## SECTION 5

## ELECTRONICS ASSEMBLY

### 5.1. GENERAL DESCRIPTION

The electronics assembly of the Model 280 Recorder is contained in a 3-1/2" x 19" x 10" deep chassis. All adjustments are accessible from the front panel. Those not commonly used are covered by the metal across the lower part of the panel. This strip is removed by loosening the captive screws holding it to the panel. The record and playback amplifiers and bias-erase oscillator sections are located on three etched boards and may be removed from the back of the assembly merely by pulling them out. Only solid-state circuitry is used. A complete system block diagram appears in figure 5-1.

#### 5.1.1. Record Amplifier (See figure 8-12.)

The record amplifier consists of a solid-state resistance-coupled amplifier, which brings live input signals up to the level required for the recording. For microphone input, two additional stages are provided on the same printed circuit board. They are switched in by means of the mode selector switch S601, located on the amplifier panel.

The two transistors which comprise the record amplifier proper, Q801 and Q802, use local feedback for stability and low distortion. CR 801 and CR802 are transistor-cased diodes used in the linearity extending circuit. See Linearity Control, paragraph 5.1.5.

L801 in conjunction with C805 and the coupling network on the chassis L602 and C613 form an impedance matching network between the collector of Q802 and the record head. This matching network favors the high frequency response so that a portion of the necessary record pre-emphasis is produced here. The remaining portion of the record pre-emphasis is produced by the coupling network between the record gain control R603 and the base input of Q801. This equalization is coupled to the speed change switch S114, automatically selecting proper equalization for either speed.

The microphone amplifier consists of Q853 and Q854. Both local and overall feedback are used here. One section of the record gain control varies the AC emitter resistance of Q853 so as to reduce its gain for strong signals.

This removes the limitation on dynamic range that presented a problem in the earlier stages of the art.

#### 5. 1. 2. Bias and Erase Oscillator (See figure 8-12.)

The bias oscillator card consists of two stages. Q701 is the 60 kc oscillator which drives the erase head. Q702 is a frequency multiplier which provides bias power at 180 kc to the record head. By this means it is possible to gain the advantage of efficient erasure with relatively little heating of the erase head, plus the advantage of a higher than usual bias frequency which leads to a higher signal-to-noise ratio.

CR701 and CR702 are a diode switch, permitting synchronization between the various oscillators of a multitrack machine while allowing one or more of the channels to be in a "non-record" condition with no chance of high frequency energy getting into the wrong places. When the machine is taken out of the Record mode by depressing the Stop or one of the Fast buttons, the energy supplied to the erase and record heads dies out gradually over a period of about 0. 1 second. This is accomplished by the gradual decay of voltage across C619 when its supply is interrupted by the dropout of the record relay.

The synchronization of bias oscillators in a multi-track machine is maintained throughout this period by the delay network consisting of CR703 and C702 on the oscillator board. This delay network insures that the voltage which activates the diode switch CR701 and CR702 decay even more slowly than the voltage across C619.

T703, the multiplier tank circuit, is tuned to resonance during factory adjustment and should not require any further attention. T702 may have to be re-adjusted if an erase head of materially different inductance than the original is used.

It will be noted that bias synchronization is accomplished on the primary of T701 for each

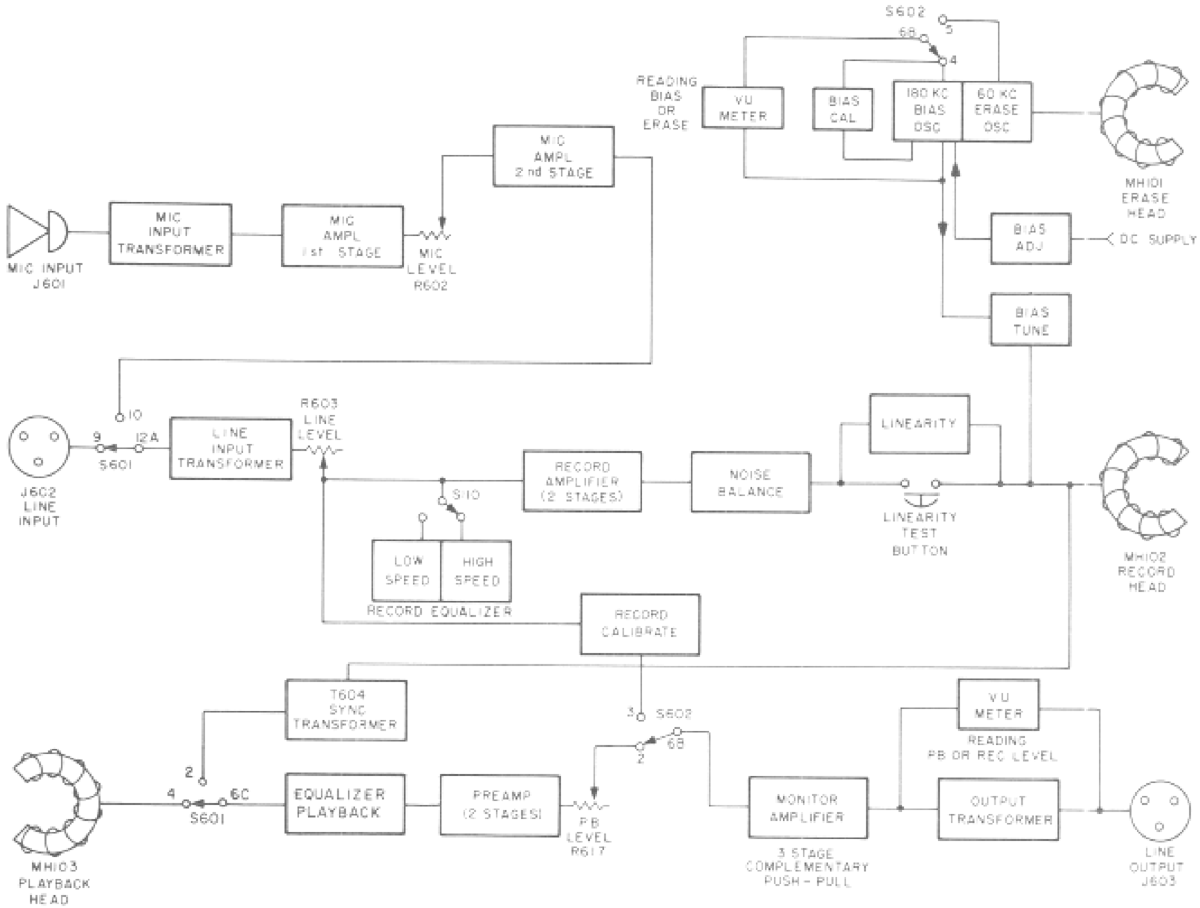



Figure 5-1. Model 280 System Block Diagram

oscillator. This eliminates the possibility that vagaries originating in one oscillator may affect the operation of the other oscillators in a multi-track machine. It also eliminates the problem of noise balance control interaction between channels.

Having a bias amplifier multiplier separate from the erase generator permits bias adjustment potentiometer R617 to be a purely DC bias control. There is no problem of bias radiation from the wiring to this control.

The network L702 and C713 in the output of the bias generator helps (with the bias tuning network L604 and C617) to insure the purest possible bias wave form. It would appear that a noise balance control is no longer needed with the arrangement. However, experience has shown that this control is useful in compensating for small residual magnetization of the record head, which is difficult to remove entirely. Any slight leakage in coupling capacitors C806 and C807 between the record amplifier and the record head will have a very similar effect. Therefore, the noise balance control introduces a small flow of DC (less than 1/2 ma) through the record head for compensation. Any time the noise balance control nulls far from its center position, it should be assumed that the record head requires de-magnetization.

5.1.3. Wiring on the Electronics Chassis (See figure 8-12.)

The electronics chassis contains a transistor, Q601, which, in conjunction with zener diode CR603, provides a source of well-filtered -18-v DC stabilized power for the operation of all the sections of the electronics. In this way, minor variations of the AC line voltage are prevented from varying the amplifier gains and the bias level.

5.1.4. Playback Amplifier (See figure 8-12.)

The playback amplifier is a two-section, five-stage audio amplifier. The signal from the playback head, after high frequency equalization, passes through the first section stages, Q901 and Q902. These stages employ local feedback for gain stability, distortion reduction and playback equalization. The signal then passes through Playback Level control R616 and Monitoring switch S602 to the second, or monitoring section of the amplifier. This section has three stages – a grounded emitter stage Q903, followed by an emitter follower Q904 to provide drive for the complementary push-pull output transistors Q905 and Q906, the output transformer T603 and feedback network. The signal from the output transformer feeds through the bias filter to the LINE OUT jack, monitoring jack and VU meter with its sensitivity setting network (+4 or +8 dbm). Amplifiers are normally supplied with the VU meter reading of zero corresponding to +4 dbm.

5.1.5. Linearity Control

In a properly adjusted tape recorder, nearly all the harmonic and intermodulation distortion is caused by the approach to saturation of the magnetic tape used. The Scully 280 uses a linearity extending circuit which permits recordings to be made at normal levels with greatly reduced distortion, or at somewhat higher levels without exceeding the usual amount of distortion.

The record amplifier card contains two diodes, CR801 and CR802, whose forward conductance increases with signal level so as to minimize the drooping tendency of the overall transfer characteristics. This can be called predistortion which is complementary to that which is inherent in the tape. It has the effect of cancelling out the distortion which would otherwise be caused by the non-linear relationship of remanent flux on the tape to the audio-frequency driving current.

As the voltage sensed by the diodes CR801, 802 increases above threshold in either direction, the diode conductance increases, cutting down on the amount of inverse feedback provided by emitter degeneration in Q802, and boosting the signal by the amount required for linearity. Now the shape of the compensation required is quite constant with changes in recording head characteristics, oxide formulation, etc. However the threshold point will be shifted by a change in recording head sensitivity (new head of different inductance) or a major change of tape characteristic e.g. low noise to high output tape. Therefore the Linearity adjusting pot., R618 is provided so that the current level which corresponds to the "knee" of the transfer characteristic can be matched to the threshold voltage of CR801, 802 where the diode conductivity starts increasing.

This adjustment can be made most accurately with a distortion analyzer, but, where one is not available, the optimum setting can be approximated by setting the pot. so that the diodes cause an increase of 0.8 db in the level of a single-frequency tone at peak record level as indicated on the playback VU meter.

The linearization of the transfer characteristic produced by this adjustment is much more than this at the peak of the signal waveform, of course, but 0.8 db is the indication produced on a normal (average responding) VU meter.

5.1.6. Synchronization

5.1.6.1. Description

Three and four-channel half-inch Model 280 recorders have built-in selective sync, permitting switching of any record channel to playback cueing function while recording on other channels. This enables the operator to monitor in exact synchronization with previously recorded material on other channels.

This circuit is standard on all three and four-channel half-inch Model 280 recorders and is available at extra cost on other models. Connections in multi-channel units with the sync feature are shown on figure 5-2.

5.1.6.2. Operation

Set the function switch S601 on the amplifier panel to SYNC position. All previously recorded material on that channel may now be monitored in synchronization with material being recorded on other channels.

CAUTION

Be sure to switch function switch S601 back to normal microphone or line position when sync work is completed. Unit will not record in SYNC position.

5.1.7. Power Supply (See figure 8-6.)

The power supply provides two 24-volt DC outputs from the full-wave semiconductor diode rectifiers. The control and transistor voltage sources have one common terminal coming from the center tap of the 48-volt secondary winding in transformer T202. There is additional filtering for the transistor electronics DC source in the amplifier assembly.

Transformer T201 is tapped to supply the AC voltages required for the various modes of tape transport operation. This method of making available the lower AC voltages avoids the additional heating normally encountered when large voltage dropping resistors are used.

Both T201 and T202 are toroidal wound transformers. This contains their respective fields and materially reduces a major source of hum found in tape transport power supplies.

The AC power switch disconnects both sides of the incoming AC power line, to assure complete isolation during servicing operation. Connector P201 plugs into the relay control panel connector J101.

The AC line and both of the 24 volt DC sources are individually protected by fuses. The fuse requirements in the power supply are as follows:

| | | |
|---|---|---|
| F201 | 117 volt AC line | 3 amp |
| F202 | 24 volt DC control voltage | 5 amp |
| F203 | 24 volt DC electronics | 3 amp |

## 5.2. ALIGNMENT AND PERFORMANCE CHECKS

The following is the complete list of alignment and performance checks that should be performed on the Scully Model 280 Recorder/Reproducer at the time the equipment is received and at any other time that such a procedure is deemed desirable by the user. (See fig. 3-2 for location of controls on Electronics Assembly.)

1. Demagnetization of heads (5.2.2).
2. Playback alignment and frequency response (5.2.3).
3. Record adjustments and calibration (5.2.4). These adjustments include overall frequency response and signal/noise measurement.
4. Record noise balance (5.2.5).
5. Erase adjustment (5.2.6).
6. Linearity adjustment (5.2.7).
7. Flutter measurement (5.2.8).

In multi-track machines, these procedures must be repeated for each channel.

### 5.2.1. Test Equipment Required

Standard alignment tape
Audio Oscillator, Hewlett Packard Model 200C or equivalent
AC Vacuum Tube Volt Meter, Hewlett Packard Model 400D or equivalent
Wave analyzer (if available)
Band pass filter } (Ref. figure 5-3.)
Bias filter }
Flutter Meter, Sentinel FL-3-D, Micom Model 8100 or equivalent
Alignment tool (Scully p/n 061008276)

### 5.2.2. De-magnetization of Heads

Before de-magnetizing the heads, turn the function switch to the DEMAG position. The tape guides and capstan shaft should also be demagnetized periodically.

### 5.2.3. Playback Alignment and Playback Amplifier Noise

a. Be sure the termination switch on the amplifier panel is properly set before adjusting PLAYBACK LEVEL. If this is a multi-channel recorder, all of the following tests should be repeated for each channel.

b. Use a standard alignment tape at the high tape speed.

c. Place the output selector on the electronics front panel at PB. Remove the dress strip (figure 3-2) for access to calibration adjustments and place the PLAYBACK LEVEL control in the CAL position.

d. Begin tape motion by pushing the START switch, and monitor the output with the external AC VTVM and speaker amplifier.

e. As the first tone or reference is heard, adjust the REF. SET control (R627) for a zero reading on the VU meter. This now represents a calibrated +4dbm output reference.

f. Following the first tone on the standard tape are a series of tones at frequencies used for head and equalization adjustments. The second tone (15 kHz) is used for playback head alignment. Loosen the single button head mounting bolt slightly, and rotate the head until maximum output is obtained. Once set, this rotation adjustment need only be checked periodically.

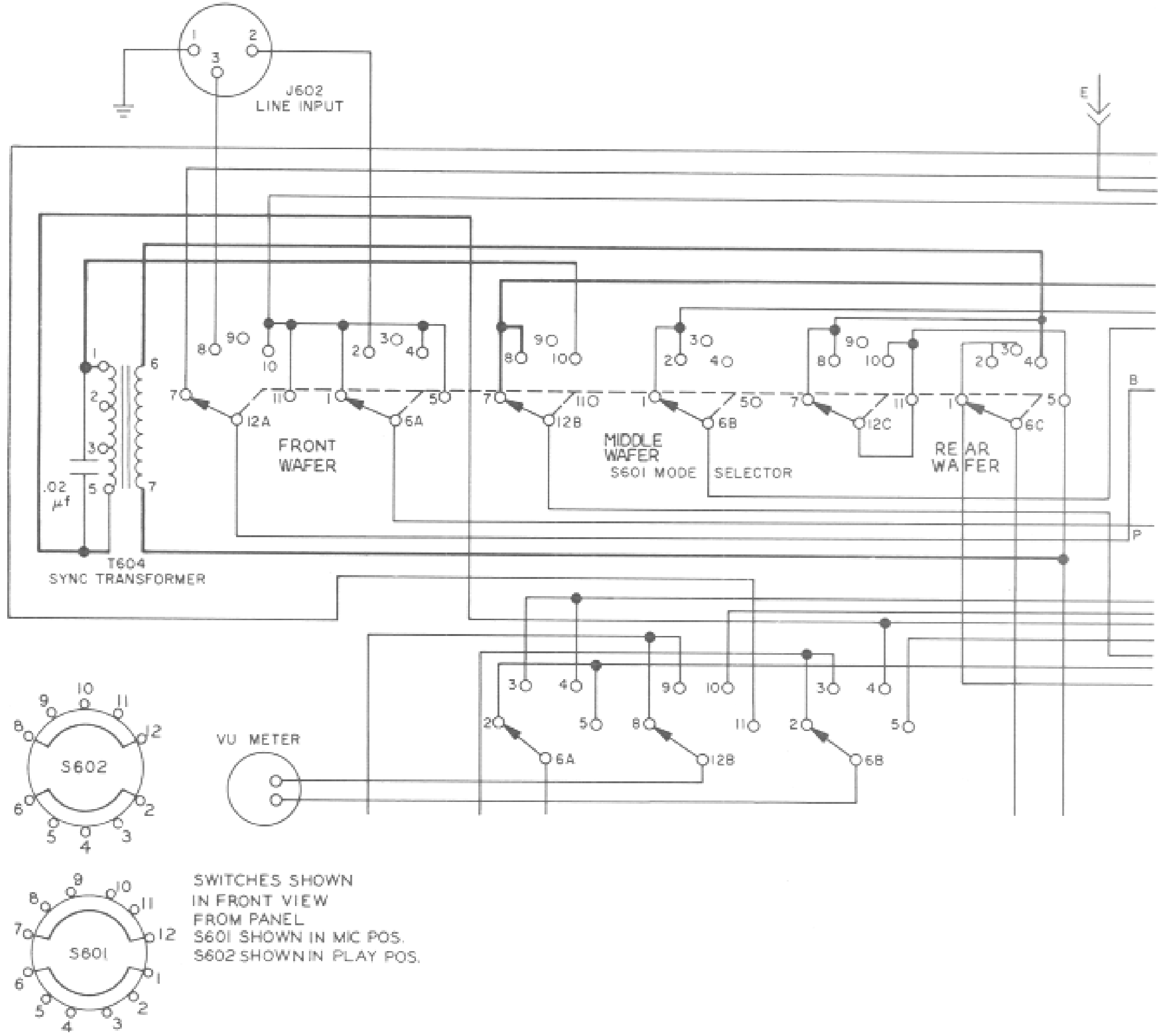



Figure 5-2. Connections in Multi-Channel Machines with Sync Feature

Visually check the heads (with hum shield down) to observe that the heads are perpendicular to the tape and also properly centered. If a zenith adjustment is required, see paragraph 4.5.5 for the adjustment procedure. The slotted azimuth adjusting screws (2) may now also be peaked for maximum output.

g. The playback equalizer (R619) is to be adjusted at 10 kHz for 0 dbm. The following tones on the alignment tape are used to check the playback frequency response.

NOTE

When a standard full-track tape is reproduced by a half- or multi-track head, readings for frequencies below 700 Hz will be higher than normal, due to "fringing effect."

### 5.2.4. Record Adjustments and Frequency Response

a. Thread a reel of blank tape of the type normally used in the recorder/reproducer. Place the unit in operation in the Record mode in the high-speed range.

b. With the machine in the Record mode, check that the erase reading on the VU meter is 100% or better. (This corresponds to the zero point on the VU meter). Now switch the meter to the BIAS position and set the Bias Adjust control (R620) for a convenient reading. Next, rotate the Bias Tuning control (C617) for a maximum reading on the VU meter. Transformer T703, located on the bias card at the rear of the amplifier, may also be peaked at this time. (Use the alignment tool supplied.)

c. Apply a 1000-Hz tone into the record amplifier at a 0-dbm reference level on the VU meter. (The monitor switch must be in the PB. position.) Adjust the BIAS ADJUST pot (R620) for a peak reading. At 7-1/2 ips, use a 400 Hz tone and at 3-3/4 ips use a 250 Hz tone.

d. Sweep the oscillator to 15 kHz. Check the record head for rotation and azimuth adjustment. Peak for maximum output. (If not previously checked, playback head rotation may also now be optimized.) Reset the oscillator frequency to 1 kHz.

e. Switch the VU meter to the BIAS position. Adjust the BIAS CAL. pot. (R621 for a (0) zero reading on the VU meter.

f. Switch the VU meter back to PB. Adjust the RECORD LEVEL control for a (0) zero VU meter reading. Switch the VU meter to REC., and adjust the RECORD CALIBRATE pot (R606) so that it, too, produces a zero (0-dbm) reading on the VU meter.

g. Sweep the oscillator to 10 kHz. Adjust the high RECORD EQUALIZER (R610) for 0 dbm (15 ips). At 3-3/4 and 7-1/2 ips speeds, the input level should be dropped 20 db below the reference level to avoid tape saturation at the higher frequencies. Slowly sweep the oscillator from 18 kHz to 35 Hz (15 ips) and adjust the record equalizer for best frequency response. For 3-3/4 ips machines, the procedure is the same as for 7-1/2 ips, except that the frequency for the maximum adjustment is 7.5 kHz.

### 5.2.5. Record Noise Balance

a. With the machine in the RECORD mode and the monitor switch in the PB. position, close the record gain control and raise the monitor gain so that tape noise can be heard.

b. Adjust the NOISE BALANCE control (R629) for minimum audible noise (popping or gravelly sounds). If a distortion analyzer is available, this adjustment can be precisely made by recording a 1,000-Hz tone while adjusting the noise balance for minimum distortion reading on the analyzer.

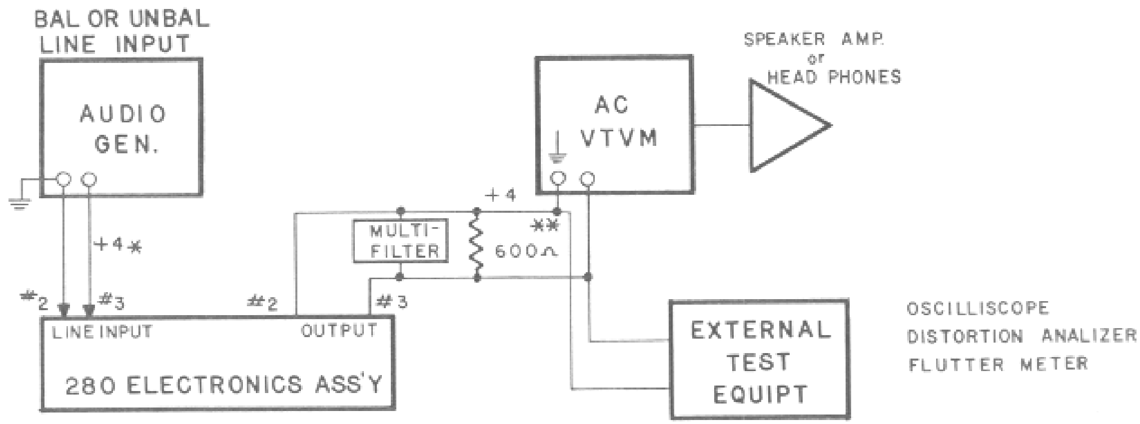
c. If the noise balance control will not reach a null, or if the null is more than 45 degrees from the center position, one or more of the heads may be in a magnetized condition. This must be corrected before proceeding further. The bias card can also be checked for a symmetrical bias waveform.

d. The overall distortion may also be measured at this time by recording a 500-Hz tone and measuring the second and third harmonics. High second-harmonic output is a reliable indication of a magnetized head.

### 5.2.6. Erase Adjustment

a. Connect a 400-Hz filter in the output line feeding the external AC VTVM (See figures 5-3 and 5-4.)

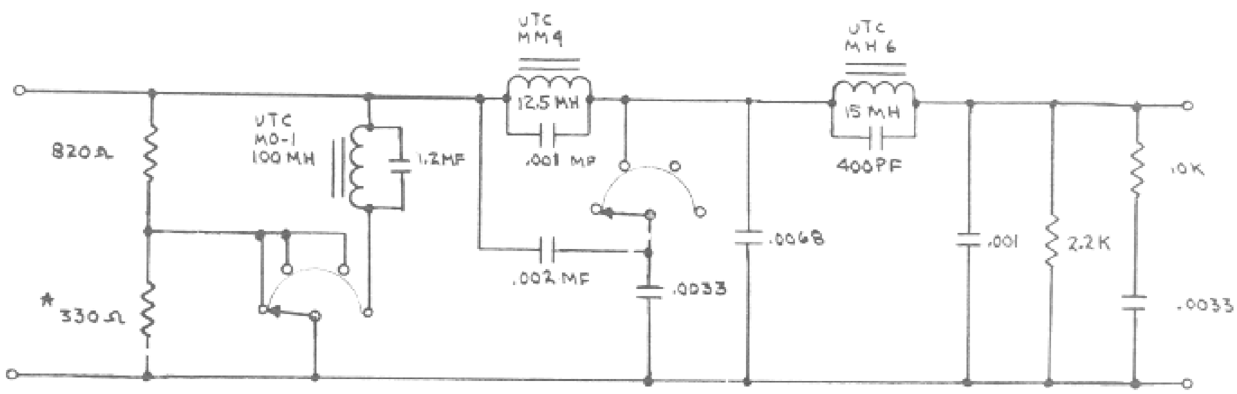
b. Record a 400-Hz tone at +10 db (+6 dbm above 0 dbm on the VU meter).




NOTES:

1. * = FOR 3-3/4 AND 7-1/2 IPS SET AUDIO GEN FOR -20 db
2. ** = 600 ohm RESISTOR NOT REQUIRED WHEN USING MULTI-FILTER
3. MULTI-FILTER OPTIONAL

Figure 5-3. Model 280 Electronics Test Setup




POS 1 0-20,000 CPS
2. 0-15,000 CPS
3. 0-20,000 CPS
4. 400 CPS

* 330Ω RESISTOR IS SELECTED FOR UNITY GAIN AT 400 CPS PEAK

Figure 5-4. Multifilter, Schematic Diagram

c. Rewind the tape. Turn the RECORD LEVEL control fully ccw and operate the machine in the RECORD mode. While observing the depth of erasure on the external ac VTVM, rotate the erase head for maximum erasure. Typical readings are 68-70 db (full-track), 67-68 db (half-track), and 65 db (quarter track).

5.2.7. Linearity Adjustment Procedures

NOTE

This unit has been shipped with the linearity control adjusted for optimum benefit. These procedures are provided for servicing and information.

5.2.7.1. Procedure No. 1.

a. After bias and noise balance has been set, play back a test tape of standard operating level with the playback gain control set so the VU meter reads -6.

b. Thread up a reel of tape of the type to be used, put the machine in the record mode, and increase the input signal until the playback VU meter reads 0 on the scale. (A 1000-Hz tone should be used).

c. You are now recording a signal at peak record level. Depress the test pushbutton and note the drop in VU meter reading. This will be 0.8 db when the linearity adjusting pot. is properly set.

d. If you get less than 0.8 db drop, rotate the LIN pot counterclockwise, increase the Record Gain, setting it so as to keep the VU meter reading zero, and retest.

e. If the VU meter drop-off is more than 0.8 db when you depress the test button, rotate the LIN post clockwise, reduce the Record Gain so as to keep the VU meter at "0", and retest.

f. Record calibration must be reset after linearity adjustment is made. Thread up the test tape with standard operating level again and bring up the playback gain control to produce zero on the playback VU meter.

g. Then, while recording 1,000 cps tone on tape of the type to be used, with the VU meter on Playback, set the Record Gain for the zero reading on the meter. A choice is now available to the user. You may either record at normal levels, or at a higher level with a better signal-to-noise ratio.

h. If the linearity circuit is to be used only to reduce distortion at normal levels, switch the VU meter to Record and set the Record Calibration control so that the meter again reads zero.

i. If it is desired to record at higher than normal levels so as to achieve a better than usual signal - to - noise ratio, then with the machine set up to record 1,000 cps tone at standard operating level as described above, set the Record Calibration control for a reading of - 2 on the record VU meter. This will cause program peaks to be recorded 2 db higher than has been possible in the past, with no increase in distortion, and a 2 db increase in the available signal-to-noise ratio.

5.2.7.2. Procedure No. 2 (Alternate Method).

The following linearity adjustment procedure is less accurate than procedure no. 1 above, but may be adequate and more convenient.

a. After checking the Record frequency response, (paragraph 5.2.4), reset the test oscillator to 1,000 Hz at zero reference level on the VU meter. The meter selector should be set for the Playback mode.

b. Turn the linearity control behind dress strip fully clockwise. Reset the Record level control to indicate +3 on the VU meter.

c. Turn the linearity control counterclockwise until the VU meter again reads zero VU.

d. Pressing the linearity test button should decrease the meter reading approximately 0.4 db.

NOTE

If the equipment required to adjust the linearity circuit is not available, turn the LIN pot. all the way clockwise. This will essentially de-activate the circuit and leave a normally operating recorder.

5.2.8. Flutter Measurement

Periodic flutter measurement will give the user a good indication of the mechanical condition of the recorder.

a. Using the Sentinel FL-3D, Micom 8100 (or equivalent), connect the 3-kHz output from the flutter meter to the line INPUT. Adjust the RECORD LEVEL control for 0 dbm.

b. Operate the machine in the RECORD mode, adjust the PB. gain to 0 dbm, and connect the 3-kHz output to the flutter meter. Calibrate as required.

c. After recording on a portion of the tape, rewind and play back. Observe the flutter meter reading. Excessive flutter may be caused by a defective capstan motor (check lubrication), noisy bearings, improper capstan idler pressure, or low line voltage.

d. When making flutter measurements at high and low speeds, it is important that the capstan motor be turned off and allowed to completely stop before re-starting at the desired speed.