FS 134
FIELD STRENGTH METER

SENCORE SERVICE MANUAL

3200 SENCORE DRIVE, SIOUX FALLS, S. DAKOTA 57107

INSTRUCTION MANUAL

SENCORE FS134 FIELD STRENGTH METER

The Sencore FS134 Field Strength Meter is a completely solid state portable instrument designed to identify and measure the frequency and signal strength of FM stations and all VHF and UHF TV stations. Because of the increase in popularity of "FM Stereocasting" and the UHF boom, it was realized that a great need for this type of instrument existed. Sencore engineers did considerable research to develop a Field Strength Meter which is rugged, lightweight, portable and accurate and yet has that "Professional" appearance.

Listed below are some of the Special Features of the Sencore FS134 Field Strength Meter.

1. Completely solid state construction provides the utmost in portability, lightweight compactness and battery power economy.

2. Printed circuit construction on unbreakable board material gives dependability and long life.

3. Completely battery operated for field use. Uses standard "C" cells available anywhere. Provisions have been made for installation of a battery charger accessory.

4. Choice of 75 ohm or 300 ohm input from the front panel.

5. Uses most popular type 75 ohm input jack for direct connection to antenna distribution systems, thereby eliminating messy adapters, which can introduce additional SWR losses.

6. Has built-in matching transformer for 300 ohm input. 300 ohm input terminals are of the thumb nut type for complete versatility of any twin lead termination.

7. Built-in 20db (X10) and 40db (X100) attenuators provide control of high level input signals, especially those signals encountered in distribution systems. The attenuators can be used with the 75 ohm or 300 ohm input.

8. Separate VHF and UHF tuners are provided for miximum stability and minimum losses.

9. Three stage 42.8 MC high gain IF system controlled by amplified AGC stages gives stability and good control of both weak and strong input signals.

10. Large four inch meter allows operator to read signal strength from several feet away.

11. Extended logarithmic microvolt range from 30 to 30,000 microvolts permits antennas to be installed without constantly changing the sensitivity range of the meter.

12. Built-in, 3 1/2 inch speaker, with six transistor audio system to drive it, is essential when monitoring FM and TV audio signals.

13. Signals as low as 5 microvolts can be heard in the speaker (the meter starts indicating at 30 microvolts) thereby permitting weak fringe area signals under 30 microvolts to be "found" and built up with proper antenna orientation to a level visable on the meter.

14. Extremely good shielding prevents strong signals from being received directly, they must be received by the antenna, thus making the peaks and valleys of signal strength more pronounced as the antenna is rotated. This, of course, makes it easier to pinpoint signal sources.

15. Detector output jack on the front panel permits external VTVM or oscilloscope connections when monitoring.

16. Front panel CAL control compensates for decreasing battery voltage and affords constant accuracy at all times.

SPECIFICATIONS

Tuning Ranges
53 MC to 109 MC - TV Channels 2 to 6 ; FM Channels 201 to 300
173 MC to 218 MC - TV Channels 7 to 13
465 MC to 895 MC - TV Channels 14 to 83

Sensitivity
53 MC to 109 MC - 30 microvolts ± 3DB
173 MC to 218 MC - 30 microvolts ± 3DB
465 MC to 895 MC - 30 microvolts ± 3DB

Selectivity (Bandwidth)
500 KC @ 3DB points

Intermediate Frequency
42.8 MC

Input Impedance
75 ohms - 300 ohms with Built-in Matching Transformer

Image Rejection
53 MC to 109 MC - 40DB
173 MC to 218 MC - 40DB
465 MC to 895 MC - 30DB

IF Rejection
40 DB

Audio Power Output
150 milliwatts

Power Consumption and Requirements
24 milliamps @ 12 volts on VHF (no signal)
35 milliamps @ 12 volts on UHF (no signal)
2 milliamps @ -1.5 volts

Nine "C" cell batteries are used for power source. An accessory battery charger, used with a rechargeable battery is available.

Dynamic Meter Range
30-30,000 microvolts (60DB) on logarithmic scale

Physical Specifications
Height - 9 1/2"
Width - 10"
Depth - 5"
Weight - 9 lbs.

Temperture Range
-5 to +105°F Operating Range
-20 to +140°F Storage Range

TRANSISTOR AND DIODE COMPLEMENT

Ref. No.	Type	Function
TR1	2N2362	VHF, RF Amplifier - UHF, IF Amplifier
TR2	2N2361	VHF, Signal Mixer - UHF, IF Amplifier
TR3	2N2362	VHF, Oscillator
TR5, TR6, TR7	2N1745	IF Amplifiers
TR8	2N2923	1st Audio
TR9	2N1304	Audio Amplifier
TR10	2N1304	Audio Driver
TR11	2N404	Audio Driver
TR12	2N1304	Audio Output
TR13	2N404	Audio Output
TR14	2N1304	AGC Amplifier
TR15	2N1304	AGC Emitter Follower
TR16	2N1304	Meter Balance
CR3, CR4	1N34	AM and Slope Detector

The following blank spaces are for you to record the signal strength levels of your local TV stations, or from your signal generator. If you do this when the FS134 is new, you will always have a handy reference for later use.

Channel	Microvolts	Input Used	Type Antenna

CONTROLS ON THE FS134

The FS134 is as easy to use as a radio and basically has the same controls as any fine receiver. In addition to normal controls found on a receiver, TUNING, BANDswitch, OFF-ON switch and VOLUME control, the FS134 has a CAL control to adjust for changing battery voltage. A front panel meter calibrated in microvolts and DB and a series of input jacks complete the controls on the panel. Following is a brief description on how each of these controls are used.

OFF-ON SWITCH. The OFF-ON switch, as the name implies turns the FS134 off or on, but in addition has a center CAL position which is used in conjunction with the CAL control and the meter to set the B+ voltage to the FS134 circuits.

CAL CONTROL. The CAL control is adjusted prior to taking a signal strength measurement by placing the OFF-ON switch in the CAL position and adjusting the CAL control until the meter indicates at the CAL line. This sets the voltage on the RF, IF and AGC circuits to 10 volts resulting in constant signal strength accuracy regardless of the battery condition. When it becomes impossible to make this adjustment the battery voltage has dropped too low and the batteries should be replaced.

BAND SWITCH. The BAND switch selects one of three frequency bands; the low VHF band, channels 2-6 and FM; the high VHF band, channels 7-13; and the UHF band, channels 14-83. It is located directly above the frequency dial.

TUNING. The TUNING control at the lower right of the frequency dial turns the frequency dial and, of course, the internal tuning capacitor at a 6:1 ratio for "fine" tuning adjustment of the selected signal. It is used for all three bands.

The tuning dial is calibrated in frequency and by TV channels. On the two VHF bands each block representing a channel starts at a point representing the carrier frequency (low frequency end) and stops at a point representing the sound carrier frequency (high frequency end). This was done to simplify field use of the FS134.

VOLUME. The VOLUME control adjusts the sound level from the speaker. In normal use the sound level should be kept as low as possible to prevent excessive drain on the batteries. The VOLUME control has been designed so that it can never be completely reduced to zero to serve as an audible reminder that the unit in ON.

METER. The panel meter has two scales for determining signal strength - one calibrated in microvolts, the other in decibels (DB). The decibel scale is used primarily when checking out an antenna distribution system for the various losses encountered in pads, feedthroughs, cables etc. The zero DB reference is 1000 microvolts across 75 ohms.

The single microvolt scale is used for all VHF and UHF frequencies thus reducing the possibility of error by reading a wrong scale.

INPUT JACKS. The basic input on the FS134 is the X1, 75 ohm jack. The signal is fed directly thru a pass filter to an RF amplifier in either of the VHF bands and in the UHF band is fed directly to the UHF tuner. When signal levels are high the signals can be attenuated by connecting into the X10 jack (20DB loss) or the X100 jack (40DB loss). Of course, when using the attenuator jacks the meter indication microvolts should be multiplied by 10 or 100 respectively, and on the DB indication 20DB or 40DB added respectively. The best meter accuracy is obtained between 30 and 1000 microvolts, therefore when you desire the most accurate indication and the meter reads above 1000, additional attenuation should be used.

The 300 ohm balanced input is changed to 75 ohm unbalanced by a matching transformer. In use, the 300 ohm twin lead from the antenna would be connected to the thumb screw terminals and the output of the matching transformer would be coupled through the jumper cable to the appropriate 75 ohm input jack. When using the 300 ohm input, the meter reading (microvolts) should be multiplied by two and for best accuracy this product should be multiplied by the conversion factor (See page 7), which takes into account the losses in the matching tranformer for the various frequencies encountered.

THE FS134 OFF-ON INDICATION. There are no pilot lights on the FS134, but there are two indicators, one is visual and the other an audible indication that the FS134 is on. The meter on the FS134, when the unit is on and no signal is fed to the input, will read negative or below the 30 microvolt line on the scale. Just glancing at the meter will tell if the unit is on. If a signal is present of course, the meter will read up scale and again you will be able to tell if the FS134 is on. The volume control on the FS134 cannot reduce the volume to zero, so there will always be either the signal sound or low background noise from the speaker. In this way Sencore has eliminated the power consuming pilot light and has provided more economical battery life.

OPERATING INSTRUCTIONS

NOTE: THE METER WILL INDICATE BELOW THE 30 MICROVOLT MARK WHEN NO SIGNAL IS PRESENT.

The first and most basic requirement when attempting to measure the strength of signals received by an antenna or from an antenna distribution system is that the output impedance of the antenna or system is properly matched to the field strength meter. If there is any mismatch, standing waves are developed, which reduce the amount of signal actually received by the meter and, of course, the meter indication will not be accurate. ALWAYS BE SURE THAT YOU USE THE CORRECT IMPEDANCE LINE OR CABLE FOR THE ANTENNA OR SYSTEM YOU ARE WORKING WITH AND THAT YOU CONNECT TO THE CORRECT INPUT ON THE FS134. Cables with 75 ohms impedance (from a straight dipole antenna, for example) should always be connected to the 75ohm input jacks (X1, X10 or X100). Three hundred ohm twin lead from a folded dipole antenna should always be connected to the matching transformer input and the short 75 ohm jumper cable used to connect the output of the transformer to the appropriate 75 ohm input jack.

With the input properly connected turn the BAND switch to the desired band, push the OFF-ON switch to CAL and with the tuning dial set to a point where no signal is present, adjust the CAL control until the meter reads at the CAL line. Push the OFF-ON switch to ON, and you are now ready to measure signal strength.

<u>Measuring Signal Strength With the FS134.</u> Rotate the tuning control to the approximate frequency of the signal to be measured and observe the meter indication. Rotate the tuning control about this point slowly to obtain a maximum meter indication. If the indication is past full scale on the meter, feed the signal into the next higher attenuator, X10 or X100 to obtain a lower meter reading. Then repeat the tuning procedure until a maximum meter indication is obtained. You can read the meter directly if 75 ohm coaxial cable is used or multiply by 2 if 300 ohm twin lead is used. Then this reading must be multiplied by the attenuator used. For example, 75 ohm coaxial cable plugged into the X10 jack produces a reading of 245 microvolts. This will be 245 X 10 or 2450 microvolts. If 300 ohm twin lead is used giving a signal strength of 350 microvolts in the X1 jack, the signal would be 350 X 2 X 1 or 700 microvolts, total signal. When using 300 ohm twin lead connected to binding posts, the meter reading must be multiplied by 2 to get the correct value of signal strength. For greater accuracy the product must be multiplied by the conversion factor found in the chart below, which takes into account the losses of the matching transformer. For the average antenna installation, however, it is not necessary to multiply by the conversion factor. On 75 ohm coaxial cable input, read the meter direct.

Matching Transformer Conversion Factor

Low VHF Band (Channels 2-6-FM) Multiply by 1.1
High VHF Band (Channels 7-13) Multiply by 1.4
UHF Band (Channels 14-83) Multiply by 3.0

If by chance in the X1 jack some signals read beyond full scale there is no danger of damaging the meter, because the AGC system will hold the meter current at a safe level.

UHF Signal Strength Measurement. UHF signals are measured the same as above except that all lead-ins, terminations, etc. are much more critical that at VHF and the finest care must be taken to see that the cables are terminated properly, cable connectors are tight, cables and lead-ins held well away from metal surfaces etc. It is much more difficult to obtain accurate measurements in the UHF band, so every precaution you take will make the reading that much more accurate.

One big advantage at UHF is that although high signal levels are harder to come by, noise is also down, resulting in good quality pictures at UHF at lower signal levels than the same quality picture at VHF requires.

Tuning the FS134 to Monitor Sound Signals. Most RF signals can be heard through the speaker on the FS134 although the sound may not be that of voice or music. For example, the signals from the video portion of a TV signal contain a low frequency (60 cycle) buzzing sound. However, the speaker is mainly intended for identifying intelligible sounds such as voice or music. When tuning in an FM station or the sound of a TV signal, the best sound will occur as the meter indication drops off slightly and will occur at either side of the peak reading. This is a normal condition because slope detection is used in the FS134 sound system. On the video carrier of a TV signal the maximum 60 cycle buzzing sound will be loudest when the meter is at its peak indication, because the video carrier is amplitude modulated (AM).

Turning the volume control clockwise will increase the sound output. It is suggested that you keep the sound output as low as useable, or off, when not using the sound signal to keep the drain on the batteries as low as possible.

Spurious Responses. Although the image rejection ratio for the FS134 is over 100 to 1 on the VHF TV bands it is possible for a "local" signal at the image frequency to be of sufficient strength to be heard in the speaker and produce a meter reading when feeding the signal through the X1 input. Therefore, if possible, feed the signal through the X10 or X100 input jacks and spurious responses, such as this, will be virtually non-existant. This also applies for UHF signal measurements.

Noise Level in the FS134. The FS134 circuits were designed to keep inherent noise at a minimum, however external noise pickup by the antenna will be amplified and received the same as an RF signal. Therefore in extremely noisy areas the FS134 meter may produce random meter indications caused by noise. The only alternative is to move the antenna to a less noisy location. In doing so, this will also improve the FM, VHF, or UHF reception.

Determining the Frequency of a Received Signal. The frequency of any signal may be read directly from the tuning dial. Set the tuning control for maximum meter indications and read the frequency at the point on the tuning dial where the cross hair passes through the frequency indication marks on the tuning dial. The FM band and the VHF TV bands are on the top of the dial, and the UHF TV band is on the lower half of the dial.

Use of Detector Output Jack. The DET OUT jack on the front panel of the FS134 is provided so that the detected video signal may be monitored with an oscilloscope or external meter if desired. It is especially useful when checking boosters or antenna amplifiers to see if these units are overloading on one or more channels causing a loss of sync or sync compression or if they are causing cross modulation in the other weaker channels.

FACTS YOU SHOULD KNOW FOR BEST USAGE OF THE FS134

Before putting the FS134 to work let's review briefly some facts concerning the transmission and receiving of VHF and UHF TV signals, and FM signals. The whole business seems quite confusing when you hear such terms as: microvolt signal strength, field intensity in microvolts per meter, antenna systems with so many DB gain, DB, DBM, DBJ, 75 ohm coax, 300 ohm twin lead, mismatch, standing wave ratio (SWR), pads, losses, matching transformers, and many others. Let's see if we can straighten some of this out.

We stated earlier the importance of matching the impedance of an antenna to the input of a receiver and talked about SWR losses if this were not done properly. As you know a straight dipole antenna has a characteristic impedance of 75 ohms and a folded dipole antenna has a characteristic impedance of 300 ohms. Most of the antenna arrays that have been manufactured over the years were designed for 300 ohm impedance, although recently some new arrays are being designed for 75 ohm impedance.

The importance of all this is that the lead-in from the antenna must have the same impedance as the antenna, and the impedance of the lead-in must match the input of the receiver, or points of mismatch will occur. Connections that are mismatched will not pass the entire signal, but rather will reflect a part of the signal back up the line. If there are two or more mismatched connections signals can actually bounce back and forth several times. When some of the signal is reflected due to mismatch, standing waves occur. This condition is referred to in terms of the standing wave ratio (SWR) which can be calculated by dividing the sum of the two signals (original signal and reflected signal) when they are in phase by the sum of the two signals when they are out of phase. The closer that the SWR ratio is to 1.0 the better the match.

It is possible to change from one impedance to another with very little mismatch, by using pads or matching transformers. A matching transformer generally called a Balun is actually an impedance transforming device that will convert a 300 ohm BALanced input to a 75 ohm UNbalanced output or vice versa. It consists of two short lengths of 150 ohm twin line that are connected in series on one end and in parallel on the other. The 150 ohm lines may be wound around a coil form, or in some cases are wound on a ferrite core.

Pads are resistive networks that can be designed to match one impedance to another, although you may be more familiar with them as attenuation pads with the same input and output impedances designed for a specific DB attenuation. It is well to note that any pad, whether it is designed specifically for attenuation or for matching two impedances, will always introduce some loss. Impedance matching pads are generally designed for a 6DB loss for ease of calculations in use, since 1/2 of the input voltage will appear at the output.

FIELD INTENSITY AND SIGNAL STRENGTH

Transmitted signals fill the air around us. Each station has a plot of their field intensity pattern in terms of microvolts per meter for the surrounding country side. This field intensity figure is the voltage induced in a conductor one meter long as the magnetic flux of the transmitted wave passes through the conductor at the speed of light. Field intensity measurements can be made with the FS134 (see procedure on page 12).

Do not confuse signal strength in microvolts with field intensity above. The strength of a received signal is dependent on the antenna array, and how much signal the antenna can pickup from the field intensity pattern. A well designed array will be able to pick up much more signal than a straight dipole, for example.

Since some antennas are more effective than others a means of rating them had to be devised. The straight dipole was chosen as the reference, and all other antennas are compared against it. Therefore an antenna array with 20DB gain would "collect" ten times the amount of signal voltage that a straight dipole would collect.

The strength of received signals is generally referred to in terms of microvolts or DB. Microvolts by itself has very little meaning unless you also consider the impedance that the voltage is developed across. In other words, it is the received power that is important, but since we are always dealing with either 75 ohm or 300 ohm impedance, we can and do get by with just the voltage term. For example, consider a 300 ohm antenna array that is receiving a 1000 microvolt signal. The signal power would be E^2 R and would equal .0033 micro-watts. Now let's assume that you would like to use a 75 ohm coax lead-in. You would place a matching transformer on the antenna mast to convert 300 ohms to 75 ohms. Assuming no losses in the matching transformer you would find that the output voltage of the transformer would equal the square root of .0033 micro-watts times 75 ohms or 500 microvolts. Notice that the microvolts at 75 ohms is just half of the microvolts at 300 ohms, yet in both cases the power is the same. The FS134 is calibrated for a 75 ohm input, therefore, when using the built-in matching transformer for 300 ohm input you must multiply the microvolt reading by two.

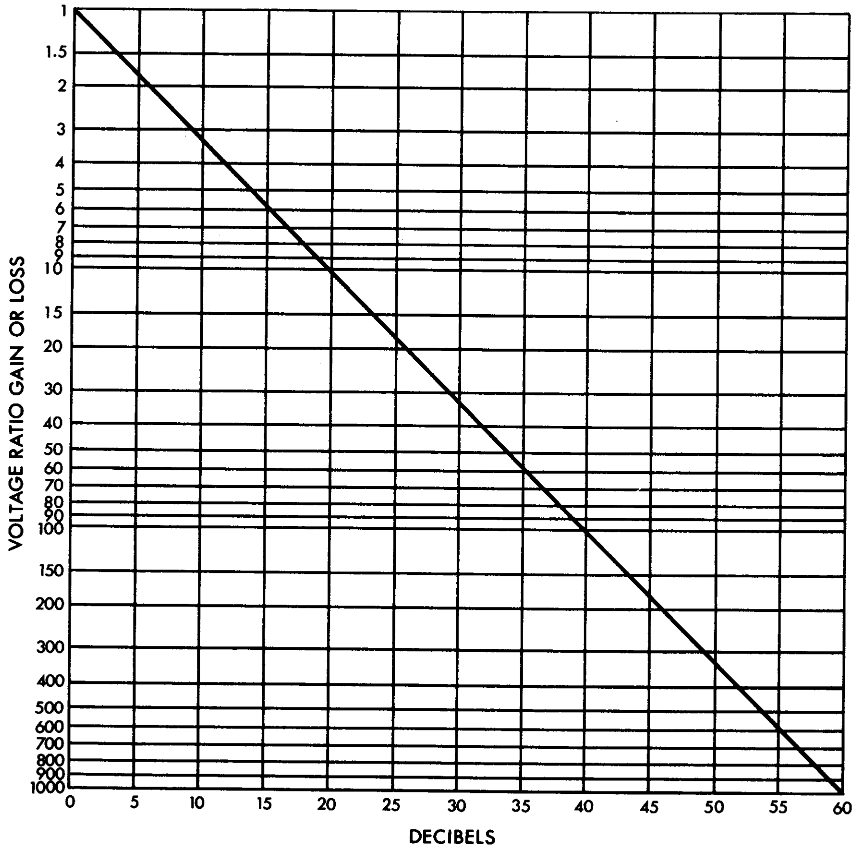
Once a signal is received and is amplified in a booster or experiences losses in cables, pads, etc., the voltage figures resulting become so large and cumbersome that the more convenient DB term is used. A big advantage is that gains and losses of a system expressed in terms of DB can be added or subtracted directly making calculations more simple.

To establish a DB scale, however, some reference must be used. The TV industry has agreed that 1000 microvolts across 75 ohms would be a good zero DB reference, since a signal of this strength will produce a good quality picture. Terms such as DBJ and DBM are expressions of this reference.

You may recall the formula for calculating DB when you know the input and output voltages, keeping in mind that the input and output impedances must be the same.

$$DB = 20 \log \frac{E\ out}{E\ in}$$

So that you won't have to dig out your old logarithm book you can simplify your calculations with the following DB chart.



Charts and useful formulas:

Coaxial Cable Losses in DB/100 ft.

Type Cable	Ch. 2	Ch. 4	Ch. 6	FM	Ch. 7	Ch. 10	Ch. 13
RG59/U	2.8	3.2	3.6	4.0	5.3	5.6	5.9
RG6/U	2.1	2.3	2.6	2.7	4.0	4.2	4.3
RG6/U Foam	1.7	1.9	2.1	2.2	3.2	3.3	3.5
RG11/U	1.6	1.8	2.0	2.2	2.7	2.9	3.0
RG11/U Foam	1.1	1.3	1.4	1.5	1.6	1.9	2.3

Frequency Data on TV Channels

Channel	Bandwidth (MC)	Picture Carrier (MC)	Sound Carrier (MC)
2	54-60	55.25	59.75
3	60-66	61.25	65.75
4	66-72	67.25	71.75
5	76-82	77.25	81.75
6	82-88	83.25	87.75
7	174-180	175.25	179.75
8	180-186	181.25	185.75
9	186-192	187.25	191.75
10	192-198	193.25	197.75
11	198-204	199.25	203.75
12	204-210	205.25	209.75
13	210-216	211.25	215.75
14-83	(470 to 476)+6(ch#-14)	471.25 + 6 (ch#-14)	475.75 + 6 (ch#-14)

$$\text{Wave Length in Feet (Air)} = \frac{984}{\text{Freq. in MC}}$$

$$\text{Wave Length in Meters (Air)} = \frac{300}{\text{Freq. in MC}}$$

E_f (Field Intensity in Microvolts per Meter) = .021 X E (Field Strength Meter Reading in Microvolts using a matched resonant dipole antenna) X E (frequency in MC)

In several places above we made reference to a straight dipole antenna. This would be a very handy device to have, because with it you would be able to make field intensity surveys, actually measure the gain of antenna arrays, (remember the dipole is the reference for all other antennas) etc. The complication is, of course, that the dipole has to be "cut" to the frequency that you wish to receive. Sencore has come up with the simple answer! Purchase a "Rabbits Ears" antenna, remove the 300 ohm line, which isn't correct for the antenna anyway, and attach a length of 75 ohm coax (RG59B/U) to the arms. The other end of the cable should have a connector that matches the FS134 input jacks (Jerrold type F59A or equivalent). The antenna should then be mounted on the end of a wooden pole.

In use, each arm would be adjusted for 1/4 wavelength of the frequency you wish to receive times .95 (end loading factor) or in terms of feet would be

$$\frac{235}{\text{Freq. in MC}}$$

If you really want to "go all out" you might even calibrate the adjustable arms by channels to prevent having to make calculations out in the field.

APPLICATIONS

FIELD INTENSITY SURVEYS

The FS134 is ideally suited for field intensity surveys, because of its portability and the fact that it does not require an external source of power. All that is necessary is a straight dipole antenna cut to the frequency being plotted and the conversion formula, to change microvolts to microvolts/meter, found in the above section. Seventy five ohm coaxial cable should be used from the dipole to the FS134. If this cable needs to be quite long, be sure to consider the cable losses in your calculations. If an antenna other than a dipole is used the conversion factor (.021) must be divided by the gain factor of the antenna for correct results.

FIELD OR AREA SURVEYS

Surveys to determine where signal levels are the highest and/or the search for the best antenna location, are quite easily performed because of the FS134 portability and internal power source. All that is necessary is an antenna that has been impedance matched to the FS134.

In searching for the best location to install an antenna, you will often discover that the height the antenna is placed above the roof can be just as important as its orientation. Also don't be alarmed if you discover that a reflected signal is stronger than the one direct from the transmitter, especially in metropolitan areas. Usually in an area where there are many reflections, a coaxial lead-in is preferred, because even though the antenna has a good directional pattern 300 ohm twin line can pick up unwanted signals, which, of course, results in ghosts.

Sometimes when it is extremely difficult to eliminate reflections, tilting the antenna upwards a few degrees will solve the problem.

Installing UHF antennas is more critical than VHF antennas. Although both signals are "line of sight" transmissions UHF is attenuated easier and can be affected by anything, including trees, between the transmitting antenna and the receiving antenna. It can almost be thought of, as a beam of light.

When installing UHF antennas, here are several things to keep in mind.

1. Try to pick a spot where there is a line of sight path to the transmitting antenna. An antenna mounted in late fall behind a tree may work good all winter, then in spring when the leaves come out, the signal level is drastically attenuated.

2. The height of a UHF antenna is critical. Especially if the antenna is mounted on a metal roof. Even if the roof does not appear to be metal, keep in mind that some insulations use aluminum foil and this gives the same effect. Generally the antenna should be mounted 5 to 10 wavelengths above the roof.

3. The lead-in should have low loss, and if twin lead is used, should be kept away from the mast, roof, and building with good quality stand-offs.

4. Quite often the best signal area is not the best location to physically mount the antenna, in which case a compromise will have to be made.

UHF, VHF, AND FM ANTENNAS ALL ON THE SAME MAST

Sometimes it will be necessary due to customer's request or because of space requirements to mount the FM, VHF and UHF antennas on the same mast. Some of the newer antenna arrays are designed to receive all of these signals with a single antenna.

When three different antennas have to be mounted on the same mast, the installation becomes more critical, because in addition to the problems with UHF discussed above, the antennas will interact somewhat, and usually the final placement of each antenna will be a compromise for the best signal level on all three mediums, FM, UHF and VHF.

Generally it is best to place the UHF antenna first, then VHF, then FM, rechecking all three signals each time an antenna is moved. With the FS134, you can switch back and forth between these frequencies with ease and adjust for the best performance on all three bands.

SETTING UP A TV DISTRIBUTION SYSTEM

TV Distribution systems are coming more in the public domain from complex systems used in Motels, Hotels, Hospitals, etc. to simple systems used in dwellings where two to four TV sets are operated off a single antenna.

Some form of distribution must be used whenever two or more TV sets are operated from an antenna. When the signals from an antenna are strong enough and the number of sets to be operated is not too great (2, 3 or 4), couplers are generally employed which maintains the correct impedance match to all TV sets connected to it, and also provides some isolation between TV sets.

The FS134 is very useful with these systems because signal levels can be checked across the band at each set of output terminals from the coupler and also at each TV set to determine if the signals are being distributed properly.

When a large number of sets are to be operated from a single antenna and the distance between the sets is quite great, the signals received by the antenna will have to be amplified, and then distributed to each TV via a network of cables, pads and matching transformers. It is important that each TV outlet is properly matched and also that the signal strength is of the proper level. Those outlets closest to the amplifier must have internal attenuation to prevent the signal from being too strong, whereas the outlets on the end of the line have very little attenuation, because the signal has already been attenuated by cable losses, feed thru pads, etc.

The FS134 can be used in the installation of a new system or in checking out an existing system. The main purpose of a system is to provide good signal levels at all outlets. With the FS134 each outlet can be checked across the band for proper levels making it easy to pinpoint trouble spots.

The FS134 can also be used to check out the amplifier for overload conditions. By using a scope in the DET OUT jack it is easy to see if one or more channels are overloading the amplifier. It can also be checked without a scope, by measuring signal levels from the antenna and checking them against the amplifier input specifications. An overloaded amplifier is easily recognized by cross modulation or "windshield wiper" effect in some channels or by excessive sync buzz and unstable sync in the receiver. The channel (s) with cross modulation are the victims and not the culprit of an overloaded amplifier - the culprit is the channel that does not display cross modulation effects, but may appear rather strong. It overdrives the amplifier and "spills" over into the other channels. The amplifier gain must be reduced or the antenna reoriented to reduce the strong signal. Of course, the FS134 would be used to determine the best gain setting and antenna orientation.

MAKING BOOSTER COMPARISON CHECKS

TV signal boosters can be checked and their gain and bandwidth compared to establish the better unit for the area. By using the same antenna or signal source, different boosters can be evaluated and compared. Signal overload can be detected as well as poor gain on a channel by using the built-in speaker or by use of the detector output jack and a scope.

CHECKING RANDOM NOISE LEVELS AND INTERFERENCE

The FS134 can be used to check out noise levels and interference by using a simple dipole antenna connected to the unit. By tuning the FS134 across its range, and rotating the dipole antenna, you can approximate the direction and the frequency of the interference or noise. By taking readings at two points, the source of the interference can be plotted by trigonometry.

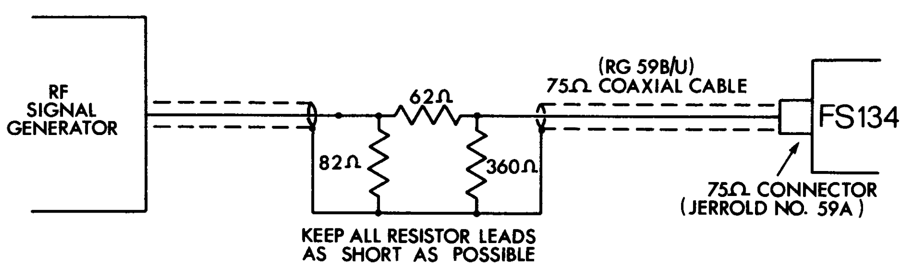
CALIBRATION OF SIGNAL GENERATORS

The output of signal generators can be calibrated in microvolts by applying the signal to the FS134 and using the microvolt scale on the unit. The frequency can be checked and compared to the dial of the FS134 and the signal generator recalibrated if it is too far off. It is important that the output impedance of the generator is matched to the FS134 input or the microvolt check will not be accurate. Loss factor introduced in matching must be considered when making microvolt checks. CAUTION: Do not overload FS134 with excess signal generator output.

INTERNAL ADJUSTMENTS

Alignment of the FS134 will not usually be required unless an electrical component in the IF section or tuner assembly was changed. If frequency indications are far off at all points on the frequency dial, alignment is necessary. Also if the sensitivity measured is greatly different at both ends of the frequency dial, alignment may be necessary.

Most signal generators have an output impedance of 52 ohms. In order to match the 52 ohms generator output to the FS134 75 ohms input, a matching pad is required. The pad is merely 3 resistors connected as shown in sketch below.

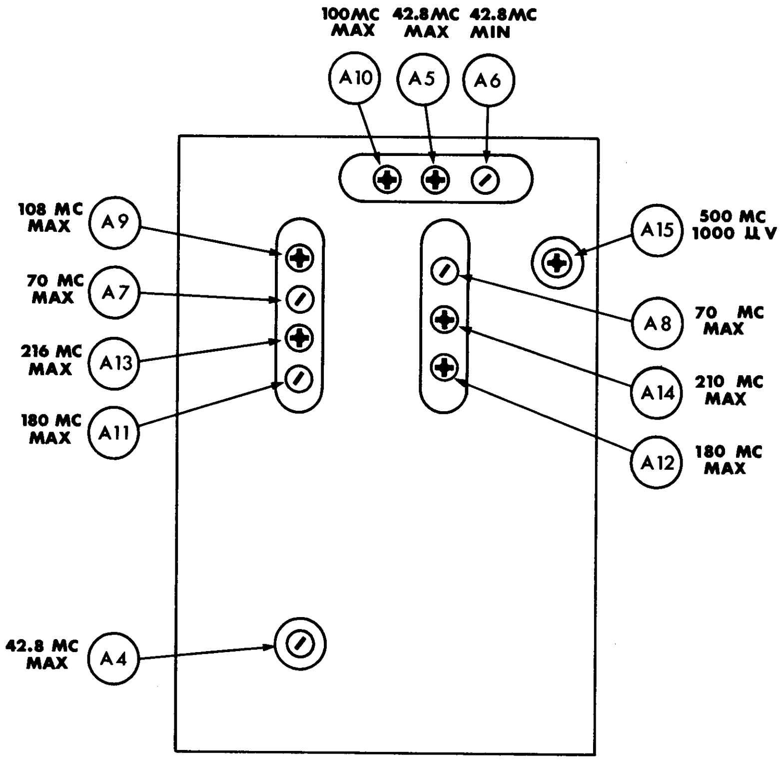


Alignment accuracy will depend on accuracy of signal generator. Always keep signal level from generator below 40 microvolts.

INTERMEDIATE FREQUENCY ALIGNMENT

1. Connect signal generator output to input jack (X1) on FS134.

2. Set FS134 Bandswitch to "CHAN 2-6-FM", and turn A6 (see drawing below) out three turns.



3. Set Signal Generator to 42. 8 MC and set signal generator output so that meter on FS134 reads less than 40 microvolts.

4. Adjust A1 (IF transformer closest to speaker) and then A2, A3 and finally A4 on tuner. Repeat adjustments to obtain a peak and reduce generator output each time.

5. Adjust A6 to get a minimum indication on meter while increasing generator output to the point where indication will fall below 40 microvolts.

6. Set Bandswitch to UHF and adjust A5 for maximum.

RF ALIGNMENT, CHANNEL 2 THROUGH 6 AND FM BAND

1. Set FS134 Bandswitch to "CHAN 2-6-FM".

2. Rotate tuning control so that cross hair passes through 70 MC on frequency indicating dial and set signal generator to exactly 70 MC.

3. Adjust A7 and A8 for maximum meter indication. Repeat adjustments A7 and A8.

4. Set signal generator and FS134 to 108 MC and adjust A9 for maximum indication.

5. Set signal generator to 100 MC and rotate tuning control on FS134 for maximum meter indication.

6. Adjust A10 while rocking signal generator frequency control back and forth for the highest maximum (below 40 microvolts) on FS134 meter.

7. Repeat steps 2 and 3 and then steps 5 and 6.

RF ALIGNMENT, CHANNELS 7 THROUGH 13

1. Set FS134 Bandswitch to "CHAN 7-13".

2. Rotate tuning control so that cross-hair passes through 180 MC on frequency indicating dial and set signal generator to exactly 180 MC.

3. Adjust A11 and A12 for maximum. Repeat adjustments A11 and A12.

4. Set signal generator and FS134 to 216 MC and adjust A13 for maximum.

5. Set signal generator to 210 MC and rotate tuning control on FS134 for maximum meter indication.

6. Adjust A14 while rocking signal generator frequency control back and forth for the highest maximum (below 40 microvolts) on FS134 meter.

7. Repeat steps 2 and 3 and then 5 and 6.

FS134 VHF CALIBRATION PROCEDURE, CHANNEL 7-13

Calibration accuracy will be only as good as that of signal generator used.

1. Set Bandswitch to "CHAN 7-13" and set tuning control for 195 MC.

2. Set slide switch on FS134 to "CAL" and carefully adjust "CAL" control to CAL line. Then set switch to "ON".

3. Set signal generator to 195 MC and set generator output control to just get an indication on FS134 meter.

4. Rock signal generator frequency control to obtain a peak meter indication on FS134 and then reduce generator output to keep meter reading near 30 microvolts.

5. Set signal generator output control to exactly 30 microvolts and while rocking frequency control on generator slightly, adjust 30 microvolt adjust on FS134 until meter indication just comes up to 30.

6. Set generator output control to 1000 microvolts and while rocking frequency control on generator slightly, adjust "1000 microvolt adjust" on FS134 until meter reads 1000 microvolts at the peak.

7. Repeat steps 5 and 6.

FS134 VHF CALIBRATION PROCEDURE, CHANNEL 2-6-FM
(latest production models only)

1. Set Band switch to CHAN 2-6-FM and set tuning for 70 MC.

2. Set slide switch on FS134 to "CAL" and carefully adjust "CAL" control to CAL line. Then push switch to "ON".

3. Set signal generator to 70 MC and set generator output control to exactly 30 microvolts.

4. While rocking frequency control on generator slightly, adjust control in tuner until meter indication comes up to 30.

UHF CALIBRATION PROCEDURE

1. Set FS134 Band switch to "UHF".

2. Rotate tuning control so that cross-hair passes through 500 MC on bottom section of frequency indicating dial and set signal generator in the vicinity of 500 MC where FS134 meter will indicate.

3. Set signal generator output to 1000 microvolts and while rocking signal generator frequency control back and forth for highest maximum meter reading on the FS134 adjust A15 so that FS134 meter reads 1000 microvolts.

ADJUSTING THE FREQUENCY DIAL

The frequency dial is adjusted by loosening the two screws under the center trim cap, positioning the dial and retightening the screws. The trim cap is removed by unscrewing it CCW from the condenser shaft.

The frequency dial will normally be adjusted so that the ends of the bands will fall under the frequency indicator line when the tuning is set to each extreme. However, if there is a channel in your area, on which you would like to have a very accurate frequency indication, merely tune this channel on the FS134 and adjust the dial until the mark for this channel falls under the indicating line.

DISASSEMBLY INSTRUCTIONS

Removing the FS134 from the case.

1. Remove the two 6-32 phillips screws at the top of the panel.

2. Place the unit face down on a cloth and remove the two 8-32 RH screws on the bottom of the case.

3. Lift the case off the unit.

Removing the Attenuator Shield.

The attenuator shield must be removed before aligning the IF transformers.

1. Remove the screw on the side of the panel.

2. Remove the nut and washer that holds the shield and speaker grill to the panel.

3. Lift the shield off the panel.

Replacing the Batteries.

When the CAL control adjustment can no longer be made, the batteries have become too weak and they must be replaced.

1. Remove the single 8-32 RH screw that holds the two battery brackets at the outside edge of the chassis.

2. The battery brackets will now slide to the side disengaging from the chassis clamp that holds the inside end of the brackets.

3. Separate the two battery brackets and fold open to completely expose the batteries. Save the three pieces of insulating paper for reuse with the new batteries.
The 12 volt supply consists of the six batteries mounted on the bottom bracket and the two batteries in series on the upper bracket. The single battery on the upper bracket is the minus 1.5 volt supply. Generally the 1.5 volt supply battery will not require replacement as frequently as the others, because of the lower current drain.

4. Remove the old batteries from the brackets and replace with new "C" cells, being sure to observe the correct polarity during the replacement. The brackets are marked with plus (+) signs to indicate the direction the positive end of the battery (small button) should be placed. CAUTION: If battery polarity is not correct, the circuit may be damaged.

5. Reassemble the battery brackets, placing the large piece of insulating paper between the batteries, and also being careful not to pinch any wires with the battery clips. Install the battery brackets on the main chassis. Be sure that both brackets are under the chassis clamp before inserting the screw. Insert a piece of insulating paper at each side of the brackets between the battery clips and the inside of the upper bracket to prevent the terminals from shorting.

6. Test the battery replacement by sliding the OFF-ON switch to CAL and seeing if the unit can be calibrated properly. When the batteries are new and the CAL control is turned all the way up the meter will read almost to full scale.

The two piece battery bracket serves two very useful purposes. If by accident, the batteries are left too long in the set or leak, only the bracket will become damaged. This is much easier to replace and is less expensive than the main chassis. The second purpose is the optional charger for rechargeable batteries. The charger comes mounted on a similar bracket and is put in, in place of the regular battery bracket.

Removing the Tuner Assembly

The tuner assembly must be removed if the dial cord has to be replaced or for trouble shooting.

1. Remove the tuner cover by taking out the six RH sheet metal screws.

2. Remove the single RH sheet metal screw located above the IF transformer (A4).

3. Disconnect the five small wires that come through the IF chassis and connect to the tuner PC board. The red wire is +10 volts, the bare wire and the black wire are ground, the green wire is signal out, and the orange wire is AGC.

4. Disconnect the long red wire attached to the feed thru capacitor at the top of the tuner chassis.

5. Place the unit face up and unscrew the trim cap in the center of the frequency dial.

6. Remove the plastic indicator by removing the four screws in the corners.

7. Remove the dial held by two screws and washers near the center.

8. Remove the band switch lever knob held with one screw and washer, and remove the tuning knob by lifting straight up.

9. Remove the four flat head screws that were exposed when the frequency dial was removed, and the tuner assembly will now be free from the rest of the unit, except for the input cable from the attenuator. This can be left on for restringing the dial. but may be disconnected at the attenuator end for further disassembly and/or trouble shooting.

10. Grasp the tuner and pull straight back away from the panel until the tuning shaft is free of the clearance hole in the panel, then lift straight up and the tuner will separate from the unit.

Disassembling the Tuner PC Board from the Tuner Chassis

1. Remove the 75 ohm antenna cable and the IF output cable from the UHF tuner. The UHF tuner is the silver colored can mounted on the battery side of the tuner chassis. Pull the two cables through the holes in the tuner chassis.

2. Disconnect the red and orange wires that connect from the band switch to the feed thru capacitors in the tuner chassis.

3. Turn the tuning condenser shaft fully CCW to prevent damage to the condenser.

4. Remove the nut and washer holding the band switch and the three 6-32 screws holding the tuning condenser. The PC board assembly can now be removed from the chassis.

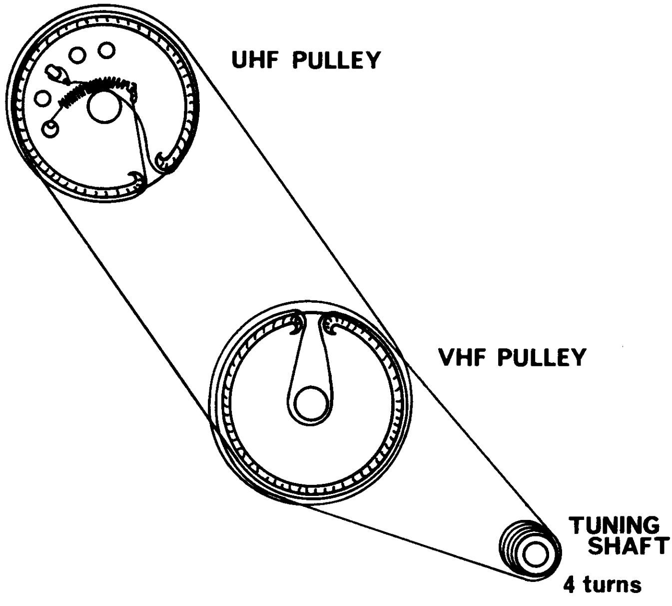
Stringing the Dial Cord

Stringing the dial cord is not difficult if the procedure below is followed.

1. Prepare a .025D non-stretchable dial cord by looping each end and tying a knot. The distance between the two loops should be 31 5/8 inches. Hint: When tying the second loop make the distance to the loop (before tying knot) 32 1/8 inches. The extra half-inch will be taken up with the knot. Make the knots as close to the ends of the cord as possible and still leave a small loop.

2. String the cord by following the diagram below. Turn both pulleys (UHF and VHF) fully CCW. Start the string on the UHF pulley, hooking it on the tab and then bring it to the outside. Go around the pulley 3/4 turn CCW and then over to the VHF pulley. Go around the VHF pulley 2/3 turn CCW, then bring the cord inside go around the hub once, then back to the outside of the pulley and continue CCW over to the tuning shaft. Wrap the cord around the tuning shaft CCW for Four complete turns. Watch that the turns lay side by side and do not overlap. Bring the cord back to the VHF pulley and make one complete turn around it CCW and then bring it to the UHF pulley making a 3/4 CCW turn around it. The cord should now be all used up with the loop and knot just inside of the pulley. It is important that the knot does not end up on the outside of the pulley, because tuning may be "jerky" at mid range.

Hook the spring to the loop in the end of the cord and then to one of the holes in the pulley making sure that there is sufficient spring tension to prevent the cord from slipping on the tuning shaft, while tuning.



3. "Tune" the condensers from one end to the other with the tuning shaft, while observing the "stop" on the UHF tuner shaft. If the "stop" does not completely make contact at each end of the range, turn the condensers to mid range and while holding the UHF pulley rotate the VHF pulley a small amount and recheck. When the stop on the UHF tuner shaft makes contact at each end, put a drop of cement on the string where it passes around the hub of the VHF pulley. This will secure the alignment of the two pulleys.

CIRCUIT DESCRIPTION

The Sencore FS134 Field Strength Meter is completely solid state with printed circuit board construction, operating from nine internal 1.5 volt "C" cell batteries. It will receive frequencies in three bands; 53-109MC (VHF low band and FM), 173-218 MC (VHF high band) and 470-890 MC (UHF band). It reads the strength of signals fed to the input on a panel meter in terms of microvolts or in decibels, with a maximum sensitivity of 30 microvolts for each band.

Signals fed to the attenuator (see schematic), via 75 ohm coaxial cable, will be fed directly into the tuner on the X1 jack or will be attenuated to one tenth or one one hundredth if connected to the X10 or X100 jacks. Signals fed to the FS134 via a 300 ohm twin line are connected to the 300 ohm input on the matching transformer and the output of the matching transformer coupled to one of the 75 ohm jacks via a short jumper cable.

As the signals enter the VHF tuner they couple through pass filters for the VHF bands or are coupled to the UHF tuner for UHF operation. The low band VHF filter is a low pass filter consisting of C17, C18, L7, C21 and C22. It will pass all frequencies up to 110 MC; frequencies above 110 MC are attenuated. Signals at 42.8 MC (the FS134 IF frequency), are attenuated with an IF trap consisting of C15 and L5. The amount of low band signal reaching the RF amplifier is controlled with R8. (Early production units have a fixed resistor divider in place of R8.)

The high band VHF filter is a high pass filter consisting of C17, L6, C19, L8 and C22. It will pass all frequencies above 173 MC and attenuate all frequencies below 173 MC. Two additional coils are used in both high and low band filters. These coils have no reference number because they are part of the printed circuit. They are across C17 and C22.

The output of the filter is coupled through C14 to the base of the RF amplifier (TR1) for low VHF band operation and through R7 and C14 to the base of the RF amplifier for high VHF band operation. For UHF operation, the UHF signals have been converted in the UHF tuner, to signals at the 42.8 MC IF frequency. These signals appear across L4, are coupled through C13, which serves as a UHF sensitivity adjustment, and then through C14 to the base of TR1. For UHF operation TR1 (RF Amplifier) and TR2 (Mixer) serve as 1st and 2nd IF amplifiers respectively, making a total of five IF amplifiers for the UHF band.

For VHF operation TR1 serves as an RF amplifier with a tuned collector circuit. It operates at fixed gain. The tuned circuit for the low VHF band consists of L2 (RF coil), C3 (trimmer) and C7A (tuning condenser). The tuned circuit for the high VHF band consists of L1 (RF coil), C2 (trimmer), C4 and C5 (padder) and C7A (tuning condenser). For UHF operation the tuned IF tank of L3 and C6, serve as the collector load.

Signals from TR1 couple through a 3.3 PF capacitor, C9, to the base of TR2. For both VHF bands, TR2 serves as a mixer, mixing RF signals from TR1, with local oscillator signals from TR3, which are coupled through R9 and C11. IF signals are developed across T1 in the collector circuit of TR2. The gain of the mixer is controlled with AGC voltage.

The local oscillator, TR3, oscillates through a range of 95.8 MC to 151.8 MC for the low VHF band, and through a range of 130.2 MC to 175.2 MC for the high VHF band. The oscillator is temperature compensated with a 2.2PF N1500 capacitor (C20) from the collector to ground. Supply voltage to the oscillator is interrupted for UHF operation, to prevent spurious operation, and likewise supply voltage to the UHF tuner is interrupted for VHF operation.

Signals from the tuner are fed to the IF amplifier, consisting of three stages TR5, TR6 and TR7. These stages are all quite similar, except the gain of the first two stages, TR5 and TR6, is controlled with AGC voltage whereas the last stage, TR7, operates from fixed 10 volts. The 1st stage is neutralized with a 4PF capacitor, C35, and the 2nd and 3rd stages are neutralized with 3.3PF capacitors, C37 and C39 respectively.

The output of the IF amplifier is coupled to the detector through C41. The detector consisting of two IN24 diodes CR2 and CR3 is a doubler that will develop the demodulated signal across C42 with a positive DC voltage reference that is equivalent to approximately two times the average RF level. R35, 1.8 meg resistor to +10 volts is used to balance out threshold voltage so that CR2 and CR3 will conduct on weak signals.

The detected signal is fed to the DET OUT jack, through a 47K resistor to prevent loading, and is also fed to the 1st audio stage, TR8. The first audio stage amplifies the audio signal, which is then controlled with the volume control R20, and coupled through C46 and R40 to the base of the audio amplifier, TR9. The 47 ohm resistor R21, prevents the volume from being tuned all the way down, which serves as an "ON" indicator for the FS134. The audio signal is amplified in TR9 and is further amplified in the push-pull audio driver (TR10 and TR11) and the audio output stages (TR12 and TR13). The output impedance of TR12 and TR13 was designed for 45 ohms, permitting a 45 ohm speaker to be driven directly without an output transformer.

The detected signal at the base of the 1st audio amplifier, TR8, has a positive DC level proportional to RF carrier level. This DC level appearing in the emitter of TR8 is divided down in the resistor network of R50 and R52, from where it is fed to the AGC amplifier, TR14. The AGC amplifier is a DC amplifier that amplifies the DC voltage present on the base. Any AC signal on the base of TR14 receives full negative feedback from the collector through C51 and C52 eliminating all traces of AC signal in the collector. The DC level at the collector of TR14, which is proportional to RF carrier level, is DC coupled to the AGC output, TR15, an emitter follower. TR15 supplies AGC voltage to the mixer and the 1st and 2nd IF stages and also feeds the meter circuit. As RF carrier level increases the AGC voltage becomes less positive, thus reducing the overall gain of the system.

When the OFF-ON switch is ON the negative terminal of the meter is connected to the AGC voltage through internal control, R57 (1000 microvolt adjust). The positive terminal of the meter is connected to the meter balance stage, TR16, which sets the point that the meter will start to indicate. R62, the 30 microvolt adjust, an internal control, is set so that with a 30 microvolt signal fed into the FS134, the meter will read at the left edge of the scale (30 microvolt mark). With a 1000 microvolt signal fed into the FS134, R57 is adjusted so that the meter will read at the 1000 microvolt mark. These adjustments are made at 195 MC at the factory, however, for extreme accuracy at any particular frequency, they could be made at that frequency.

In the CAL position of the OFF-ON switch the meter is connected to measure the voltage on the +10 volt line, so that when R23, the CAL control is set for the "CAL" indication on the meter there will be approximately 10 volts supplied to the tuner, IF and AGC circuits. This adjustment is provided to take into account changes in battery voltage, as the batteries become weak.

FS134 TROUBLE CHART

SYMPTOM	PROBABLE CAUSE	CORRECTIVE MEASURE
Weak Sound	Batteries weak, bad electrolytic C46, C47, C49 or C50.	Replace batteries, check for leakage or loss of capacity and replace if defective.

Meter can be calibrated, but no other indications.	Broken cable at switch in tuner, poor switch contact.	Remove tuner cover and locate broken cable or poor switch contact.
UHF inoperative	Broken wire to side of UHF tuner, poor switch contact.	Reconnect broken wire if loose, locate and repair bad contact on tuner switch.
Chan 2-6 FM inoperative	Poor switch contact, possibly on rear wafer of switch.	Locate and repair.
Chan 7-13 inoperative	Poor switch contact, possibly on rear wafer of switch.	Locate and repair.
No sound or meter indications	Open connection, loose battery, open CAL control.	Locate open connection, possibly in battery compartment, tighten loose battery. Check CAL control and replace if defective.
Unit will not CAL	Weak batteries.	Replace batteries.
Unit seems insensitive	Poor switch contact in tuner.	Locate poor contact by pressing each contact with an insulated tool, while unit is receiving a signal.
Meter calibration falls off rapidly after calibrating.	Weak batteries, internal short.	Replace batteries, if short exists locate short before replacing batteries.
Frequency dial appears to stick when tuning.	Insufficient spring tension in dial stringing system.	Remove tuner and increase spring tension on dial string system.
Cannot pick up signals at low end of both VHF bands.	Tuning condenser plates touching when plates start to mesh.	Closely examine and gently move plates with a non-metalic alignment tool while tuned to point where signal pickup disappears.
Motor boating or erratic operation.	Corroded or poor battery contacts.	Clean battery contact, and see that proper pressure exists between contact and battery terminal.
Distorted or scratching sound from speaker.	FS134 incorrectly tuned defective or warped speaker cone.	Retune FS134 for better quality sound. Replace speaker if defective.

WARRANTY AND SERVICE INSTRUCTIONS

You have just purchased one of the finest pieces of test equipment on the market. Although the FS134 is completely solid state and there are no tubes to replace there is always the possibility of something going wrong. The FS134 is covered by a standard 90 day warranty as explained on the warranty policy enclosed with your instrument.

For best service out of warranty work, the FS134 should be returned to the factory service department. Be sure to state the nature of the trouble to insure faster service. To save money on shipping costs and also to prevent further damage to the FS134, REMOVE THE BATTERIES, before shipping the unit. If you wish to repair your own FS134, we have included a schematic and parts list and a chart for location of the troubles you may encounter. Special replacement parts are available and may be ordered direct from the factory service department.

We reserve the right to examine defective components before an in-warranty replacement part is issued.

ACCESSORIES

RECHARGEABLE BATTERY SYSTEM FOR THE FS134

You may purchase as an accessory, a rechargeable battery system that will fit in the FS134 in the present battery bracket. This system will enable you to use a rechargeable battery such as Burgess # CD28, to eliminate battery replacement. Simply hook up the AC leads from the system as described in the instructions with the rechargeable system. The battery is not furnished by Sencore, only the recharger. The recharger is over-charge proof, and can be left on over night or all day without damaging the battery. To order the rechargeable system, simply write the factory service department, enclosing a check or money order for $9.95 The part number is 39G15.

SENCORE, INC.
3200 SENCORE DRIVE, SIOUX FALLS, S. DAKOTA 57107

FORM NO. 268

SENCORE

SCHEMATIC AND PARTS LIST

for

FS134 FIELD STRENGTH METER

3200 Sencore Drive
Sioux Falls, South Dakota 57107
Phone (605) 339-0100

FS134 PARTS LIST

REFERENCE	DESCRIPTION	PART NO.	PRICE
C2,C3,C4,C6			
C25,C26	Capacitor, trimmer, 1.5-10pf	24G99	.25
C7	Capacitor, two gang tuning	24B137-2	6.50
CR2, CR3	Diode, 1N695	19G28A	.50
L1	Coil, RF tuning, VHR high band	46A22	1.50
L2	Coil, RF tuning, VHF low band	46A23	1.00
L5	Coil,1uh	46A19	.25
L3	Coil, 3uh	46G33	.25
L6, L8	Coil, .043uh, VHF high band filter	46A27	.50
L7	Coil, .21uh, VHF low band filter	46A41	.50
L9, L10	Coil, Osc. tuning, VHF bands	46A24	1.25
M1	Meter, 0-500 microamp	23B18	20.00
R20	Potentiometer, 5K, 10%	15A51	1.00
R23	Potentiometer, 1K, 30%	15G50	1.00
R57, R62	Potentiometer, 10K, 30%, PCmtg.	15A53	.75
R73	Control-100K, PC mtg.	15C7-13	.50
S1	Switch, 9P3P bandswitch	25B81	8.00
S2	Switch, 4P3P on-off	25G82	1.50
T1,T2,T3,T4,	Transformer 1F44MC	28C28	2.00
T5	Transformer, balun 75-300 ohm	28A29-1	.75
TR2	Transistor, 2N3284	19G24	3.75
TR3	Transistor, 2N3285	19G25	3.00
TR5, TR6,TR7	Transistor, 2N3286	19G22	2.25
TR4,TR8,TR9,			
TR14,TR15,TR16	Transistor, 2N5172	19G29	.50
TR10,TR12	Transistor, 2N1304	19G5	1.25
TR11,TR13,	Transistor, 2N404	19G4	1.25
	Frequency Dial	33B137	1.25
	Frequency Indicator	33A138	.50
	Battery Clip	33G143	.25
	75 ohm coax plug	35G11	.50
	75 ohm Coax jack	36G15	1.00
	UHF Turner Assembly	60B1-2	25.50
	Speaker	48A1	4.00
	Knob, bandswitch	21G4	.25
	Knob, cal, volume, tuning	21G16	.25
	Case	10C212	10.00
	Cover	10C193	5.00
	Panel	10C141C	10.00
	Battery Mounting plate	10A145	.75
	Battery Mounting bracket	10A146A	1.00
	Frequency dial trim cap/screw	30A35/33A151	.75
	Jumper cable assembly	13G26/35G11	2.75

(PRICES SUBJECT TO CHANGE WITHOUT NOTICE)
$2.00 minimum billing

NOTE: The following alignment procedure replaces that found on pages 15, 16, and 17 of the FS134 manual #268. Disregard the UHF calibration procedure on page 17.

ALIGNMENT OF THE FS134 IF AND RF CIRCUITS

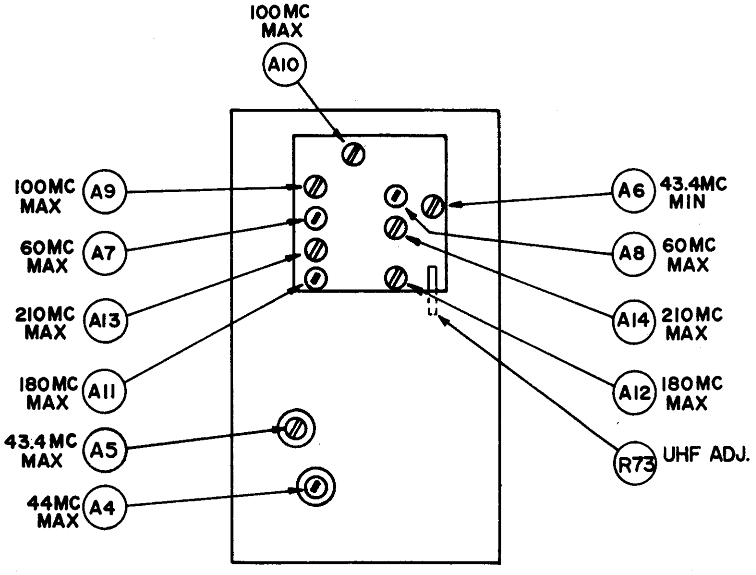
The IF circuits must be in alignment before the RF circuits are aligned or the unit is calibrated.

1. Unplug the lead from the VHF tuner to the UHF tuner and inject the output of the signal generator into the VHF tuner through this cable. Set the BANDSWITCH to the UHF position.

2. Set the signal generator to 43.4 MHz and the output so that the FS134 meter reads less than 40 microvolts.

3. Adjust A1, A2, A3, A4, and A5 for maximum reading on the FS134 meter. Repeat each adjustment to obtain a peak and reduce the signal generator output each time to keep the FS134 meter reading below 40 microvolts.

4. Plug the lead back into the UHF tuner and inject the signal into the X1 jack on the front panel. Set the BANDSWITCH to the CHAN 2-6 FM position. Adjust A6 for a minimum reading at 43.4 MHz while increasing the generator output to keep the FS134 meter reading around 40 microvolts.



RF ALIGNMENT, CHANNEL 2 THROUGH 6 and FM BAND

1. Set the FS134 BANDSWITCH to CHAN 2-6-FM position, and set the TUNING control until the crosshair passes through 60 MHz on the frequency indicating dial.

2. Inject a 60 MHz signal from the generator into the X1 jack. Adjust A7 and A8 for maximum meter indication.

3. Set signal generator to 100 MHz and adjust A9 for maximum meter indication. Adjust A10 while rocking signal generator frequency control back and forth for the highest maximum (below 40 microvolts) on the FS134 meter.

4. Repeat steps 2 and 3.

RF ALIGNMENT, CHANNELS 7 THROUGH 13

1. Set FS134 BANDSWITCH to CHAN 7-13 and rotate the TUNING control until the crosshair passes through 180 MHz on the frequency indicating dial.

2. Set the signal generator to 180 MHz and adjust A11 and A12 for maximum indication on the FS134 meter. Repeat both adjustments for best peak.

3. Set the signal generator to 210 MHz and adjust A13 for maximum meter indication. Adjust A14 while rocking the signal generator frequency control back and forth for the highest maximum, keeping the generator output below 40 microvolts on the FS134 meter.

4. Repeat steps 2 and 3.

30 and 1000 MICROVOLT CALIBRATION PROCEDURE

The accuracy of the calibration of the FS134 will only be as good as that of the signal generator used.

1. Set the BANDSWITCH to CHAN 7-13 and the TUNING control to 195 MHz.

2. Set the slide switch on the FS134 to CAL and carefully adjust the CAL control until the meter reads on the CAL line of the meter. Then set the switch to the ON position.

3. Set the signal generator to 195 MHz and adjust the output until you just get an indication on the meter just above 30 microvolts.

4. Rock the signal generator frequency control back and forth to obtain a peak indication on the FS134 meter and then reduce the generator output to 30 microvolts and adjust the 30 microvolt adjust on the IF board in the FS134 until the meter reads 30 microvolts.

5. Set the generator output to 1000 microvolts and while rocking the frequency control on the generator slightly, adjust the 1000 microvolt adjust until the FS134 meter reads 1000 microvolts at the peak.

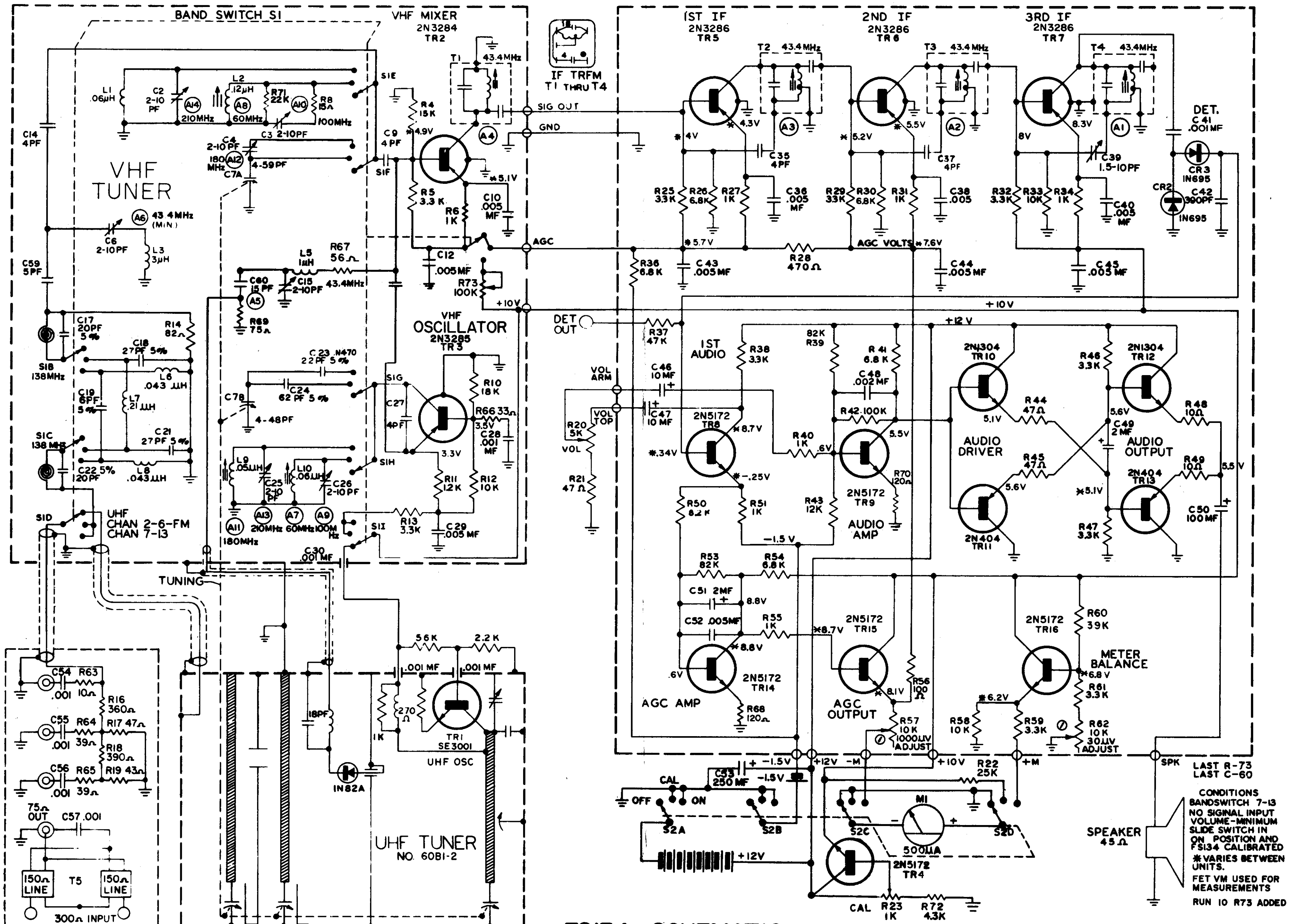
6. Repeat steps 4 and 5.

UHF ADJ. PROCEDURE:

1. Set the BANDSWITCH to UHF, the TUNING control to 550MHz, adjust the CAL control, and note the meter reading for a zero db 1000uv signal.

2. Set the TUNING control to 800MHz, adjust the CAL control, and note the meter reading for a zero db 1000uv signal.

3. Adjust R73 the UHF ADJ. for the best compromise of accuracy at 550MHz and 800MHz.



FS134 SCHEMATIC

ISSUE DATE 11-22-72

SENCORE

INSTALLATION INSTRUCTIONS

FOR THE FS134

BATTERY CHARGER ACCESSORY NO. 39G15

Installation Instructions for the FS134 Battery Charger Accessory. No. 39G15

The 39G15 Battery Charger Accessory for the FS134 permits the FS134 to operate from a rechargeable battery, or it can be operated directly from the AC line. The battery used with this accessory is a nickle-cadmium battery, Burgess type CD28, Eveready type Y5383 or equivalent. The battery is not supplied with the accessory; it is available from most parts distributors.

The rechargeable battery replaces eight of the nine "C" cell batteries in the FS134, which comprise the + 12 volt supply. The minus 1.5 volt supply, consists of a single "C" cell, which is not rechargeable because the low current drain on this supply, only 2 MA, makes this unnecessary.

The FS134 equipped with a 39G15 battery charger accessory can be operated from the AC line without the rechargeable battery installed, however the voltage developed is higher than 12 volts and also there may be excessive 60 cycle hum at high volume levels. It is best to always have a battery installed.

The 39G15 battery charger has been designed so that the rechargeable battery cannot be damaged due to overcharging. As the battery comes up to charge the 1N816 stabistor diode reduces the current to the battery to a safe level.

Installing the 39G15 in the FS134

1. Remove the FS134 from the case by first removing the two phillips screws at the top of the panel. Place the unit face down on a cloth and remove the two round head screws on the rear of the case. Lift the case off the unit.

2. Remove the single screw holding the battery bracket assembly to the chassis. Slide the battery bracket assembly towards the side of the unit until the assembly disengages from the chassis hold down clamp. The battery bracket and battery plate assembly may now be folded open exposing the batteries. Save the three pieces of fish paper for use when the unit is reassembled.

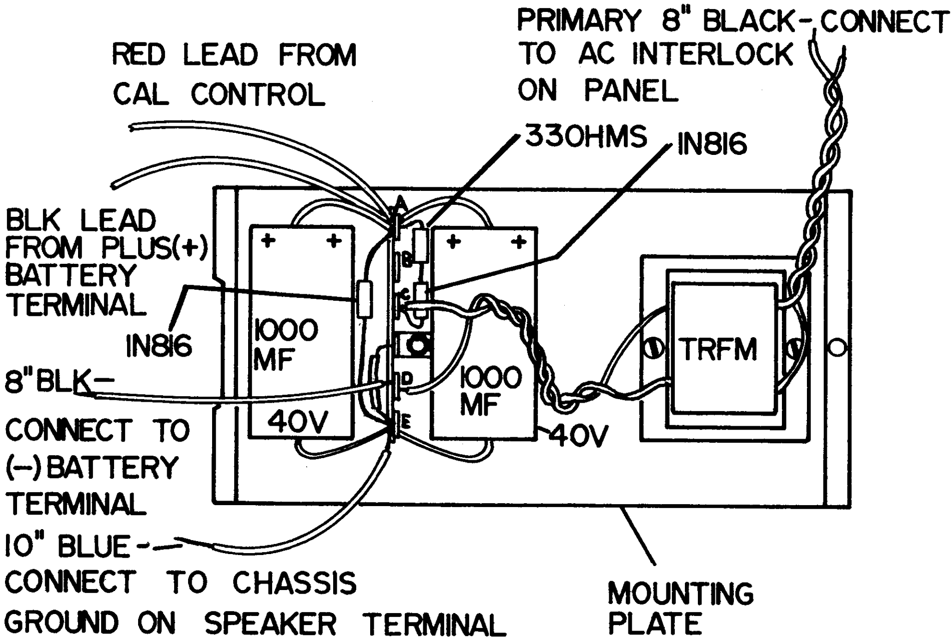
3. Remove the six "C" cell batteries from the battery plate and remove the two "C" cells that are in series on the battery bracket; the battery bracket is the U shaped bracket. Do not remove the single "C" cell on the battery bracket, because this will still be used for the minus 1.5 volt supply.

4. The two battery clips on the battery bracket will be used to mount the rechargeable battery. However, since the rechargeable battery is a little shorter than two "C" cells in series, it is necessary to extend the contacts on the clips.

   Two 2-56 x 3/8 screws, spacers and nuts are supplied with the 39G15 kit. Place a spacer over the screw and place this through the center hole in one of the contacts from the inside. Secure this with a nut from the other side of the contact. Do the same with the other contact. The rechargeable battery will now make proper contact.

5. Disconnect the black and red wires that go to the battery clips on opposite corners of that battery plate. One wire comes from the + clip on the battery bracket, the other comes from the center terminal of the CAL control. The battery plate can be discarded.

6. Place the 39G15 battery charger plate in the vicinity of the unit and connect the two red leads disconnected in step 5 above, to terminal "A" on the 39G15 battery charger (see wiring diagram). Solder this connection.



7. Pass the long blue wire from terminal E of the charger through the hole in the chassis and connect to the speaker terminal with the yellow and black wire. Solder the blue wire to this terminal.

8. Remove the spaghetti from the terminal on the negative battery clip on the battery bracket, but leave the black wire from the OFF-ON switch connected. Connect and solder the black lead from terminal "D" on the 39G15 charger to the negative battery terminal. Be sure that the terminal does not short to the battery clip frame. Wrap a piece of electrical tape around the terminal to prevent shorting.

9. Pass the twisted pair of black wires from the transformer on the charger through the hole in the chassis and connect to the AC interlock on the panel. Solder both connections.

10. Install the rechargeable battery in the battery bracket being sure to observe polarity.

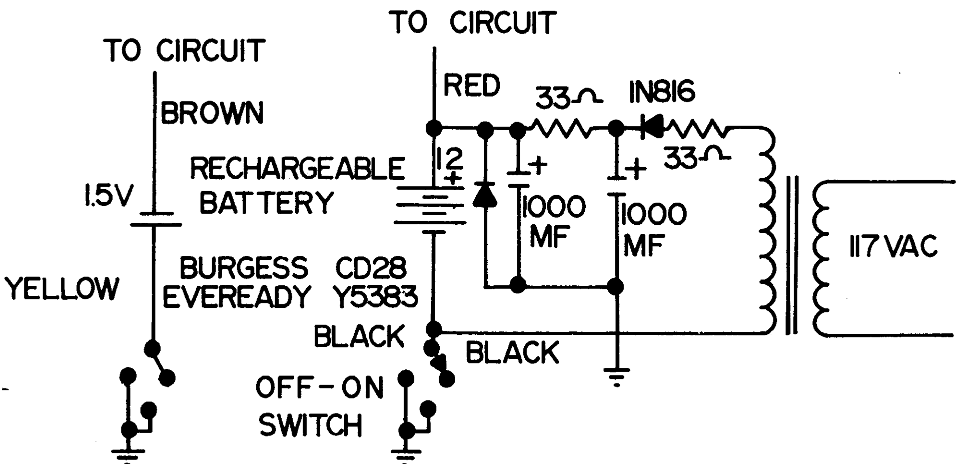
11. Fasten the battery bracket and charger plate to the chassis. Use the fish paper as before. The large piece goes between the charger plate and the battery bracket, and the two smaller pieces are used at each end of the bracket.

12. Install the unit in the case.

13. To recharge the battery, merely insert the cheater cord into the AC interlock on the FS134 sub panel and plug the other end into 117VAC line. The FS134 should not be turned on.

To operate the unit from the AC line merely turn the unit on and operate as you would from batteries.

To operate the FS134, as a portable instrument, remove the cheater cord. You can operate the FS134 for approximately 10 hours before the battery needs to be recharged.



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