MODEL 1000A

FM ALIGNMENT GENERATOR *

Serial ______________

SOUND TECHNOLOGY

Sound Technology Division
SIGMATEK, Inc.
10601 S. Saratoga-Sunnyvale Rd.
Cupertino, California 95014

November 8, 1971

* Patented

MODEL 1000A

FM ALIGNMENT GENERATOR

COMPLETE RECEIVER ALIGNMENT – A MINIATURE LOW DISTORTION FM TRANSMITTER PLUS FAST, ACCURATE DUAL SWEEP ALIGNMENT

Five instruments in one!

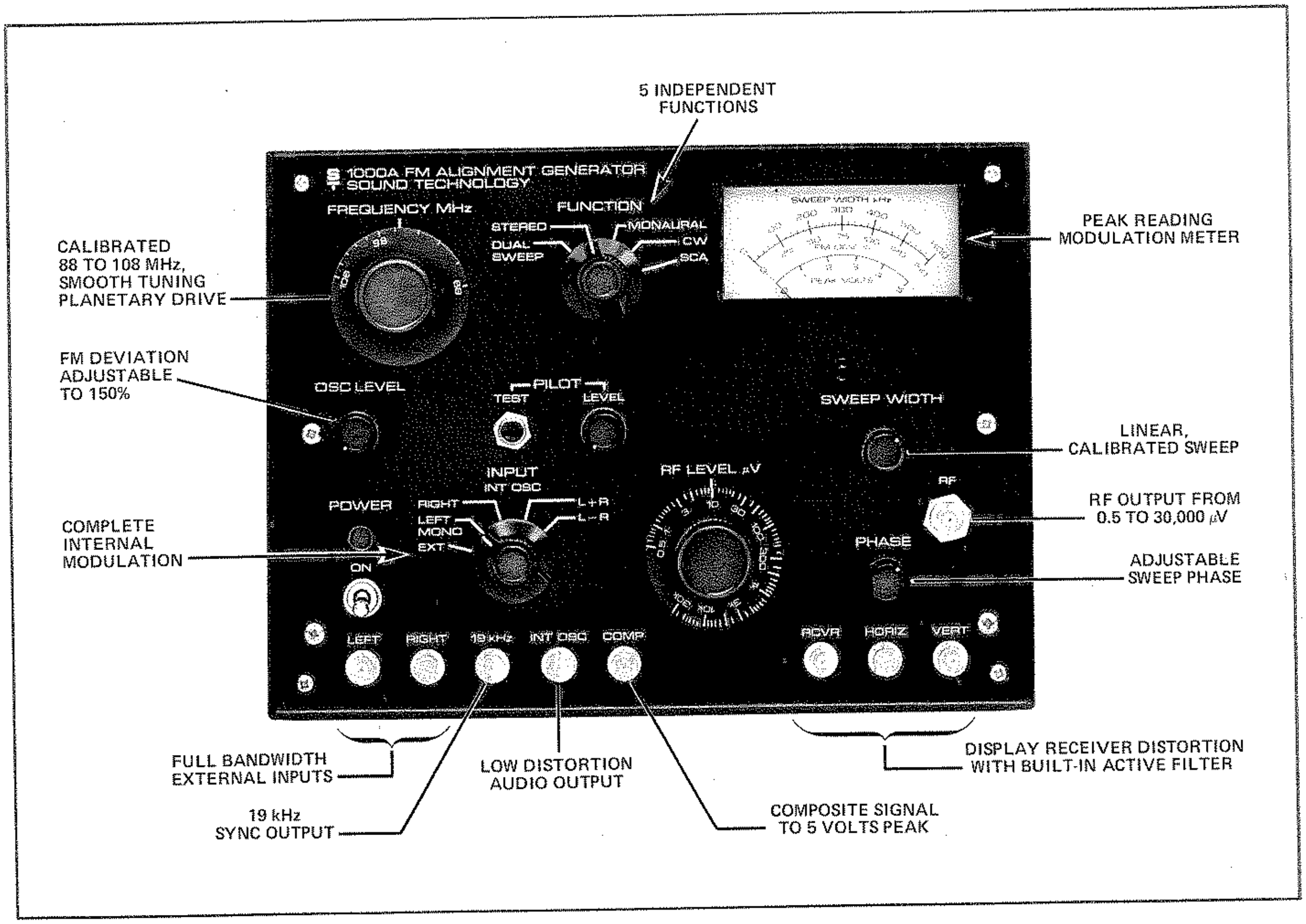
1. Dual sweep alignment.
2. Complete stereo generator.
3. Monophonic FM generator.
4. Clean CW signal.
5. SCA modulation.

DESCRIPTION

The all solid-state 1000A FM ALIGNMENT GENERATOR is designed specifically to permit fast, accurate adjustment of monaural and stereo FM systems. DUAL SWEEP, a refinement of conventional sweep alignment techniques, provides a unique visual display of receiver performance. An operator need only connect the 1000A RF output to the receiver antenna terminals and feed the receiver audio output to the 1000A's built-in filter. Distortion and tuning characteristics will then be displayed – even on an inexpensive scope – without probing inside the receiver.

The 1000A offers much more than DUAL SWEEP capability. With a highly linear modulator, it produces complete, high quality, monaural and stereo signals exceeding FCC specs. An internal RF oscillator is tuneable across the fm band and provides an output continuously adjustable in level from 0.5 to 30,000 μv.

SOUND TECHNOLOGY
10601 SOUTH SARATOGA-SUNNYVALE ROAD
CUPERTINO, CALIFORNIA 95014
(408) 257-9171



Features

- ★ Unique DUAL SWEEP function with a wide-band linear modulator and a built-in active filter lets you see at a glance the critical parameters, LINEARITY, BANDWIDTH, and TUNING SYMMETRY – without probing inside the receiver.
- ★ Conventional sweep alignment capability.
- ★ Linear, calibrated sweep permits direct determination of receiver bandwidth and tuning symmetry.
- ★ RF tuneable from 88 to 108 MHz. Modulation sensitivity held constant across the band.
- ★ Piston attenuator calibrated from 0.5 to 30,000 μV permits a quick look at receiver alignment vs RF level.
- ★ Precision stereo modulator utilizes crystal controlled digital circuits for precise phase relationships. Overall separation better than 50 dB at 1 kHz.
- ★ Low distortion MONAURAL function for over-all receiver distortion measurements.
- ★ CW function provides a signal with very low incidental FM for receiver quieting (signal-to-noise ratio) tests.
- ★ Internal SCA modulation for receiver SCA trap adjustments.
- ★ Sweep width, monaural and stereo modulation, pilot level (X10 scale on PILOT TEST), and composite output monitored on peak reading meter.
- ★ Metered COMPOSITE output for separate alignment and testing of stereo decoders.
- ★ Optional wideband modulation input.
- ★ Optional front panel switch selects 400 Hz or 1 kHz as internal oscillator frequency.

Applications

- ★ Development of stereo FM systems.
- ★ Rapid, accurate production alignment of stereo equipment.
- ★ Servicing FM tuners, receivers, and stereo adapters.
- ★ Fast determination of receiver performance without internal connections.
- ★ Manufacturer's final QA of receivers.
- ★ Development of SCA equipment.

What Dual Sweep Does

Dual sweep permits receiver alignment with unexcelled rapidity and precision by providing an accurate scope display of linearity and distortion. A highly linear modulator driven by a dual frequency sweep signal yields far more resolution and accuracy than conventional sweep techniques. All the signals required for a display of receiver distortion, bandwidth, and tuning characteristics are provided by the 1000A. The text below describes how the dual frequency sweep method works.

How Dual Sweep Works

To understand the operation of DUAL SWEEP, consider the effect of a non-linear S-curve on a low level 10 kHz modulating signal. As shown in Figure 1, changing the carrier frequency from F1 to F2 shifts the demodulation region to a different portion of the S-curve and results in a change in the detected 10 kHz output voltage. The ideal S-curve would have a constant amplitude in the pass band.

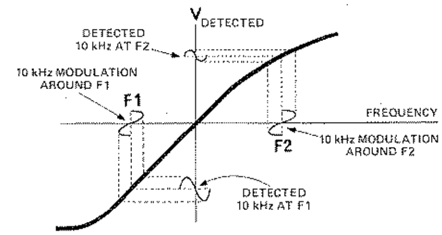


Figure 1.

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10 kHz output level is actually a measure of S-curve slope over a very small region. As the carrier frequency is shifted over the receiver band, changes in the detected output are directly proportional to S-curve non-linearity and resulting receiver distortion. Receiver linearity could actually be measured by hand tuning an oscillator with 10 kHz low level FM and plotting receiver output voltage vs. carrier frequency (Figure 2) – a slow and cumbersome technique.

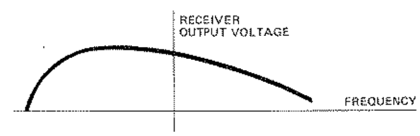

Figure 2.

The DUAL SWEEP signal eliminates the need for hand tuning by superimposing the 10 kHz on a 60 Hz sweep signal, permitting a scope display. Receiver output will be a 60 Hz waveform with 10 kHz superimposed on it. In order to determine the 10 kHz amplitude (our measure of linearity and thus distortion), the 60 Hz must be filtered out. The 1000A has a built-in filter to provide a clean 10 kHz signal. By using the 60 Hz modulation signal for horizontal deflection of a scope and the filtered detector output for vertical deflection, receiver linearity will be displayed as in Figure 3.

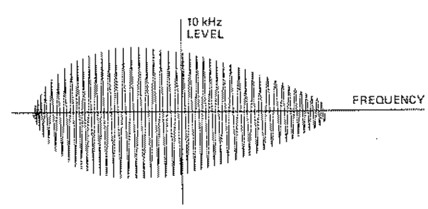

Figure 3.

Advantages of Dual Sweep

Because DUAL SWEEP measures the slope of the S-curve, it provides a display of receiver distortion which is far more sensitive than that obtained by conventional sweep methods. DUAL SWEEP has all the advantages of minimum distortion alignment (it is a direct measure of IM distortion) and yet retains the benefits of conventional sweep alignment. We all know that sweep alignment is highly desireable, not only because of the rapidity and ease of adjustment that goes with a scope display, but because of the information contained in the pattern we see. A conventional sweep display provides immediate information on the effect of receiver adjustments on tuning symmetry and bandwidth, but is not a sensitive measure of distortion. Alignment with a distortion analyzer can yield low distortion but may result in critical tuning characteristics. DUAL SWEEP combines the advantages of both techniques – and eliminates the disadvantages of each.

Not only can a receiver's distortion be measured over its full bandwidth using DUAL SWEEP, but the character of the distortion is displayed on the scope. Figure 4 shows a scope display of the DUAL SWEEP pattern for a receiver with even-order distortion.

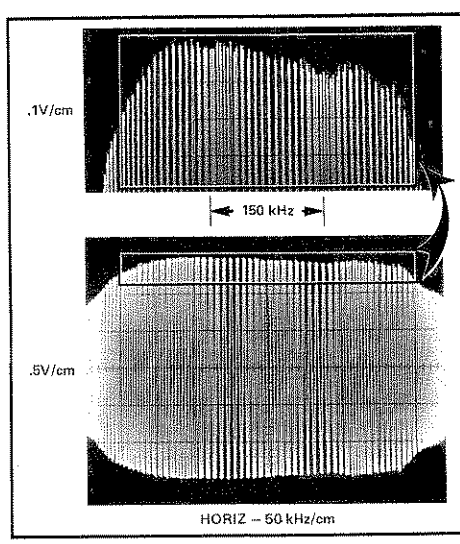

Figure 4. DUAL SWEEP pattern for 0.7% THD.

Specifications

FM RF OUTPUT

TUNING RANGE: 88 to 108 MHz. 6:1 planetary drive provides approx. 10 kHz tuning resolution.

RESIDUAL FM (CW MODE): <25 Hz, 20 Hz to 15 kHz (measures quieting to -70 dB).

DRIFT: <10 kHz/hr after 1 hour warm-up.

TOTAL HARMONIC DISTORTION: <0.1% at 1 kHz monaural, <0.2% stereo, 100% modulation.

RESIDUAL FM (MONO OR STEREO): <75 Hz, 20 Hz to 15 kHz.

RESIDUAL 38 kHz SUBCARRIER: <0.5%, applies to stereo only.

OUTPUT LEVEL: 0.5 to 30,000 μV into 50 ohm load, continuously adjustable. Accuracy is ±1 dB at 98 MHz. Sealed RF unit provides sufficiently low leakage to permit accurate measurements below 0.5 μV.

OUTPUT IMPEDANCE: 50Ω, VSWR <1.3, 200 Vdc isolation.

DUAL SWEEP

INCREMENTAL LINEARITY: ±0.3% for 150 kHz bandwidth. (Incremental linearity is the change in small signal FM deviation sensitivity over a stated bandwidth and is equivalent to peak intermodulation distortion).

SWEEP WIDTH: Adjustable and metered from 0 to 600 kHz.

SWEEP LINEARITY: ±3% of width.

RCVR INPUT: Impedance: >100KΩ at 10 kHz, >10MΩ at 60 Hz. Maximum input is 25 volts peak.

VERT OUTPUT: Impedance 10KΩ. RCVR input-to-VERT output gain ≈ 30 at 10 kHz. 10 kHz modulation in DUAL SWEEP ≈ 10%.

HORIZ OUTPUT: Impedance 20KΩ. Level ≈ 20 volts peak-to-peak.

SWEEP PHASE: Adjustable over 60° range at 60 Hz.

STEREO

SEPARATION: >50 dB at 1kHz. Specification includes mono/stereo subchannel separation and pilot phase accuracy and is applicable to composite or RF outputs.

PILOT: 19 kHz ±2 Hz, adjustable from 0 to 20%. PILOT TEST pushbutton removes external LEFT and RIGHT or INT OSC modulation and expands meter scale to 15% full scale.

EXTERNAL LEFT (MONO) AND RIGHT INPUTS

FREQUENCY RESPONSE: ±0.5 dB, 50 Hz to 15 kHz.

INPUT IMPEDANCE: 10KΩ.

LEVEL: ≈ 0.4V rms for 100% modulation (no damage at 15 volts peak).

19 kHz OUTPUT

WAVEFORM: 19 kHz ±2 Hz squarewave, ≈ 5 volts peak-to-peak.

OUTPUT IMPEDANCE: 3.3KΩ.

INT OSC OUTPUT

FREQUENCY: 1 kHz ±10%, 10 kHz with FUNCTION switch on DUAL SWEEP, 67 kHz on SCA.

TOTAL HARMONIC DISTORTION: <0.1% at 1 kHz.

LEVEL: ≈ 2 V rms.

OUTPUT IMPEDANCE: 1KΩ.

COMPOSITE OUTPUT

LEVEL: Adjustable and metered from 0 to 5 volts peak.

OUTPUT IMPEDANCE: <600Ω.

TOTAL HARMONIC DISTORTION: <0.2% at 5 volts peak.

RESIDUAL 38 kHz SUBCARRIER: >50 dB down from 5 volts peak. Applicable to stereo only.

RESIDUAL HUM AND NOISE: >60 dB down from 5 volts peak.

METERED FUNCTIONS

MONO AND STEREO: 0 to 150% peak reading.

DUAL SWEEP: 0 to 600 kHz sweep width.

PILOT: 0 to 15%.

COMPOSITE OUTPUT: 0 to 5 volts peak.

ACCURACY: ±7% of reading ±2% of full scale, 88 to 108 MHz.

OPTIONS

WIDEBAND AUXILIARY INPUT (Rear Panel BNC): This wideband modulation input may be used for SCA program material, intermodulation distortion tests, or for adding other complex modulation to the conventional stereo signals. Order M1.

INTERNAL OSCILLATOR: With your order you may specify a 400 Hz internal oscillator instead of the standard 1 kHz at no additional charge.

400Hz/1kHz INTERNAL OSCILLATOR: Front panel toggle switch allows choice of 400 Hz or 1 kHz internal oscillator frequency. Permits measurement of receiver distortion at 400 Hz, separation at 1 kHz as specified in IHF standards. Order M2.

BROADCAST QUALITY STEREO MODULATOR: When M3 is included, a more complex stereo filter is installed in the 1000A. This permits a separation specification of 50 dB from 50 Hz to 8 kHz decreasing to 40 dB at 15 kHz. Essential for receiver design and for receiver testing and evaluation at high audio frequencies. Order M3.

GENERAL

DIMENSIONS: 8-3/8" high x 11-1/8" wide x 11-3/4" deep.

POWER: 115V ±10%, 50 to 60 Hz, 12.5 W.

WEIGHT: 12 lbs.

SHIPPING WEIGHT: 18 lbs.

PRICE: $1450, M1 add $25, M2 add $75, M3 add $225.

All prices f.o.b. Cupertino, California — data subject to change without notice.

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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.

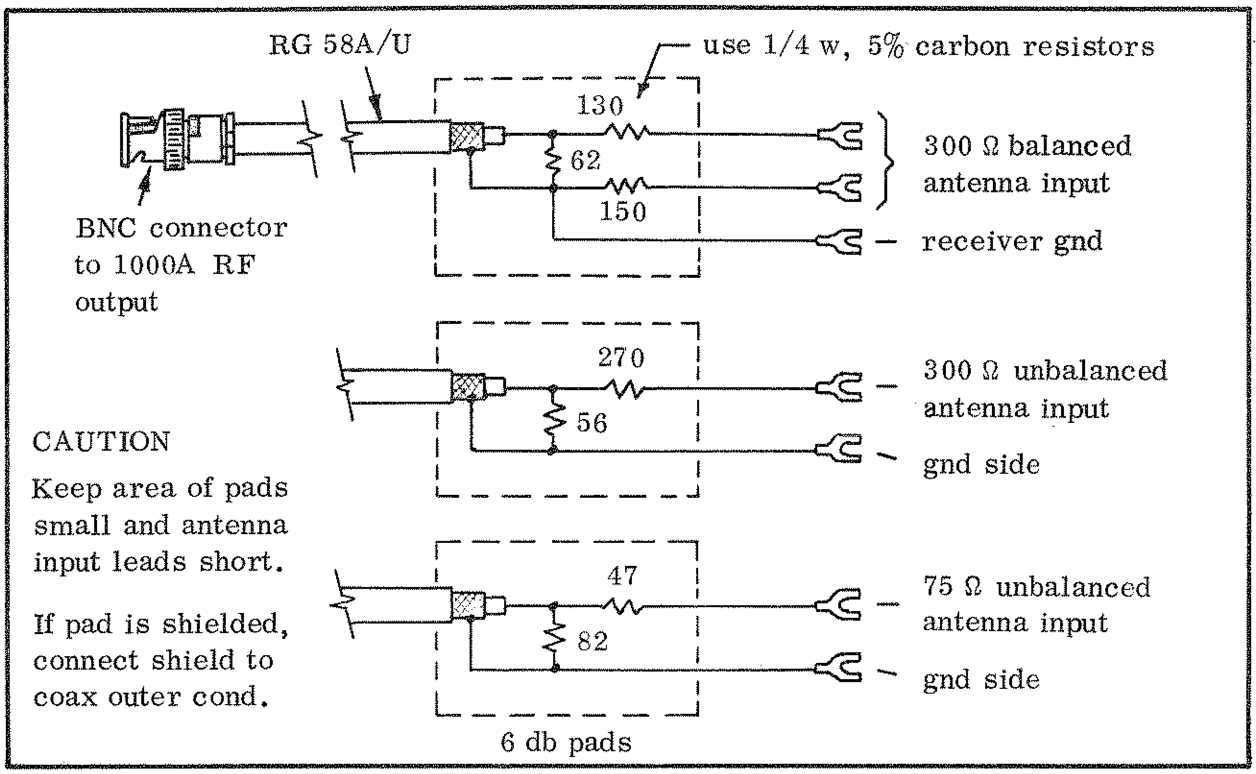


Figure 1. Resistive antenna matching networks

DUAL SWEEP

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

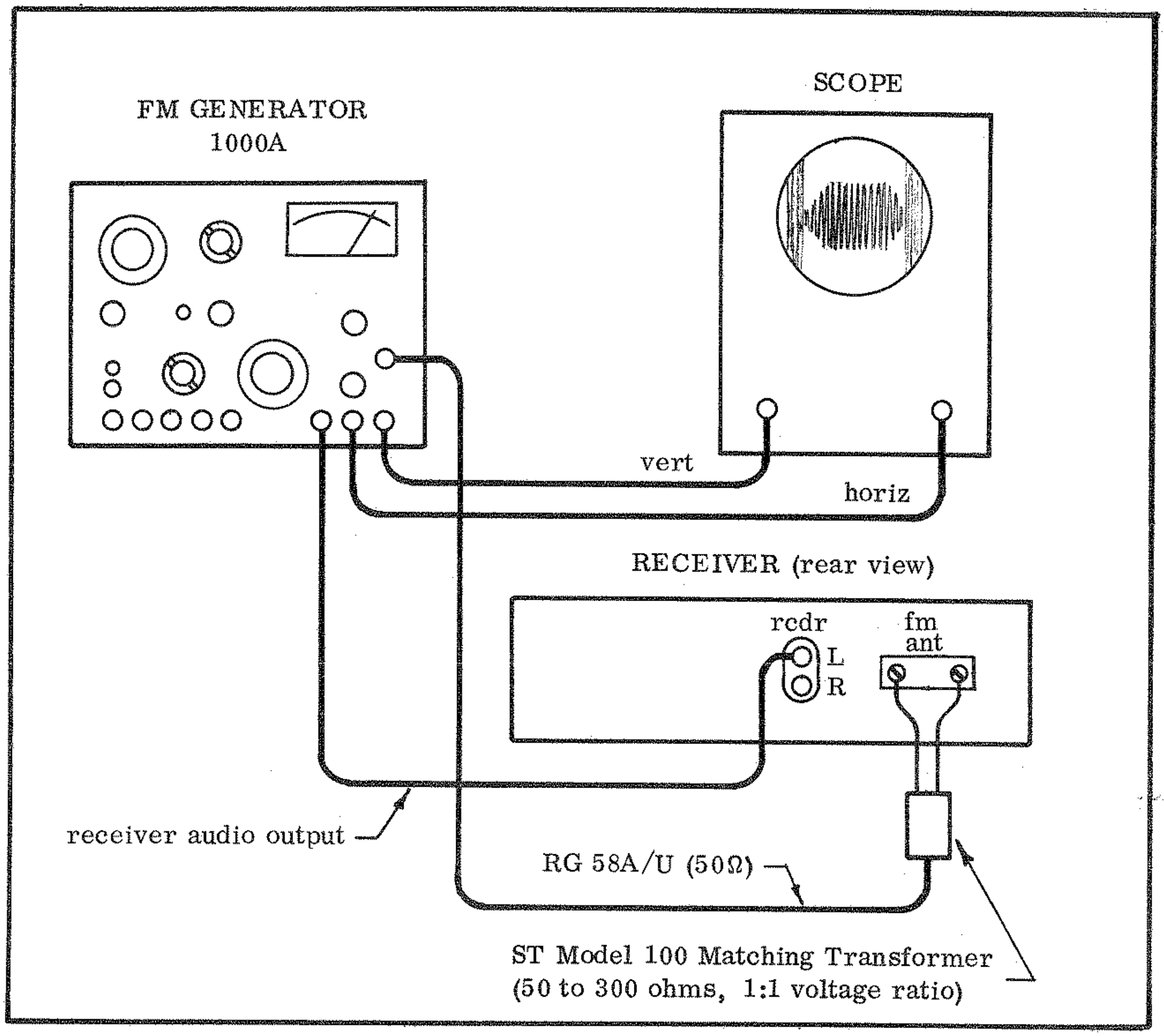


Figure 2. Interconnections for DUAL SWEEP alignment

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.

CAUTION: 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 external 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 KΩ, 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.

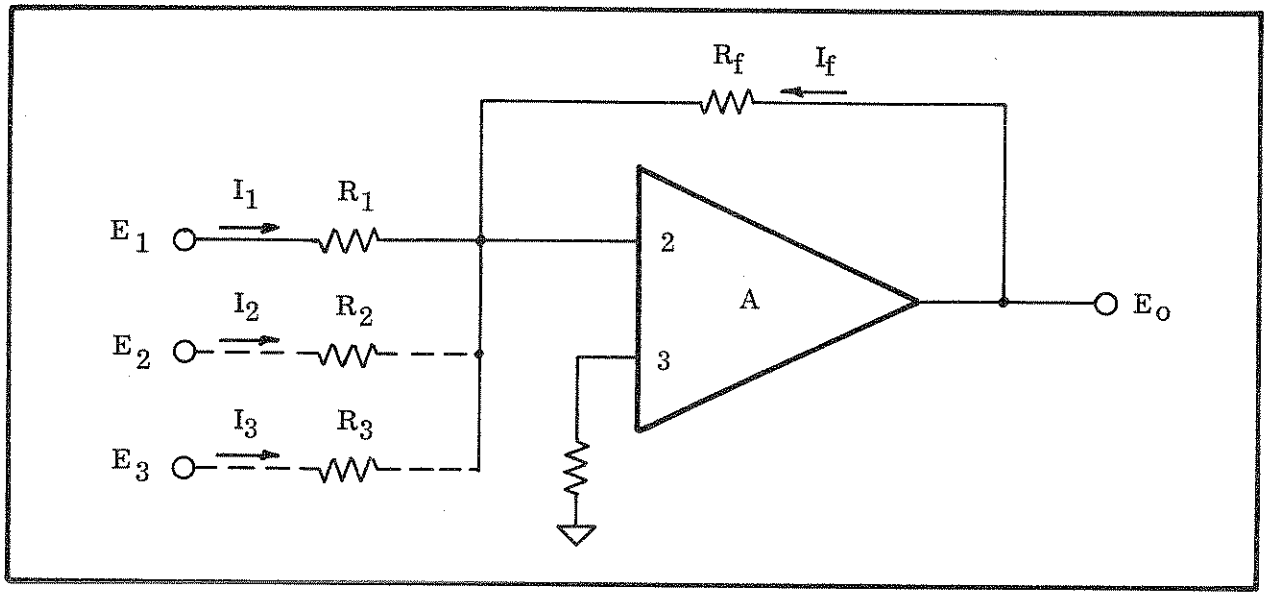


Figure 3. Summing amplifier

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 transistor 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 squarewave 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.

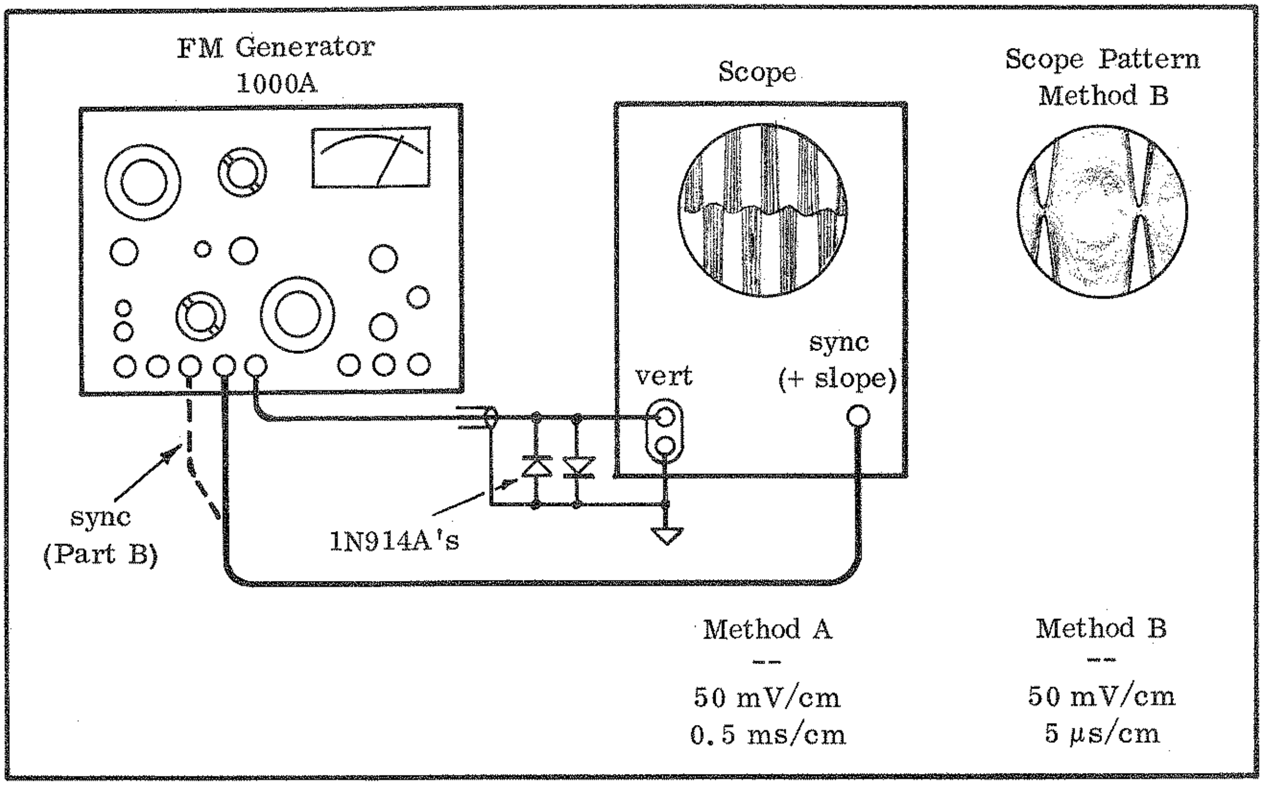


Figure 4. Setup for checking stereo separation

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 discrimimator 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 $\approx$ 7.5 kHz peak deviation. The difference frequency from the balanced mixer (Hewlett-Packard 10534A 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).

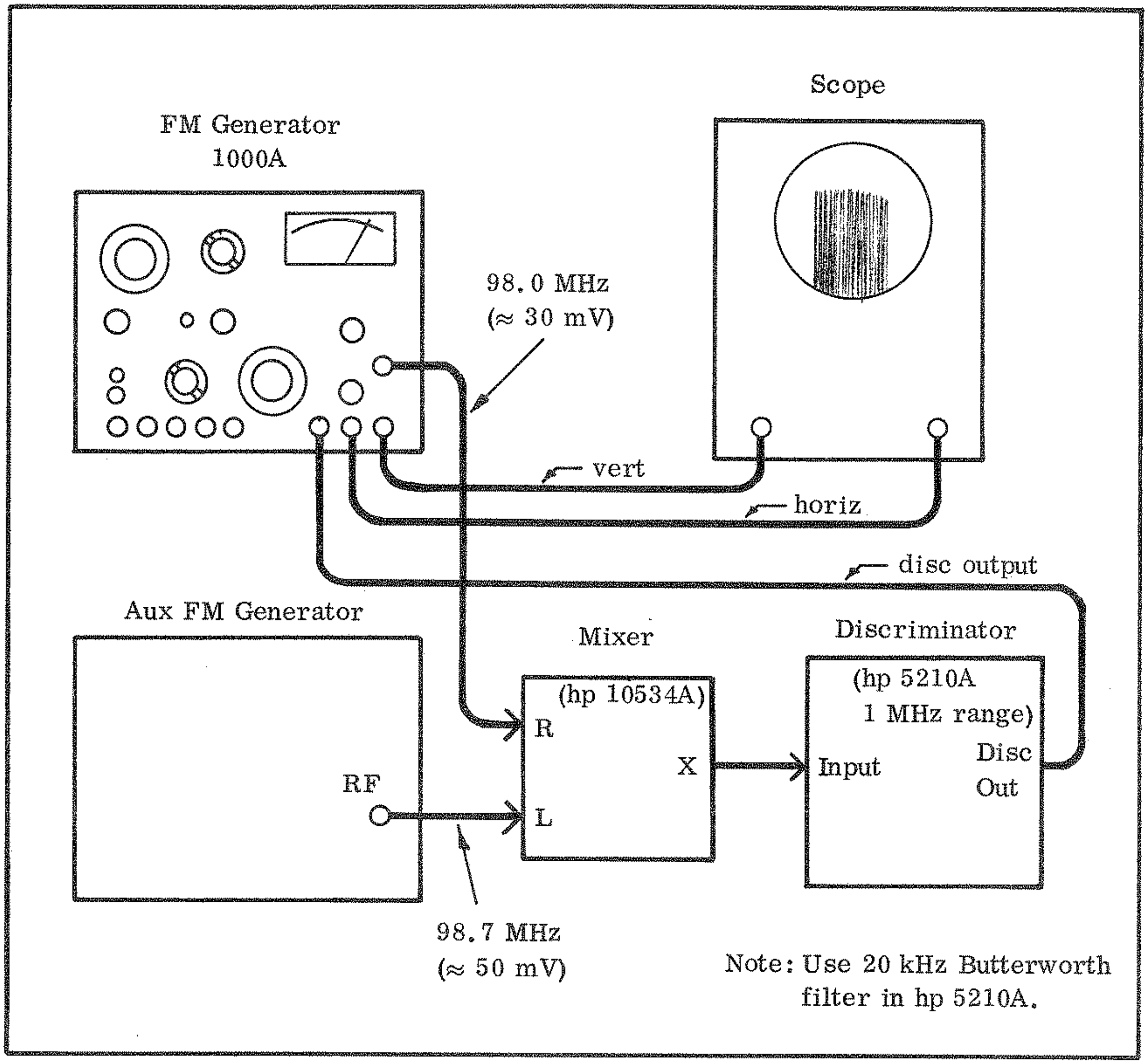


Figure 5. Interconnection for linearity tests

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 ($\approx$.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 ($\approx$-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 0.2 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 $\approx$ 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 $\approx 0.6°$, 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).

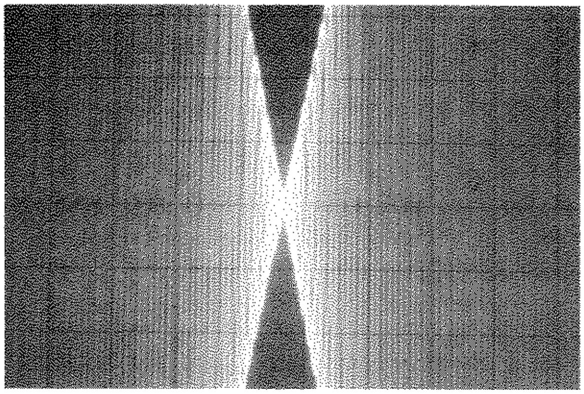


Fig 9A. L-R crossover, 25% modulation, no pilot, 0.05 V/cm.

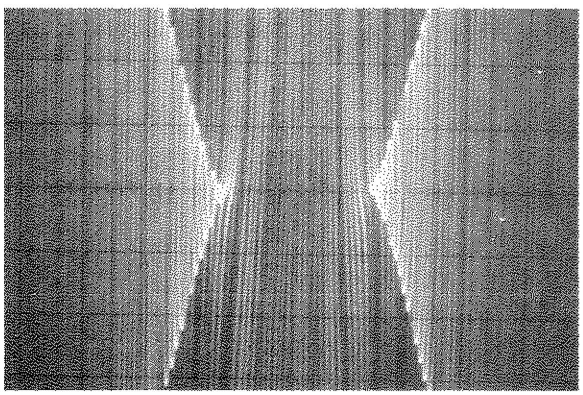


Fig 9B. Pilot level control all the way up. Correct phase.

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

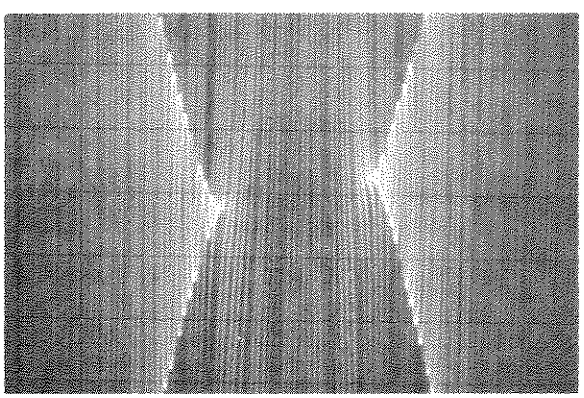


Fig 9C. Tilt corresponding to phase error of ≈ 0.6°. (1.75° pilot phase accuracy required for 60 dB separation, assuming perfect base line flatness.)

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.

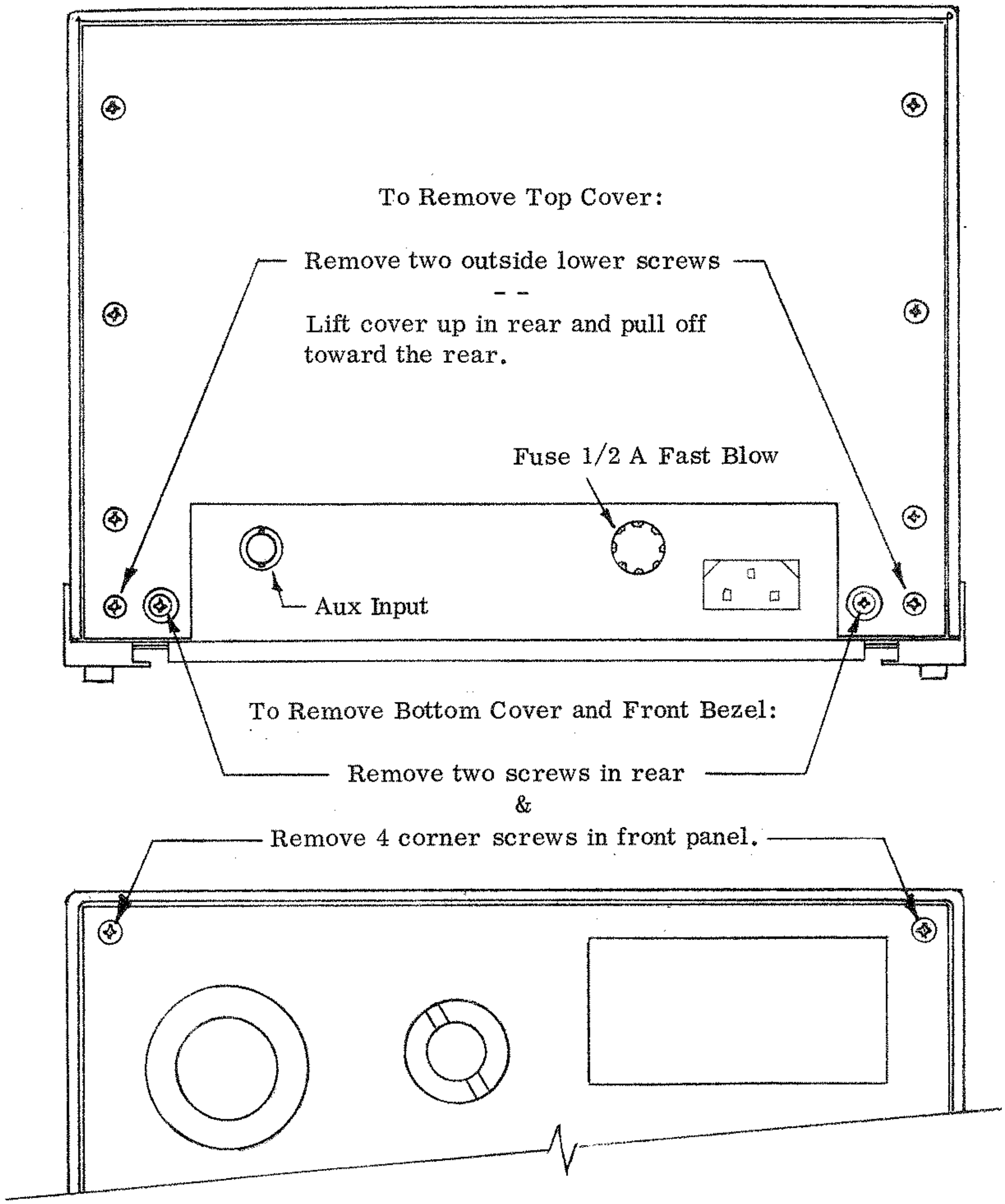
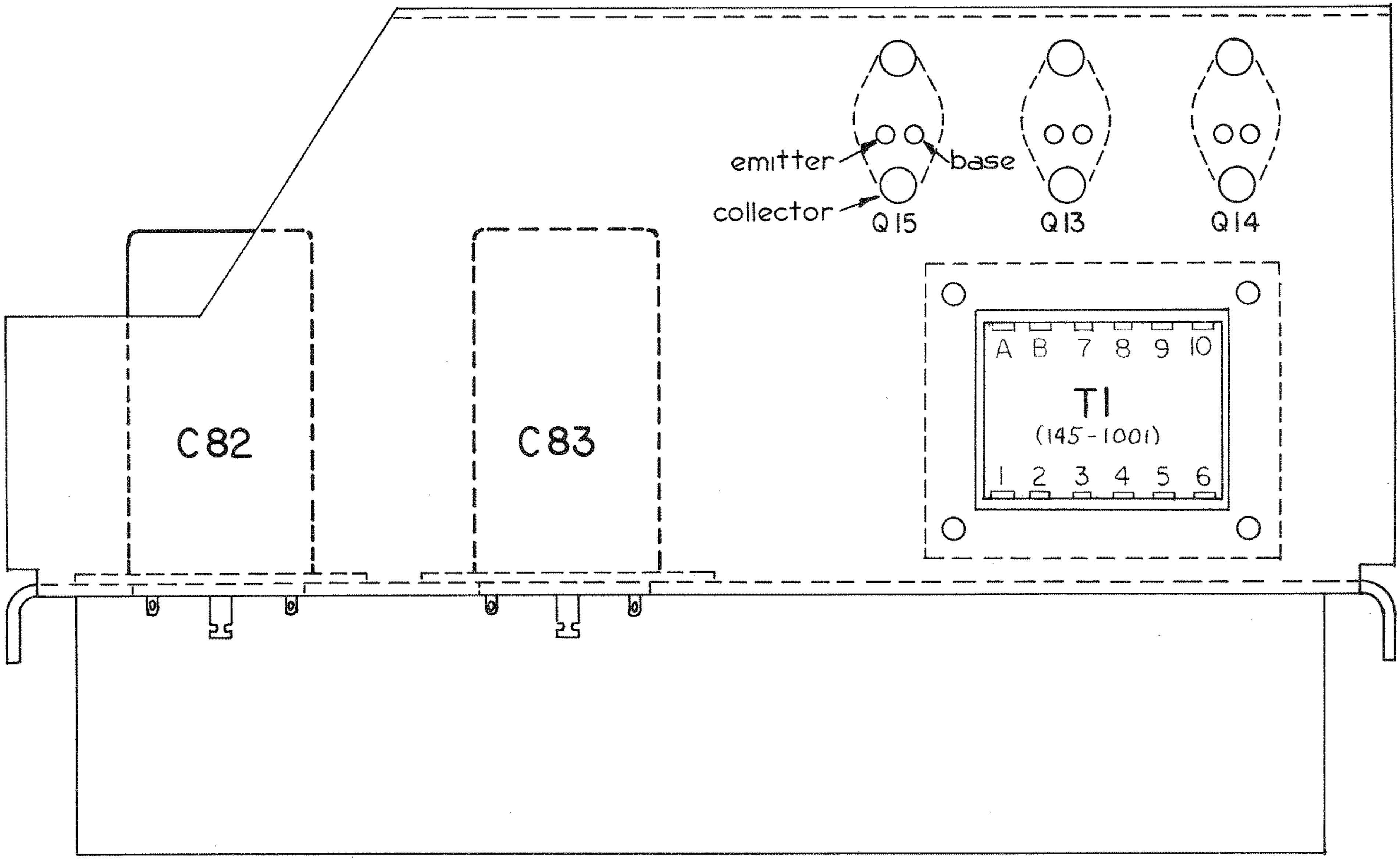
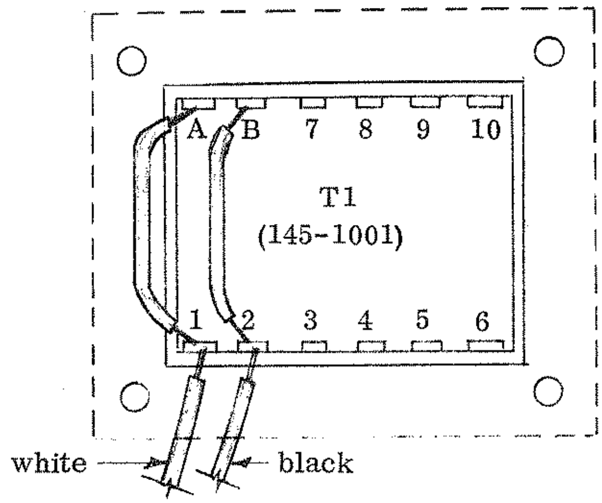


Figure 6. Cover removal

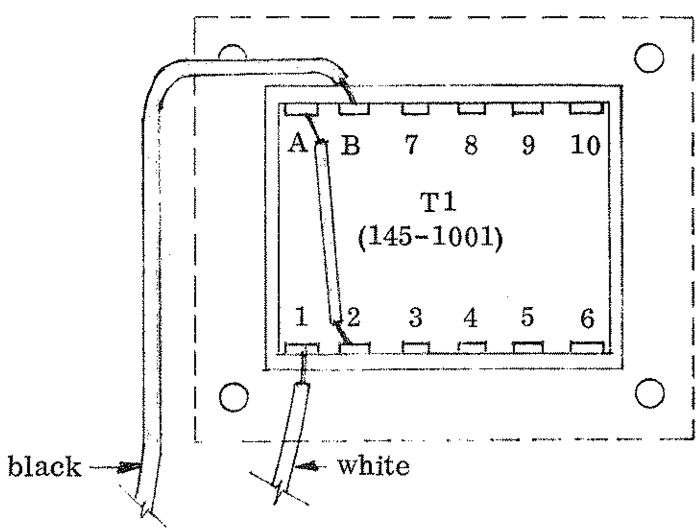


FRONT VIEW

Figure 7. Chassis parts layout

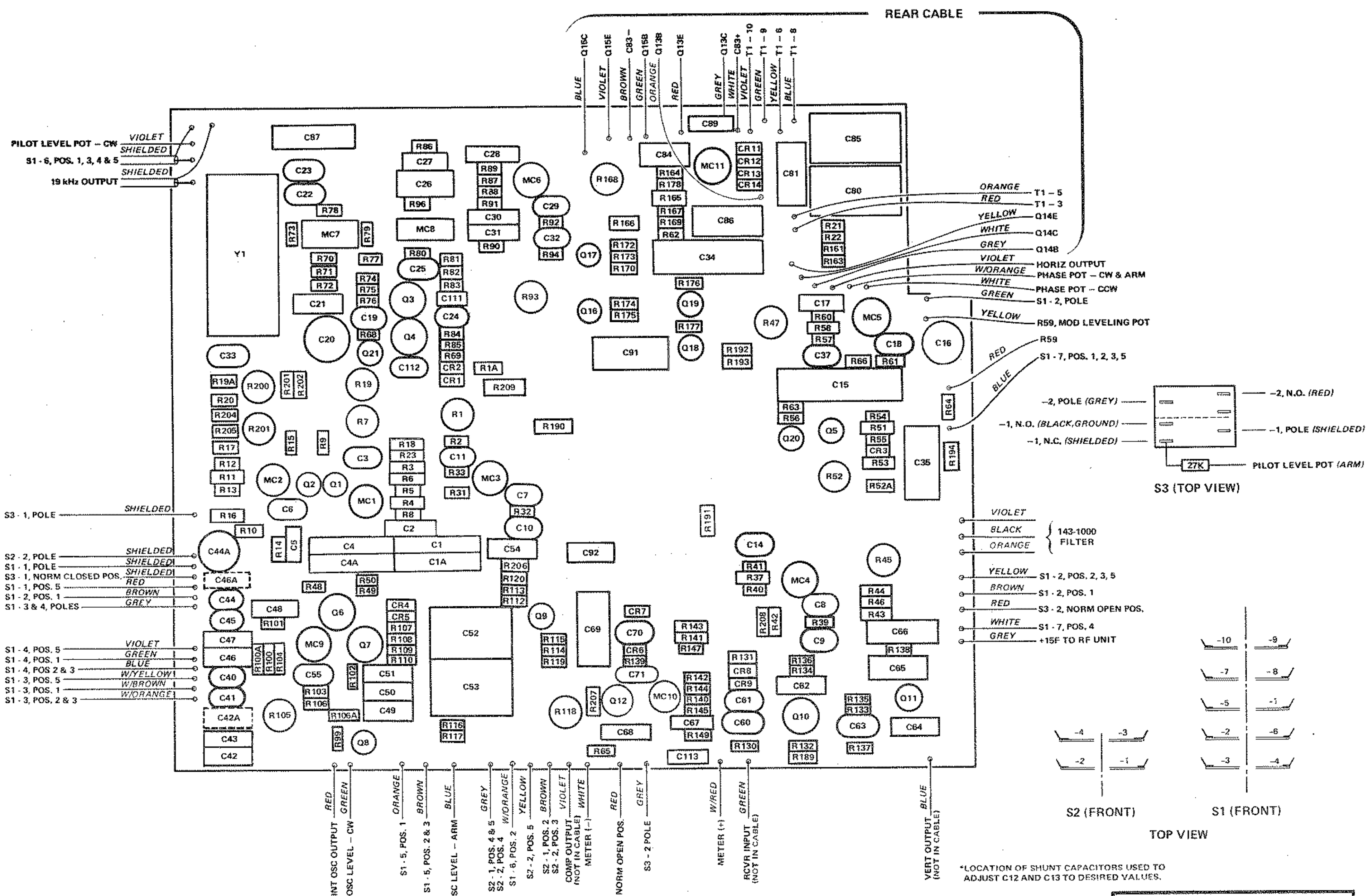


Primary Wiring for 115V



Primary Wiring for 230V

Figure 10. 115/230 volt primary wiring.

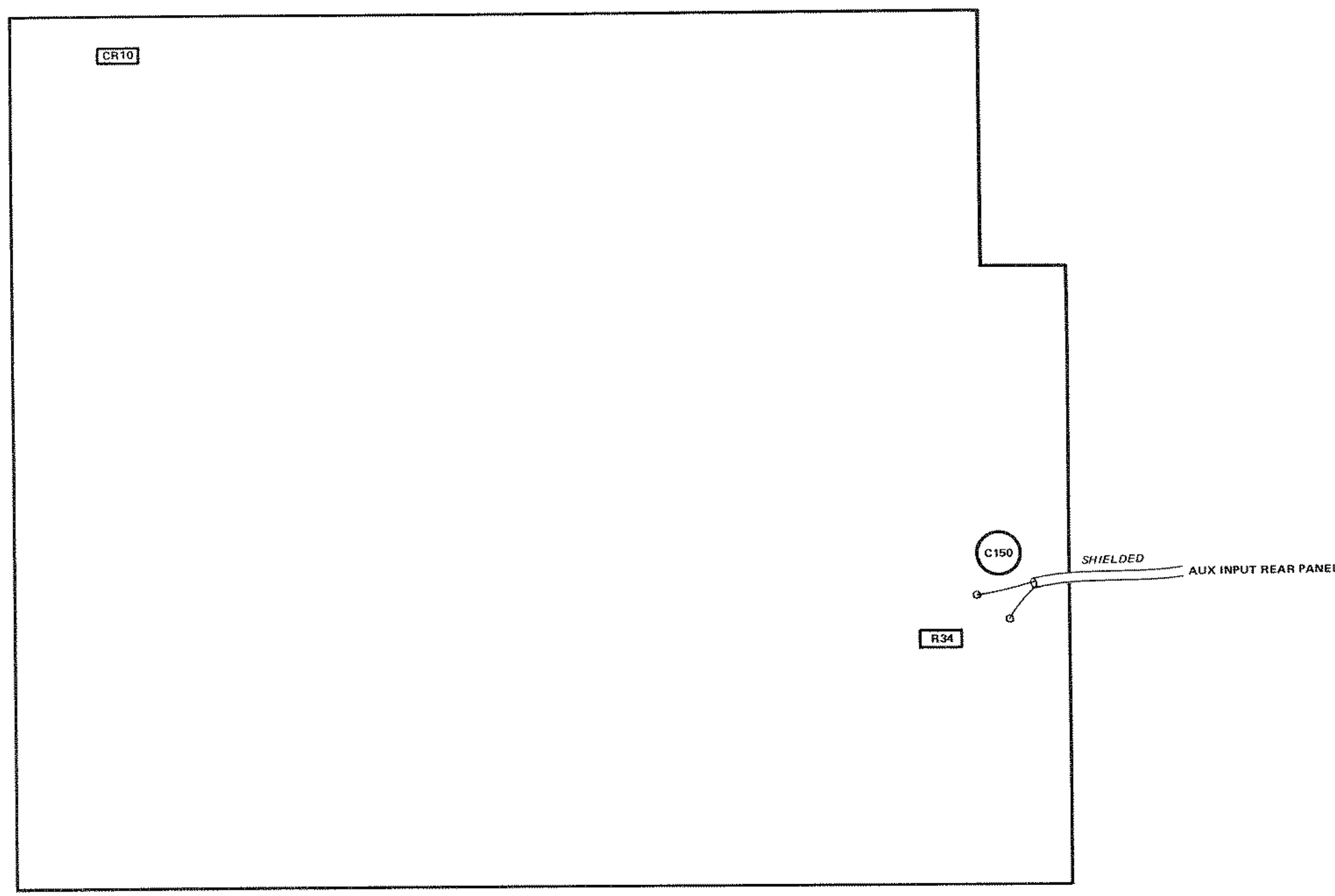


*LOCATION OF SHUNT CAPACITORS USED TO ADJUST C12 AND C13 TO DESIRED VALUES.

SOUND TECHNOLOGY
10601 SOUTH SARATOGA SUNNYVALE ROAD
CUPERTINO, CALIFORNIA 95014

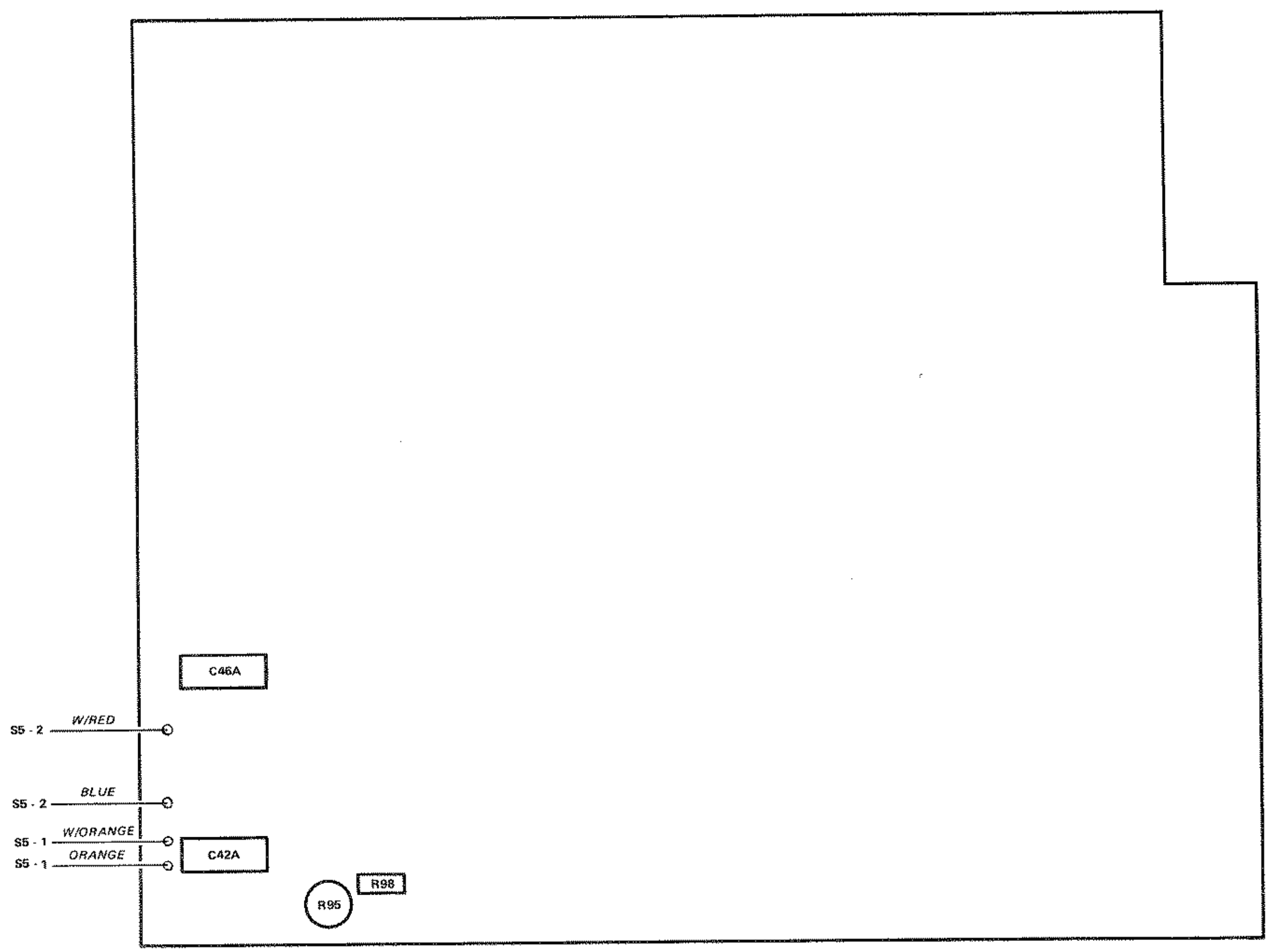
CIRCUIT LAYOUTS
MODEL 1000A M3

2/72

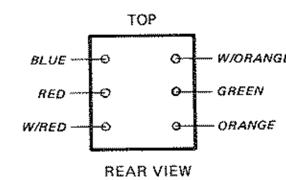


SOUND TECHNOLOGY
10601 SOUTH SARATOGA SUNNYVALE ROAD
CUPERTINO, CALIFORNIA 95014

CIRCUIT LAYOUTS
MODEL 1000A M1



FREQUENCY SELECT SWITCH
(ON FRONT PANEL)



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CIRCUIT LAYOUTS
MODEL 1000A M2

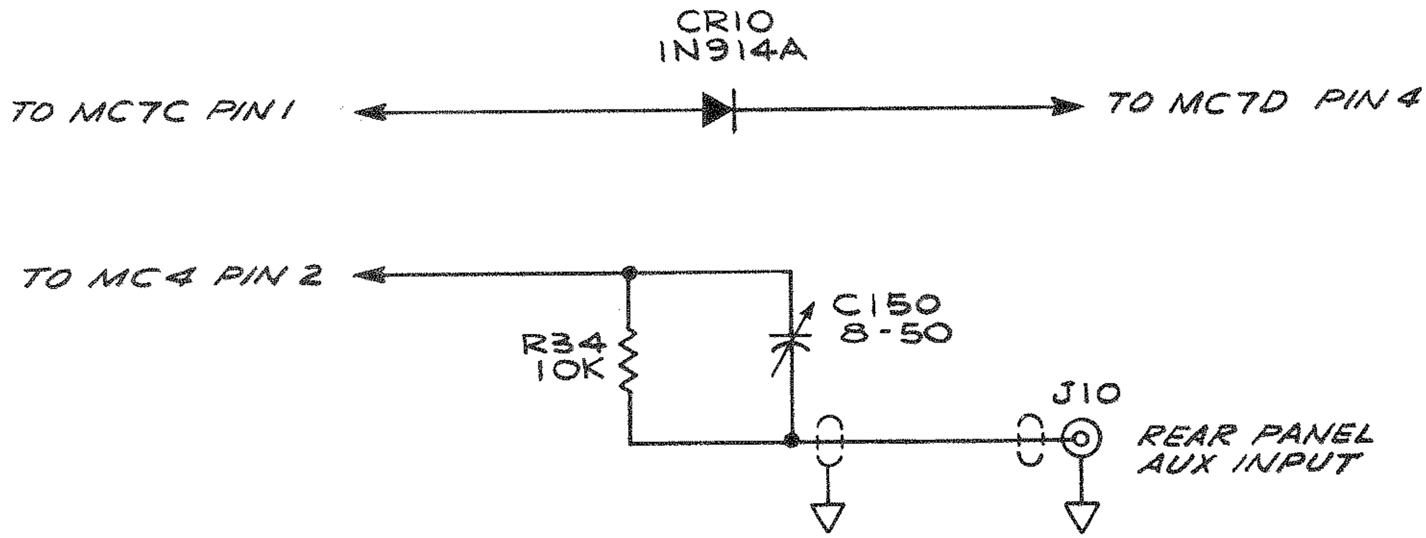
REFERENCE DESIGNATION	DESCRIPTION	SOUND TECHNOLOGY STOCK NUMBER	MANUFACTURER	MANUFACTURER PART NO.
All fixed resistors except 1% values	R: Fxd, Comp, 1/4 w, ±5% 5.1Ω thru 1MΩ	100-0510 (5.1Ω) thru 100-1050 (1MΩ)	Allen-Bradley	Type CB
All 1% resistors	R: Fxd, Met Flm, 1/8 w, ±1% 100 ppm	105-1001 (1K) thru 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	Transistor: P-Ch. FET	236-5110	General Instruments	MEM511C	
Q8	" " "	230-3700	Siliconix	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	220-4040	RCA	2N404	
Q30	Transistor: Si, NPN, 2N4996	226-4996	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	Removed when option M3 is installed.
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	

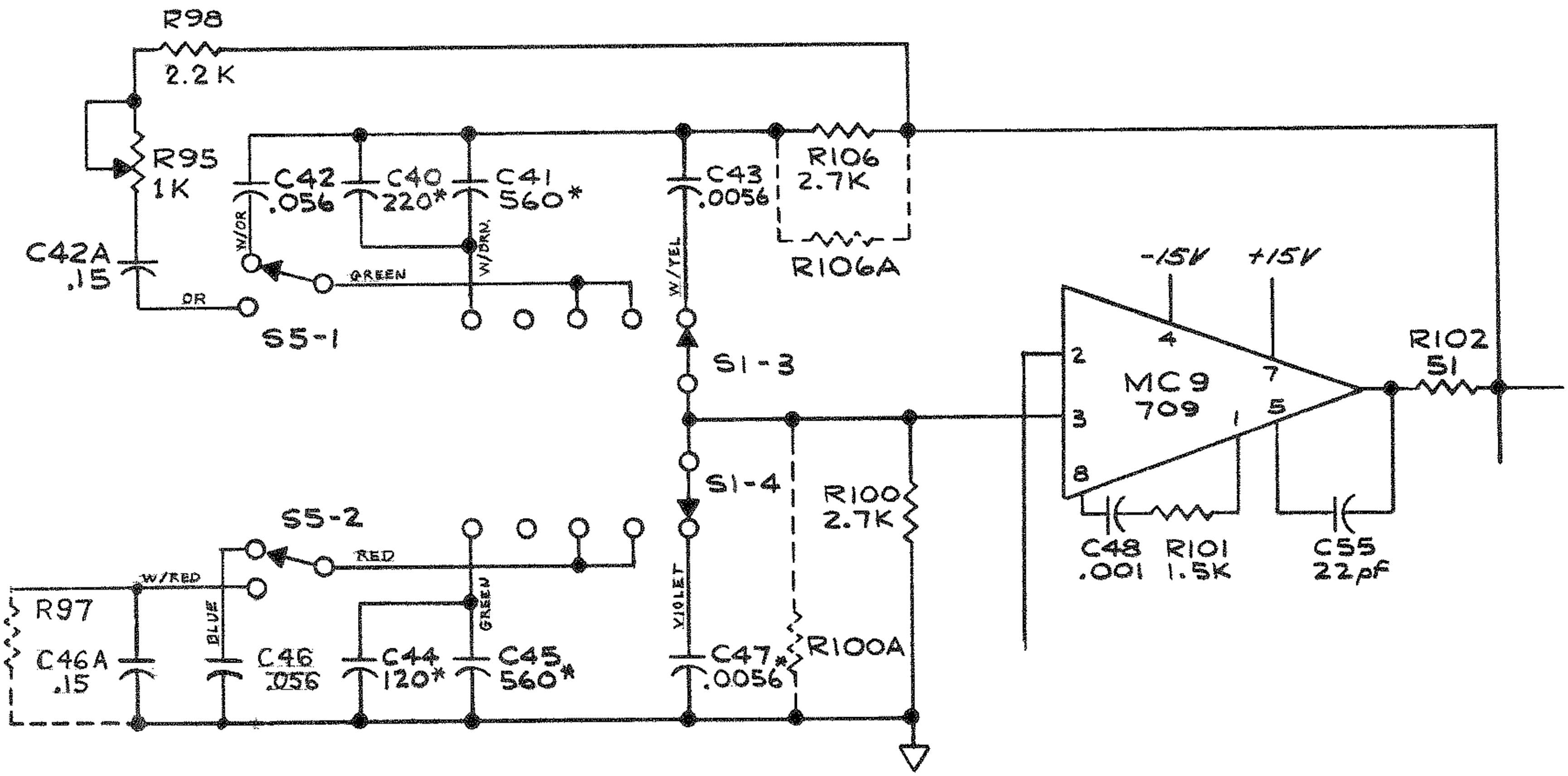
L5	Coil: 4.7 μh	140-0470	Miller	74F476AP
T1	X'fmr, Pwr	145-1000 145-1001 (115/230V)		Special
M1	Meter, 0-500 μA DC	360-1000		Special
W1	Pwr Cord	310-1200	Belden	17250
XF1	Fuse Post, 3AG	440-3420	Littlefuse	342014
F1	Fuse, 3AG, 1/2A	330-0500	Littlefuse	312.500
DS1	Indicator Light, Neon	321-1311	Leecraft	36N1311-6
Y1	X'tal, 152 kHz	370-0152		
S1	SW, Rotary 7P-5T	340-8280		Special
S2	SW, Rotary 2P-5T	340-7209		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
Mechanical Hardware:	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	430-1000		
	RFI Braid	491-0001		
	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		

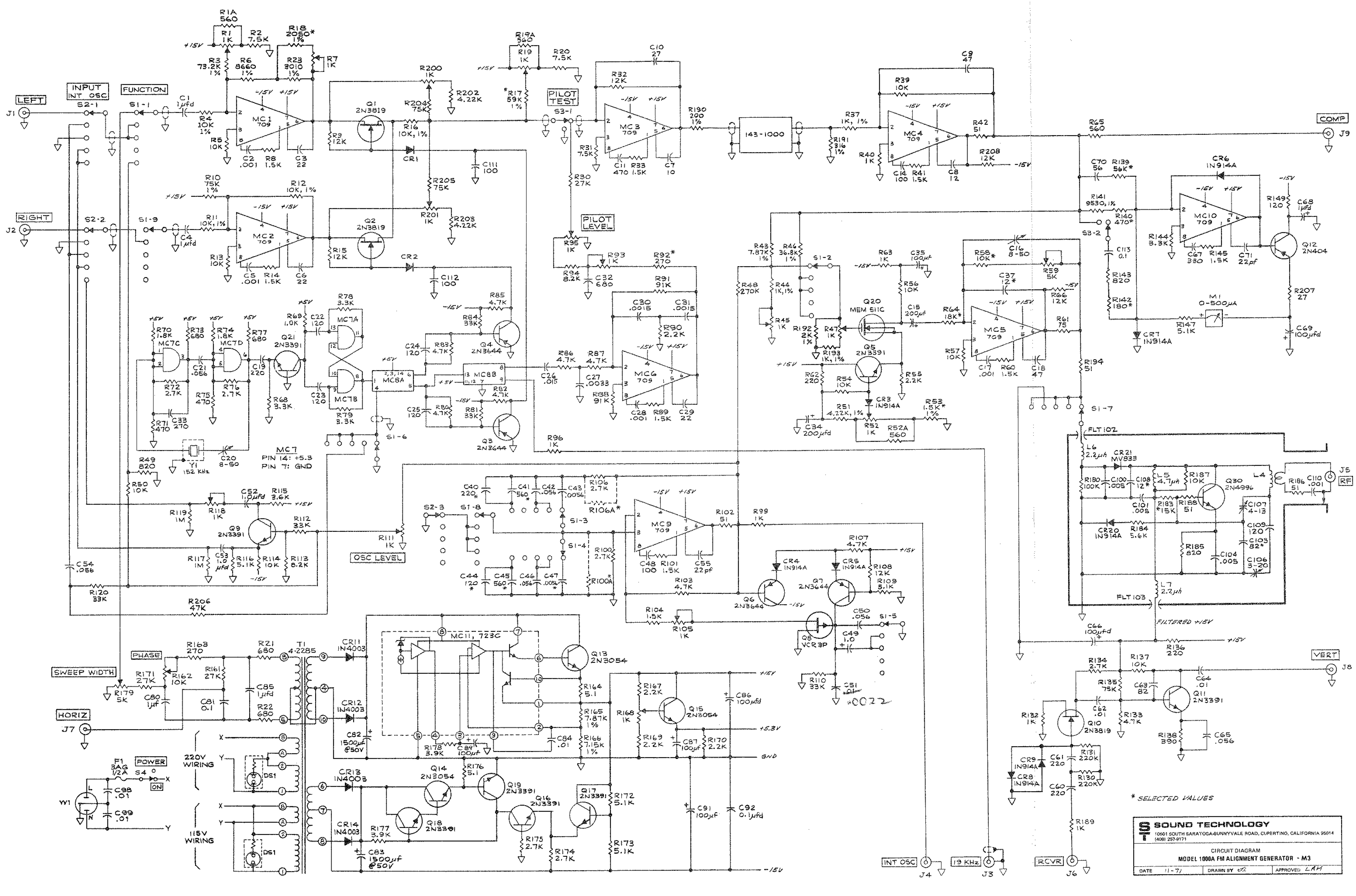
NOTE: It is recommended that problems in the RF unit be referred to the factory. Changes in RF circuit components can require changes in the modulator driver circuit (MC 5).



AUXILIARY INPUT - OPTION M1



Internal Oscillator Option M-2

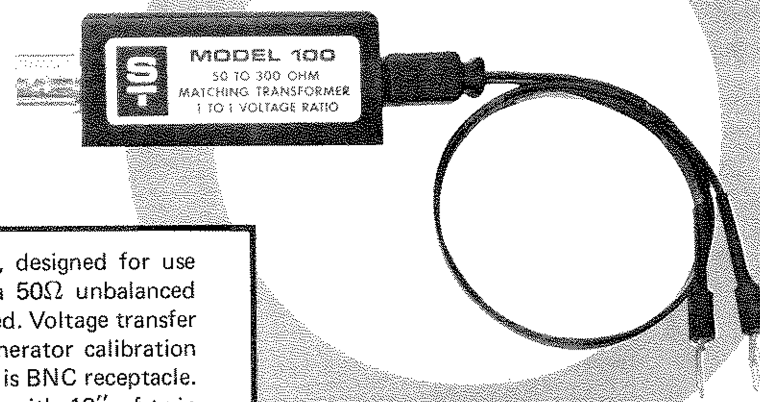


SOUND TECHNOLOGY
10601 SOUTH SARATOGA-SUNNYVALE ROAD, CUPERTINO, CALIFORNIA 95014
(408) 257-9171

CIRCUIT DIAGRAM
MODEL 1000A FM ALIGNMENT GENERATOR - M3

DATE 11-71 | DRAWN BY | APPROVED LAH

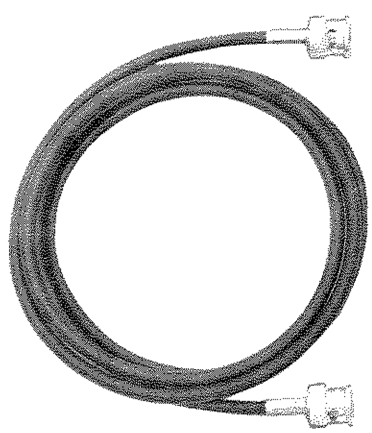
Model 100
MATCHING TRANSFORMER



The Model 100 Matching Transformer, designed for use from 54 MHz to 216 MHz, converts a 50Ω unbalanced signal generator output to 300Ω balanced. Voltage transfer ratio is 1:1 ± 10%, retaining signal generator calibration into a 300Ω load. 50Ω input connector is BNC receptacle. Detachable 300Ω output plug is wired with 12″ of twin lead terminated in spade lugs.

Price: Model 100, $38.00

Additional unwired 300Ω plugs, stock number 421-1677, $1.50 each.

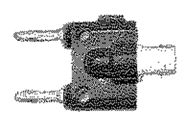


50Ω RG58C/U cable terminated with a BNC plug at each end. Four feet long.

Price: stk. no. 310-1040, $5.00 each.

Adapter, BNC receptacle to banana plugs on 3/4″ centers.

Price: stk. no. 380-1010, $4.25 each.



Adapter, BNC receptacle to phono plug.

Price: stk. no. 380-1020, $4.75 each.

Recommended kit for use with the 1000A FM Alignment Generator:

1 ea. Model 100 Matching Transformer
2 ea. 421-1677 unwired 300Ω Plugs
4 ea. 310-1040 Cables
2 ea. 380-1010 Adapters
1 ea. 380-1020 Adapter

Price: Kit stk. no. 381-1000, $68.00

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HI-FI PRODUCT REPORT

EW LAB TESTED

by Hirsch-Houck Labs

Sound Technology 1000A FM Generator

A basic requirement for any measurements on FM tuners, either mono or stereo, is an FM signal generator. There are several well-established companies manufacturing laboratory-grade FM signal generators, but until recently there has been no single instrument whose performance parameters matched or surpassed those of a modern FM tuner and whose operating functions met the needs of an equipment manufacturer or a hi-fi specialist's service department.

The traditional laboratory-grade FM signal generator is a general-purpose instrument. It covers a wide range of frequencies, with a calibrated tuning dial, and its metered and calibrated output level is adjustable down to a fraction of a microvolt, usually with an accuracy of ±10%, or ±1 dB. Often the generator is equipped for other modes of modulation such as AM or pulse. Its versatility is reflected in its price, typically from almost $1000 to over $6000, yet it still requires the use of an external multiplex generator ($500 to $1000 for an instrument of comparable quality) and a low-distortion audio generator in order to make measurements on a stereo-FM tuner.

Even with such an imposing and costly array of equipment, it is not possible to make meaningful distortion measurements on most FM tuners. The inherent distortion of the signal generator's own modulating circuits is about 0.5% at best (at 75 kHz deviation), and even this level cannot be guaranteed except over a limited frequency range. Most tuner and receiver manufacturers claim distortion levels under 0.2% for their products. Measurement or verification of these specifications heretofore has required a specially modified and calibrated signal generator.

A new company, *Sound Technology* of Cupertino, California, has recently introduced a unique instrument designed specifically for the hi-fi FM-receiver manufacturer or service organization. Its Model 1000A FM alignment generator represents a radical departure in features and performance from any previous commercial FM test equipment we have seen.

Features and Specifications

The Model 1000A is a multipurpose instrument. It is an FM signal generator, covering 88 to 108 MHz, with an output attenuator calibrated from 0.5 microvolt to 30 millivolts. The frequency dial is calibrated only at the ends and middle of the FM band (88, 98, and 108 MHz), but its smooth planetary drive permits a tuning resolution of 10 kHz. The output level, into 50 ohms, has a rated accuracy of ±2.5 dB and its shielding is adequate for making accurate measurements down to 0.5 microvolt.

A unique feature of the Model 1000A is its wide-band linear modulator. Deviations up to ±300 kHz are possible and, with 100% modulation (±75 kHz deviation) at 1 kHz, the generator harmonic distortion is less than 0.1%. There is a built-in 1-kHz low-distortion (less than 0.1%) source and an external modulating signal can be used for modulation over the full range of 50 Hz to 15 kHz (flat within ±0.5 dB). One-hundred-percent modulation requires a signal of 0.4 volt r.m.s. at the 10k-ohm input connector. With modulation removed (CW mode), the residual FM noise level is at least 70 dB below 100% modulation. Modulation level, either from internal or external sources, is adjustable and is read directly on a meter scale calibrated from 0 to 150%, with 100% corresponding to ±75-kHz deviation.

The instrument also contains a stereo multiplex generator capable of delivering a standard composite modulating signal from the 1-kHz internal oscillator, or from an external source. A selector switch connects the internal signal source to provide L, R, L+R (mono), or L−R modulation modes. Separate input connectors for external L and R signals can be switched into the circuit. The 19-kHz pilot carrier level is read on the meter by pushing a button, which expands the meter scale by a factor of ten. The pilot carrier may then be set accurately, within the standard 8% to 10% modulation limits, since the meter reads 15% full scale. Three connectors on the front panel carry out the 19-kHz pilot signal, the internal 1-kHz modulating signal, and the composite stereo modulating signal, for scope synchronization or for checking a multiplex demodulator unit. All connectors are type BNC.

The function selector switch has positions for Stereo, Mono, CW, SCA, and Dual Sweep. In the SCA position, external modulation is removed and an internal 67-kHz signal is applied to the modulator, for checking or aligning SCA traps in stereo tuners and receivers.

The Dual-Sweep function is a unique feature of the generator. It provides a means for aligning an FM tuner rapidly, with a constant display of over-all distortion on an oscilloscope as the alignment is performed. The Dual-Sweep technique in effect plots the *slope* of the discriminator S-curve over a wide and adjustable deviation range. The generator frequency is swept by a 60-Hz signal, on which is superimposed a small deviation at a 10-kHz rate. The sweep width is adjustable from 0 to 600 kHz, and is indicated on the meter.

The audio output from the tuner is returned to the instrument where the 60-Hz component is filtered out and a clean 10-kHz signal is extracted. The amplitude of the 10-kHz component is proportional at all times to the slope of the tuner's discriminator characteristic. With a perfectly linear discriminator, it would have a constant level as the 60-Hz sweep moves the generator frequency across the tuner passband.

Two output connectors on the generator supply vertical (10 kHz) and horizontal (60 Hz) deflection signals to an external oscilloscope. Any variation in the vertical dimension of the swept display indicates a nonlinearity in the tuner. The i.f. and discriminator circuits are aligned to produce the smoothest, widest, and most uniform display possible. As a final check, the sweep width can be reduced to 150 kHz, corresponding to 100% modulation, and the vertical scale of the oscilloscope expanded to reveal the smallest departure from flatness. The amplitude of any irregularity, expressed as a percentage of the total vertical amplitude, is a direct measure of IM distortion. The rated peak nonlinearity of the generator in the Dual-Sweep mode is less than ±0.3% over a 150-kHz bandwidth.

Clearly, the Model 1000A is an uncommonly versatile instrument. It was designed for a manufacturer's final-test or quality-assurance departments, or for the service specialist dealing in the highest caliber of home receiving equipment. This unit makes more use of up-to-date components and techniques than any comparable laboratory instrument we have seen. For example, its design employs 8 linear IC operational amplifiers, an IC power-supply voltage regulator, and two digital IC's serving flip-flop and gating functions. In addition, there are 22 transistors (5 of them FET's) and 13 diodes.

The end result is a compact instrument, 8 3/8" high by 11 1/8" wide by 11 3/4" deep and weighing only 12 pounds. It is very nearly a single unit FM/stereo-FM test laboratory, whose functions could only be partially duplicated by a clumsy and expensive array of separate instruments.

Tests and Evaluation

Our tests of an instrument such as this had to be done indirectly, by comparison with other instruments whose performance was in some respects inferior to the unit we were "testing." Nevertheless, we were able to satisfy ourselves that this instrument does what is claimed for it, and then some.

Our own FM signal generator, a *Boonton* Model 202B, has a residual distortion of about 0.5% at 75-kHz deviation. We used it to measure the IHF usable sensitivity, distortion, signal-to-noise ratio, and stereo crosstalk of a new FM receiver, and similar measurements (except for crosstalk) on an older mono-FM tuner of high quality. A *Scott* Model 830 multiplex generator was used to develop the composite modulating signal for the stereo measurements. The same measurements were then repeated using only the *Sound Technology* Model 1000A.

With our own equipment, the IHF sensitivity of the receiver measured 3.0 microvolts; with the Model 1000A it was 2.9 microvolts—remarkably close in view of its relatively loose output-level specifications. The distortion measured 0.54% with our equipment, and a remarkable 0.07% with the Model 1000A. The two sets of stereo-crosstalk measurements agreed within 3 dB at all frequencies. The signal-to-noise ratio was 72 dB with our equipment; 73 dB with the Model 1000A.

With the mono tuner, our equipment showed an IHF sensitivity of 2.1 microvolts, while the Model 1000A gave a reading of 2.6 microvolts—still within specification limits. Distortion with our generator was 0.53%; with the Model 1000A it was 0.19%. The signal-to-noise ratios were, respectively, 70 dB and 73 dB.

We then used the Dual-Sweep mode to align the mono receiver. It was interesting to note how easily rather large irregularities from 100 kHz to 300 kHz away from the center frequency could be produced by conventional alignment methods. With a little practice, the Dual-Sweep technique allowed a modest reduction in distortion, but with an improved symmetry over a wide bandwidth which makes the receiver easier to tune for low distortion.

In effect, Dual Sweep replaces the rapid, but purely *qualitative* sweep alignment of a discriminator by visual display of its S-curve with an equally fast, but precise and *quantitative* indication of the tuner's IM distortion.

Our only criticism of the generator is the choice of 1 kHz as its internal modulating frequency. The IHF standard on FM tuner measurements specifies a 400-Hz modulating frequency and this frequency has long been a part of other standard measurement practices for home FM receivers. The principal reason for this, we believe, is that harmonics of 400 Hz appear in the correct amplitude relationship to the fundamental, even the third harmonic is reduced by only about 1 dB by the tuner's de-emphasis circuits. On the other hand, the second harmonic of a 1-kHz modulating signal is reduced by 1.9 dB, and the third harmonic is down 3.8 dB, relative to the 1000-Hz level, since de-emphasis begins just below 1000 Hz. This can give misleadingly optimistic readings of tuner distortion. Of course, 400 Hz can be used with the Model 1000A, from an external source (which we did), but it should be internally available, either instead of or in addition to the 1-kHz signal.

(Editor's Note: The manufacturer will supply the instrument with a 400-Hz modulating frequency if desired at no extra cost. However, this means that separation will have to be measured at 400 Hz rather than 1 kHz. Both frequencies are available at the flick of a switch as an extra-charge option.)

All in all, the *Sound Technology* Model 1000A is a fine instrument, which we wouldn't mind having in our own laboratory. Its price is $1250. ▲

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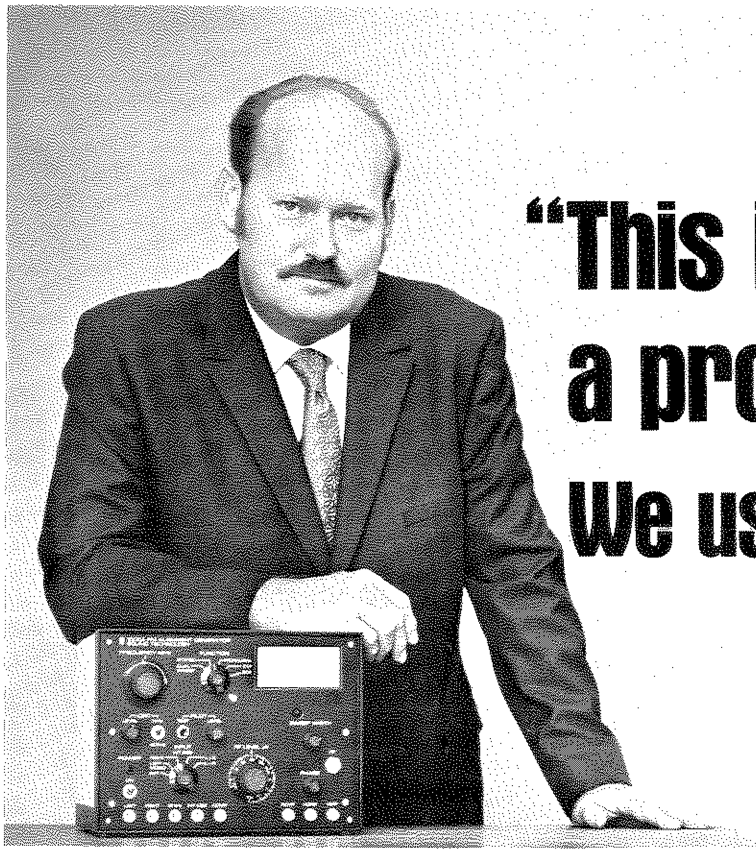

"This instrument is a profit-maker. We use ~~13~~ 14 of them."

Mr. Jerry Philipp
Service Manager,
Pacific Stereo

Mr. Philipp bears the responsibility for profitable service operations in Pacific Stereo's California store chain. You can be sure he pays attention to new profit-making methods.

Mr. Philipp uses the new Sound Technology Alignment Generator *in all of his stores.* That's because this revolutionary new instrument saves time. Makes money. And does a much better aligning job.

It uses a new technique that *lets your technician inspect alignment without even removing the receiver from its cabinet.* He (or you) can show the customer on the spot if alignment is needed.

HELPS YOU SELL

The Sound Technology 1000A helps you sell, too. It gives your salesmen the *confidence needed to sell* because they *know*—they can *see*—that they have strong service backing.

You can sell with fast-moving rf clinics that won't clog with annoyed, waiting people.

You can sell servicing because the customer can *see* when his receiver needs alignment/repair.

DON'T BE CAUGHT SHORT

The Sound Technology generator is revolutionary. Patented. It's already in use by at least 12 receiver manufacturers because it's the only generator that can test the improved new receivers.

It is sure to have a profound—repeat, profound — effect on servicing. Don't let this technological advance catch you unaware.

Call or write today for information. TODAY, man. Because making money hurts a lot less than being sorry.

"It is very nearly a single unit FM/stereo-FM test laboratory."
Hirsch-Houck Labs report in April, 1971 *ELECTRONICS WORLD*

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