TEAC Tascam Series

40-4

OWNER'S REFERENCE MANUAL

SAFETY INSTRUCTIONS

PREPARATION

- BEFORE OPERATING APPLIANCE, read and understand all the following Safety Instructions as well as operating instructions in the Owner's Manual.
- HEED all WARNINGS and FOLLOW all INSTRUCTIONS – in these Safety Instructions, in the Owner's Manual, and on the appliance itself.
- RETAIN the INSTRUCTIONS for reference when needed.

LOCATION AND HOOKUP

- Appliance should not be used near water or in areas of high humidity – for example, near a swimming pool or in a damp basement.
- Appliance should not be used near heat sources such as heat radiators, stoves, direct sunlight.
- Appliance should be located so that its position does not interfere with proper ventilation. Make sure that air vents on the appliance are not blocked from air by such objects as other appliances, draperies, walls, or carpets.
- Appliance should not be suspended from ceilings or walls except as specifically recommended by the manufacturer.
- Similarly, appliance should not be used with a cart or stand except as specifically recommended by the manufacturer.
- Appliance should be used only on power line sources as indicated in the Owner's Manual and as marked on the appliance itself.
- If appliance requires grounding, or polarization of power source, follow instructions in the Owner's Manual for proper connections.
- If appliance, such as a Receiver or Tuner, is to be used with an Outdoor Antenna, make sure the Antenna is mounted in accordance with provisions of the National Electrical Code. Normally, commercially available Antenna Kits come with instructions for proper installation.
- Such an Outdoor Antenna should be located away from Power Lines.
- Power supply cords of the appliance should be routed so that they are not likely to be walked on or pinched by items placed upon or against them, paying particular attention to cords at plugs, convenience receptacles, and the points where they exit from the appliance.

MAINTENANCE

- Cleaning of the appliance should be done only as recommended by the manufacturer.
- In extended periods of non-use, the appliance should be unplugged from the power line source.
- Care should be taken so that objects do not fall and liquids are not spilled into the enclosure through openings.
- The appliance should be serviced by qualified service personnel when:
  A. The power supply cord or the plug has been damaged;
  B. Objects have fallen, or liquid has been spilled into the appliance;
  C. The appliance has been exposed to rain;
  D. The appliance does not appear to operate normally or exhibits a marked change in performance;
  E. The appliance has been dropped, or the enclosure damaged.

SERVICING

The user should not attempt to service the appliance beyond that described in the operating instructions. All other servicing should be referred to qualified service personnel.

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TEAC CORPORATION

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This deck is adjusted and carefully inspected prior to shipment from the factory. Although this Owner's Reference Manual contains some instructions for electrical adjustments we do not recommend that the owners attempt these procedures.
The side boards and external cover panels should not be removed as there are potentially dangerous voltages and moving parts located inside your deck. In addition, many of the adjustments require test equipment that is not readily available to the owner and inadvertent or unnecessary adjustment may render your deck inoperative or greatly decrease its performance.
We recommend that you contact your TEAC dealer or authorized service facility for installation of the optional equipment such as the DX-4 or MA-4.
If you have any doubt about the condition of this deck, please contact your TEAC dealer or authorized service facility. All of the servicing information, removal instructions, adjustment procedures, schematic diagrams, etc. are included only for use by qualified technical personnel.

This tape deck has a Serial Number located on the rear panel. Please record the Model Number and Serial Number and retain them for your records.
Model Number_____
Serial Number_____

INTRODUCTION

Introduction to the 40-4 and Its Design Philosophy

No matter how elaborate a multichannel tape recorder is, it doesn't do the job without help. A lot of equipment is involved, and a lot of talent as well. The recorder becomes the keystone in a system that involves microphones, mixers, loudspeakers, amplifiers and many sophisticated electronic devices. Everything contributes a part to the system of multichannel recording.

Because of what we have learned about multichannel recording systems in the past 8 years, TEAC decided to concentrate on improving functions in the 40-4 that are strictly the province of the tape recorder and to remove features that we felt were best placed elsewhere in the system. The cost saved by eliminating features that are usually duplicated by our mixers, such as headphone amps and microphone inputs has been used to improve the overall quality of the recorder. The result, a better and more flexible recorder/reproducer for the system of multitrack recording. This logical growth now reflects the needs of the studio style or, if you will, the professional recordist.

It has long been our contention that professionalism is defined by people and what results they achieve. It's not something that automatically happens when you buy a tape machine with a lot of tracks, or a very high price. It's what you do with the equipment and how well you do it that makes the point.

In designing the 40-4, we believe we have been guided by the multi-channel system as it truly is. We are sure our recorder/reproducer can deliver the performance necessary to achieve solid results.

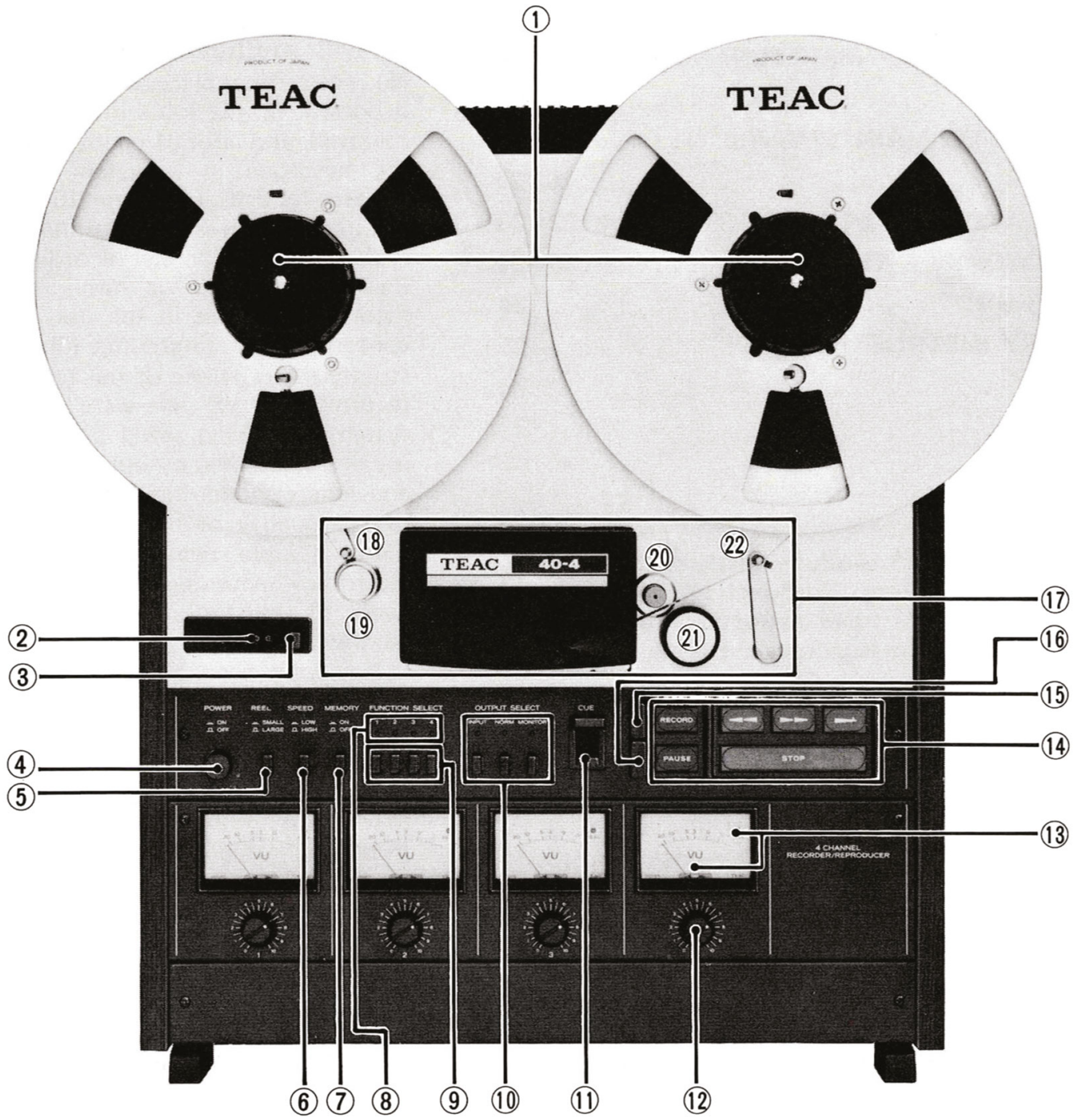
If you would like to comment on our design philosophy, please feel free to contact us. Criticism and comment from our owners has helped us improve our products and our business. We welcome all feedback.

Please send in the warranty card. Although it is not absolutely necessary to insure warranty protection, it will allow us to learn some things about who you are and what you do with tape. From time to time we mail out literature and information of interest to the multichannel recordist. Let us know where you are and we'll keep in touch.

* dbx noise reduction system made under license from dbx, Incorporated. The word dbx and the Symbol are trademarks of dbx, Incorporated.

WARNING: TO PREVENT FIRE OR SHOCK HAZARD, DO NOT EXPOSE THIS APPLIANCE TO RAIN OR MOISTURE.

CONTROL IDENTIFICATION



Front Panel Controls and Indicators

① NAB-Hub Adaptors
These can be installed to allow use of 10½" reels. (See illustration)

② Index Counter
4-digit counter indicates relative location of selections on tape. Used in conjunction with memory button for memory stop operation.

③ Index Counter Reset Button
Push to set counter to zero.

④ POWER Switch
Controls AC power to transport and electronics. Push again to shut off power.

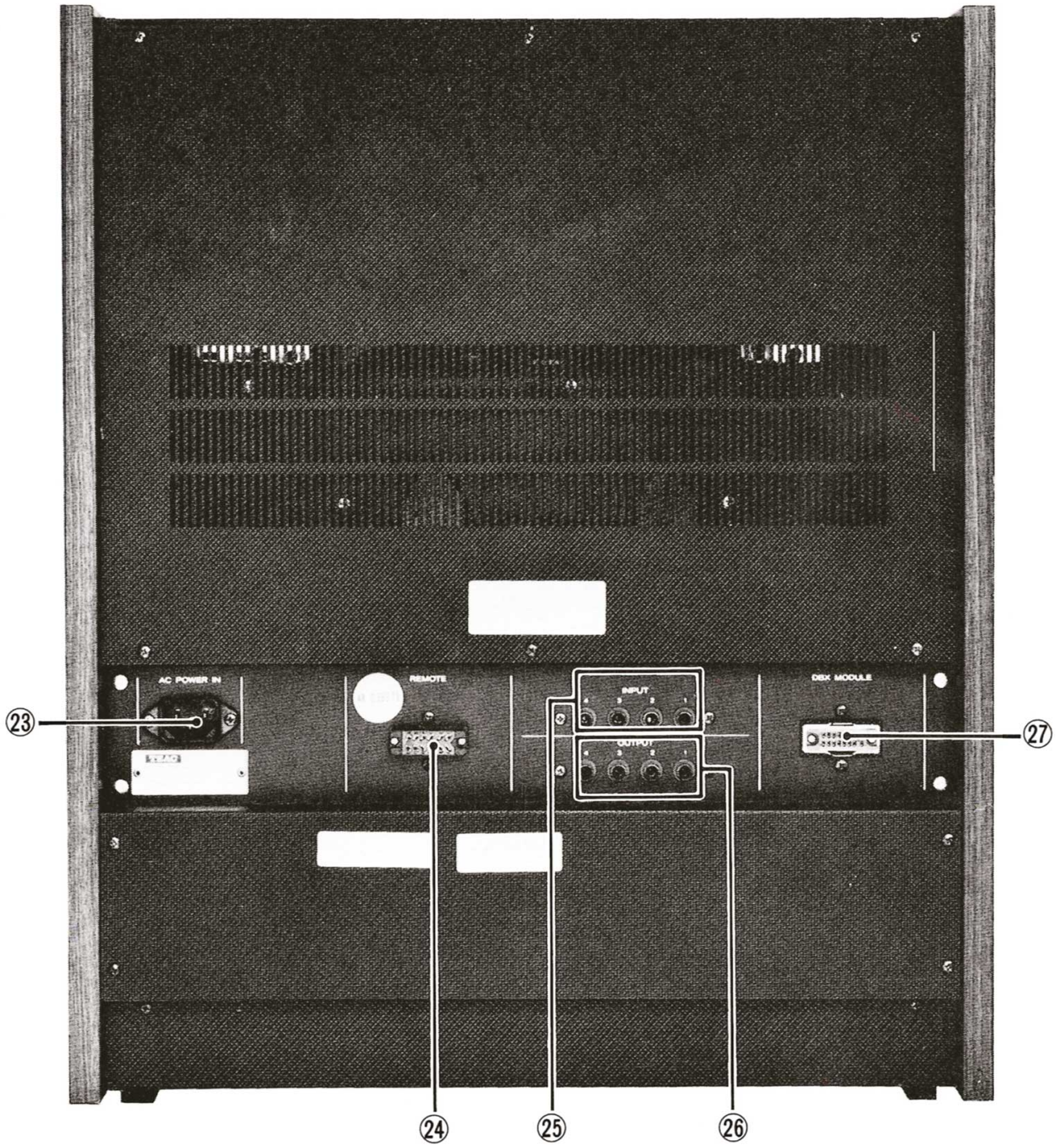
⑤ REEL Size Selector
Controls back tension of supply reel. When using reels of dissimilar size, select supply reel size as compromise.

⑥ SPEED Selector
Controls the play/record speed of the transport. Selects the appropriate record equalization.

⑦ MEMORY
When depressed, transport will enter stop mode when counter reads 9999 during rewind operation. Actual stopping point of tape will depend on transport speed when counter triggers the stop operation.

⑧ LED Record Status Indicators (FUNCTION SELECT)
These lights show three states.
Light off – Safe, playback or input
Light blinks – Record ready, but not in progress
Light stays lit – Recording in progress (or RECORD/PAUSE Mode)

⑨ FUNCTION SELECT Buttons (4)
Determine record and play status.
Up – Safe, playback or source determined by OUTPUT SELECT buttons.
Down – Ready to record. If transport controls have



selected "Record" depressing button will begin recording immediately. Output of recorder switches to source.

⑩ OUTPUT SELECT Buttons
Selects which of 3 possible sources will feed the output jacks and the meter circuits. LED's above buttons show selection.

INPUT — Meter reads line input to recorder, input signal appears at output jacks. Tape signal will not be heard.

NORM — Used for all normal operations, recording, sync/reproduce and playback. Meter reads input or head #2 play output depending on setting of function select buttons.

MONITOR — Selects head #3. Meter now reads tape playback. Does not prevent recording on head #2. Used in set-up to check performance and record/play monitoring of tape.

⑪ CUE Lever
This control will defeat the fast motion tape lifters. The more pressure you apply, the closer the tape will come to the heads. This will allow playback signal to be heard in fast motion for cueing. Use only enough pressure to hear the signal. Too much signal will damage the electronics, so be sure the cue lever is not engaged (locked) when in fast motion. The latch position is provided only for hand winding the tape to find an edit point. Push the lever all the way up a second time to release.

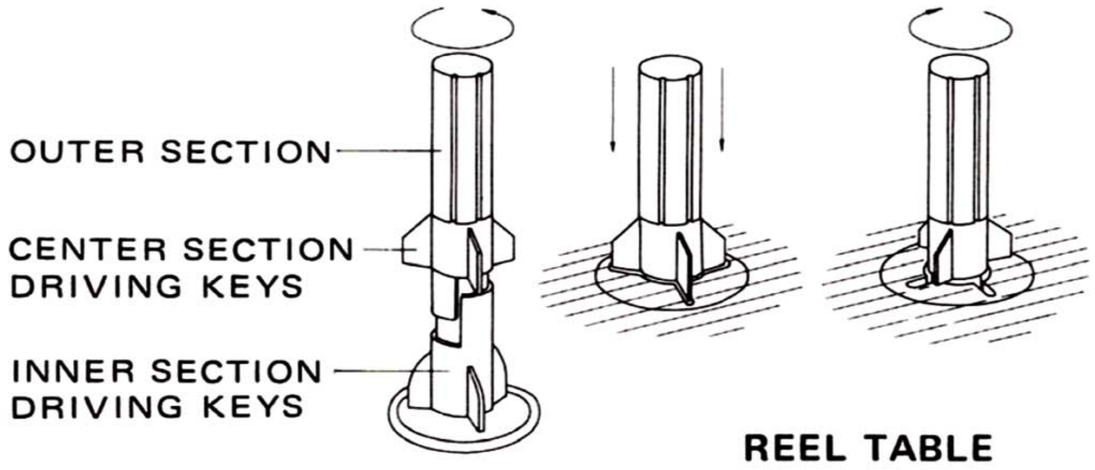
⑫ Input Level Control (4)
For adjusting the source of line level signal. Setting has no effect on playback.

⑬ VU Type Averaging Meter with LED Peak Indicator
For visual reference. Zero VU =0.3 Volt (–10 dB) adjustable.
LED Ignition Level = 0.3 Volt (–10 dB) + 10 dB also adjustable.

⑭ Transport Motion Controls
6 microswitches – Fast forward, rewind, stop, pause, play and record. The use of a remote control RC-170 will not disable the front panel controls.

Reel Installation

Small Hub Reels



Large Hub Reels

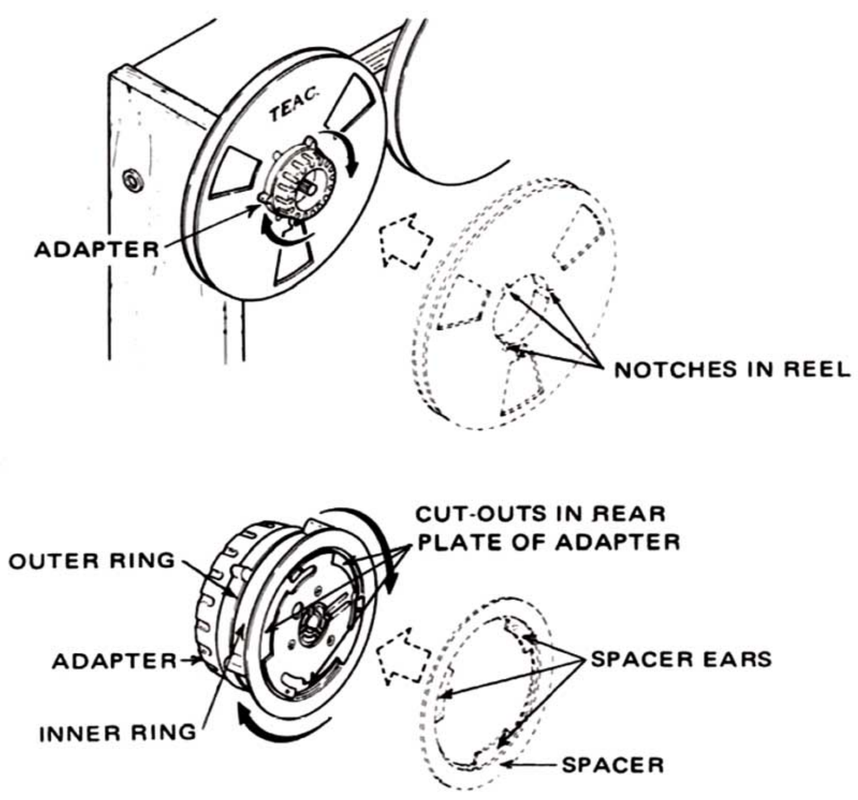


Fig. 1 Reel Installation

Head Location and Adjustment

Head Block illustrations showing all parts, tape path, and all adjustments. Screw for guides and head adjustments. Larger type screws are for azimuth adjustment.

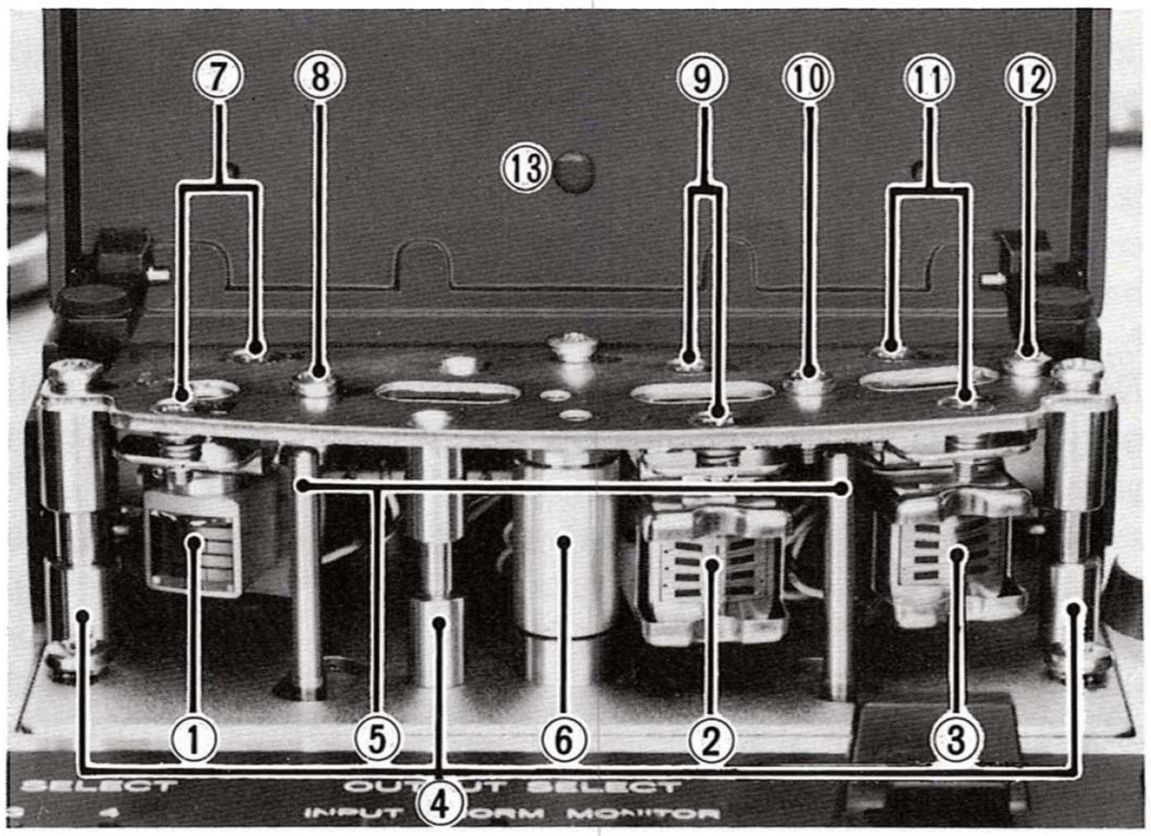


Fig. 2 Head Location and Adjustment

① ERASE HEAD
② NORM (RECORD) HEAD
③ MONITOR (REPRODUCE) HEAD
④ TAPE GUIDES
⑤ TAPE LIFTERS
⑥ SCRAPE FLUTTER ROLLER
⑦ ERASE HEAD HEIGHT AND TILT ADJUSTMENT SCREWS
⑧ ERASE HEAD AZIMUTH ADJUSTMENT SCREW
⑨ NORM HEAD HEIGHT AND TILT ADJUSTMENT SCREWS
⑩ NORM HEAD AZIMUTH ADJUSTMENT SCREW
⑪ MONITOR HEAD HEIGHT AND TILT ADJUSTMENT SCREWS
⑫ MONITOR HEAD AZIMUTH ADJUSTMENT SCREW
⑬ HEAD HOUSING

⑮ Master Record Status LED
Shows record state.
Off – safe
Blinking – Record ready
On – Recording in progress (or RECORD/PAUSE)

⑯ PAUSE LED
This LED will blink for the first 10–15 seconds after the power is switched on. Transport will not operate until this LED goes out. Lights up in PAUSE.

⑰ Tape Path
Thread the tape as indicated on the diagram. Over the tape tension arm ⑱ (on reel side) under the impedance roller ⑲ (away from reel) across heads, between capstan ⑳ and pinch roller ㉑ and behind shut off arm ㉒ (away from reel side).
The shut off arm will drop power to the transport if the tape breaks. It's a good idea to allow it to drop when you take a break in the middle of a session. Doing this will stop the constant rotation of the capstan, and will lengthen the life of the capstan motor bearings. It is not necessary to unthread the tape. Just allow it to become slack so that shut off arm can drop.

Back Panel Plugs and Jacks

㉓ AC Socket
For power input

㉔ REMOTE Control Jack
Needs no dummy plug when not in use.

㉕ Line Outputs (OUTPUT) 1-4

㉖ Line Inputs (INPUT) 1-4

㉗ DBX MODULE Connection
Special connector socket to attach interface cable from DX-4. This plug will supply control signals to the DBX unit. Record or play will automatically follow tape recorder function select commands.

THEORY OF OPERATION-MAINTENANCE

If you are new to high quality sound recording equipment, you should become aware of the fact that high quality sound requires high quality maintenance.

Recording studios that rent time by the hour are very fussy about maintaining their equipment. Tape recorders and other electronic gear in the studio are checked out before every session. And, if necessary, adjusted to "spec" by an "in house" service technician. He is usually prepared to correct any problem from a minor shift in circuit performance to a major breakdown in a motor. He has a full stock of spare parts and all the test equipment he needs.

Now that you are running your own "studio" you will have to make some decisions about maintaining it, and your 40-4. You will have to become your own "in house" service technician. Well, what about the test gear and the spare parts? A stock of spare parts and a super deluxe electronic test bench can easily cost many times the price of the recorder. Fortunately, the most frequently needed adjustments use the least expensive equipment, and the very costly devices are only needed for major parts replacements such as drive and rewind motors or head assemblies. Replacing parts cannot be considered "daily maintenance" by any means, so we suggest that you leave the major mechanical and electrical repair to the Dealer Service Center. That's what it's for.

Adjustments to the motors — back tension and brake torque are not required often and can safely be left to dealer service. The adjustments for wow and flutter require several thousands of dollars of test gear to perform. It's not practical to consider doing these adjustments yourself unless you have fifty machines to service. Then it might pay to buy the test gear.

In order to help you make plans about the more routine adjustments to your 40-4, we have made this maintenance section of the owners manual as easy to understand as technology will allow. It's a short course in tape recorder theory as well as a list of adjustments and will help you to understand what is going on inside when you record. Read the manual, decide what test equipment you can afford (although it is not violently expensive, it is not free) and determine what service you can do yourself.

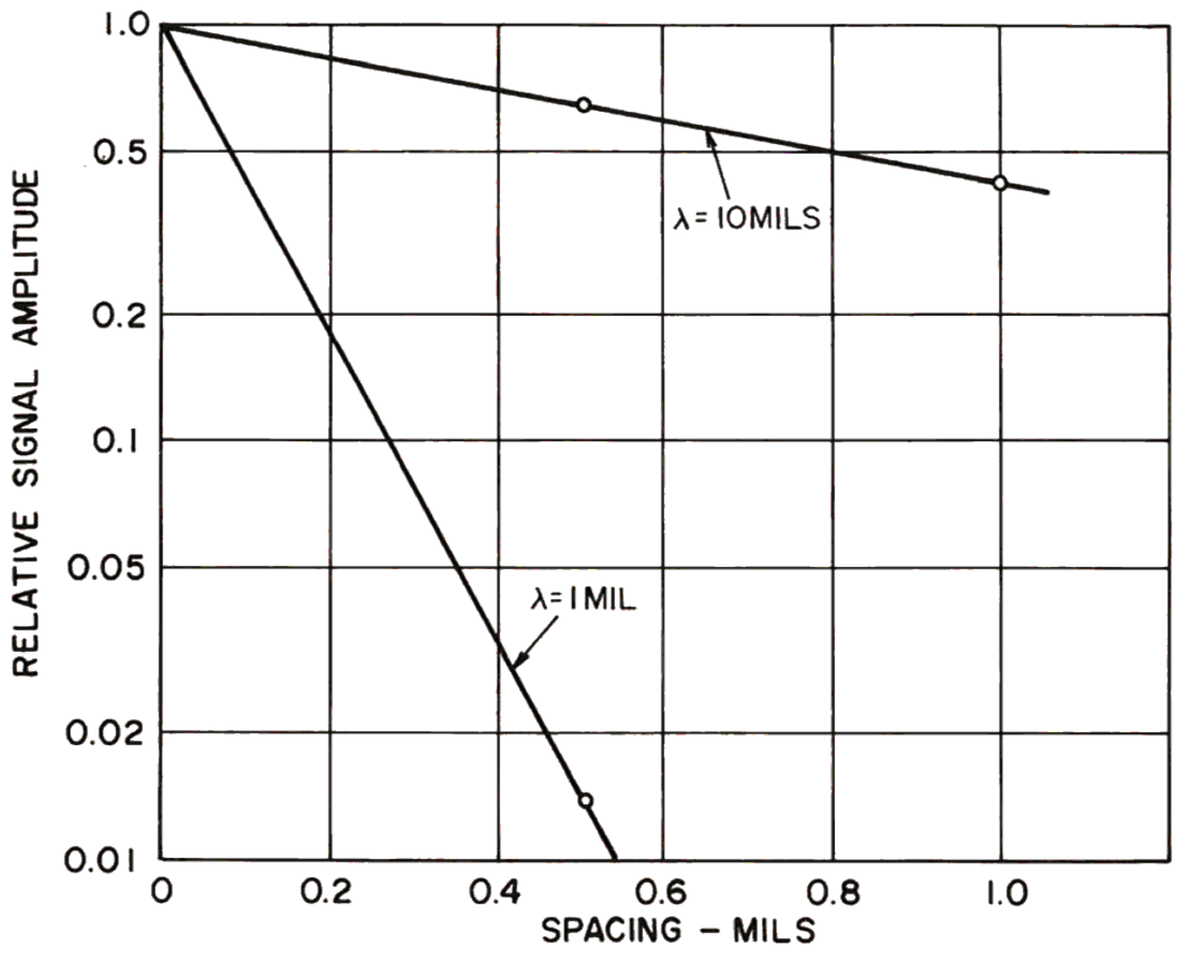


Fig. 3 Curves showing fall-off of reproduced signals versus spacing from reproducer head.
(Courtesy, Minnesota Mining and Manufacturing Co.)

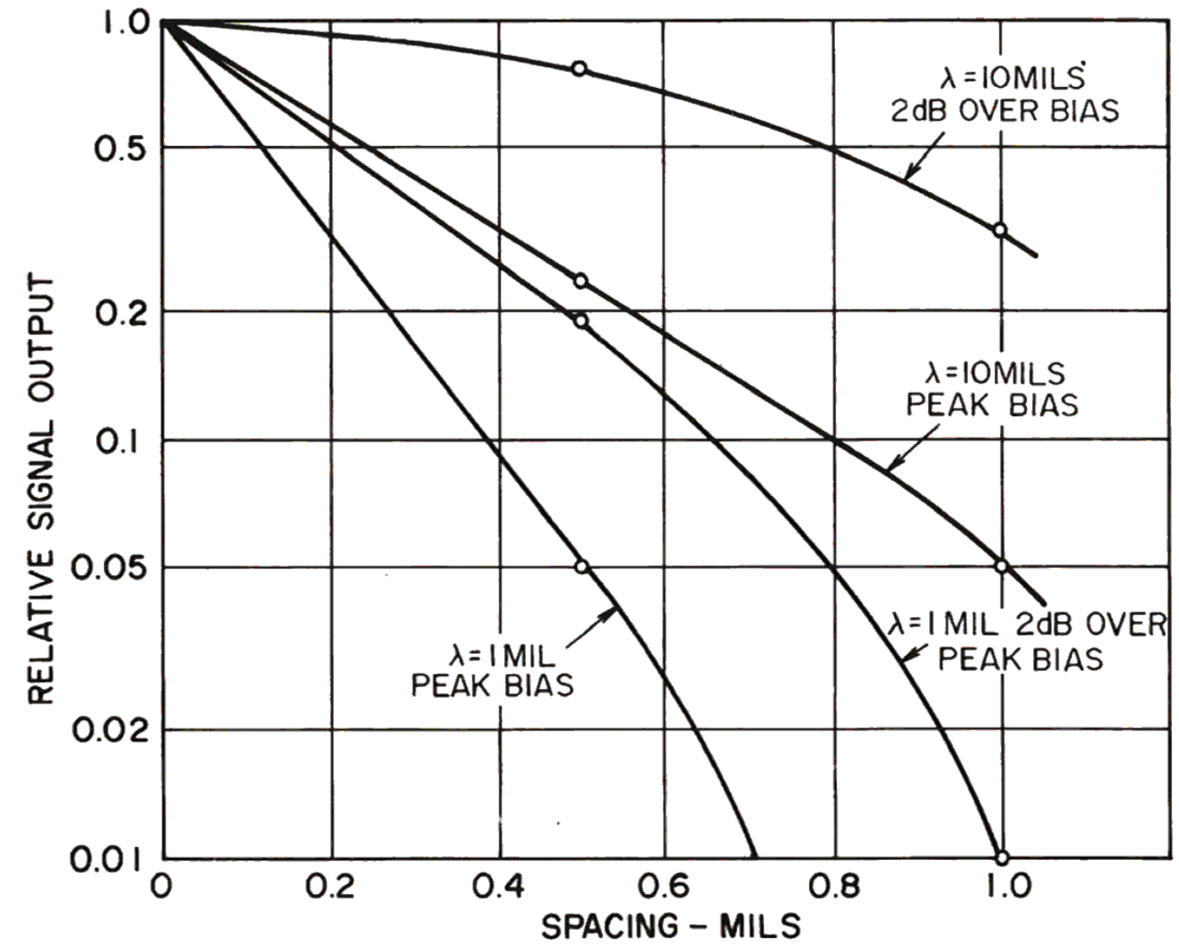


Fig. 4 Curves showing the fall-off of recorded signals versus spacing from recording head.
(Courtesy, Minnesota Mining and Manufacturing Co.)

Cleaning

The first thing you will need for service is definitely the least expensive — Cleaning fluids and swabs. The whole outfit, 2 fluids and all the cotton swabs you'll need for months cost less than one roll of high quality tape. We can't stress the importance of cleaning too much. Clean up before every session. Clean up after every session. Clean up every time you take a break in the middle of a session (we're serious). How come? Well there are two good reasons we can think of right off the top:

1. Any dirt or oxide buildup on the heads will force the tape away from the gaps that record and playback. This will drastically affect the response. Even so small a layer of dirt as one thousandth of an inch will cause big troubles. All the money you have paid for high performance will be wiped out by a bit of oxide. Wipe it off with head cleaner and get back to normal.
2. Tape and tape oxide act very much the same as fine sandpaper. The combination will grind down the tape path in time. If you don't clean off this abrasive on a regular basis, the wear will be much more rapid and, what's worse, it will become irregular. Even wear on heads can be compensated for by electronic adjustments for a time, but uneven wear can produce notches on heads and guides that will cause the tape to "skew" and skip around from one path to another, making adjustment impossible. This ragged pathway chews up the tape, thus dropping more abrasive, thus causing more uneven wear and so — a vicious spiral that can't be stopped once it gets a good start. The only solution will then be to replace not only the heads, but all the tape guides as well. Being conscientious about cleaning the tape path on the 40-4 will more than double the service life of the head assembly.

Degaussing (Demagnetizing)

A little stray magnetism goes a long way. A long way towards making trouble for your tapes. It only takes a small amount (.2 gauss) to cause trouble on the record head and playing 10 rolls of tape will put about that much charge on the heads and other ferrous parts of the tape path. A little more than that (.7 gauss) will start to erase high frequency signal on previously recorded tapes. Demagnetize the whole tape path, including the tips of the tension arms every six fully played 10½" reels. This is a fair "rule of thumb" even though it may be a bit hard to keep track of. Fast motion isn't as significant to the heads, so we don't give an hourly reference. It's the record/play time that counts.

Degaussing is always done with the recorder turned off. If you try it with the electronics on, the 60 cycle current pulses produced by the degausser will look just like 60 Hz audio to the heads, at about 10,000 VU and will seriously damage the electronics and/or the meters. Turn off the machine, turn on the degausser at least 3 feet away from the recorder. Move slowly in to the tape path. Move the degausser slowly up and down in close proximity to all ferrous parts and, slowly move away to at least 3 feet before turning off.

It's a good idea to concentrate when 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 off or on by accident while it is near the heads, you may put a permanent charge on them that no amount of careful degaussing will remove — head replacement time again, we're sorry to say. Make sure you are wide awake for this procedure.

A clean and properly demagnetized tape recorder will maintain its performance without any other attention for quite some time. Even if it does drift as a recorder, it won't ruin previously recorded material, and getting it back in good shape will not be too difficult. To make electronic adjustments, you need test gear, so let's go over what's necessary.

1) **Alignment Tapes**

You need one for each speed that the recorder operates at. For the 40-4 the specs are:

Reference fluxivity:	250 nWb/m
Equalization standard:	NAB
15 ips	3180 μs + 50 μs
7½ ips	3180 μs + 50 μs

These test tapes are made by several companies, but there are many different tape specs. Be sure you have the right one.

Lets's talk about each spec separately.

Reference Fluxivity — How much magnetic energy is necessary on the tape to make the meter read "0 VU" in playback? This is the "benchmark" or standard you tune your playback electronics to. 250 nano Webers per meter is the correct value for the 40-4. If a lower or higher "Reference Fluxivity" is used to set up the playback, all your other measurements will be off.

NAB Equalization — Here we have a lot to talk about. The process of magnetic recording is far from "flat." Every circuit in a tape recorder will alter the level of signal with respect to its frequency — some deliberately, some unavoidably. The deliberate errors are used to overcome the unavoidable problems. Here is a selection of frequency response graphs at various points in the recording process:

1. If the input signal starts this way

Beginning, okay

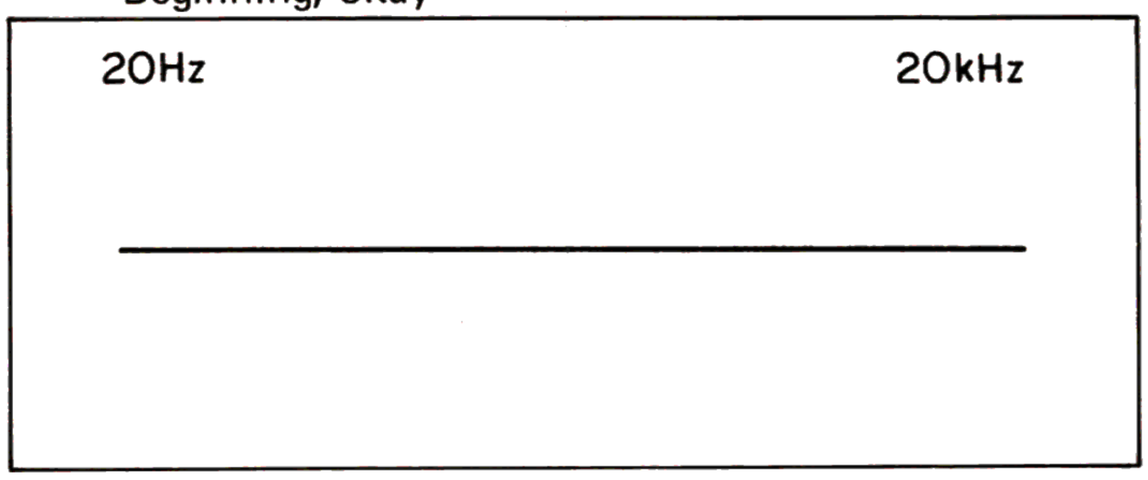


Fig. 5

2. EQ to overcome head loss at high frequency and bass anomalies (NAB)

Deliberate error

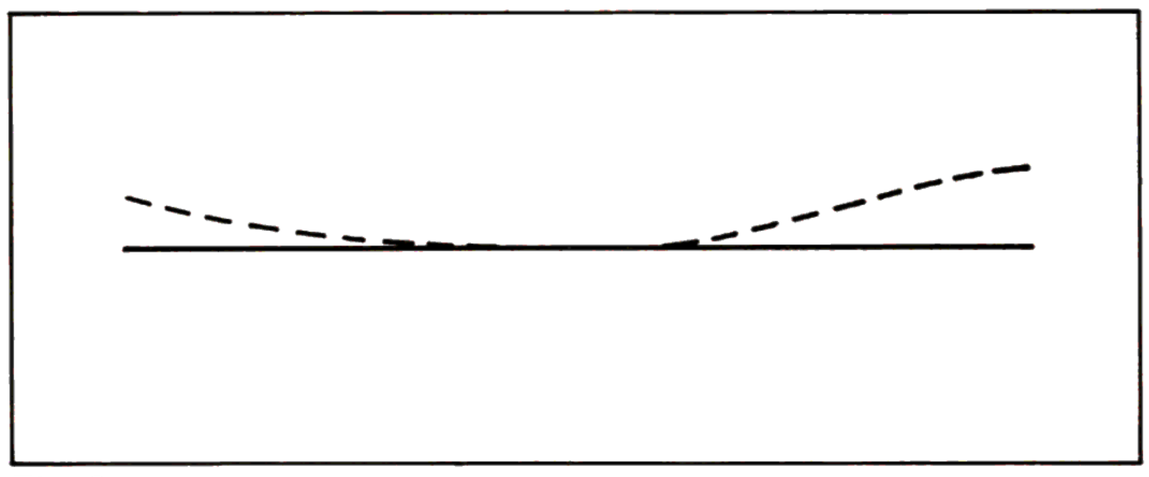


Fig. 6

3. Record Head Response

(6 dB per octave rise until gap in head approaches wavelength)

Unavoidable error

Small wavelengths (high frequencies) are partially erased as fast as they are recorded.

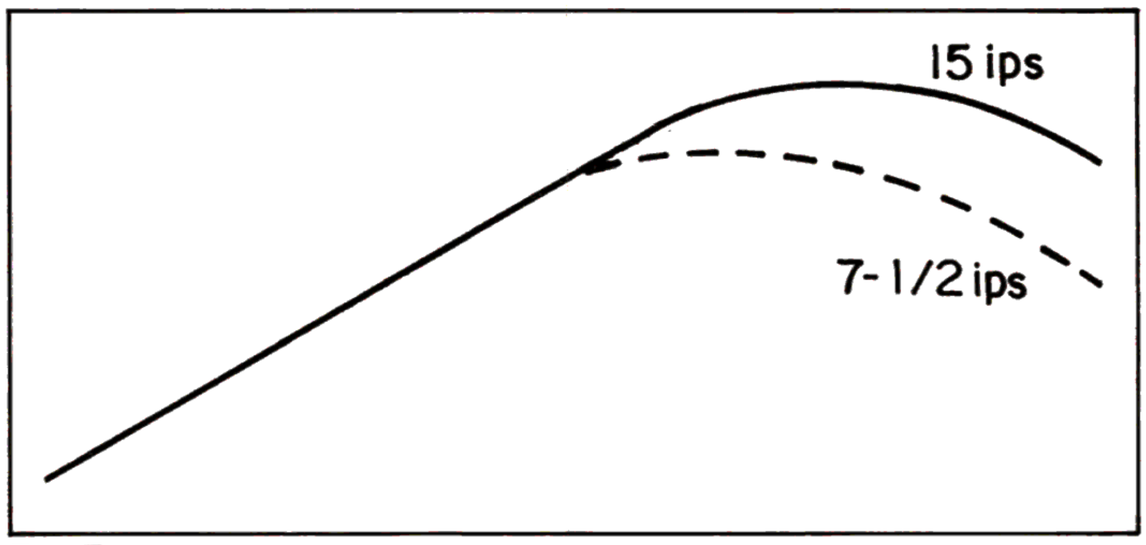


Fig. 7

We will assume something recorded, but it's not flat on the tape either. Now we'll play it back.

4. Playback Head Response

(6 dB per octave rise again, same as record head)

Unavoidable error

Small wavelengths are not picked up by gap.

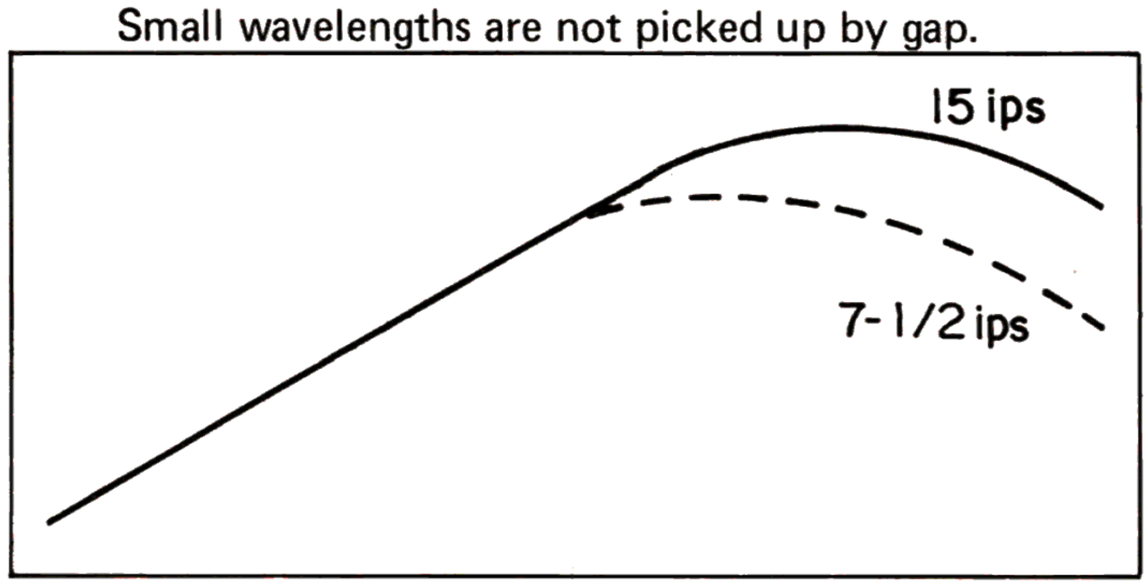


Fig. 8

THEORY OF OPERATION-MAINTENANCE(Continued)

5. Playback EQ
   Now we must overcome the characteristic response of heads in magnetic work.
   Big deliberate error
   Helps lower tape hiss as well as restoring proper levels to high frequencies.

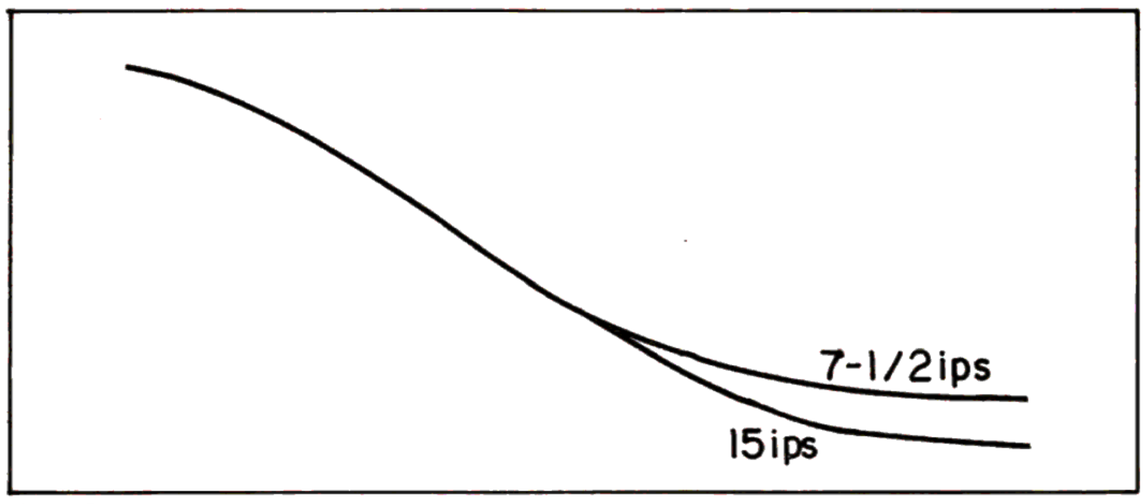


Fig. 9

6. The result of all this equalization is this (hopefully)

Fig. 10

The idea is to use the electronics that are adjustable to cope with the problems that are caused by the nature of the magnetic recording process. We can't change the basic laws of magnetic physics, so we change the record and playback equalization. Now comes the sticky part. How much EQ do we use in each stage? If every manufacturer of tape recorders used their own standard, their idea of what was best, there would be no playback compatibility. Tapes made on one recorder would not play back properly on another of different make. The standards for record and playback equalization are established by societies of scientists, engineers and users in the profession. They are:

NAB National Association of Broadcasters
IEC International Electrotechnical Commission
CCIR International Radio Consultive Commission
DIN Deutsche Industrie Normen

Unfortunately, they don't all agree. Each organization has a slightly different approach to solving the problems of tape recording. Scientists and engineers are human, as well, and have been known to disagree, sometimes violently about what ways are best. Advances in the manufacture of tape, improvements in head design, and the lowering of electronic circuit costs have made bizarre solutions quickly change into practical realities. The optimums have shifted and will probably continue to do so. Standards are set by man, not cast in stone.
But while the scientists are boxing in the conference room, we would like to be recording, so TEAC has selected the NAB standard for record/reproduce EQ as the recommendation for the 40-4.

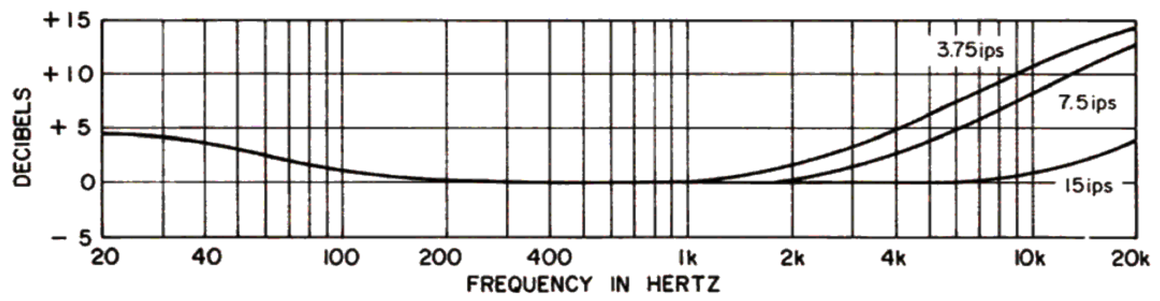


Fig. 11 Typical recording (pre-equalization) for ¼-inch tape recorders using NAB characteristics.

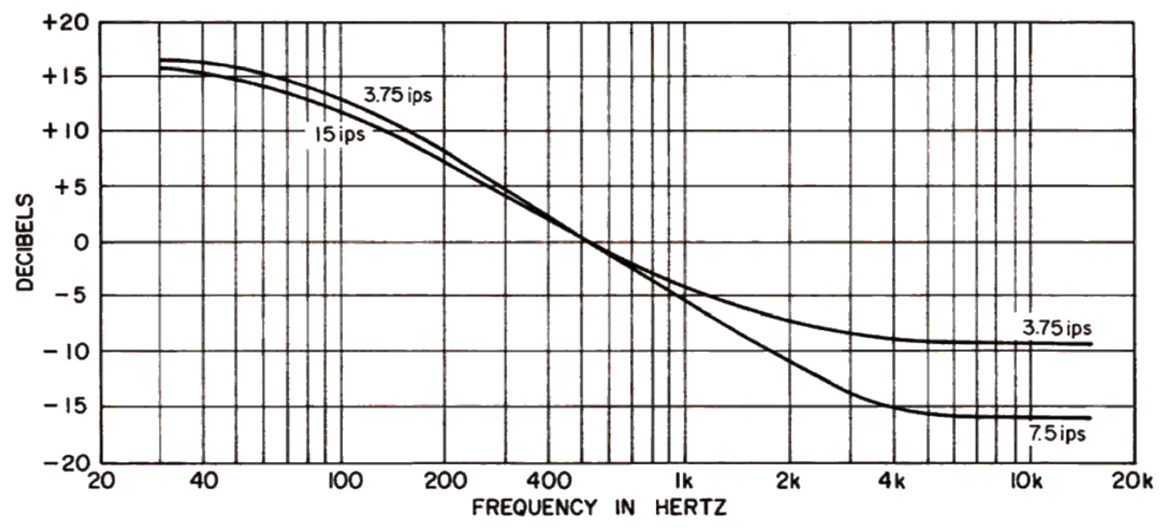


Fig. 12 Typical post-equalization for ¼-inch tape recorders using NAB characteristics.

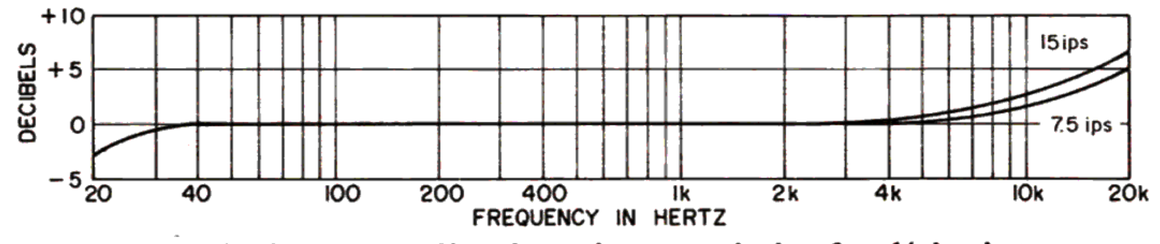


Fig. 13 Typical pre-equalization characteristics for ¼-inch tape recorders running at 7.5 and 15 ips using the CCIR (DIN) standard.

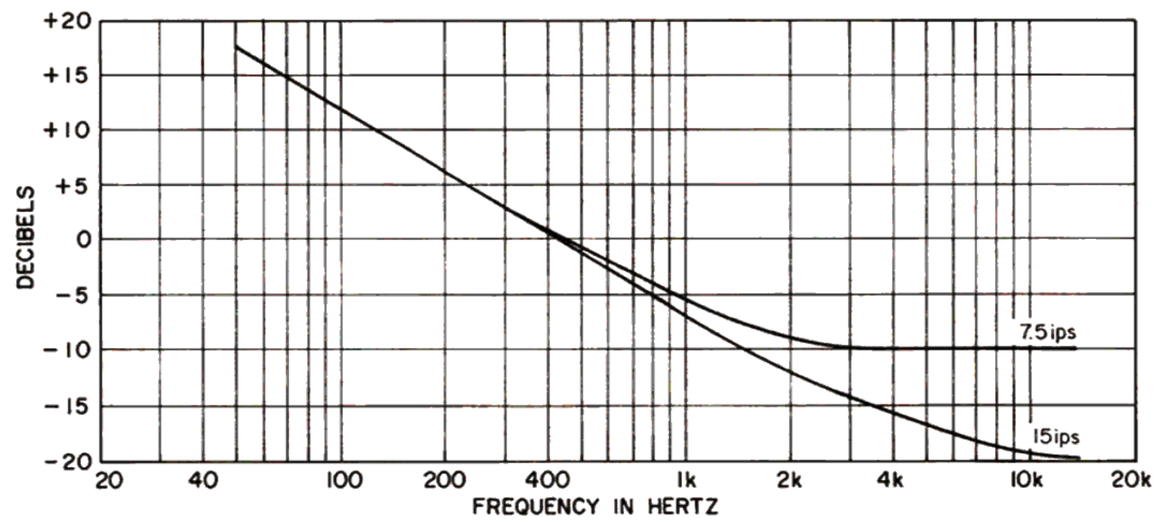


Fig. 14 Typical post-equalization curves for ¼-inch recorders using CCIR characteristics, at 7.5 and 15 ips.

You will need a separate reference tape for each speed. The curves are not the same.
Since these Reference Standard tapes cost about 3 times the price of a big roll of the best blank tape, plan on storing them carefully in a place that will not encounter any magnetic fields that might damage them — away from loudspeakers, guitar pickup, tape recorder and record player motors, power amplifiers (magnetic field surges in big transformers when amps are turned on and off can be very powerful) or anything magnetic that might alter the quality of the reference standard. If you don't damage them physically or magnetically (don't play them on dirty or magnetized recorders, or loan them out to the careless) they will last for several years.

If it is not possible to obtain a tape that has both the NAB EQ and a fluxivity of 250 nWb/m, select the NAB EQ as the preferred single standard. A different reference fluxivity requires only that you make a level correction once. Just use a different mark on the meter instead of "zero." A different EQ curve requires a different amount of correction for each frequency and is much harder to use — especially for a beginner.
Level corrections for different reference fluxivity:

			Use this instead of "0" VU
15 ips	185 nWb/m	— (Ampex operating level)	−3 VU
	200 nWb/m	— (STL, MRL)	−2 VU
7½ ips	185 nWb/m	operating	−3 VU
		sweep frequencies	−13 VU
	200 nWb/m	operating	−2 VU
		sweep frequencies	−12 VU

Below are tabulated some commonly encountered flux levels along with their dB differences, and their differences in dB from 185 nWb/m.

	Flux Level nWb/m	Flux Level Difference in dB	Difference from 185 nWb/m in dB
	150		1.82
		0.56	
	160		1.26
		0.53	
	170		0.73
		0.50	
	180		0.24
		0.24	
Ampex operating level	185		0.00
		0.23	
	190		0.23
		0.45	
	200		0.68
		0.42	
	210		1.10
		0.40	
	220		1.51
		0.39	
	230		1.89
		0.37	
	240		2.26
		0.35	
	250		2.62
		0.34	
	260		2.96
		0.04	
3 dB above Ampex operating level	261.32		3.00
		0.28	
	270		3.28
		0.32	
	280		3.60
		0.30	
	290		3.90
		0.29	
	300		4.20
		0.28	
	310		4.48
		0.28	
DIN Standard	320		4.76
		0.27	
	330		5.03
		0.26	
	340		5.29
		0.25	
	350		5.54
		0.24	
	360		5.78
		0.22	
6 dB above Ampex operating level	369.12		6.00
		0.02	
	370		6.02
		0.23	
	380		6.25
		0.23	
	390		6.48
		0.22	
	400		6.70

IEC Correction Chart (illus.)

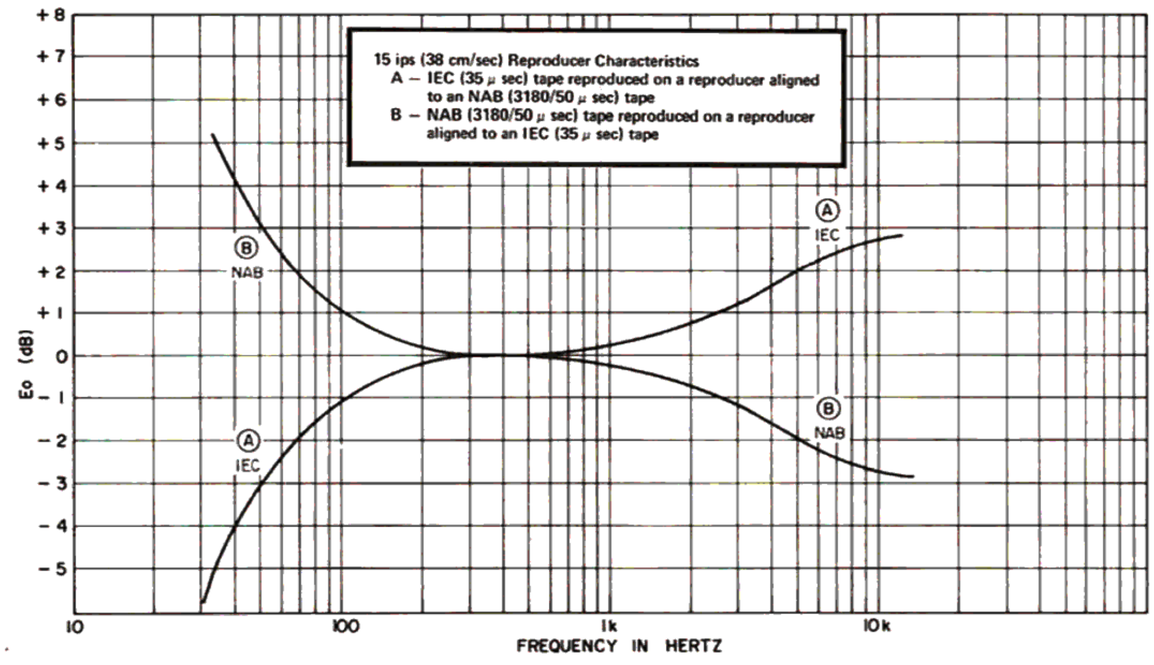


Fig. 15

If you must use IEC EQ tapes, these amounts of reading are correct. IEC has less boost in playback, the tape will read grogressively lower as frequencies rise when played on a NAB adjusted recorder. At 250 nWb/m reference read these numbers to set NAB EQ.

30	50	100	400	1K	3K	5K	7K	10K	15K
0	0	0	0	+0.2	+1.2	+1.9	+2.3	+2.6	+2.9 dB

Since the low frequency EQ on the 40-4 is fixed, the differences are academic. On to the next piece of test equipment.

2) VTVM or FET Multimeter

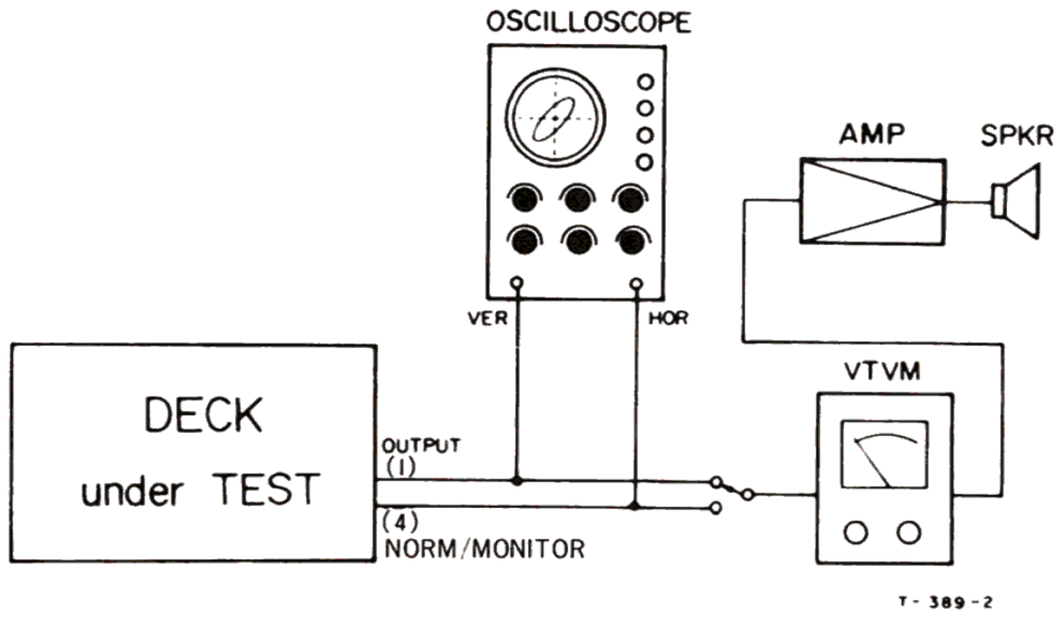


Fig. 16 Head Alignment Fine Adjustment Set-up and Test Connections (PLAYBACK)

With an input impedance of at least 1 megohm that can read levels down to −70 (full scale) you can think of this as a very accurate VU meter of very wide range. Meters with lower input impedances will draw power from the circuits to be measured and will affect the readings. Meters that have adequate input impedance but do not read below −40 (.01 V) can be used for reference levels and frequency response measurements, but will not be capable of making signal-to-noise, erase efficiency or bias circuit measurements where the output of the circuit being adjusted is expected to be very low.

THEORY OF OPERATION-MAINTENANCE (Continued)

This tool is not cheap and is just as important as the test tapes. Without a good reference meter, you can do very little in the way of accurate adjustment. Spend as much as you can here. It's worth it. Next. . . .

3) **Signal Generator or Oscillator.**
Here you get a break. A simple oscillator will do all the work and won't send you to the poor house. There are several on the market for less than $100. If you get one with a meter on it, you won't have to calibrate its output with the big meter as often. This device is very useful in a studio for troubleshooting a good investment. It should have at least the following frequencies.

40 Hz — 400 Hz — 1 kHz — 4 kHz — 10 kHz — 15 kHz

Sine wave is all that is required, at a distortion of no more than .5%. Most modern units do better than this easily. This unit is the workhorse on the equipment list. Whether you are reading the big meter (FET) or the meters on the recorder, you will need a signal to read, this instrument or the test tapes will provide you with signals.
Test tapes, tone generator, VTVM or FET meter . . . This is the basic package and will do almost every adjustment in the sequence – except the first one . . .

4) **The Oscilloscope.**
Even a simple one is not cheap. Fortunately, a simple one is all you need. You can spend $6,000 and more for the big ones, but for this purpose $100 – $200 will be more than enough. It must have a "vertical" and a "horizontal" amplifier and an X–Y mode. That's all you use to do the one adjustment you need it for.

Assuming that the motors are not in need of attention (that's for Dealer Service), Azimuth, or head alignment is the number one step in maintenance. . . . so let's begin.

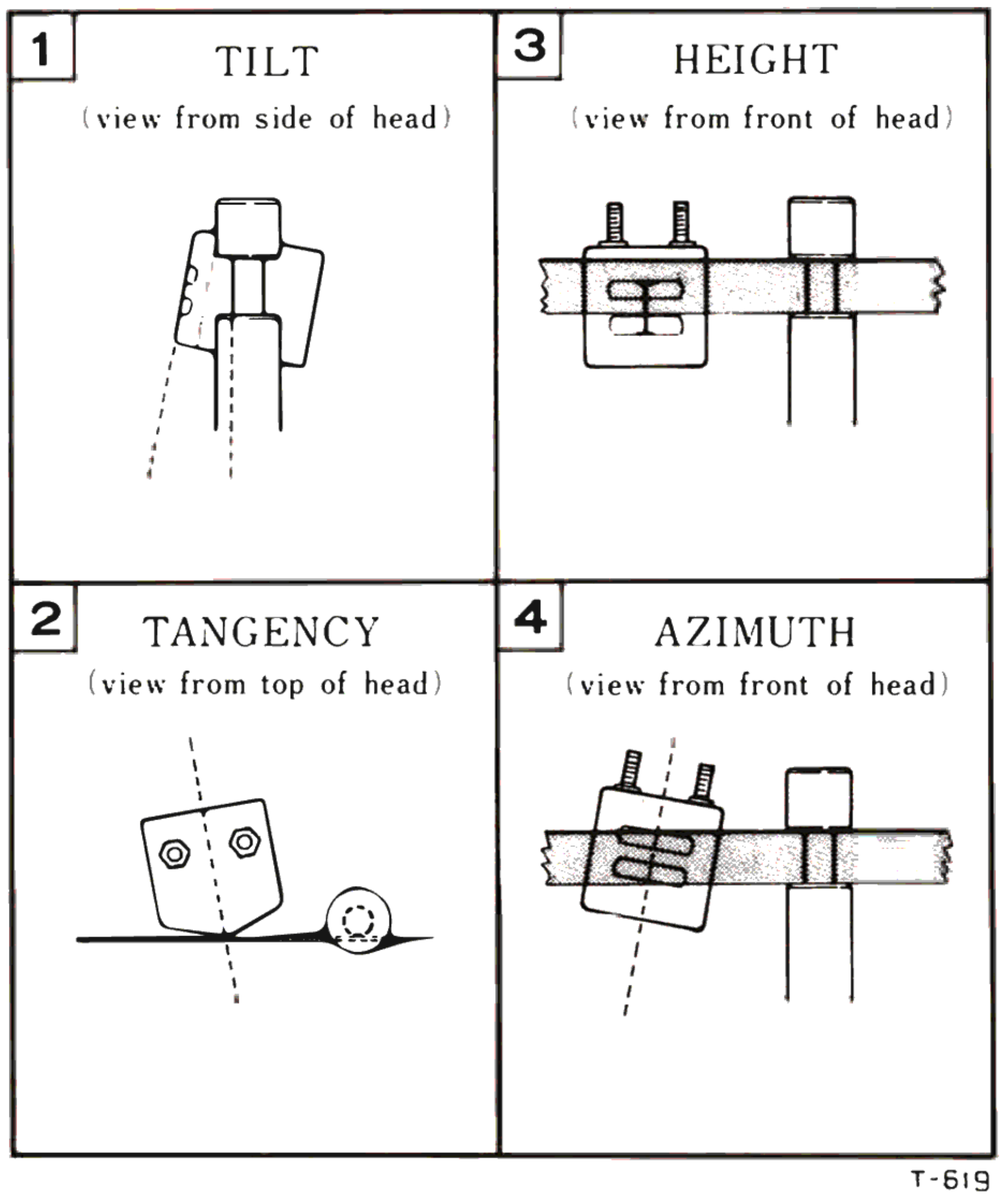


Fig. 17 Head Mis-Alignment-Example

The gaps in the heads that do the erasing, recording, and playing back must be precisely perpendicular to the tape. PRECISELY. Even a tiny error in alignment will make problems for the recorder. If the heads are not in alignment, both with the tape, and with respect to each other, tones recorded on one head will not play properly on the other. In the table below, the error is shown with the loss in dB for 1K and 10K. The amount of tilt is given in the fractions of a single degree called minutes, 60 minutes to a degree. As you can see, it only takes ¼ degree to cause big trouble.

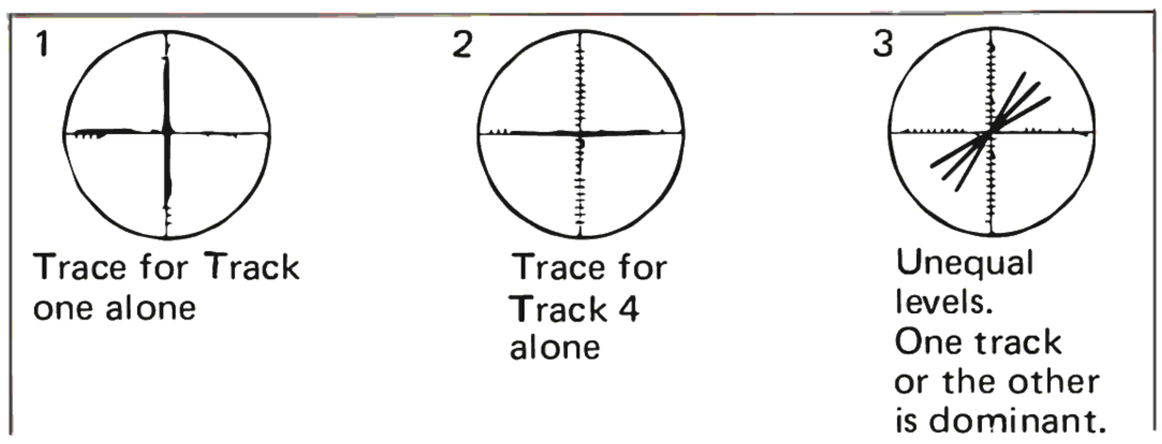
1-Mil Wavelength		½-Mil Wavelength		¼-Mil Wavelength	
Loss in dB	Azimuth Error in Minutes	Loss in dB	Azimuth Error in Minutes	Loss in dB	Azimuth Error in Minutes
0.5 dB	14.86	0.5 dB	7.43	0.5 dB	3.71
1.0 dB	20.90	1.0 dB	10.45	1.0 dB	5.22
2.0 dB	29.21	2.0 dB	14.60	2.0 dB	7.30
3.0 dB		3.0 dB	17.67	3.0 dB	8.83
4.0 dB		4.0 dB	20.16	4.0 dB	10.08
5.0 dB		5.0 dB	22.16	5.0 dB	11.13
6.0 dB		6.0 dB	24.08	6.0 dB	12.04
7.0 dB		7.0 dB	25.68	7.0 dB	12.84
8.0 dB		8.0 dB	27.09	8.0 dB	13.54
9.0 dB		9.0 dB	28.36	9.0 dB	14.18
10.0 dB		10.0 dB	29.50	10.0 dB	14.75

Fig. 18 Loss due to azimuth misalignment for 43-mil quarter-track. (Courtesy, Ampex Corp. Test Tape Laboratory)

Since the 40-4 can use a single head (head #2 in the stack) to perform all functions (recording, sync play and playback) it won't hurt the recorder to use the "whizbang studio alignment" procedure, which is to do nothing about alignment at all. You won't notice anything wrong with the sound you make, but there are drawbacks.

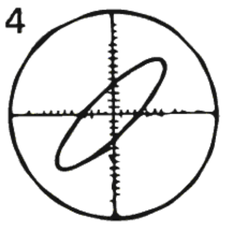
1. Your tapes won't play properly on any other recorder (whizbang standards are unique).
2. No accurate tune-up of the recorder will be possible, as most test procedures use one head as a reference for the other. To do this, they must be aligned perfectly.

Thread the 7½ ips test tape on the recorder and find the operating level section of the tape. Connect the outputs for tracks 1 and 4 of the recorder to the 2 inputs of an oscilloscope, track 1 to the vertical input that makes the beam draw lines up and down and 4 to the horizontal input (draws lines left to right). Set the 'scope to the "Vector" or XY mode. You will have to consult the instrumentation book for the scope to determine how to do this. We don't know what brand of test gear you have. Play the tone, and this is what you should see:



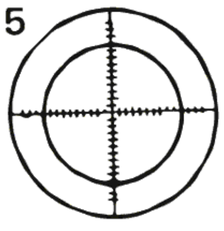
If the lines are not the same length for each track alone, it indicates that the 2 tracks are not putting out the same level. Adjust with the 'scope controls.
If the playback head is not straight up and down, you will see this kind of picture:

4



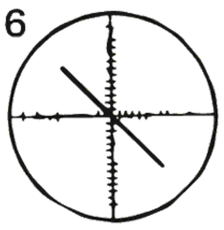
(A small misalignment 30° out of phase)

5



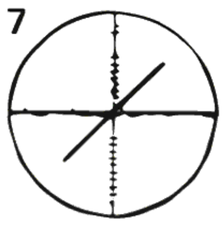
(A larger error 90° outof phase)

6



(A big one, 180° out of phase)

7



(Perfect azimuth 0°, in phase)

Fig. 19 Phase Shift

How much distance error is involved depends on the frequency or pitch of the tone and the speed of the tape. One "cycle" per second at 15 ips would be hard to misalign. To get Scope picture No. 6, you would have to separate the gaps in the playback head by 7½ inches, but one cycle per second is not audio. How about 1,000 cycles per second of tape travel? At 15 ips, the separation or tilt in the head for scope picture No. 6 becomes .0075 inch. And at 15,000 Hz at 15 ips it's .0005 inch. Not much tilt will produce a big error. Slower tape speeds mean even smaller spacings and good azimuth becomes even more important. The proper method of adjustment is to look first at a long wave, say 1000 cycles, and make a coarse adjustment. Then work up in frequency, adjusting shorter and shorter wavelengths smaller and smaller amounts. If you start adjusting with 10kHz or 15kHz, you can make a big mistake. Here's why. . . . Since the very short wavelengths are very close together on the tape, it is possible to get a good "picture" on the scope by adjusting one full cycle off. If you work up to 15K, checking and adjusting as you go, you will avoid this mistake.

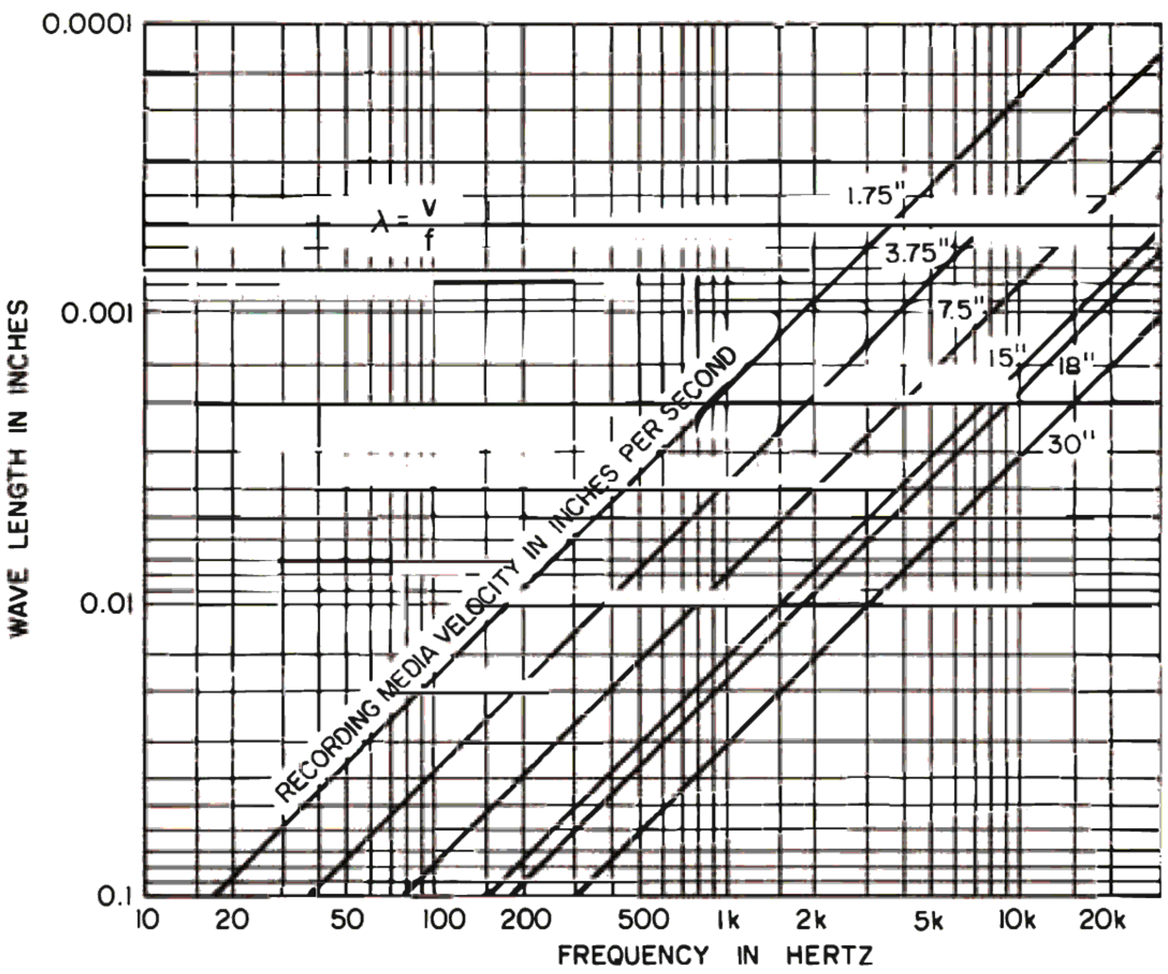
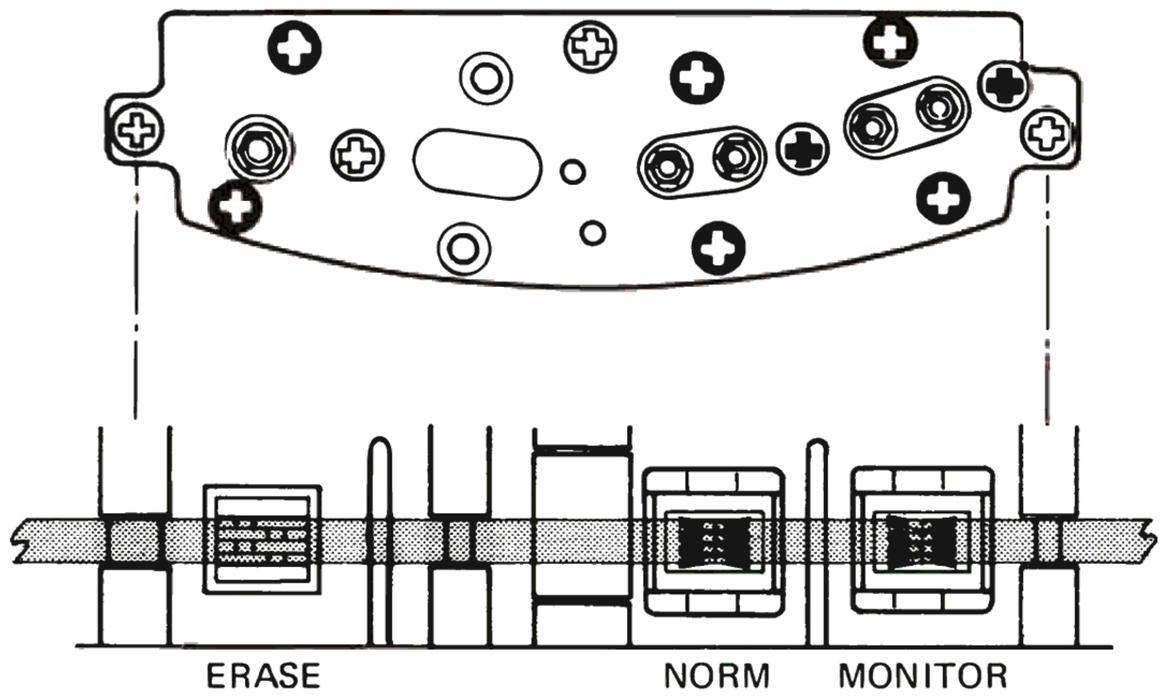


Fig. 20 Velocity of recording media versus recorded wavelength in inches for a given frequency.

Once you have everything set up — the reference tape is playing, the scope is running and showing the x-y display, you need a Phillips head screwdriver and this diagram to find the right adjustment point. Adjusting the screw will rotate the head very slightly.



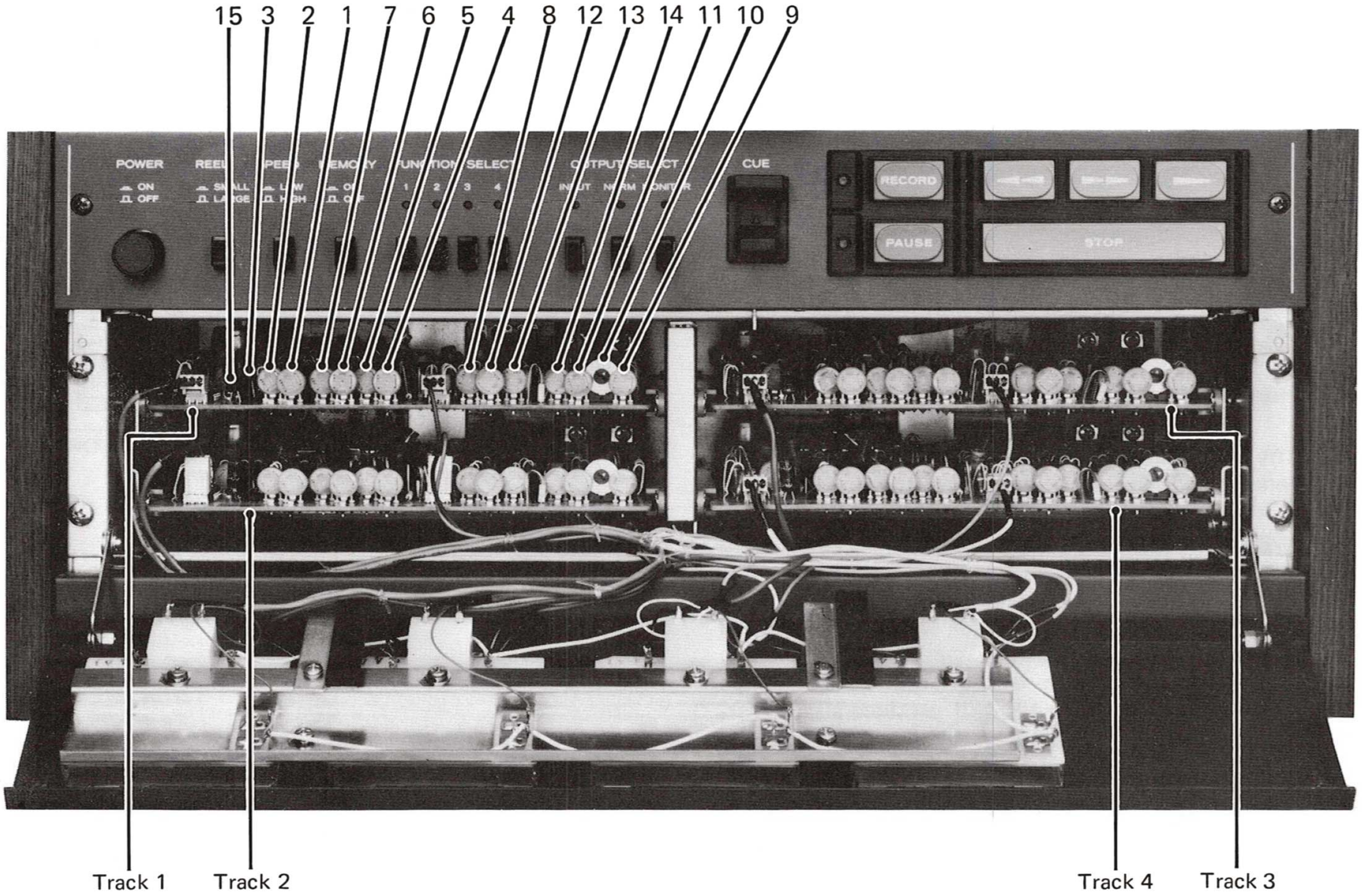
⊕ AZIMUTH ADJ. SCREWS
○ HEIGHT AND TILT ADJ. SCREWS
◎ TANGENCY ADJ. NUTS

Fig. 21 Head Adjustment Screws and Alignment

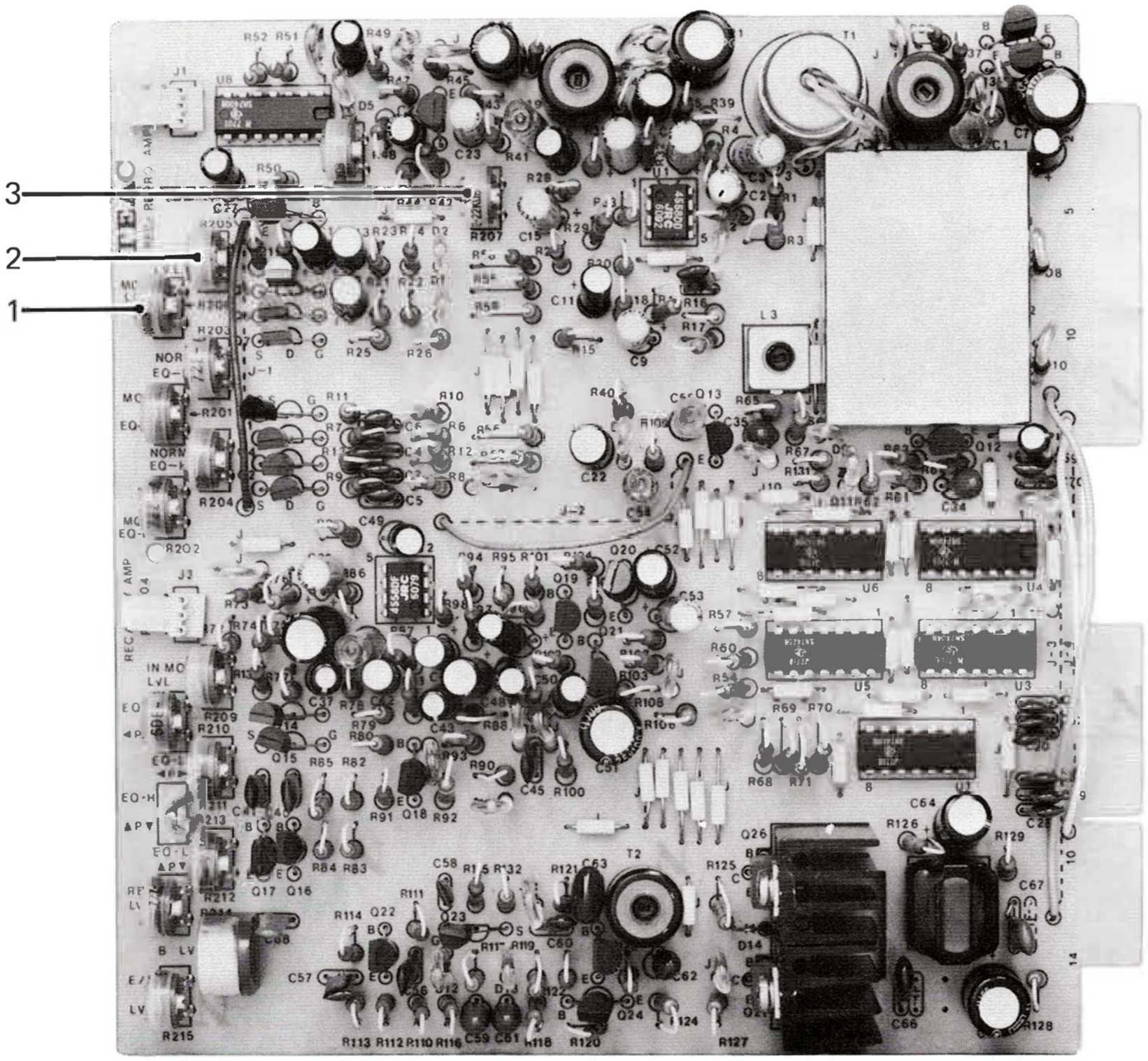
The next step is to play all the signals from the lowest frequency to the highest on the 7½ ips alignment tape — one play for each head position (2–3), and DO NOTHING. Just have a look.
It's not a good idea to turn knobs just to "see what happens." Just because an adjustment can be made doesn't mean it's necessary. The recorder is very solid and is well adjusted at the factory, so in all test and maintenance procedures, check first, then if something is not right, adjust. Taking your time will save endless grief. A new machine is very likely to be "on the money" when you get it and if you keep it clean and degaussed will drift away from top shape very slowly. It's not necessary to plan on a major overhaul when it comes out of the box.

THEORY OF OPERATION-MAINTENANCE (Continued)

Locations of Electrical Adjustments



TRIM POT NUMBER	REFERENCE NUMBER	DESCRIPTION
#1	R206 (MON LVL)	RESISTOR, SEMI, 10K
2	R205 (NORM LVL)	RESISTOR, SEMI, 10K
3	R207	RESISTOR, SEMI, 22K
4	R202 (MON EQ-H)	RESISTOR, SEMI, 6.8K
5	R204 (NORM EQ-H)	RESISTOR, SEMI, 6.8K
6	R201 (MON EQ-L)	RESISTOR, SEMI, 6.8K
7	R203 (NORM EQ-L)	RESISTOR, SEMI, 6.8K
8	R209 (IN MON LVL)	RESISTOR, SEMI, 22K
9	R215 (E/B LVL)	RESISTOR, SEMI, 3.3K
10	R216 (B LVL)	RESISTOR, SEMI, 50K
11	R214 (REC LVL)	RESISTOR, SEMI, 10K
12	R210 (EQ-H)	RESISTOR, SEMI, 3.3K
13	R211 (EQ-L)	RESISTOR, SEMI, 3.3K
14	R212 (EQ-L)	RESISTOR, SEMI, 470
15	R208	RESISTOR, SEMI, 22K



Note: Value of "dB" in the Data refers to 0dB = 1V, except where specified. If a Test Set or VTVM calibrated to 0 dB = 0.775V is to be used, appropriate compensation should be made.

For example, −10 dB (0.3V) is applied to the line in jacks, the VTVM which is connected at the line out put jacks reads −7.8 dB (0.3V) instead of −10 dB (0.3V).

Electrical Adjustment Procedure

When we're sure the playback and record heads are properly aligned, we can move on to the electronic adjustments.

The first step here is actually to check your meter calibrations. Open the service door by removing the four screws, one in each corner, on the front panel. Connect the VTVM to the output terminal of track 1. Turn the machine ON, and thread the 15 ips alignment tape. Play the "operating level" portion (a voice on the tape identifies each section at the beginning).

Switch the OUTPUT SELECT on the 40-4 to MONITOR. Adjust the playback or "reproduce" level with trim pot #1 R206, 10k Ohms MON LEVEL, until the VTVM reads −10 dB (0.3 V).

Switch the OUTPUT SELECT to NORMAL. Adjust the playback level with trim pot #2 R205, 10k Ohms NORM LEVEL, until the meter reads −10 dB (0.3 V). Now read the meter on the front panel of the 40-4. It should read "0 VU."

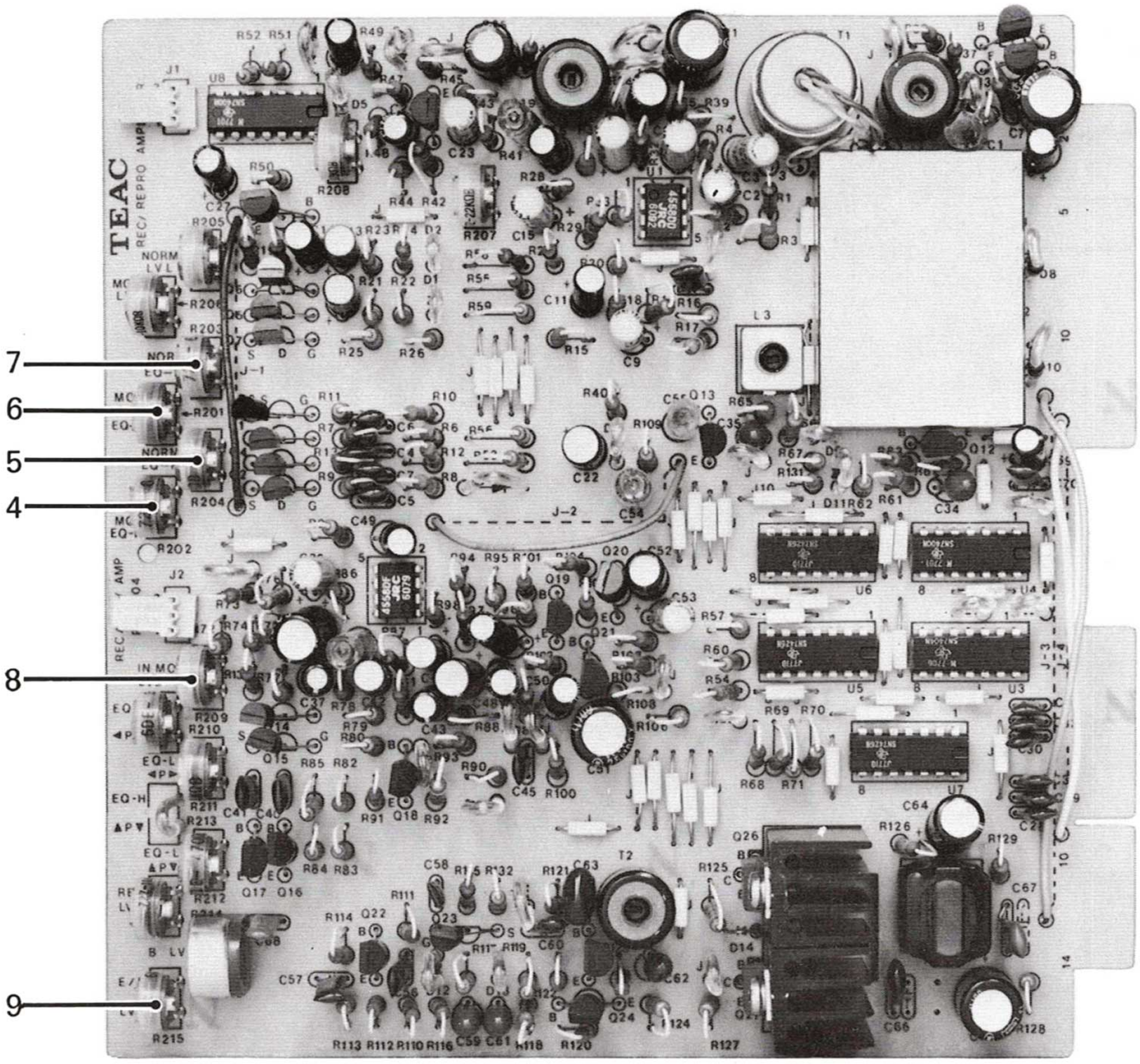
Adjusting trim pot #3 R207, 22k Ohms will allow you to set the meter on the 40-4. You adjust the 40-4 meter to read "0" VU, not −10, the reading on the VTVM. The VU meter will read 0 at any voltage you set it for — the correct one is .316 Volt. This is the right setting for the 40-4. You read −10 dB (0.3 V) on the VTVM and adjust the 40-4 meters to read 0 VU at this level.

Plug the VTVM into channel 2 output. Play the "operating level" section of the test tape. Switch the OUTPUT SELECT to MONITOR, adjust trim pot #1 on track 2 electronics so the VTVM reads −10 dB (0.3 V).

Switch the OUTPUT SELECT to NORMAL, adjust trim pot #2 on track 2 electronics so the VTVM reads −10 dB (0.3 V). Now read track 2 meter. It should read 0 VU. If not, you must repeat the previous procedure for adjusting the meter circuit.

Two tracks still remain to be checked and adjusted, but as you can see, the adjustments are the same as for track 1. In brief:

1. play the tape "operating level"
2. read the VTVM for head 3, MONITOR
3. adjust for −10 dB (0.3 V) reading with trim pot #1
4. switch to NORMAL on OUTPUT SELECT
5. read the VTVM. Adjust trim pot #2
6. read the meter on the 40-4 — it must read 0 VU
7. adjust the meter trim pot #3 R207.



Electrical Adjustment Procedure

You do this for all 4 tracks: 8 level sets and, if necessary, 4 meter trims. Don't get discouraged. When you are unfamiliar with anything, it takes more time. Practice will speed things up. The entire adjustment procedure involves reading and setting (if necessary) about 68 controls. When you are used to doing it, it should only take about an hour and a half. Have patience, you'll learn soon enough. It is absolutely worth it.

One more word of encouragement. The circuits in the 40-4 are very stable. Most of the time you will make a reading and not have to adjust anything. When something does go wrong, you will be able to fix it very quickly, and get back to recording.

In summary, with the VTVM and test tape, you have adjusted the playback level on the 40-4 to the test tape. But your playback reference is not yet complete. You have only "zeroed" one point on a line of frequency response. To establish the rest of the line, you must measure and adjust one more frequency.

Advance the alignment tape for 15 ips to the section that is recorded at 16 kHz and adjust the trim pot marked MON EQ #4 R202, 6.8 kOhms – switch to NORMAL on the OUTPUT SELECT, and adjust trim pot #5, R204, 6.8 kOhms NORM EQ. The reading for both positions should be –10 VU on the 40-4 meters. Since you have checked and adjusted the playback meter circuit, you now can use the meters on the 40-4 for the test readings.

By adjusting all of the preceding trimmers, you have established two things: an operating playback level or "zero", and a playback frequency response reference. You know that both heads on the 40-4 are reproducing the test tape in an identical manner, at 15 ips.

You now repeat the frequency adjustments for both heads at 7½ ips. Change test tapes and use trim pot #6 R201, 6.8 kOhms and adjust the high frequency playback response for "MONITOR." The reading on the meter should be "–10 VU." If you are still using the VTVM, the reading will be –20 dB. The test frequency is 10 kHz.

Repeat the adjustment for "NORM" trim pot #7 R203, 6.8 kOhms at 10 kHz. The reproduce response section is now complete for both speeds.

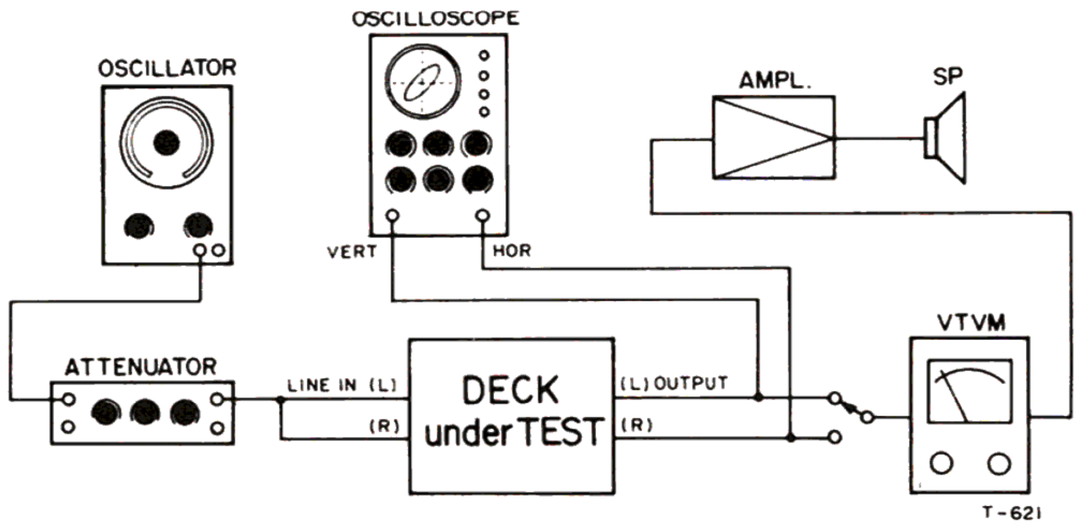


Fig. 22 Test Connection for Recording Check

Now you can use the MONITOR head as a test instrument to check and adjust the record circuits. Almost all of the following steps involve recording a tone on a tape and reading the playback output of the recorder. YOU WON'T ALTER THE PLAYBACK CONTROLS. They are now all set. You will make all necessary adjustments by trimming the record electronics.

This way, you can be sure that the recordings you make, no matter what brand of tape you use (the brand of tape becomes part of the test procedure when you record your test tones on it), will playback properly on any 40-4.

The alignment tape can be put away. Before storing, the tape should be played all the way from front to back (not fast wound), and stored tails out, so it will last longer. Even if you decide not to attempt any major maintenance yourself, we strongly suggest you purchase an alignment tape. An occasional playing will tell you when you need to call the "doctor". It's good insurance to know the truth.

The record adjustments begin with the INPUT MON LEVEL trim of the 40-4. The INPUT MON LEVEL controls the meter reading of the signal as it arrives at the electronics (before it is recorded). You must be sure you are sending the right amount of signal in before you can adjust record levels and equalization controls.

Connect the reference level, or signal generator to track 1 input on the 40-4. The correct level is −10 dB (0.3 V).

The frequency to use is 1 kHz. Rotate the front panel knob to the "2 o'clock" position. It's a good idea to mark it. Check the OUTPUT SELECT. Make sure you have the button marked INPUT depressed. If you get a reading, use trim pot #8 R209, 22 kOhms, INPUT MON LEVEL, and adjust the meter to read 0 VU. As always, repeat this check on all 4 tracks of the 40-4.

Plugging and unplugging test equipment can be tedious. You can save some time by doing a reference check on your mixer. If you know that your console meter reads 0 VU accurately (check it with the VTVM), you can assign the reference oscillator signals to the 40-4 through the mixer connections to the inputs. Assign, read, adjust: next track, assign, read adjust. . . no need to pull plugs.

At this point in the adjustment procedure we'll stop for a time and talk about a major section of the recorder electronics. The Bias Oscillator and its related circuitry. The Bias Oscillator produces a very high frequency signal that does two big jobs in the 40-4. It supplies the 100 kHz (one hundred thousand cycles per second) frequency to the Bias Amplifiers in the 40-4. There is a Bias Amplifier on every card, one for each track. The Bias Amplifier provides power for the erase head and bias signal for the record head. Erasure is easy to explain, so we'll tackle that subject first. A lot of power is used to remove all signal from the tape just prior to its being recorded. The erase head has a rather large gap and completely cleans off any magnetic field on the tape by brute force. No new signal is recorded by this head. The gap is much too large to be effective as a recording device.

From the same amplifier, current is added to the record head circuit lead. This high frequency signal overcomes magnetic inertia in tape, and gets everything moving. If there were no "starter current" to help the record signal, we would see this kind of trouble on a scope.

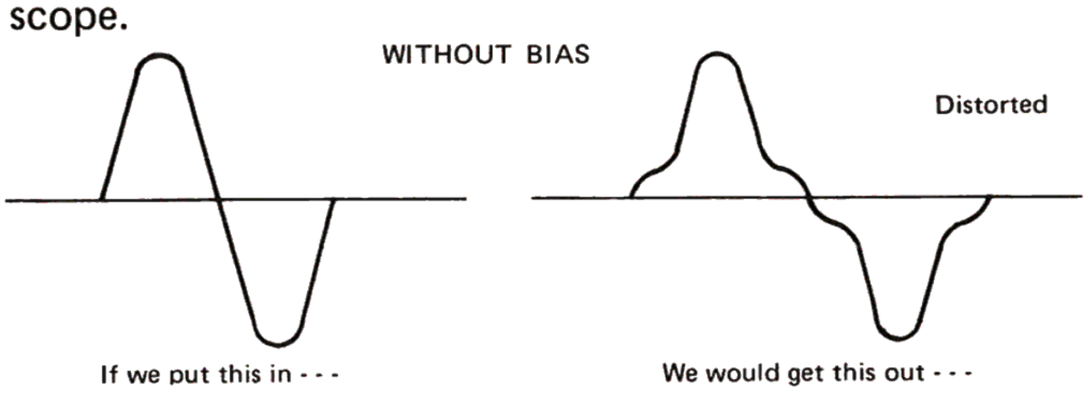


Fig. 23

The beginning and ending points of the wave would be distorted by the reluctance of the iron bits to change their magnetic state from one polarity to the other. Crossing that zero line takes extra energy. The Bias Signal provides it. We put in this:

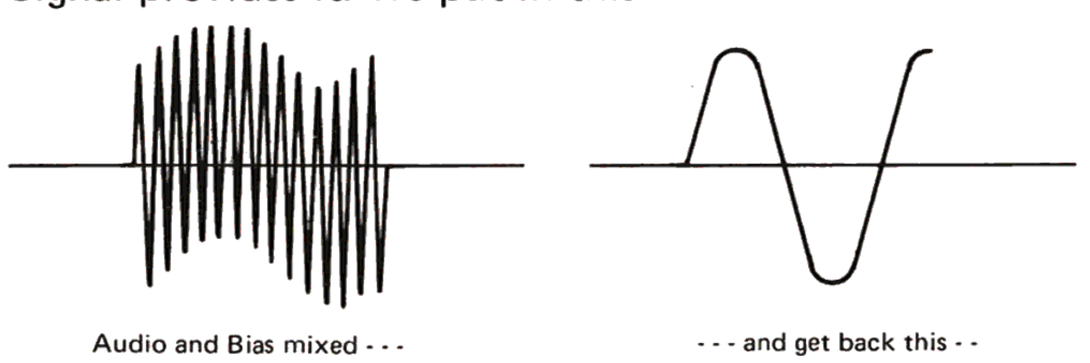
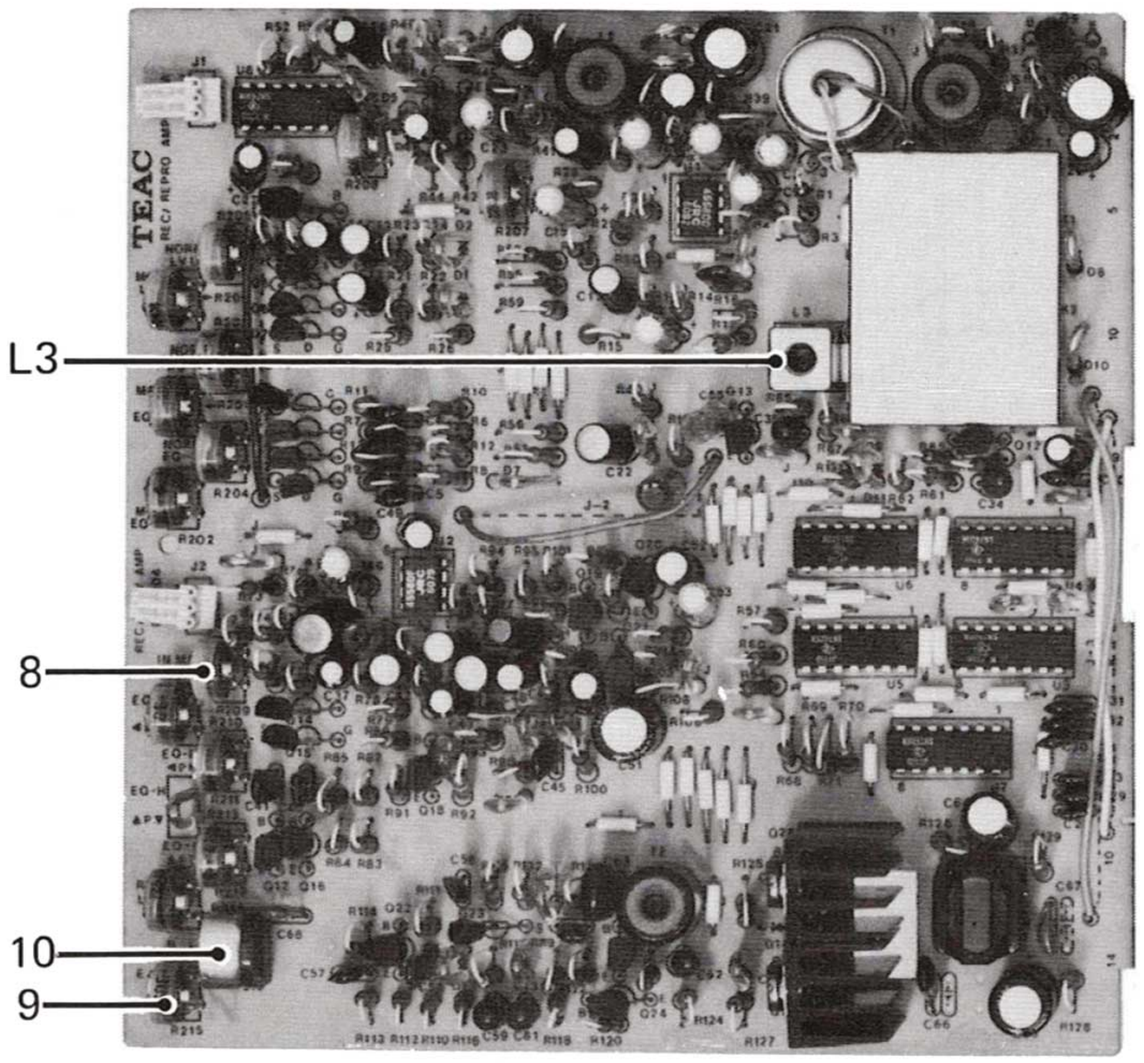


Fig. 24

Where did the 100 kHz go? It disappears from the output because the head gap is too large to play it back. The individual changes of magnetic energy on the tape are smaller than the gap size so a plus and a minus wave are both within the gap at the same time. They cancel out. Marvelous! On with the problems of alignment.

Well, maybe not so marvelous. Because of the fact that there is one amplifier doing 2 separate jobs. The adjustments we make on one circuit will affect the other. In fact, there are 3 interacting circuits and life can get pretty tricky right here. The 3 adjustables are (in sequence):

1. The erase current adjustment trim pot #9 R215, 3.3 kOhms E/B LVL
2. The bias current (for the record head) trim pot #10 R211, 50 kOhms B LVL the large blue one.
3. The bias traps. Since there is a lot of power involved here, you have 2 problems. The record bias signal must not go to the record electronics, only to the head so there is a big high frequency filter (very high, just to keep the bias out) on the wire to the record head.



Electrical Adjustment Procedure

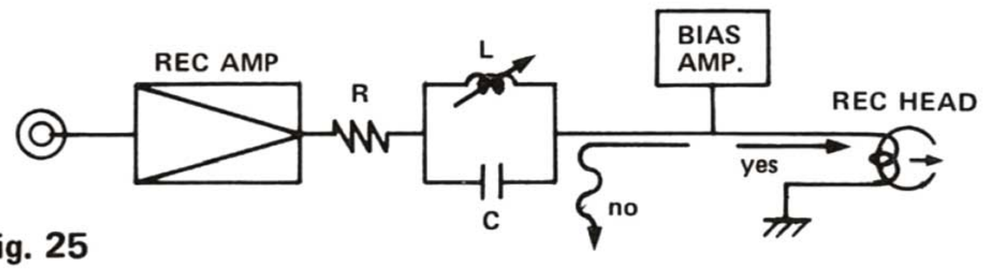


Fig. 25

These adjustable circuits are on the card inside, and the extender must be used if adjustments are necessary. We've given you the bad news (they interact). Now we'll give you the good news. Unless you adjust the erase current or the bias current by a very large amount, you won't need to check these circuits more than once every six months or so. The traps seldom need adjustment unless something is wrong with the master oscillator. The "traps" are expected to tune out the 100 kHz frequency that the bias oscillator is producing, and the range of adjustment that they have is not very good at filtering a much different frequency. If the master bias oscillator drifts, it must be re-adjusted to produce 100 kHz. Since this bias oscillator master circuit adjustment requires something expensive (very) called a frequency counter, it's wise to assume it's a dealer problem. Cart it in for this kind of service. There are also bias traps in the playback circuit to keep any stray leaks out of them as well, but they are not as touchy as the record-related circuit traps, and won't affect the load on the bias amplifier. They are tricky to adjust, but very stable. In sequence, you adjust them (if necessary) at the very end of the entire alignment procedure so we'll mention them again.

Let's get back in sequence again. First – the erase adjust. The idea here is to make sure all signals come off the tape when you want them to, so you record a 1 kHz tone on the brand of tape you wish to use at 0 dB level, that's +10 VU, full saturation and then, erase it (record no input signal over the tone). While erasing, you read the output with the VTVM and a 1 kHz filter. Since the filter will "pass" only 1 kHz, you should get a reading of –65 dB. If the reading is higher than that, you need more erase current. Adjust trim pot #9 R215, 3.3 kOhms to correct the reading to –65 dB. This circuit does not require daily or weekly adjustment. Once every 6 months should do, unless you hear signal left on the tape when you are working. The filter is TEAC part No. M-206. You connect it between the recorder output and the meter (VTVM).

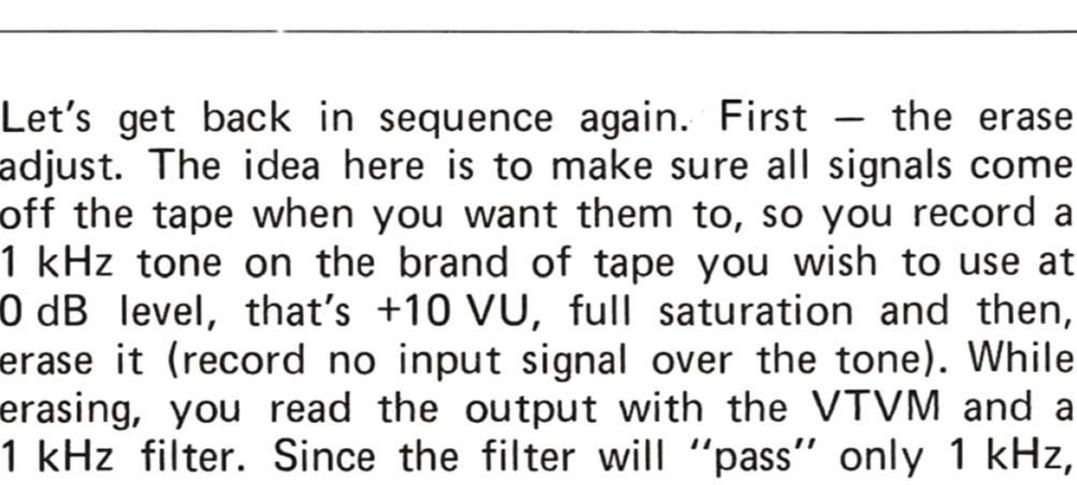


Fig. 26 Test Connections for Erase Measurement

BIAS LEVEL ADJUST: This adjustment is made while you are recording a tone on the type of tape you'll be using for the session. It will be different for each brand of tape.

Set up the signal generator (oscillator). The frequency is 10 kHz. The level should be 0 VU on the meters of the 40-4 on INPUT. Start the machine, record the signal, and switch to MONITOR on the OUTPUT SELECT. Raise the bias level by rotating trim pot #10 R216, 50 kOhms, BIAS LEVEL, until the VU meter rises, peaks out as high as it will go, and starts to fall back. Reduce the peak reading by 5 dB by turning the trim pot clockwise.

If the meter goes off scale, adjust the front panel input level control to keep the reading on scale. What is important here is not the zero. It is the reduction of the peak by precisely 5 dB. If you have moved the input level pot on the front panel of the 40-4 to keep your reading on scale, the next adjustment will correct your input reference.

With the oscillator running at 1 kHz, switch back to INPUT. Adjust the front panel input knob to 2 o'clock position and adjust trim pot #8 R209 in MON LVL for 0 VU indication on meters.

Now is the time to do the bias trap in the record circuit: the card extender is used. With no input signal, test point is located on the card. Positive side of VTVM is connected to test point, negative side to ground. Tune inductor L3 for minimum.

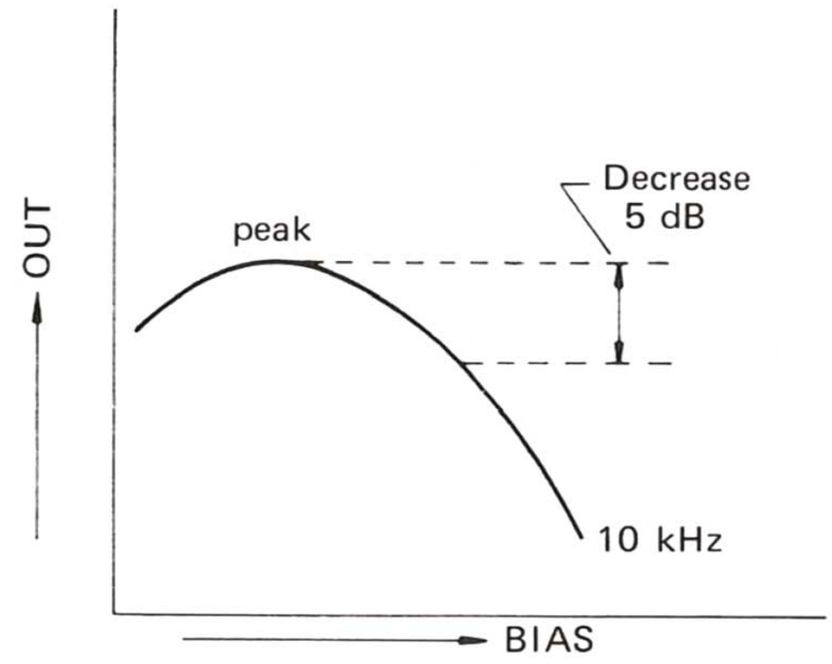


Fig. 27 Bias Limits Chart

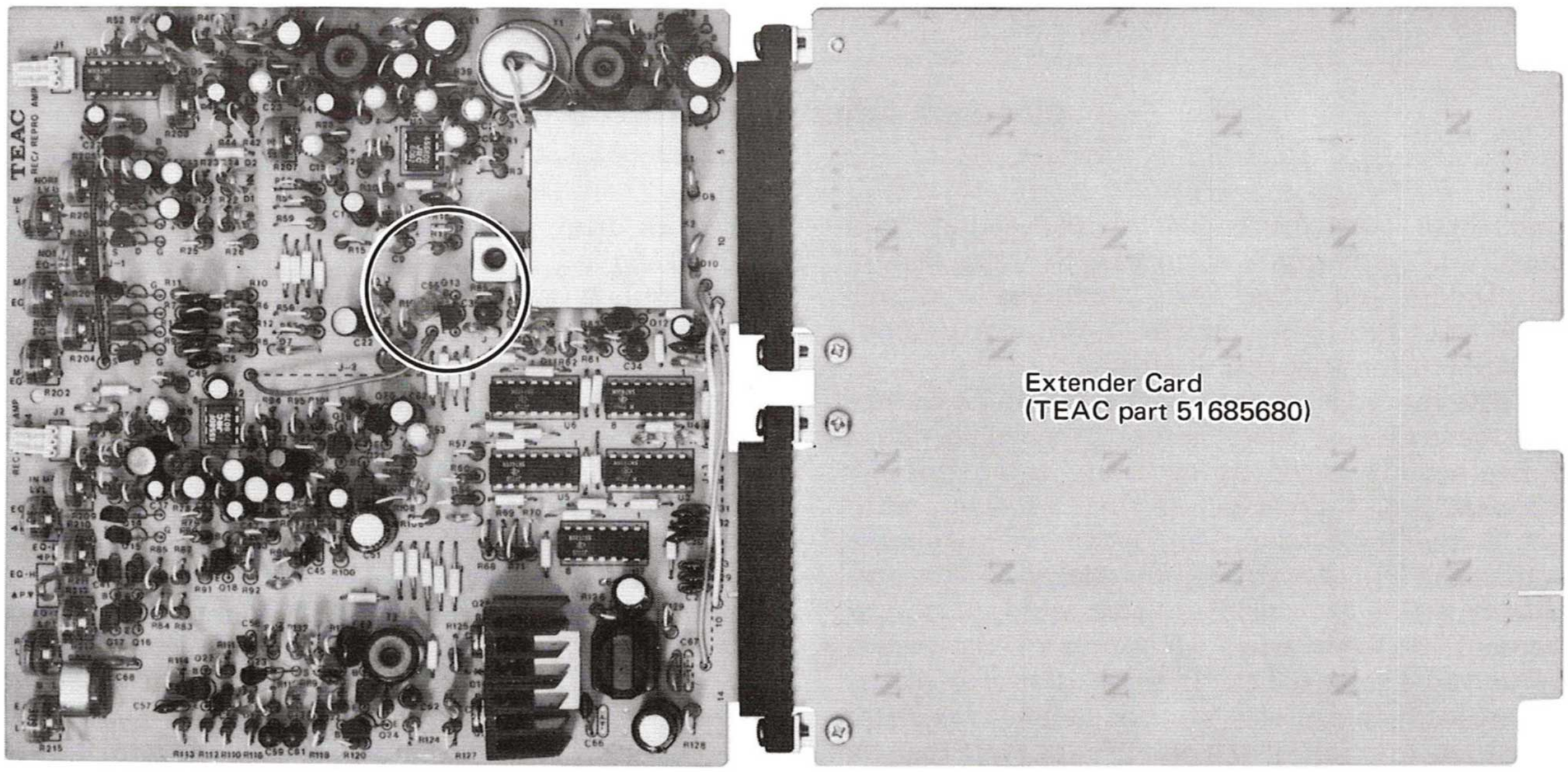


Fig. 28 Using Extender Card for access to Bias Trap Test Point

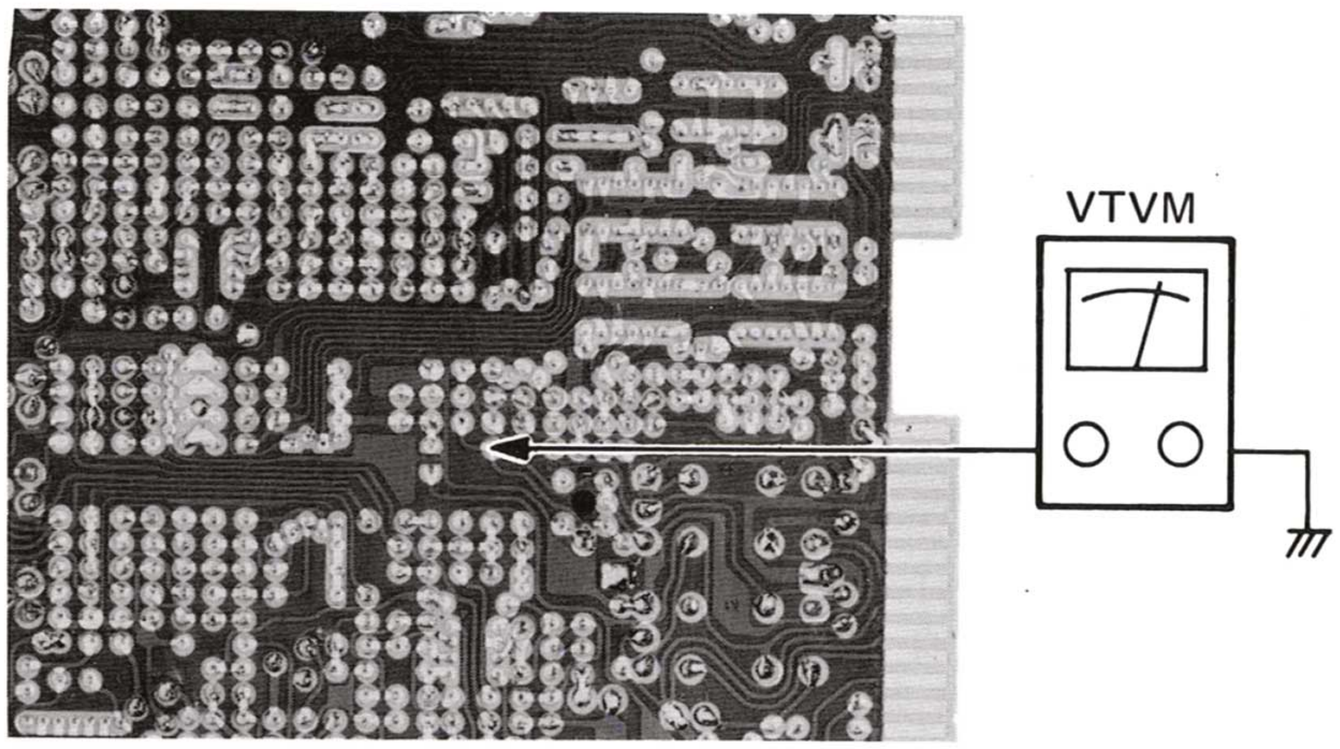
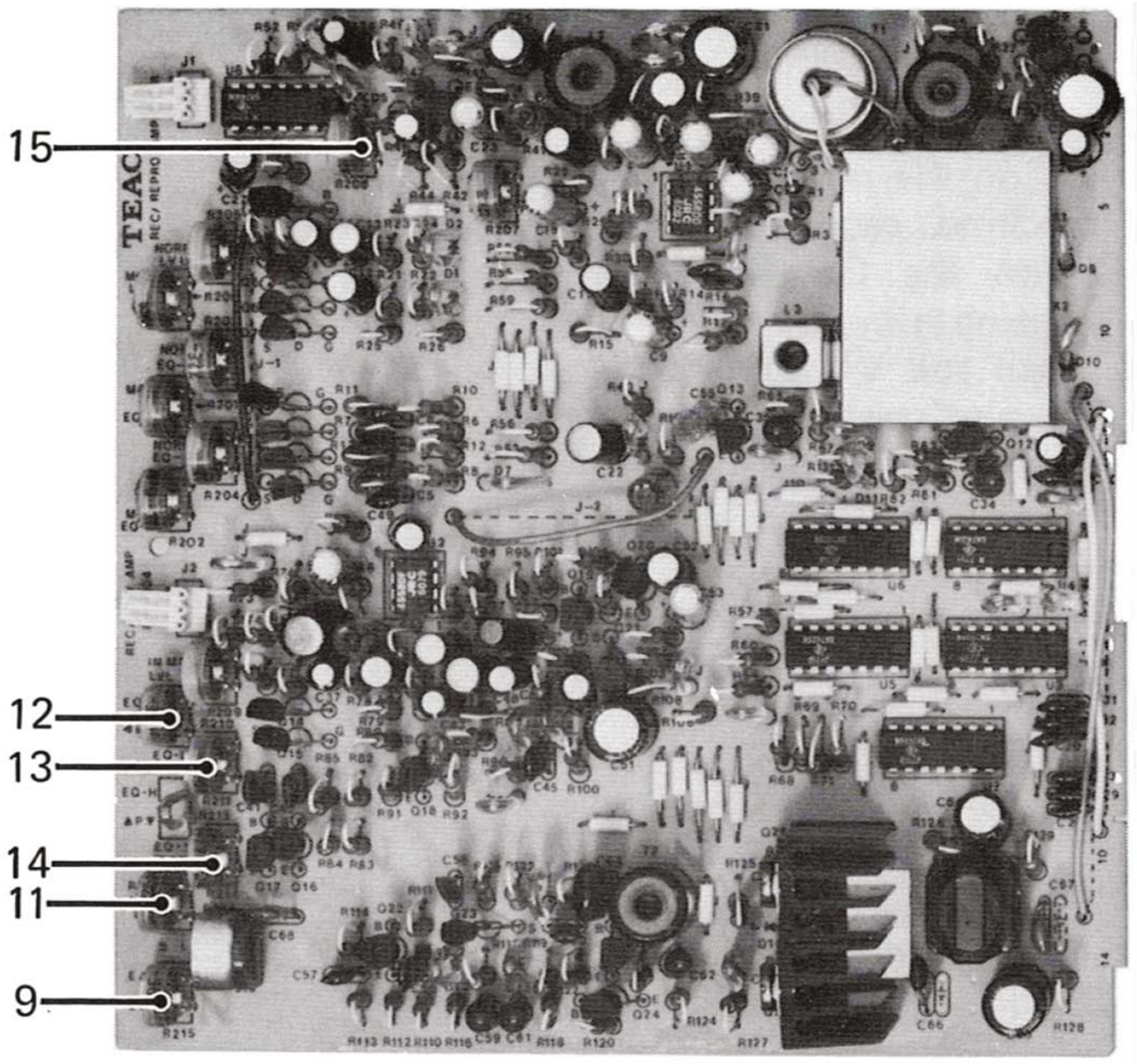


Fig. 29 Bias Trap Check Point



Electrical Adjustment Procedure

We give these adjustments just to be accurate and thorough, and remind you again that they are seldom needed. Unless you have made some really drastic change in your recorder, you should not worry about this adjustment for at least 6 months.

Again, to be thorough, at this point it would be wise to check erase and bias again before proceeding. On a major overhaul it might be necessary to go through these 3 steps 3 or 4 times before finally moving on to the record equalization and then, once more from erase through to the end. Describing this procedure this way is probably giving the manufacturing setup, or a head replacement sequence when all values of the record circuit must be re-qualified. If noise is heard, signals don't erase completely even after adjustment, or there is not enough rotation of the bias trim pot left to get a "drop" in bias, the whole adjustment should be considered, but only under these unusual circumstances.

However, we do recommend that you select a brand of high quality tape and stick to it. Changing bias every day for different tapes will make the recorder cranky and a little harder to adjust. Constant messing with the controls is unwise. It is a much better idea to do as little as possible and let the recorder "settle in" to one kind.

We are now ready to adjust the record circuitry. We first check the low frequency input level at 1 kHz to get a reference. The steps are as follows:

1. Adjust oscillator to 1 kHz
2. Select "INPUT" on OUTPUT SELECT buttons
3. Send in .316 volt, set "0 VU" on 40-4 meter
4. Record the tone at 15 ips.
5. Switch to "MONITOR" read 40-4 meter
6. With trim pot #11 R214, REC LVL, adjust to "0 VU".

With only a few adjustments remaining in the complete procedure, let's review all you have done up to this point. Step by step, you have:

1. Cleaned and degaussed the tape path.
2. Adjusted the head azimuth of both heads to 90° by checking and adjusting progressively higher and higher frequencies.
3. Checked the 40-4 meters against a precision meter and set .316 volt output as "0 VU" playback.
4. Adjusted playback from both playhead positions to be "0 VU" at 1 kHz and at 15 kHz – at both speeds, using the test tapes as an absolute reference of magnetic level.
5. Applied a reference level to the input of the 40-4 and adjusted the "0 VU" point to be .316 volt, both in the circuit and on the meter.
6. Set the erase level, using blank tape of your selected brand and type.
7. Set bias level for the tape of choice.
8. If you have the equipment, make sure no bias is going to the record amplifiers.
9. If you have the equipment, set (after bias) the record "0 VU" and read it off playback. You now know that the tape you are making has the same level of magnetic flux recorded on it as the reference alignment tape, but only at 1 kHz, the basic adjustment frequency – you now select 18 kHz and adjust trim pot #12 R210, 3.3 kOhms, EQ-H, and read playback from the MONITOR position. Adjust to "0 VU". One setting remains to be done at 15 ips and 2 settings at 7½ ips. We'll finish the faster speed before we do the lower speed.

The Peak Adjust Circuit

The trim pot in this circuit only has a very small range, ½ dB. It is for final high end adjustment. The frequency to send in is 20 kHz, record the tone at "0 VU" in, switch to MONITOR and read the result. Adjust trim pot #12 R210, to read "0 VU" in playback.

Both of the record equalization circuits have rather a small range of adjustment. The high frequency adjust is 3 dB, the peak adjust is ½ dB. If you can't seem to get a "good" reading because you run out of adjustment range, check these 3 points.

1. The "Record adjust" (point #9 in this review). Re-do, send in "0 VU" at 1 kHz. Record the tone and read playback. If it is low, it will be impossible to get 15 kHz or 20 kHz up to "0 VU." Reset and try again. Still no good? Re-check the bias. If the bias current is too high, the high frequency sensitivity is reduced in relation to the 1 kHz point. Check it out.

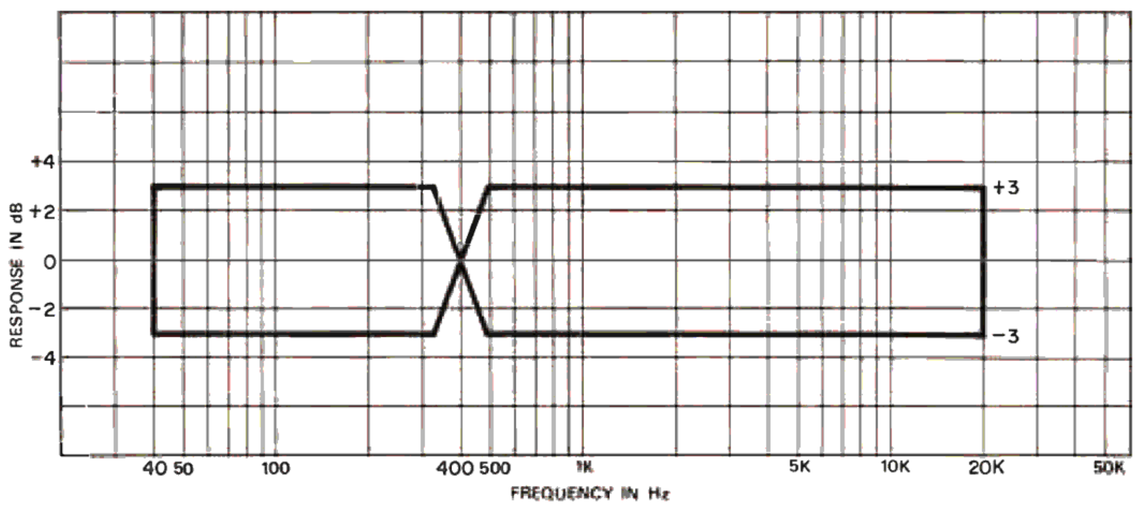


Fig. 30 Frequency Response-OVERALL (HIGH 15 ips)

If all this fails to produce a reading that lies within the tolerances for frequency response on this graph, it is time to replace the heads. If more equalization were added to the record circuit to overcome wear, the boost needed would be large enough to make the Signal to Noise ratio specification impossible to achieve.

Let's assume everything is OK so far. You have sent in and read back good numbers for 15 ips, everything in spec at both frequencies. Now, as a check, record everything you have on your tone generator (if it is variable be reasonable, say 10 frequencies) 40 Hz, 100 Hz, 400 Hz, 1 kHz, 4 kHz, 10 kHz — compare with the graph above.

Fine tuning the bias against the frequency trim pots will allow you to get a little closer to perfectly flat. It's time consuming but worthwhile. Suit yourself.

Now we'll repeat this whole process for 7½ ips:

1. Send 1 kHz in record, switch heads, check playback.
2. Send 1 kHz in at "−10 VU." Remember, the 7½ ips alignment tape is recorded at the lower level, so we do the record EQ for low speed at the same "−10 VU" level.

   Record the tone, switch to play, read the meter (adjust to "−10 VU" with trim pot #13 R211, 3.3 kOhms, EQ-L, and then peak adjust — the frequency 15 kHz, the trim pot is #14 R212, 470 Ohms, EQ-L.

Since there is only one bias setting for both speeds, it is wisest to fine tune for the speed you use the most. Here is the specification graph for the low speed frequency response. Remember, −10 VU record level.

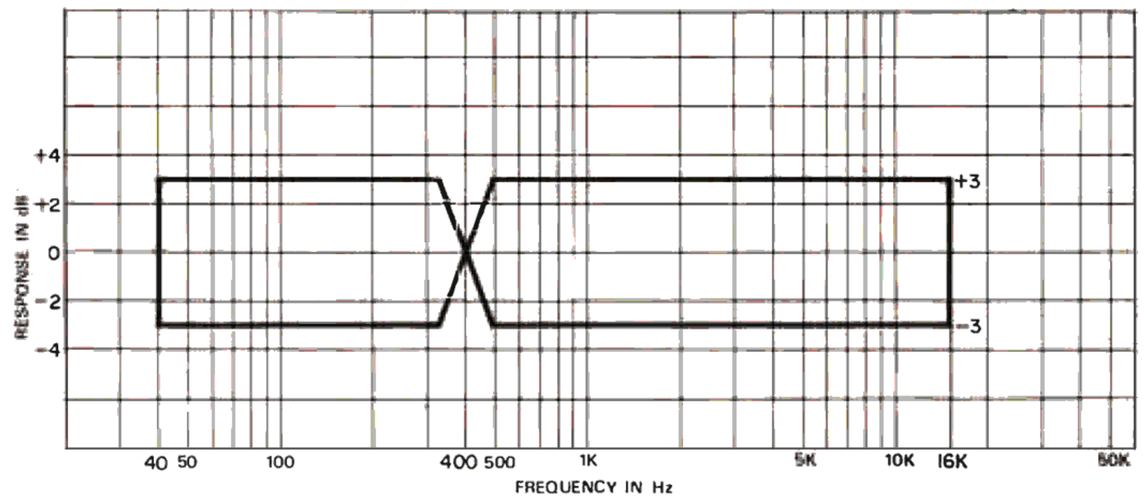


Fig. 31 Frequency Response-OVERALL (LOW 7½ ips)

Remember the bias traps? We've discussed the adjustment of the bias traps in the record circuit and what they do and now that we're done with the final changes to the record equalization, we can measure the Signal to Noise performance and tune the playback bias traps. Connect the VTVM to the output of the recorder. Use the card extender (Part 51685680). Locate the play bias traps on the card. With the unit in RECORD but no signal other than the bias being recorded, adjust for a minimum reading on the TEST meter (VTVM).

We suggest that you do this LED adjustment as rapidly as possible. +10 VU is not good for the meter movement. More than one minute of operation at +10 may damage the armature, so set everything up before applying the signal and be brief.

While you have the extender card on the electronics we should describe the LED or peak reading adjustment. Examine the diagram/illustration to find the trim pot. Switch the 40-4 to INPUT and send in a signal of 1 kHz at a level of 1 volt (0 dB, +10 VU). Adjust the trim pot #15 R208, 22 kOhms until the LED goes on.

With the 40-4 all buttoned up and the service door closed you can now check the Signal to Noise ratio of the whole system. You use the big test meter and a noise filter. Record with no input signal and read the result. The reading should be — [illegible] dB or better.

That's it. The whole procedure for an electronic overhaul of the 40-4. Mechanical adjustments such as brake and holdback torque, reel height adjust and wow and flutter measurements must be done first, but they are major service and should not be necessary "out of the box." The transport logic control and switching system are described in the service manual.

DAILY SETUP

It's obvious that this entire procedure is not something that can be completed quickly. You don't begin a "major" ten minutes before the musicians arrive. It is not likely to be necessary every day, but what is reasonable? Most good engineers make two quick tests. If nothing is amiss, they start setting up the rest of the session with confidence. If there is a problem, they go further. Here is what they do.

1. Clean and degauss. Obvious first step.
2. After the recorder has been on for 10 minutes and is nicely warmed up, they check the playback response with the test tape. A little trim? OK, no problem.
3. They then set up the signal generator and record several frequencies, say 100 Hz, 4 k, 10 k. Looks good? Then we can begin.
4. A very fussy engineer will take a look at the bias adjust to make sure everything is OK there as well, before he looks at the record EQ.

These three quick checks will usually uncover any serious troubles, and the idea is to work backwards up the chain of adjustments if anything shows an error. "Playback" is the first step in a major overhaul, and Record EQ is the last.

If everything works OK, you can assume all is well. If you get something funny as a reading, you will have to track it down, but these three tests will usually give you some idea of where the problem lies. Work backwards through the recorder (that's forward through the adjustments, by the way, they run from back to front in the procedure, don't get confused) until you uncover the problem. You always clean and degauss, and you should always check the playback response with the test tape. Again, playback, bias, record check, no problems, OK, go, and good luck with your tapes.

Speaking of tape, we strongly suggest that you buy good quality tape and stick to one kind. White box tape is cheap for a reason. It doesn't perform as well as the "good stuff," and will be hard to tune up to, and may even damage your recorder. Excessive shedding of oxide, uneven slitting and other defects too numerous to mention will make all your efforts go for very little. Tape is important, use the best.

It's awkward to flip pages in doing the test procedures, so we are including a chart of all the adjustments in their proper sequence on one page. Once you have the idea, all you need are the trimmer numbers and such. Here they are.

GENERAL ADVICE ON MAINTENANCE

Don't attempt to adjust a stone cold machine. Turn it on and let it warm up for 10 minutes.

Don't adjust the "traps" with a metal screw driver or tool. The metal tip will affect the value of the part and will give false readings. Use a plastic T.V. adjustment tool, or cut a strip of rigid plastic to size. (Credit cards will work, if you have an old one you don't need.)

Suspect any large change in adjustment that happens all at once.

Stop and think, if you turn a pot and get no change in reading, have you adjusted the wrong control?

Always turn the machine "off" when installing the extender card.

Remove the alignment tape from the heads when switching power "on" or "off." A switching transient on a badly adjusted recorder can "print" on the tape.

Tape and electronic "hiss" should be smooth sounding. If, when recording, you detect popping, or sputtering noises, degauss the heads. If this doesn't change the sound, plan on a record bias trap adjustment.

If the oscilloscope picture is not stable when using the alignment tape (the trace opens and shuts like a mouth) suspect the holdback torque adjustment. When recording and playing test tones, suspect the tape slitting as well as the motor adjusts. If the reference tape doesn't do this, but the recording tape does, it's definitely not the recorder. It is the tape that is at fault.

At the end of a session, take the time to slow wind (play) the roll off the machine and store it "tails out." This is the best way.

Don't plan on recording over a splice. Any steady tone such as singing, or violins that you attempt to print over a cut in the tape may show a dropout, or momentary interruption. Even the best splice in the world is thicker than normal. The splicing tape adds quite a lot, and makes the tape "bump" when it goes by the head. This is especially important if you are using DBX. The dropout will be made much more noticeable by the action of the DBX.

It is a good idea to pad your master tapes by winding some blank tape on both ends, and adding leader tape.

Put a test tone (1 kHz) on each tape for reference level checks. Then it's easier to set up machines and mixers when recording sessions occur on different dates or different machines.

Keep a TRACK SHEET. Write down what happened during the session and what went on to the tape. You might list such things as mic placement; complete/incomplete takes; brand of tape used; speeds; noise reduction; comments (for example: a producer might have liked a particular bass part more than others, so you can save it and use it during overdubbing and mix-down).

Have the tools-of-the-trade handy — leader tape, razor blades, splicing tape, masking tape, grease pencils, etc.

There's another old saying around studio circles: if it's not labeled, use it. So it's a very good idea to label all tape boxes and reels. And pack a track sheet in every box.

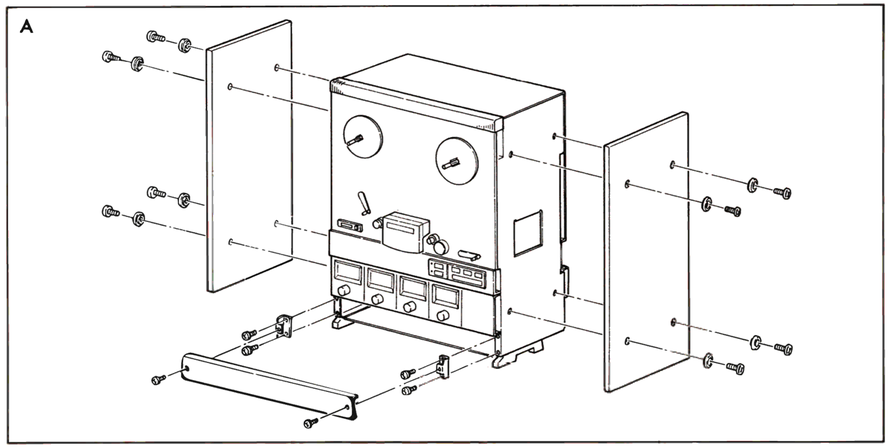
When you're not working on a tape, it's safest to put it in its box; don't leave it on the machine where an accident could wipe out weeks of work.

SERVICE CHART

AD-JUST STEP	WHAT IS IT CALLED	SIGNAL SOURCE AND AMOUNT	WHAT TEST GEAR TO USE	WHAT IS THE RE-CORDER DOING?	POINT TO ADJUST	WHAT READING TO ADJUST FOR
1	Playback head Align-ment	TEAC YTT-1003 Playback Alignment Test Tape (7½ ips)	VTVM and Oscillo-scope with vertical and horizontal inputs connected to OUT-PUT tracks 1 and 4.	Playback at 7½ ips speed. OUTPUT SELECTOR at MONITOR	Play head #3 azimuth adjusting screw.	Adjust for maximum output and for output of tracks 1 and 4 less than 90° out of phase. (at 10 kHz)
2	Record head Align-ment	Same as above	Same as above	Playback at 7½ ips speed. OUTPUT SELECTOR at NORM	Record head #2 azimuth adjusting screw	Same as above (at 5 kHz)
3 *	Playback Level (head #3)	TEAC YTT-1004 Playback Alignment Test Tape (15 ips)	VTVM connected to OUTPUT terminal	Playback at 15 ips speed. OUTPUT SELECTOR at MONITOR	Trim pot #1 R206 (MON LVL)	−10 dB (0.3 V) on VTVM
4 *	Playback Level (head #2)	TEAC YTT−1004 Playback Alignment Test Tape. Play 400 Hz reference level signal	Same as above	Playback tape at 15 ips. OUTPUT SELEC-TOR at NORM	Trim pot #2 R205 (NORM LVL)	−10 dB (0.3 V) on VTVM
5 *	Meter Adjustment	Same as above	VU Meter	Same as above	Trim pot #3 R207	Adjust to read 0 VU on VU meters
REPEAT STEPS MARKED WITH AN ASTERISK FOR EACH CHANNEL. THE ADJUSTMENT NUMBERS ARE THE SAME BUT THE CIRCUIT BOARD LOCATION, INPUT/OUTPUT TERMINAL NUMBERS, VU METERS, ETC., WILL BE DIFFERENT DEPENDING ON THE CHANNEL.						
6 *	Playback EQ at 15 ips speed (head #3)	YTT−1004 Test Tape Play 16 kHz signal on the tape.	VTVM connected to OUTPUT terminal	Playback at 15 ips speed. OUTPUT SELECT at MONITOR	Trim pot #4 R202 (MON EQ-H)	Adjust to read −20 dB on VTVM
7 *	Playback EQ at 15 ips speed (head #2)	Same as above	Same as above	Playback at 15 ips speed. OUTPUT SELECTOR at NORM	Trim pot #5 R204 (NORM EQ-H)	Same as above
8 *	Playback EQ at 7½ ips speed (head #3)	YTT-1003 Test Tape Play 10 kHz signal on the tape.	Same as above	Playback at 7½ ips. OUTPUT SELECTOR at MONITOR	Trim pot #6 R201 (MON EQ-L)	Same as above
9 *	Playback EQ at 7½ ips speed (head #2)	Same as above	Same as above	Playback at 7½ ips. OUTPUT SELECTOR at NORM	Trim pot #7 R203 (NORM EQ-L)	Same as above
10 *	Input MON Level	1 kHz signal at −10 dB from oscillator connected to LINE IN terminals	VU meters	Stop mode OUTPUT SELECTOR at INPUT . Input level pots set to 2 o'clock position (#7)	Trim pot #8 R209 (IN MON LVL)	Adjust for 0 VU on VU meters
11 *	Erase Current	1 kHz signal at 0 dB connected to LINE IN terminals. This is +10 VU on meters so apply signal for short time.	VTVM and 1 kHz band pass filter at output	Record 1 kHz signal, rewind, remove input. Record with no input signal. Measure output while recording no in-put signal. OUTPUT SELECTOR at MONITOR	Trim pot #9 R215 (E/B LVL)	Check for −65 dB or less signal measured through 1 kHz filter to VTVM

AD-JUST STEP	WHAT IS IT CALLED	SIGNAL SOURCE AND AMOUNT	WHAT TEST GEAR TO USE	WHAT IS THE RE-CORDER DOING?	POINT TO ADJUST	WHAT READING TO ADJUST FOR
12 *	Bias Level Adjust-ment	10 kHz, −10 dB oscillator signal con-nected to Input jacks	VTVM connected to OUTPUT jacks	Record signal on type of tape that will be used for actual re-cording. OUTPUT SELECTOR at MONITOR	Trim pot #10 R216 (B LVL)	While recording adjust trim pot until VU meter indication rises to peak value, then turn pot further clockwise until signal drops off by 5 VU (over-bias). If necessary reduce Input Level knob setting to keep reading on scale.
IF INPUT LEVEL KNOB WAS MOVED, REPEAT CONDITIONS OF STEP 10 TO RESET.						
13 *	Bias Trap Adjust-ment	No input signal	VTVM connected to Bias Trap test point, negative lead to ground, positive lead to test point.	Record mode, no input signal	Inductor L3	Adjust inductor for minimum output at Bias Trap test point. See Fig. 28, 29 on page 16 for test point location.
14 *	Low Frequency In-put (REC EQ)	1 kHz signal at −10 dB (0 VU on VU meters) connected to input terminals	VTVM connected to OUTPUT jack or use VU meters	Record on selected tape at 15 ips. OUTPUT SELECTOR at INPUT (to set re-ference), then OUT-PUT SELECTOR at MONITOR	Trim pot #11 R214 (REC LVL)	Set for −10 dB (0.3 V) at OUTPUT jacks or 0 VU on VU meters
15 *	High Frequency Record EQ	18 kHz signal at −10 dB (0 VU on VU meter meters)	Same as above	Same as above	Trim pot #12 R210 (EQ-H)	Same as above
16 *	Overall Frequency Response	40 Hz to 20 kHz signal at −10 dB connected to Input terminals	Same as above	Same as above	Check only. Adjust-ment done in steps 14 and 15.	Check that frequency response matches limits given in Chart Fig. 30 on page 18.
17 *	Low Frequency REC EQ at 7½ ips speed	1 kHz signal at −20 dB (−10 VU on VU meters)	Same as above	Record on selected tape at 7½ ips. Other conditions the same as above.	Trim pot #11 R214 (REC LVL) Same as Step 14	Adjust for −20 dB at OUTPUT jacks or −10 VU on VU meters
18 *	Mid Frequency EQ (7½ ips)	10 kHz at −20 dB Input signal (−10 VU on meters)	Same as above	Same as above	Trim pot #13 R211 (EQ-L)	Same as above
19 *	High Frequency EQ (7½ ips)	15 kHz signal at −20 dB (−10 VU on VU meters)	Same as above	Same as above	Trim pot #14 R212 (EQ-L)	Same as above
20 *	PEAK Level Indica-tor ignition level	1 kHz Input signal at 0 dB level (+10 VU on VU meters). Apply signal for short time only	PEAK Level Indicator lamps in VU meters	OUTPUT SELECTOR at INPUT Input Level pots at 2 o'clock (#7) position	Trim pot #15 R208	Adjust until PEAK Indicator goes ON.
21 *	Overall Signal-to-Noise Ratio	No input signal	VTVM connected to OUTPUT jacks	Record mode at 7½ ips speed. OUTPUT SELECTOR at MONITOR		Check for −50 dB or better

INSTALLATION AND OPERATION OF THE DX-4



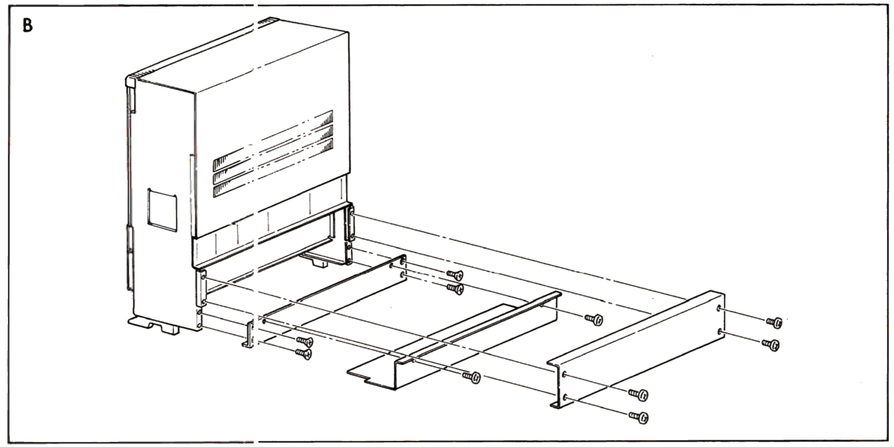
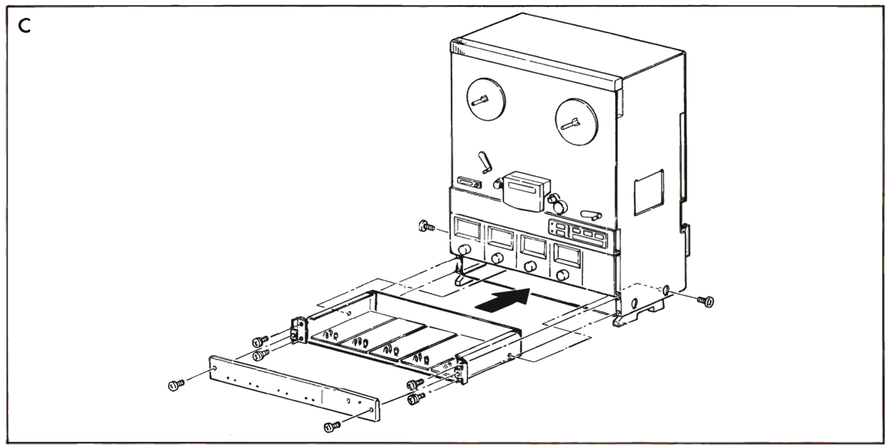
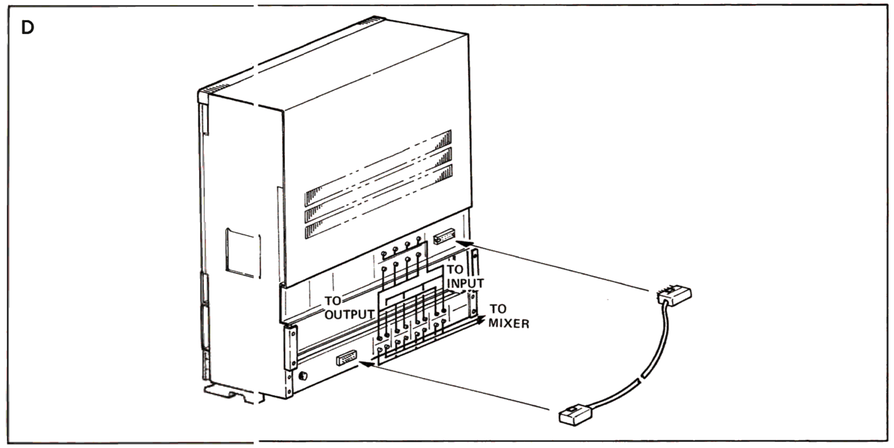


Fig. 32 Installation of the DX-4





How to plug in:

1. Remove lower front panel (2 screws) and 2 lower front panel mounting brackets (2 screws on each side).
2. Remove rear panel located just below rear connection panel (4 screws).
3. Remove 2 screws in lower rear panel and slide panel out toward rear of the deck.
4. Remove lower inside rear panel (4 countersunk screws).
5. Slide the DX-4 into the deck from the front and replace the 2 screws that were removed in step 1.
6. Remove the two wooden side panels (4 screws on each) and install 2 screws on each side of the DX-4 through the access holes.
7. Replace the two wooden side panels. Save the removed panels and hardware for possible future use.
8. Connect the LINE OUT jacks of the 40-4 to the DECODE IN jacks of the DX-4.
9. Connect the LINE IN jacks of the 40-4 to the ENCODE OUT jacks of the DX-4.
10. Use the INPUT and OUTPUT jacks of the DX-4 to provide the connection between your mixer and the 40-4. (Connect mixer's line outs to DX-4 INPUT, etc.)
11. Connect POWER CORD of DX-4 to DX-4 connector on 40-4.

DBX Switch: IN activates the encode or decode circuits with respect to the FUNCTION SELECT buttons on the 40-4 (see RECORDING SECTION). OUT (up position) eliminates the DX-4 from operation by bypassing the encode/decode circuit. The OUT position is for reproducing non-DBX encoded tapes, and sending signals to the recorder for alignment and maintenance procedures. You don't "noise" reduce your test tones when making adjustments to the 40-4.

BYPASS Switch: See DX-4 Supplemental Instruction.

EXAMPLE: Suppose you are going to record on 2 tracks. With the OUTPUT SELECT in the NORMAL position, depress FUNCTION SELECT buttons 1 and 2. The LED indicators will blink, signaling ready-to-record on these tracks. Enter RECORD with the transport controls and the LEDs will remain lit. At the same time, the red LEDs on the DX-4 are lit, indicating encode processing on these channels.

HOW THE DX-4 WORKS-THEORY

The DX-4 is a wide-band compression-expansion system which provides a net noise reduction (broadband, 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 playback. 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 doing live recording.

The DX-4 employs RMS level sensors to eliminate compressor-expander tracking errors due to phase shifts in the tape recorder, and provide excellent transient tracking capabilities.

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

If you're an electronic engineer, all of the above gab may tell you the whole story of what's going on in the DBX, but if you're not, to make things a little easier to understand we'll ask you to use your imagination.

Imagine four little recording engineers in the box with their hands on a volume control each. They are incredibly fast but very stupid, so you must give them a set of rules. You tell them to raise signals that are below "0 VU," and reduce signals that are higher than "0 VU."

The lower the signal is, the more they raise it, and the higher levels above "0 VU" get lowered more and more as they go up in level past "0." This is the 2:1 compression. You also tell them to call ".316 volt" "0 VU." Here they do nothing, no change except frequency pre-emphasis or boost. Since you know they are going to keep the high levels under control, you can raise the "top end" a bit and still not overload the tape. Just to keep it simple for them, the boost in highs is fixed. They put it in all the time, no matter what level changes they are making. Now we play the tape back, and say OK, do everything backwards. Levels above ".316 volt" "0 VU" are raised and levels below ".316 volt" are lowered, and while you're at it, fellows, take off the extra top end as well. Follow the rules in reverse. As long as you don't confuse them by shifting the "0 VU" point, they work just great, but – don't put in more than ".316 volt" as zero VU, and don't make the tape playback zero anything other than ".316 volt" either. As we said they're very dumb and will follow instructions very precisely. Differing levels will produce decoding errors.

The reason these errors may not be objectionable is that people could have played or sung or whatever with a little more or less dynamics. A small change won't be noticeable as a mistake, but it is not perfect. The tolerance here is not electronic, it's human. To get exactly what you put in, it is necessary to get an exact "0 VU," .316 volt in and out. The system is level sensitive although it is realistic to say it is "artistically" forgiving.

MIXING: Program material must be in uncompressed form for mixing and sound-on-sound recording. You must first decode the program material which has been encoded by the DX-4 in order to mix it with any other material – compressed or uncompressed. Of course, mixed material may be compressed again for recording. If this precaution is not followed, you'll get cross-modulation of the separate signals or tracks.

Also, the DX-4 automatically sends the input signal to the output terminals. Thus the signal going to the tape is encoded, but the signal which you are monitoring is pre-encoded (source).

When you are using the DX-4, you will not be able to monitor the recorded signal while actually recording. Here's why.

The DX-4 is designed to provide switchable encode-decode processing. This means there is only one noise reduction circuit (card) for each channel. The DX-4 does all switching internally and automatically. It is automatically switched to encode (record) when the 40-4 is placed in the record mode. When playback is desired on the 40-4, the noise reduction electronics are automatically switched to the decode (playback) mode.

Since the single card can only do one job at a time, you will have to forego the "play while recording" feature of the 40-4 when using the DX-4.

The function select buttons control the DX-4 as well as the recorder, so when you switch from PLAY to RECORD, the DBX also switches from PLAY to RECORD, and provides an unencoded monitor signal for you to listen to.

The little guys in the box will look at their "chart" and give you some really entertaining level shifts, as we have said, they're fast but dumb.

SUBSONICS and INTERFERENCE: The DX-4 incorporates an effective bandpass filter with –3 dB response at 20 Hz and 30 kHz. This filter suppresses undesirable sub- and supersonic frequencies to keep them from introducing errors into the encode or decode process. However, if rumble from trains or trucks, for example, is picked up by your microphone and fed to the DX-4 — filters are not perfect — 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 playback 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 ahead of the DX-4 and after the mic preamplifier for further attenuation of these subsonic frequencies.

ENTERING "RECORD"

OUTPUT SELECT BUTTONS: The signal presented at the output terminals is controlled by the OUTPUT SELECT buttons.

INPUT will typically be used for source calibrations during system interface and set-up procedures. When this button is depressed, the input signals are sent directly to the output terminals.

MONITOR will present the monitor head signal to the output jacks for those situations where it is desirable to monitor the printed signal on the tape for reference during the recording.

NORMAL will be used for most operations: recording, overdubbing (sync), and reproduce. The monitoring status is then determined by the FUNCTION SELECT buttons.

FUNCTION SELECT BUTTONS: When the OUTPUT SELECT is in either the INPUT or MONITOR position, the FUNCTION SELECT buttons have the single purpose of determining the record status. UP is safe. DOWN is ready-to-record.

When the OUTPUT SELECT is in the NORMAL position, the FUNCTION SELECT buttons serve two purposes: (1) they determine the record status — UP is safe, DOWN is ready-to-record, and (2) they determine the monitoring status — UP is sync/tape reproduce; DOWN is source.

There are 3 ways to enter record

1. With the OUTPUT select in the NORMAL position, depress the FUNCTION SELECT buttons for those tracks on which you wish to record. The blinking LEDs will indicate ready-to-record on those particular tracks. Enter record with the TRANSPORT CONTROLS — depress RECORD (LED will light) and PAUSE together. Then push PLAY and all of the FUNCTION SELECT LEDs will remain lit until the record mode is deactivated.
2. To facilitate punch-ins, the logic can be reversed by first setting FUNCTION SELECT button in the UP position and entering record with the RECORD and PLAY buttons. Now the record LED will blink, indicating ready-to-record, and you are monitoring sync/tape reproduce. At the appropriate time, depress the FUNCTION SELECT button(s) for the tracks you wish to punch-in, and you enter record while simultaneously switching the monitor to source.

   Now, imagine two different occasions where it is desireable to punch-in a correction on a given track, instead of recording the entire part all over again. If the correction needs to be made at the BEGINNING of the tune — say a hesitant start that is slightly out of sync with the downbeat — then there is no need to monitor reproduce (sync) since the bad start will only serve to confuse the musician. Indeed, that part of the track will be re-recorded.

   So the punch-in is straightforward enough: enter the record mode on the appropriate track with the corresponding FUNCTION SELECT button. Press the record button when the slate occurs — at the beginning of the tune — then enter stop at a convenient, appropriate time, after the punch-in is completed.

   EXAMPLE 2: In this situation, suppose an error has been made near the end of the tune — or in the middle — the example is still valid. Now the musician will likely need to hear his performance up to that point so that the punch-in does not represent a different style or feel, and therefore, is consistent with the rest of the performance. In this case, enter record ready by pressing the record and play buttons simultaneously. The record mode will be activated when a FUNCTION SELECT button is depressed.

   When the FUNCTION SELECT is in the UP position, the musician will be monitoring reproduce (sync) and probably play along with the previous performance until the time comes to punch-in the correction. When that moment occurs, simply press the appropriate FUNCTION SELECT button for the corresponding track that is ready to be recorded. Two things then happen. First, you instantly enter the record mode on that track, and the new part will replace the previous one, in sync of course. Second, the monitor is automatically switched from tape (UP position) — sync reproduce — to source (DOWN position) — so the musician can hear his new part as it is being added. The logic remains consistent.
3. For very brief "punch-in," if you can "cue" or find the spot to begin re-recording by listening to other tracks — depress FUNCTION SELECT to the READY position, put the transport in PLAY. For short segments you can now press RECORD and hold it down. The recorder will stay in the RECORD mode as long as you hold down the RECORD button. When you release it, the tape will play, but will not be erased. This mode will allow you to re-record small parts of a track that are separated by sections you wish to keep quickly, but since you cannot hear what's on the tape, it can be risky. You can also enter and leave the record mode by raising and lowering the function select buttons while the transport is "locked" in the RECORD mode. It's not necessary to enter STOP to stop recording. This is called "punch and roll" and is sometimes very useful. Again it is risky because you run the risk of waiting too long to "punch out." Be careful.

MA-4 ACCESSORY INSTRUCTIONS

The MA-4 is a simple microphone/line mixing accessory for those purchasers who require only a limited amount of input mixing flexibility. This unit will allow you to use one mic per track, mix one line with it, and monitor the result as you record. It has a "pad" or microphone attenuation circuit to handle high level signals that might overload the preamp and a headphone jack that can select any or all inputs. It will not control line output levels in playback, being an input expanding device only.

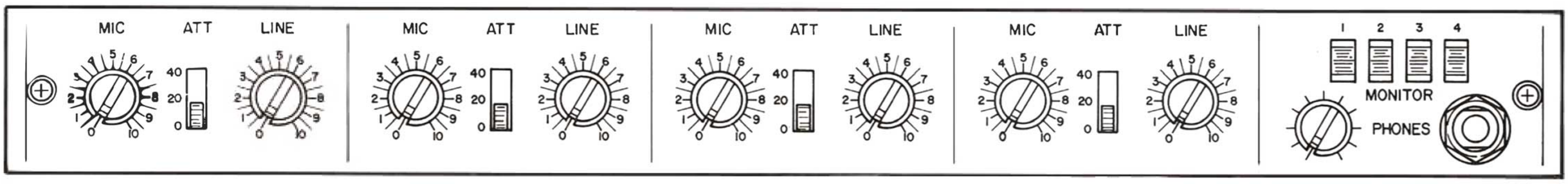


Fig. 33 MA-4 Front Panel

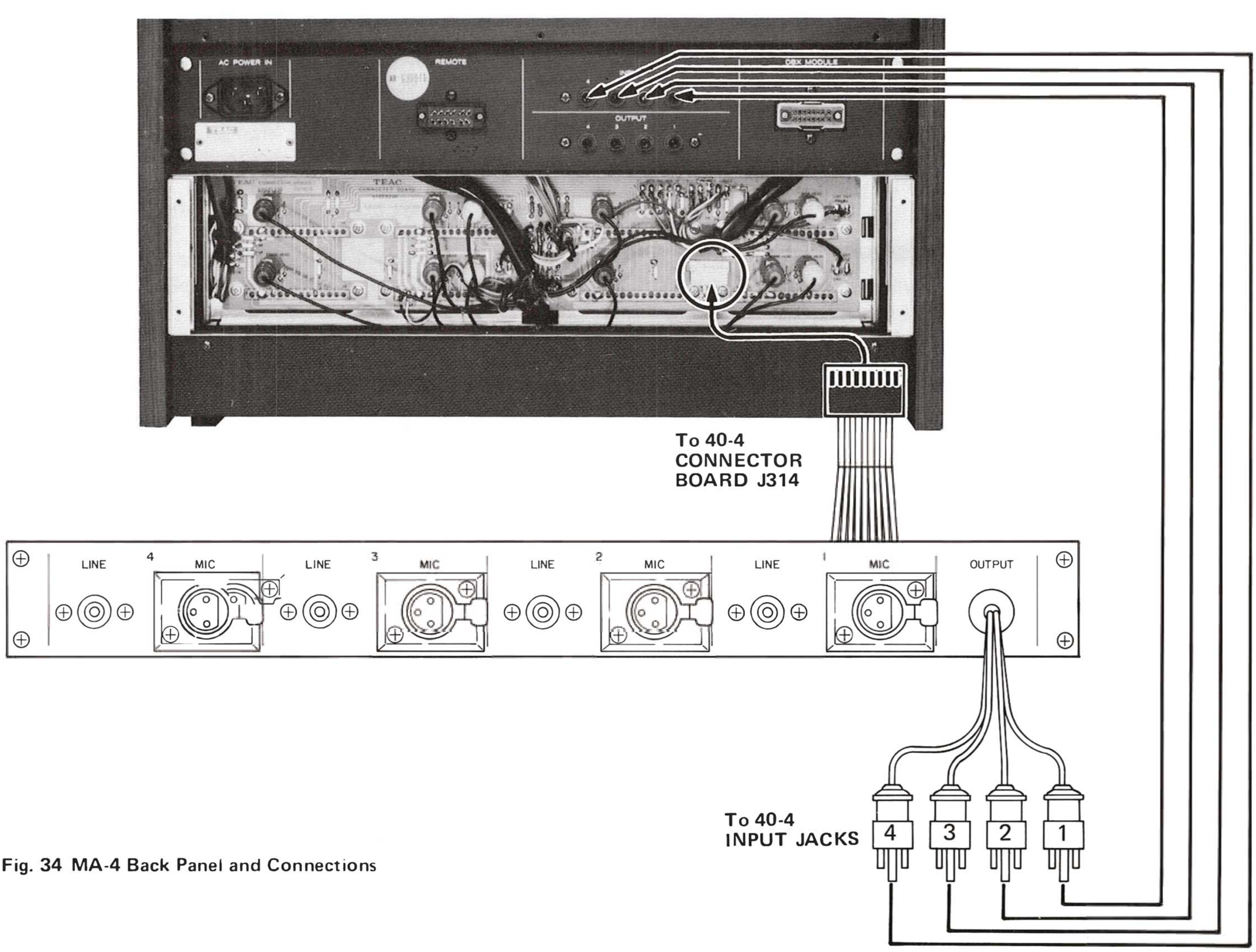


Fig. 34 MA-4 Back Panel and Connections

SPECIFICATIONS

TAPE WIDTH	¼ inch
FORMAT	4-track, 4 channel
REEL SIZE	10½" maximum
TAPE SPEED	15 ips and 7½ ips
LINE INPUT	−10 dB (0.3V) impedance; greater than 20k Ohms, unbalanced
LINE OUTPUT	−10 dB (0.3V) load impedance; greater than 10k Ohms, unbalanced
RECORD LEVEL CALIBRATION	0 VU referenced to 3 dB above 185 nWb/m of tape flux, adjustable
SPEED ACCURACY	±0.5%
WOW AND FLUTTER	measured with flutter test tape 0.04% rms weighted (NAB), ±0.06% peak weighted (ANSI) at 15 ips 0.06% rms weighted (NAB), ±0.09% peak weighted (ANSI) at 7½ ips
STARTING TIME	less than 0.5 sec
FAST WIND TIME	120 sec for 2,400 ft. of tape
OVERALL FREQUENCY RESPONSE:	40 Hz — 20 kHz, ±3 dB at 15 ips
SYNC MODE	40 Hz — 15 kHz, ±3 dB at 7½ ips
SIGNAL TO NOISE	65 dB weighted, 60 dB unweighted referenced to 3% T.H.D. (9 dB above 0 VU) at 400 Hz
DISTORTION (overall)	1% at 1 kHz, 0 VU 3% at 9 dB above 0 VU
CROSSTALK (overall)	greater than 50 dB at 400 Hz
ERASURE	greater than 65 dB at 1 kHz, +10 VU reference
POWER REQ	117V, 60 Hz 160 W
DIMENSIONS	17¼" (W) x 21" (H) x 12" (D)
WEIGHT	75 lbs.

- Performance measured with Ampex 456 tape.
- Changes in specifications and features may be made without notice.
- Value of "dB" in the Data refers to 0dB = 1V, except where specified. If a Test Set or VTVM calibrated to 0 dB = 0.775V is to be used, appropriate compensation should be made.
  For example, −10 dB (0.3V) is applied to the line in jacks, the VTVM which is connected at the line out put jacks reads −7.8 dB (0.3V) instead of −10 dB (0.3V).

A final note.
If you notice any differences, either on the outside or the inside of the unit from the illustrations and descriptions in this manual, talk to your dealer. He may have revision sheets that will show manufacturing changes, or notifications of how to deal with any changes in set-up or maintenance procedures.
Save this booklet, refer to it when necessary, and good luck with your 40-4.

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