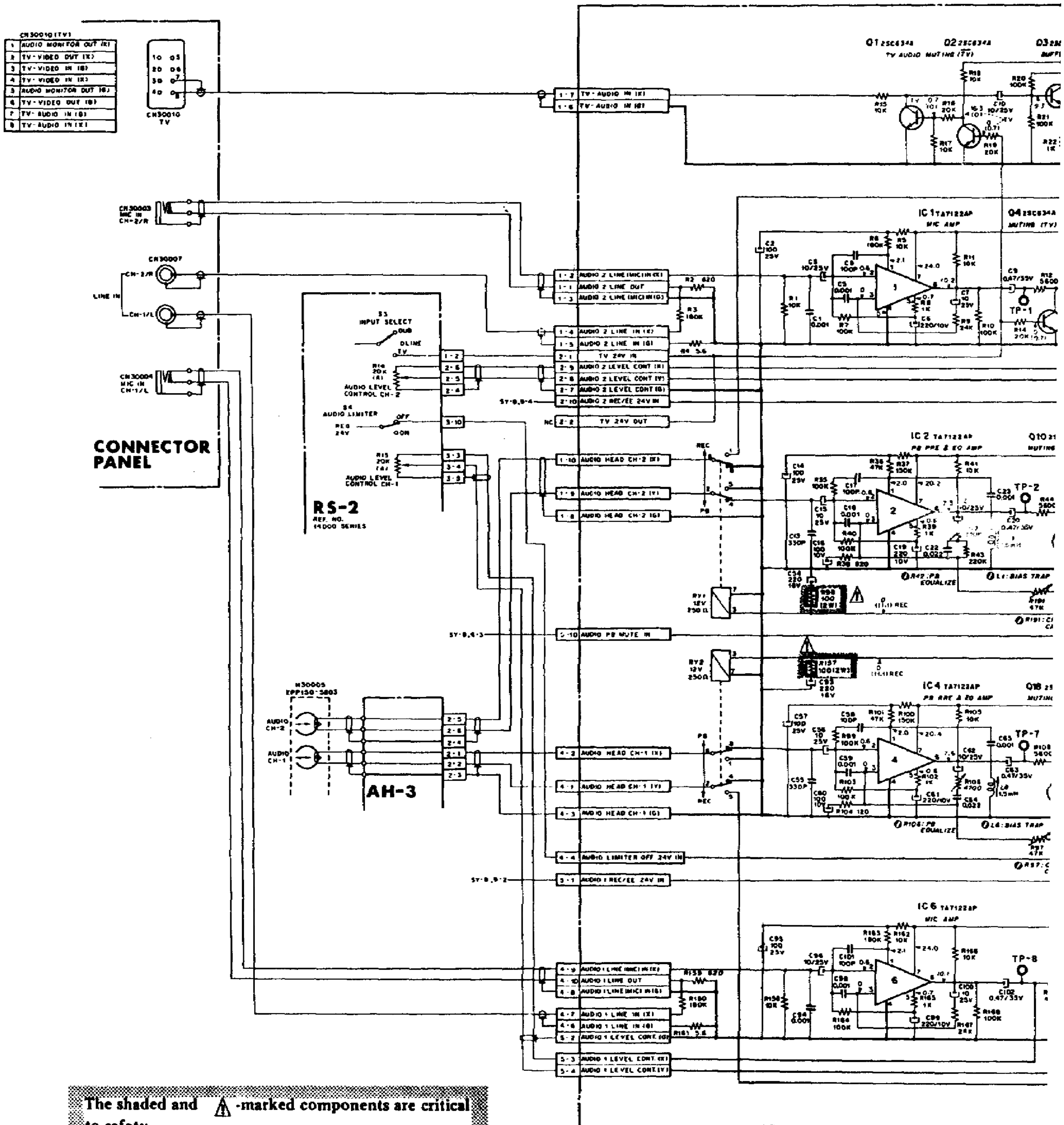


Figure (fo) 5-1. (CS-8) capstan servo - continued



The shaded and ⚠ -marked components are critical to safety.
Replace only with same component as specified.

Figure (fo) 5-2. (AU-8) audio rec/PB amplifier

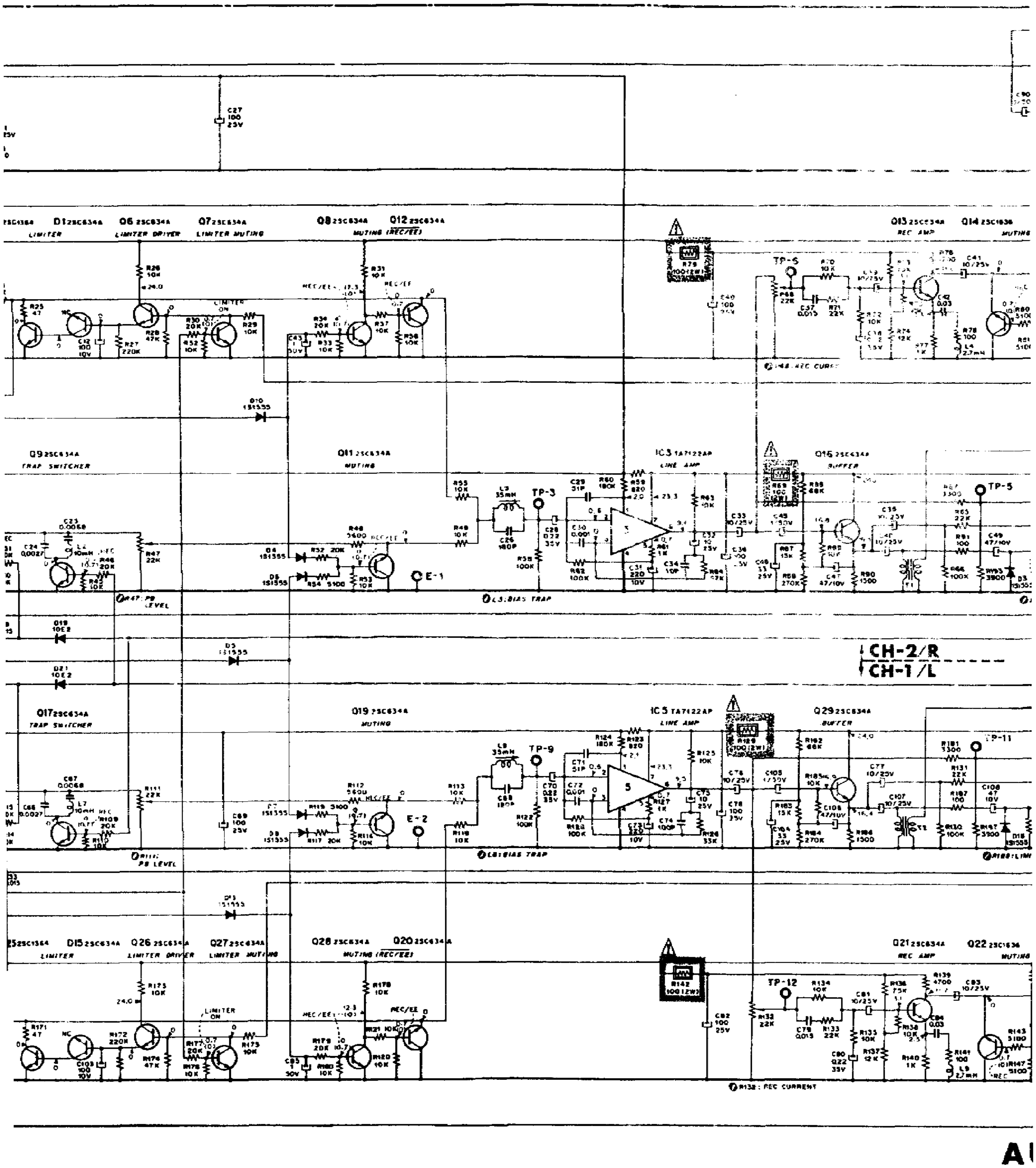


Figure (fo) 5-2. (AU-8) audio rec/PB amplifier - continued

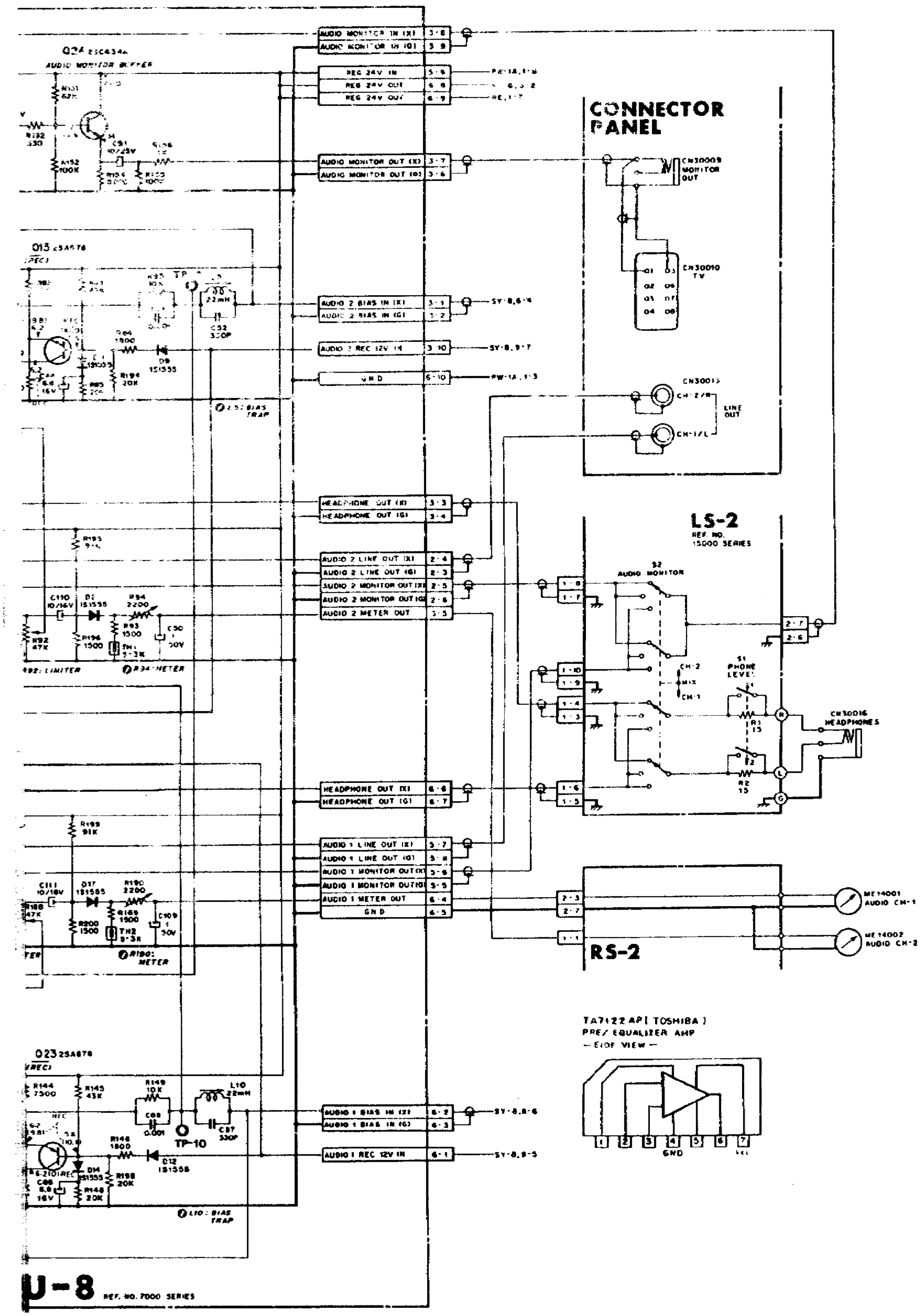
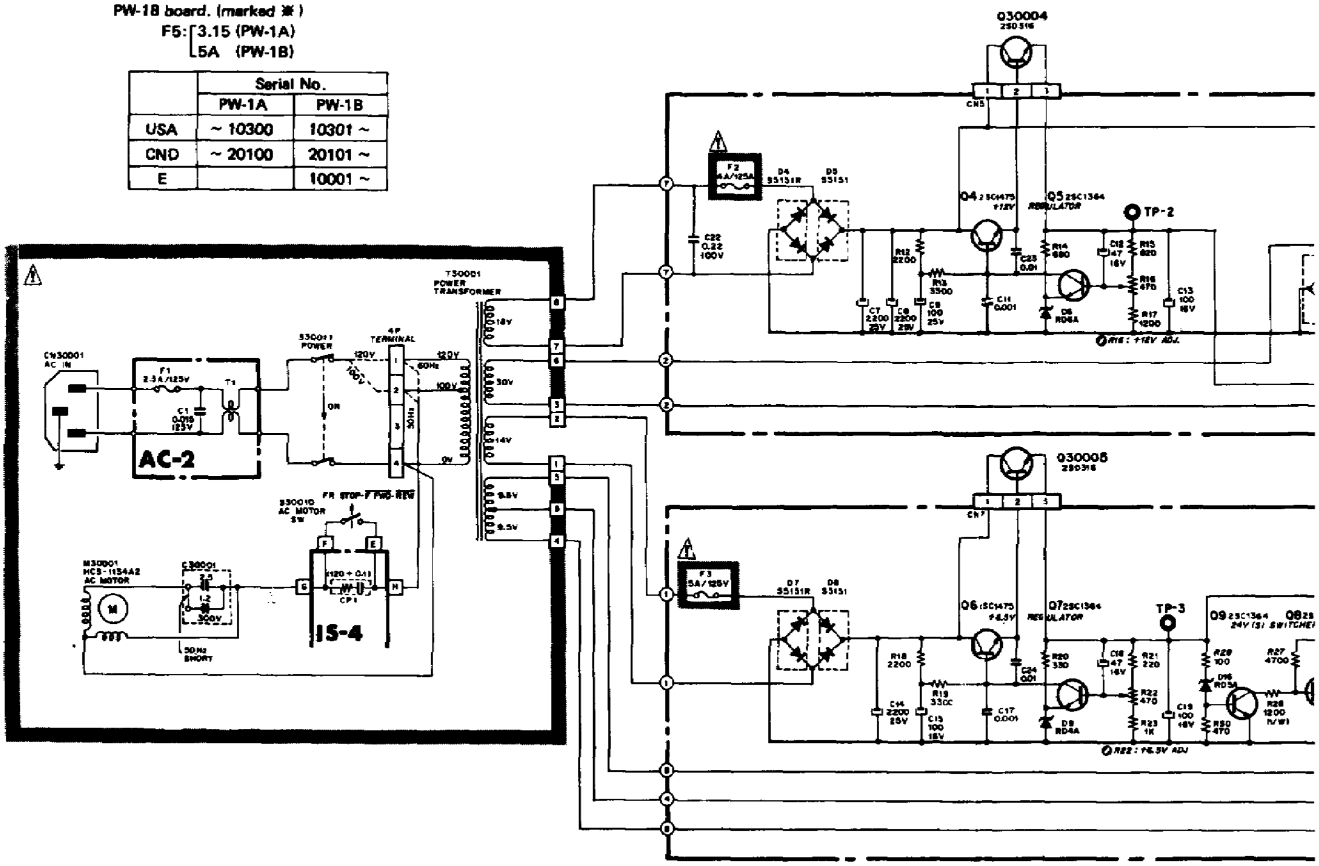


Figure (fo) 5-2. (AU-8) audio rec/PB amplifier - continued

NOTE: Only a fuse (F5) is difference between the PW-1A and the PW-1B board. (marked ✱)
F5: [3.15 (PW-1A)
5A (PW-1B)

	Serial No.	
	PW-1A	PW-1B
USA	~ 10300	10301 ~
CND	~ 20100	20101 ~
E		10001 ~



The shaded and ⚠-marked components are critical to safety.
Replace only with same component as specified.

Figure (fo) 5-3. (PW-1A, PW-1B, and AC-2) Power supply

PW-1A or PW-1B/IS-4/AC-2

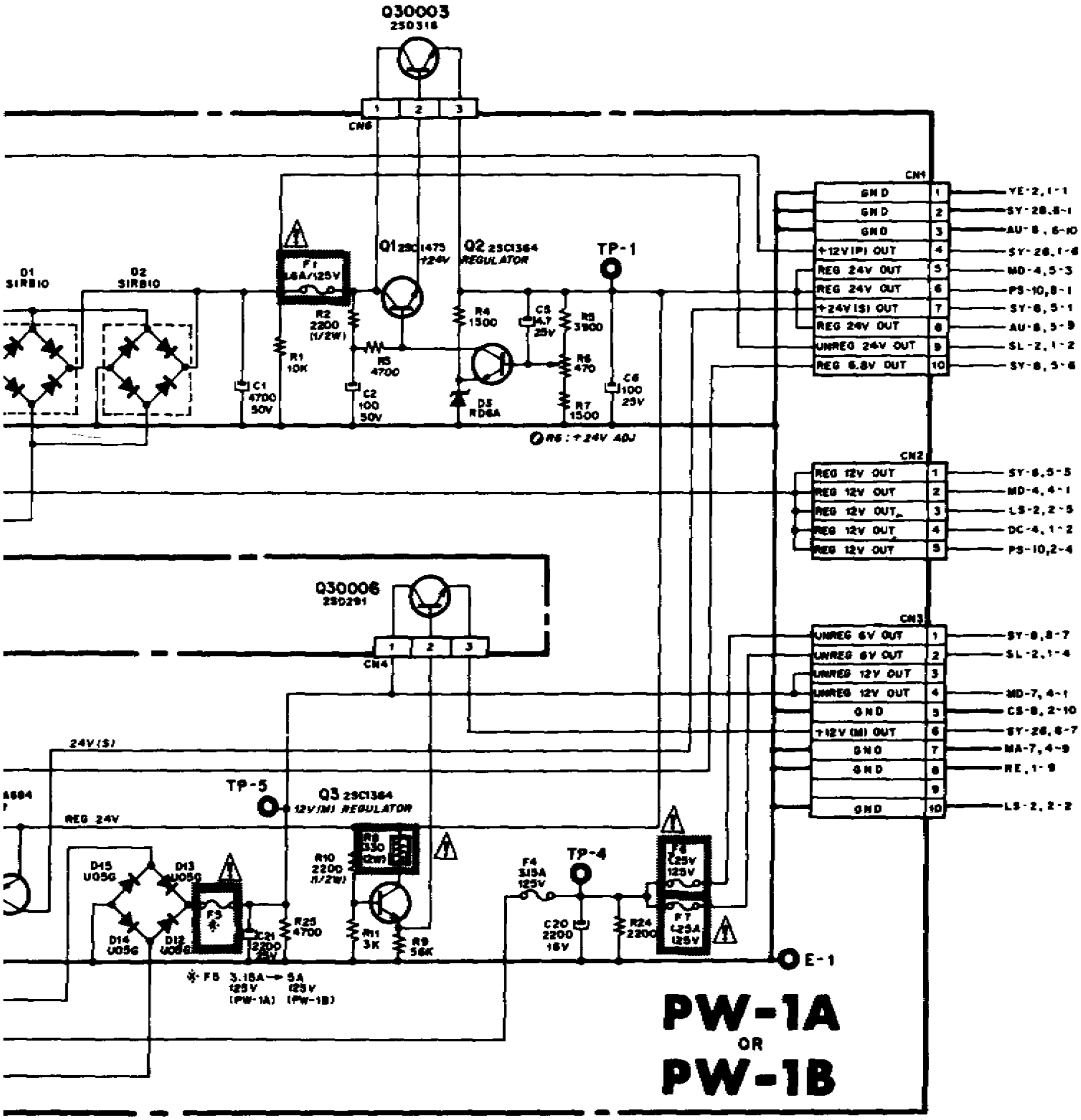


Figure (fo) 5-3. (PW-1A, PW-1B, and AC-2) Power supply - continued

ANSWERS TO PRACTICE EXERCISES

Lesson 1

1.	c	LE 1	para 1	pg 1
2.	a	LE 1	para 4	pg 4
3.	b	LE 2	para 2	pg 4
4.	d	LE 3	para 2	pg 6
5.	a	LE 5	para 1	pg 7

Lesson 2

1.	c	LE 1	para 3	pg 10
2.	a	LE 2	para 1	pg 11
3.	c	LE 3	para 4	pg 12
4.	d	LE 3	para 3	pg 12
5.	b	LE 3	para 4	pg 12

Lesson 3

1.	b	LE 1	para 2	pg 14
2.	a	LE 1	para 4	pg 15
3.	c	LE 2	para 1	pg 15
4.	d	LE 3	para 1	pg 15
5.	a	LE 3	para 4	pg 16
6.	c	LE 4	para 2	pg 17
7.	b	LE 5	para 1	pg 17
8.	d	LE 6	para 3	pg 18
9.	a	LE 6	para 5	pg 19
10.	b	LE 7	para 1	pg 19

Lesson 4

1.	b	LE 1	para 2	pg 23
2.	c	LE 1	para 2	pg 23
3.	a	LE 2	para 3	pg 24
4.	d	LE 3	para 1	pg 25
5.	a	LE 3	para 2	pg 25
6.	a	LE 4	para 1	pg 26
7.	c	LE 5	para 2	pg 27
8.	d	LE 6	para 1	pg 28
9.	b	LE 7	para 2	pg 29
10.	d	LE 7	para 10	pg 31
11.	a	LE 8	para 2	pg 32

ANSWERS TO PRACTICE EXERCISES (continued)

Lesson 5

1.	a	LE 2	para 3	pg 36
2.	c	LE 2	para 1	pg 36
3.	b	LE 2	para 1	pg 36
4.	c	LE 3	para 1	pg 37
5.	b.	LE 4	para 6	pg 38