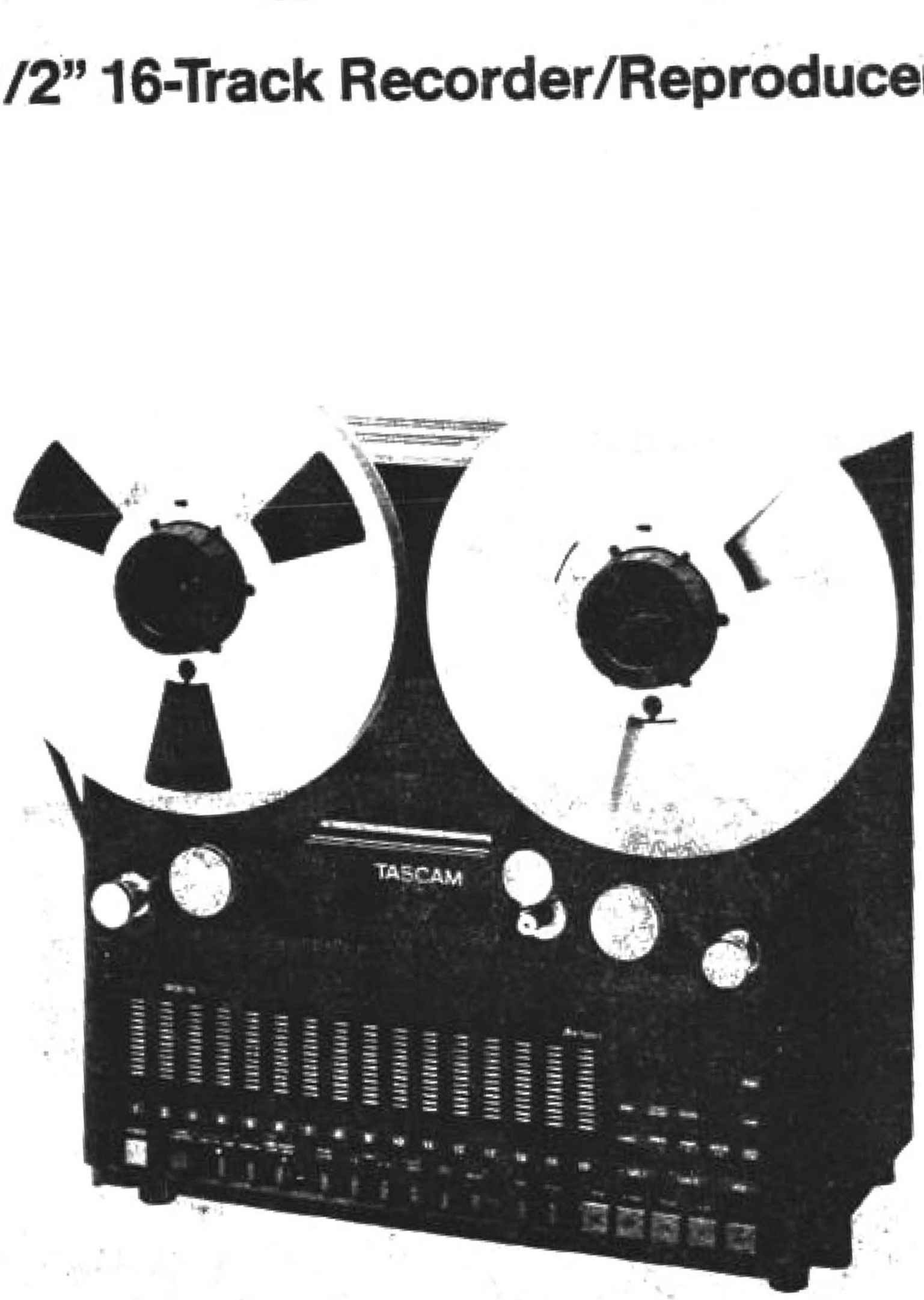
TASCAM
TEAC Professional Division

MSR-16

1/2" 16-Track Recorder/Reproducer



OPERATION/MAINTENANCE

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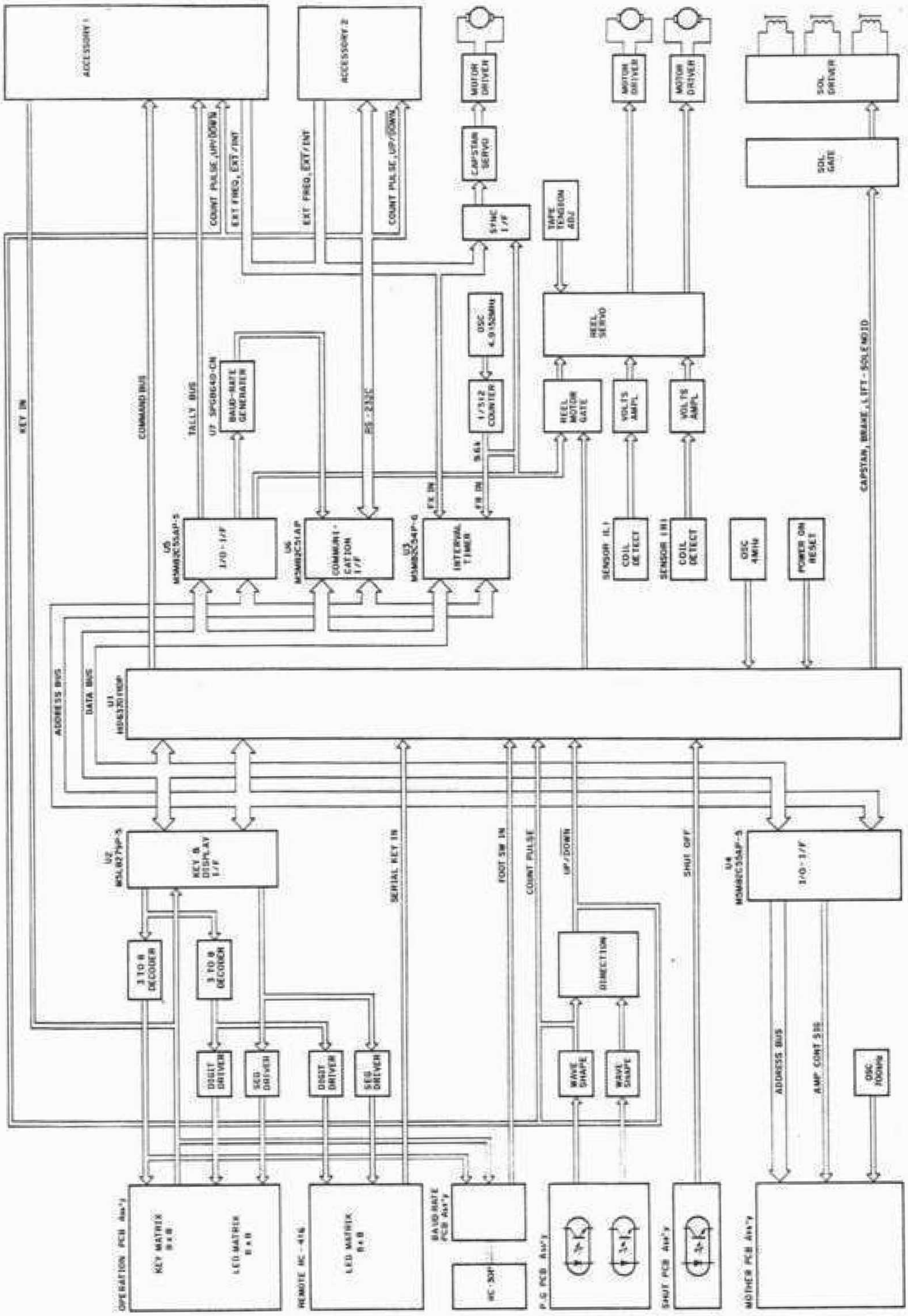
Control Signal Block Diagram



OTHERS

Connector/Jack	
Line Input/Output:	RCA jack
Remote Control:	D-sub, 25-pin
Accessory 1 (Parallel):	D-sub, 37-pin
Accessory 2 (Serial):	D-sub, 15-pin
Punch-in/out Remote Control:	1/4" phone jack (for RC-30P)
Standard Equipment:	Power Cord, Empty Reel (RE-1013), Operation/Maintenance Manual, Warranty Card
Option:	RC-416 Remote Control Unit RC-30P Punch-in Footswitch RE-1013 Metal Reel (10.5-inch, half-inch) CS-607B 19" Console Rack LA-40 Low-Impedance Adaptor

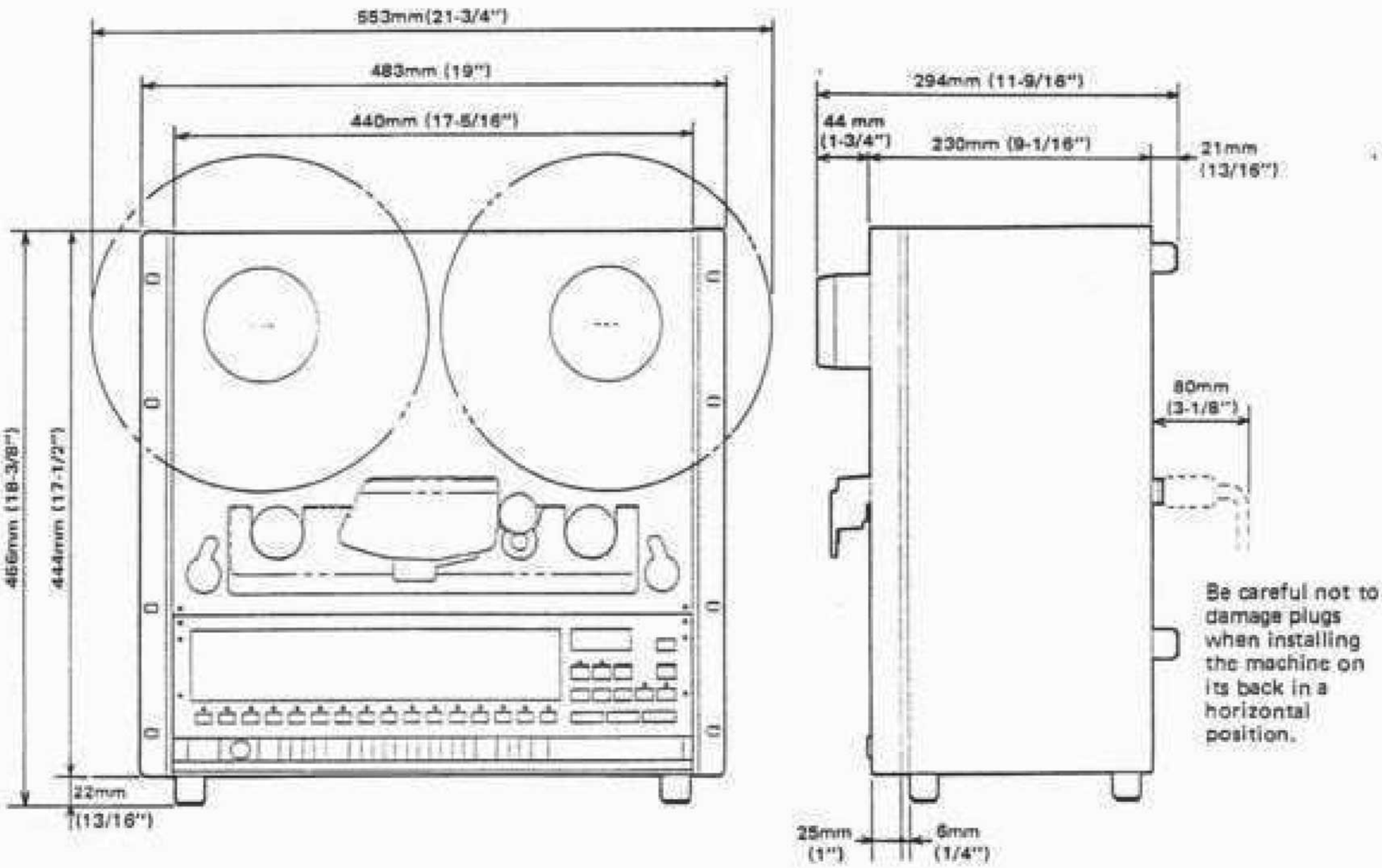
Measurements were made using the following TEAC test tapes:

1) TEAC YTT-11442 (15 ips, 38 cm/s)/YTT-1143 (7.5 ips, 19 cm/s)
2) TEAC YTT-8163 Blank Tape
3) TEAC YTT-2104 (15 pis, 38 cm/s)/YTT-2103 (7.5 ips, 19 cm/s)

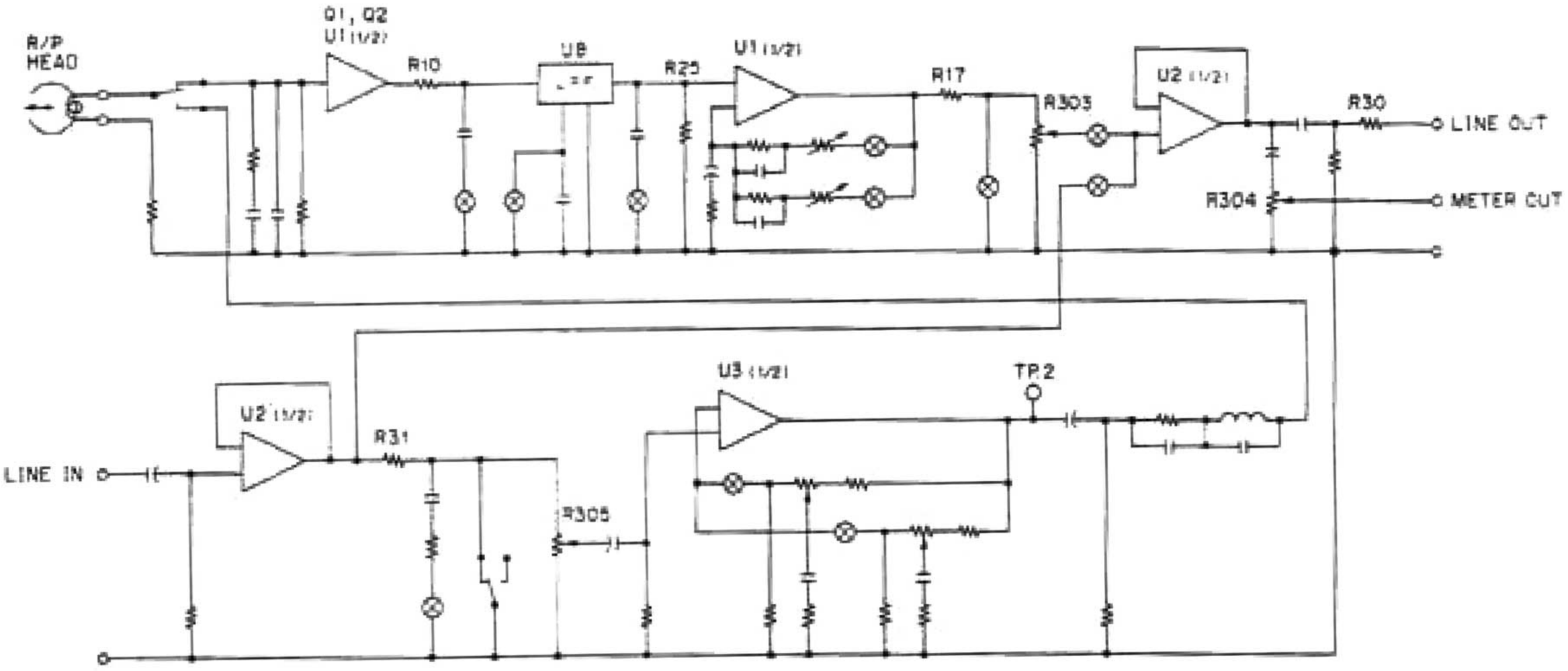
In these specifications, 0 dBV is referenced to 1.0 Volt. Actual voltage levels are also given in parenthesis. To calculate the 0 dB = 0.775 Volt reference level (i.e., 0 dBm in a 600-Ohm circuit), add 2.2 dB to the listed dB value; i.e. -10 dBV re: 1 V = -7.7 re: 0.775 V.

Changes in specifications and features may be made without notice and obligation.

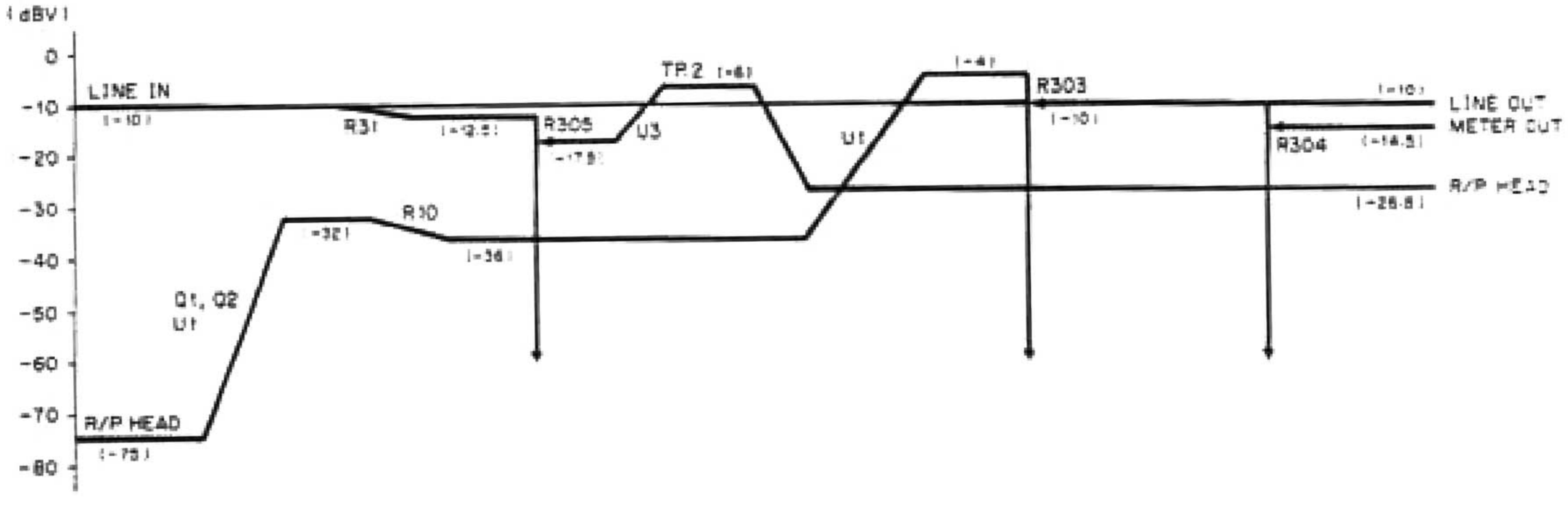
*dbx is a registered trademark of dbx Incorporated.



Audio Signal Block Diagram



Level Diagram

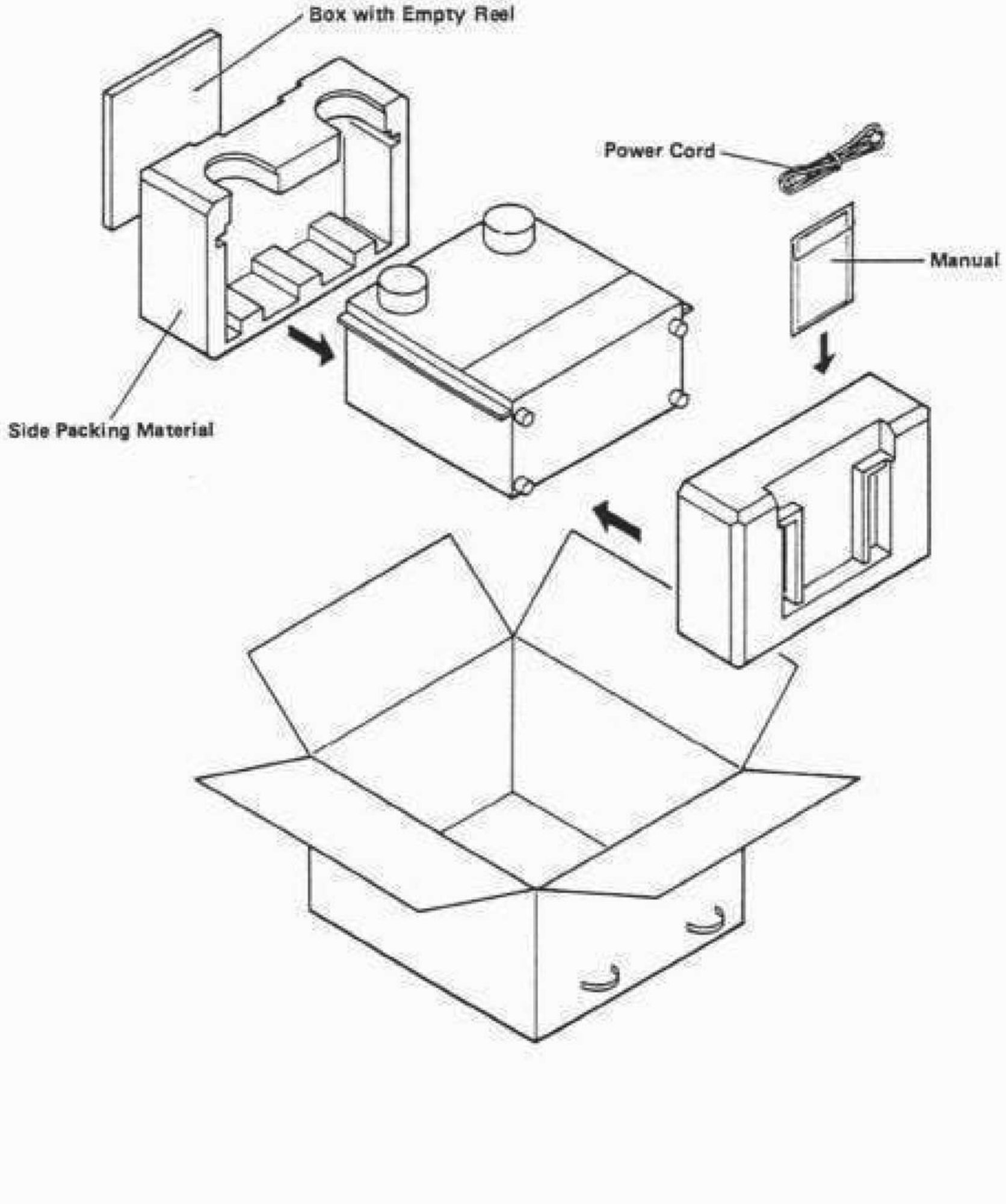


Installations

1. UNPACKING AND INSPECTION

During unpacking, be careful not to damage the MSR-16. Save the carton and packing material as well; you may need them to transport your MSR-16 sometime in the future.

After unpacking, give the machine a complete visual inspection. If there is any evidence of damage due to rough handling during transport, it is your responsibility to notify the carrier and submit a claim.



2. INSTALLATION SITE

The MSR-16 may be used in most areas, but to maintain top performance and prolong operating life, observe the following environmental limitations:

1) Nominal temperature should be 5 to 35 degrees C (41 to 95 degrees F).

2) Relative humidity should be 30 to 90% (non-condensing).

3) Strong magnetic fields should not exist nearby.

4) The fan motor grid on the machine's rear should be at least 4 inches (10 cm) apart from walls or any objects to ensure free cooling air flow.

3. RACK MOUNTING THE MSR-16

The MSR-16 may be mounted to a standard EIA 19" rack, such as the TASCAM CS-607B. Before mounting, make sure the rack you are mounting the MSR-16 to is not warped or bent. Screwing the MSR-16 to badly warped surface may cause misalignment of the transport.

4. INITIAL CONNECTIONS

CAUTION: Before attempting any cable connection, check to make sure that all the units involved in your system are turned off.

When connecting the MSR-16 to your system, use shielded cables that are as short as your situation will allow. We recommend low-capacitance cables with quality connectors, such as the TASCAM Pro Series. Cheaper cable has less shielding and may introduce radio frequency interference, hum and noise into your system.

A. Input/Output Connections

The MSR-16's inputs and outputs are handled by RCA jacks located on the rear connector panel of the machine.

Make the appropriate cable connections to the Program busses and Tape Returns of your mixer.

If your mixer has phone jack (RCA) outputs conforming to the –10 dBV standard, the meter readings of your mixer and the MSR-16 should match, i.e., 0 VU on the mixer will read 0 dB on the MSR-16 track it's connected to. If the readings don't match, always go by the readings on the recorder.

B. AC Power Cord

Make sure of a stable, firm connection both on the MSR-16 and mains sides. Route the cord where there is no possibility of stepping on it, to prevent accidental disconnection.

C. Remote Control Connection and Computer/Synchronizer Interface

On the MSR-16's rear panel are located a REMOTE CONTROL connector and ACCESSORY 1 and 2 connectors. The REMOTE CONTROL connection makes it possible to connect the optional RC-416 remote control unit to provide remote control of all transport functions. The ACCESSORY 1 connection is a parallel port, meaning transport controls are each brought to a separate pin of the connector for external connection to the TASCAM ES-50 or other SMPTE synchronizers. The ACCESSORY 2 is a serial port, in which fewer wires carry digital messages to and from the MSR-16's microcomputer for external connection to a controlling computer with RS-232C serial data buss. It is possible to hook up a serial-capable synchronizer (such as the TASCAM MIDiiZER) to this port for control and other advanced functions. For detailed information on the use of the ACCESSORY connections, consult TASCAM or the nearest TASCAM dealer. (Also see pp. 11-14.)

5. REEL INSTALLATION

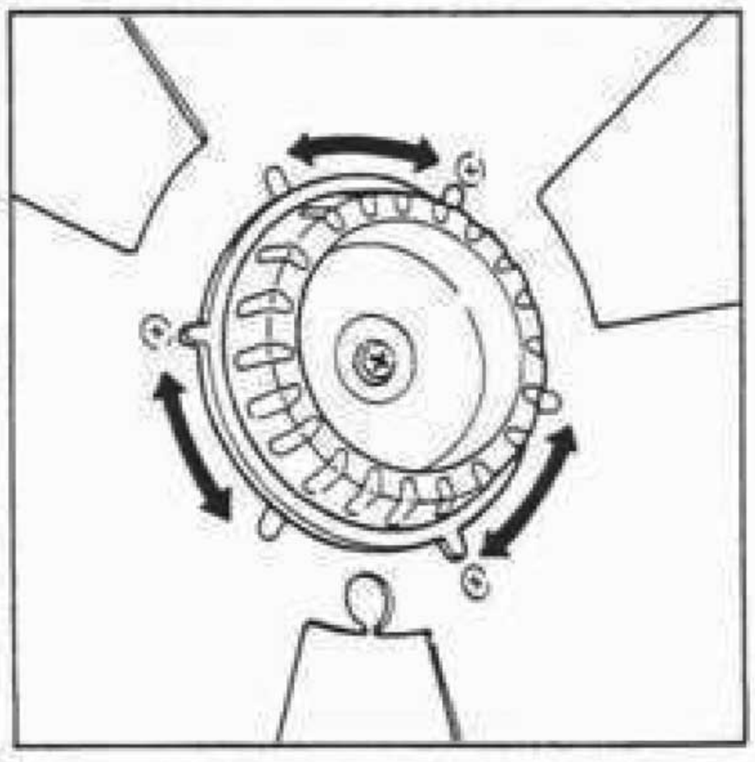
Proceed as follows:

1. Turn the holddown knob until its outer and inner three detents line up with each other.

2. Line up the three notches in the full supply reel with the three detents in the holddown knob on the supply reel table and push the reel against the reel table.

3. Turn the holddown knob fully clockwise until it is firmly seated in place.

4. Repeat the procedure for the empty takeup reel.



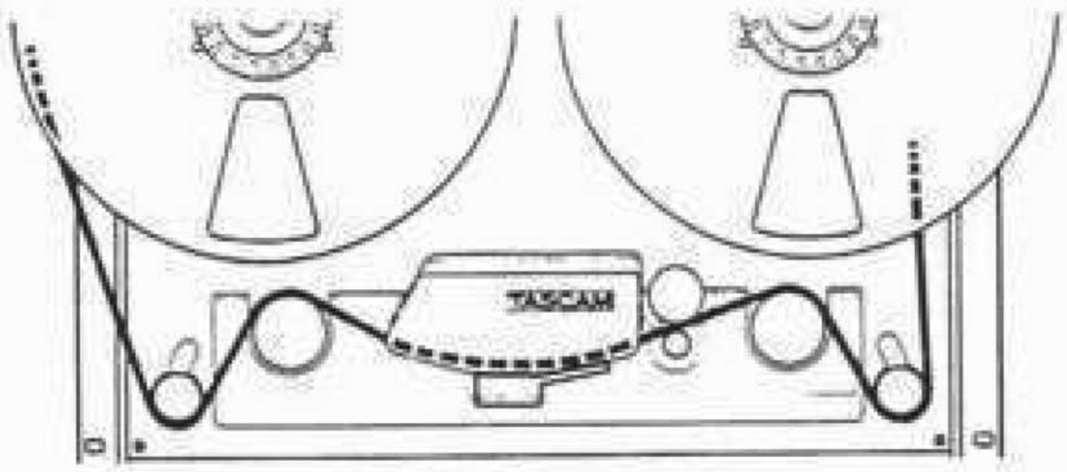
NOTE: Before running tape, make sure that the reel holddown knob is tight on both the supply and takeup reels.

6. TAPE THREADING

1. Press the Head Shield (head gate) downward toward the plate. It will latch down, revealing the heads.

2. Thread the tape exactly as shown below.

3. Replace the head shield by pressing it down lightly (it will unlatch).



"ACCESSORY 1" PARALLEL CONNECTOR

SMPTE/EBU Time Code

SMPTE is an acronym for the Society of Motion Picture and Television Engineers. The SMPTE Time Code (C98.12: time and control code for video and audio tape for 525/30 television system) was defined in 1970, and it is now accepted as a universal standard.

This reference is to an 80-bit digital code developed by SMPTE and used to designate the exact location in hours, minutes, seconds and frames (24 frames/sec. for film or 30 frames/sec. for video) on a film, video tape, or audio tape. Suitable equipment can synchronize ("lock up") two or more machines by using the SMPTE time code recorded on each.

SMPTE European Standard, that refers to 25 frames per second, states the EBU (abbrev. for European Broadcasting Union) time code when it is especially necessary to distinguish from the USA Standard with 30 frames per second.

A *time code generator* is used to record SMPTE code onto one track of the tape. A *time code controller* can then read the code from two or more tape machines, and by also servo-controlling the reel motors of those machines, bring them to specifiec cue points. A *time code synchronizer* further controls the capstan motors to keep both of the tape machines running synchronously. These techniques can be used to obtain more tracks for recording (two or more audio machines "locked up" together), to mix audio signals in sync with video or film images, to make complex edits by transferring material from one or more audio machines to another, and so forth.

Connecting a Synchronizer to the TASCAM MSR-16

Connection between the ES-50 synchronizer/ES-51 edit controller and the MSR-16 is a plug-and-go proposition. Pre-wired interface cables needed are available from TASCAM.

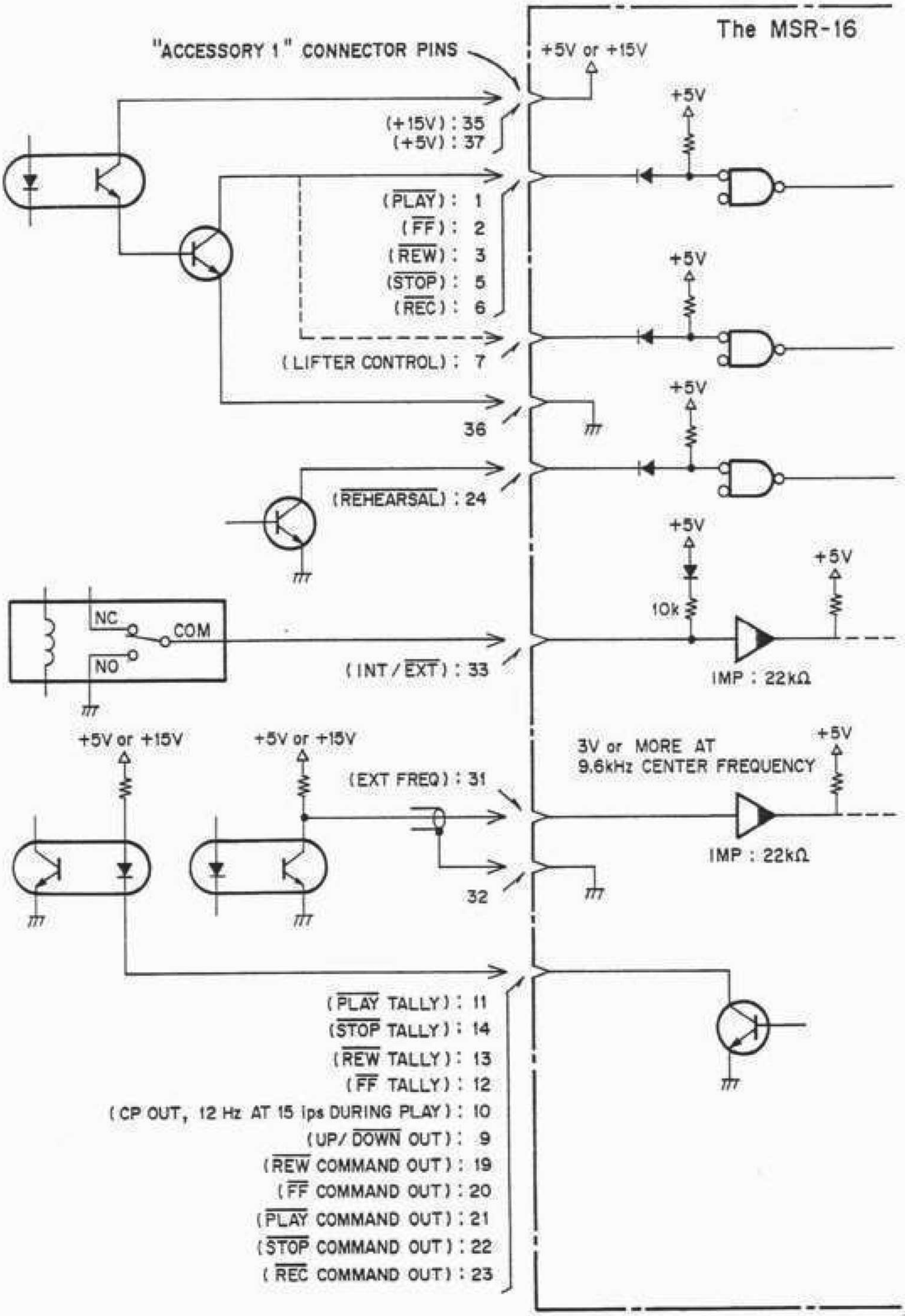
The TASCAM MSR-16 provides signals to the synchronizer (via the ACCESSORY "1" connector) which indicate its speed, the direction of the tape travel, and a reference power supply. Also, tally signals indicating the MSR-16's mode (PLAY, F. FWD, REW, STOP) are given to the synchronizer so it knows the current transport status. Inputs on the same ACCESSORY "1" connector are provided for status commands from the synchronizer (PLAY, F.FWD, REW, STOP, REC, LIFTER CONT). Also, there is an input for a capstan drive reference frequency signal from the synchronizer so that the actual record/play speed can be varied to maintain synchronization.

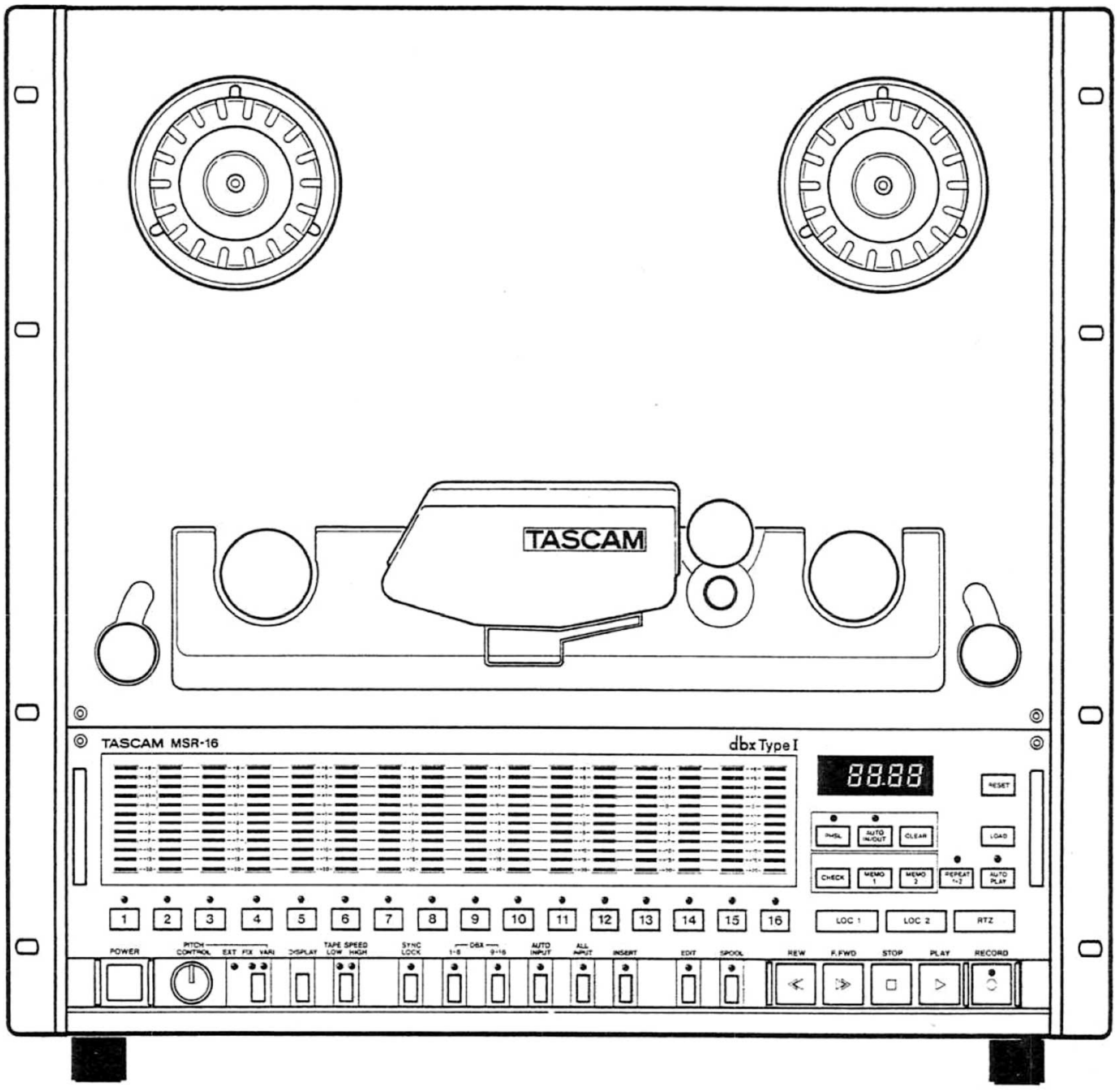
The MSR-16 will also operate satisfactorily with a variety of other manufacturers' synchronizer/controllers. The manual for these products should provide you with enough interface information for use with the TASCAM tape machines. Or else, consult the synchronizer manufacturer for further details on interfacing.

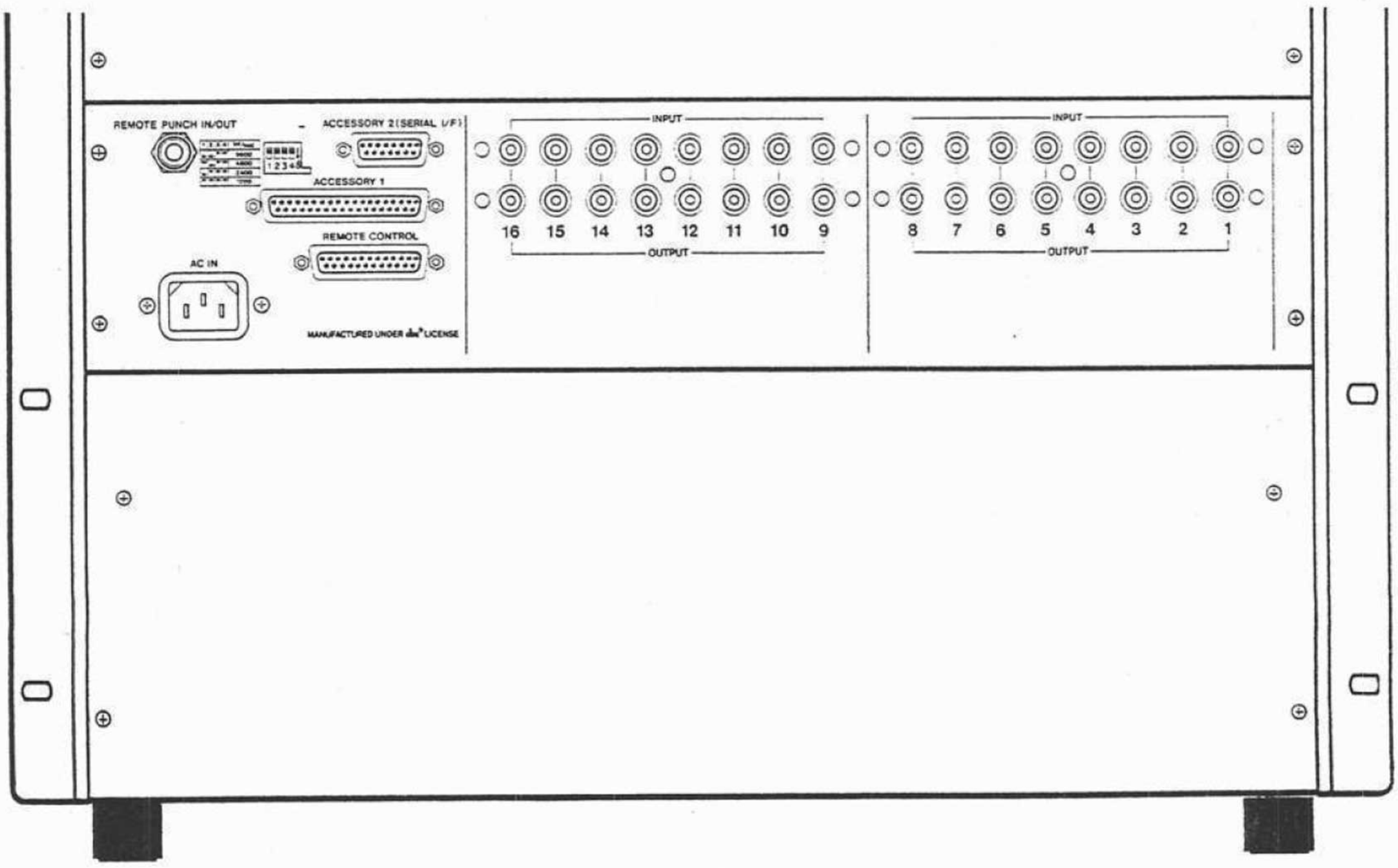
Pin Assignment (ACCESSORY 1)

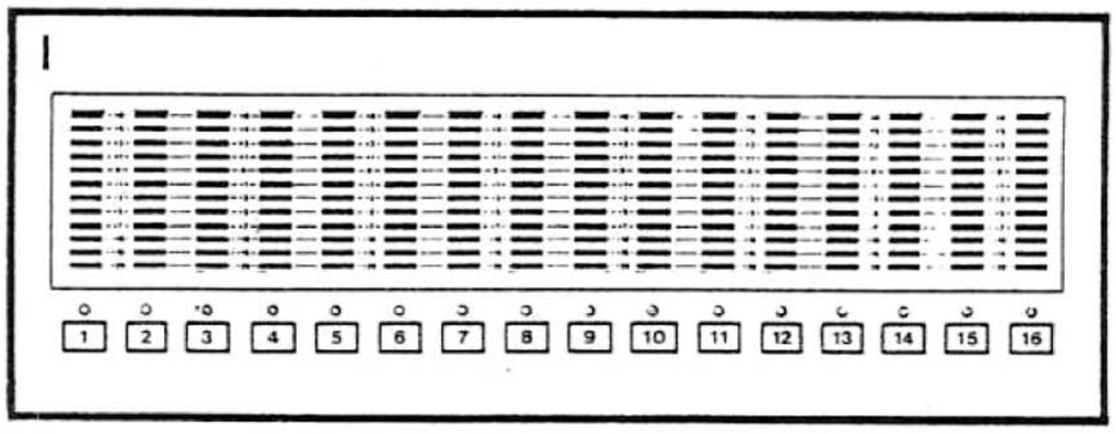
Pin =	IN(put)–OUT(put) signals		Function
1	PLAY	IN	Inputs PLAY signal at L level.
2	$\overline{FF}$	IN	Inputs FF signal at L level.
3	$\overline{REW}$	IN	Inputs REW signal at L level.
4	open terminal		
5	$\overline{STOP}$	IN	Inputs STOP signal at L level.
6	$\overline{REC}$	IN	Inputs REC signal at L level.
7	$\overline{LIFTER\ CONT}$	IN	Inputs LIFTER shift cancellation signal at L level.
8	open terminal		
9	UP/$\overline{DOWN}$	OUT	Outputs tape running control signal at H or L level.
10	CP	OUT	Outputs open-collector signal (12 Hz pulse at 15 ips.)
11	$\overline{PLAY}$ TALLY	OUT	Outputs open-collector signal (Low level during PLAY mode.)
12	$\overline{FF}$ TALLY	OUT	Outputs open-collector signal (Low level during FF mode.)
13	$\overline{REW}$ TALLY	OUT	Outputs open-collector signal (Low level during REW mode.)
14	$\overline{STOP}$ TALLY	OUT	Outputs open-collector signal (Low level during STOP mode.)
15	$\overline{REC}$ TALLY	OUT	Outputs open-collector signal (Low level during record mode)
16	$\overline{SHUT\text{-}OFF}$ TALLY	OUT	Outputs open-collector signal (Low level during tape stop)
17	open terminal		
18	open terminal		
19	$\overline{REW}$ COMMAND	OUT	Outputs open-collector signal (Low level when REW is pressed)
20	$\overline{FF}$ COMMAND	OUT	Outputs open-collector signal (Low level when F. FWD is pressed)
21	$\overline{PLAY}$ COMMAND	OUT	Outputs open-collector signal (Low level when PLAY is pressed
22	$\overline{STOP}$ COMMAND	OUT	Outputs open-collector signal (Low level when STOP is pressed)
23	$\overline{REC}$ COMMAND	OUT	Outputs open-collector signal (Low level when REC is pressed)
24	$\overline{RHEARSAL\ MODE}$	IN	Accepts Rehearsal enabling signal coming from a properly equipped external control unit (low level with Rehearsal in)
25			
26			
27			
28	open terminal		
29			
30			
31	EXT FREQ	IN (HOT)	Inputs speed control signal at input signal of 3.0 V or more and of 4.8 k to 19.2 kHz (HOT side)
32	EXT FREQ	IN (COLD)	Inputs speed control signal (COLD side)
33	INT/$\overline{EXT}$	IN	Inputs internal/external speed control select signal Internal: HIGH level External: LOW level
34	open terminal		
35	+15 V supply voltage	OUT	Maximum: 50 mA
36	Main unit GND		
37	+5 V supply voltage	OUT	Maximum: 50 mA

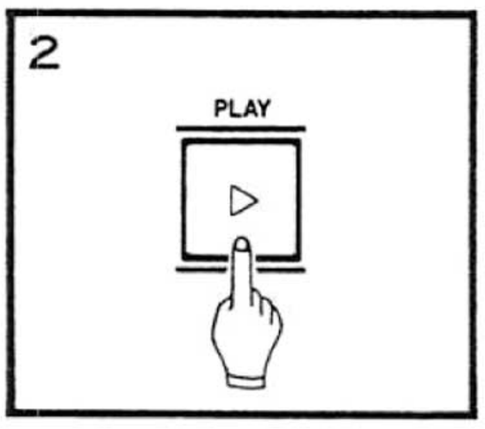
ACCESSORY 1 Connector Pins and External Signal Connections











First Playback

1. Release the Track 1 Record button by pressing it. Its blinking LED will go out showing that Track #1 is now in "safety" status. Check to make sure that all other tracks are also in "safety" status with their LEDs off.

2. Press PLAY. The track you just recorded can be listened (monitored) through the mixer.

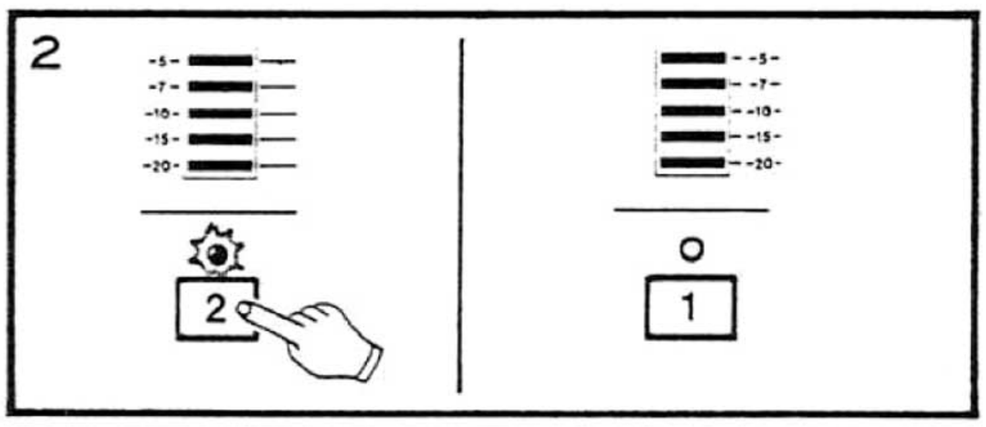
If you are not satisfied with your first take and want to re-record it (therby erasing the first take), all you have to do is:

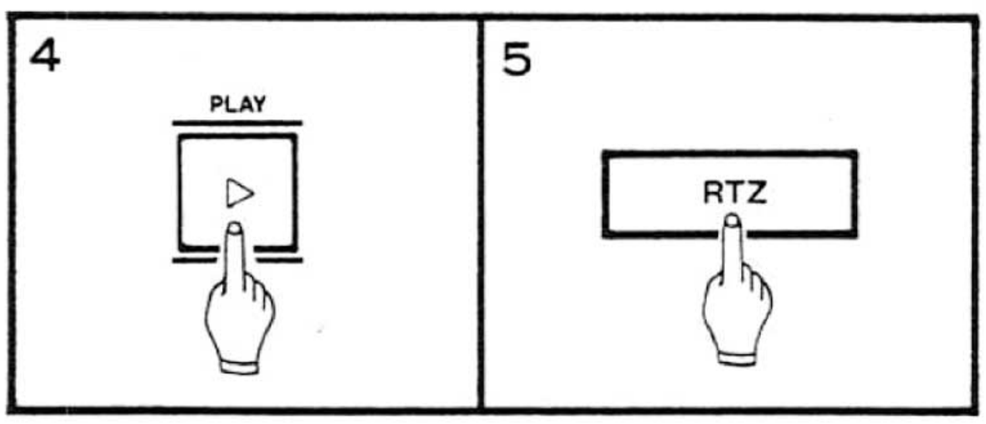
a) Make any changes that occured to you while you listened to the first playback.
b) Press RTZ to rewind the tape to 00.00.
c) Press the Track 1 Record Enable button.
d) Press RECORD and PLAY together and try again.

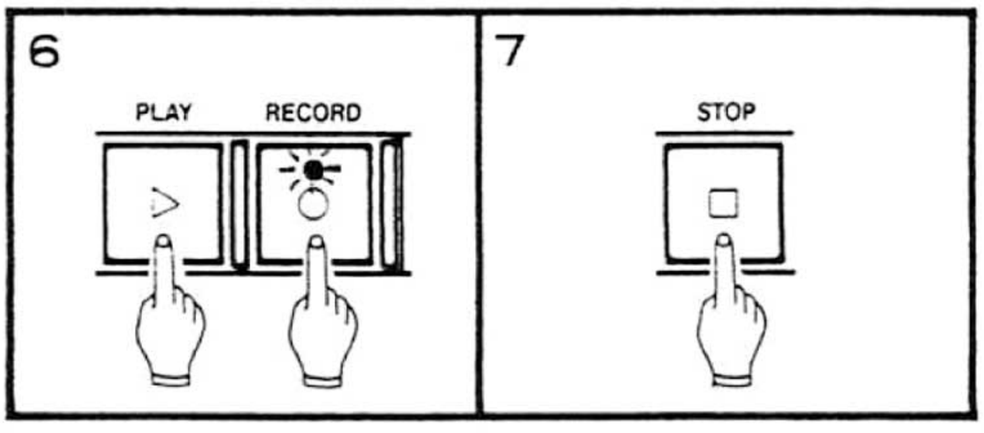
Once you have a basic track you're satisfied with, you are ready to move on to overdubbing.

4. OVERDUBBING

There are two tasks in overdubbing. First, the new signals must be adjusted for proper level going to the MSR-16, as in tracking. Second, you must make a proper monitoring mix of the existing track(s). Here is a basic overdubbing procedure:







1. Select an open track for the overdub: Since we assume, in our example, that you have recorded your first take on track 1, you can choose any other track for the overdub. Factors affecting which track you choose include how many total parts you will record, and whether you plan to bounce ("ping-pong") tracks later. In this example, we'll assume that you choose track 2.

2. Place the track in record ready mode: Press the Record Enable button for track 2. Its LED will start blinking. Make sure that previously recorded tracks (such as track 1 in our example) are in safe mode so you don't accidentally erase them.

3. Adjust the recording level of the new sources using your mixer controls, watching the meter level on track 2.

4. Play the tape and adjust monitor levels for a proper balance of the incoming new signal with the signal being played back from track 1 in your headphones or monitor.

5. Rehearse your overdub until you feel confident that your levels are correct. Rewind to 00.00 by pressing RTZ.

6. Record the first overdub by pressing RECORD and PLAY.

7. Stop the recording by pressing STOP (or PLAY).

8. To listen to playback of the overdub, press the track 2's record enable button (to place the track in safe mode), then rewind to the beginning of the take and hit PLAY.

5. PUNCH-IN OR INSERT RECORDING

The MSR-16 can manualy punch in with the master RECORD button, the Track Record Enable buttons, or the optional RC-30P footswitch. You can also program the punch-in and punch-out with the REHEARSAL and AUTO IN/OUT functions so the MSR-16 automatically punches in and out for you.

Manual Punch-In

METHOD A: Punching with the master RECORD button or footswitch

1. Make the following preliminary settings:

a) Press the Record Enable button of the track you intend to INSERT on. Its LED will start blinking.

b) Press the INSERT switch. Its LED will light solid.

c) Adjust the recording and monitoring levels for the desired balance.

2. Press PLAY. You can use the INSERT switch to toggle the MSR-16's meter and output between source and tape. While the tape is in PLAY and INSERT is on, you'll hear tape; while tape is stopped or INSERT is off, you'll hear source.

3. When the tape reaches the desired punch-in point, press RECORD or the footswitch to start recording. The monitor switches from tape to input on that track. The master RECORD LED and Track Record LED both stay on.

4. Punch out by pressing STOP, PLAY or the foot-switch.

METHOD B: Punching with the Track Record button

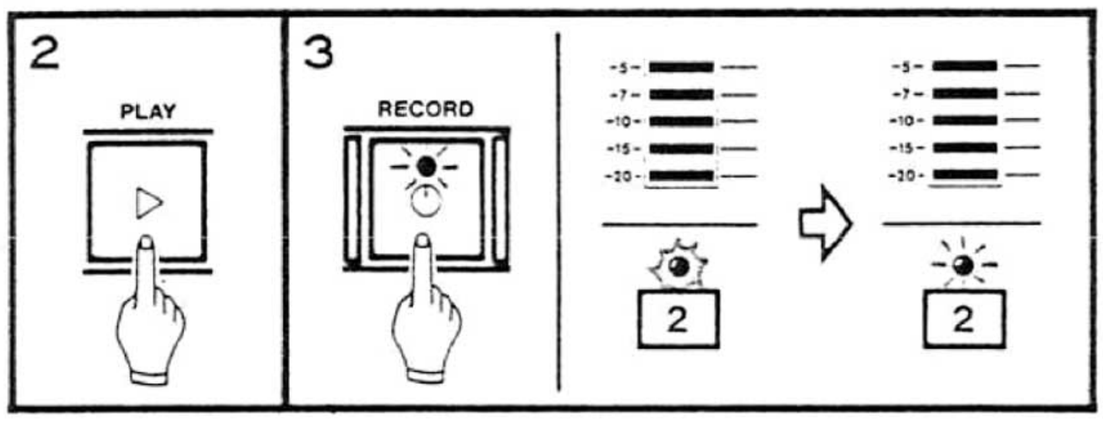
This method is sometimes called "rolling in record" and requires that you have a free hand.

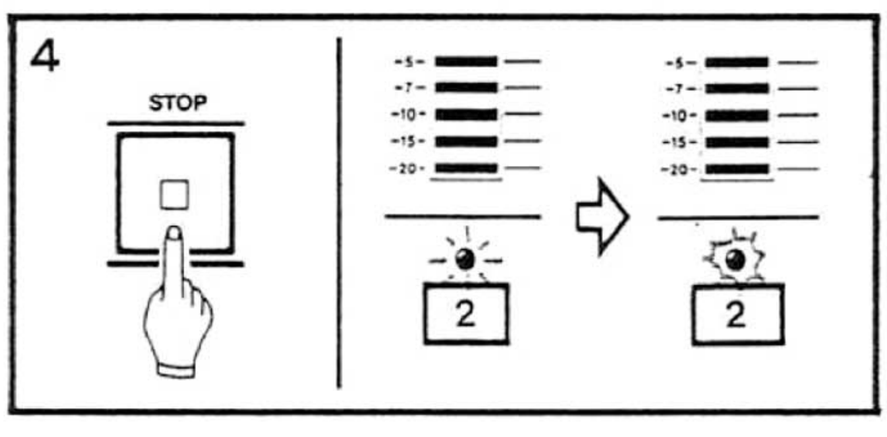
1. After the recording and monitoring levels are set, make sure that all tracks are SAFE (no track LED blinking).

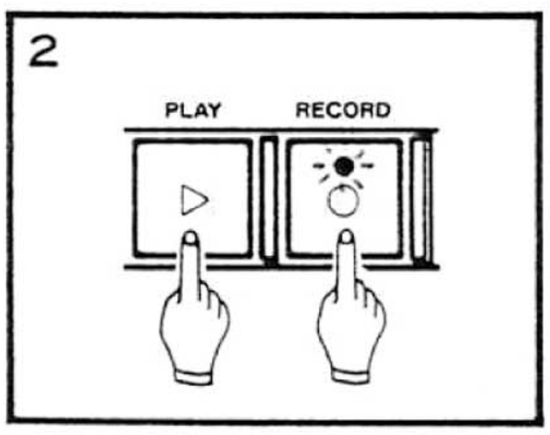
2. Press RECORD and PLAY together to start playing the tape. The RECORD LED will blink, showing that the MSR-16 is in record-ready mode.

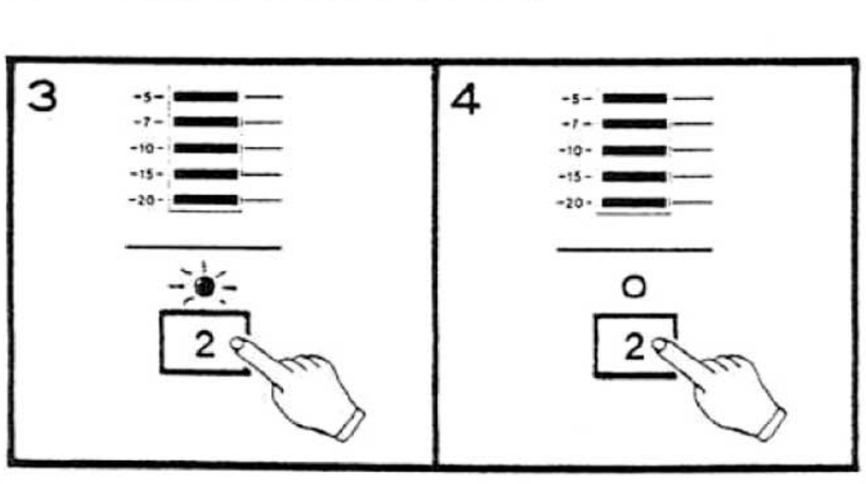
3. Press the punch-in track's record button when the tape reaches the punch-in point. The master RECORD and track record LEDs will both light up steadily, showing that recording is taking place.

4. To punch out, press the Track Record button again (you could also press STOP or PLAY).









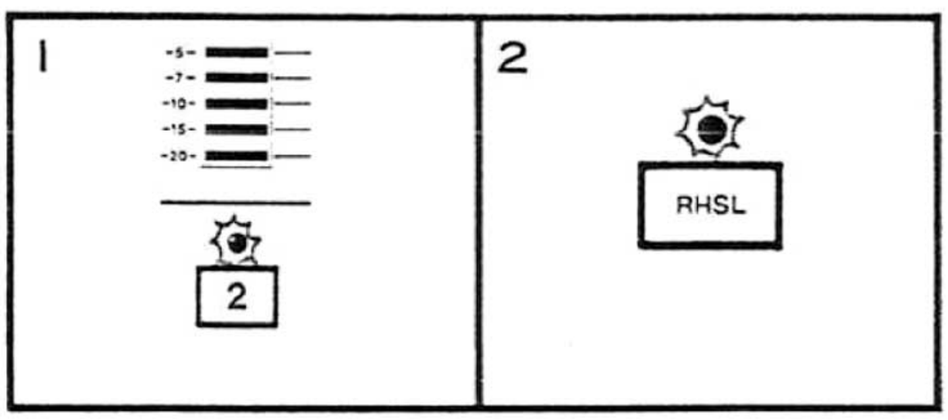
6. REHEARSAL PROGRAMMING AND AUTO IN/OUT PROCEDURES

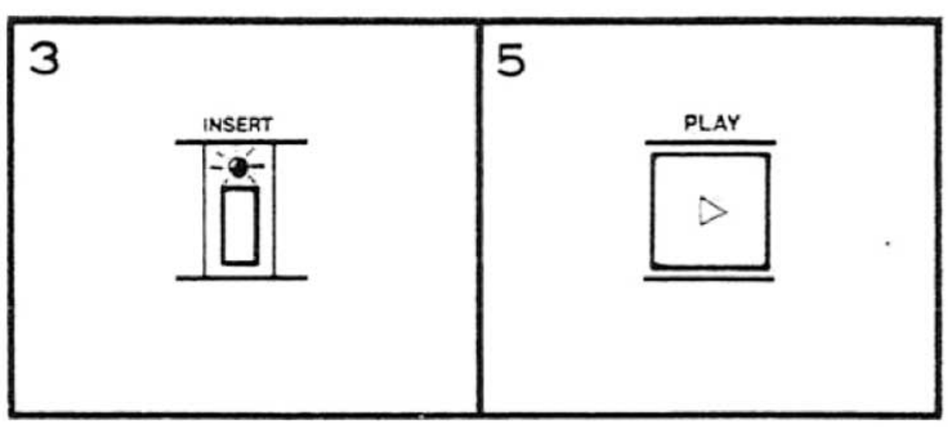
The Auto Locator has priority over the Rehearsal and Auto In/Out modes. If LOC 1, LOC 2, REPEAT, or RTZ is pressed, the function pressed is activated erasing all the memories you have set for punch-in. The LED RHSL or AUTO IN/OUT will then blink until CLEAR is pressed.

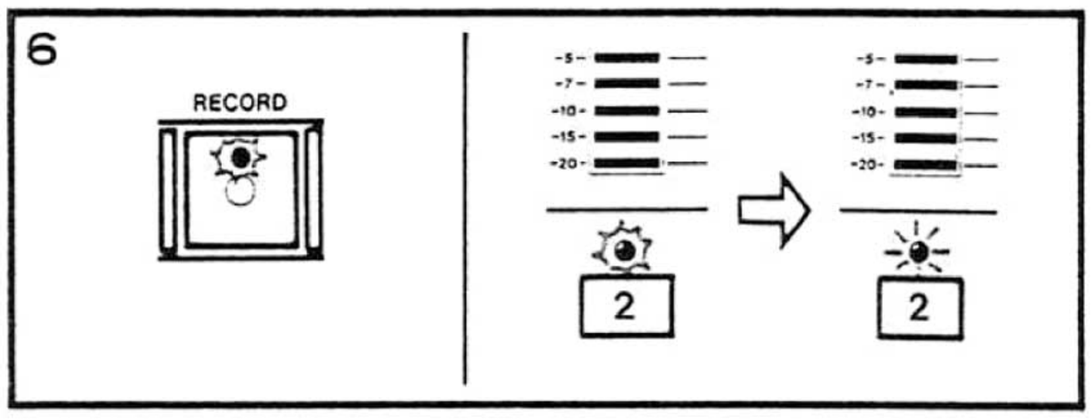
Programmed Rehearsal of Inserts (RHSL)

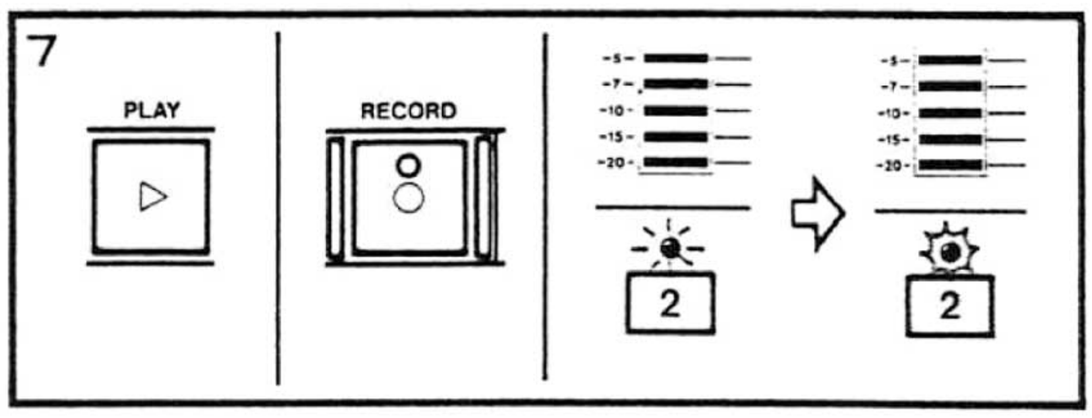
Before you actually record an insert, the MSR-16 allows you to "preview" the punch-in and out points with its special REHEARSE function. During a rehearsal, the tracks in record ready mode will switch meter and output from tape to source and back again, but won't actually record. What you hear in your monitor mix will be the same as during recording; so if the first in-out points aren't correct, you'll hear it and can CLEAR the old points and try again until you've got exactly what you want.

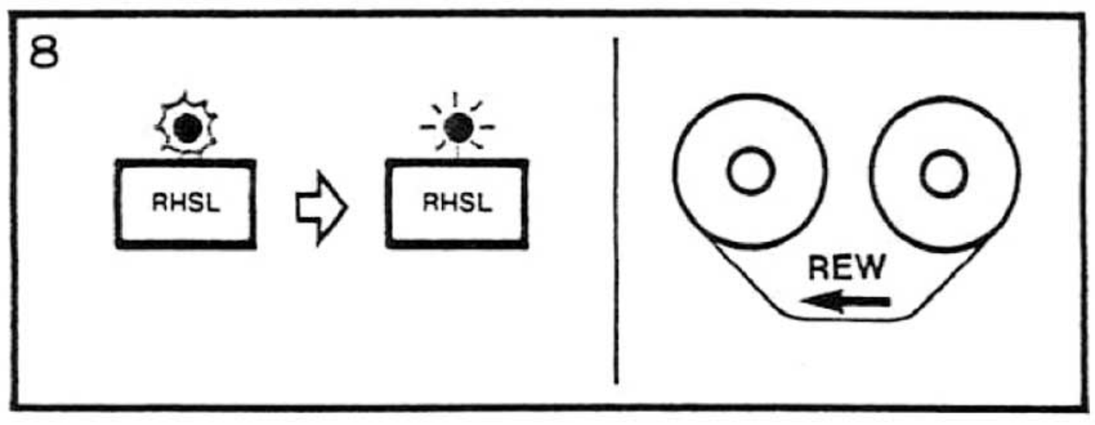
CAUTION: Although the advanced circuitry of the MSR-16 allows gapless punch-in on the tape, there is still the distance between the erase and record heads to be compensated for. Depending on tape speed, the time from a punch point to the actual in/out is 1/15th or 1/8th of a second. A few practice runs will get you accustomed to the timing of punching in.











Entering the Automatic Preroll and Punch-In/Out Points

NOTE: If you want to quit what you are doing at any time during the following procedures, press CLEAR.

1. Press the Record Enable button of the track you want to punch-in on. Its LED will start blinking. Check to make sure that all other tracks are in safe mode.

2. Press the RHSL switch. Its LED will begin blinking. As long as this light blinks (or stays on solid as it will do later, in step 8), you can't actually record, even though the master RECORD and track's Record LEDs may go on solid.

3. Press the INSERT switch. Its LED will light.

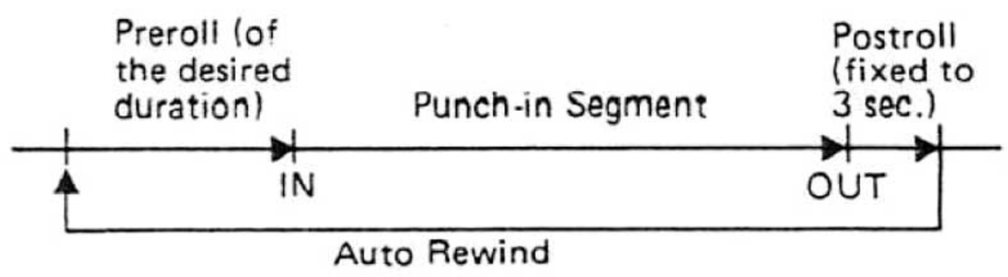
4. Adjust the record and monitoring levels for the desired balance.

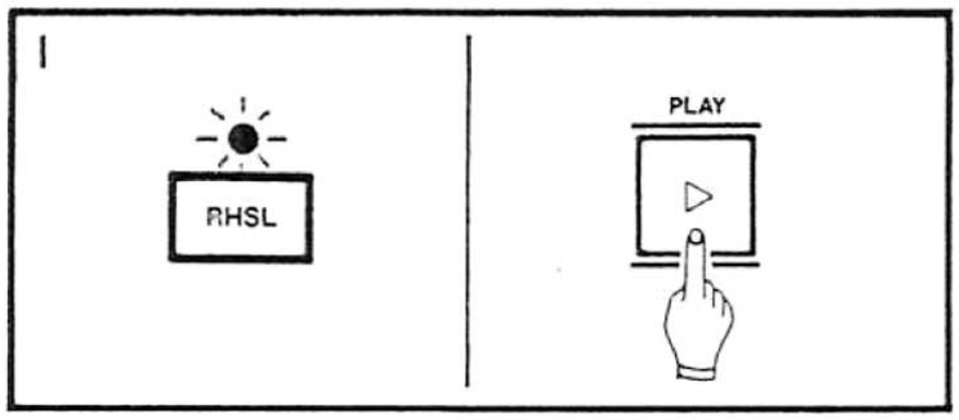
5. Press PLAY. That point on the tape will be put into memory defined as the preroll start point.

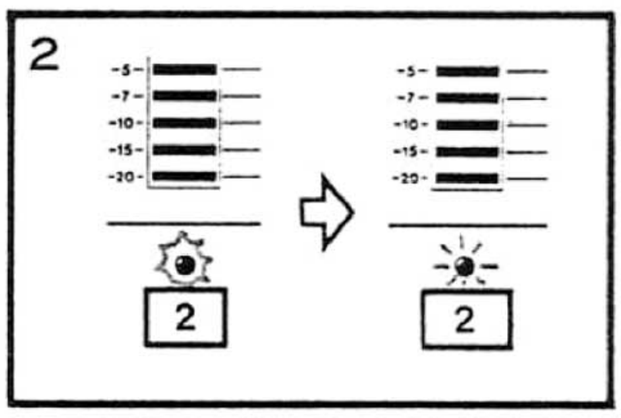
6. At the punch-in point, press RECORD or the footswitch. Your punch-in point will be put into memory. The track's record LED will light steadily, but the master RECORD LED will blink, showing that recording is not actually taking place.

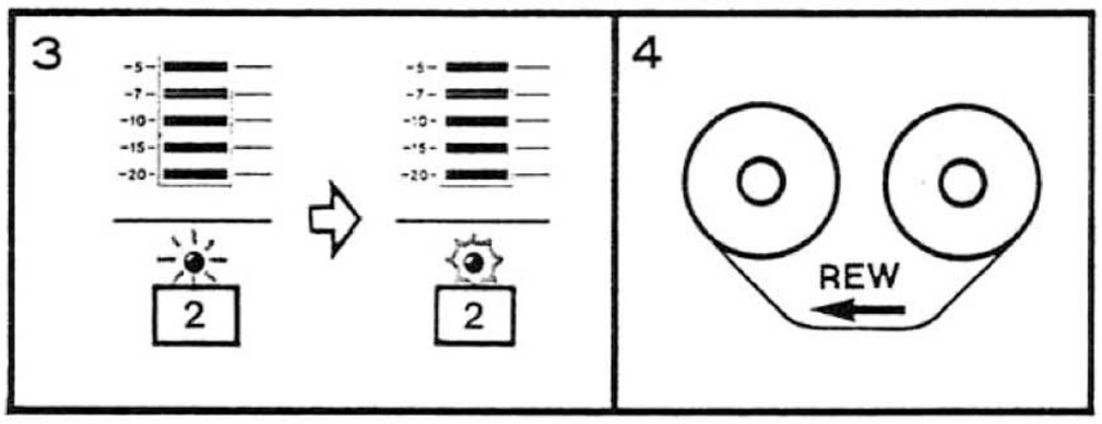
7. Press PLAY or the footswitch when the tape reaches the punch-out point. That point will be put into memory. The LED for the selected track will start blinking and the RECORD LED will turn off.

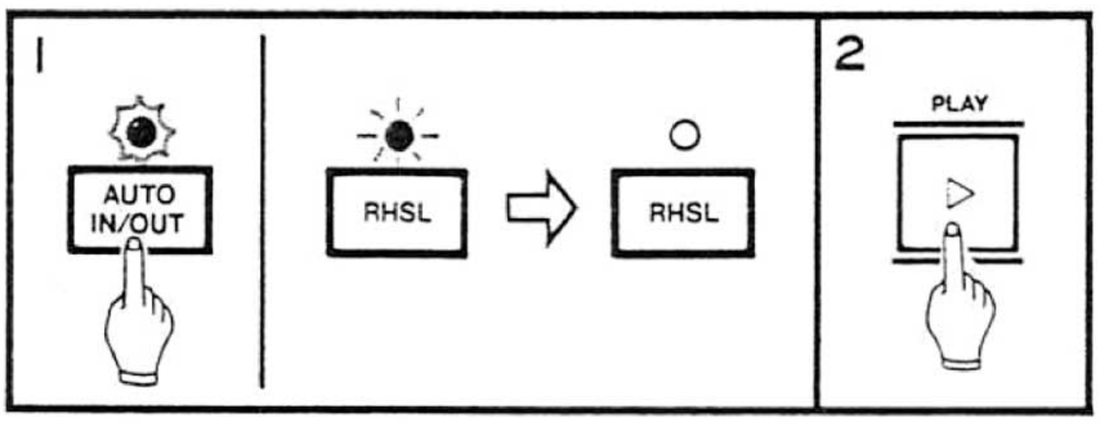
8. After a 3-second postroll, the RHSL LED will go on solid, while the tape will automatically rewind, stopping at the preset start point. The MSR-16 is now in Rehearsal Ready mode.

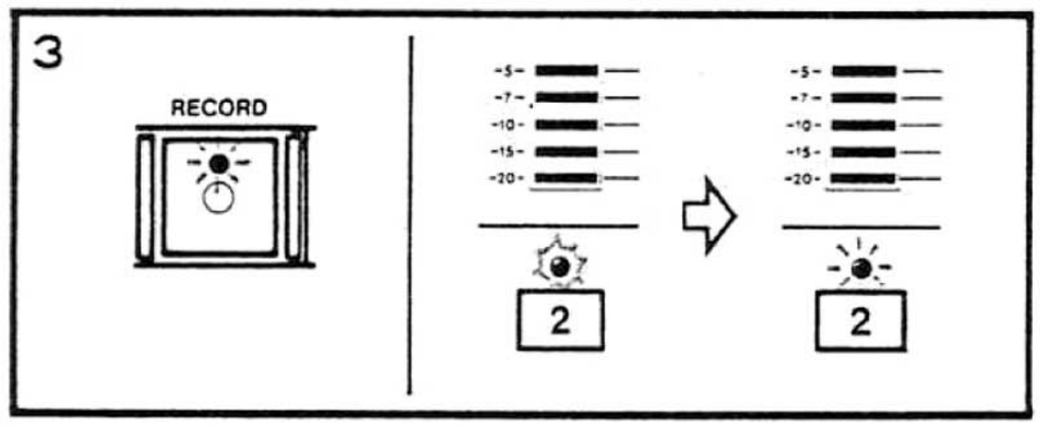


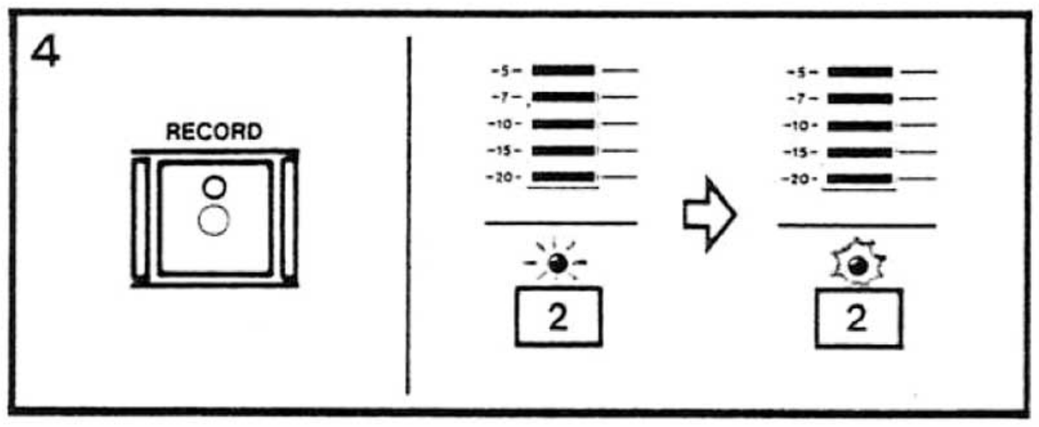


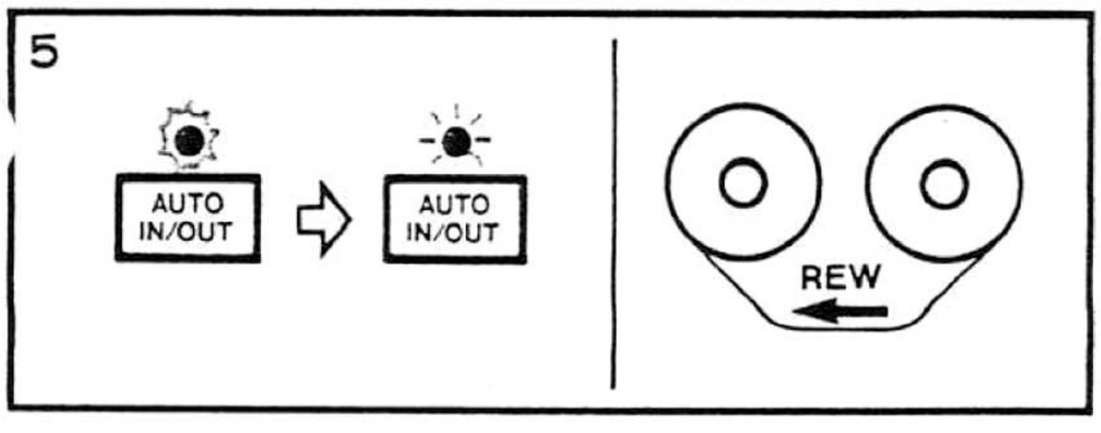












Rehearsing the Punch-in ("Dry Run")

1. Make sure that the MSR-16 is in "Rehearsal Ready" mode with the punch-in and out points memorized and the RHSL LED on solid. Press PLAY or the RC-30P footswitch. The MSR-16 will begin playing from the preset start point.

2. When the tape reaches the preset punch-in point, the track's output will switch from tape to source. The LED for the punch-in track stops blinking and stays on, although recording is not yet taking place. Your live instrument can be heard from the output of the track.

3. When the tape reaches the punch-out point, the track's output will switch back from source to tape. The LED for the punch-in track will start blinking, indicating that the "dry run" record is over.

4. After a 3-second postroll, the tape will automatically rewind to the preset start point, ready for as many rehearsals as you wish.

Practice the performance until you are sure that you will get it right when actually recording. Remember, once you punch in over existing material, that original signal is erased.

Actual, Auto Punch-In

Once you're sure your performance and the punch-in/out points selected are correct, you're ready to actually record the insert. The INSERT and RHSL LEDs should still stay on. All tracks should be in SAFE except the ones you intend to record.

1. Press the AUTO IN/OUT switch. A red LED will begin blinking above the AUTO IN/OUT switch, while the RHSL LED that was on solid will turn off, indicating that the MSR-16 is switched from REHEARSAL mode to actual, automated "punch-in ready" mode.

2. Press PLAY or the footswitch to begin the preroll from the preset point.

3. When the tape reaches the preset punch-in point, the punch-in track will automatically enter actual record mode, and the RECORD and Track LEDs will turn on solid. New material is being recorded, erasing the original part.

4. When the tape reaches the memorized punch-out point, the MSR-16 punches out of Record. The RECORD LED will turn off and the track's LED should again be blinking.

5. After a 3-second postroll, the AUTO IN/OUT LED that was blinking will turn on solid and the tape will automatically rewind to the memorized start point.

To review the result, press PLAY or the footswitch. The tape will play the entire segment and rewind to the start point.

To record again using the same memory points, press the AUTO IN/OUT switch again (its LED will again blinking), then press PLAY.

To terminate the Auto In/Out procedure, press the CLEAR switch. The AUTO IN/OUT LED which was on solid will turn off. By hitting CLEAR, you erase all of the three memory points (Preroll Start, Punch-in and Punch-Out points).

About Punching In

Setting in and out points: For both musical and technical reasons, when punching in or out of a track, you must select points that are "in the clear", i.e., in the pauses between phrases or notes. It sounds unnatural and makes the insert noticeable if you record a new note before the old one has ended, or are holding a note as you punch in or out. For this reason, some session players leave a beat or two of silence between passages they might want to edit later. Making inserts well requires some practice. Many engineers count bars and beats to keep track of the punch in and out points and hit them on cue. Because of the spacing between the erase and record heads, you may need to anticipate your in/out points by a fraction of a second for extremely tight cues though the gapless operation and high speed of the MSR-16 makes it much easier.

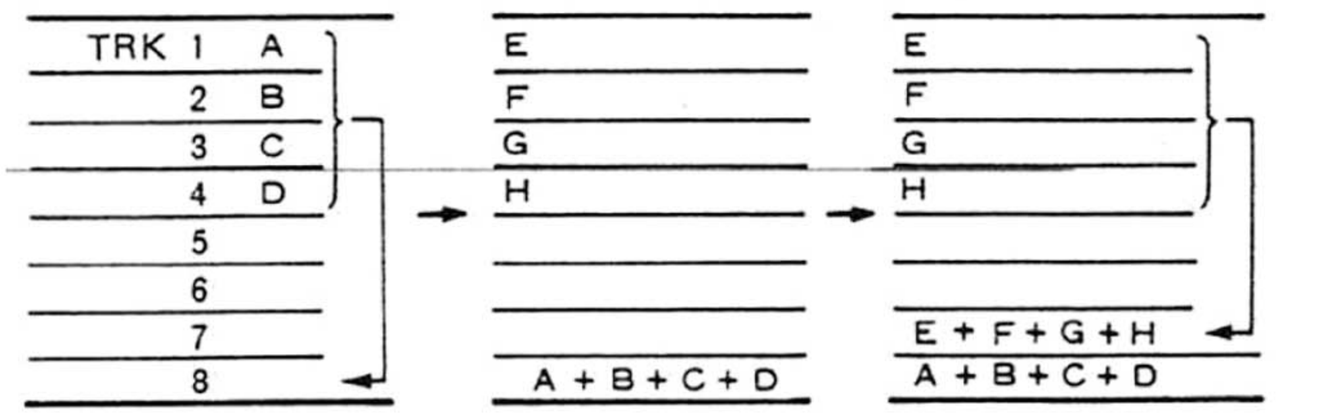
External computer punching: If you need insert points that are consistently repeatable within 1/30th of a second, you may want to control the MSR-16 by an external computer device. With this method, track 16 is recorded with SMPTE time code and punch-in/out points are entered into the MSR-16 via the serial connector on the back panel. The procedure is similar to the MSR-16's built-in AUTO IN/OUT function but more accurate because the computer is reading a reference actually recorded on tape instead of tach pulses generated by the movement of the tape reels.

Level matching: No matter how carefully you set your punch points, if the inserted material is louder, softer, or a different tone from the original track, it will be noticeable. Set the EQ and volume settings on your mixer the same as they were during the original recording. If you make inserts immediately after recording, don't change the instrument or mixer settings at all. Keep in mind that at a certain point it's better to record the whole track over than making multiple punch-ins.

7. BOUNCING TRACKS (PING-PONG)

The recording capability of the MSR-16 is not limited to the sixteen tracks. As you progress with recording, you may reach a point where you need more than sixteen tracks of material. This is where Bouncing — also called Collapsing or Ping-ponging tracks — is invaluable. Essentially, bouncing tracks consists of a "mini mixdown": taking tracks that have already been recorded, making a mix of these tracks and re-recording them back onto an empty track (or tracks) of the MSR-16.

With all multitrack recorders, it is possible to get feedback when a track is recording signal being bounced from the track right next to it. To eliminate feedback, it is advisable to bounce on a track away from the originals.



Bouncing tracks 1 — 4 onto track 8

Tracks 1 — 4 available for recording new parts

Bouncing new tracks 1 — 4 onto track 7

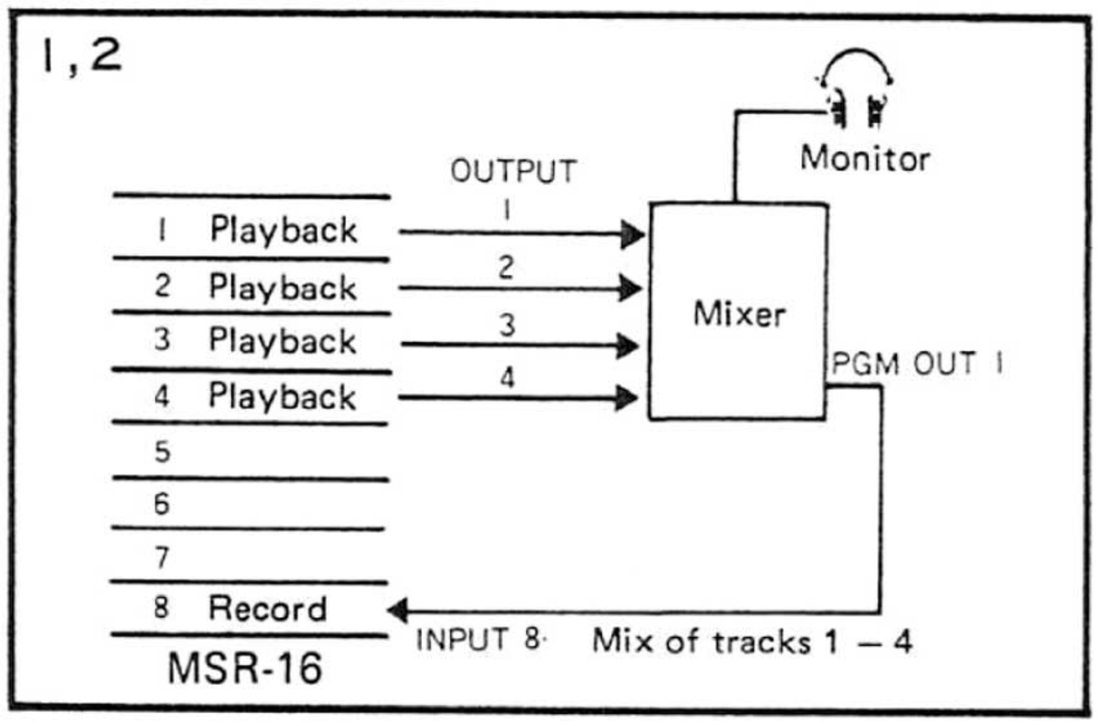
Other Tips About Bouncing

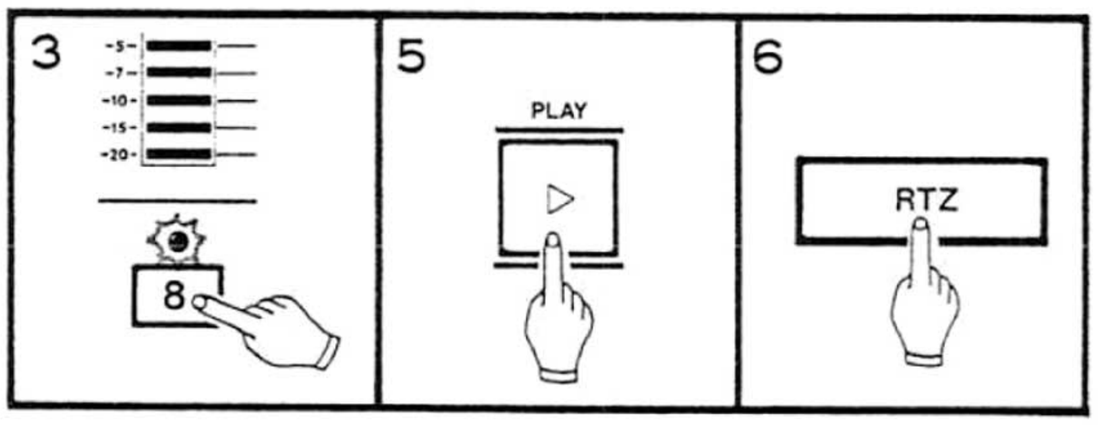
1. Before you record over the parts that have been bounced together, make certain that you're happy with the overall sound of the bounced parts, because you won't be able to change their mix or punch-in to fix errors.

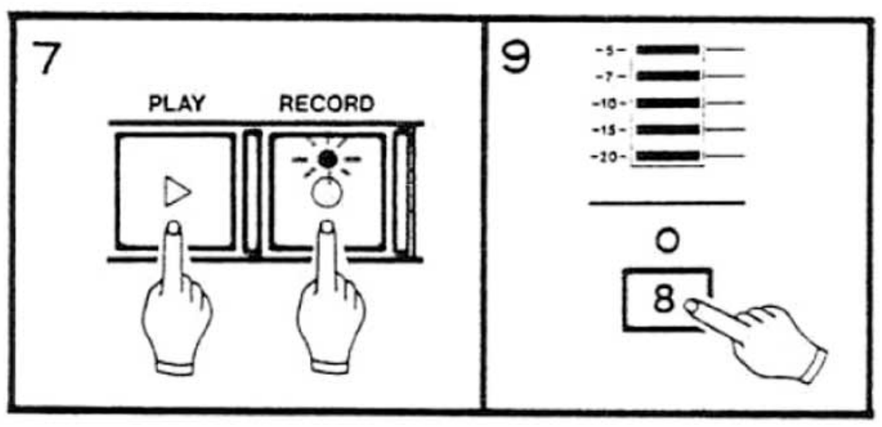
2. It is possible to bounce tracks more than once, i.e., to take a bounced track and combine it yet again with other material onto another empty track. There are limits, however, just as there are anytime you make a copy of a copy. Eventually the sound will get "blurry" — treble will be decreased and added dropouts will become more noticeable. Whether the added versatility of bouncing is worth the slight loss of sound is up to you and the demands of your project.

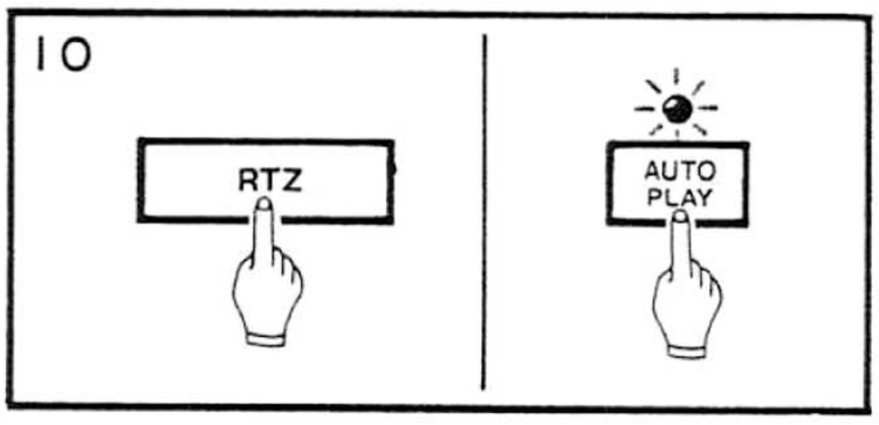
3. It is also possible to add new, previsously unrecorded parts to the bounced material, for example to take Tracks 1-4 and mix them with additional "live" sounds onto Track 5.

4. Certain material lends itself to bouncing — vocal backgrounds, layered keyboards, etc. Main parts of the program such as lead vocals and instrumental solos are best left on their own tracks so you can control them in the final mix.









Bouncing: Example

Let's take the contents of tracks 1-4 and bounce them to track 8.

1. Set your mixer so that the main input channels 1-4 are receiving the MSR-16's tape outputs.

2. Assign channels 1-4 to the group output on the mixer connected to track 8 of the MSR-16.

3. Press the Track 8's Record Enable button (Record Ready Mode). Its LED will start blinking.

4. Make sure that the monitor section of your mixer is receiving the output from track 8 and nothing else. All other signals feeding the monitor should be turned off. This gives you an accurate monitor of the mix you're actually bouncing.

5. Start playing the tape. Slowly raise up the channel faders 1-4, and the master fader of the program group the channels are assigned to. Get the balance you want from the channel faders, then adjust the master fader for overall level until you get proper meter readings on the MSR-16.

6. Press the RTZ button to rewind the tape to counter 00.00.

7. Press PLAY and RECORD to begin recording.

8. Stop recording by pressing STOP or PLAY.

9. Press the track 8 Record button to prevent accidental erasure of the track.

10. Press RTZ then AUTO PLAY to hear the result. Make sure you've got a mix that you want to keep. If so, you're free to record over the old tracks; if not, make whatever adjustments that are necessary on your mixer and try it again.

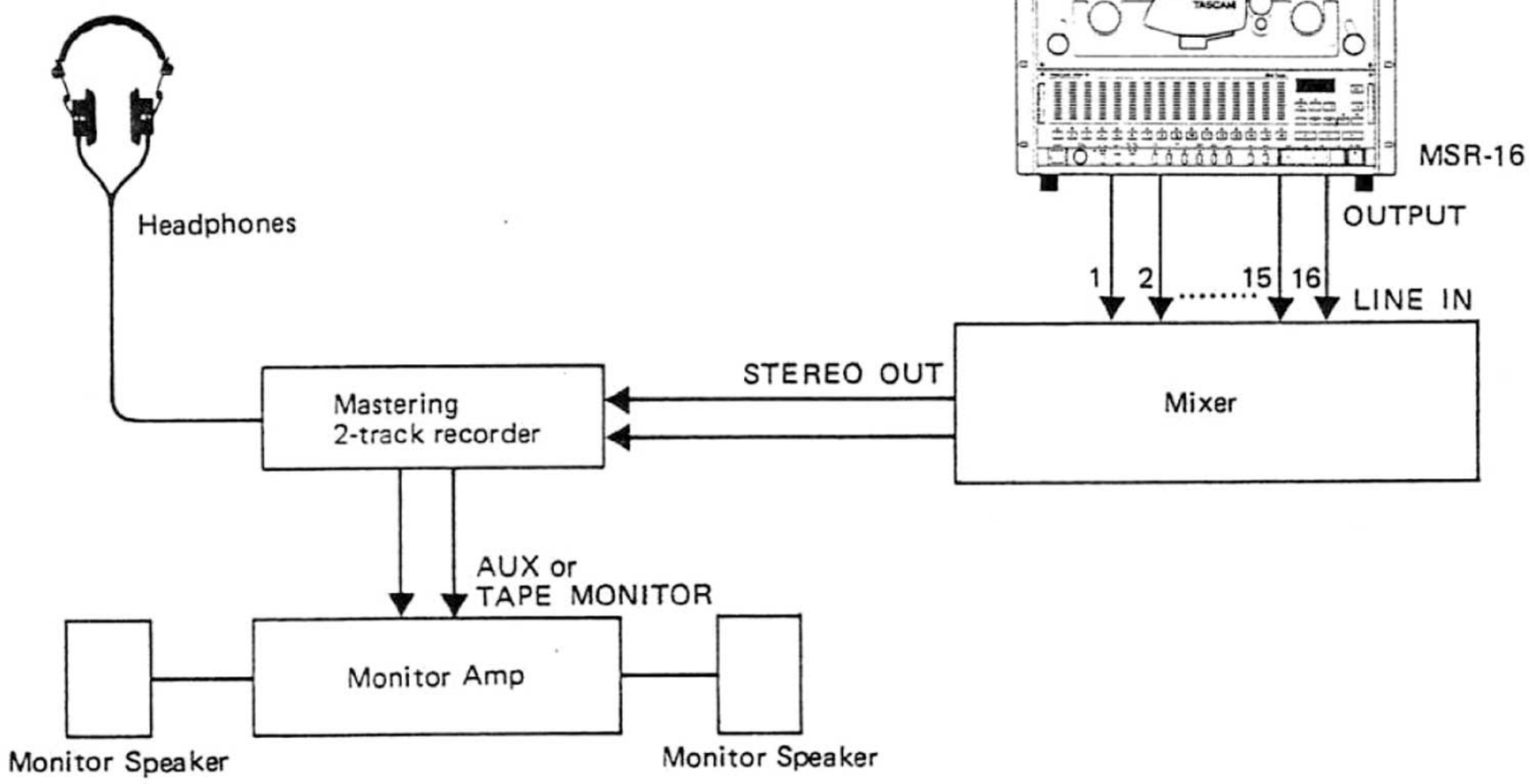
8. MIXDOWN (REMIX)

Once all the tracking and overdubbing is complete, it will be time to mixdown to stereo. At this point, the MSR-16's tracks should all be in safe mode, and the main input channels of the mixer should be switched to receive signal from the MSR-16. The stereo outputs of the mixer should be connected to your 2-track recorder, and your monitor "where from" switch should be switched to receive signal either from the 2-track outputs or the stereo output of the mixer.

NOTES:

1. If you recorded the 16-track tape with DBX noise reduction, you should play it back with DBX on. DBX is an encode/decode process. It is not possible to get a "DBX mixdown" by defeating the noise reduction on playback, mixing encoded tracks to stereo, and then playing back the 2-track master through a DBX decoder.

2. Once outputs of the MSR-16 have been decoded by the DBX unit within the MSR-16 they behave like any other audio source, and can be mixed down to any medium: digital tape recorders, cassettes with Dolby B, C or DBX noise reduction, or the audio tracks of a VCR.

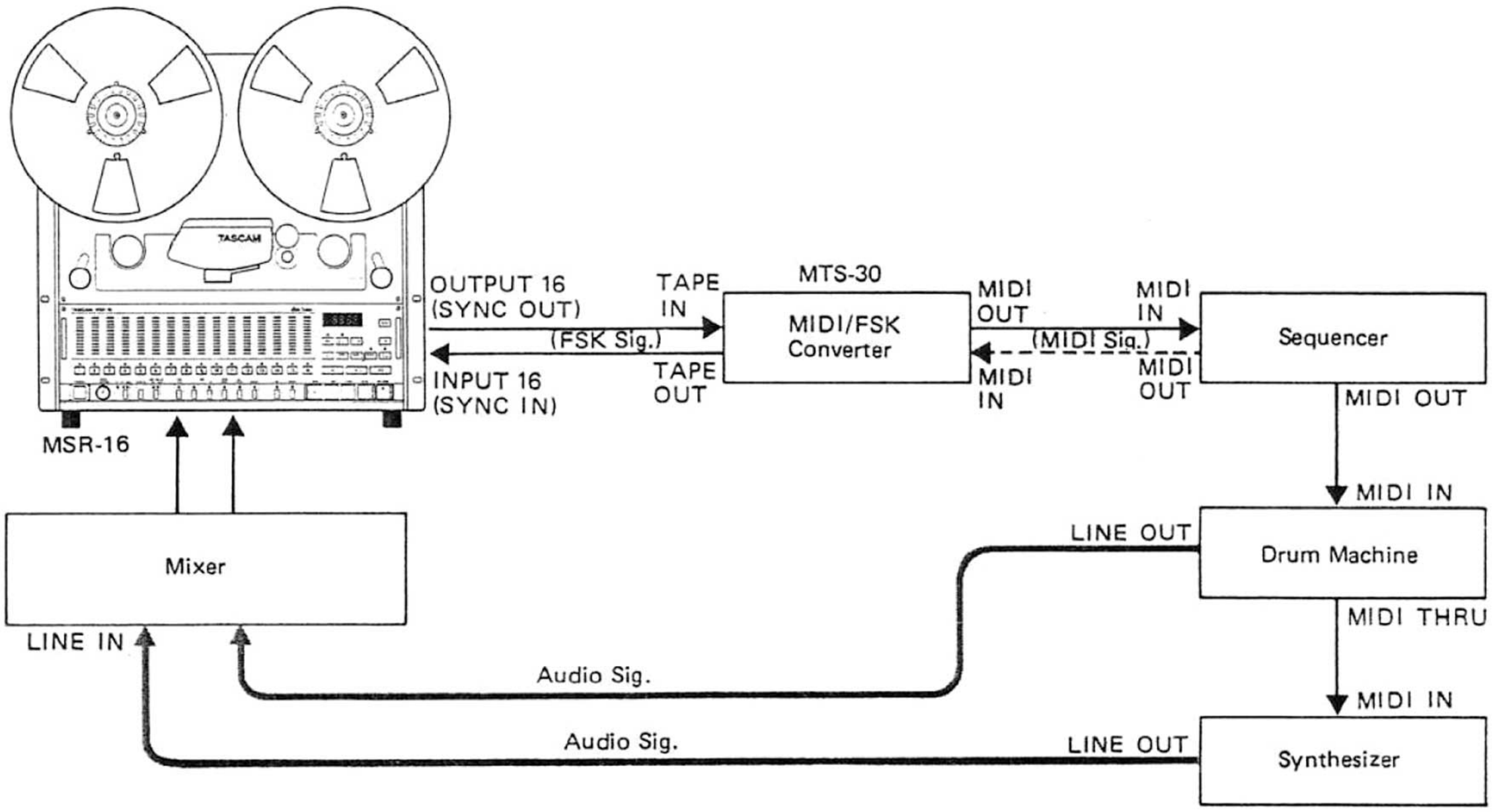


9. RECORDING WITH TAPE SYNC

Your MSR-16 has special features designed to make it an ideal recorder for use with electronic musical instruments. Track 16 is specifically designed to be used with the recordable synchronizing codes used by MIDI (Musical Instrument Digital Interface) as well as the SMPTE time code. Since MIDI itself is a computer type digital language and cannot be recorded on analog tape, it is necessary to convert MIDI timing clocks to recordable FSK (Frequency Shift Keying) signals using a MIDI/FSK converter such as the TASCAM MTS-30. Sometimes this type of converter is built into sequencers, drum machines and computer interfaces.

If you record the sync tone at the same time as instrument tracks, processing delays in some sequencers may cause phasing or timing lags during Playback. It's good practice to record the sync tone *before* recording instruments to tape.

- Connect the FSK output (labeled "Sync Out" or "Tape Out") of your sequencer, MIDI converter, or computer interface directly to the INPUT of track 16. Do not patch through your mixer. A direct connection between the sync tone generator and the MSR-16 ensures that FSK won't accidentally leak into the audio, and unwanted audio won't leak into the FSK.
- Press on the Record Enable button of Track 16 (red LED blinking).
- Turn on the SYNC LOCK switch on the front of the MSR-16. This defeats the dbx encode/decode for track 16 only. The SYNC LOCK LED will blink.
  CAUTION: *Be sure to press the track 16's Record Enable button* BEFORE *the SYNC LOCK switch. Otherwise recording is* NOT *possible on that track.*
- Consult the owner's manual of the device that is generating the sync tone to find out how to start the tone. Most units utilize a "pilot tone" that is output before the unit is started to help you set the level on the tape deck.
- Press RECORD and PLAY. After a few moments, hit START on your sequencer unit. Let the sequence play to its completion without stopping the MSR-16.
- Once track 16 is complete, release the Track Record button by pressing it. Its LED will go out, and the SYNC LOCK LED will go on solid showing that the track is locked to play mode.



Playback of Sync Tones

- Connect the Track 16 output **directly** to the Sync in ("Tape in") of the sequencer or MIDI converter. Again, do not patch through the mixer.
- Consult the owner's manual of your sequencer unit for specifics of how to switch it to follow external tape or MIDI clocks, depending on whether you're using a MIDI/FSK adapter.
- Rewind and play the tape. The sequencer or drum machine will start **at the correct place on the tape every time and play at the same tempo** that was recorded. Or your converter will translate the sync code playing back from track 16 into MIDI clock information which, in turn, will drive the MIDI program in the sequencer or drum machine. In addition, the synthesizers and other sound sources or processors connected to the sequencer will now operate in sync with the tape. In this way you can continue to record other "non-MIDI sound sources" — vocals, acoustic instruments, etc. — on the remaining tracks while listening to the MIDI instruments playing along with the sync track 16.
  By following this procedure, the sequencer in effect uses track 16 as a "guide" track to play as many instruments as are being controlled via MIDI from the sequencer, creating "virtual" tracks. You may decide to actually record the audio output of some of those tracks so you can use the instrument in a different way on another track, or you can leave the "virtual" tracks unrecorded until mixdown time. Combining virtual tracks with the normal tracking procedures used in recording makes it possible to record a tremendous number of different instrument sounds on a small number of tape tracks. Your only real limitation is the number of sound sources and the capacity of your sequencer.

About Tape Sync

- It is possible to record onto track 15 while locked to time code or sync tone from track 16 without any problem if you keep in mind that crosstalk is greatest during the overdubbing of track 15, since the record level in the head is 40 dB hotter than it is during playback. The signal of track 15 inductively crosstalks to the head windings of track 16, possibly causing a sequencer to miscue or a synchronizer to drop lock. If this happens, there are a few remedies:
  a) Lower the record level of the signal onto Track 15.
  b) Insert a 10 or 20 dB pad between Track 16 out and the synchronizer. There is a point with many units where the crosstalk is attenuated below the "confusion threshold" of the code reader, but there is still enough level on the time code for it to be read.
  c) Consider recording track 15 while the virtual tracks aren't locked up. In playback, the crosstalk returns to a normal level, and you can lock up to track 16 again. If you record code and sound simultaneously, record tracks 15 and 16 at the same time ... there is no sync crosstalk if 15 is never overdubbed onto.

NOTE: Certain types of instruments — percussion or other instruments with extreme transients, synths with pulse waves, etc. — are more likely to cause a reading problem than other instruments.

—REAR PANEL—

1. REMOTE PUNCH IN/OUT Jack

This is for connection of the optional RC-30P footswitch. Whether you're a busy engineer, producer, or a musician with both hands on an instrument, there are times when you can't drop what you are doing to press RECORD button. The RC-30P is the solution. It lets you punch-in and out of Record with a tap of your foot.

2. ACCESSORY 1 Connector (37-pin, D-sub)

It has the inputs/outputs necessary for the direct interface with the TASCAM ES-50 Synchronizer or other SMPTE/EBU Synchronizers/controllers. ACCESSORY "1" is a parallel port, as opposed to the ACCESSORY "2" connector.

3. ACCESSORY 2 (SERIAL I/F) Connector (15-pin, D-sub)

This is a serial I/O port confirming to the RS-232C standard for linking the MSR-16 to an external computer, or synchronizer such as the TASCAM MIDiiZER.

The dip switch adjacent to the connector is used to select the bit rate (data transmission speed) as per the diagram beside the switch.

4. REMOTE CONTROL Connector (25-pin, D-sub)

This is for connection of the optional RC-416 remote control unit. With the remote control unit, you can control all tape motion from a distance of up to 15 ft (5 m).

5. INPUT Jacks 1-16

Each of these RCA jacks accepts a nominal input level of −10 dBV (0.316 V). The input impedance is 50 kOhms (unbalanced).

6. OUTPUT Jacks 1-16

These outputs carry either the tape signal of the corresponding track, or the source (input) signals, depending on the position of various front panel controls. See the switching logic table on page 27.

The MSR-16 has no output level controls of its own and the output level is the same as the input level; that is, −10 dBV (0.316 V). The output impedance is 100 Ohms (unbalanced).

7. AC IN Connector

For connection of the provided AC power cord.

—FRONT PANEL—

1. Reel Holddown Knobs

These are permanently mounted, and are used for the installation of large hub 10.5-inch reels. Clockwise rotation of the knobs tightens the reels in place.

2. Reel Tables

Support 10.5-inch reels/half-inch tapes. Use the same size and type of reels for both the supply and takeup sides.

3. Impedance Roller

Also referred to as "flutter filter," which insures even tape travel across the heads and low wow and flutter performance.

4. Tension Arms

The capstan servo controls the tape tension and motor torque through the use of a position sensor attached to the right tension arm. The right tension arm is also associated with a shut-off mechanism that stops all tape motion if the tape slackens or spills off the reel. The left tension arm compensates for slight irregularities in the supply reel in addition to maintain even tape tension.

5. Capstan Shaft and Motor

The DD (Direct Drive) capstan motor is controlled by a PLL (Phase Lock Loop) servo to ensure precise tape speed.

6. Counter Roller

This measures linear tape footage, which is converted into elapsed time from whatever zero point is entered. The counter roller is associated with a tach generator to provide information about tape motion to external synchronizers during fast wind movements.

7. Pinch Roller

The MSR-16's pinch roller is a "self-centering" type for maximum tape motion consistency. A rubber coating on it is of urethane for maximum resistance both to wearing and to cracking or hardening. Also, the pinch roller is, as with all other major rotating components, supported by ball-bearings to minimize friction and retain close tolerance.

8. Head Shield (Head Gate)

Pushing this shield plate down into the plate provides a full access to the head block for tape threading and maintenance.

9. POWER Switch

Controls AC power to the MSR-16. Pressing POWER a second time turns the machine off, and clears the MEMO 1, MEMO 2, Punch-in Rehearsal (RHSL), AUTO IN/OUT, and LOAD memories.

10. LOAD Switch

This feature ensures that your tape will never run off the reel at either end. When LOAD is pressed while holding RESET pressed down, that point on the tape is put into the MSR-16's memory system. Once the LOAD point is established, the tape will stop at that point whenever it runs in REW or F.FWD. The memory point does not move even if the counter is subsequently reset to zero elsewhere on the tape.

When you wish to remove tape from the deck, simply press REW (or F.FWD) again to get past the LOAD point.

To change the LOAD point, move the tape to the desired point and press again RESET and, holding it pressed down, press LOAD.

When the MSR-16 is turned off, whatever LOAD point has been memorized is cleared from memory.

NOTE: There is only one load point; you cannot set LOAD points at the beginning and end of the tape simultaneously. Typically, set the load point 30 seconds

(to allow for overshoot) from the beginning of the reel when you're working at the start of the tape, and when you're working towards the end of a reel set LOAD about 30 seconds from the end.

11. Speed Mode Selector Switch

This switch selects either FIX or VARI mode. The setting of the switch is defeated as soon as external specific signals are fed into the MSR-16 via it's rear panel ACCESSORY 1 or 2 connector in which case the EXT LED will automatically turn on.

FIX: Locks tape speed to LOW (7.5 ips, 19 cm/s) or HIGH (15 ips, 38 cm/s) speed, as selected by the TAPE SPEED selector switch (#12). Setting to FIX is indicated by a green LED.

VARI: Switches tape speed control to the PITCH CONTROL. "Non standard" tape speeds can then be used. Setting to VARI is indicated by a red LED.

When the MSR-16 capstan motor is under external control of a synchronizer/controller the EXT LED will light steadily in yellow. When either the control signal or 9,6 kHz reference to the MSR-16 is interrupt, the EXT LED will flash and the FIX LED will turn on solid, indicating that the FIX speed mode is active, as summed up in the table below.

FIX LED	EXT LED	ACCESSORY 1 (Parallel)		ACCESSORY 2 (Serial)	
		Ext. Cont.	9.6 kHz	Ext. Cont.	9.6 kHz
On Solid	Off	None of the above four signals is coming			
On Solid	Flash-ing	Only one of the four signals is coming			
Off	On Solid	Either pair of the signals (control and frequency reference) is coming			

12. TAPE SPEED Selector Switch

When the switch is in its Up/HIGH position, the tape will record or play at 15 ips (38 cm/s); and when the switch is in its Down/LOW position, the tape will record or play at 7.5 ips (19 cm/s), unless the machine is in VARI or EXT speed mode.

13. PITCH CONTROL

When and only when the Speed Mode selector switch (#11) is in its VARI position and its red LED is on solid, the PITCH CONTROL is active and provides a stepless plus or minus 15% variation to the capstan motor speed both in Record and Play modes. Turn the knob to the left to lower the motor speed, or to the right to increase the motor speed. You may see a readout of the percentage of speed change using the DISPLAY switch (#14).

You can use this speed control to accomodate minor changes necessary in the length or relative pitch of your program material. If you're making a 30 second radio commercial and it runs a litte long, you can speed it up enough to drop out the extra seconds, although the material on it will raise in pitch. This can sometimes be used in a creative way to save parts that are a litte out-of-tune, or to create sound effects such as flanging. If you record with the PITCH CONTROL at its maximum or minimum settings, you will NOT have the ability to make further adjustment in that direction upon playback.

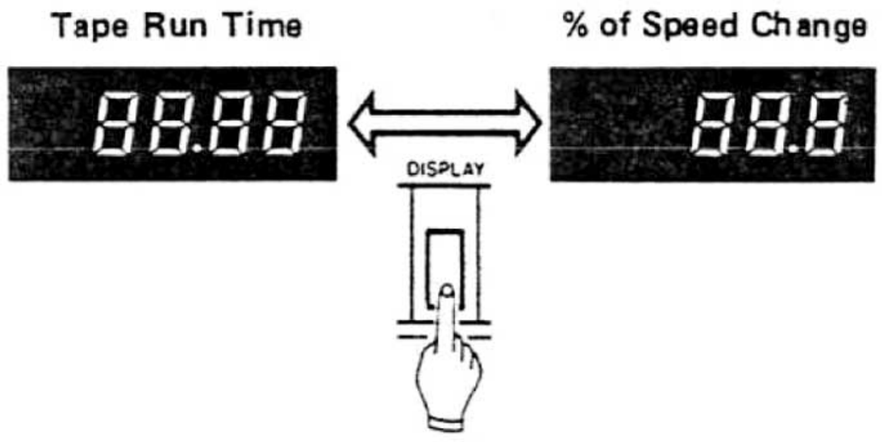
Also, it is recommended that you run the MSR-16 for several seconds in the play mode for the speed to stabilize, especially when the change in speed is large. Before beginning to record again, check the pitch carefully with a short playback, and you will have less troubles with drift.

CAUTION: The PITCH CONTROL affects the record speed also. Check to make sure that TAPE SPEED select switch is set to FIX unless you are using the PITCH CONTROL intentionally.

14. DISPLAY Switch

This switch "toggles" (switches forth and back) the digital counter between "Tape Run Time" and "% of Speed Change" displays.

When the MSR-16 is initially turned on, the counter switches to Tape Run Time mode.



15. REW(ind) Button

Pressed, winds tape at high speed in reverse.

16. F.FWD Button

Pressed, winds tape at high speed in the forward direction.

17. STOP Button

Stops any tape motion, and cancels all transport modes.

To cancel RHSL and AUTO IN/OUT modes, use CLEAR. If STOP is used instead, the LED RHSL or AUTO IN/OUT blinks, not turns off though those functions are actually disabled, and to turn off the LED you have to press CLEAR anyway.

18. PLAY Button

a) Pressing this button alone starts tape playback.

b) Pressing the button while recording stops the recording ("punch out") without stopping the tape motion.

19. RECORD Button

Pressing the RECORD button together with the PLAY button will cause either of the following two events:

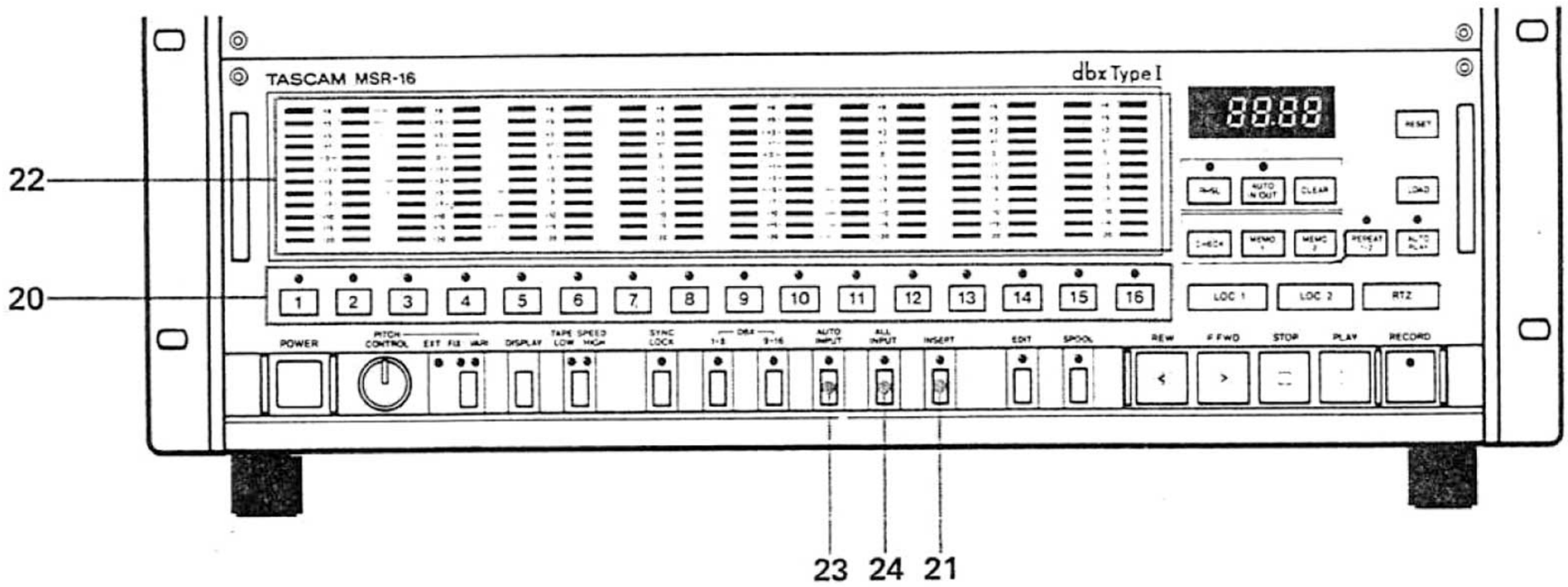
1) If any Track Record buttons are engaged, the LED above them as well as the RECORD LED will stay on, and recording will begin on the corresponding tracks.

2) If none of the Track Record buttons is engaged, the master RECORD LED will blink to indicate a record ready.

Pressing the RECORD button alone during the tape is rolling in PLAY will enable a punch-in ("insert").

The RECORD LED conveys the following messages:

A) LED off: safe mode — no recording is taking place.



23 24 21

B) LED blinking: record ready mode — tape is rolling at play speed, but no actual recording is in progress. Recording will start as soon as any Track Record button or buttons are pressed on.

C) LED on solid: record mode — recording is taking place.

20. Track Record Buttons

Pressing any of these sixteen buttons puts the corresponding track into Record-Ready, or directly into Record mode if RECORD and PLAY have already been pressed.

Functions of the Track Record LEDs

A) LED off: Safe — recording cannot occur on that track.

B) LED blinking: Record Ready — recording on that track will occur when RECORD and PLAY are pressed.

C) LED on solid — recording on that track is in progress (RHSL or actual).

21. INSERT Switch

INSERT determines what signal (source or tape) appears at the output of tracks placed into record ready mode by the Track Record buttons. It allows automatic monitor switching from tape to source during punch-in, and back to tape at punch-out.

A) When insert is ON, the output of any tracks whose LEDs are blinking (in record ready mode) will be Tape.

B) When insert is ON and RECORD mode is entered (LEDs solid), the output of the tracks being recorded will be source (Input).

C) When insert is OFF, the output of any tracks whose Record Enable buttons are on will be source (Input) regardless of whether you're actually recording or not.

The INSERT button only affects tracks whose LEDs are on. When INSERT is off, you can use the Track Record buttons to manually toggle between tape and source, and rehearse a punch-in.

Switch Setting		Transport Mode		
Track Record Button	INSERT	STOP	PLAY	RECORD
ON	ON	—	Tape	Input
	OFF	Input		
OFF		—	Tape	

CAUTION: When performing Spot Erasures also, the INSERT switch MUST BE ON, so you can hear the output of the tape to find the erase point.

22. Peak Level Meters

These meters register the signal levels being fed to the MSR-16's OUTPUT connectors, in the limits of –20 dB to +8 dB.

23. AUTO INPUT Button

This feature automatically switches the output of tracks in REC READY mode to input during REW, F.FWD or STOP. This allows the control room to hear the talent through the tape monitor for communication, without having to change any settings on the mixer.

24. ALL INPUT Button

When ALL INPUT is pressed on, all the channels' output will carry signals derived from the input electronics regardless of the transport mode.

25. SYNC LOCK Switch

SYNC LOCK is used to "lock" track 16 to playback mode so sequencers or synchronizers can constantly read sync signals (FSK or SMPTE time codes) played back form that track. Another function the switch provides is to turn off the DBX on track 16 only, enabling sync signals to be recorded and played back without being affected by the dbx encode/decode

When recording sync signals on track 16 be sure to press the SYNC LOCK switch AFTER the track's record enable button. A red LED will then start blinking above the SYNC LOCK switch to indicate that the DBX on track 16 is disabled.

CAUTION: If the SYNC LOCK switch is pressed

when the track 16 button is in its OFF position, the SYNC LOCK LED will turn on solid, instead of blinking, to indicate that the track is "locked", and pressing the track button has no effect and any recording can't start on that track.

Once track 16 is complete, release the track button by pressing it again. This will cause the SYNC LOCK LED that was blinking to turn on solid. As the LED is on solid, the track will NOT switch to Input, regardless of the settings of ALL INPUT or AUTO INPUT.

The track 16's status is determined by the following logic.

Switch Setting		Track 16 Status	
Record Enable Button (track 16)	SYNC LOCK Switch	Recording	DBX System
ON (LED flashing or on solid)	ON (LED flashing)	Possible or Currently in progress	Ineffective*
	OFF (LED off)	Possible	Effective or Ineffective**
OFF (LED off)	ON (LED on)	Impossible	Ineffective*

*) Regardless of the setting of the DBX switch
**) Depending on the setting of the DBX switch

26. DBX On/Off Switches, 1-8 and 9-16

When these switches are engaged, their LEDs will light and the built-in dbx noise reduction system for each group of channels (1-8 and 9-16) is turned on. This system provides a noise reduction of about 30 dB and increase of tape saturation level (headroom) of about 10 dB, resulting in a dynamic range of more than 100 dB.

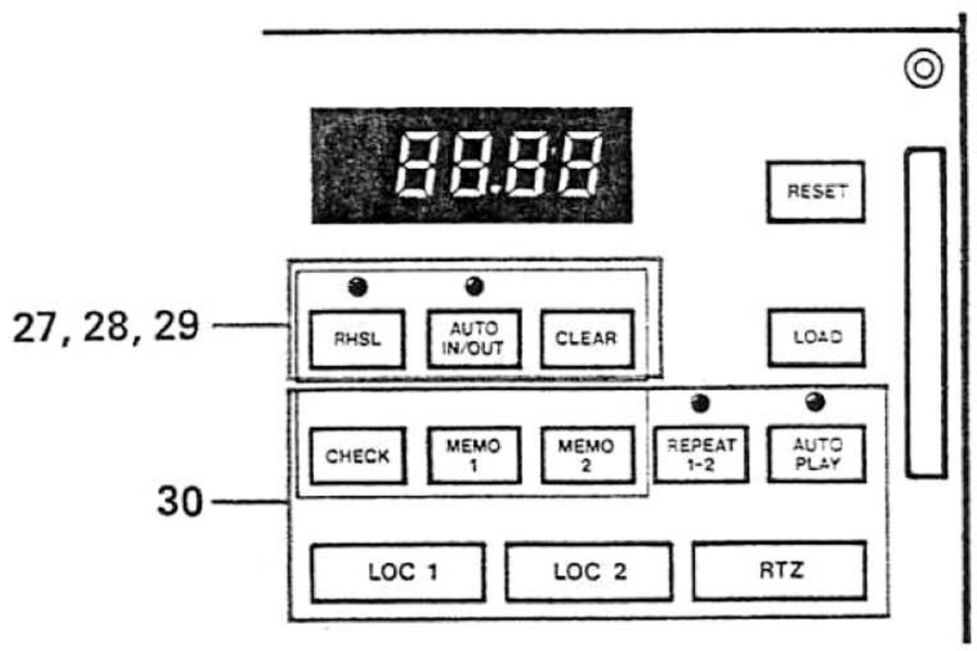
When the SYNC LOCK switch is engaged, the dbx system for track 16 is disabled, as shown in the table above.

27. RHSL (Rehearsal) Button

RHSL is the first stage of an automatic punch-in recording. During Rehearsal Set mode (RHSL LED blinking), the MSR-16 memorizes the preroll, punch-in, and punch-out counter locations that are used for rehearsals and for AUTO IN/OUT.

When the desired Rehearsal points are memorized and the RHSL LED is on solid, the MSR-16 is in RHSL Ready mode, and pressing PLAY or footswitch will start a rehearsal loop. After a 3-second postroll, the tape will rewind, stopping at the preset preroll start point. The MSR-16 will again be in RHSL Ready mode. You can repeat the rehearsal sequence as many times as you wish.

In the above Rehearsal mode, the RHSL function (in combination with the INSERT feature) switches the output of tracks in record ready mode from tape to source and back again at the preset points BUT NO SIGNAL WILL BE RECORDED TO TAPE. This allows you to hear what a punch-in will sound like before you actually record it, without having to manually press any keys or footswitch.



28. AUTO IN/OUT Button

After you have set the tape's preroll start, punch-in, and punch-out points in RHSL mode, entering the MSR-16's AUTO IN/OUT mode puts it into a ready status to commit the record Punch to tape. Pressing PLAY or the RC-30P footswitch initiates the actual recording by activating the automatic Punch-In/Punch-Out sequence (Preroll, Punch-In, Punch-Out and Post-roll).

29. CLEAR Button

This is used to turn off the RHSL and AUTO IN/OUT functions.

Pressing CLEAR during any other modes than RHSL and AUTO IN/OUT has no effect.

30. Auto Locator Section

Grouped to this section are the following:

1) MEMO 1 and 2
2) CHECK
3) LOC 1 and 2
4) REPEAT
5) RTZ
6) AUTO PLAY

1) MEMO 1 and MEMO 2 Buttons

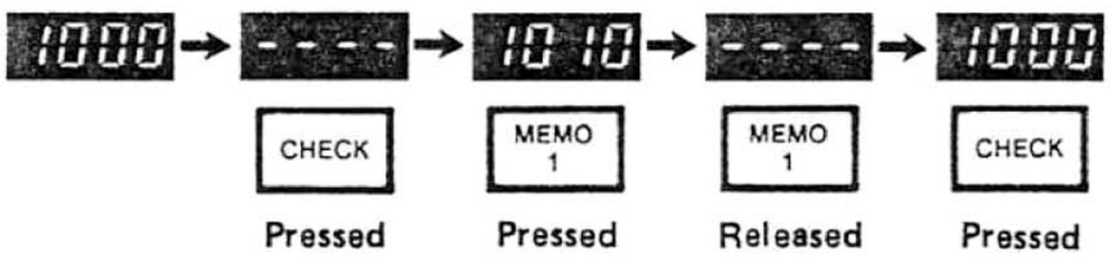
These buttons are used to establish 2 autolocation points in the MSR-16's memory system. They can be used while the tape is stopped or rolling. Pressing either button at any point on the tape loads the current tape location into that memory register. Each time the button is pressed, a new MEMO point is established, erasing the previous memory in that register. Neither MEMO location can be used if the MSR-16 is in RHSL or AUTO IN/OUT mode. Both MEMO points are erased when power is turned off.

If the RESET button is pressed, and the counter is set to 00:00, the two MEMO points are automatically recalculated, so they stay the same relative to their original tape position.

2) CHECK Button

When the CHECK button is pressed, the digital counter shows a broken line. Pressing then the MEMO 1 or 2 button causes the counter to show, for as long as the MEMO button is held pressed down, the content of the corresponding register. As you release the MEMO

button, the counter again shows the broken line. A second press of CHECK, switches the counter to the original display (Tape Run Time or Speed Variation).



3) LOC 1 and LOC 2 Buttons

Pressing either of these buttons causes the tape to roll (in either F.FWD or REW) to the corresponsing MEMO point. The tape will stop when it reaches the MEMO point. If the AUTO PLAY feature is used together, the MSR-16 will enter automatically Play mode after reaching the memorized point.

The LOC 1 and 2 buttons can safely be pressed at any time except during RHSL and AUTO IN/OUT modes; if pressed during these modes, they erase the punch-in memory points.

4) REPEAT 1-2 Button

The REPEAT function provides a "Playback Loop" or "Block Repeat" between the two programmed MEMO points. Note that MEMO 2 does NOT have to be a number greater than MEMO 1. When REPEAT is enabled and the current tape location is between the two MEMO points, the tape will play to the higher MEMO location, rewind to the lower MEMO location and start over. This cycle will repeat until STOP, or any other transport button is pressed.

If LOC or RTZ is pressed when REPEAT is on, REPEAT is cancelled and LOC or RTZ is entered, instead.

5) RTZ (Return to Zero) Button

Pressing the RTZ button will cause the MSR-16 to fast wind (FAST FORWARD or REWIND) the tape to the counter 00.00 point on the tape (even if the display isn't showing the counter). If the AUTO PLAY feature is active, the MSR-16 will automatically enter Play mode after reaching the counter zero point.

During RHSL and AUTO IN/OUT modes also, the RTZ function can be activated, but remember, the punch-in memory points are then erased.

6) AUTO PLAY Button

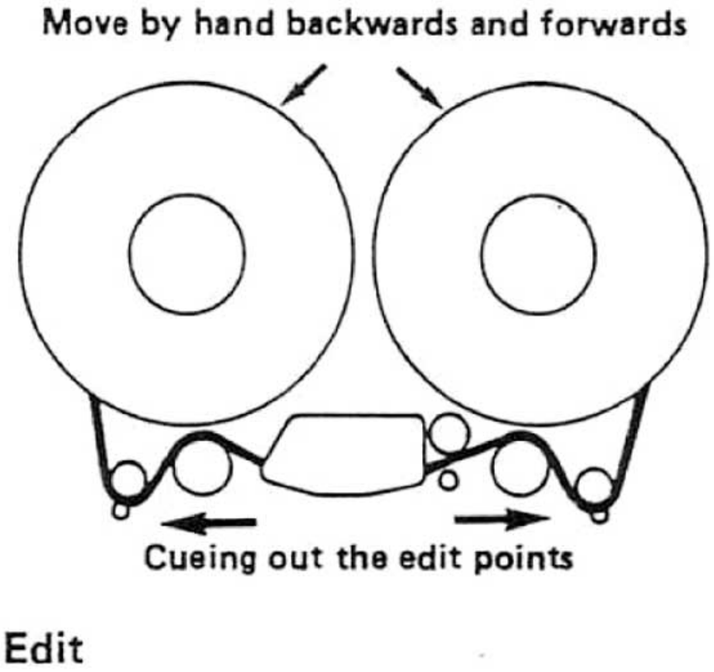
This feature is used together with the LOC 1 and 2 and RTZ functions. Pressing AUTO PLAY before (or after) RTZ, LOC 1 or LOC 2, will program the MSR-16 to start playback each time after it has located to the counter zero or MEMO points.

31. EDIT Button

The EDIT button provides the following five functions (all of which are disabled when STOP or any other transport buttons are pressed):

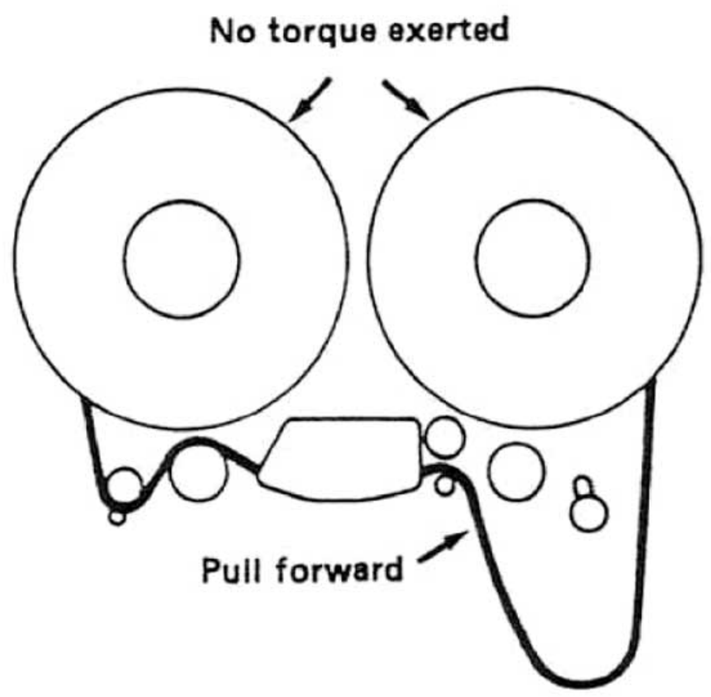
1) Manual Edit

When the transport is in STOP and the right (takeup) tension arm is in its "on" position, pressing EDIT will turn its LED on and disengage the reel motor brakes, and the same amount of torque will be exerted on both reels. The reels may then be "hand rocked" to locate the exact edit points.



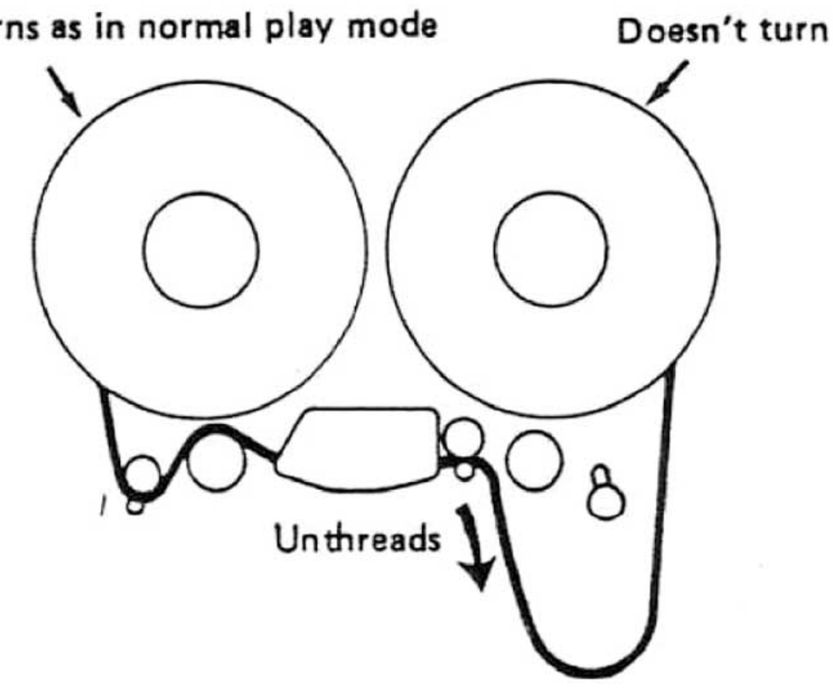
2) Stop Edit

When the transport is in STOP and the right tension arm has dropped to its "off" position, pressing EDIT will turn its LED on and disable the output mute. The tape may then be pulled forward off the supply reel as you listen to it play.



3) Dump Edit

If EDIT and PLAY are simultaneously pressed when the transport is in STOP, the EDIT LED will turn on and the tape will begin unthreading from the supply reel as you listen to it play. The right tension arm position is disregarded by the shut-off sensing logic.



NOTE: Dump Edit can not be enabled unless EDIT and PLAY are pressed simultaneously. Pressing EDIT then PLAY only causes the tape to play normally. Pressing EDIT after PLAY has no effect; the tape continues to play.

4) Spot Erasure

This function makes it easy to erase specific portions on a given track. First, designate the track to be erased by pressing on its Record Enable button. Press INSERT so you can hear tape, enter the Manual Edit mode as explained above and "hand rock" the reels until you cue out the spot to be erased. Then back up the tape slightly so that the portion you were hearing is now at the erase head (a china marker on the tape point is helpful for this). Press and hold RECORD while slowly moving the tape by hand. Erasure continues for as long as you advance the tape with RECORD hold down.

5) Cueing

If EDIT is pressed and held down during the Fast Winding modes (including SPOOL, LOC, RTZ, and REPEAT), the tape lifters will retract so that the tape contacts the heads, enabling high-speed tape monitoring. As the cueing mode is activated, a high-cut filter is automatically inserted to prevent the meter circuits and speaker components from being damaged by high energy audio signals.

32. SPOOL Button

When the SPOOL button is pressed after (or before) REW or F.FWD, the tape will begin rolling at a constant speed of approximately 80 ips (203 cm/s) which is 1/3 times the normal fast wind speed, to obtain a tight, uniform tape pack. Generally, spooling will be done onto the takeup reel at the end of a recording or editing session so the tape can be stored "tails out", which reduces audible print-through effects (pre-echoes).

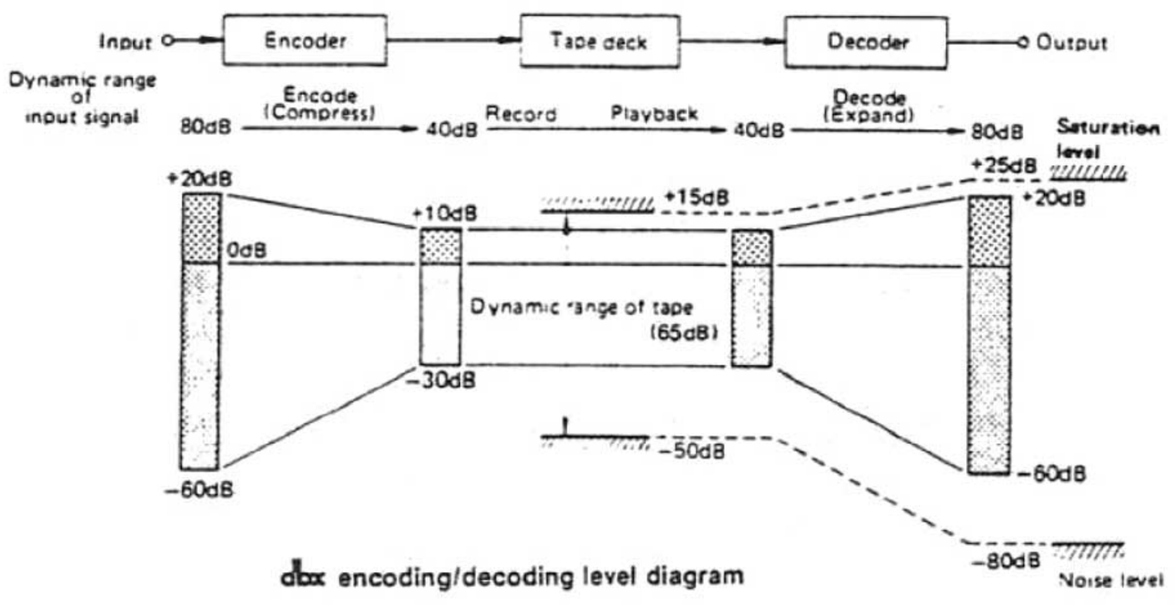
A second press of SPOOL after tape starts spooling, switches the transport to the normal fast wind mode (REW or F.FWD).

How the dbx Works

The DBX is a wide-band compression-expansion system which provides a net noise reduction (broad-band, not just hiss) of a little more than 30 dB. In addition, the compression during recording permits a net gain in tape headroom of about 10 dB.

A compression factor of 2:1 is used before recording; then, 1:2 expansion on reproduce. These compression and expansion factors are linear in decibels and allow the system to produce tape recordings with over a 100 dB dynamic range — an important feature, especially when you're making live recordings. The DBX employs RMS level sensors to eliminate compressor-expander tracking errors due to phase shifts in the tape recorder, and provides excellent transient tracking capabilities.

To achieve a large reduction in audible tape hiss, without danger of overload or high-frequency self-erasure on the tape, frequency pre-emphasis and de-emphasis are added to the signal and RMS level sensors.



dbx encoding/decoding level diagram

SUBSONICS AND INTERFERENCE

The DBX incorporates an effective bandpass filter. This filter suppresses undersirable subsonic frequencies to keep them from introducting errors into the encode or decode process. However, if rumble from trains or trucks is picked up by your microphone and fed to the DBX, modulation of the program material during low level passages may occur. This low-frequency component will not itself be passed through the recorder and so, will not be present at reproduce for proper decoding. If this low-level decoding error is encountered, and subsonics are suspected, we suggest the addition of a suitable high-pass filter in the Microphone Line.

MAINTENANCE

" **CAUTION** – THESE SERVICE INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER ALL SERVICING TO QUALIFIED SERVICE PERSONNEL."

INSTRUCTIONS FOR SERVICE PERSONNEL

BEFORE RETURNING APPLICANCE TO THE CUSTOMER, MAKE LEAKAGE-CURRENT OR RESISTANCE MEASUREMENTS TO DETERMINE THAT EXPOSED PARTS ARE ACCEPTABLY INSULATED FROM THE SUPPLY CIRCUIT.

NOTES

★ Parts marked with * require longer delivery time.

★ All resistors are 1/4 watt, 5 % unless marked otherwise. Resistor values are in ohms (K=1,000 ohms, M=1,000,000 ohms).

★ All capacitor values are in microfarads (p=picofarads).

★ ⚠ Parts marked with this sign are safety critical components. They must always be replaced with idential components – refer to the TEAC Parts List and ensure exact replacement.

★ 0 dB is referenced to 1 V in this manual unless otherwise specified.

★ PC boards shown viewed from electro-parts side.

1. BRIEF SIGNAL THEORY

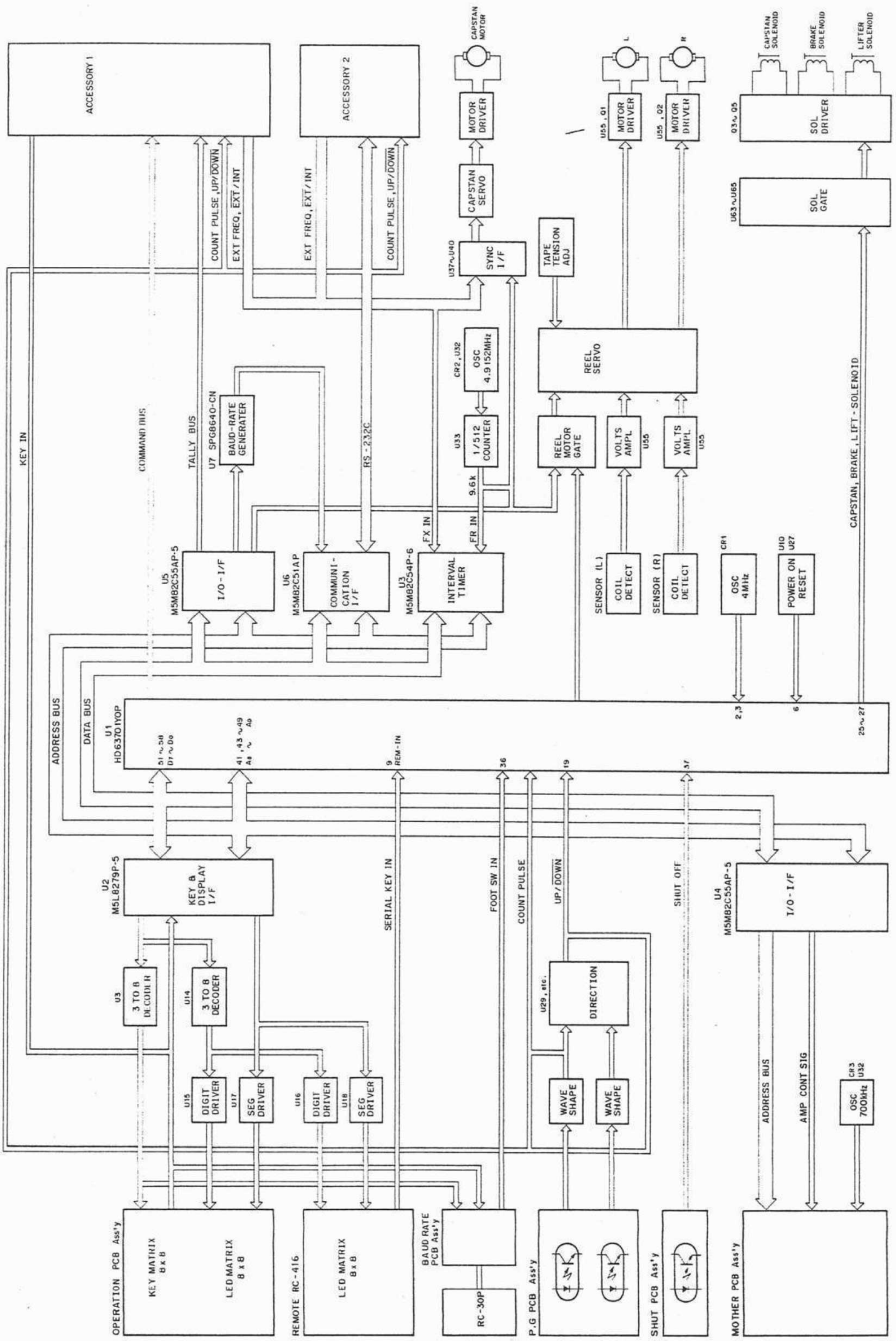


FIG. 1. CONTROL SIGNAL BLOCK DIAGRAM

1-1. Controls

Refer to the Control Signal Block Diagram and Control PCB Schematic (p. 55).

The MSR-16 uses an 8-bit micro computer U1, HD63701YOP, to control all tape motions.

Keyed-in signals are sent in parallel to U1 through the key matrix in U2. Keyed-in signals from the remote control unit are sent to pin 9 of U1 as a serial data.

In the P.G. PCB are generated two signals which have a phase difference of 90° each other. One of the two is that which serves as the tape count pulse. Advance/delay in phase occured in the two signals yields the tape counter the UP/DOWN signal.

From the expander U4 are sent mode instructions and timing signals to the amplifier of each channel.

The ACCESSORY 1 connector (37-pin, D-sub) is a parallel interface port for connection to SMPTE synchronizers/controllers.

The ACCESSORY 2 connector (15-pin, D-sub) is a serial interface port complying with the RS-232C standard for connection to MIDI tape synchronizers or computers.

The capstan motor is controlled using the 9.6 kHz reference which is obtained by dividing by 512 the frequency signal from CR2.

Switching between VARI/FIX/EXT is controlled by the SYNC I/F circuit which is made up of U37-40.

The GATE circuit to the reel motor generates reference voltages following the switchings of the transport mode, to accordingly control the reel servo. The SENSOR circuits "watch" the tape tension and control the reel motor so the tape runs with the optimum tension in whatever mode the transport may be.

1-2. Amplifiers

Refer to the R/P AMPL PCB Schematic (p. 56).

The MSR-16's electronics are controlled by the U6, μPD7554CS-100, micro computer.

U6 decodes serial data from the control circuits and transmits the following signals:

(Outputs from pins 12 through 16 are active at LOW.)

Pin 5	AISO	Switches the monitor output to INPUT or SYNC. When the pin goes L, INPUT is selected.
Pin 6	AHLD	This is a tape speed signal and used to select the record/reproduce equalizers and cut-off frequencies of LPF (U8), and optimize record bias. The pin goes L when the tape speed is set to 38 cm/s.
Pin 7	ANFO	Sends out a signal controlling the on/off switching of the dbx system. At L, the dbx turns on.
Pin 8	AMTO	Sends out the play mute on/off signal. The mute is disabled as the pin goes L.
Pin 12	ARB	Controls the record bias start/stop.
Pin 13	ARRL	Energizes the record relay (K1) which is used to switch the R/P head functions and release the record mute.
Pin 14	AEC	Controls the erase current start/stop.
Pin 15	AERL	Energizes the erase relay (K2).
Pin 16	SE	Sends out the spot erase signal.

The gapless punch-in/out is controlled by the timing of the above ARB, ARRL, AEC and AERL signals. The circuit made up of U3 (2/2), R43-49, and C33-37, is a sync crosstalk cancel circuit which is activated when one channel is in record and any other channels are in playback, to deafeat record signals leaking onto the playback channels. The CANCEL 1 and 2 signals have effect on directly surrounding playback tracks (channels), and the CANCEL 3 and 4 on the next far away surrounding playback tracks (channels).

2. VOLTAGE CONVERSION

NOTE: This voltage conversion is only possible on general export models and NOT on models sold in the U.S.A., Canada, U.K., Australia, or Europe.

Proceed as follows:

1. Make sure that the power cord is unplugged.
2. Remove the top upper rear panel by removing four screws on the rear upper.
3. Locate the voltage selector where indicated in the illustration below and pull off the selector plug (the center shaded square piece) to reinsert it so that the arrow on it points at the required voltage values.
4. Replace the top upper rear panel and fully tighten the four screws.

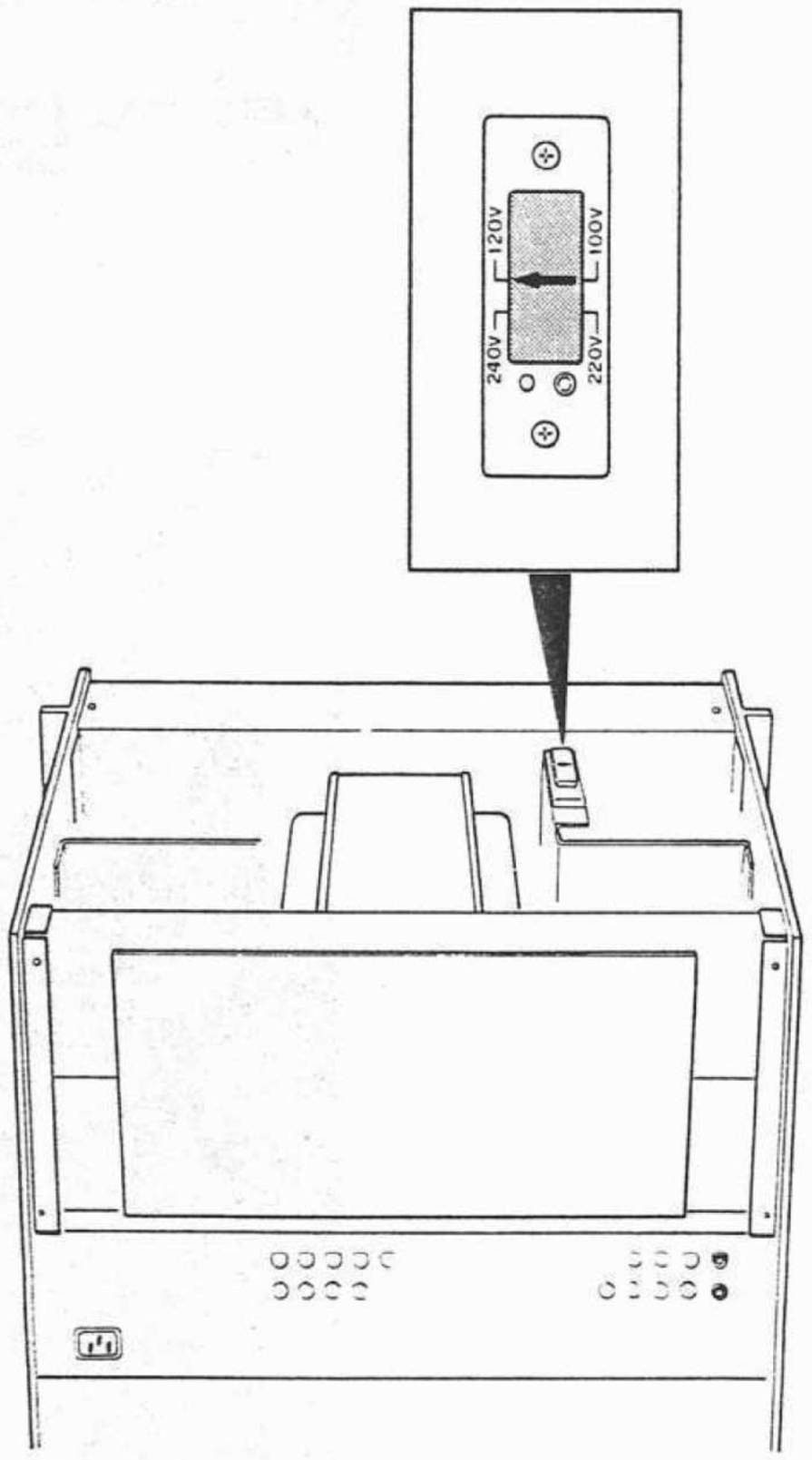


FIG. 2. VOLTAGE CONVERSION

3. CHECKS AND ADJUSTMENTS

3-1. Parts Locations

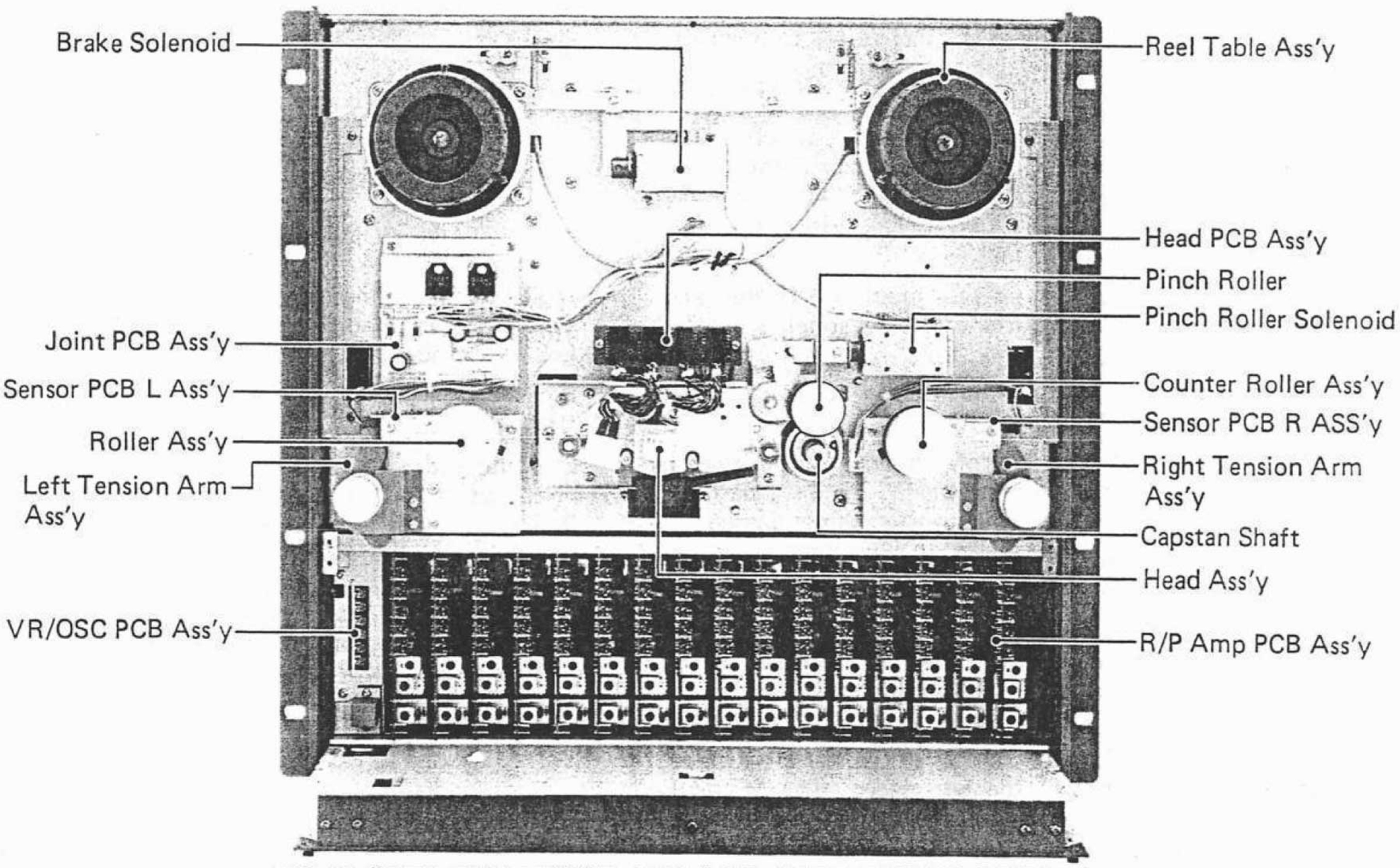


FIG. 3. WITH THE FRONT AND AMPLIFIER PANELS REMOVED

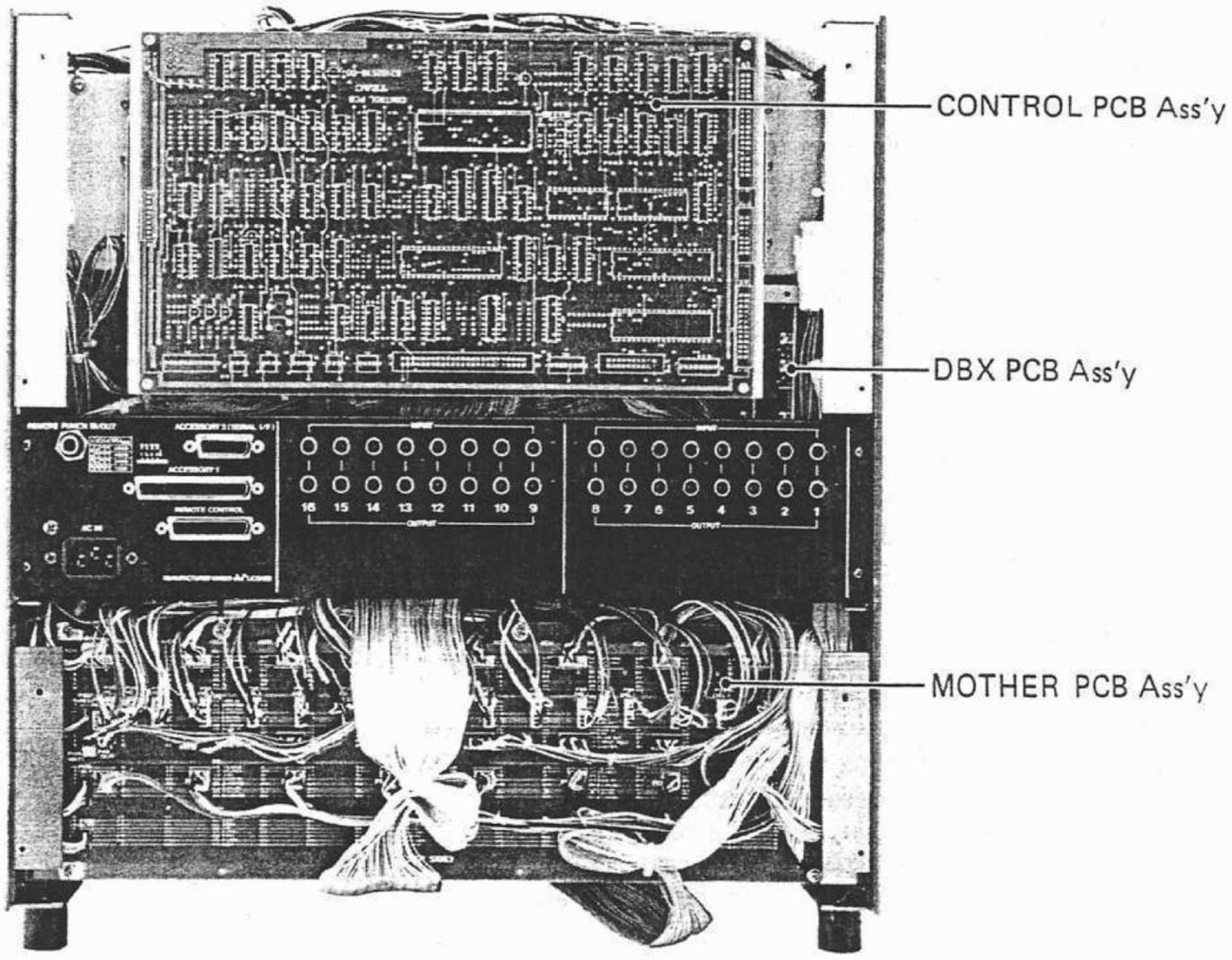


FIG. 4. WITH THE REAR PANELS REMOVED

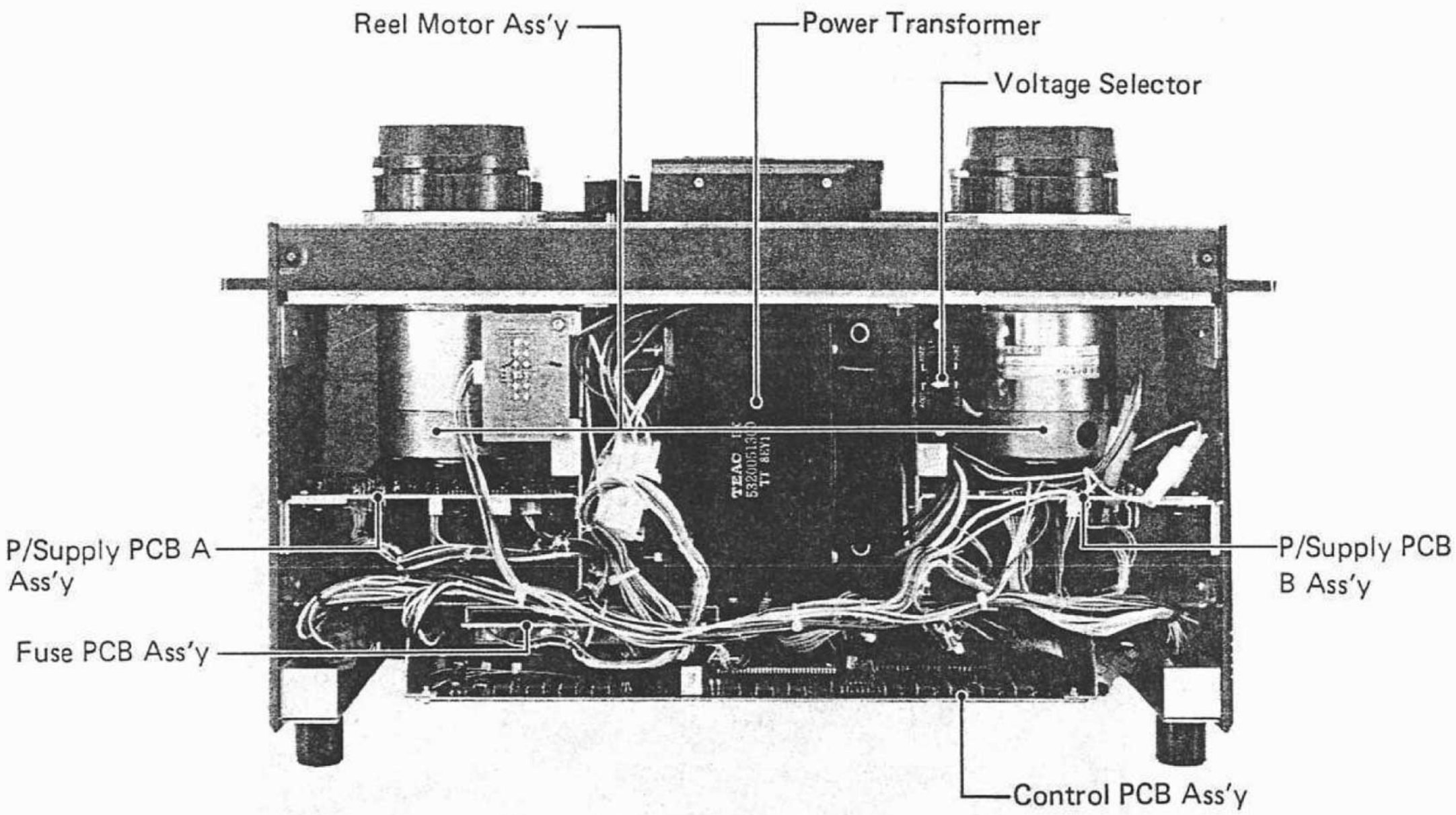


FIG. 5. BENEATH THE TRANSPORT

3-2. Test Equipment

Wow & flutter meter	Meguro Denpa Sokki K.K., Model MK-668C or MK-669 (JAPAN), or Mincom Division, 3M Co, Model 8155 (U.S.A.)
Audio oscillator	Hewlett Packard, Model 204C or equivalent
Digital frequency counter	Range: 10 Hz ~ 1 MHz; sensitivity: 0.1 Vrms; imp.: > 1 MΩ, < 25 pF
Band-pass filter	1 kHz narrow band pass type
AF level meter	Range: -80 dB ~+40 dB; imp.: > 1 MΩ, < 25 pF (example—HP 400GL)
Distortion meter	General purpose (400 Hz, 1 kHz)
Oscilloscope	General purpose
Attenuator	General purpose
Tools	Spring scale: 0 ~ 8 lbs (0 ~ 4 kg) 0 ~ 2.2 lbs (0 ~ 1 kg) Hex head Allen wrenches, Plastic alignment tool
Cleaning fluid:	TEAC TZ-261 or equivalent TEAC Spindle Oil TZ-255 or equivalent
Head demagnetizer	TEAC E-3 or equivalent
Test tapes	Reproduce Alignment Test Tape: TEAC YTT-11442 (for 15 ips) TEAC YTT-1143 (for 7.5 ips) Equlization Standard.: IEC, CCIR. Time Constant: 15 ips = ∞ μs +35 μs. Wow and Flutter Test Tape TEAC YTT-2104 (for 15 ips) TEAC YTT-2103 (for 7.5 ips) Blank Test Tape (Recording) TEAC YTT-8163.

3-3. Removal of Mains Parts

WARNING! TO AVOID ELECTRIC SHOCK, BE SURE TO UNPLUG POWER CORD PRIOR TO REMOVING OR REPLACING ANY PARTS.

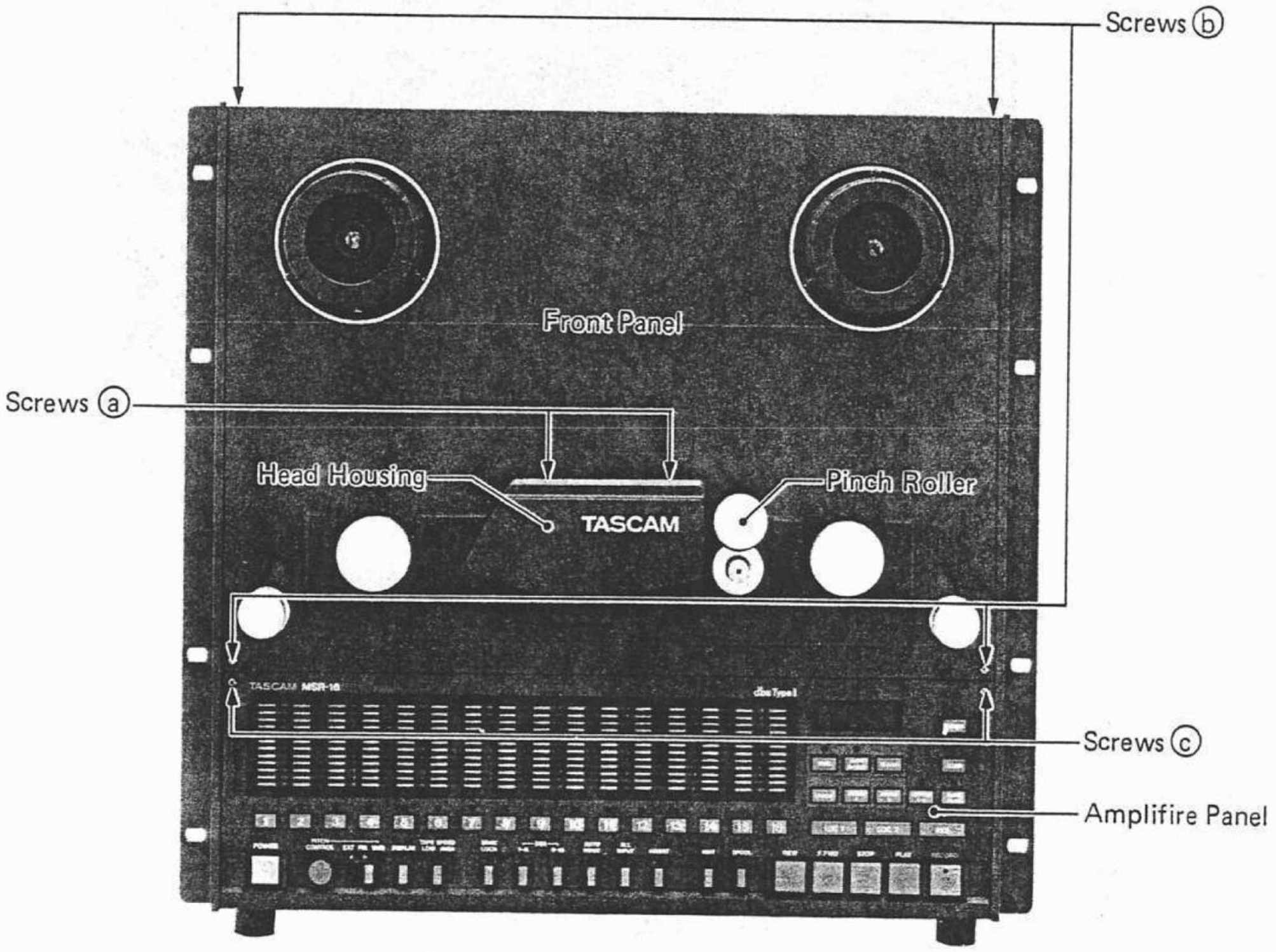


FIG. 6. FRONT VIEW

3-3-1. Front trim panel

CAUTION: When removing hex head screws in the following procedure, use care not to lose washers under them.

1. Remove the head housing by removing the two hex head screws marked ⓐ in Fig. 6.
2. Remove the pinch roller by removing the retaining screw in the top center of the roller (counterclock rotation).
3. Remove the four hex head screws marked ⓑ in Fig. 6.

3-3-2. Amplifier panel

Remove the two hex head screws ⓒ in Fig. 6 and the amplifier panel can be opened by pulling it toward you.

The amplifier panel need be opened when performing tape tension and pitch control adjustments, in addition to amplifier adjustments.

3-3-3. Top rear panel

Remove the four screws ⓓ shown in Fig. 7 (two of them holding the feet), then pull the top rear panel toward you off the chassis.

3-3-4. Connector panel

Remove the four screws ⓔ shown in Fig. 7 and the panel can be opened by pulling that toward you.

3-3-5. Bottom lower rear panel

Remove the four screws ⓕ shown in Fig. 7 (two of them holding the feet), and pull the panel toward you off the chassis.

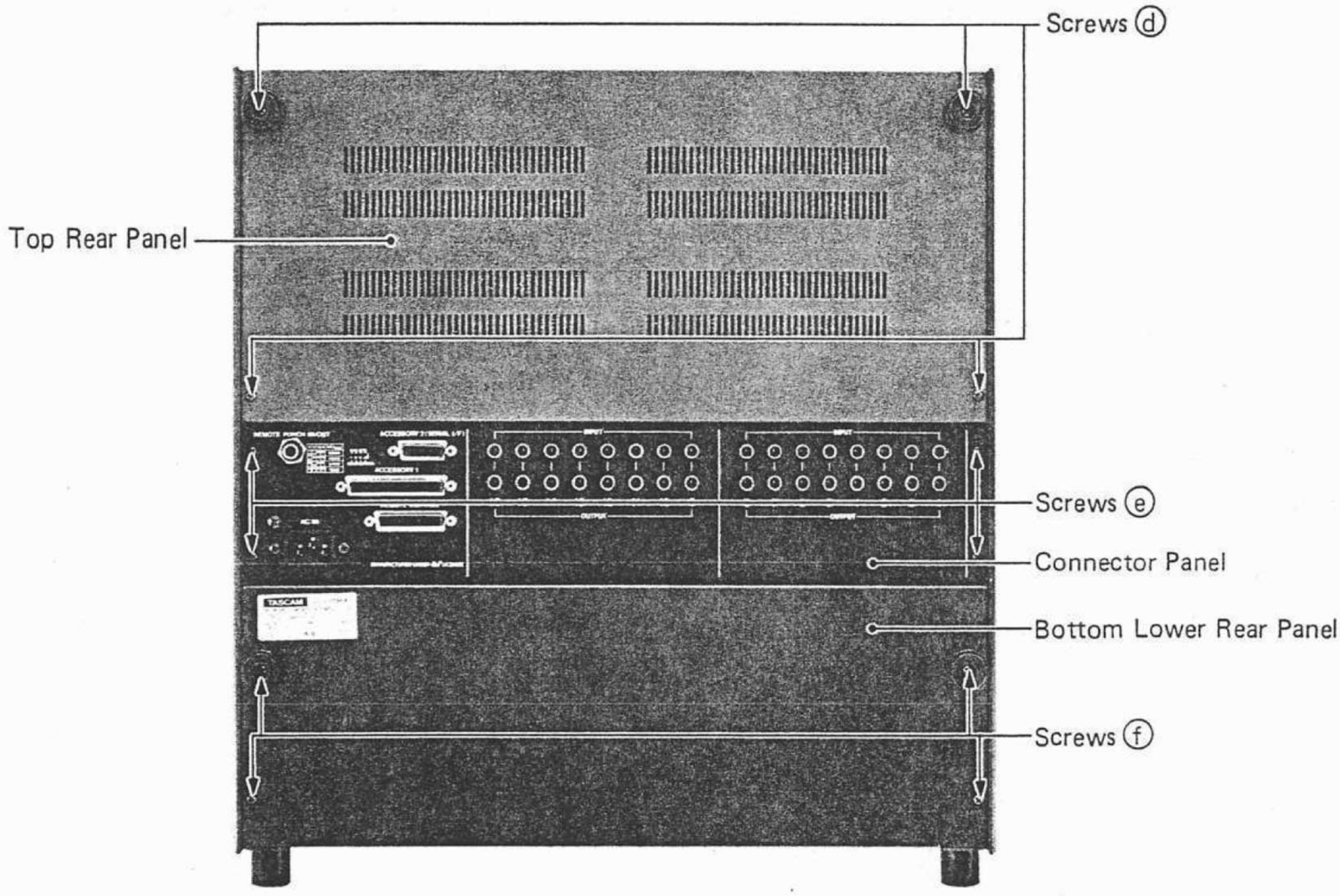


FIG. 7. REAR VIEW

3-3-6. Head replacement

Degradation of erasure or frequency response due to excessive head wear necessitates replacing the erase or rec/repo heads.

1. Remove the head housing, pinch roller cap, pinch roller and front panel, in this order, as in paragraph 3-3-1.
2. Unplug the connectors, remove the three screws marked ⓐ in Fig. 8, then remove the head assembly.
3. Remove the two azimuth adjustment screws ⓒ from the rec/repro head and the four hex head screws ⓑ from under the head base, to remove the individual heads.

NOTE: The erase head is "fixed", there is no adjustment, and is held in place with two mount screws ("b") only, while the rec/repro head is "semi-fixed" and has two azimuth adjustment screws ("c"); there is no necessity of adjusting its zenith (tilt).

After replacing erase head, rec/repro head or head assembly, the following must be performed:

1) Tape travel check (paragraph 3-4-7)
2) Head azimuth adjustment (rec/repro head only) (paragraph 3-5-1)
3) Electrical adjustments (Section 3-5)

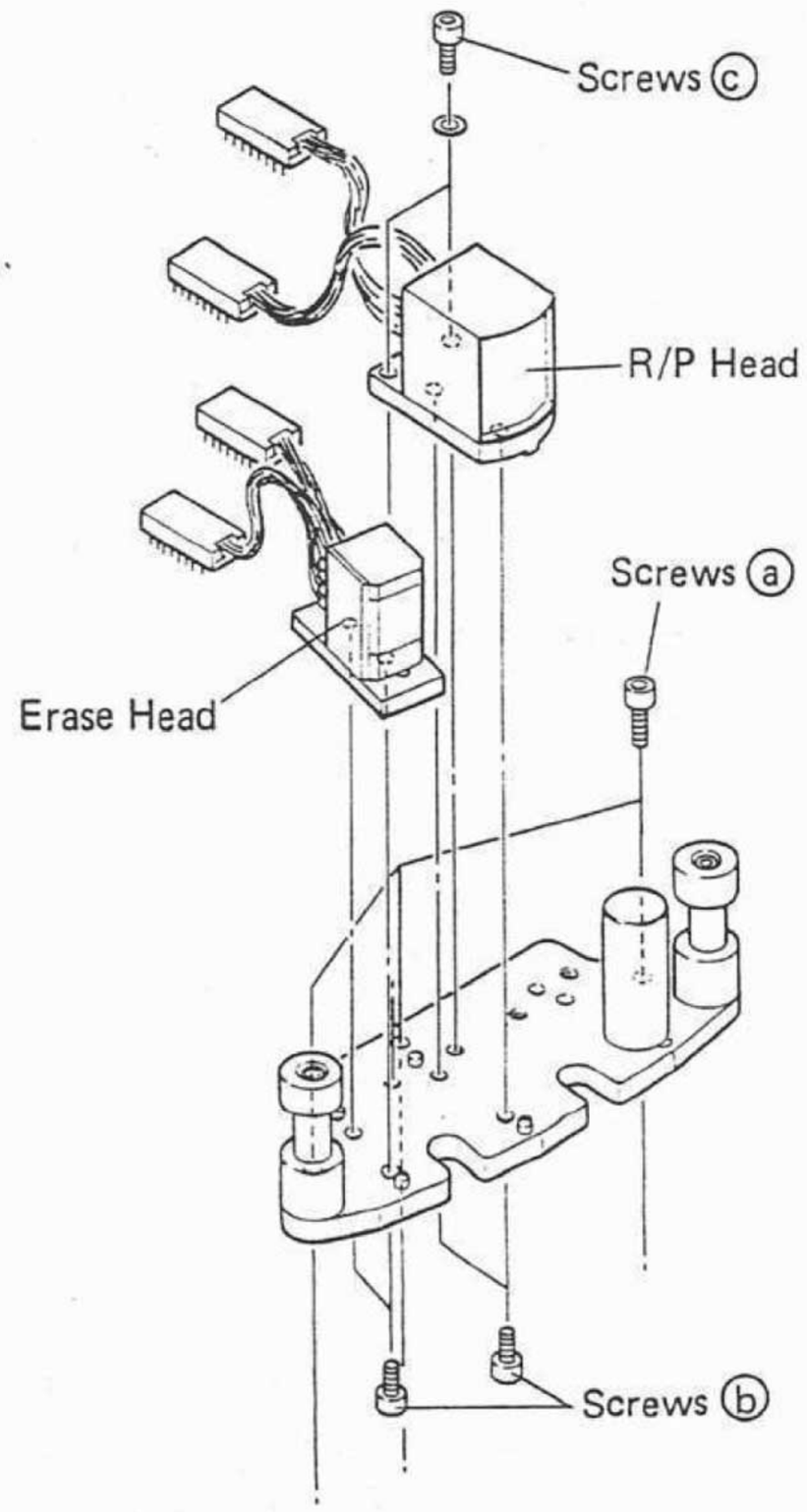


FIG. 8. HEAD REMOVAL

3-3-7. Capstan motor replacement

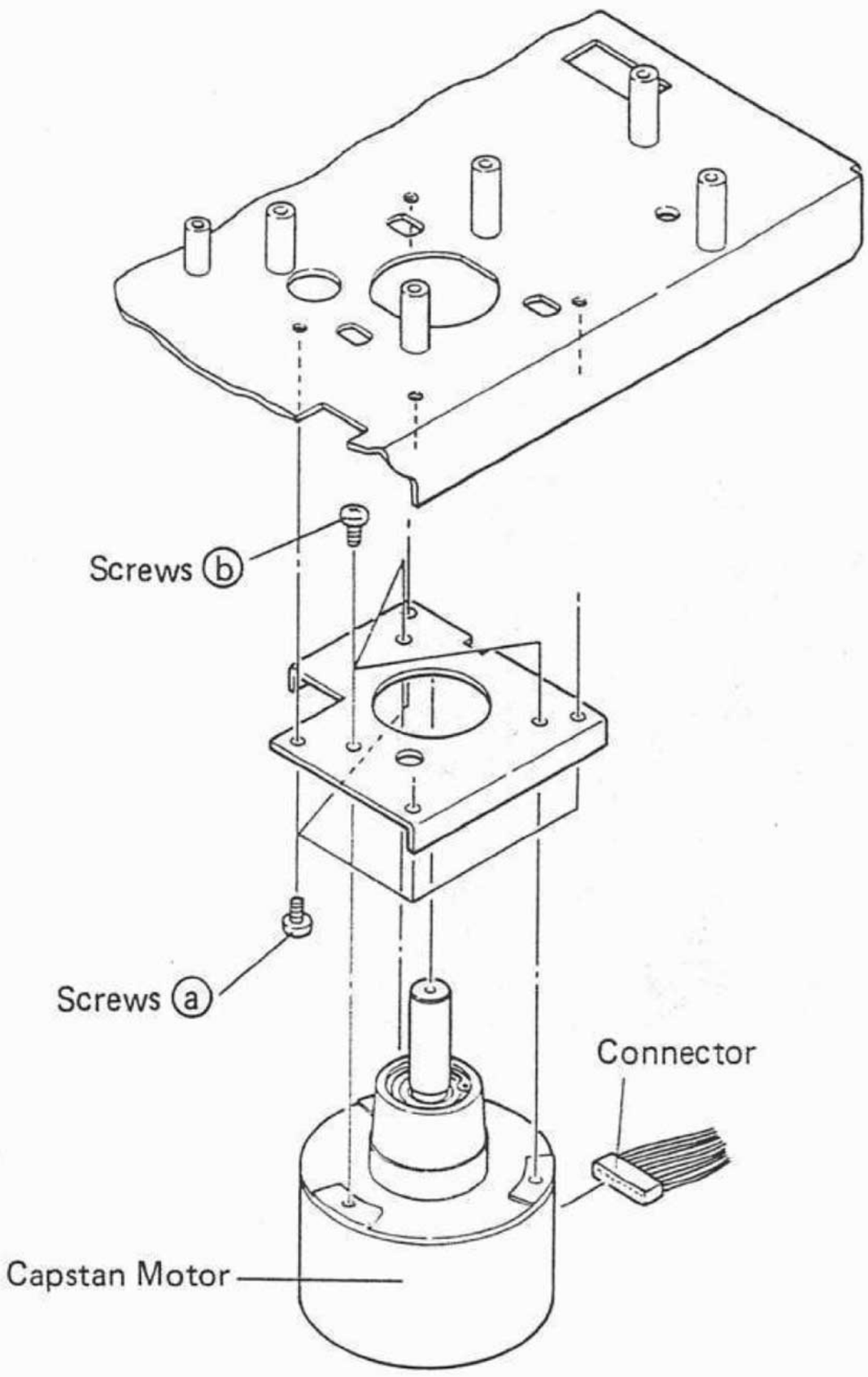


FIG. 9. CAPSTAN REMOVAL

1. Remove the rear connector panel and unplug the connector from the capstan motor.
2. Remove the four (a) screws.
3. Remove the three (b) screws and remove the capstan motor.

After replacing capstan motor, check the following:
1) Capstan servo (paragraph 3-4-9)
2) Tape speed (paragraph 3-4-6)
3) Wow anf flutter (paragraph 3-4-8)

3-3-8. Reel motor replacement

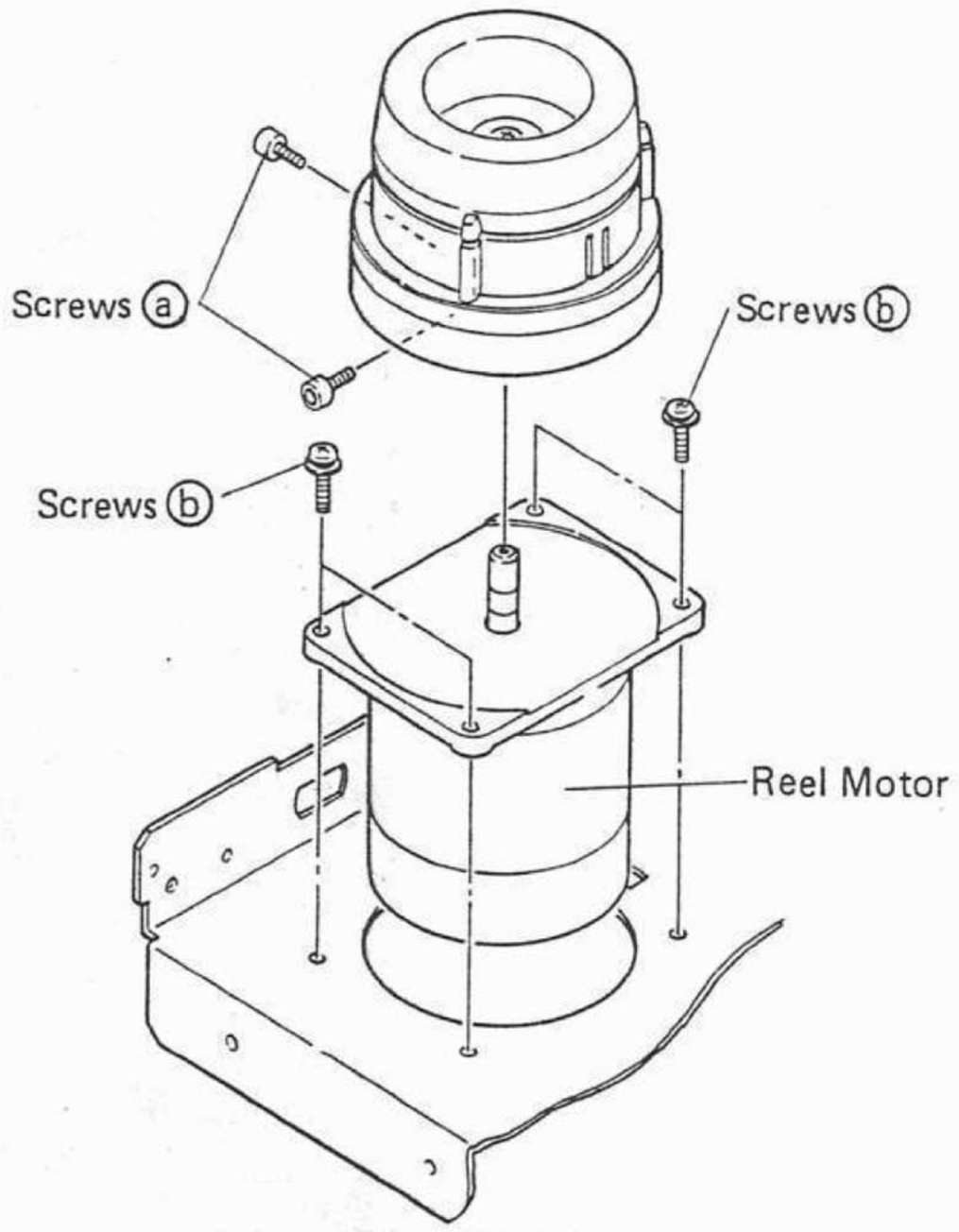


FIG. 10. REEL MOTOR REMOVAL

1. Remove the head housing, pinch roller cap, pinch roller and front panel, in this order, as in paragraph 3-3-1.
2. Remove the two (a) screws, then remove the reel table from the motor shaft.
3. Remove the four (b) screws, then remove the reel motor.

3-3-9. Fuse replacement

When fuses have blown, fix the problem before replacing them.

CAUTION: When replacing fuses, make sure that the power cord is unplugged. Be sure also to use fuses with the same specifications as the originals.

To get to the fuses, pull the control PCB toward you by referring to paragraph 3-3-10.

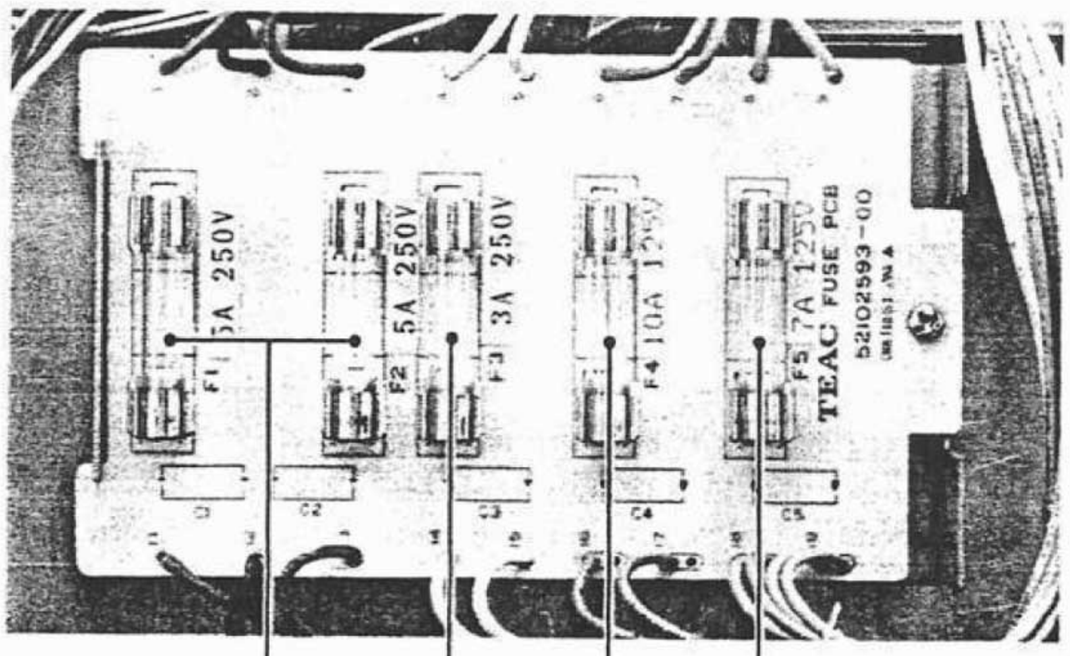


FIG. 11. FUSES

F5 (Regulated +5 V Control, VU, Amplifire, +12 V Reel Motor)
F4 (Regulated +11 V VU, Regulated +12 V Relay, SOL, +24 V Reel Motor)
F3 (Regulated +24 V Cap, Servo, Regulated +15 V Control)
F1, F2 (Regulated +12 V, -12 V Bias, Amplifier, dbx)

3-3-10. Control PCB

Remove the two screws shown in Fig. 12, slide the control PCB assembly up, then pull the assembly toward you as shown in Fig. 13.

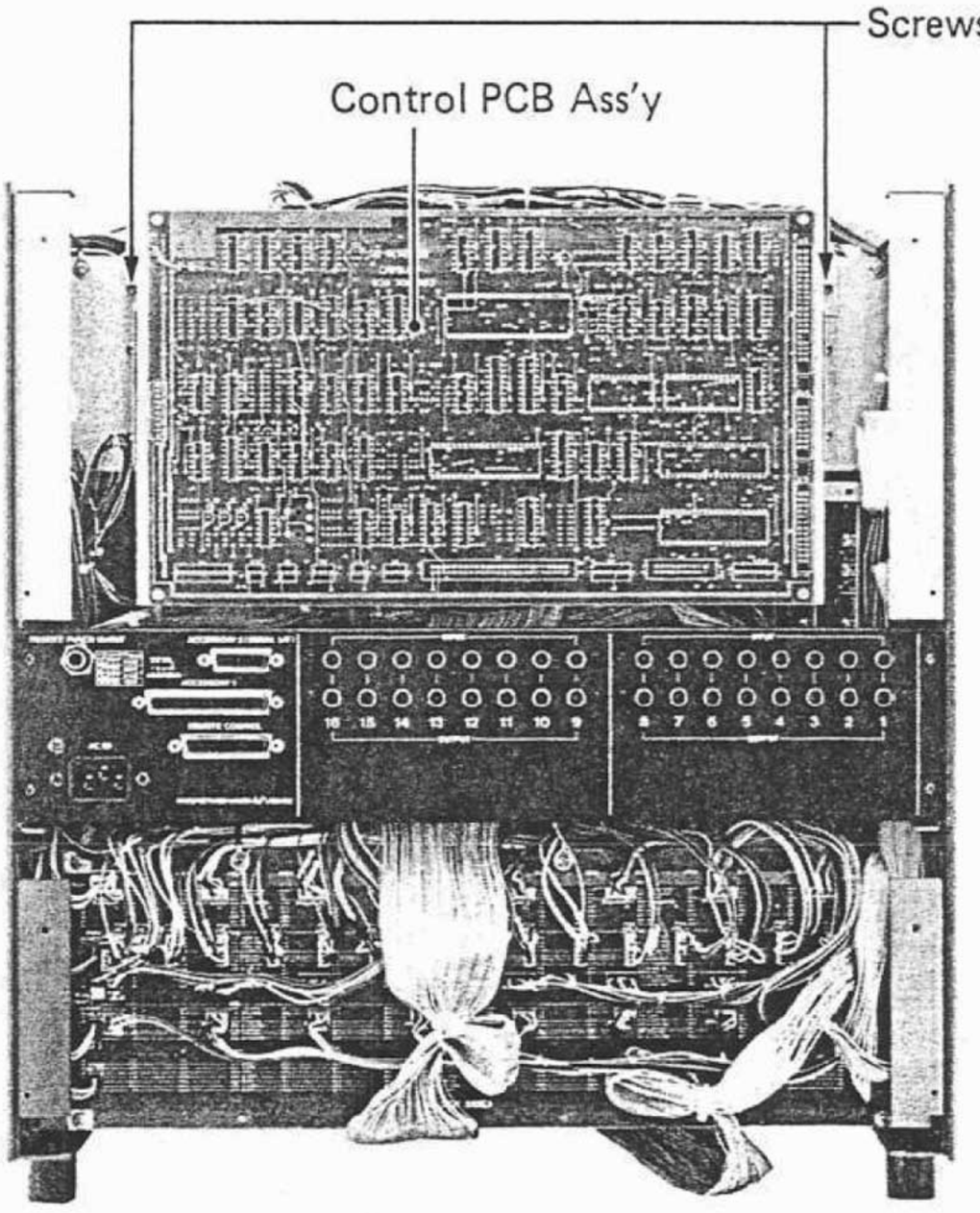


FIG. 12. CONTROL PCB INSIDE THE TOP REAR PANEL

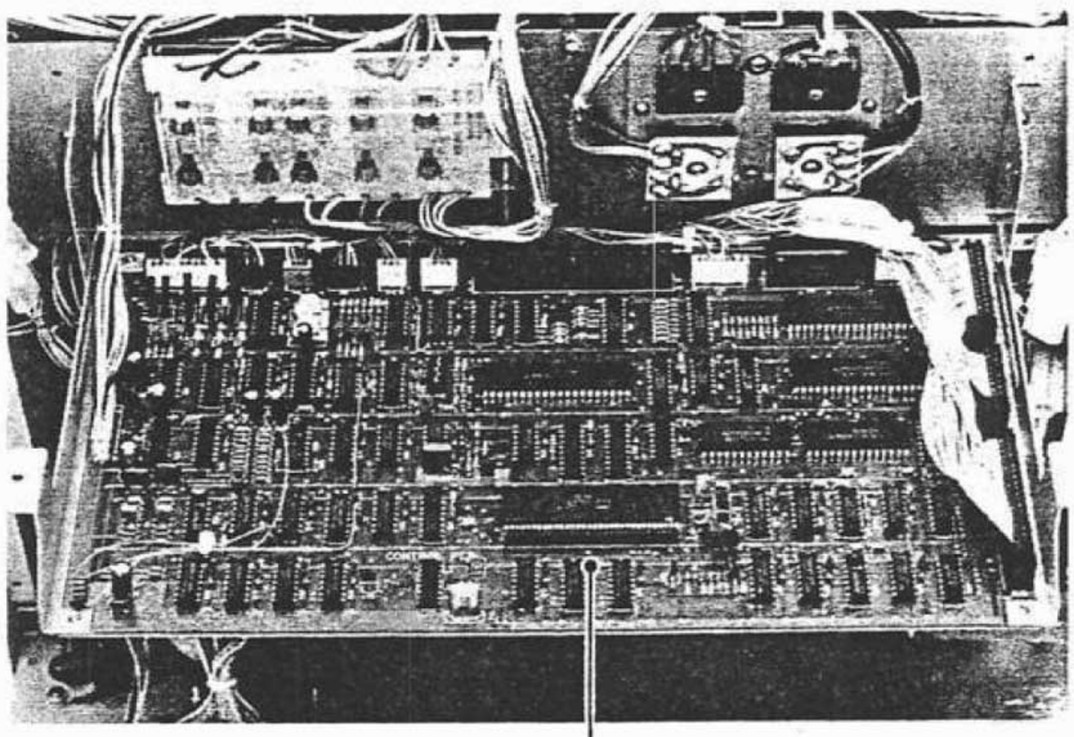


FIG. 13. CONTROL PCB PULLED TOWARD YOU

3-3-11. DBX and capstan servo PCBs

1. Remove the connector panel (see 3-3-4) and top rear panel (3-3-3), then slide the control PCB up (3-3-10).
2. Loosen the three screws shown in Fig. 14, and slide the holder plate until the cutouts in the plate line up with the PCB cards so these can be slid out.

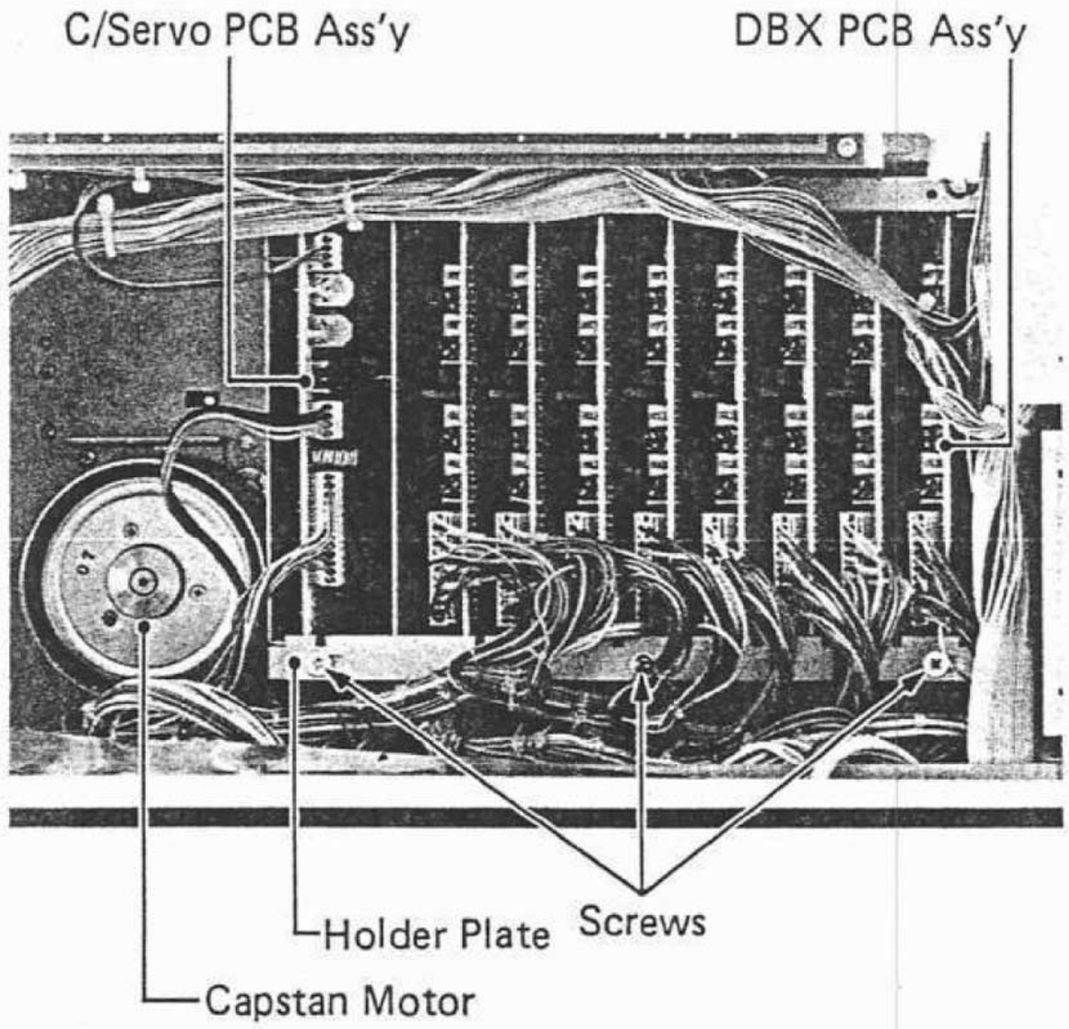


FIG. 14. REMOVAL OF DBX & CAPSTAN SERVO PCB CARDS

3-3-12. Amplifier PCBs

Remove the amplifier panel (see 3-3-2), then use the provided "card puller" (a hook) to withdraw the amplifier PCB cards.

3-4. Transport Alignment

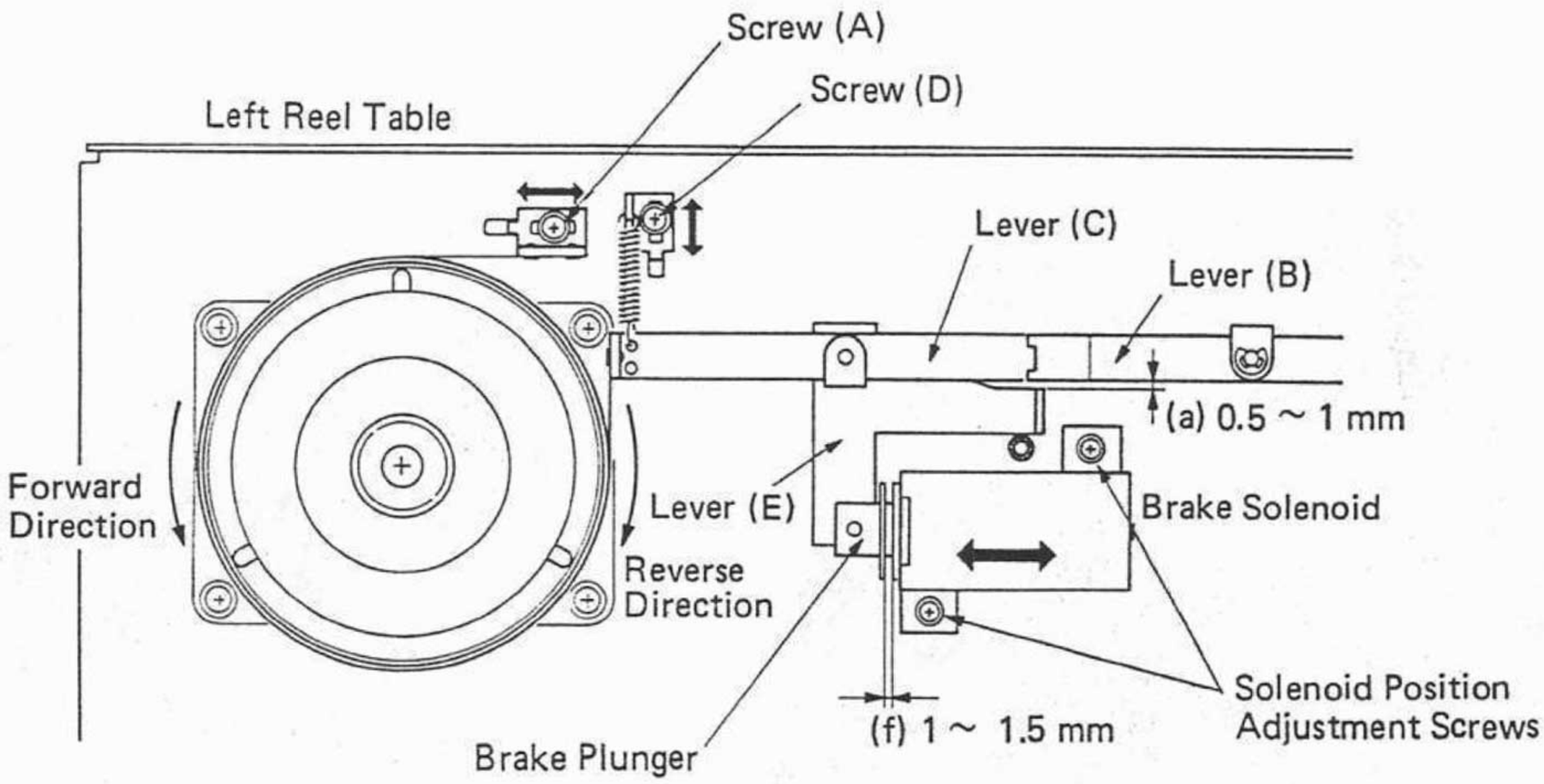


FIG. 15. BRAKE MECHANISM & TORQUE ADJUSTMENTS

3-4-1. Brake mechanism

CAUTION: Make sure that no power is applied to the deck before performing the following.

1. Refer to Fig. 15 and adjust screw (A) so clearance (a) is within 0.5 and 1 mm. If adjusting the (A) screw does not provide any clearance, it will be necessary to move the brake solenoid until gap (f) (plunger and washer distance) is within 1 and 1.5 mm.
2. Adjust screw (A) of the right brake assembly (not shown in the figure) so lever (B) is parallel to lever (C).

3-4-2. Brake torque

CAUTION: Make sure that no power is applied to the deck before performing the following.

1. Mount an empty 10-1/2" reel onto either reel table and attach a spring scale to the reel with a string. See Fig. 16.
2. Smoothly pull the scale away from the reel under test and note the torque value when the reading on the scale is steady. Take the four measurements A through D shown in Fig. 16. The proper torque values are shown below the figure.
3. If forward brake torque is not within specifications, adjust the spring hanger hooking position by loosening screw (D) shown in Fig. 15. If this adjustment has no effect or
4. If reverse brake torque does not meet specifications, perform the following:
   a) After cleaning brake belt inner side with an alcohol cleaning solution, replace brake felt pad with a new one.
   b) Recheck brake mechanism, paragraph 3-4-1.

If the above procedure has no effect, replace reel table(s).

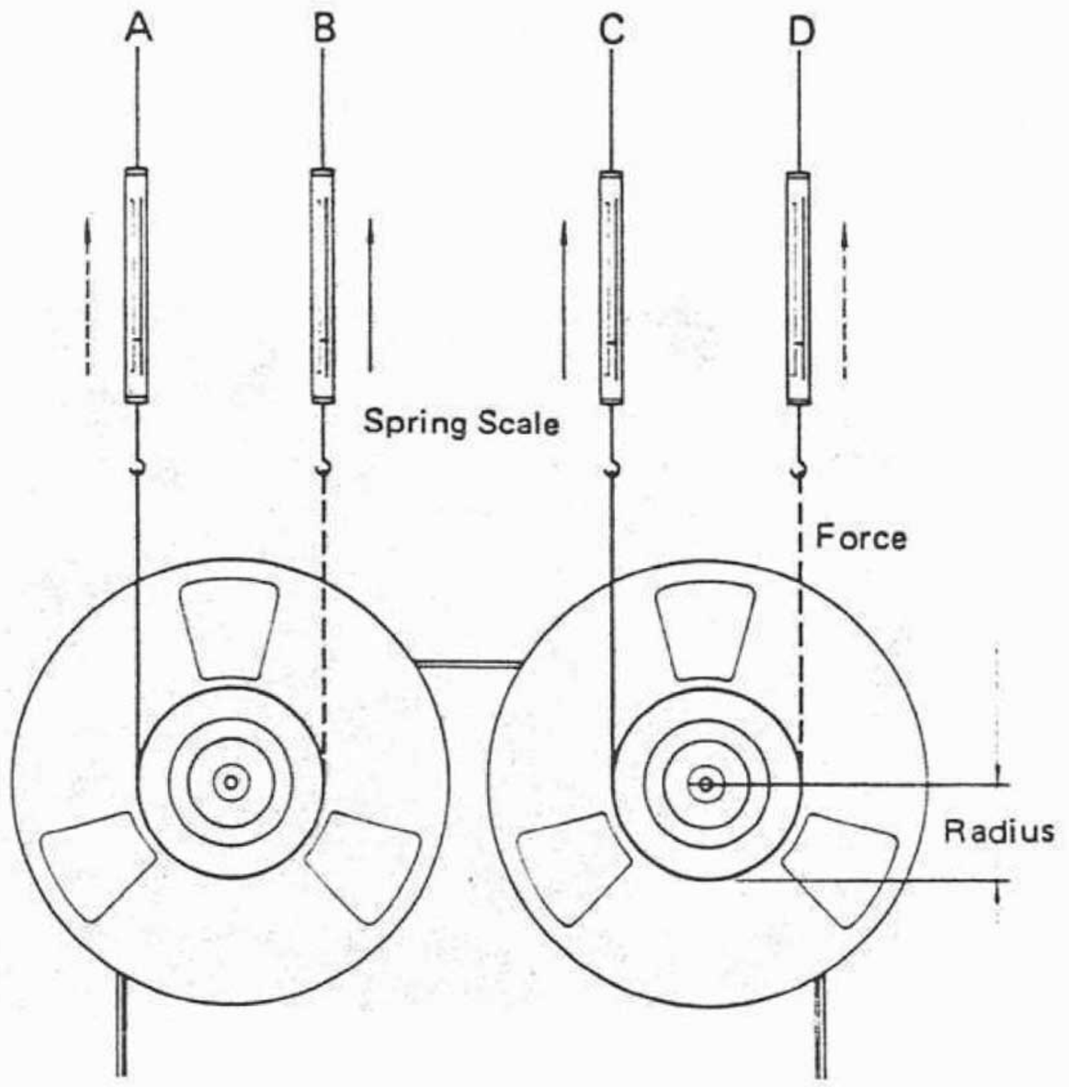


FIG. 16. BRAKE TORQUE MEASUREMENT

Forward Torque; B & C in Fig. 16	1700 – 2000 g-cm (23.6 – 27.8 oz-inch)
Reverse Torque; A & D (approx. *reference values)*	650 – 800 g-cm (9.0 – 11.1 oz-inch)

Torque calculating formulas:

1. Torque (in g-cm or oz-inch)
   = Force or Weight (in g or oz) x Radius (in cm or inch)
2. Conversion of g-cm to oz-inch:
   g-cm x 0.0139 = oz-inch

3-4-3. Pinch roller pressure

NOTE: Pinch roller pressure is supplied by the pinch roller spring arm, and it is most important that the solenoid plunger be fully bottomed before taking any pressure measurements.

1. Hold the right tension arm up with a rubber band, string, etc.
2. Place the deck in reproduce mode, without threading tape.
3. Attach a spring scale to the pinch roller as shown in Fig. 17.
4. Pull the spring scale perpendicularly to the pinch roller arm as shown in the figure below, until the pinch roller just stops turning. The scale should then read 1.0 kg to 1.6 kg (2-3/16 lbs to 3-8/16 lbs), and there should be a clearance of approx. 0.5-1 mm at "A".
5. If necessary, loosen the adjustment screws shown in Fig. 17 and move the solenoid mounting plate until pressure and tolerance "A" are both within specifications.

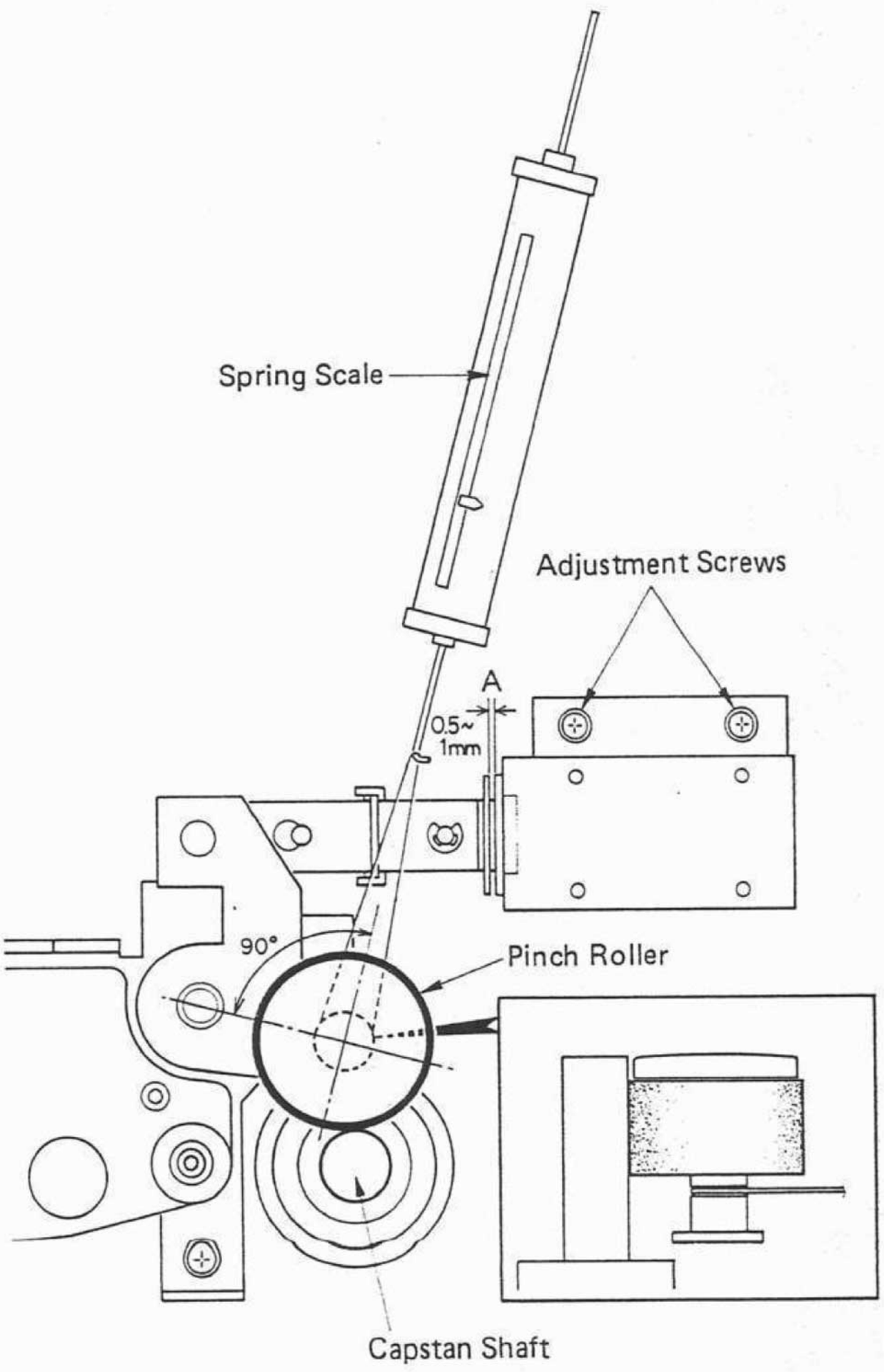


FIG. 17. PINCH ROLLER PRESSURE ADJUSTMENT

3-4-4. Tape tension servo

Tension Arm Positions and their Detection

The tape tension servo detects and controls the tape tension through either left or right tension sensor assemblies located under the front transport panel. The left and right servos function exactly the same.

The assembly includes two coils with an aluminum plate inserted between them. The aluminum plate moves as tape tension varies and, accordingly, mutual inductance between the coils varies. This causes the sensor oscillation frequency and output voltage to vary proportionately. Variation of the output voltage is used to detect the movement of the tension arm.

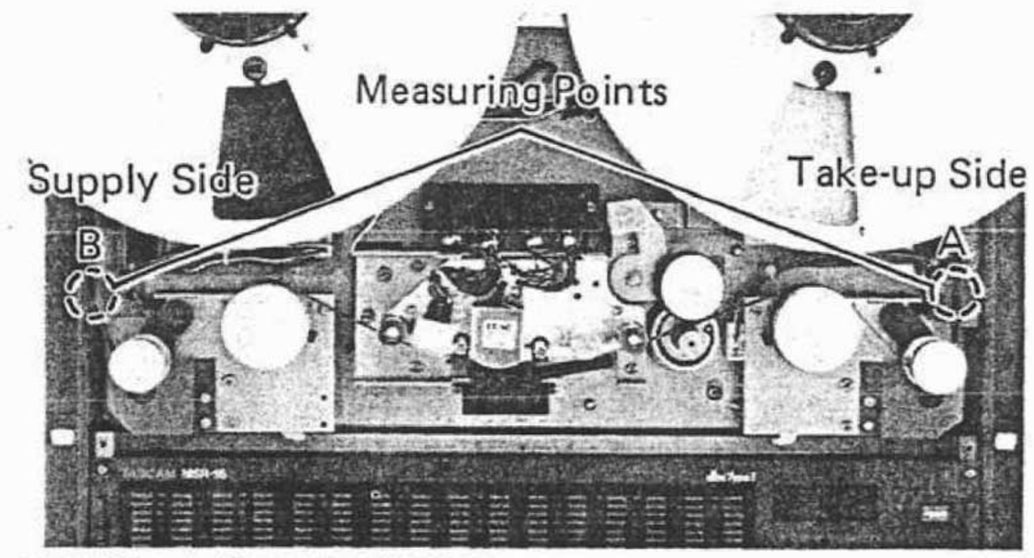


FIG. 18. TAPE TENSION MEASUREMENT POINTS

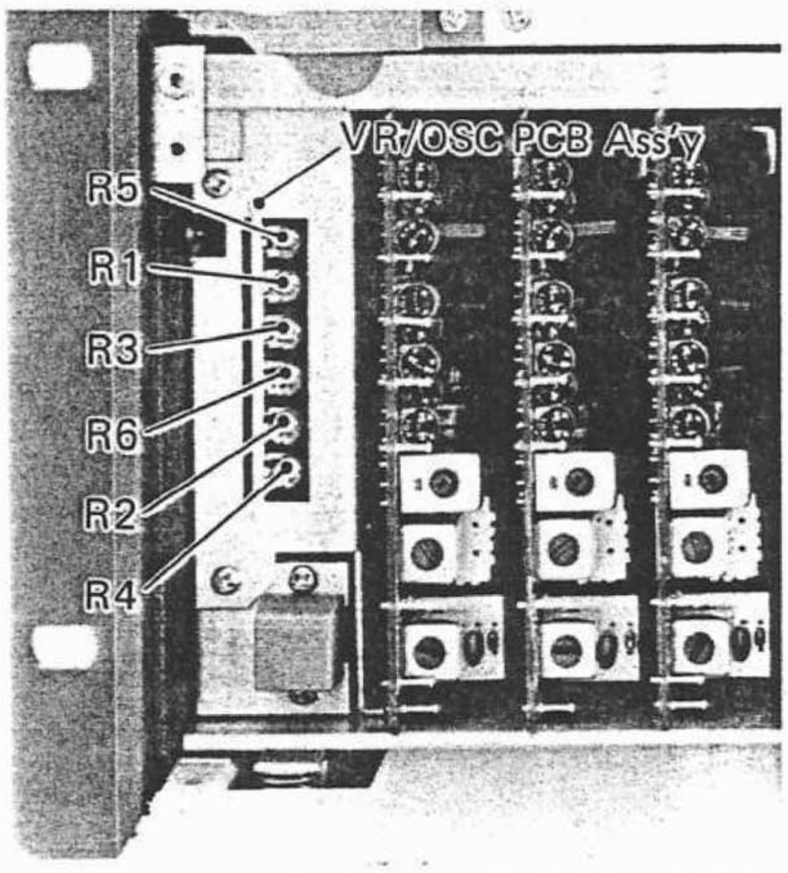


FIG. 19. TAPE TENSION ADJUSTMENT RESISTORS

FIG. 20. USING A TENTELOMETER

A. Tape Tension in Edit

1. Remove the front panel as described in 3-3-1.
2. Thread a blank tape onto the machine and wind half of the tape onto the take-up reel so that there is an equal amount of tape on both reels. Press STOP then EDIT to put the transport into Manual Edit mode.
3. Using a tension analizer or tentelometer, measure take-up tension at test point A and back tension at test point B (Fig. 18).
   Both readings should be 70 ± 5 g. If not, adjust R2 (for take-up tension) and/or R1 (for back tension). Refer to Fig. 19 for locations of adjustment resistors.

B. Tape Tension in Reproduce

1. Load a blank tape and wind half of it onto the take-up reel so that there is an equal amount of tape pack on both reels.
2. Press PLAY to roll the tape in reproduce mode.
3. While the tape is rolling in reproduce mode, take a reading from a tension analizer or tentelometer at test points A (take-up tension) and B (back tension). Both readings should be 70 ± 5 g. If either or both readings are not within the limits, adjust R4 (for take-up tension) and/or R3 (for back tension). Refer to Fig. 19 for locations of adjustment resistors.

C. Fast Winding Back Tension

1. Load a blank tape and run it to about half way so that there is an equal amount of tape pack on both reels.
2. Run the tape in F.FWD and read the tension analizer or tentelometer at the B point shown in Fig. 18. Similarly, run the tape in REW and read the tension analizer or tentetometer at the point A shown. Specifications (both in F.FWD and REW) are 60 ± 5 g. If necessary, adjust the following resistor(s):
   R5 for F.FWD Back Tension
   R6 for REW Back Tension

3-4-5. Reel table height

Reel height adjustment is required only when reel motor has been replaced or tape rubs excessively against the reel flanges.

1. Remove the front trim panel as described in paragraph 3-3-1.
2. Loosen the two set screws shown in Fig. 21.
3. Move the reel table in and out to adjust height.
4. Tighten the set screws and run tape to check the adjustment.

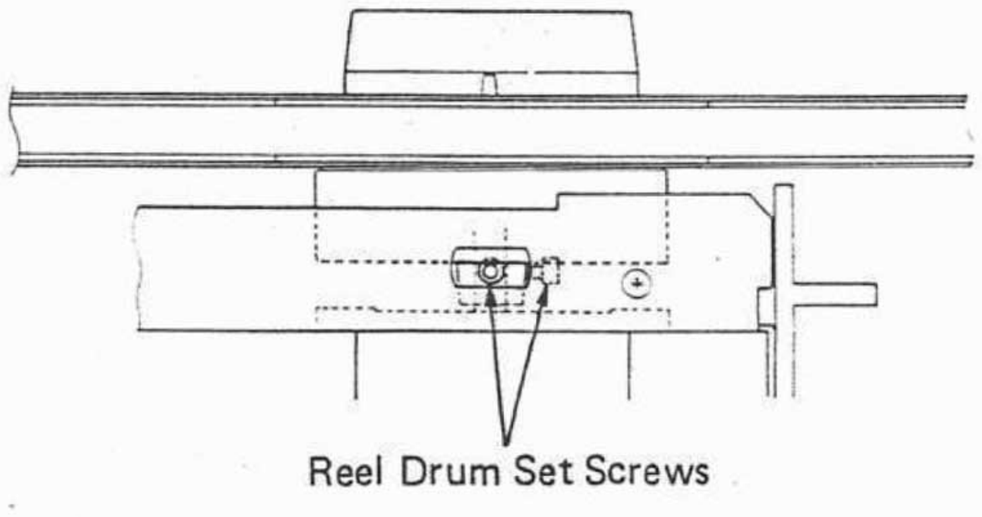


FIG. 21. REEL HEIGHT ADJUSTMENT

3-4-6. Tape speed

Tape speed is measured by using a Flutter Test Tape containing a highly accurate, continuous 3 kHz tone.

A. "FIX" Tape Speed

1. Connect a digital frequency counter to any OUTPUT, set the SPEED MODE switch on the deck to FIX.
2. Playing the beginning of the test tape, check for 3000 Hz ±0.2 % on the frequency counter. Then fast forward the tape, stop it when its end nears, and play it back to check that the deck output is within the limits as before.
3. If limits are exceeded, check pinch roller pressure and takeup tension, and clean tape path.

B. "VARI" Tape Speed

CHECK

1. Make the following settings:
   SPEED MODE switch to VARI;
   PITCH CONTROL knob to center;
   DISPLAY switch for "% of tape speed change" display.
2. Run the appropriate test tape in PLAY and check for 00.0 (%) in the counter display window. Then turn the PITCH CONTROL knob fully left to check that the percentage reading drops to −15 (or lower), and turn the knob fully right to check that the reading goes up to +15 (or higher). If readings don't meet specifications, proceed as follows:

ADJUSTMENT

1. Check to make sure that the deck is set as in step 1 under the previous paragraph, CHECK.
2. Open the amp panel (refer to paragraph 3-3-2).
3. Locate R5 and R6 on the DISPLAY PC Board (refer to Fig. 22) and set them to mechanical center.
4. Run the tape in PLAY and, while it plays, adjust R5 for less than 1% display, then adjust R6 for 00.0% display.

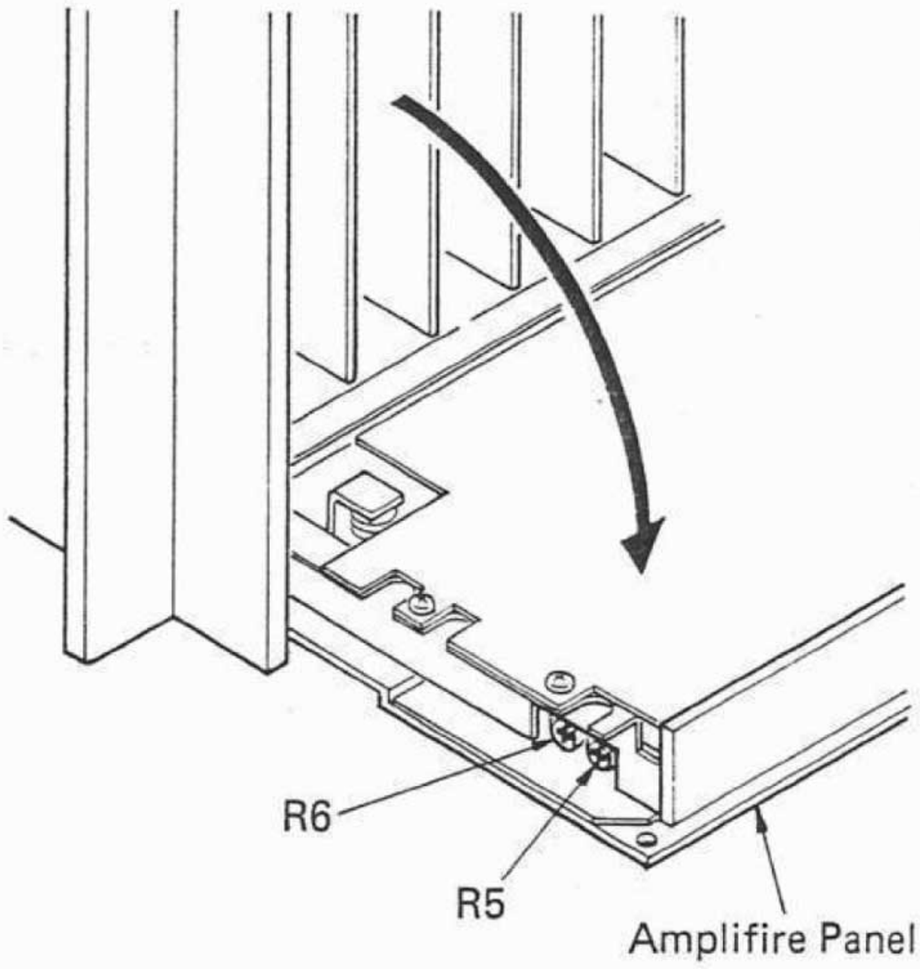


FIG. 22. "VARI" SPEED ADJUSTMENTS

3-4-7. Tape travel

After replacement or adjustment of heads, tension arm, pinch roller, capstan motor shaft or any other parts that contact tape, it is essential to check for correct tape travel.
To check tape travel, run tape in PLAY to see whether or not the tape rubs on the lower flange of the left and right tape guides. Repeat the check in F.FWD and REW also. If adjustments are necessary, proceed as follows:

1. Using a good cleaner, thoroughly clean pinch roller, capstan shaft and all other parts in the tape path.
2. Remove the left tape guide cap using a 3-mm hex wrench. Unscrew the left tension roller cap by turning it counterclockwise with your fingers.
3. Run the tape in PLAY and turn the adjustment screw located in the top center of the left tension roller in and out so the tape's lower edge nearly touches the left tape guide lower flange (no tape curl must be observable).
4. Replace the two caps.
5. Similarly, remove the cap from both the right tape guide and right tension roller, and run the tape in Reverse Spool mode to adjust the right tension roller height.
6. Replace the caps.

After performing the above steps, be sure to check for correct height of both the left and right reel tables (paragraph 3-4-5).

NOTE: Upon completion of adjustments, be sure to check head azimuth by referring to paragraph 3-5-1.

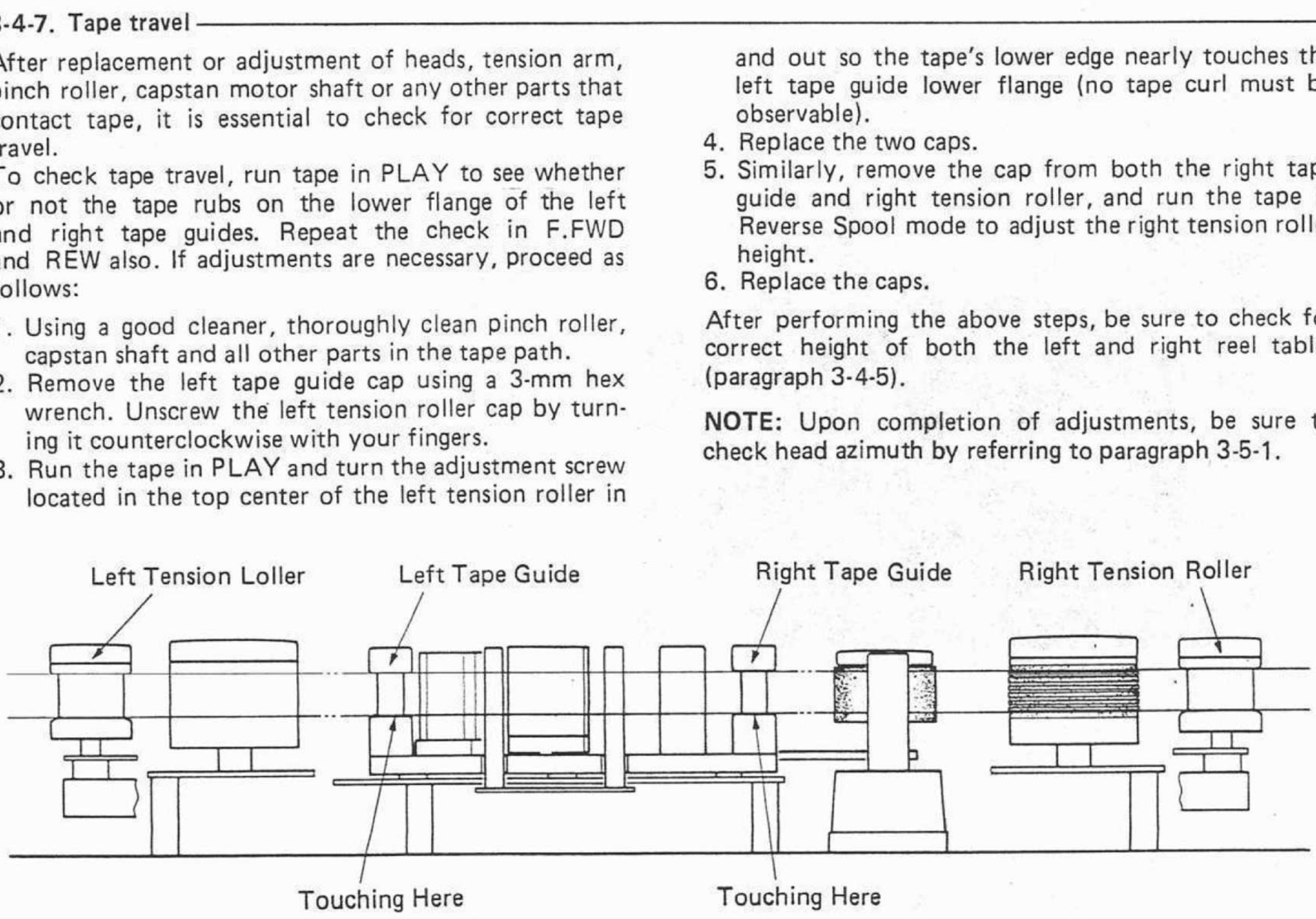


FIG. 23. TAPE POSITIONING

3-4-8. Wow and flutter (reproduce method)

1. Connect a wow and flutter meter to any channel's OUTPUT jack on the deck. Set the wow and flutter meter for "weighted" readings. Check to make sure that the meter is properly calibrated.
2. Playback the appropriate wow and flutter test tape, at normal "FIX" speed.
3. Read the wow and flutter meter. Values should be as follows:

   DIN/IEC/ANSI (Peak Value, Weighted)
   HIGH Speed: ±0.08%
   LOW Speed: ±0.09%

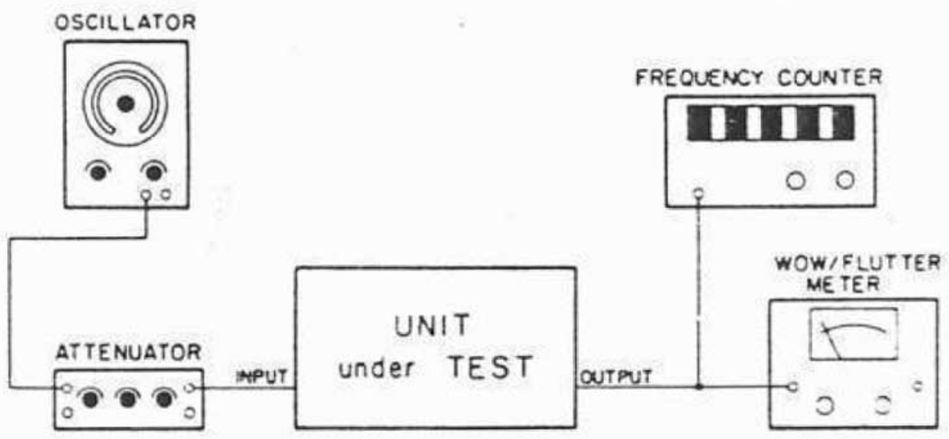


FIG. 24. WOW AND FLUTTER MEASUREMENT SET-UP

NOTE: As the measured results may vary with respect to the location on the tape at which the measurement is taken, at least two locations — the beginning and end of the tape — should be checked. There may also be a slight difference in measured absolute values, depending on the brand of meter being used.

3-4-9. Capstan servo

1. Load a blank tape, and set the TAPE SPEED selector switch to HIGH for 15 ips (38 cm/sec.) speed.
2. Locate S2 switch on the control PCB and pull out the jumper plug to reinsert it into position 2, as shown in Fig. 26.

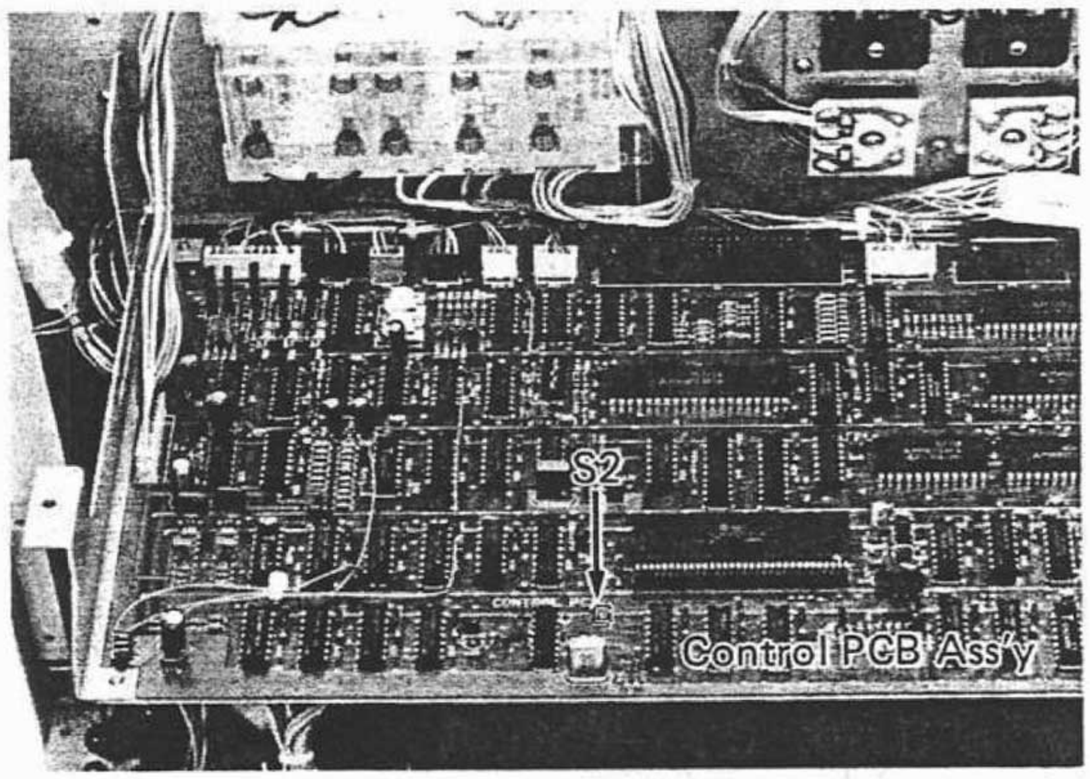


FIG. 25. SWITCH S2 LOCATION

3. Connect an oscillator to the S2's pin indicated below.

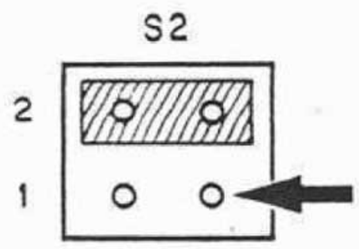


FIG. 26. OSCILLATOR CONNECTING POINT

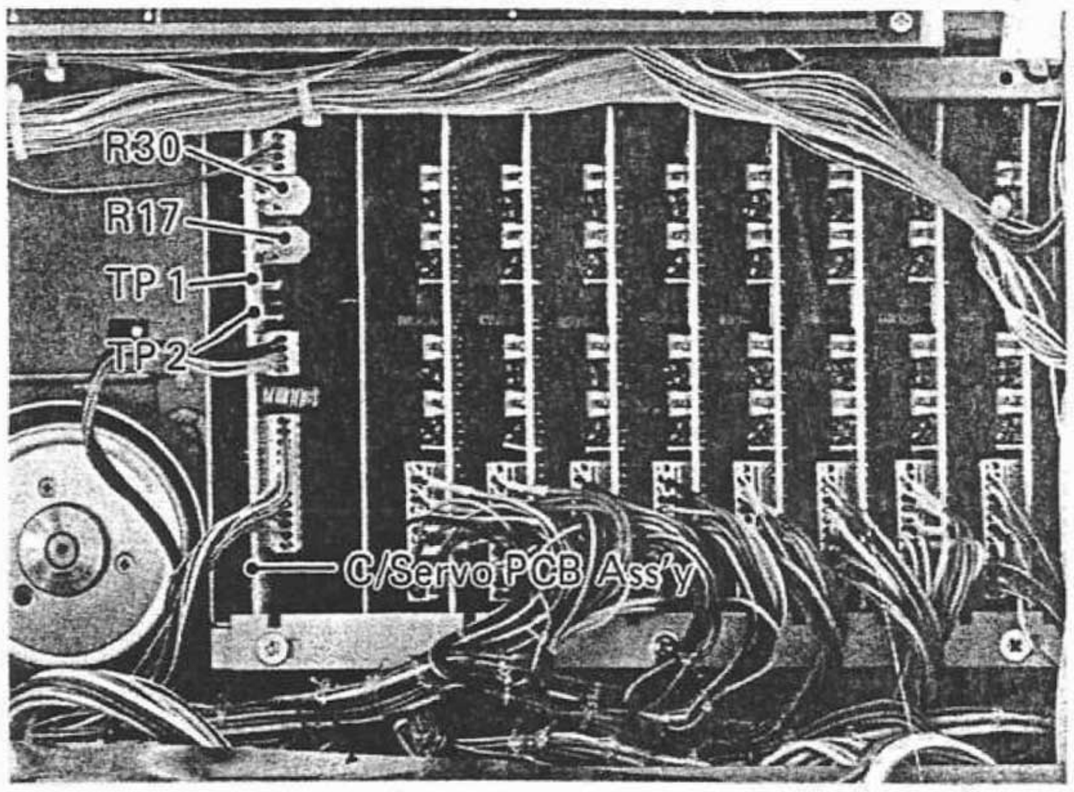


FIG. 27. CAPSTAN SERVO ADJUSTMENTS & TEST POINTS

4. Locate test point TP1 on the capstan servo PCB and connect an oscilloscope to TPI.
5. Locate R30 (5KB) on the capstan servo PCB and set that provisionally to center.
6. Run the tape in PLAY and set the oscillator so it provides a square wave signal of 1200 Hz (any voltage within 5 to 10 V).
7. Watching the scope adjust R17 (20KB) (on the capstan servo PCB) until the TP1 signal shows a duty factor of 25 % (approximate).

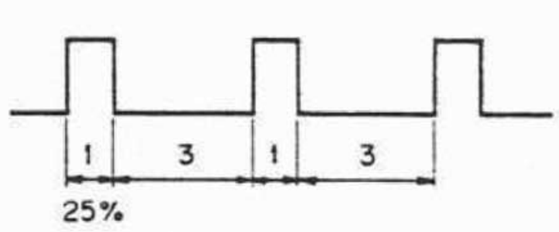


FIG. 28. R17 ADJUSTMENT

8. Change the signal frequency to 1560 Hz and adjust R30 until the duty factor of TP1 signal is 10 %
9. Change the frequency back to the reference 1200 Hz and adjust R17 for 50 % duty factor at TP1.
10. Change the frequency to 720 Hz then 1560 Hz, to check to see that the servo is locked. If it becomes unlocked at 720 Hz, adjust R30 (5KB) for 90 % duty factor, then recheck.

Be sure to replace the jumper plug to its original position upon completion of adjustments.

3-5. Audio Alignment

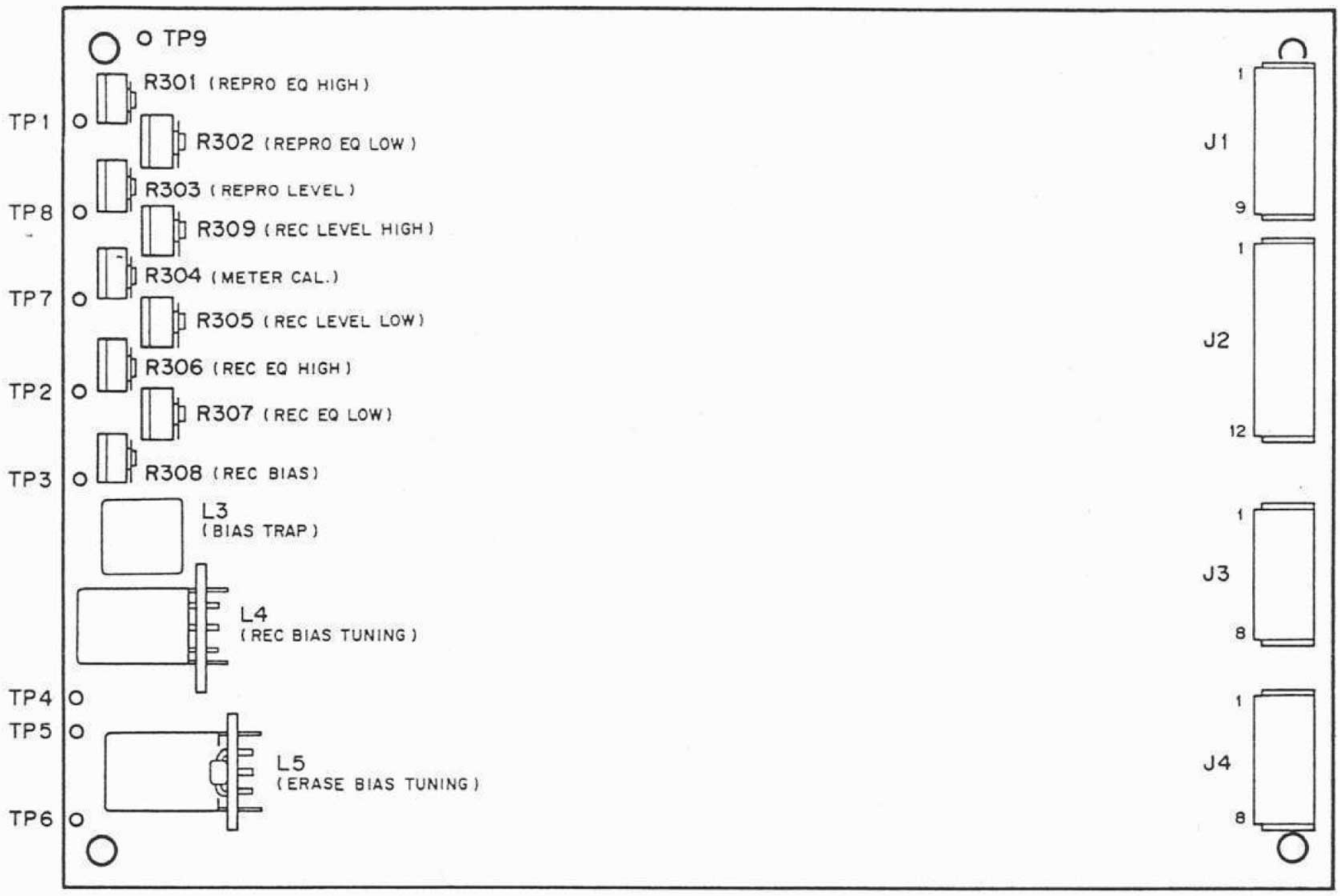


FIG. 30. LOCATIONS OF ELECTRICAL ADJUSTMENTS & TEST POINTS

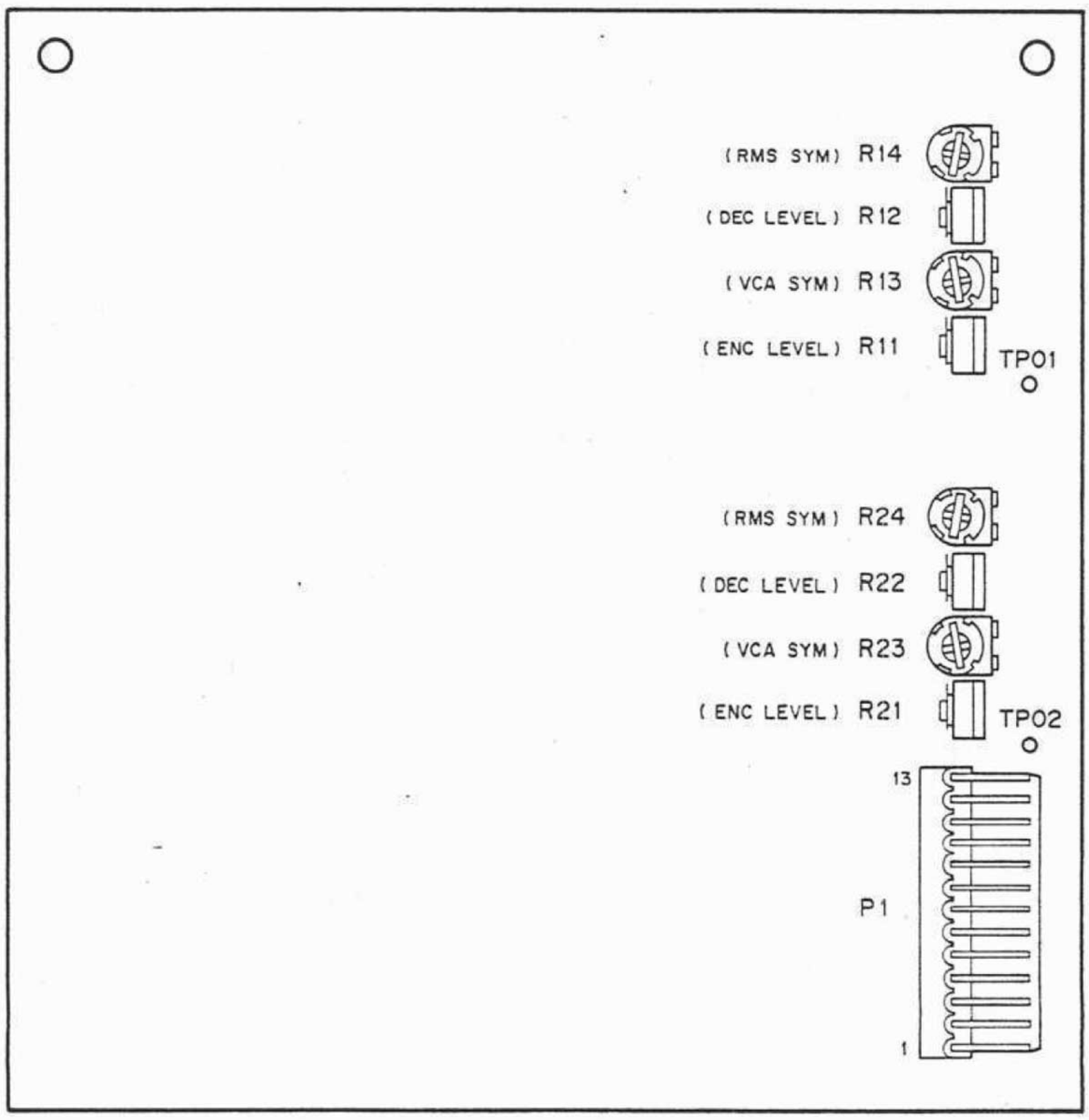


FIG. 31. DBX ADJUSTMENTS & TEST POINTS

3-5-1. Preliminary procedure (Head azimuth adjustment)

Before proceeding to audio alignment, be sure to check and adjust head azimuth as follows (only the record/repro head need be checked and adjusted; the erase head is fixed and has no adjustment):

A. CHECK

1. Make sure that tape runs at the proper height (see paragraph 3-4-7).
2. Connect the output of channel 2 to the vertical (y-axis) input terminal of an oscilloscope and the output of channel 15 to the horizontal (y-axis) input terminal of the scope. Also connect an AC voltmeter in parallel to the scope, to monitor the channels' output level.

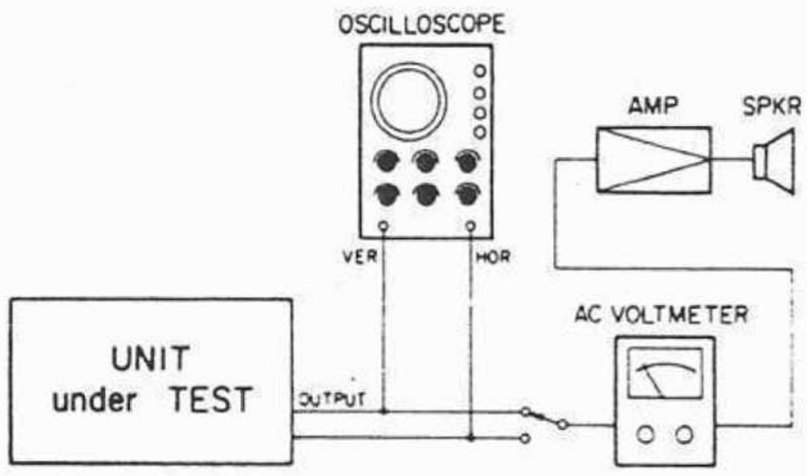


FIG. 32. HEAD AZIMUTH TEST SET-UP

3. Load the appropriate test tape (refer to page 7) and reproduce its 1 kHz and 10 kHz signals at HIGH speed, to check for less than 45° phase descripancy between the two channel outputs as seen on the scope. Then, slowly press the running tape against the record/repro head to make sure that there is no play between the tape and head and therefore the voltmeter reading does not rise any further. If adjustment is necessary, proceed as follows:

B. ADJUSTMENT

1. Reproduce the 1 kHz and 10 kHz signals contained in the test tape as before.
2. Adjust the azimuth adjustment screws shown in Fig. 33 (by slightly loosening one while tightening the other, alternately) for less than 45° phase descripancy between the channels as seen on the scope and, at the same time, for maximum reading on the voltmeter.
3. Upon completion of adjustments, retighten the two adjustment screws, evenly. Watch the oscilloscope to be sure that the adjustment you've achieved is not undone by unevenly retightening the screws.

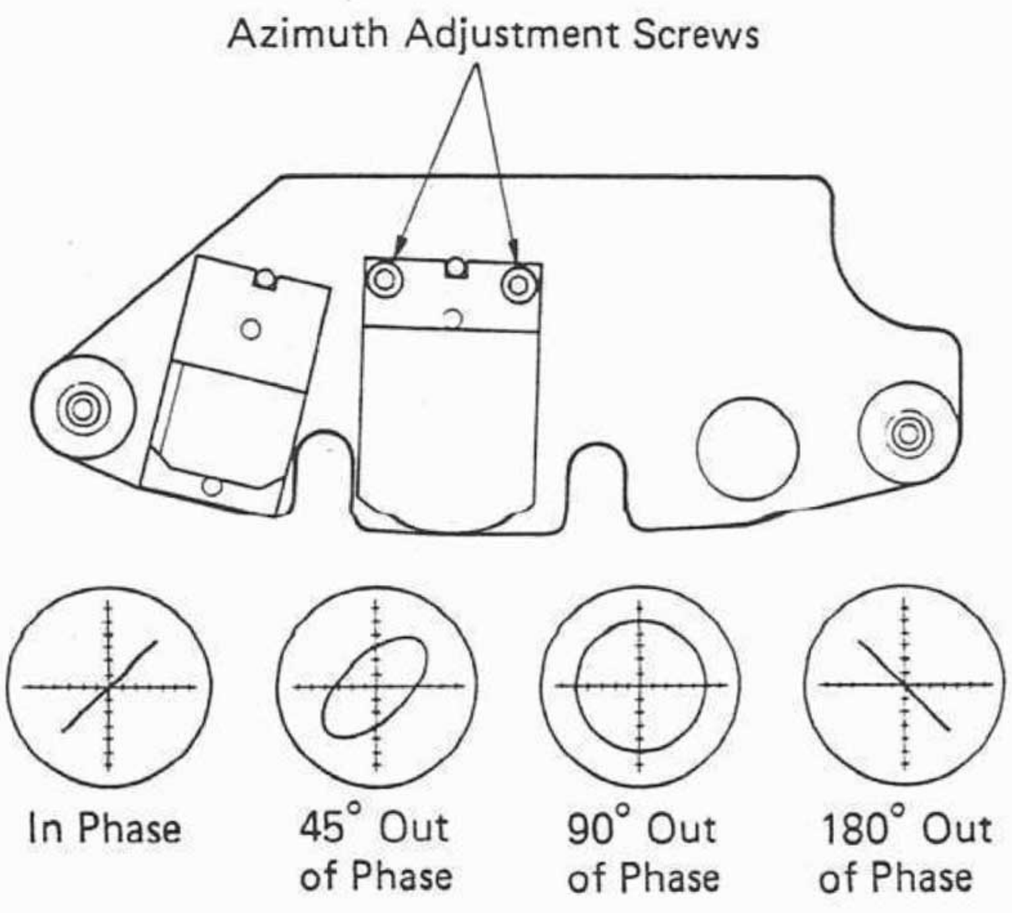


FIG. 33. HEAD AZIMUTH ADJUSTMENTS

Once head azimuth is aligned, you are ready to move on to electronics adjustments. Observe the following:

— Perform each check (and adjustment when necessary) for channel 1 first, then repeat procedure for all the remaining channels.
— Before removing and reinstalling any PCB cards, check to make sure that power is turned off.

In the following, 0 dBV is referenced to 1 V.

3-5-2. Input level check

1. Connect test equipment to the channel 1 input and output jacks of the deck as shown in Fig. 34.
2. Set the oscillator to apply a 1 kHz, –10 dBV (316 mV), and engage ALL INPUT.
3. Check for -10 dBV (316 mV) on the AC voltmeter.
4. Repeat procedure for the remaining channels.

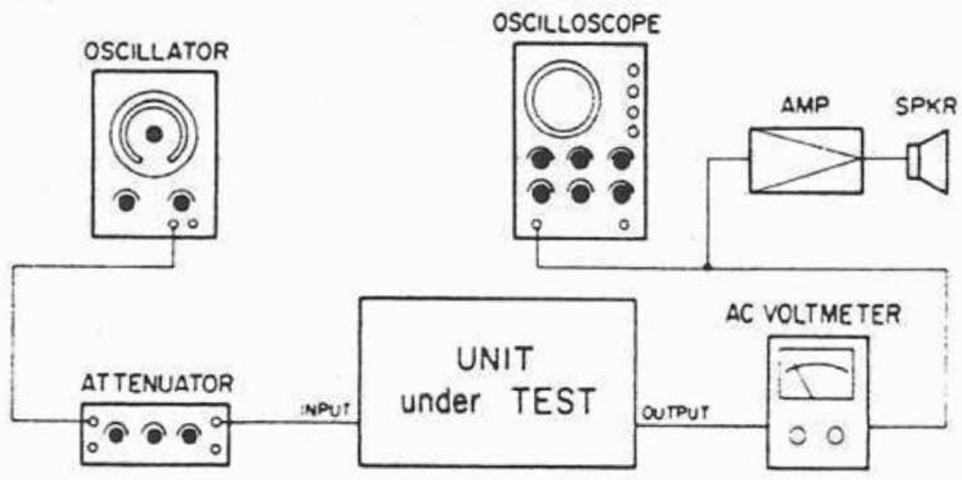


FIG. 34. SET-UP FOR LEVEL & FREQUENCY RESPONSE CHECKS

3-5-3. Meter setting (input signal reading)

1. Apply the nominal –10 dBV level to input jacks and check that the corresponding channels' LED meters read 0 dB. If not, proceed to the next step.
2. Locate R304 on the R/P AMPL PCB of channel being checked and adjust R304 until the meter reads 0 dB.

3-5-4. Reproduce level

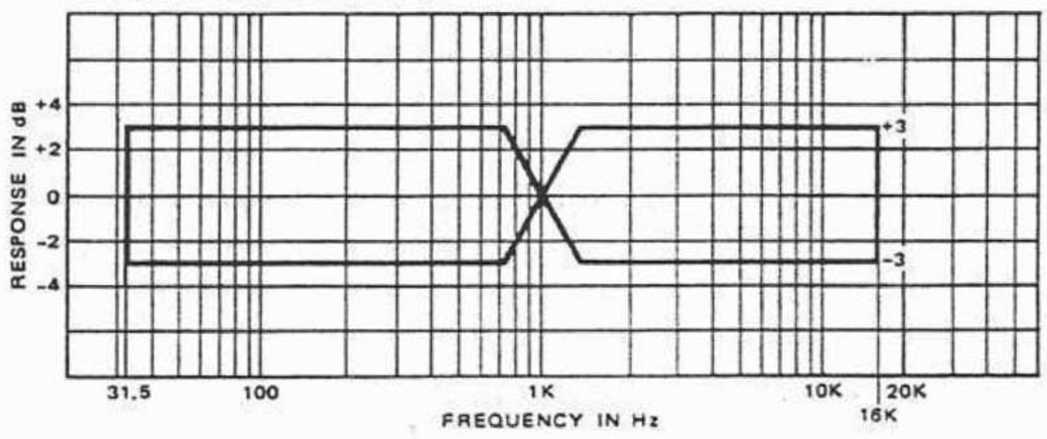
1. If the ALL INPUT is engaged (LED on), release it (LED off).
2. Load a reproduce alignment test tape for HIGH speed use (refer to page 7) and reproduce the 1 kHz signal contained in the tape, to check for –10 dBV (316 mV) on the AC voltmeter connected to the channel 1 output jack of the deck. Also check that the LED meter on the deck reads 0 dB. If necessary, adjust R303 on the R/P AMPL PCB of the channel concerned.
3. Repeat procedure for the remaining channels.

3-5-5. Reproduce frequency response

1. Load the appropriate test tape (refer to page 7) on the deck.
2. Check to make sure that ALL INPUT is not engaged (LED off), then press PLAY.
3. Measure the output signal and check that the frequency range is within the limits shown in Fig. 35. If necessary, adjust the following pots on the R/P AMPL PCBs:
   R301 for response at HIGH;
   R302 for response at LOW.

   If adjustments of the pots have no effect, perform the following:
   a. If specific channel or channels don't meet specifications, replace the R/P AMPL PCB of the corresponding channels.
   b. If all the channels don't meet specifications, check power supplies, head alignment, and clean and demagnetize tape path. If, for all that, every channels remain out of specs, the record/repro head must be replaced.

LOW Speed (7.5 ips)



HIGH Speed (15 ips)

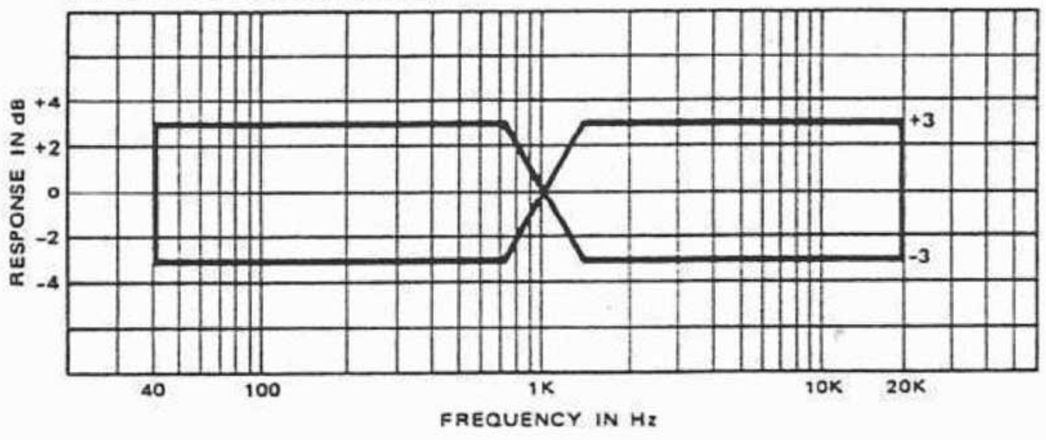


FIG. 35. REPRODUCE FREQUENCY RESPONSE

3-5-6. Bias tuning and bias trap adjustments

Generally, erase bias tuning need be adjusted only when erase head is replaced, and record bias trap only when R/P AMPL PCBs or record/repro head are replaced.

Precautions

Observe the following:
- Be sure to use a non-conductive screwdriver (i.e., wooden, plastic).
- For bias level measurements (paragraph 3-5-7), use an AC voltmeter whose input has a floating capacitance of less than 100 pF.

A. ERASE HEAD BIAS TUNING (L5)

CAUTION: Do not short-circuit between TP-6 and GND during the following procedure.

1. Connect a DC voltmeter between TP-5 (Hot) and TP-6 (Cold) on the CH 1 R/P AMPL. PCB.
2. Press the "Rec Function" switch of channel 1 then the master RECORD and PLAY buttons to initiate Record mode.
3. Use an insulated screwdriver to adjust L5 on the same amplifier PC board until the DC meter shows minimum reading.
4. Repeat the procedure for the remaining channels.

B. RECORD HEAD BIAS TUNING (L4)

CAUTION: Do not short-circuit between TP-6 and GND during the following procedure.

1. Connect a DC voltmeter between TP-4 (Hot) and TP-6 (Cold) on the CH 1 R/P AMPL. PCB.
2. Press the "Rec Function" switch of channel 1 then the master RECORD and PLAY buttons to initiate Record mode.
3. Turn R308 on the R/P AMPL. PCB fully clockwise.
4. Use an insulated screwdriver to adjust L4 on the same amplifier PC board until the DC voltmeter shows minimum reading.
5. Repeat the procedure for the remaining channels.

C. RECORD BIAS TRAP (L3)

1. Connect an AC voltmeter between TP-3 and TP-9 (GND) on the CH 1 R/P AMPL. PCB.
2. Press the channel 1 "Rec Function" switch then the master RECORD and PLAY buttons to initiate Record mode.
3. Adjust L3 on the CH 1 R/P AMPL. PCB for minimum reading on the voltmeter.
4. Repeat the procedure for the remaining channels.

3-5-7. Record bias adjustment

1. Load a blank test tape YTT-8163 on the deck.
2. Set the TAPE SPEED selector switch to LOW.
3. Connect an AC voltmeter between TP-1 and TP-9 on the R/P AMPL. PCB.
4. Initiate Record mode.
5. Adjust R308 on the R/P AMPL. PCB for a 23 mV ±2 mV reading on the voltmeter.

3-5-8. Record level

The following procedure MUST be performed AFTER completion of the bias adjustment.

1. Set the TAPE SPEED selector switch to LOW.
2. Connect test equipment to the tape deck as in paragraph 3-5-2.
3. Apply a 1 kHz, −10 dBV (316 mV) signal to the channel 1 INPUT jack.
4. Load a blank test tape YTT-8163 on the deck.
5. Record the 1 kHz, −10 dBV signal. Then rewind the tape and play the recording, to check for −10 dBV (316 mV) at the OUTPUT jack. If necessary, adjust R305 on the R/P AMPL. PCB.
6. Set the TAPE SPEED selector switch to HIGH and repeat procedure. If necessary adjust R309.
   Check and adjust all the channels in the same way.

3-5-9. DBX IN/OUT level

When record level is adjusted (paragraph 3-5-8), perform the following:

1. Connect a 1 kHz, –10 dBV (316 mV) signal to the INPUT jack of channel 1.
2. Record the input signal on a blank tape, first with the DBX switch (1-8) turned on, then with the DBX switch turned off.
3. Rewind the tape and play the recording, to check that the OUTPUT level from the recording made with DBX is -10 dBV ±0.5 dB, and the level from the recording without DBX is exactly -10 dBV.
4. Similarly, check the remaining channels.

3-5-10. Overall frequency response

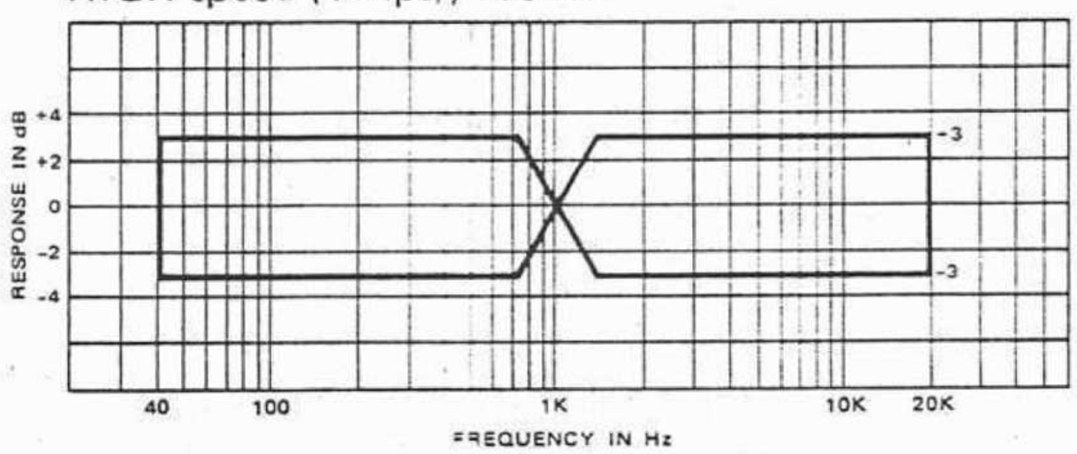
HIGH SPEED

1. With the same connections as in paragraph 3-5-8, change the input signal to 20 kHz, –10 dBV (316 mV) and connect this signal to channel 1 INPUT jack.
2. Making sure that the TAPE SPEED selector switch is set to HIGH, record the input signal, then rewind the tape and play the recording, to check for –10 dBV (316 mV) at the channel 1 OUTPUT jack. If necessary, adjust R306 on the R/P AMPL. PCB.
3. Initiate again record mode and sweep the signal frequency over the range of 40 Hz to 20 kHz. Then rewind the tape and play the recording. Measure the output level over the specified frequency range and check that the level falls within ±3 dB (without DBX). (With DBX, the tolerance is ±6 dB.) There is no adjustment.

LOW SPEED

4. Set the TAPE SPEED selector to LOW, change the input signal to 16 kHz, –20 dBV (100 mV), initiate record mode, rewind the tape, and play the recording, to check for –20 dBV at the OUTPUT jack. If necessary, adjust R307 on the R/P AMPL. PCB.
5. Initiate again record mode and sweep the signal frequency over the range of 30 Hz to 16 kHz. Then rewind the tape and play the recording. Measure the output level over the specified frequency range and check that the level falls within ±3 dB (without DBX). (With DBX, the tolerance is ±6 dB.) There is no adjustment.
6. Repeat the procedure for the remaining channels.

HIGH speed (15 ips), -10 VU



LOW speed (7.5 ips), -20 VU

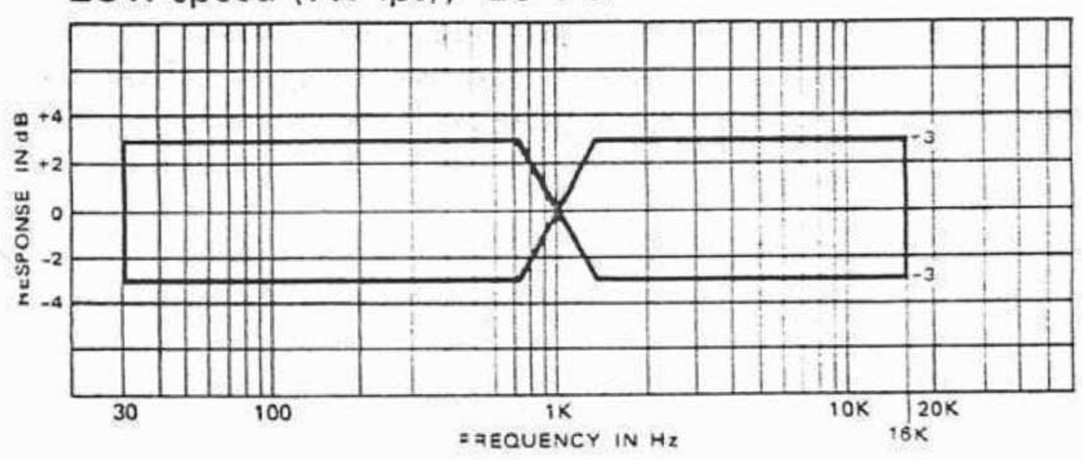


FIG. 36. OVERALL FREQUENCY RESPONSE

3-5-11. Overall signal-to-noise ratio

The following procedure necessitates connecting a 20 Hz-20 kHz band pass filter between the deck's OUTPUT jacks and AC voltmeter.

1. Record on a blank test tape a 1 kHz, –10 dBV (316 mV) signal for a while, then disconnect the input signal and initiate again record mode.
2. Stop the tape and rewind it to the beginning of the 400 Hz recording.
3. Play the tape and compare the level on the voltmeter from the 1 kHz recording with the level from the "no-signal" recording. The level difference should be 45 dB or greater (HIGH speed)/43 dB or greater (LOW speed).

   If difference is below specifications, perform the following:
   a. Demagnetize heads and other metal parts in the tape path.
   b. Check Erasure (paragraph 3-5-13).
   c. Check and adjust Record Bias (paragraph 3-5-7).

   Then repeat the procedure above using another blank test tape.

3-5-12. Overall distortion check

1. Connect test equipment as shown in Fig. 37.
2. Set the oscillator to provide a 1 kHz, –10 dBV (0.3 V) signal, and record this signal.
3. Play back the recording to read the distortion analyzer.

   Reading should be less than 1%. If values are greater than this specification, the following may fix the problem:
   – Repeat the record bias adjustment procedure (paragraph 3-5-7).
   – Demagnetize the erase and record/repro heads.
   – As a final measure, replace the record/repro head.

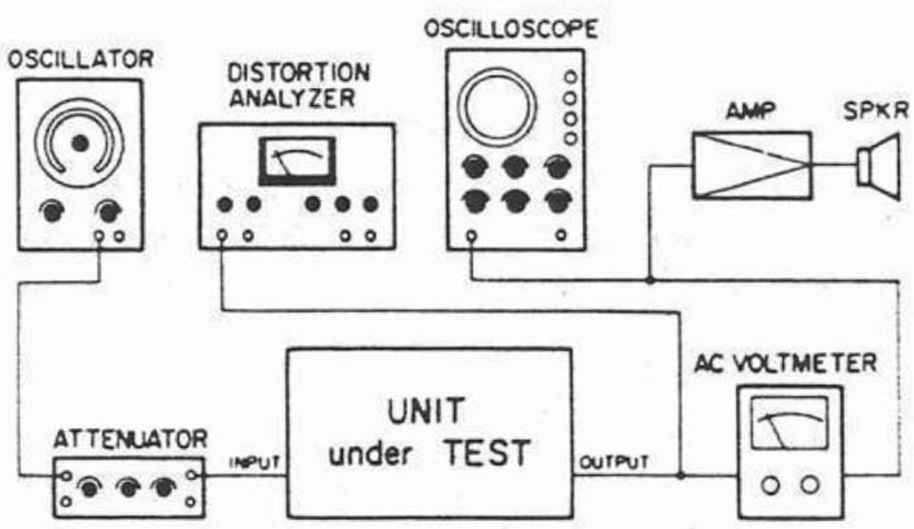


FIG. 37. DISTORTION TEST SET-UP

3-5-13. Erasure

1. Connect test equipment as shown in Fig. 38.
2. Set the oscillator to apply a 1 kHz, 0 dB (1 V) signal to the deck, record this signal, rewind the tape to the beginning of the recording, then play it back to measure the output level.
3. Rewind again the tape to the beginning of the recording, disconnect the input signal, then put the deck again into Record mode.
4. Rewind the tape to the beginning of the "no-signal" recording, and play it back to measure the output level. Compare the level from the original 1 kHz recording with the level from the "no-signal" recording. The level difference should be 70 dB or greater. If not, perform the following:
   a. Clean tape path.
   b. Check transport performance (section 3-4).

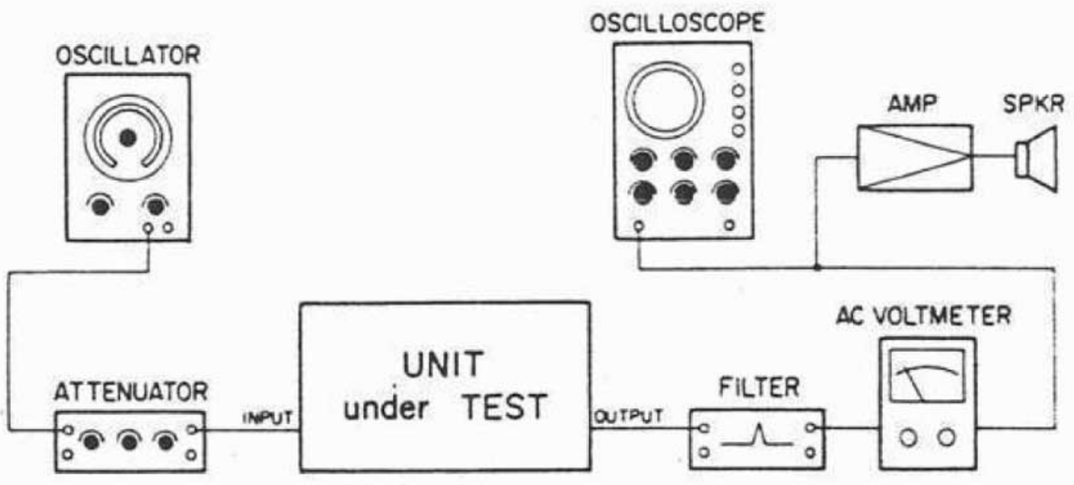


FIG. 38. ERASURE TEST SET-UP

3-5-14. Channel crosstalk

1. Connect test equipment as shown in Fig. 39.
2. Connect a 1 kHz, –10 dBV (316 mV) signal to the input connector of channel 1 and record this signal on track 1.
3. Rewind the tape to the beginning of the recording.
4. Play back the recording and first measure the output of channel 1 to get a level reference. Then measure the output of channel 2. The difference should be 48 dB or greater.
5. Repeat procedure to check crosstalk from each remaining channel onto its surrounding channels (from channel 2 onto channels 1 and 3, from channel 3 onto channels 2 and 4, from channel 4 onto channels 3 and 5, and so forth).

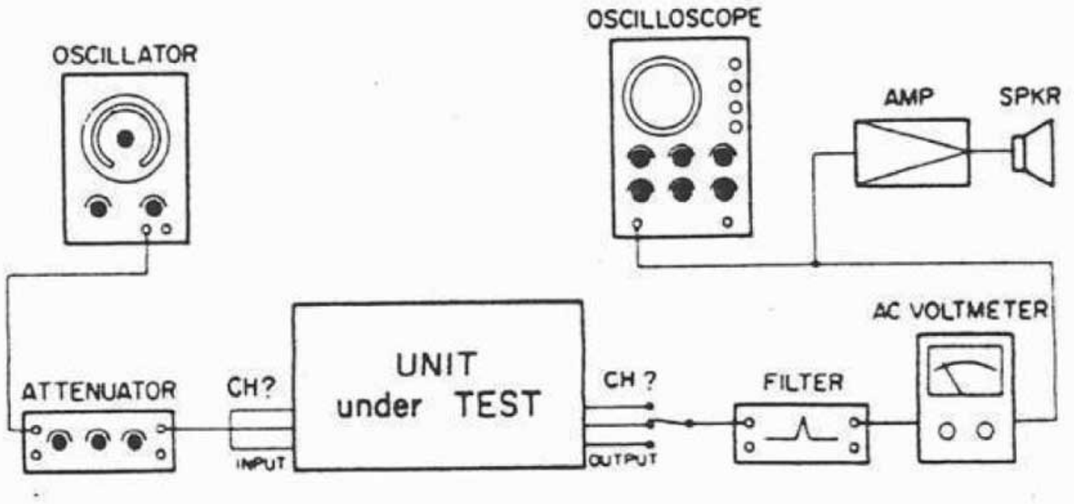


FIG. 39. CROSSTALK TEST SET-UP

3-5-15. Sync crosstalk

Sync crosstalk refers to the crosstalk occured during sync recordings (overdubs) because record bias signal leaks from a channel set for record onto its surrounding channels set for playback.
Test set-up is the same as in paragraph 3-5-14.

1. Apply a 1 kHz, –10 dBV (316 mV) signal to the channel 1 INPUT jack and start recording.
2. While the recording is taking place, measure the output of channel 1 to get a reference level. Then measure the output of channel 2. The difference between the channels should be 10 dB or greater.
3. Repeat procedure to check sync crosstalk from each remaining channel onto its surrounding channels (from channel 2 in record onto channels 1 and 3 in play, from channel 3 in record onto channels 2 and 4 in play, from channel 4 in record onto channels 3 and 5 in play, and so forth).

3-6. DBX PCB Adjustments

The DBX PCBs have been properly adjusted before shipped and the following adjustments need be performed only when components on the PCBs are replaced because damaged.

CAUTION: Prior to removing or replacing DBX PCBs, check to make sure that the deck is turned off.

Preliminary procedure

1. Apply +12 V to J1-3 and -12 V to J1-1 on the DBX PCB (refer to Fig. 40).
2. Set all the adjustment resistors to center (Fig. 31, page 17).

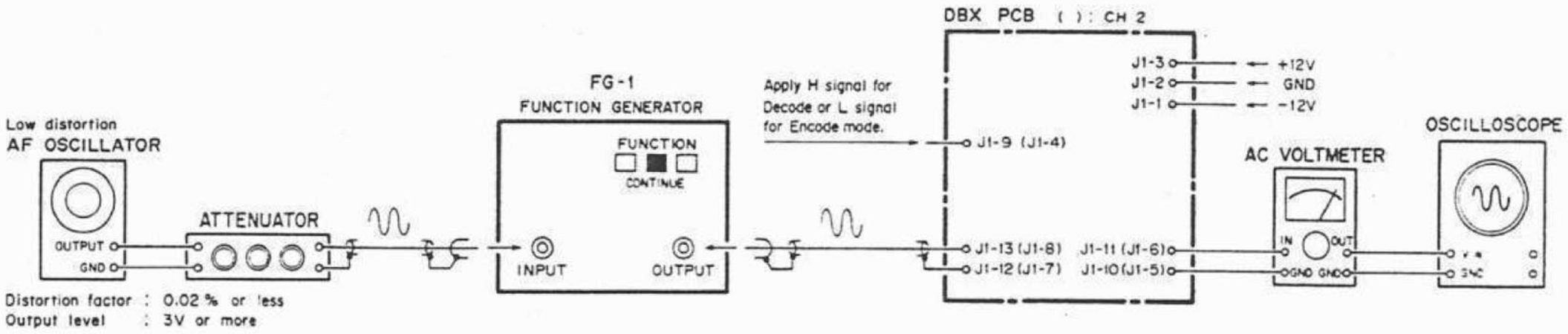


FIG. 40. RMS SYMMETRY & LEVEL ADJUSTMENTS

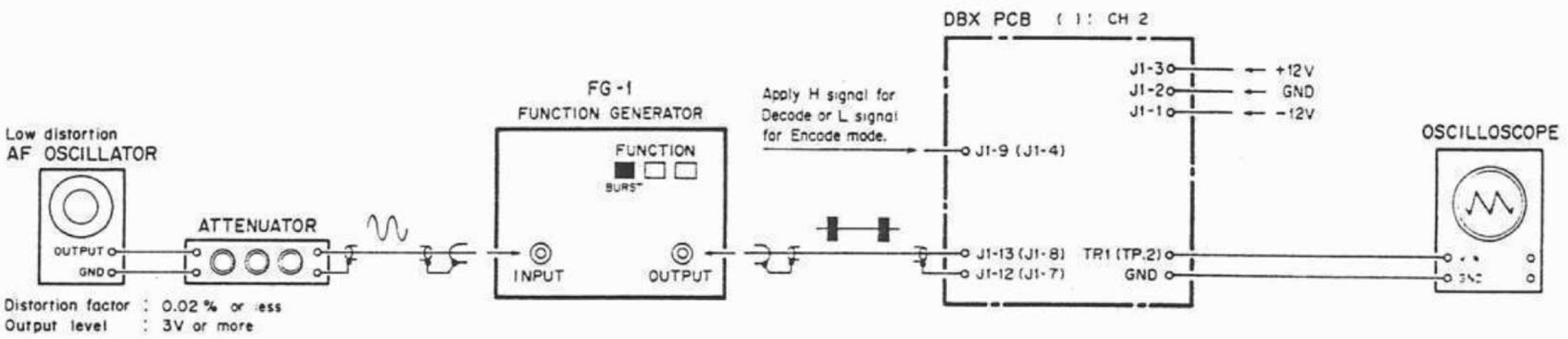


FIG. 41. RELEASE RATE ADJUSTMENT

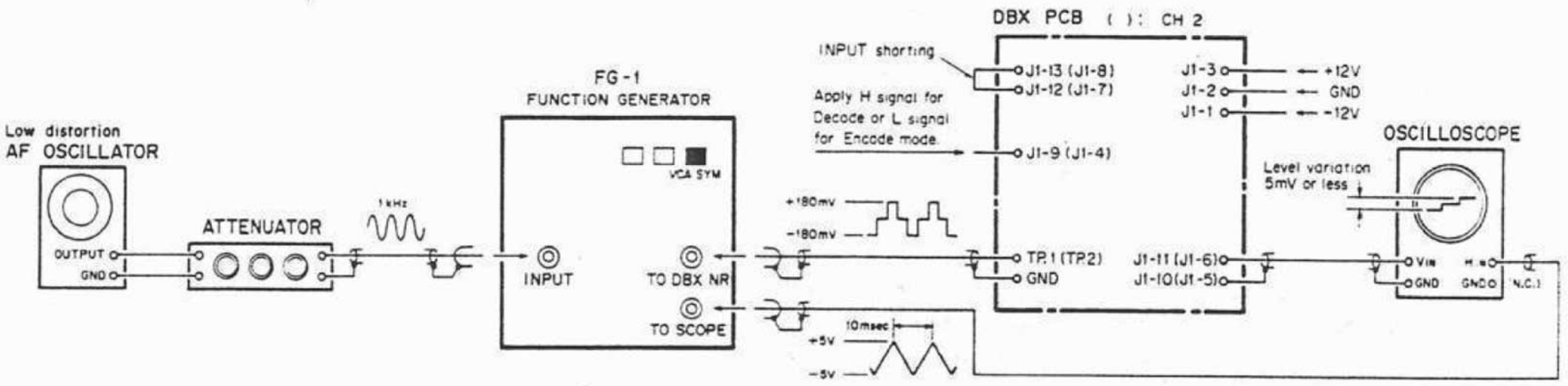


FIG. 42. VCA SYMMETRY ADJUSTMENT

Misaligned **Properly Aligned**

FIG. 43. RMS SYMMETRY

3-6-1. Adjustments location

Refer to Fig. 31, page 17.

3-6-2. Decoder

Apply High signal to J1-9 (J1-4) to activate DBX Decode mode.

A. RMS Symmetry Adjustment (Connections: Fig. 40)

1. Apply a 100 Hz, 316 mV signal to J1-13 (J1-8) terminal.
2. Adjust R14 (R24) to obtain a clean 200 Hz sinewave on TP01 (TP02) (see Fig. 31).

B. VCA Symmetry Adjustment (Connections: Fig. 42)

1. Apply a staircase wave signal to TP01 (TP02), and a triangle wave signal to the horizontal input terminal on the oscilloscope.
2. Shortcircuit between J1-13 (J1-8) and J1-12 (J1-7).
3. Adjust R13 (R23) for a relatively straight horizontal line display on the oscilloscope. (Level deviation: 5 mV or less)

C. Decoding Level (Connections: Fig. 40)

1. Apply a 1 kHz, 316 mV signal to J1-13 (J1-4) terminal.
2. Adjust R12 (R22) for a 316 mV reading at J1-11 (J1-6) terminal.

D. Frequency Response (Connections: Fig. 40)

1. Vary the signal frequency to 50 Hz (316 mV) and then to 10 kHz (316 mV).
2. Read the output level at the J1-11 (J1-6) terminal for each frequency. The output level should be within the following limits with reference to level at 1 kHz.

   50 Hz: +5 dB ± 1 dB (447 mV to 602 mV)
   10 kHz: +9.4 dB ± 1 dB (793 mV to 997 mV)

E. Release Rate Check (Connections: Fig. 41)

1. Apply a 1 kHz tone burst wave signal with 8 cycles on and 128 cycles off.
2. Confirm that release rate is less than 750 mV ± 10%.

F. Decode Effect Check (Connections: Fig. 40)

1. Apply a 1 kHz, –20 dB signal to J1-13 (J1-8) terminal.
2. Confirm that the level at J1-11 (J1-6) terminal is –30 dB ± 0.5 dB (i.e., –20 dB against –10 dB (316 mV) reference level).
3. Apply a 1 kHz, 0 dB signal to J1-13 (J1-8) terminal.
4. Confirm that the level at J1-11 (J1-6) terminal is +10 dB ± 0.5 dB (i.e., +20 dB against –10 dB (316 mV) reference level).

3-6-3. Encoder

Apply Low signal to J1-9 (J1-4) to activate DBX Encode mode.

A. RMS Symmetry Adjustment (Connections: Fig. 40)

1. Apply a 100 Hz, 316 mV signal to J1-13 (J1-8) terminal.
2. Check for clean 200 Hz sinewave at TP01 (TP02) (see Fig. 31).

B. VCA Symmetry Adjustment (Connections: Fig. 42)

1. Apply a staircase wave signal to TP01 (TP02), and a triangle wave signal to the horizontal input terminal on the oscilloscope.
2. Shortcircuit between J1-13 (J1-8) and J1-12 (J1-7).
3. Confirm that J1-11 (J1-6) supplies a relatively straight horizontal line on the oscilloscope (level deviation: 10 mV or less).

C. Encoding Level (Connections: Fig. 40)

1. Apply a 1 kHz, 316 mV signal to J1-13 (J1-8) terminal.
2. Adjust R11 (R21) for a –10 dB reading at J1-11 (J1-6) terminal.

D. Frequency Response (Connections: Fig. 40)

1. Vary the signal frequency to 50 Hz (316 mV) and then to 10 kHz (316 mV).
2. Read the output level at the J1-11 (J1-6) terminal for each frequency. The output level should be within the following limits with reference to level at 1 kHz.

   50 Hz: –2.5 dB ± 1 dB (213 mV to 240 mV)
   10 kHz: –4.8 dB ± 1 dB (166 mV to 186 mV)

E. Release Rate Check (Connections: Fig. 41)

1. Apply a 1 kHz tone burst wave signal with 8 cycles on and 128 cycles off.
2. Confirm that release rate is less than 750 mV ± 10%.

F. Encode Effect Check (Connections: Fig. 40)

1. Apply a 1 kHz, –70 dB signal to J1-13 (J1-8) terminal.
2. Confirm that the level at J1-11 (J1-6) terminal is –40 dB ± 0.5 dB (i.e., –30 dB against –10 dB (316 mV) reference level).
3. Apply a 1 kHz, +10 dB signal to J1-13 (J1-8) terminal.
4. Confirm that the level at J1-11 (J1-6) terminal is 0 dB ± 1 dB (i.e., +10 dB against –10 dB reference level).

CHECKS AND ADJUSTMENTS CHART

ADJUST STEP	WHAT IS IT CALLED	SIGNAL SOURCE AND AMOUNT	WHAT TEST GEAR TO USE	WHAT IS THE RECORDER DOING	POINT TO ADJUST	WHAT READING TO ADJUST FOR
1	Input Level	1 kHz signal at –10 dBV from oscillator connected to INPUT jack	VTVM connected to OUTPUT jack	Stop mode with ALL INPUT engaged.	Check only	–10 dBV (316 mV) on VTVM
2	Meter (Input)	Same as above	LED meter	Same as above	R304	0 dB on LED meters.
3	Reproduce Head Alignment	16 kHz, nominal level signal contained in test tape for HIGH speed use. See p. 7, "Test Equipment".	VTVM and oscilloscope with vertical and horizontal inputs connected to OUTPUT CH2 and 15.	Reproduce at HIGH speed with ALL INPUT disengaged.	Repro head azimuth adjusting screw.	Maximum output, less than 45° out of phase of Trk 2 & 15 outputs (at 10 kHz).
4	Reproduce Level	Nominal level signal contained in test tape (p. 7)	VTVM connected to OUTPUT jack.	Reproduce at High speed with ALL INPUT disengaged.	R303	–10 dBV (316 mV) on VTVM.
5	Reproduce EQ (High frequency) at High speed.	20 kHz signal contained in test tape (p. 7)	VTVM connected to OUTPUT jack.	Reproduce at High speed with ALL INPUT disengaged.	R301	Same reading on VTVM as for 1 kHz signal.
6	Reproduce EQ (High frequency) at Low speed.	16 kHz signal contained in test tape.	Same as above	Reproduce at Low with ALL INPUT disengaged.	R302	Same as above
7	Bias Trap Adjustment	No input signal	VTVM connected to Bias Trap test points TP-3 and TP-9.	Recording with no signal connected.	L3	Minimum output at Bias Trap test point.
8	Bias Level Adjustment	No input signal	VTVM connected between TP-1 & TP-9.	Record at LOW onto the same type of tape as used for the actual recording.	R308	23 mV ± 2 mV on VTVM
9	Recording Level	1 kHz signal at –10 dBV connected to INPUT jack.	VTVM connected to OUTPUT jack.	Recording at HIGH then its playback.	R305	–10 dBV (316 mV) at OUTPUT jack.
10	Overall Frequency at High speed. (HIGH-FREQ)	20 kHz signal connected to INPUT jack (at –10 dBV).	Same as above	Same as above	R306	Within the limits given in Fig. 36.
11	Overall Frequency at Low speed. (HIGH-FREQ)	16 kHz signal connected to INPUT jack (at –20 dBV).	Same as above	Same as above	R307	Same as above
12	Overall Signal-to-Noise Ratio	No input signal	VTVM connected to OUTPUT jacks.	Recording at HIGH then at LOW, with ALL INPUT disengaged.		Check for 45 dB or better (for HIGH speed)/ 43 dB or better (for LOW speed)
13	Erasure	1 kHz signal, 0 dBV connected to INPUT jack. Apply signal for short time only.	VTVM and 1 kHz band pass filter connected to OUTPUT.	1 kHz recording then no-signal recording through the 1 kHz recorded section. Playback to measure the level difference.		70 dB or greater (through 1 kHz filter). (Refer to paragraph 3-5-13.)
14	DBX Adjustment DECODER	Same as step 4	Same as step 4	dBx IN and OUT.	R12 (R22) on the DBX PCB	–10 dBV (316 mV) on VTVM
15	DBX Adjustment ENCODER	Same as step 9	Same as step 9	Same as above	R11 (R21) on the DBX PCB	Same as above

Care and Maintenance

We can't stress the importance of cleaning and demagnetizing too much. Oxide shed from the tape and accumulated on the heads and other components in the tape path and dust or debris picked up from the air can result in poor high frequency response. Also, the heads may become magnetized. This residual magnetism can increase noise and distortion, significantly degrading record/reproduce performance. Clean up and demagnetize at least every day before you start to work with the MSR-16.

A clean and properly demagnetized tape recorder will maintain its performance without any other attention for quite a while. It won't ruin previously recorded material, nor will getting it back to original specifications be difficult.

CLEANING

1. Press down the head shield to get full access to the heads.

2. Apply cleaner to a coton swab or lint-free gauze and wipe the entire surface of the tape path.
Wipe off any excess cleaning fluid with a dry swab.

CAUTION: Be sure to use a good cleaner. We remommend the following:
TEAC HC-1 (U.S. only) or TZ-261A (for heads, tape guides, impedance roller, and capstan shaft); and
TEAC RC-1 (U.S. only) or TZ-261B (for pinch roller and counter roller).

DEGAUSSING (DEMAGNETIZING)

A little stray magnetism can become quite a big nuisance in tape recording. It only takes a small amount (.2 Gauss) to cause trouble on the record head. (Gauss is the unit used to measure magnetism.) A little more than that (.7 Gauss) will start to erase high frequency signals on previously recorded tapes. You can see that it's worth taking the trouble to degauss regularly.

DEGAUSSING IS ALWAYS DONE WITH THE RECORDER TURNED OFF. If you try it with the electronics on, the current pulses produced by the degausser will look just like audio signals to the heads. These pulses are around 10,000 Gauss, and will seriously damage the electronics and/or meters. Turn off your MSR-16, then turn on the degausser at least 1 m (3 feet) away from the recorder.

Be certain that your degausser has either a plastic cover or plastic tape covering the tip. Make sure that no metal ever touches the tape heads as it will scar them and ruin them.

Slowly move in to the tape path. Move the degausser slowly back and forth, touching lightly all metal parts in the tape path. Slowly move it away again to at least 1 m (3 feet) from the recorder before turning it off.

Be sure to concentrate while you are degaussing. Don't try to hold a conversation or think of anything else but the job you are doing. If the degausser is turned on or off by accident while it is near the heads, you may put a permanent magnetic charge on them that no amount of careful degaussing will remove. You will have to get the heads replaced. Make sure you are wide awake for this job.

USE OF THE RS-232C SERIAL INTERFACE PORT (ACCESSORY 2)

The MSR-16 operates to its full potential when interfaced with the MIDiiZER, an intelligent, highly versatile serial synchronizer, which provides a link between SMPTE/EBU based audio/video production and MIDI music creation. It shifts between time code and MIDI data to constantly adapt the MSR-16 and other associated machines/units to ever changing requirements of each application.

Specifically, advanced functions the MIDiiZER provides access to include Record On/Off Programming (up to 16 individual tracks), 20-point Autolocation, Synchronization either referenced to time code addresses or to MIDI coded bar numbers, Time code/MIDI data triggered events, MIDI Program Change which can be controlled with time code too, a "Total Time" function which accommodates your program material to the required length by automatically changing the tempo, and more. (Complete, update information about the MIDiiZER will be made available no later than its upcoming release.)

The method of communications performed in compliance with the RS-232C standard differ depending on the mechanical/electrical characteristics and system programs of the associated machines/devices, and a small error in communications thwarts the interfaced system even causes this to run "wild." For detailed technical rmation about the use of the MSR-16's Serial Port, consult TASCAM or your local TASCAM dealer.

VOLTAGE CONVERSION

NOTE: Voltage conversion is not possible on models sold in the U.S.A., Canada, U.K., Australia or Europe.

For general export models, if the input voltage specified on the MSR-16 or packing carton differs from the line voltage at the installation site, please request your dealer to change the voltage setting of the machine. The procedure entails the opening of the machine.

NOTE FOR U.K. CUSTOMERS

As the colours of the wires in the mains lead of this apparatus may not correspond with the coloured markings identifying the terminals in your plug proceed as follows:

The wire which is coloured GREEN-and-YELLOW must be connected to the terminal in the plug which is marked by the letter E or by the safety earth symbol ⏚ or coloured GREEN or GREEN-and-YELLOW.

The wire which is coloured BLUE must be connected to the terminal which is marked with the letter N or coloured BLACK.

The wire which is coloured BROWN must be connected to the terminal which is marked with the letter L or coloured RED.

IMPORTANT

THE WIRES IN THE MAINS LEAD ARE COLOURED IN ACCORDANCE WITH THE FOLLOWING CODE:

GREEN-AND-YELLOW:	EARTH
BLUE:	NEUTRAL
BROWN:	LIVE

WARNING: THIS APPARATUS MUST BE EARTHED.