MODEL 1000A

FM ALIGNMENT GENERATOR *

Serial 121-00478

SOUND TECHNOLOGY

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* Patented

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WARRANTY

All new Sound Technology products are warranted against defects in materials and workmanship for one year from the date of delivery. Any instrument or component that is found to be defective within the warranty period after examination by Sound Technology or an authorized representative thereof will be repaired or replaced without charge for labor or material. No other warranty is expressed or implied. We are not liable for consequential damages.

Before returning a product to Sound Technology for service, authorization must be obtained from the factory. For products not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay. Please include instrument model number and serial number with all requests for parts or service to facilitate the fastest possible response.

All products returned to the factory must be shipped prepaid. For products under warranty, Sound Technology will pay for shipment back to the customer.

OPERATING INSTRUCTIONS

INTRODUCTION

The 1000A is a frequency-modulated RF generator with modulation and output capabilities which permit complete alignment and testing of stereo or monaural receivers and tuners. DUAL SWEEP, a unique and very sensitive sweep alignment technique, has been incorporated in the 1000A. Although the 1000A may be used for conventional sweep alignment, it is highly recommended that the user learn the DUAL SWEEP method. With a little practice it is much faster and leads to the best possible alignment.

ANTENNA CONNECTION

The RF LEVEL dial reads RF output voltage appearing across a 50Ω load. The load normally consists of a length of 50Ω cable such as RG 58A/U terminated in 50Ω. A matching network is required in order to properly terminate the 50Ω cable and at the same time provide the correct impedance looking back from the antenna terminals of the receiver under test.

The Sound Technology Model 100 Matching Transformer was designed for this purpose. The input to the Model 100 (a BNC connector) presents a 50Ω load to the generator. The output (a detachable 300Ω plug wired with 12" of twin lead terminated in spade lugs) presents a 300Ω source impedance to the receiver under test, thus simulating the 300Ω source impedance of a folded dipole antenna system. Voltage transfer ratio is 1:1 so that the 1000A RF LEVEL dial reads directly the voltage applied to the receiver antenna terminals. Because of its internal electrostatic shielding, it may be used with either a balanced or an unbalanced (one side grounded) receiver antenna input configuration.

If a suitable matching transformer is not available, a resistive network may be used to match the 50Ω unbalanced output of the 1000A to the 300Ω antenna input of the receiver under test. Examples of how to do this with common values of resistors are shown in Fig. 1. In all of these cases the matching network provides 6 dB of attenuation, and it is necessary to divide RF LEVEL dial reading by 2 in order to get the voltage appearing across the antenna terminals.

When using the resistive networks, one must be careful to keep all leads as short as possible. Also note in Fig. 1 that a third connection to receiver ground is required in the case of a balanced input, which is the most common case.

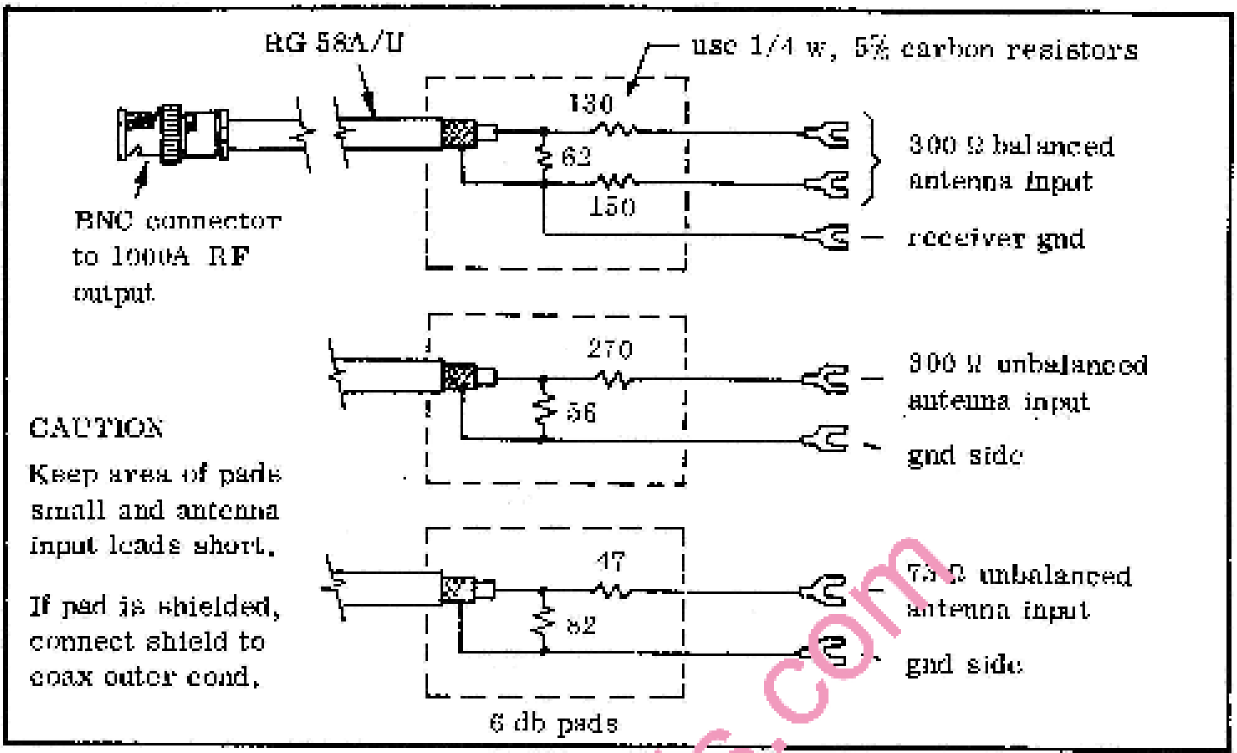


Figure 1. Resistive antenna matching networks

DUAL SWEEP

Connect the 1000A to the receiver or tuner under test and to a scope as shown below in Figure 2.

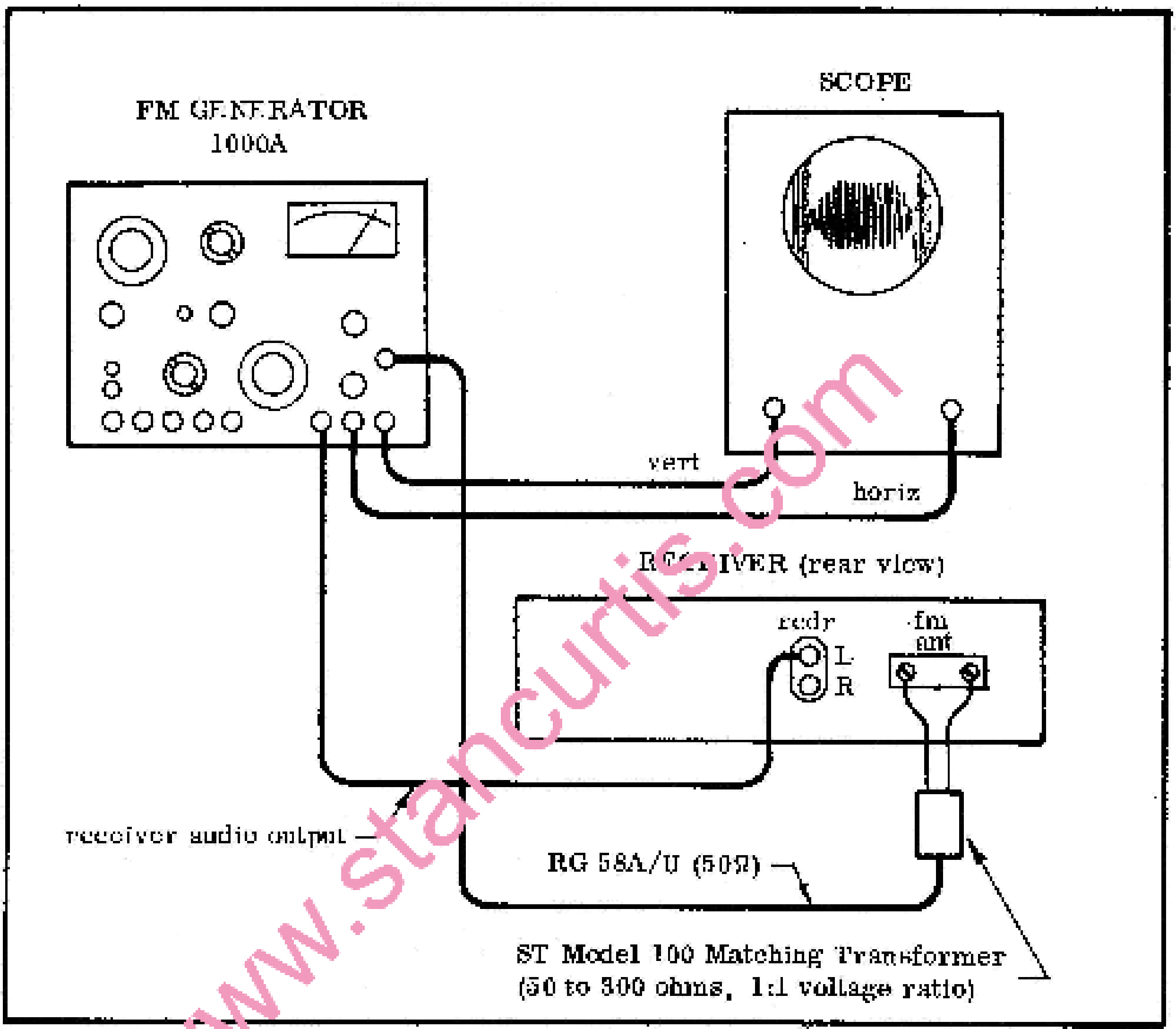


Figure 2. Interconnections for DUAL SWEEP alignment

Set the scope for external horizontal drive and vertical sensitivity of 1 V/cm.

The receiver (or tuner) should be in MONAURAL with MUTING turned off. Tune to a point on the dial where there is no interfering station.

Note that the audio signal in Figure 2 is taken from the tape recorder output (Left or Right side is optional). A BNC-to-Phono Plug cable can be made up, or a BNC-to-BNC cable may be used with a BNC Receptacle-to-Phono Plug adapter such as a Pomona model 2957.

Speaker terminals may also be used, but keep in mind that one side of the 1000A RCVR input is at ground potential. Some receivers have internal feedback from the low side of the speaker terminals, in which case it would be necessary to connect the 1000A RCVR input between the high speaker terminal and ground. If speaker terminals are used, set BASS and TREBLE controls at their normal position and bring the level up being careful not to saturate the 1000A filter/amplifier in the receiver bandpass. It is normal for receiver noise outside the bandpass to cause clipping.

Set up the 1000A as follows:

FUNCTION . . . . . DUAL SWEEP

RF LEVEL . . . . . Start at 100μV.

SWEEP WIDTH . . Start at 600 kHz. Read sweep width on top scale of meter.

FREQUENCY . . . . Adjust to get the receiver bandpass centered on the scope. The pattern should appear somewhat as shown in Figure 2.

PHASE . . . . Adjust to make forward and retrace patterns coincide.

The horizontal axis of the scope display is linear in frequency with peak-to-peak width read directly on the top scale of the 1000A meter. For example, by setting sweep width to 600 kHz and scope horizontal deflection to 6 cm, a horizontal scale of 100 kHz/cm is obtained.

Once the DUAL SWEEP pattern has been centered on the scope, the receiver discriminator and IF strip can be aligned. Amplitude of the 10 kHz signal at a given point on the horizontal axis, as explained on the third page of the data sheet, is proportional to S-curve slope at the corresponding carrier frequency. The receiver is aligned to have a DUAL SWEEP pattern which is as flat as possible (constant amplitude) in the required passband (150 kHz p-p) and symmetrical about the center frequency. Normally the discriminator adjustments will have the greatest effect on flatness; however a detuned IF circuit will degrade the pattern and shift it off to one side. In a critical alignment, final adjustment of the discriminator secondary should be done with SWEEP WIDTH reduced to about 200 kHz and scope sensitivity turned up with a corresponding vertical offset so that the top of the pattern can be viewed.

Words of Caution:

1. On wide sweep widths a large signal comes out of the discriminator, and in some cases one or more audio stages may overload. This can be seen on the DUAL SWEEP pattern as dropouts (signal goes to zero) near the pattern edges or a warping effect on the pattern as the center of the sweep is moved to left or right by tuning the receiver or changing the FREQUENCY dial. In this case it is necessary to reduce sweep width or probe closer to the discriminator to see the response characteristic for a wide sweep. Another method is to reduce RF LEVEL, but the pattern will become increasingly noisy.

2. It is sometimes possible to improve DUAL SWEEP pattern flatness by making adjustments which at the same time reduce receiver sensitivity. In a fringe area alignment should probably favor sensitivity; whereas in metropolitan areas the customer would probably prefer low distortion. In any event, a knowledgeable compromise can be made using the 1000A.

Alignment Hints:

1. It is usually better to align the receiver to have a DUAL SWEEP pattern which is symmetrical rather than making it drop precipitously or bump up at one edge in order to get maximum flatness in a particular 150 kHz part (corresponding to 100% modulation) of the bandpass. An abrupt loss of linearity means that tuning will be critical and also a small amount of drift will cause abrupt distortion. Either of these characteristics are likely to cause more customer dissatisfaction than a small amount of distortion.

2. During the alignment process it is a good idea to run RF LEVEL up and down frequently to be sure that the sweep pattern holds good over the required range. With the piston attenuator it is very easy to check this at each adjustment.

3. The horizontal presentation on the scope is linear in frequency. Receiver bandwidth can be read directly by calibrating the display as described in the setup procedure. Alternatively, if the SWEEP WIDTH and FREQUENCY controls are set to display only that portion of the receiver response to be measured, bandwidth can be read directly on the 1000A meter.

4. A good way to learn the DUAL SWEEP method is to use a dual channel scope and, with the scope display set on CHOPPED, simultaneously view the DUAL SWEEP pattern on one channel and the more familiar discriminator response (S-curve) or IF response on the other channel.

Applications:

1. DUAL SWEEP provides a direct measure of intermodulation distortion, that is, the modulation of a small amplitude, high frequency signal by the presence of a large amplitude, low frequency signal. Peak intermodulation distortion is calculated by taking the maximum amplitude change of either the top or bottom of the pattern over a 150 kHz width at the center of the pattern and dividing this number by the average height of the pattern across the band.

2. DUAL SWEEP measures the distortion from receiver antenna input to the point at which the audio signal is connected to the 1000A RCVR input. If the audio is taken directly from the discriminator output, the audio amplifier stages are excluded. If it is taken from the speaker output terminals, all of the audio stages are included. In this manner it is possible to track down the source of distortion whether it arises in the IF/discriminator part of the receiver or one of the audio stages.

STEREO

Set the FUNCTION switch on STEREO and the INPUT switch on LEFT or RIGHT if the internal audio oscillator is to be used. The OSC LEVEL control is used to set % modulation which is read directly on the FM DEV % scale of the meter. 100% corresponds to 75 kHz peak deviation of the FM carrier. If an external audio signal is used for modulation, set the input switch to EXT and use the signal source level controls to adjust % modulation as read on the 1000A meter.

Pilot level is set by depressing the PILOT TEST pushbutton and adjusting the PILOT LEVEL control for the desired % modulation. When the pushbutton is depressed, internal oscillator and external modulation sources (except auxiliary rear panel input) are automatically removed and the meter scale sensitivity is increased by a factor of ten, thus reading 15% full scale. The FCC specifies that pilot modulation should be between 8 and 10% (between 80 and 100 on the expanded meter scale). After pilot level is set, total modulation can be set at the desired level, usually 100% for receiver testing, by means of the OSC LEVEL control or external signal level. Note that modulation level controls are completely independent in going between the sweep function and any of the other functions.

Setting the INPUT switch to L + R causes the monaural subchannel to be generated by making L = R. Switching to L − R causes the stereo subchannel to be generated by making R = − L. These two modulation functions are useful for aligning matrix type demodulators. They also find application in troubleshooting demodulators and checking left/right balance.

MONAURAL

Set the FUNCTION switch to MONAURAL and the INPUT switch to LEFT/MONO if the internal oscillator is used. The OSC LEVEL control is used to set % modulation which is read on the FM DEV % scale of the meter. The INPUT switch is set to EXT and the LEFT input is used for an external audio signal on MONAURAL.

<u>CAUTION</u>: The internal oscillator will also provide modulation if the INPUT switch is set to L + R or L - R; however distortion will be higher.

CW

Setting the FUNCTION switch to CW removes all modulation and provides a clean RF carrier signal for quieting (signal-to-noise ratio) measurements on receivers. To perform quieting tests, connect an AC voltmeter having a 20 Hz to 15 kHz bandwidth to the receiver recorder output. Measure the output level with the 1000A on MONAURAL and modulation level set at 100%. Then switch the 1000A to CW and measure the output level again. The first measurement divided by the second gives the signal-to-noise ratio. RF LEVEL is normally set at 1000 microvolts for this measurement (2000 µV if one of the 6 db pads is being used). Quieting can easily be measured as a function of RF level by using the RF LEVEL control on the 1000A.

SCA

SCA trap alignment can be conveniently performed by setting the FUNCTION SWITCH to SCA. This removes internal modulation, sets the internal oscillator to 67 kHz, and applies this signal to the modulator. Modulation level is variable by means of the OSC LEVEL control.

AUXILIARY FRONT PANEL OUTPUTS

19 kHz: 5 volt square wave primarily used for scope sync when viewing stereo waveforms.

INT OSC: 3 V rms sine wave used primarily for scope sync when viewing receiver waveforms and distortion products at the output terminals of a distortion analyzer. Frequencies appearing here are 1 kHz on MONAURAL and STEREO, 10 kHz on DUAL SWEEP, and 67 kHz on SCA. Because of the low distortion at 1 kHz, this signal is also useful for amplifier testing. Source impedance is 1 KΩ.

COMPOSITE: This signal is normally used for separate testing and alignment of stereo demodulators. It consists of the full modulating signal except on DUAL SWEEP and is monitored on the bottom scale, PEAK VOLTS, of the meter. Maximum amplitude is 10 volts peak-to-peak. Source resistance is 600 Ω.

AUXILIARY REAR PANEL INPUT (Option M-1)

This input is intended primarily for external SCA program material but can be used for other modulation requirements. If one wished to do overall intermodulation distortion testing of a receiver at frequencies other than those provided in DUAL SWEEP, the large amplitude, low frequency signal could be applied at the front panel LEFT input (1000A on MONAURAL) and the small amplitude, high frequency signal applied at the auxiliary rear panel input.

This is a true summing input ahead of the metering circuit. Input resistance is 10 K Ω, frequency response is flat to 75 kHz (modulation level should not exceed 50% at 75 kHz), and the level requirement is about 2.4 V rms for 100% modulation.

CIRCUIT OPERATION

The amplifier configuration shown below in Fig 3 is used repeatedly in the 1000A. It will help to understand this circuit before continuing with overall circuit operation.

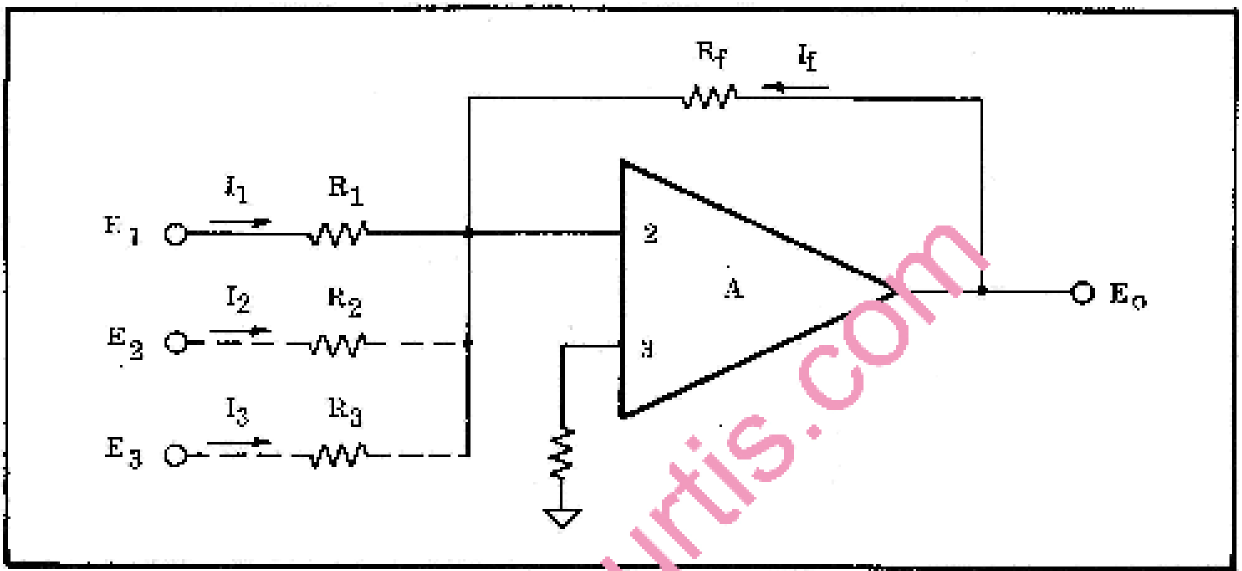


Figure 3. Summing amplifier

Amplifier A in this case is an integrated circuit amplifier with very high voltage gain and high input impedance. A positive voltage at pin 2 causes a negative output swing and a positive voltage at pin 3 causes a positive output swing. In other words, pin 2 is the inverting input and pin 3 is the non-inverting input.

The overall amplifier circuit works as follows: A positive voltage appearing at one of the inputs E_1 causes a current I_1 to flow through input resistor R_1. This causes a positive signal to appear at pin 2 which in turn causes E_o to go negative. E_o forces a current I_f to flow through R_f. Equilibrium is reached when the difference between I_1 and I_f multiplied by the amplifier input impedance is just equal to E_o divided by amplifier gain. For most practical purposes the voltage at pin 2 is reduced to zero and I_1 made equal to I_f. We may therefore write the following equations:

$$I_1 = \frac{E_1}{R_1} = -I_f = -\frac{E_o}{R_f}$$

therefore

$$\frac{E_1}{R_1} = -\frac{E_o}{R_f}$$

or $$E_o = -\frac{R_f}{R_1} \times E_1. \text{ The voltage gain is } -\frac{R_f}{R_1}.$$

The high gain and input impedance of the IC amplifier causes the sum of currents coming into pin 2 to be very nearly equal to zero, that is, the current flowing in from the inputs must equal the current flowing out through the feedback resistor. Pin 2 is called a current summing point in this particular configuration. By the same arguments we may write the following equation for the case in which there are three inputs.

$$E_o = -\frac{R_f}{R_1} \times E_1 - \frac{R_f}{R_2} \times E_2 - \frac{R_f}{R_3} \times E_3$$

For the following discussion refer to the 1000A schematic diagram. Primary signal flow is from the LEFT and RIGHT inputs across the top of the diagram to the COMP (composite) output and then back down through the linearizer (Q20) and modulator driver (MC5) to the RF unit.

LEFT and RIGHT input amplifiers, MC1 and MC2, serve several purposes. They buffer the inputs and provide a constant input impedance (10Kohm). Remember pin 2 is a summing point and has practically zero voltage with respect to ground. They also provide dc bias and low output impedance for the switching field-effect transistors Q1 and Q2. The dc bias is obtained by summing inputs from the +15 volt supply. This bias is later cancelled by a summing input through R17 to MC3.

The time division multiplex signal is generated by switching back and forth between MC1 and MC2 outputs at a 38 kHz rate and letting the currents, first from one and then the other, flow into the summing point of MC3 through input resistor R16. Q1 and Q2 act as switches -- going to a very high resistance when the gates are driven negative and to a low resistance when the driving voltage goes to zero. At zero the driving voltage source is effectively decoupled from Q1 and Q2 gates by diodes CR1 and CR2. These are depletion mode FET's, and therefore with a low source-to-gate voltage they have a low source-to-drain resistance.

MC3 is used to buffer the multiplex signal and provide a low output impedance for driving the composite filter (circuit containing L1, L2, and L3). It is also used to add in the pilot signal through R30 (another summing input). The purpose of the composite filter is to remove odd-order harmonics of 38 kHz from the multiplex signal and correct the amplitude of the stereo subchannel.

MC4 buffers the filter and provides a high-level, linear, composite signal. The auxiliary, rear-panel input is summed with the filter output through R34.

LINEARIZER and RF CIRCUITS

The RF oscillator is contained in the metal can mounted at the top of the attenuator tube. The circuit is a single transistor (Q30) oscillator with capacitive feedback to the base. Radiation from tank coil L4 propagates down the attenuator tube. The tube is a waveguide operating below cut-off and attenuation down the tube follows a precise logarithmic law. The output pick-up loop and its associated components are mounted on a probe which is moved up and down the tube by the RF LEVEL control.

The RF oscillator is frequency modulated by a varactor diode CR21 connected in the tank circuit. The varactor diode has a capacitance which is related to the voltage appearing across it. The resultant voltage tuning characteristic is not linear and in order to have a linear modulator it is necessary to provide a compensating non-linearity. This is the purpose of the field-effect translator Q20 which is biased into a region to best compensate the non-linearity. Emitter follower Q5 and its surrounding circuitry provides a low-impedance, adjustable bias source. Amplifier MC5 buffers the linearizing amplifier and provides a low impedance drive to the RF unit.

SUBCARRIER and PILOT GENERATOR

Both the 38 kHz subcarrier and the 19 kHz pilot signal are derived from the 152 kHz crystal oscillator comprised of crystal Y1 and one-half of MC7. This half of MC7 is connected as an amplifier with the crystal in the feedback loop. The output is amplified by Q21 and divided down to 76 kHz by the other half of MC7 wired as a binary divider. Dual flip-flop MC8 is used to further divide down to 38 kHz and 19 kHz. Q3 and Q4 provide the 38 kHz drive to the analog switching circuits described above.

Output of MC8B is a 19 kHz squarewave. This signal is converted to a sine wave by MC6 which is wired as a double integrator. The chief characteristic of the double integrator is a low frequency roll-off at 16 db/octave, thus it is able to eliminate the harmonics of the square wave input. Since it is not a "perfect" integrator, it has a slight phase shift which is corrected by the circuit consisting of R92, R93 and C32. By means of R93 it is possible to adjust the phase over a 4° range.

INTERNAL OSCILLATOR

This is a Wien bridge oscillator built around IC amplifier MC9. When the peak output voltage exceeds the voltage on the base of Q7, the gate of Q8 is driven more positive, thus increasing the source-to-drain resistance and increasing the negative feedback around MC9. Q8 acts simply as a voltage controlled resistor. R105 is used to put the circuit in the proper operation region and is used to adjust oscillator distortion. Q6 in the level detecting circuit acts as a buffer and also provides temperature compensation for Q7. CR4 and CR5 prevent emitter-base breakdown.

The phase splitter circuit, Q9, is used to provide the input signals for generating the monaural (L + R) and stereo (L - R) subchannels. Since some distortion is introduced here, these two positions of the INPUT switch should not be used for receiver distortion measurements.

METER CIRCUIT

The peak-reading meter circuit is based on a summing amplifier configuration. It is used to monitor the composite output level.

If feedback current through the meter drops below the peak input current determined by peak input voltage (positive swing) and R140 and R141, output of MC10 will swing far enough negative to increase the charge on C69 and thereby increase the feedback current. Feedback current through M1 continues full time. Except at times corresponding to the positive input peaks, MC10 output swings slightly positive to produce a counteracting feedback current through CR6.

Q12 isolates the output of MC10 from the meter feedback path. R147 and C69 determine the discharge time constant and therefore the low-frequency response of the meter circuit.

C70 and R139 form a high-frequency compensating circuit. R143 and R142 are switched in on PILOT TEST to increase meter sensitivity by a factor of ten.

DUAL SWEEP FILTER/AMPLIFIER

The purpose of this circuit is to provide very high rejection of 60 Hz and an amplifier with a frequency response peaking at about 10 kHz. A high-pass filter consisting of C60, R130, C61, and R131 leading into the gate of field effect transistor Q10 provide the required low frequency rejection. Feedback capacitor C63 around amplifier Q11 provides the high-frequency roll-off.

POWER SUPPLY and SWEEP CIRCUIT

Integrated circuit MC11 contains the regulating amplifier and reference zener for the +15 volt supply. R165 and R166 form the feedback reference divider, and R164 sets the current at which short circuit protection occurs. Q13 is the series regulator for the +15 and is driven from MC11.

The -15 volt supply is referenced to the +15 through divider R172 and R173. The circuit regulates to keep the base of Q17 at zero volts. Q16 and Q18 amplify the error signal to the base of Q14 which is the series regulator for the -15. R176 in conjunction with Q19 provide short circuit protection, turning off Q18 and Q14 as current exceeds the prescribed limit.

Q15 is an emitter follower to provide the +5 volts from the +15. The +5 achieves its short circuit protection from the protection built into the +15 supply.

One winding of the power transformer (3 - 5) is used to supply the horizontal sweep voltage and low-frequency modulation voltage in DUAL SWEEP. The voltage is first filtered by R21, R22, and C85, then it is applied to the phase shifter circuit. Varying R162, the SWEEP PHASE control, changes the phase of the modulation signal with respect to the HORIZ output voltage. A special feature of this type of phase shift network is that amplitude changes very little with a change in phase.

INTERNAL ADJUSTMENTS

+5 Volt Supply - R168

Measure the +5 volt supply at the emitter of Q13 (see Fig 7 on separate page at back of manual). Nominal value is 5.4.

Crystal Oscillator - C20

Set FUNCTION switch to STEREO. Connect a counter to the end of C20 opposite the X'tal (underside of board). This is the same as pin 6 of MC7 but a more convenient test point. Connect to the counter with clip leads to avoid excess capacitive loading. Adjust C20 for 152.000 kHz. The 19 kHz output may be used instead, but a 10 second gate time will be required to get sufficient resolution. A counter with sufficient accuracy to insure meeting the .01% requirement of FCC specifications should be used.

L/R Gain Balance (38 kHz Subcarrier Suppression) - R1, R7

Set FUNCTION switch to STEREO, INPUT switch to L + R, PILOT LEVEL full off, OSC LEVEL to approximately 100% deviation. Connect a scope to COMP output, sync on INT OSC output.

Observe the positive peaks of the COMP output waveform with scope gain as high as possible. Adjust R1 to remove the 38 kHz ripple seen here.

Observe the negative peaks (invert scope polarity or slide the pattern up), and adjust R7 to remove the 38 kHz ripple seen here. Repeat adjustment of R1 and R7 several times since they are interacting.

Turn OSC LEVEL full off and make final adjustment of R7 for minimum 38 kHz at COMP output.

DC Balance - R19

Set FUNCTION switch to STEREO, INT OSC control full off. Adjust R19 for minimum dc voltage (<20 mV) measured at the COMP output.

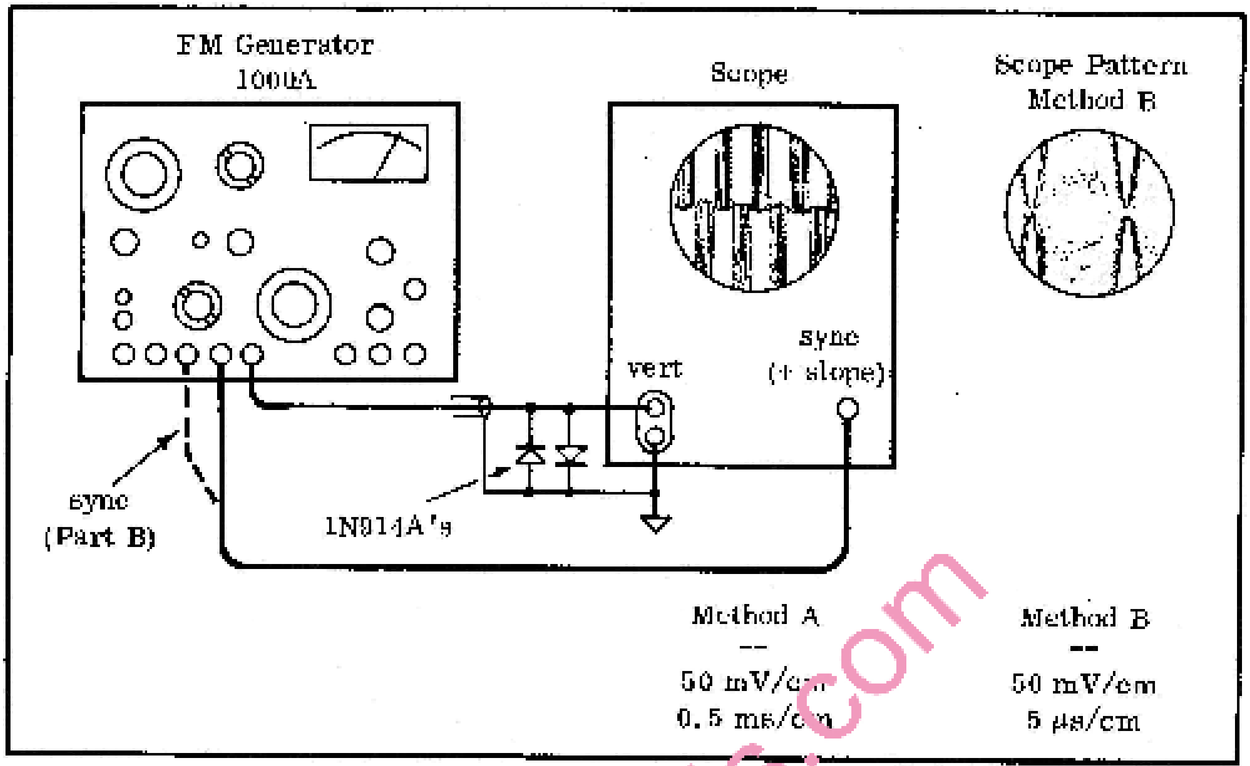


Figure 4. Setup for checking stereo separation

MONO/STEREO Subchannel Separation (See page 13A if unit is equipped with option M3)

This adjustment should not be attempted unless a high quality, wide-band scope is available. To be on the safe side, the scope should have a dc to 10 Mhz response. Vertical sensitivity should be at least 50 millivolts/cm at DC. Do not use AC coupling and do not use a scope probe. A slight misadjustment of the probe could cause an apparent lack of separation.

Method A

Connect the COMP output to the scope vertical input (as shown in Fig 4) with two high speed silicon diodes such as 1N914A's across the scope input. The purpose of the diode is to clip the input voltage and reduce scope overload. Sync the scope on INT OSC output and set sweep speed to 0.5 ms/cm, vertical sensitivity to 50 mV/cm.

Set FUNCTION switch to STEREO, INPUT switch to LEFT, PILOT LEVEL full off, and OSC LEVEL to 5 volts peak on the modulation meter. Adjust R35 and R38 for maximum base line flatness. Start R38 at one end and slowly rotate while constantly seeking minimum base line ripple with R35.

CAUTION: Check possibility of scope overload by reducing vertical sensitivity and seeing that the centimeters of base line ripple reduces accordingly.

Option M3 Separation Adjustment

If option M3 has been installed, variable resistors R35 and R38 have been omitted. The composite filter is now mounted on a side panel and is permanently adjusted at the factory.

With option M3, low frequency separation can be independently adjusted with a LEFT signal only (adjust R200) or a RIGHT signal only (adjust R201). The test signal may have a frequency anywhere between 50 Hz and 1 kHz. Use either Method A or Method B to observe separation on a scope.

Method B

Synchronize the scope on the 19 kHz output and set sweep speed to 5 µs/cm. A series of opposing zero cusps will appear (see sketch in Fig 4) at 26.3 µs intervals (38 kHz period). These "zero" points occur at the instant the composite waveform would be sampled to determine the voltage at the right input. Changing the INPUT switch to RIGHT shifts these points 13.16 µs with the level at the "zero" points now representing the left input.

Adjust R35 and R38 to minimize the voltage levels occuring at the "zero" points and to make the cusps symmetrical. Normally the optimum condition will result in a slight separation of the opposing cusps on either the LEFT or RIGHT position and a slight overlap on the other position of the INPUT switch. With the composite level set at 5 volts peak, the peak-to-peak separation or overlap at the "zero" points should be less than 20 mV.

To optimise separation over the full audio frequency range, turn the INPUT switch to EXT and connect an external audio oscillator set at 5 kHz with sufficient output to bring the composite level to 5 volts peak. Now adjust R35 and R38 to make the opposing cusps symmetrical and just touch at the center.

FM Modulator Linearity - R52

A discriminator which is either linear or has a known non-linearity is required to adjust the linearity of the 1000A modulator. The following method can be used to determine the linearity of a discriminator.

The discriminator is measured just the same as if you were using the DUAL SWEEP function of the 1000A -- with one important difference. The two-signal modulation is achieved by mixing the outputs of two FM generators as in Fig 5, one -- the 1000A -- having the 60 Hz sweep modulation and the other -- the auxiliary generator -- having a 10 kHz modulating frequency with ≈7.5 kHz peak deviation. The difference frequency from the balanced mixer (Hewlett-Packard 10514A or equivalent) contains both modulations; however, with this setup, amplitude of the 10 kHz modulation is independent of the 1000A carrier frequency.

The 1000A is set on DUAL SWEEP and the built-in filter/amplifier is used to generate the familiar DUAL SWEEP pattern (see Fig 5). However the auxiliary FM generator supplies the 10 kHz modulation, and so the 1000A internal 10 kHz modulation must be removed. To do this, take the cover off the 1000A (see Fig 6) and connect a clip lead between chassis ground and the pole of S1-3. This kills the internal oscillator which supplies the 10 kHz in DUAL SWEEP. S1-3 is on the front wafer of the FUNCTION switch. The terminal to be grounded is at the top and has a grey lead connected to it. The other terminal at the top of this wafer is ground (black lead).

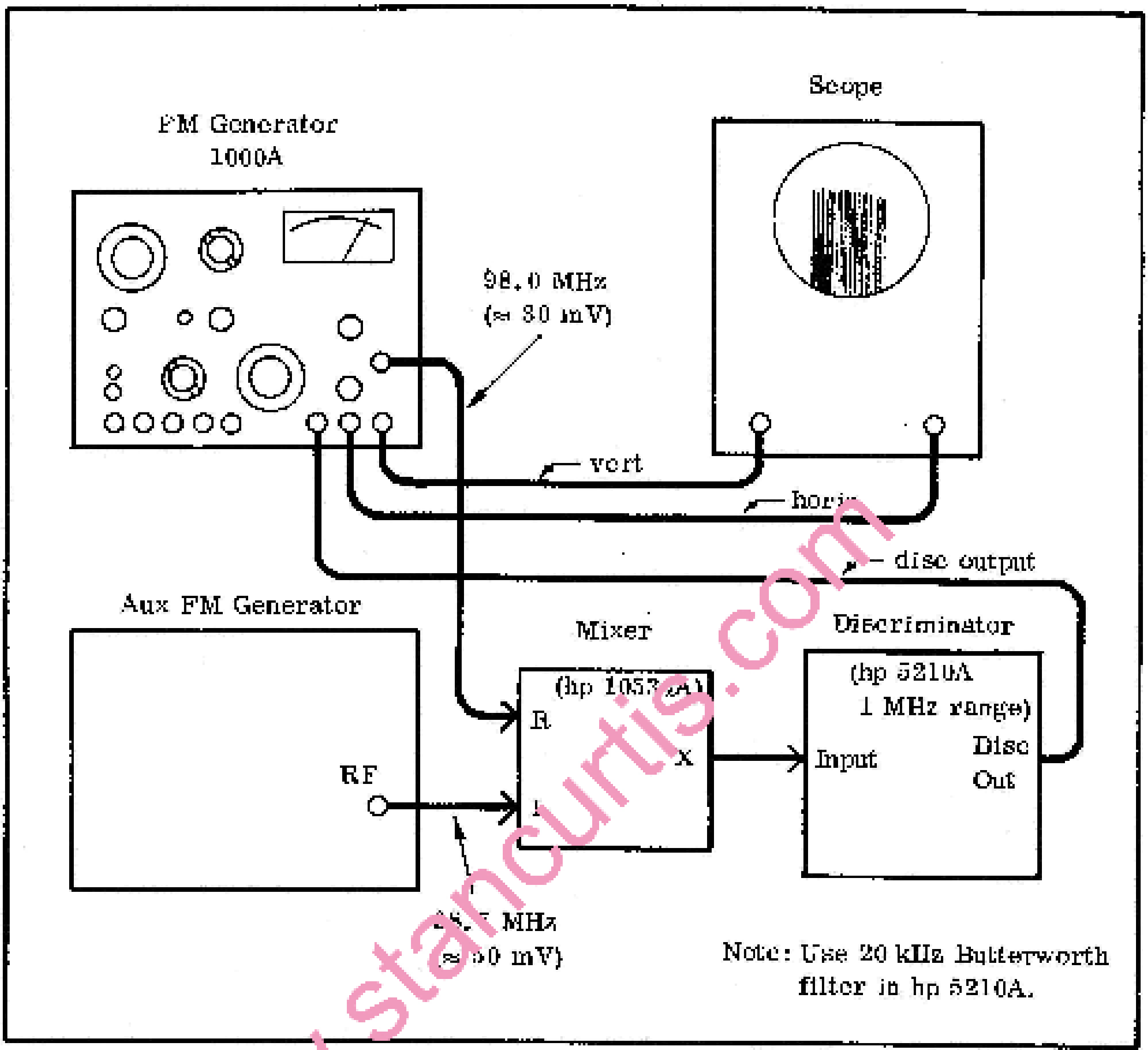


Figure 5. Interconnection for linearity tests

In the example of Fig 5 the discriminator is a Hewlett-Packard 5210A Frequency Meter set to the 1 MHz range. The two generators are set to have center carrier frequencies 700 kHz apart (98 and 98.7 MHz). If a 10.7 MHz discriminator were used, the auxiliary generator would be set at 98 + 10.7 or 108.7 MHz. The test frequencies aren't critical, but the 1000A should be somewhere between 96 and 98 MHz. The auxiliary generator can be either above or below the 1000A frequency. Discriminator tests and subsequent adjustment of R52 should be done at a sweep width of ≈ 300 kHz.

If the 5210A is available it should be used with one of the active plug-in filters. A good choice would be the 10 to 100 kHz Output Filter Assembly with resistors chosen for a 20 kHz Butterworth roll-off (see 5210A manual). Discriminator output is fed back to the 1000A RCVR input just as in the DUAL SWEEP mode. HORIZ and VERT outputs of the 1000A are connected to a scope to get the DUAL SWEEP type display.

Vertical gain of the scope should be set as high as possible with a corresponding vertical offset in order that the top of the pattern may be viewed. An effective height of 35 cm means that a pattern tilt of less than 0.3 cm (sweep width = 300 kHz) is required to insure an equivalent total harmonic distortion of less 0.1% at 100% modulation. Pattern tilt can be seen more easily by making the horizontal display narrow. An effective way to see the tilt is to vary the 1000A sweep width up and down between 0 and to 300 kHz. Using the 5210A it should be possible to vary the carrier frequency of either generator slightly (thus varying the difference frequency) to find a flat segment of the discriminator. A suitable alternative is simply to record the tilt. RF levels from the two generators must be sufficiently high that changes in level do not affect apparent linearity.

Having either found a linear segment on the discriminator or recorded the tilt, turn off the modulation of the auxiliary generator (leave carrier frequency untouched) and remove the clip lead from the 1000A. Now both modulating signals are coming from the 1000A and R52 is adjusted to obtain the same sweep pattern as observed above.

After adjusting linearity, the modulation level accuracy should be checked.

Modulation Level - R47, R95

In order to adjust modulation level, it is necessary to have a standard. The standard can either be another generator with known accuracy or a calibrated discriminator.

Standard Generator Method

If another generator is used, measure receiver output with 100% modulation (monaural) using the same modulating frequency as the internal oscillator in the 1000A. Then connect the 1000A in place of the standard generator, set modulation to 100% (monaural) and adjust R47 for the same receiver output.

Adjusting sweep width (R95) using a standard generator is more difficult because of limited receiver bandwidth. One must either calibrate at the low end of the meter scale -- say 200 to 300 kHz sweep width -- or go into the receiver just ahead of the discriminator. Some receivers also have a wider bandwidth at high signal levels. In any event, R95 is adjusted to make the receiver output the same for the standard generator having a peak deviation at 60 Hz modulating frequency equal to one-half the 1000A sweep width. For this adjustment the 1000A is set on DUAL SWEEP.

Calibrated Discriminator Method

The calibrated discriminator method utilizes a setup similar to that shown in Fig 5 for the linearity adjustment. However, in this case discriminator output is fed to an AC voltmeter instead of the RCVR input of the 1000A. The discriminator can be calibrated at dc by shifting the difference frequency a known amount. The dc frequency shift should be measured on a counter. If the Hewlett-Packard 5210A is used, the discriminator output is calibrated by a rear panel control according to the 5210A manual (a calibrating crystal is included in the 5210A). After calibration, the shorting plug board is removed from the 5210A and the appropriate active filter (same one as used above) is plugged in. Range is set to 1 MHz and DISC OUT read directly on an AC VTVM.

Set 1000A FUNCTION switch to MONAURAL, INPUT switch to LEFT/MONO, OSC LEVEL to 150%. Adjust R47 for 79.5 mV rms. Now switch the 1000A to DUAL SWEEP, and with SWEEP WIDTH set to 600 kHz adjust R95 for 212 mV rms.

Internal Oscillator - R105

Connect a distortion analyzer such as the Hewlett-Packard 333A to the 1000A INT OSC output. Set the 1000A to MONAURAL and adjust R105 to get total harmonic distortion of approximately -64 dB (≈.06%). Note that it is possible to get much lower THD, but the oscillator becomes harder to start as the distortion is reduced. As a final check, particularly when R105 has been set for a very low THD, make sure the oscillator is still working on DUAL SWEEP (10 kHz) and SCA (67 kHz).

If a distortion analyzer is not available, look at the INT OSC output with a scope. R105 should be adjusted so that the oscillator is just into the safe start-up region when switching between DUAL SWEEP, MONAURAL or STEREO, and SCA. Normally, start-up will be slowest in MONAURAL or STEREO.

Internal Oscillator - R95 (Option M-2)

After adjusting R105, adjust R95 for the same THD at 400 Hz (≈ -64 dB).

Pilot Phase - R93 (Do this only after checking mono/stereo subchannel separation, page 13)

Connect a scope to the 1000A COMP output. Synchronize the scope on the INT OSC output. Set scope vertical sensitivity to 0.05 V/cm. Sweep speed is not critical. In the figures shown below (internal oscillator frequency 1 kHz) sweep speed was set to 0.[illegible] ms/cm with the sweep magnifier on X5. Set 1000A FUNCTION switch to STEREO, INPUT switch to L-R. With PILOT LEVEL all the way down, adjust OSC LEVEL for approximately 25% modulation.

Adjust scope to get the L-R crossover pattern shown in Fig 9A. Now turn PILOT LEVEL all the way up (meter will read ≈ 50% modulation). The bright points of the pattern should move out on a horizontal axis as in Fig 9B. If there is a tilt as in Fig 9C, adjust R93 to remove the tilt. An end-to-end tilt of 20 mV corresponds to a pilot phase error of ≈ 0.6°, which is more than adequate to assure 60 dB separation assuming perfect mono/stereo subchannel separation (perfectly flat base line with L only or R only input).

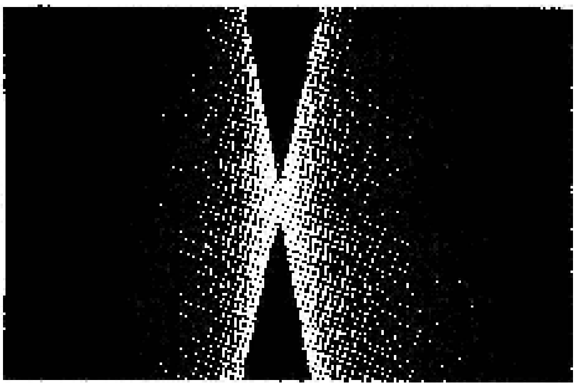


Fig 9A. L-R crossover, 25% modulation, no pilot, 0.05 V/cm.

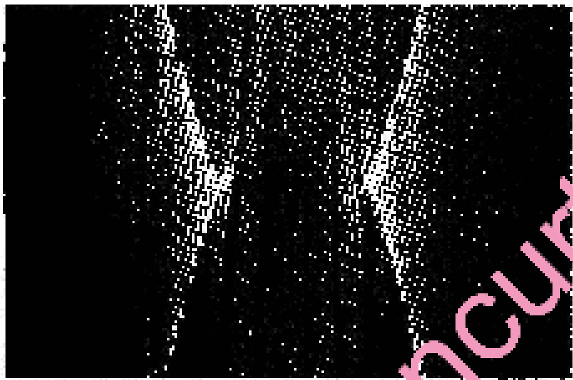


Fig 9B. Pilot level control all the way up. Correct phase.

Bright spots occur where pilot amplitude equals twice the L-R subchannel amplitude. Spots move out horizontally if pilot and sub-channel signals cross zero at the same time.

Fig 9C. Tilt corresponding to phase error of ≈ 0.6°. (1.75° pilot phase accuracy required for 60 dB separation, assuming perfect base line flatness.)

Fig 9. Composite waveforms for setting pilot phase - R93.

L – R Balance – R118

Connect a scope to the 1000A COMP output. Set sweep speed to 2 ms/cm and sync on the INT OSC output. Set 1000A FUNCTION switch to STEREO, INPUT switch to L – R. Turn PILOT LEVEL full off and OSC LEVEL to about 10 V p-p on the scope (5 V peak on the 1000A meter).

Adjust R118 so that adjacent positive and negative peaks are as nearly equal as possible.

C16 - RF Stereo Separation

Connect scope vertical input to FLT 102 (one of the two feed-thru inputs to the RF unit – violet wire). To reduce noise on the signal, isolate the scope input at the RF unit with a 470 Ω resistor. Do not use a scope probe and keep the length of the shielded lead to the scope (RG 58 U or equivalent) under 4 feet. Set scope vertical sensitivity to 10 mV/cm. Now, having already adjusted stereo separation at the COMP output, adjust C16 for optimum separation at FLT 102. Method B (page 14) is the preferred method for observing separation. Separation (or overlap) of the "zero" cusps should be less than 2 mV.

CAUTION: Check possibility of scope overload by reducing vertical sensitivity of the scope. Separation (or overlap) of the "zero" cusps should reduce accordingly.

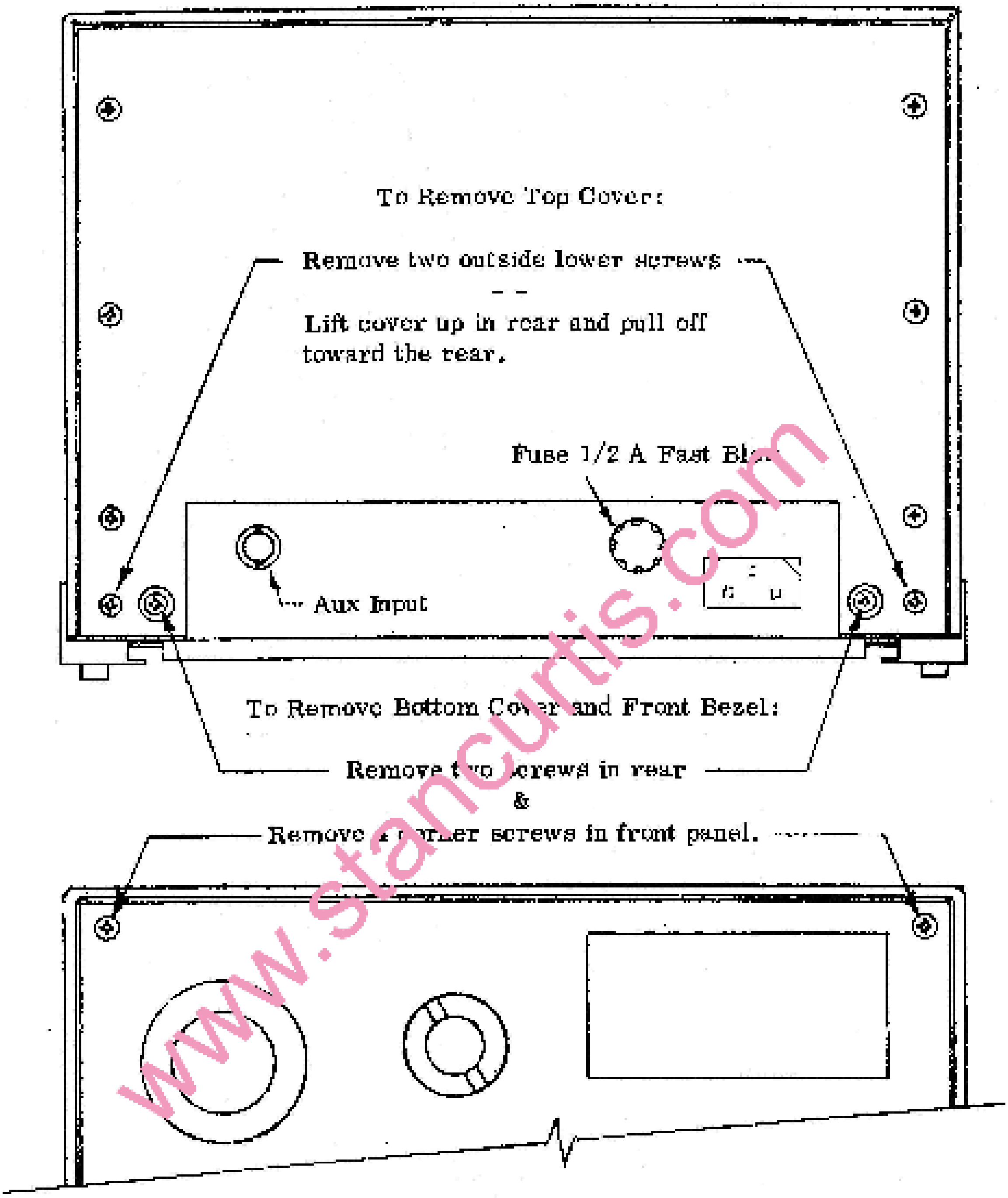
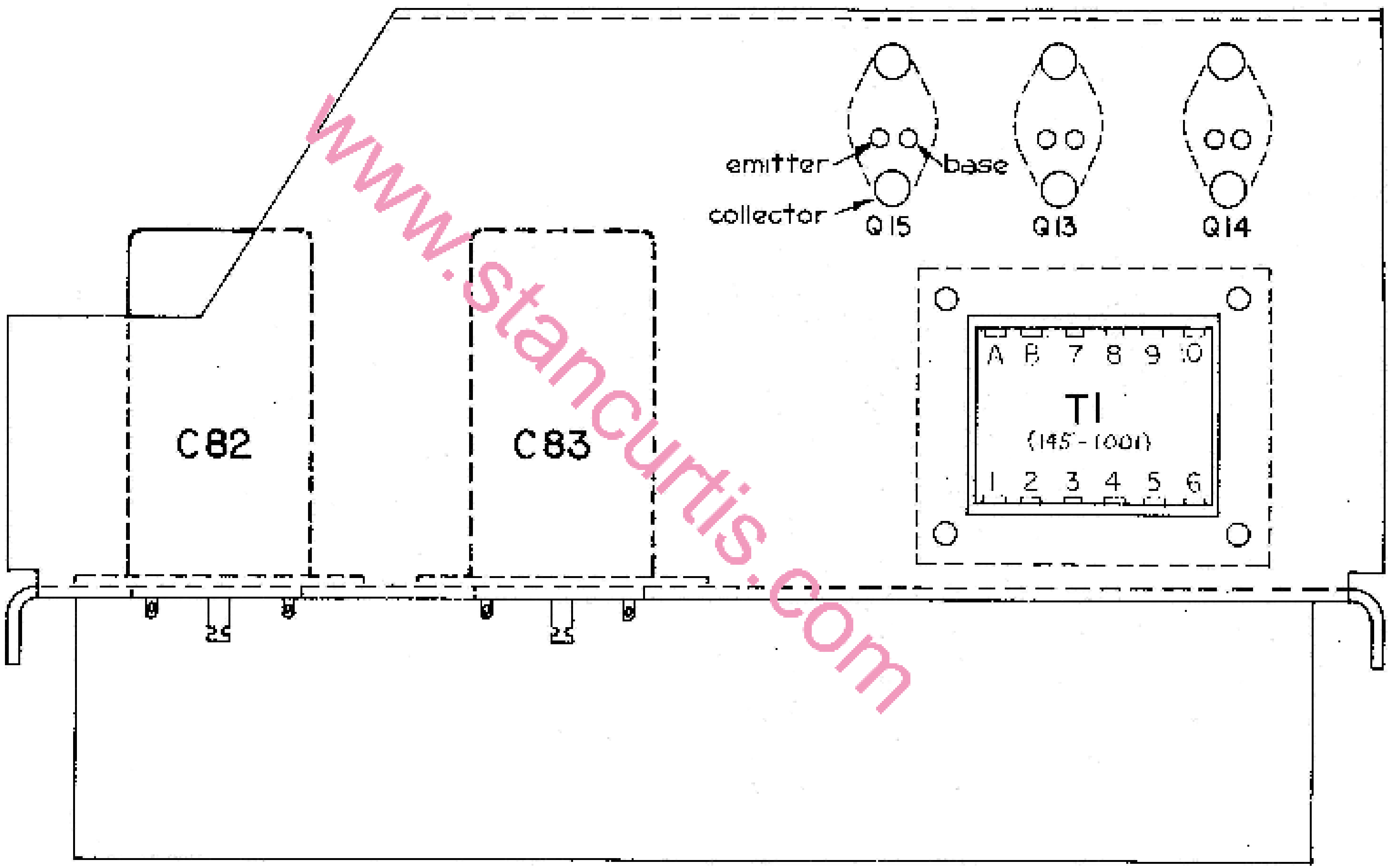
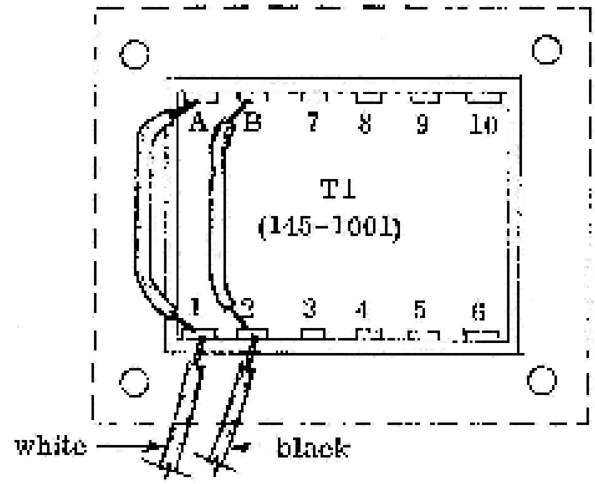


Figure 6. Cover removal

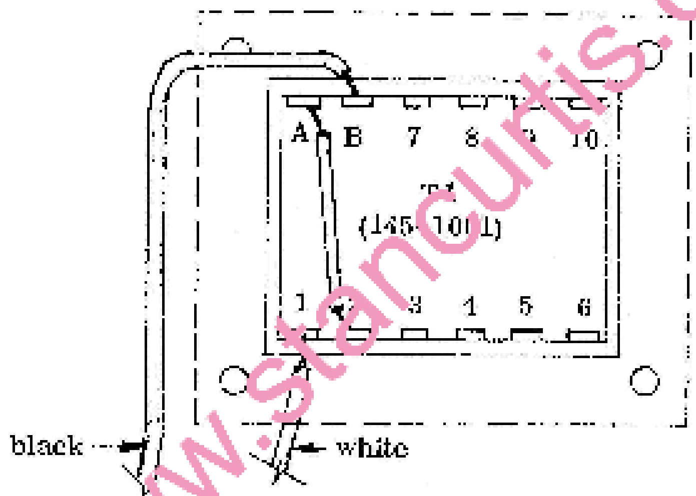


FRONT VIEW

Figure 7. Chassis parts layout

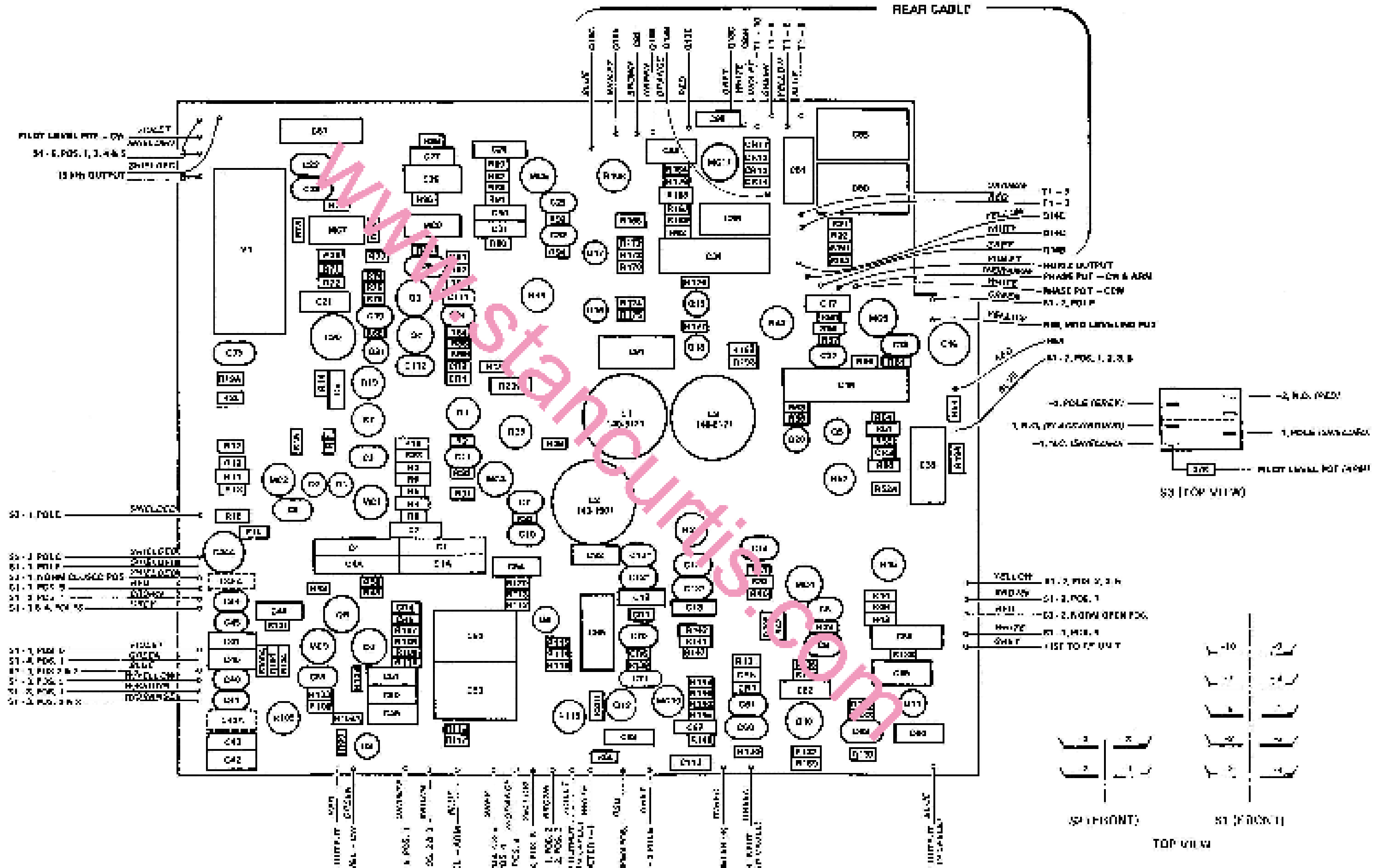


Primary Wiring for 115V



Primary Wiring for 230V

Figure 10. 115/230 volt primary wiring.

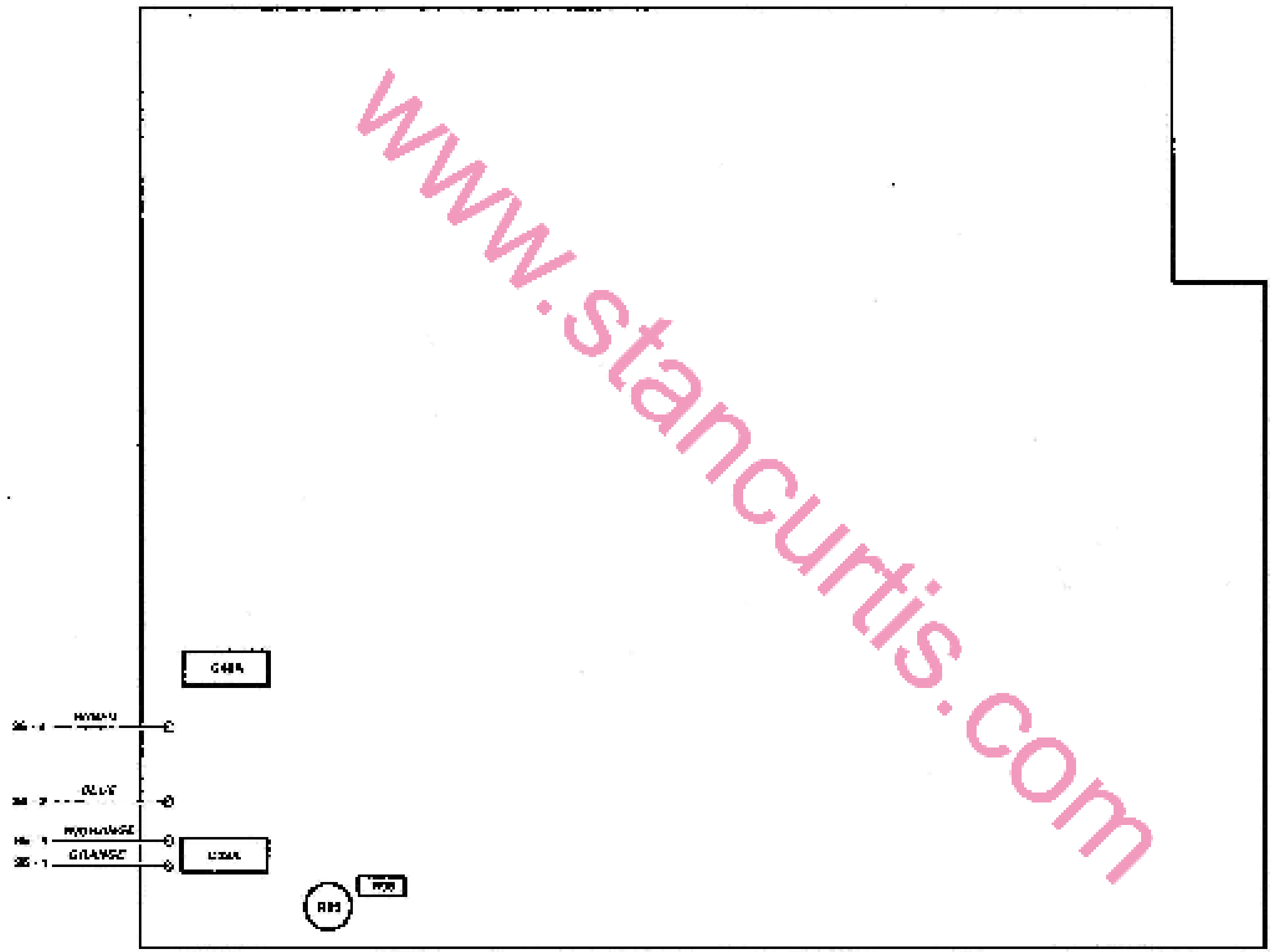


† CONSULT FACTORY FOR SHUNT CAPACITORS USED TO ADJUST C… AND C… TO DESIRED VALUES

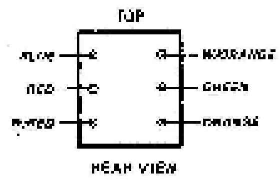
SOUND TECHNOLOGY

CIRCUIT LAYOUTS
MODEL 1000A

2/72



FREQUENCY SELECT SWITCH
(ON FRONT PANEL)



SOUND TECHNOLOGY

CIRCUIT LAYOUTS
MODEL 1000A M?

REFERENCE DESIGNATION	DESCRIPTION	SOUND TECHNOLOGY STOCK NUMBER	MANUFACTURER	MANUFACTURER PART NO.
All fixed resistors except 1% values	R: Fxd, Comp, 1/4 w, ±5% 5.1Ω thru 1MΩ	100-0510 (5.1Ω) thru 100-1050 (1MΩ)	Allen-Bradley	Type CB
All 1% resistors	R: Fxd, Met Film, 1/8 w, ±1% 100 ppm	105-1001 (1K) thru 105-7502 (75K)	Corning	NA55
All variable resistors mounted on the printed circuit board	R: Var, ww, 1K, ±10%	110-1020	Bournes or IRC	3305P-1 500
R45, 111	R: Var, Comp, 1K, ±10%	110-1021	Allen-Bradley	JA1N056S102UA
R179	R: Var, Comp, 5K, ±10%	110-5020	Allen-Bradley	JA1N056S502UA
R162	R: Var, Comp, 10K, ±10%	110-1030	Allen-Bradley	JA1N056S103UA
R59	R: Var, Comp, 5K, Rear Shaft	110-5021	CTS	Special
All Mylar capacitors	C: Fxd, Mylar, 100V, .001 µfd thru 1.0 µfd, ±10%	125-1020 (.001 µfd) thru 125-1050 (1.0 µfd)	Sprague	225P10291 thru 225P10591
All Polystyrene capacitors	C: Fxd, Polystyrene, 33V, .001 µfd thru 1.0 µfd, (1%, 2.5%)	126-1020 thru 126-1050	Mial	611
All Mica capacitors	C: Fxd, Mica, 500V, 10 pf thru 820 pf, ±10%	120-1000 (10 pf) thru 120-8210 (820 pf)	Arco	DM15-100J thru DM15-821J
MC 1, 2, 3, 4, 5, 6, 9, 10	Int. Ckt: OP AMP	250-7090	Motorola	MC1709CG

MC 7	Int. Ckt: Quad, 2-input gate	250-8460	Motorola	MC 846P
MC 8	Int. Ckt: Dual JK Flip-Flop	240-8560	Texas Instruments	SN158094N
MC 11	Int. Ckt: Voltage Regulator	250-7723	Fairchild	U5R7723393
Q1, 2, 10	Transistor: N-Ch. FET 2N3819	230-3819	Texas Instruments	2N3819
Q3, 4, 6, 7	Transistor: Si, PNP, 2N3644	225-3644	Fairchild	2N3644
Q20 Q8	Transistor: P-Ch. FET " " "	236-5110 230-3700	General Instruments Siliconix	MEM511C VCR3P
Q5, 9, 11, 16, 17, 18, 19, 21	Transistor: Si, NPN, 2N3391	226-3391	General Electric	2N3391
Q13, 14, 15	Transistor: Si, NPN, 2N3054	226-3054	RCA	2N3054
Q12	Transistor: Ge, PNP, 2N404	22[illegible]-1040	RCA	2N404
Q30	Transistor: Si, NPN, 2N4996	226-[illegible]	Texas Instruments	2N4996
CR 1, 2, 3, 4, 5, 6, 7, 20	Diode: Si, 1N914A	210-9140	GE	1N914A
CR 11, 12, 13, 14	Diode: Si, 1N4003	210-4003	Motorola	1N4003
CR 21	Diode: Varactor	138-8330	Motorola	MV833
L1	Coil: Torroid, 3.12 mh	140-3121		Special
L2	Coil: Torroid, 1.6 mh	140-1601		Special
L3	Coil: Torroid, 6.12 mh	140-6121		Special
L6, 7	Coil: 2.2 μh	140-0220	Miller	74F226AP

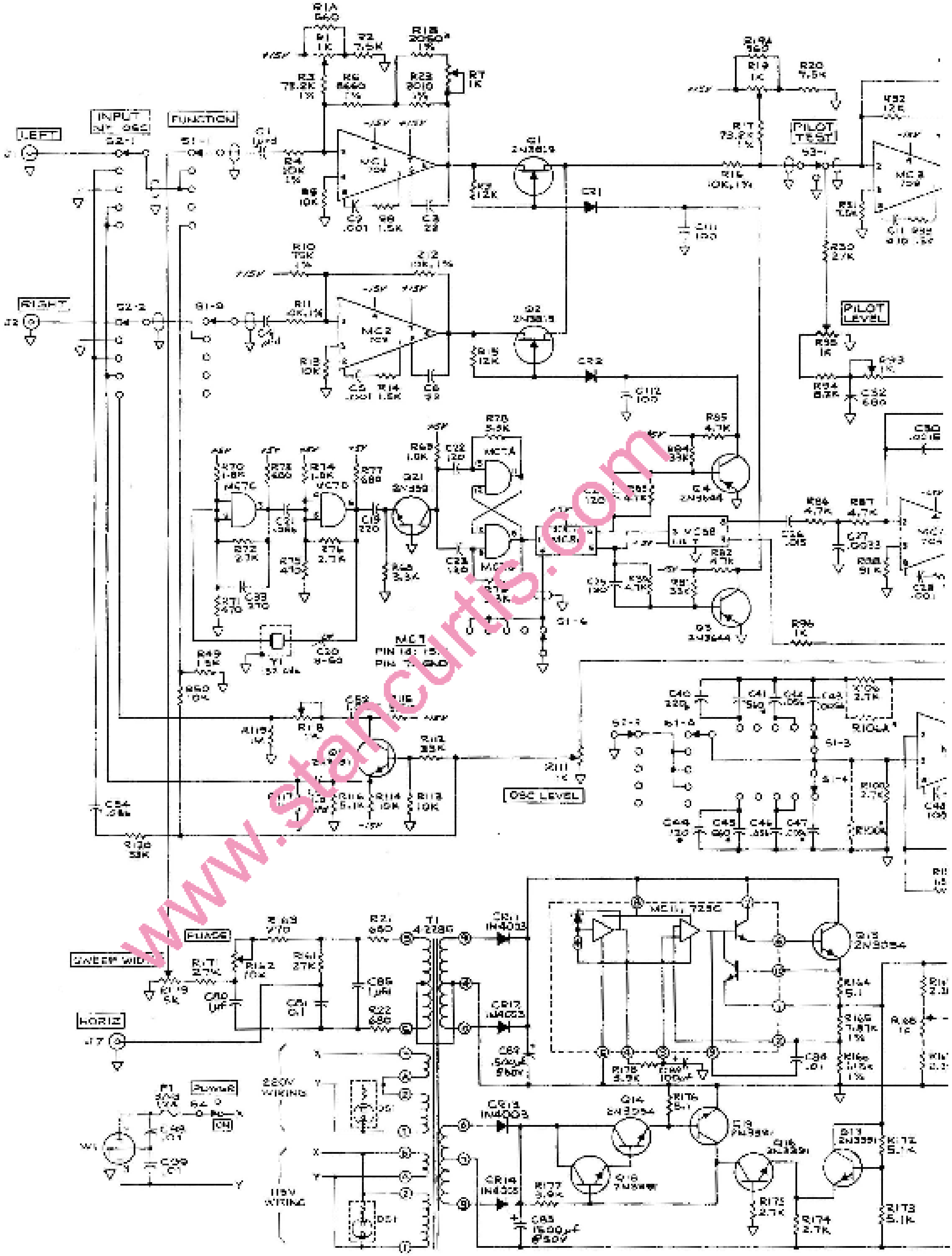
Removed when option M3 is installed.

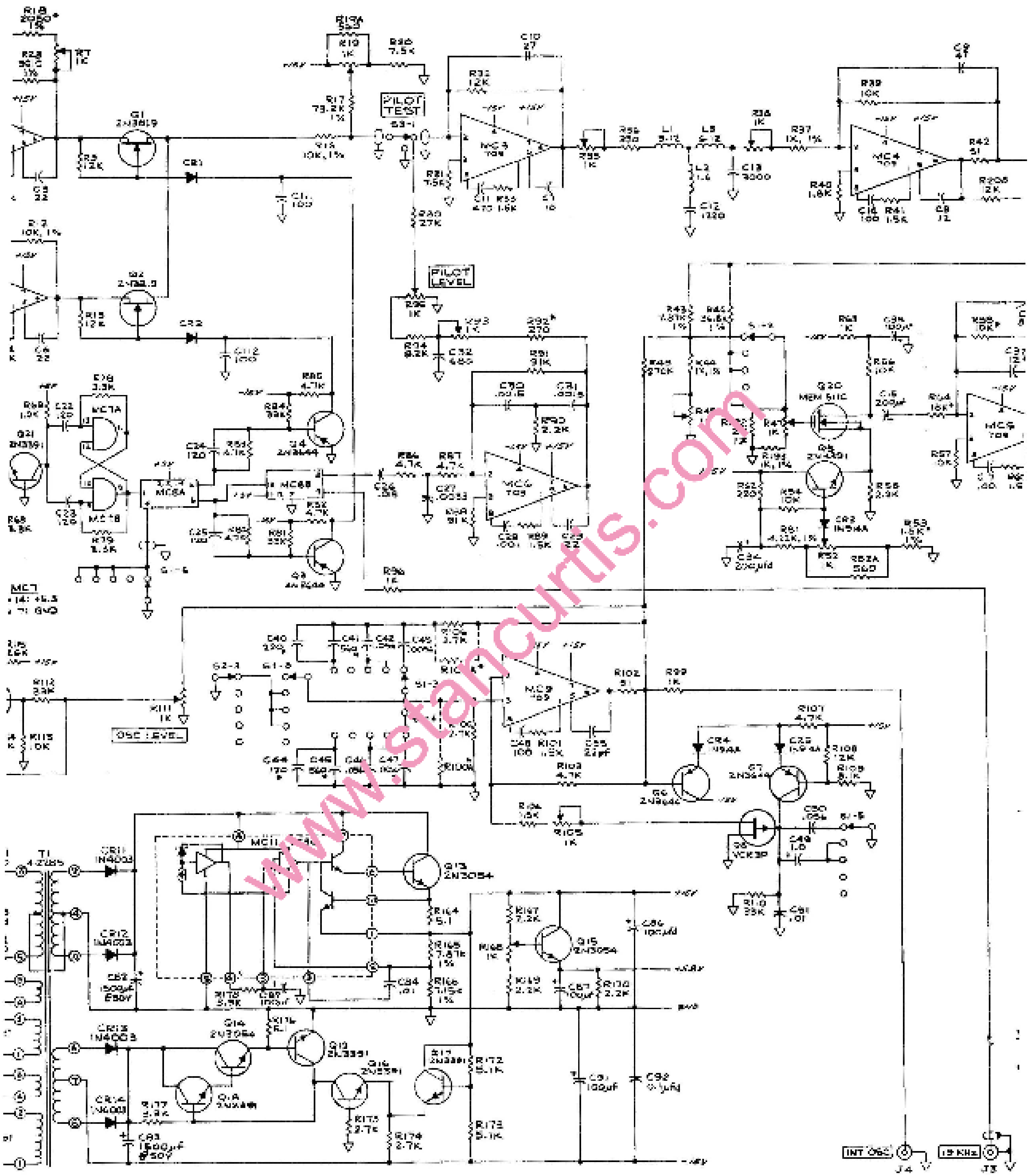
L5	Coil: 4.7 µh	140-0470	Miller	74F476AP
T1	X'fmr, Pwr	145-1000 145-1001 (115/230V)		Special
M1	Meter, 0-500 µA DC	360-1000		Special
W1	Pwr Cord	310-1200	Belden	17250
XF1	Fuse Post, 3AG	440-3120	Littlefuse	342014
F1	Fuse, 3AG, 1/2 A	330-0500	Littlefuse	312,500
DS1	Indicator Light, Neon	321-1311	Leecraft	36N1311-6
Y1	X'tal, 152 kHz	370-0152		
S1	SW, Rotary 7P-5T	340-5280		Special
S2	SW, Rotary 2P-5T	340-5209		Special
S3	SW, Pushbutton	340-9327	Switchcraft	1006
S4	SW, Toggle, SP-ST	340-9492	Cutler-Hammer	8280K16
J1, 2, 3, 4, 6, 7, 8, 9, 10	Connector, BNC	420-1094	Amphenol	31-221-1050
J5	Connector, BNC	420-9090	Amphenol	31-206/UG909/U
<u>Mechanical Hardware:</u>	Dial, RF	405-0002		
	Dial, Attenuator	405-0003		
	Hub, Attenuator Dial	406-0005		

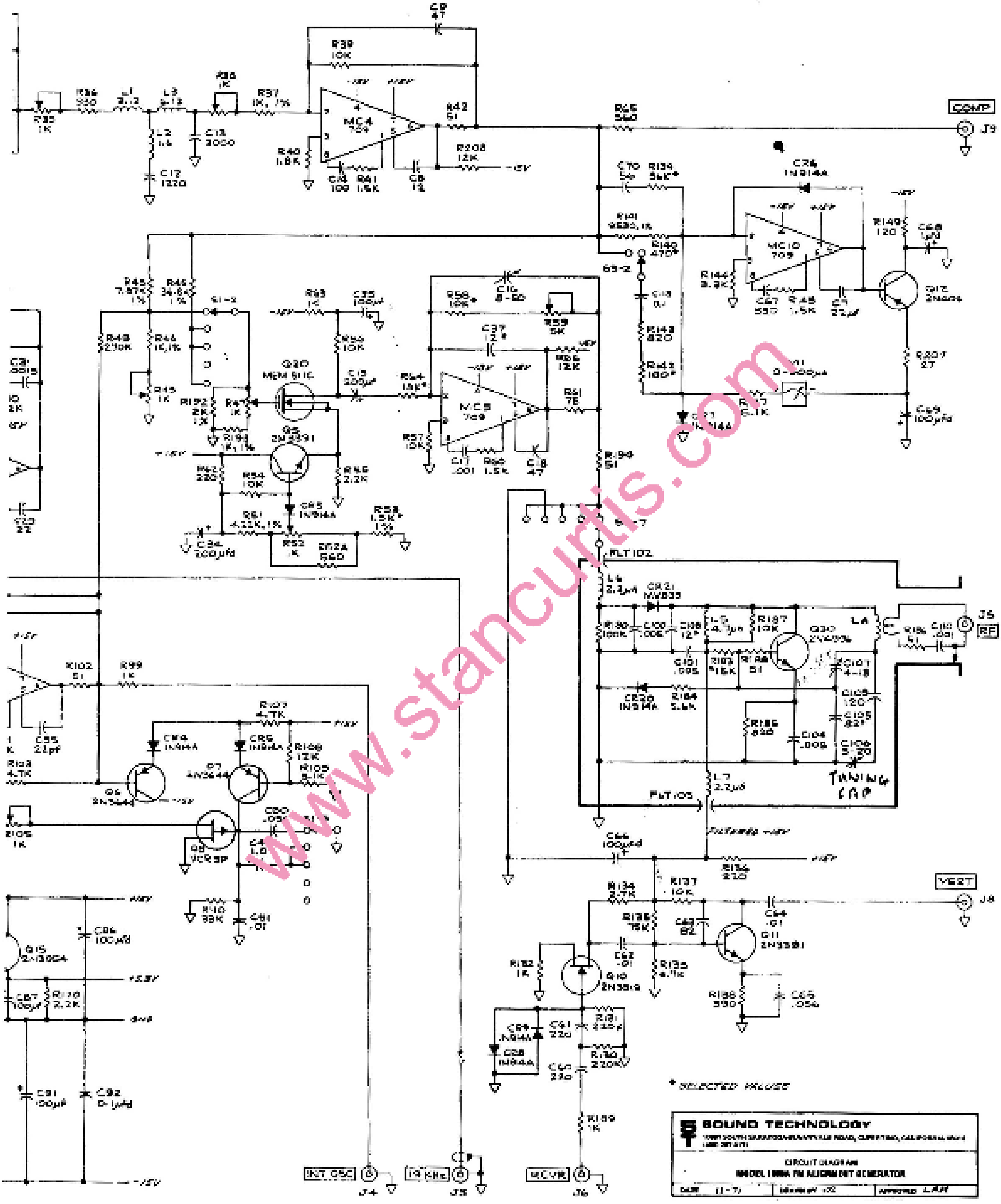
RF Unit:

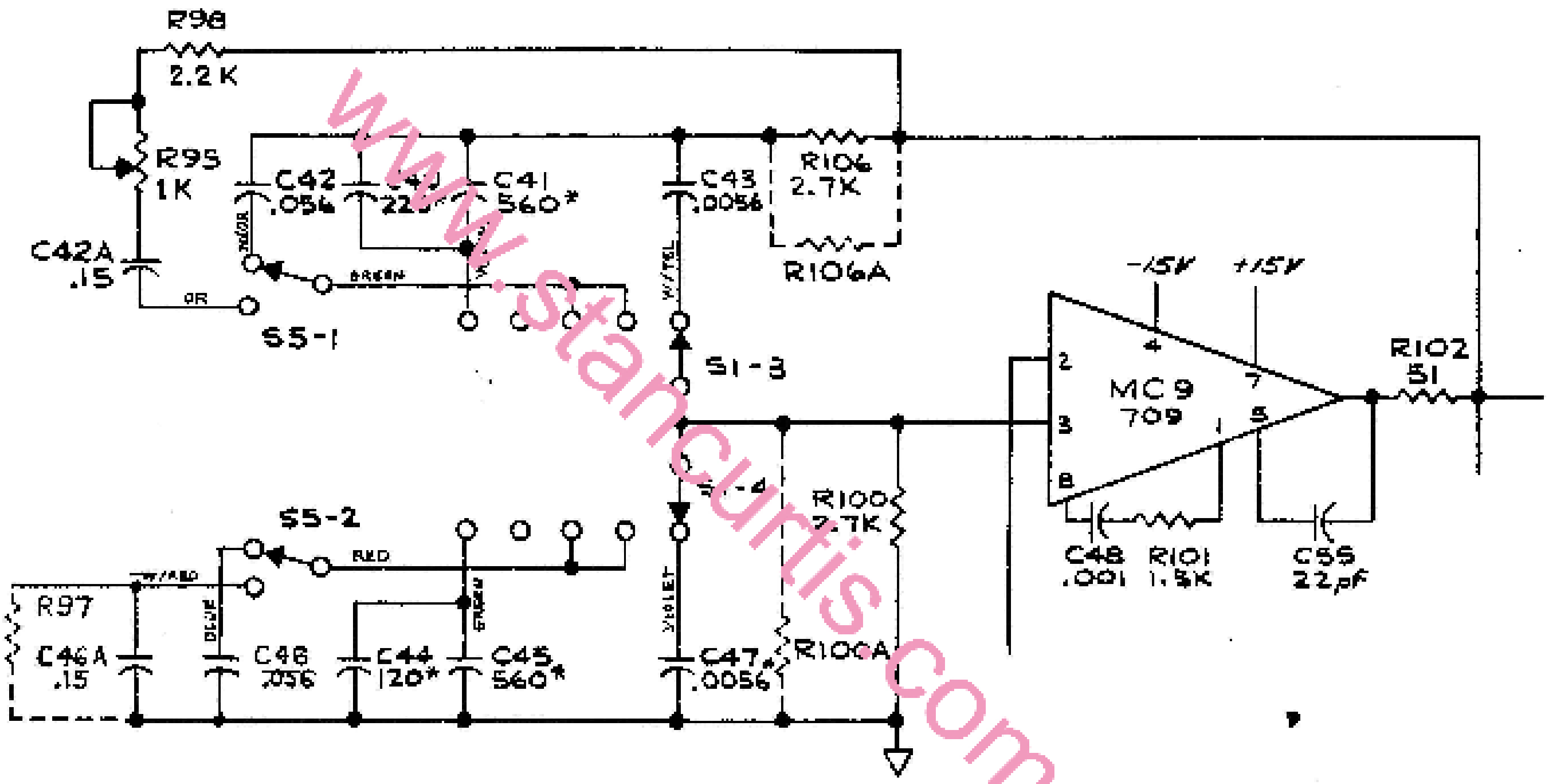
Planetary Drive	470-4511		
Coupling, Flexible	471-0016	Millen	39016
Coupling, R59-to-Tuning Capacitor	407-0001		
Bearing, Nylon	472-1400		
Shaft, 1/4" dia x 6-1/8" long	442-1449		
Knob with bar and skirt	400-1001		
Knob, Round, 23/32" dia	400-1000		
Knob, Round, 1-1/4" dia	400-1002		
Cabinet	4[illegible]0-1000		
RFI Braid	491-0[illegible]01		
RF Housing and Piston Attenuator Assembly including: mtg. brackets, coax cable, lower part of osc. housing, feed-thru filters (Ckt board, tuning capacitor and cover not included)	610-0010		

NOTE: It is recommended that problems in the RF unit be referred to the factory. Changes in RF circuit components can require changes in the modulator driver circuit (MC5).


LEFT
RIGHT
INPUT
FUNCTION
PILOT TEST
PILOT LEVEL
OSC LEVEL
PHASE
HORIZ
POWER
220V WIRING
115V WIRING


PILOT TEST
PILOT LEVEL
OSC LEVEL
INT OSC
19 KHz
J4
J3


COMP
J9
VERT
J8
RF
J6
INT OSC
J4
19 KHz
J5
MCVR
J6
TUNING CAP
* SELECTED VALUES
SOUND TECHNOLOGY
CIRCUIT DIAGRAM



Internal Oscillator Option M-2

CALIBRATION PROCEDURE FOR 1000A RF UNIT

The following, 5-step calibration procedure is to be used if Q30, or any other component on the RF printed circuit board is changed. (We recommend however, that the RF housing not be opened unless absolutely necessary).

The procedure begins, assuming the defective component has been changed and the housing lid replaced such that the trimmer capacitor can be seen through access holes. Be sure to use the original flat washers and locking nuts and tighten them to approximately their original position. (Caution: it is relatively easy to overtighten these nuts, thereby causing the housing to deform.)

1. FREQUENCY DIAL - This is the most probable change (possibly several hundred KHz). Use a high frequency counter that will work down to 80 mV. At 80 mV output there shouldn't be more than about 20 KHz frequency pulling due to the attenuator probe being too near the oscillator coil. If the counter will work at a lower level - so much the better. An alternative method of measurement is to use a frequency standard such as our Model 120, a balanced mixer such as HP 10534A and a frequency meter such as the HP 5210A.

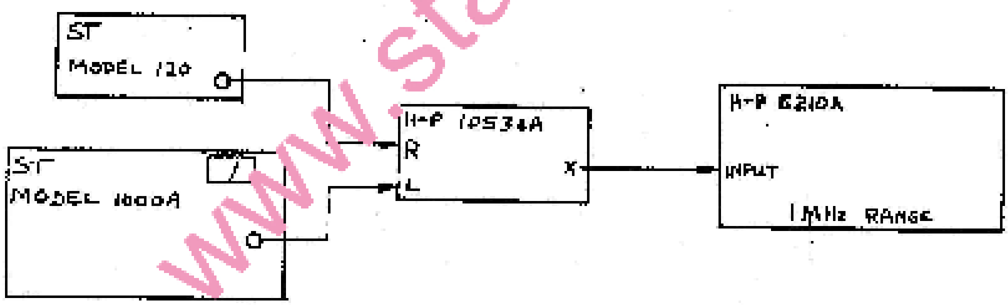


FIGURE 1

There are two frequency adjustments on the RF Unit:

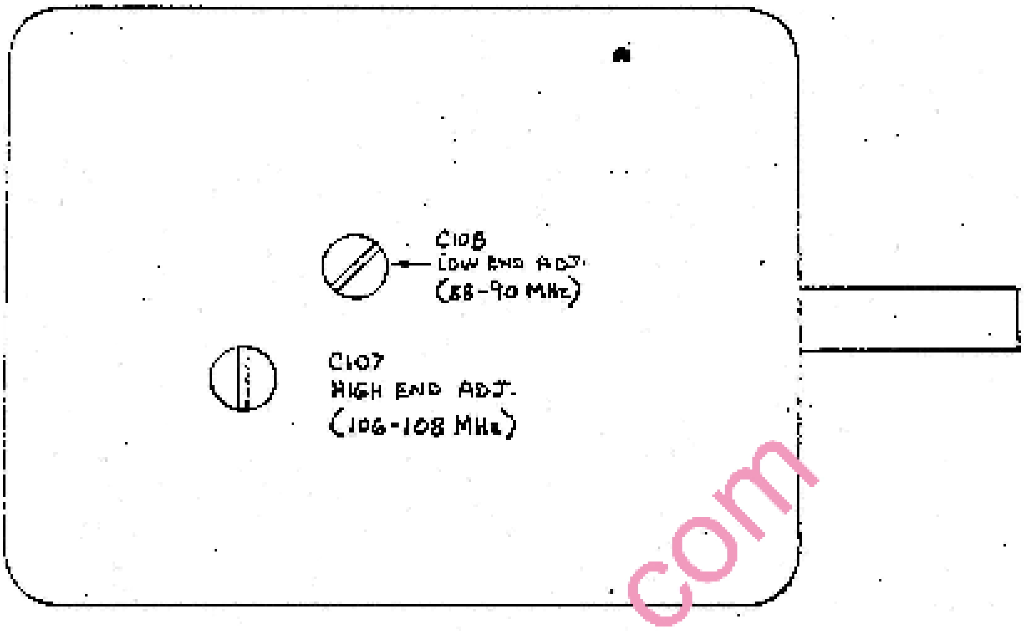


FIGURE 2. REAR VIEW OF RF UNIT

Remove the two screws shown in Figure 2 and make the adjustments with a small, low-capacitance screwdriver. If you are using a counter, set the dial at 88 MHz and adjust C108 (note that C108 is not shown as a variable capacitor on the schematic) until the counter reads 88.0 ± .05 MHz. Using the frequency standard, adjust for a null (± 50 KHz) at 90 MHz. Then go to the high end and adjust C107 in the same manner. C108 has a direct effect on the high as well as the low end; C106 has a small (about 30%) effect on the low end. It may be necessary to go back and forth between low and high end several times.

2. Next check RF level at 10 mV and adjust the shaft position if necessary. (Note: If you loosen the shaft, be sure to squeeze the shaft coupler before re-tightening set screws so that there is constant pressure on air-variable capacitor shaft pushing it away from the front panel.) Normally the high and low ends of the frequency dial will produce RF levels about 4 to 7% lower than at 98 MHz. Therefore, we usually set the level about 2% low at 108 MHz (or 3% high at 98 MHz). We use the HP 3406A Broadband Sampling Voltmeter for this measurement; however you can use another 1000A and a receiver. Adjust for the same AGC voltage on both generators. In this case you will probably want to make the adjustment at 1 mV or less. Be sure the generator is terminated with a 50 ohm load when calibrating RF level. The Model 100 is a good termination when using the receiver comparison method.

3. Check and if necessary, adjust linearity (R52). The preferred method is shown on page 15 of the 1000A manual. Here again you can use a good 1000A. Align a high quality tuner at 200 KHz sweep width for minimum distortion using Dual Sweep with as much vertical gain on the scope as the vertical position control of the scope will permit (you have to be able to see the top of the pattern!). Now connect the repaired 1000A and adjust R52 to get the same flatness. It's easier to see the flatness if you work with a narrow pattern on the scope. The repaired 1000A should be turned on at least 15 minutes before making a final R52 adjustment.

4. Check modulation level and adjust R47 using either a calibrated modulation meter or a working 1000A and a receiver. In the latter case, set the working 1000A to Monaural, 100% modulation and read the receiver RCDR output signal on an AC voltmeter. Be sure the receiver is on Monaural also! Now connect the repaired 1000A to the receiver and adjust R47 for the same output. You should always check R47 adjustment after making a linearity adjustment. If you have to make more than a 10% adjustment on R47, you should go back and check the linearity adjustment.

5. Put the two little screws back in the RF Unit and you're on your way.