

# Aligning the Tuner

Two methods are provided for aligning the tuner. One is the unique EZ-A-LINE method which eliminates the necessity of using test equipment, while insuring top quality results. The second method is the conventional process employing standard laboratory techniques and instrumentation. This is outlined in the enclosed Service Bulletin.

For the EZ-A-LINE method the following items are necessary: a special alignment tool, a small screwdriver, an FM dipole antenna, a standard audio cable, a CC .05 capacitor, and two alligator clips, all of which are provided. You must provide an amplifier and a speaker.

One end of the alignment tool is for adjusting the IF transformers and the other end is for the detector. See fig. 17. As part of the detector alignment procedure, a unique method has been devised which utilizes a small capacitor (CC .05) which will be found in one of the small hardware envelopes. For ease of use, connect each end of the CC .05 to an alligator clip. Make a good mechanical connection to the clips. You may solder if you wish.

1. Connect the dipole antenna wire supplied to the antenna terminals on the rear of the tuner. Connect one of the leads to the G terminal and the other to the 300 ohm terminal. See fig. 18. After the antenna has been screwed on tightly, spread the antenna wire out on the table or tape it on the wall. Make sure that no part of the antenna wire touches the chassis of the tuner.
2. Connect the shielded audio cable from the Left Channel audio output on the rear of the tuner to the tuner input of the amplifier. Connect a loudspeaker to the appropriate amplifier terminals and

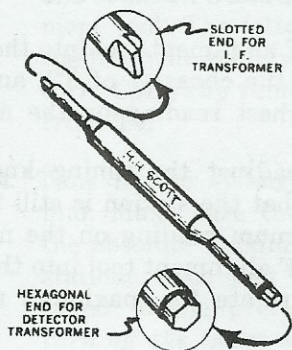


FIGURE 17

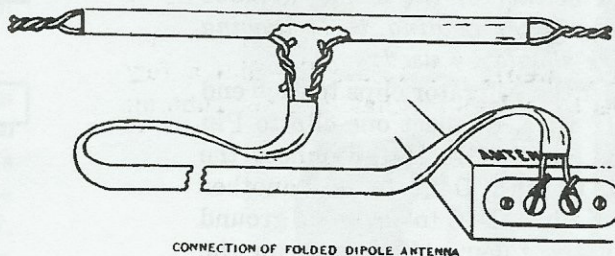


FIGURE 18

make sure that all the amplifier controls are set properly to reproduce the tuner signals. For the moment leave the amplifier turned off.

3. Make sure the tuner is turned off (the Selector knob, the second from the left, in the OFF position, fully counterclockwise). Set the Sonic Monitor switch to the LISTEN position. Set the Stereo Noise Filter switch to the OUT position. Set the AGC control to NORMAL position. On the rear apron of the tuner, set the right and left LEVEL controls to zero (maximum counterclockwise). Insert the tuner line cord into an AC wall outlet (do not use with DC).
4. Turn the tuner on its side as shown in fig. 19. Turn the selector switch to the mono position. This automatically turns the tuner on. Watch carefully for any signs of overheating or smoking, either under the chassis or on top. All the tubes and bulbs should light up normally and not show evidence of unnatural bright glowing. At the first sign of difficulty turn off the tuner immediately. Refer to the section on "In Case of Difficulty". The meter will probably swing down to a low reading (about "2" or lower) unless you happen to be tuned to a strong station. Rotate the tuning dial slowly from one end to the other. Each time a station is tuned in, the meter will move up to a higher number. The amount of meter deflection (e.g., meter swing) will depend on the strength of the station's signal, its distance from you, and how well the tuner is aligned. If there are no indications on the meter and you live some distance from any FM broadcasting stations, see section following on CONNECTIONS — Antenna, "Extreme Fringe Areas."

**Normal areas** — if you are in an average listening area, you will tune in some strong stations that make the meter move up over "4" and some weak stations that barely manage to wiggle the meter at all. Tune in one of the strong stations, setting the tuning dial so that the meter is at its highest position for that particular station.

**Extreme fringe areas** — if you live many miles from any transmitter, you may find that it is impossible to note even a wiggle on the meter. Try raising the antenna off the table and taping it to the wall. If that does not help, connect the tuner to the antenna wire coming from an outdoor television antenna. A final approach is to use the amplifier as a guide. Turn the input selector of the amplifier to the "tuner" input. Turn up the left channel level control on the rear of the tuner. Adjust the volume control of the amplifier so that the sound from the tuner itself can be heard. Turn the tuning knob of the tuner until a station is audible. It will undoubtedly be very distorted, faint, and noisy. Start the alignment procedure at this position. Once meter deflection occurs, readjust the tuning knob so that the meter is at its highest reading for the station. Ignore the sound quality from then on (in fact, you can turn down the volume); however, you may find that in making the following adjustments the presence of some volume will be helpful. You will find that when the volume is approximately at its highest point, you will be very close to maximum meter deflection. This method of locating the peak point in the can will eliminate the necessity of going from one end of the can to the other. **THE SOUND AT THIS POINT WILL BE DISTORTED. DO NOT MAKE REFERENCE TO THE SOUND QUALITY.**

*Should neither of the above methods give you a meter reading, the following procedure should be used:*

Connect the Alligator clips to each end of an 11" wire. Connect one clip to Pin 3, D3MA on the Z-FM-1. Connect the other clip to Pin 1, D4C. Connect another wire from Pin 4, D4C to any good ground point on the tuner. (You can run the end of the wire through one of the holes in the bottom flange of the set and twist

it around.) You should now be able to locate at least one station which gives a meter reading of between 0 and 2. Now start aligning your tuner. **AS SOON AS YOU HAVE ALIGNED THE TUNER ENOUGH TO SUSTAIN A METER READING WITHOUT THE USE OF THESE TWO WIRES — REMOVE THE WIRES.**

If this procedure gives you no meter reading, refer to the section on "In Case of Difficulty".

- 5. Carefully adjust the tuning knob so that the meter is at its highest position for the station tuned in.

NOTE: The passage overhead of an airplane will cause the meter indicator to swing up and down. Hold up the alignment until this stops. Set the tuner on its end with the black transformer side down, and the front panel facing you (see fig. 19).

- 6. Insert the IF alignment tool (see fig. 17) into the top (above the chassis) of T2 (skip T1 for the moment) until the end of the tool makes contact with the tuning slug inside. The slug may be over a half inch inside the transformer. Rotate the tuning slug slowly back and forth with the alignment tool while *carefully* watching the tuning meter for the highest reading. At this time the meter action may be small, so you have to *look carefully* to insure getting the highest point. You will have to rotate the slug both clockwise and counterclockwise to locate this maximum position. A scraping noise will be audible as the slug is turned. This is normal. *At the extreme clockwise and counter-clockwise position of the slug there is a stop beyond which you should not turn.* Do no force beyond this point as this will damage the transformer cans. It is possible for the maximum reading to occur at a stop.

- 7. Insert the IF alignment tool into the bottom (below the chassis) of T2, and rotate for highest reading on the meter.

- 8. *Carefully* readjust the tuning knob to make sure that the station is still tuned to the maximum reading on the meter. Insert the IF alignment tool into the top of T3 and rotate for maximum meter reading.

- 9. Insert the alignment tool into the bottom of T3 and rotate for highest reading on the meter.
- 10. At this point, retune to a different station, one that has a lower reading on the meter. If possible, find a station that is only "4" or lower. Sometimes a weak signal will cause the needle to wander up and down due to the inherent fading found with these signals. Try and pick a station that is quite stable.
- 11. *Carefully* adjust the tuning knob so that the meter is at its highest position for the station tuned in. Insert the IF alignment tool into the top of T1 (on the silver-plated front end) and rotate for maximum reading.
- 12. Repeat for the bottom of T1, top and bottom of T2, and top and bottom of T3. At all times make sure the tuning knob is tuned to maximum. Each time adjustments take meter above "4", change to a station having a lower reading. At this point only a *very slight* movement of the aligning tool will be necessary.

## Aligning the Detector

- 13. This part of the alignment requires *extreme care* to insure a clean, undistorted signal. Using the *detector* end of your alignment tool, insert into the bottom of T4. Rotate counterclockwise until you reach the stop at the end of the rotation.

### DO NOT FORCE THE STOP

Very carefully start rotating clockwise and count off 3 and  $\frac{1}{4}$  turns on the alignment tool. The lettering on the side of the tool will guide you in figuring a full turn. *Carefully* remove the aligning tool from T4.

- 14. Tune to the strongest station you can find. Make sure that you are tuned to the absolute maximum reading for this station. Once you are sure you have tuned to the precise maximum point, *turn off the tuner* and *do not touch the tuning dial* under any circumstances. If the amplifier volume has been up, turn it down. Take the CC .05 with the alli-

gator clips. Clip one to pin 1 of V1 and the other to pin 4 of V1. *Watch for short circuits.*

- 15. Check to see that the amplifier is turned on. Make sure it is set for tuner input. Turn up the bass control to its maximum position clockwise. Keep volume turned down. Turn up the level on the tuner all the way (on the rear of the tuner) — **DO NOT TOUCH TUNING KNOB.** Turn on the tuner.
- 16. Turn up the volume of the amplifier until a loud hum is clearly audible. Hum refers to a low frequency noise very deep in the bass region. Do not confuse with noises of higher frequency. Insert the alignment tool, detector end, into the top of T4. Turn clockwise or counterclockwise, until the hum begins to disappear. As the hum fades you may have to turn up the volume on the amplifier again. The desired point is the spot where the hum is at its absolute *lowest* point. At this point other noises will still be audible, but the hum will be virtually non-existent. *Carefully* remove the aligning tool.
- 17. Turn off the tuner. Remove the alligator clips. Turn the amplified bass control to normal. Turn on the tuner. Most stations should sound clear and undistorted. If none of them do (assuming no amplifier or speaker difficulties) repeat the entire alignment procedure. If there are no problems, the tuner is now ready for final assembly. No adjustments are required for the multiplex section and none should be made. However, it is recommended that you carefully read the section on Separation towards the back of this booklet.



FIGURE 19

# Final Assembly, Part 2

A3-1

Mount the bottom cover by sliding the two clips under the lip of the chassis towards the front of the tuner. Screw two H-SMS-6 x 1/4 HW sheet metal screws into the two inner holes on the bottom rear of the chassis.

A3-2

If the tuner is not going to be used in one of the regular H. H. Scott metal or wooden cases, you will want to install the plastic feet now. These will be found in one of the small envelopes, entitled ZP-1. Mount the four plastic feet with the four sheet metal screws provided.

If the tuner is to be custom mounted in a cabinet, instructions for doing this are on the mounting template provided.

## Congratulations!

Now . . . sign your personal label "This kit was built by —" . . . turn your tuner on . . . relax . . . and listen to one of the finest FM tuners ever made. For complete enjoyment of your tuner you will want to read the actual Operating Instructions which start on page 39.

## In Case of Difficulty

No matter how careful you are, a mistake is possible. Don't panic! First, make sure each tube is in the proper location. Then go back to the assembly notes and check off each step with the written instructions and the pictorials. Or if possible, have someone else do this for you. Often a fresh approach may disclose mistakes that you might be consistently overlooking. While checking for errors, carefully probe each and every wire, lead, component, and part to make sure there are no short circuits and poor solder joints.

In case the fuse has blown (the unit will not light up) it is very likely that there is a short circuit. Before replacing the fuse (instructions for this will be found in the service notes enclosed) search for the cause.

In case the unit lights up but does not operate properly, voltage readings are supplied on the schematic. If you can obtain a good vacuum tube voltmeter (VTVM) use the voltage readings for locating the portion of the circuit that is malfunctioning.

If none of the above suggestions help in curing the problem, you should write to our Laboratory Kit Service Dept. for prompt assistance. There is no charge for this help. The engineers in this department are thoroughly familiar with all aspects of the kit, and can probably localize the cause of your difficulty. However, you must be very explicit in describing your problem. Mention all the approaches you have undertaken to cure it. Describe all the symptoms and signs that may be involved. With complete information supplied, the possibilities of a cure through the mail are greatly increased.

## Service

When all else fails the facilities of the H. H. Scott Laboratory Kit Service Department and the vast network of Authorized Warranty Service Stations are available to you. A fixed inspection fee of \$2.50 will be made should your unit be submitted either to the factory or to a Warranty Station. If it is found, however, that it is necessary to go into the unit and touch up any solder joints, miswires, etc., then an additional \$7.50 charge will be made. This fee will be in addition to any parts that have to be replaced. If the unit is still within the 90 day warranty period (see description of the Warranty Policy below), then the charge for parts will be governed by this policy.

In case you receive sound from one channel but not from the other, you should check the interconnecting audio cables. Occasionally audio cables become intermittent or shorted. Reverse the cables, one for the other, and again listen to the system. If the dead channel switches to the other channel, then you should replace the cable in the dead channel.

Many H. H. Scott dealers have service facilities and are fully competent to repair this kit. These dealers are not governed by our price policy and can charge any fee they wish. This fee should be ascertained before service is begun.

Only the factory and certain of the warranty stations have the necessary equipment to service the multiplex section. Before any servicing is done to this section, check with the factory to locate the names of those warranty stations qualified. Service to the regular FM section can be performed by any of the warranty stations.

The service policies described above only apply to completely assembled instruments constructed

according to the instructions supplied. Any unit that is not complete, or has been modified in any way will not be accepted. Instruments showing the use of fluxes and acid core solder will also not be accepted.

## Warranty

To protect your investment, H. H. Scott, Inc. warrants that for a period of three months from the date of purchase, all parts shall be free of defects in materials and workmanship under normal use and service. H. H. Scott, Inc. will replace any defective parts upon the return of same to the factory, either by the customer, the dealer, or a warranty service station. There will be no charge for this replacement.

This warranty does not apply to any parts damaged during the course of handling and assembling the kit. No other warranty, either expressed or implied, shall apply to this unit.

## Packing For Shipping

If it becomes necessary to return the instrument to the factory, it is possible to use your Kit-Pak container for shipping. Remove the die cut platform (the large piece of white cardboard in the bottom of the box that held all the parts). Place the tuner into the box so that it fits into the long slot in the die cut pad underneath the platform. Remove the knobs and dial from the tuner. Put them into an envelope and pack them with the unit. Tie a shipping tag to the tuner with your name, address, and a complete list of the problems involved. Place the white die cut platform back over the tuner. Cut the rectangular section out of the white chimney piece that was originally used to hold the tuner down. Place this section over the tubes (do not remove the tubes). Fill the rest of the box with crumpled newspaper so that the tuner does not move around. Close and seal the box with strong tape or a heavy cord. Insure for its full value and

Ship by railway express prepaid to:

**Laboratory**  
**Kit Service Dept.**  
**H. H. Scott, Inc.**  
**111 Powder Mill Road**  
**Maynard, Mass.**

## Operating Instructions

Your model LT-110 FM multiplex stereo tuner is the product of the highest quality engineering and design. It utilizes wideband circuitry pioneered by H. H. Scott. The LT-110 incorporates a highly sensitive FM tuner with complete multiplex circuitry on a single chassis. In designing this unit special attention was paid to obtaining high fidelity performance in both monophonic FM reception and FM multiplex stereo broadcasts. A remarkable feature of the LT-110 is the Sonic Monitor\*. By tuning to the tone, you can easily locate a station broadcasting multiplex stereo.

The LT-110 is simple to operate. Careful reading of the following instructions should enable any member of your family to operate this unit.

## Installation

The LT-110 can be placed on a table or bookshelf, in existing furniture like an end-table, buffet, or room divider, or in a specially designed equipment cabinet. A handsome hand rubbed wood accessory case is available from your dealer.

Wherever the LT-110 is placed, adequate provision should be made for ventilation. If this is not done, drift will occur and the life of the internal components will be appreciably shortened. By adequate ventilation we mean some space above and behind the unit where air may circulate freely, or, if it is installed in a cabinet, an open back. Always remember that this model draws about 100 watts of electricity and if you placed a 100 watt bulb in a cabinet, you would need a fair amount of moving air to keep it from getting too

warm. If mounted with an amplifier, place the LT-110 alongside or below, never directly above the amplifier where it would come into contact with warm air heated by the amplifier's output tubes.

## Connections

### AUDIO OUTPUT

There are two sets of outputs for Left Channel and for Right Channel on the rear of the LT-110 chassis. To use the LT-110 with a stereo amplifier, one audio cable should be connected from the Left Channel output of the LT-110 into the Left Channel input on the stereo amplifier. A second lead should be run from the Right Channel output of the LT-110 to the Right Channel tuner input at the rear of the stereo amplifier. For optimum performance, the cable length between the tuner and the amplifier should be no longer than 10 feet. For connections to a tape recorder see section on "Tape Recording."

### POWER

The power cord should be plugged into any 105 to 125 volt, 50 to 60 cycle, AC source. Do not attempt to use with DC. If the amplifier has an auxiliary power outlet, you should use it.

### ANTENNA

An FM dipole antenna is supplied with the unit. In most strong signal areas this should be more than adequate to pull in all the FM stations available. Antenna connections are made to the terminal strip marked "Antenna" located on the back panel. The dipole leads are connected to the screws marked 'G' and 'FM 300 ohm' respectively. The dipole should then be opened to a full "T" shape. To position the antenna, tune in a fairly weak station. The meter will read highest when the signal is at its best. Keep rotating the antenna until the signal is strongest.

In fringe areas (or even some nearby areas with interference problems) an external antenna may be necessary. This can be either a standard FM antenna or a presently existing TV antenna. If the TV antenna is used, make certain that it is not one of those designed to avoid the FM band; these will obviously not give satisfactory results. Also a double-pole, double-throw switch should be incorporated in some accessible place so that the TV antenna can be switched either to the television or the LT-110. Both the LT-110 and a TV set should not be in operation at the same time on the same antenna.

In areas of extremely high noise, such as a busy highway, the following system is suggested:

Mount a yagi antenna (either single or stacked) at some point as far removed from the source of

the disturbance as possible. Connect a 300 ohm to 72 ohm transformer on the mast, and run 72 ohm shielded antenna lead-in wire to the tuner. The lead-in should not be more than 50 feet in length, if possible. Since the yagi antenna is extremely directional, it is important that it be positioned for the best reception of desired stations. In areas where stations are available in diverse directions, an antenna rotator is suggested. For good multiplex reception the antenna is very important.

### TAPE RECORDING

Most stereo amplifiers provide tape recorder outputs which can be connected directly to the recorder. If your amplifier does not provide this, or if it is not convenient to use, the LT-110 includes a set of tape outputs for your use.

Audio cables (no longer than 10') should be run as follows. The Channel A tape output should be connected to the input which corresponds to the left channel in your tape recorder. The second lead should be run from the Channel B tape output to the lead which corresponds to the right channel of the tape recorder.

A stereo tape output is available on the front panel for use with portable tape machines. This output can also be used for a set of high impedance head phones.

## Description of Controls

### PILOT LIGHTS

The pilot lights behind the tuning dial and tuning meter indicate the power is on.

### TUNING METER

The tuning meter indicates the relative strength of the input signal. The tuning control should be adjusted until the indicator either reads maximum or until the signal sounds clearest.

### LEVEL CONTROLS

The level controls on the rear of the LT-110 allow the volume of sound from the LT-110 to be set to match your amplifier.

The level controls should be set once when you first install the tuner. Compare the volume of sound coming from a typical phonograph record played on your own record playing equipment with the volume of sound coming from a typical FM monophonic broadcast. Adjust the level controls so that the two are about the same intensity. By having individual controls you can adjust the volume from each channel so they are identical. Switch between Left Input (Channel A) and Right Input (Channel B) on your amplifier and adjust the level controls for equal sound level.

## SELECTOR

*Off* — turns off the power to the tuner.

*Mono* — permits you to listen to the main FM channel only. Usable when the station is not broadcasting stereo or when the subcarrier is of extremely poor quality.

*Stereo — subchannel filter out* — for normal stereo reception.

Does not affect frequency response of the stereo system, but does reduce separation slightly.

*Stereo — subchannel filter in* — provides stereo reception but reduces noise and interference.

## STEREO NOISE FILTER

*In* — reduces high frequency noise on both the main FM channel and the multiplex subchannel.

Does not reduce stereophonic separation, but does limit high frequency response.

*Out* — removes the filter for normal operation.

## AGC (AUTOMATIC GAIN CONTROL)

*Multiplex* — provides better signal-to-noise ratio of the subchannel and should be used for multiplex stereo reception.

*Mono* — provides best performance when listening to a monophonic FM broadcast; reduces interference which might be created by nearby strong FM stations. Use this position when tuning in a station as the "multiplex" position affects the tuning meter.

## SONIC MONITOR\*

A unique Scott development, the Sonic Monitor acts as an extremely accurate guide to the presence of an FM station broadcasting in multiplex stereo. To locate a stereo station, slide the switch to the *monitor* position and turn the **Selector** to *FM stereo*. All stations will now become inaudible and as you turn the tuning dial all you will hear is some hissing sounds in the background. Turn the dial slowly from one end to the other. The moment you hear a steady tone, stop at that point. Carefully adjust for the cleanest tone combined with as high a reading on the meter as possible for that spot on the dial, and put the **sonic monitor** switch to the *listen* position. You will be perfectly tuned in to a station broadcasting multiplex stereo. **Note:** It is normal for some faint sound to be heard above the steady Sonic Monitor tone.

## STEP-BY-STEP OPERATING INSTRUCTIONS

Before proceeding with the actual operation of the LT-110, check the function of each switch as described under "Description of Controls."

To listen to stereo multiplex broadcasts: 1) set **AGC** to *Mono*; 2) select a station on your FM tuner known to be broadcasting stereo via multi-

plex transmission, or as indicated by the Sonic Monitor; 3) Slide the **stereo noise filter** to *out* position. 4) Set the **selector** switch to *stereo, subchannel filter out*. 5) Set **AGC** to *MPX*.

To listen to stereo multiplex broadcasts when some background noise is experienced:

If you notice that the sound is somewhat noisy (make sure that it isn't record surface noise or tape hiss being broadcast by the FM station), turn the **selector** switch to *mono* position. If the noise disappears return the **selector** switch to *stereo subchannel filter in*. If the noise is still present in *mono* position, return the **selector** switch to *stereo subchannel filter out*, and slide the **stereo noise filter** switch to *in*.

## TO LISTEN TO REGULAR MONOPHONIC FM BROADCASTS

Turn the **selector** switch on the front of the LT-110 unit to *mono* position. Select the station of your choice on the tuning dial. It will not be necessary for you to turn the stereo switch on your *amplifier* to "monophonic" position. When the **selector** switch of the LT-110 is in *mono* position, both A and B channels of the amplifier are being fed the same signal.

If on monophonic broadcasts the station's signal is extremely weak, objectionable noise can be eliminated by moving the **stereo noise filter** switch to *in* position.

## THINGS TO WATCH FOR

Multiplex stereo broadcasting is a new experience for most FM stations. Certain problems may arise in their own equipment. Operating techniques may not be developed to the point where you can consistently expect the ultimate in performance in the beginning. Here are some hints and suggestions to help you improve poor techniques:

**Background music** — Multiplexing has been used by many broadcast stations to transmit background music to restaurants, offices, factories, etc. The FCC approved stereo multiplex system does not interfere with this additional source of station revenue in any way. Without this additional income, many FM stations would not be able to stay on the air and bring you their wonderful good music programs.

You will *not* be able to receive these background music programs with any tuner which meets the FCC specifications. However, occasionally, if a station is using a subcarrier in the range of the stereo subcarrier channel for background music and is not broadcasting stereo, you may hear some interference effects (such as whistles) on your music system. This will only happen if you are using your LT-110 tuner for stereo FM reception. Turning the **selector** switch to *mono* will eliminate this interference.

\*pat. pending

## DISTORTION

Distortion when the selector is set for "stereo" which disappears when the selector is turned to "mono" is primarily due to antenna problems. This difficulty may be apparent in areas where many hills or tall buildings cause reflection. Distortion can be reduced by any or all following suggestions: a) tune in the station more carefully; b) reposition your antenna; c) reverse the antenna lead; d) use a better (higher gain) directional antenna.

## Separation

The Federal Communications Commission has ordered broadcasting stations to maintain at least 30 db. separation at the transmitter during multiplex stereo programs. What does this mean to you? Take an example: Suppose the station is broadcasting multiplex stereo and it just happens that the only sounds being picked up are on the right side. The station should transmit so that the only sound you hear comes from the right speaker. There should be no sound coming from your left speaker. In practice, it is impossible to have such separation. Some of the right channel signal is bound to sneak into the left channel, either at the transmitter or in your tuner. If the FCC specs are being met throughout, the amount of sound audible in the left speaker should be 30 db. lower in volume than the sound from the right speaker.

This is very difficult to accomplish. Most FM stations beginning to broadcast multiplex stereo take months of solid work before they obtain that much separation consistently. It is an enormous tribute to their abilities that most of them are eventually able to meet these strict standards. However, the 30 db. is only specified for the transmitter. If the station is using a phono cartridge with 15 db. of separation then you will only hear 15 db. of separation. Or if the station is using stereo records with limited separation, that is all you will hear, also.

Your LT-110 is capable of as much separation as most stations provide and more. This is a function of both the FM section and the multiplex subassembly. The multiplex subassembly has been prealigned at the factory, using a typical LT-110 as the basis. If you have carefully followed directions and properly assembled your tuner, it should match the multiplex section quite well. If for any reason it does not, then the separation provided by the complete tuner will not be as good as it might be. This is most rare so should not be of much concern.

However, if you are not getting good separation and you find that the problem is in the tuner and not the broadcast (the only way to check is to try another multiplex stereo tuner under the same circumstances) there are two courses of action

available. Assuming the tuner is working well monophonically, it is possible to readjust the multiplex section so that it more closely matches your particular FM section. This can either be done at the factory or by certain of our warranty stations with the necessary equipment (Write to the Kit Service Department for their names). It is also possible under certain conditions to make adjustments yourself. Read through this next section completely before undertaking anything.

## SEPARATION ADJUSTMENT

Certain FM multiplex stations will occasionally broadcast test tones. At certain times of the day they will transmit over the right channel only or over the left channel only. Also, many stations make their spoken announcements over only one channel. Write to your FM station to see if they do either of these and at what time.

If they do, AND ONLY IF THEY DO, you may be able to improve the separation yourself. This is how to go about it:

1. Tune in the station and set all controls for optimum stereo reception.
2. Suppose the station is sending out a right channel signal, or their announcer is speaking on the right channel only. You should hear this loudly on the right speaker and quite faintly on the left speaker. (If the station is broadcasting left only this would be reversed.)
3. Adjust the amplifier so that you are only listening to the left speaker (or right as the case may be). If you have a Scott amplifier, this is done by rotating the **stereo balance** control to its maximum counterclockwise position. Turn up the volume so you can hear easily.
4. Take the tuning dial and rotate it very minutely in either direction until you have the exact point where the sound is faintest. This should be near the maximum indication point on the tuning meter (it may be slightly off the exact maximum).
5. Look at the top of the multiplex section on the LT-110. **TOUCH NOTHING YET.**
6. Notice one little slotted pot, identified as "Sep". Observe carefully its position so that you can reset it exactly if necessary.
7. With the small screwdriver, rotate this in either direction till you find the spot where the sound from your left speaker is faintest. Stop right there and touch nothing else.
8. If there is no difference, return the pot to its original position. The difficulty was not with the tuner after all. Investigate elsewhere, or write to the Kit Service Dept.



Let us repeat — these adjustments are rarely necessary. (In careful checks of over 100 home built kits, only 5 needed even a slight adjustment.) In all other cases, the separation in the LT-110 exceeded that of the program material being received.

## Notes on Multiplex

Multiplexing is a method of broadcasting two or more signals from one FM transmitter. This means that a *single* FM station can broadcast *both* the right and left channels of a stereophonic source from records, tapes, or live performances.

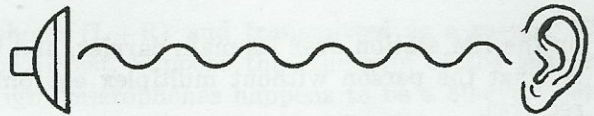
In your home you hear stereo . . . the sounds from the left side of the stage from a speaker placed on the left side of your room, the sounds from the right side of the stage from the right, where they belong. Stereo sound is really an aural version of 3-D photography . . . you hear two slightly different sound pictures . . . and get a realistic sound spread across your living room.

Before multiplex, a station transmitting stereophonic program material had to use an FM transmitter for the left channel and an AM transmitter for the right channel. Because of interference problems and limited frequency response found in present day AM broadcasting, this was not an ideal solution. An alternate method was to have two FM stations in a single community share the broadcast. This was feasible, but the listener needed two FM tuners, and the community two friendly FM stations — two extremely unlikely possibilities. Multiplex eliminates these difficulties.

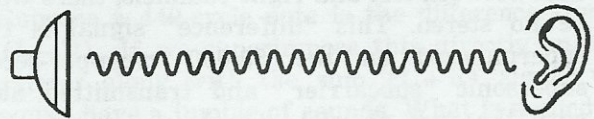
A single FM station can broadcast *both* stereo channels. The listener needs only an FM tuner equipped for multiplex plus the usual accoutrements of stereo (two speakers and a dual channel amplifier). Operation is not complex. You just tune to one station as you do now for regular FM broadcasts and you hear true stereophonic sound with all the advantages of FM: freedom from noise, interference, and distortion. At first glance FM multiplex stereo seems like a pretty remarkable feat — two separate signals from one station. Let us see how it is done.

## In The Beginning . . .

When you listen to FM through your loudspeakers, you hear sounds, such as music, talk, or even (sigh!) commercials. These sounds result from waves (known as cycles) created by the motion of the loudspeaker cones. If the loudspeaker cone moves back and forth twenty times a second it creates 20 sound waves (or cycles) every second. A 20 cycle per second sound wave would be very deep or low in the bass region.



If the loudspeaker cone moves back and forth 20,000 times a second it creates 20,000 waves or cycles per second. Such a sound would be very high pitched and in the extreme treble region.



Humans are capable of hearing sounds between about 20 and 20,000 cycles per second. Any sound above 20,000 cycles per second is referred to as "supersonic" because it is above the range of human hearing.

Most good FM tuners are capable of reproducing these supersonic frequencies above 20,000 cycles per second ("cps" for short). Though you cannot hear them, these supersonic frequencies are used very effectively for multiplex. At a frequency of 38,000 cycles per second (cps), high above the sounds you can hear, the second (stereo information) signal is added on. While you can't hear this second signal, your FM multiplex stereo tuner can, and will convert this into sound you *can* hear — stereo sound.

## How FM Multiplex Stereo Works

It would be possible for a regular FM tuner to pick up the left stereo channel of the stereo program, while the supersonic signal carries the right stereo channel. However, this method is *not* used because the person with a monophonic FM tuner would hear only the left channel, or half of the total material. Instead, a method is used that provides stereo for the listener with multiplex equipment and a full monophonic signal for the listener with a regular FM tuner.

Visualize a symphony orchestra spread out before you on the stage. One microphone is positioned on the left side of the stage and another on the right. The left microphone (L) picks up mostly sound from the musicians on the left side, while the right microphone (R) picks up mostly the right side. The broadcasting station takes the signal from the left microphone (L) and adds it to the signal from the right microphone (R) to produce the sum (L + R) of the music, or in effect, a complete monophonic signal. This sum is sent

2. Unscrew and remove the tuning knob and dial. This will permit access to the pilot light which is a #47 bulb.

After the bulb has been replaced, use the following procedure:

1. Close the condenser plates by rotating the condenser to the extreme counter-clockwise position.
2. Replace the dial, lining up the heavy white lines of the dial with the pointers and keeping the logging scale toward the top of the front panel.
3. Replace the tuning knob.

#### ALIGNMENT INSTRUCTIONS FOR FM SECTION

Note: No attempt should be made to align the tuner or repair it unless the person so doing has had extensive experience in tuner alignment and repair procedures and has the necessary laboratory equipment. Without proper experience or equipment, the repairman may seriously damage the tuner.

1. Equipment required: VTVM (AC), FM Signal Generator (must be Measurements 210AB or equivalent), Oscilloscope, 400 cps null, and insulated alignment tools.
2. Equipment setup: Connect signal generator directly to the 300 ohm antenna input of the tuner using a matching impedance network if necessary. The Channel A audio output of the LT-110 then feeds into the 400 cps null and from the null to the oscilloscope and VTVM in parallel. If no null is available (a schematic for making one of these very simple and useful devices is available from the Engineering Dept.) the tuner can still be serviced. However, it will not be possible to measure the tuner's "Usable Sensitivity" as per IHFM standards, or align the detector.
3. Allow tuner and test equipment to warm up fully before beginning alignment. Adjust line voltage for 117 volts. Remove bottom cover of tuner. Always tune primary and secondary of I.F. transformers at the same time, using one alignment tool in each hand. Set LT-110 Selector Switch to Mono, Level to Maximum, Stereo Noise Filter to Out, ACG switch to Mono.
4. Set generator and tuner for 92 mc. Generator should be modulating a 400 cps signal at 75 kc deviation. Adjust output of generator so that a barely adequate sine wave appears on the scope (on the order of 3 to 6 microvolts input to tuner). The null filter should be switched out of the setup, so the tuner is feeding directly to the VTVM and scope.
5. Peak the IF transformer cans, (T1, T2, and T3) top and bottom, for maximum reading on the LT-110 tuning meter (ignore your VTVM). Make frequent checks that the tuning dial is set for the maximum reading on the meter. Rotate the bottom slug of the detector can (T4) to its extreme counter-clockwise position. Then count off  $4\frac{1}{2}$  turns clockwise. Increase the FM generator output to 1000 microvolts. Carefully adjust tuning dial for maximum reading on the tuning meter. Turn off the tuner. Connect a .05 capacitor between pins 1 and 4 of V1 (6AU6). Turn on tuner. Adjust the secondary of the detector (top slug) for minimum reading on the VTVM. Turn off the tuner, remove capacitor. Reduce the FM generator output to 3-6 microvolts. Touch up the bottom of the detector for maximum audio output.
6. Return generator output back down to 3 to 6 microvolts. Adjust antenna coil (under chassis) for maximum output. Tune generator and tuner to 106 mc. with same output and deviation, and adjust antenna trimmers (on top - FM ANT.) for maximum output. Repeat this operation until best results are obtained.
7. If calibration is off, repeat "6" except adjust oscillator coils (under chassis) for correct tracking at 92 mc. and oscillator trimmer (FM OSC - on top) for correct tracking at 106 mc.

#### MISCELLANEOUS SERVICE PROCEDURES AND TESTS - (Qualified technicians only)

Note: Replace bottom plate before testing.

1. Test for IHFM Usable Sensitivity measurements: Use 117 volt regulated line, set generator and tuner at 92 mc, with 5 microvolt input. Take a reference reading on the db. scale and check for 38 db. or more reduction in output with 400 cycle null filter switched in to setup. Repeat at 106 mc. If specification is not met, tuner should be realigned and tubes checked. It is very important that the null filter be carefully adjusted so that it is at exactly the same frequency as the 400 cps modulation being fed in. Otherwise, it will be impossible to obtain stated sensitivity figure. Note that 5 microvolt output of generator is equivalent to less than 3 microvolt on tuner input due to drop through the matching impedance network.

2. Audio output: With 1000 microvolt input, 75 kc deviation, maximum output should be 2.0 volts.
3. Automatic Gain Control: The maximum permissible difference in output between an input of 6 microvolts and 1000 microvolts is 8 db.
4. F.M. Hum: At 100 mc., 1000 microvolts input, 400 cycle modulation, take a reference reading and remove modulation. A 50 db drop should be noted. Have level control at maximum. With level control at minimum a drop of 70 db can be noted.
5. A.C. Hum: With no modulation and level control at minimum, adjust hum pot for minimum hum. Should not exceed .002 volts.
6. Oscillation Check: Check entire FM band for oscillation, with and without antenna, at 105 and 130 volt line.

#### PRELIMINARY MULTIPLEX TESTS

Use same equipment described above, plus a good Audio Oscillator.

1. Connect the audio oscillator to the test point input on the multiplex section. Adjust the output of the oscillator for 0.25 volts. Set the LT-110 controls as follows: level to maximum, selector to mono, filter to out, and AGC to mono.
2. Measure the output of the tuner. It should be 2 to 3 volts with selector switch in either mono or stereo. With selector switch in mono adjust the balance pot (BAL) on the multiplex section so that the Channel A and B outputs are the same within 1 db.
3. Disable the multiplex section oscillator by grounding pin #2 of 12AU7 (V503). With the audio oscillator at 400 cps take a reference reading. It should be down maximum of 2 db at 20 cps., 2-4 db at 2 KC, 7-9 db at 5 KC, 12-14 db at 10 KC. Switch in the stereo noise filter and note additional 5-8 db drop. Switch the filter out and continue to 15 KC -- 15-18 db drop, a minimum of 21 db at 20 KC, and minimum of 44 db at 40 KC.
4. Turn LT-110 selector switch to Stereo, subchannel filter out. Set oscillator to 67 KC, 0.25 volts output. Adjust L-502 for minimum output from either Channel A or B. The null is quite broad. If necessary increase output of audio oscillator for better null.

#### STEREO MULTIPLEX SEPARATION TESTS AND ADJUSTMENTS

Equipment needed: In addition to all the equipment mentioned before you will need a Hewlett-Packard 200CD Audio Oscillator or equivalent (with balanced output to ground -- oscillator with unbalanced outputs cannot be used), and the H. H. Scott Model 830 FM multiplex stereo generator.

Equipment set-up: Use the same arrangement described with the tuner alignment procedure, plus: Connect the Audio Oscillator to the 830 (as described in the 830 Instruction Manual) and the 830 to the FM generator. Set the FM generator for External Modulation.

1. Set audio oscillator to 400 cps. and 830 for left channel (Channel A) signal only. **IMPORTANT:** The 830 MUST be carefully adjusted for input signal and output phase as described in the 830 Instruction Manual. The output phase must be monitored with a scope to check for variances. If the phase is off even slightly, your alignment will cause the tuner to have poor separation when tuned to station.
2. Set all controls on the LT-110 for full stereo (level control to maximum, Selector switch to Stereo, subchannel filter out; stereo noise filter out; and AGC switch to Mono). Tune the LT-110 to the point on the dial where you are transmitting your Channel A signal. Make sure you pick a point on the dial that does not coincide with a local FM station.
3. Adjust the tuning dial for maximum reading on the tuner's meter. Take a reference reading on the VTVM, db scale. Remove the output cable from the tuner's Channel A output and insert it into the tuner's Channel B output. The difference in output should exceed 30 db. Adjust the top of L-501 with a detector alignment tool for maximum separation. Then turn the pot marked "Sep" for maximum separation.
4. Readjust the 830 so it now provides a right channel signal only (Channel B). Repeat step 4, only the output of Channel A from the tuner should be 30 db down, from Channel B. If often happens that a slight adjustment of BAL pot will increase separation slightly.
5. It is important to realize that maximum meter reading will not exactly coincide with maximum audio output (within 2 db) and maximum separation. However, it comes extremely close to both and does give a good combination of separation, output, and low distortion.

## ALIGNMENT OF STEREO GUIDE INDICATOR

This Procedure Should be Accomplished After the Alignment of The Tuner

1. Turn P3 pot full counterclockwise. (The indicator light should be out.)
2. With the tuner connected to your stereophonic amplifier, tune in a broadcast station that is definitely broadcasting multiplex. If possible, the station should have a meter reading of between 4 and 6. Turn the selector switch on the tuner to the stereo Sub-Channel Filter Out position. If possible, the station tuned in should be a station that makes its commercial voice announcements over only one of the channels.
3. Turn P3 until the indicator light comes on. Now rotate the tuning dial back and forth from one end of the scale to the other to see whether or not spurious noise from other stations tends to inadvertently make the light come on. If spurious noise is indicated by the light, back off on the control until the spurious noise is no longer picked up although stereo broadcasting stations still cause the light to illuminate.

### Separation control adjustment

1. Be sure the selector switch on the tuner is in the Stereo Sub-Channel Filter Out position. Be sure that the multiplexing station that you are listening to makes its voice announcements on only one channel.
2. Insert the aligning tool into the bottom slug of transformer T501 on the Z-MX-4 multiplex section of the tuner. Be sure to use caution in making this adjustment, as the rest of the adjustments on this section of the tuner require service shop equipment to readjust should anything be put out of alignment. Do not yet turn the aligning tool.
3. Disconnect the green mic lapel wire from pin 7, V503. Carefully listen to the separation noticed between the loudspeaker over which the voice announcements are made and the amount of cross-talk that is heard in the "quiet" loudspeaker.
4. Reconnect the green mic lapel wire to pin 7, V503 (S4).
5. Again listen to the amount of separation noticed between the two speakers. There will probably be a slight increase in the amount of audio heard from the "quiet" loudspeaker. Turn the alignment tool in either direction until you have adjusted for minimum cross-talk. Do not turn the tool more than half a revolution in either direction. If you find that the cross-talk does not become lower in one direction, simply turn the tool in the opposite direction. It is possible that you will notice two points of fairly low cross-talk. Adjust for the point that gives the lowest amount of audible sound from the "quiet" speaker.
6. At this point, you should recheck your setting of the indicator light. (Step #3, top of page.)

### EMERGENCY MULTIPLEX SEPARATION ADJUSTMENTS WITHOUT SPECIAL TEST EQUIPMENT

The following adjustments should only be attempted if it is impossible to get the proper multiplex test equipment and it is obvious that stereo separation is not satisfactory. The only way to be sure the tuner is at fault is to substitute another tuner, known to be working properly. (very often a tuner will not appear to have good separation when actually the station or the program material is at fault).

The primary requirement is to have a local FM station broadcasting multiplex stereo with spoken announcements on one channel only. Most multiplex stations do provide this service at certain times of the day. Call the station and check. If they are among the few that are not broadcasting speech on one channel only, you might point out how valuable it would be to service people in their area if they did.

1. Assume the FM multiplex station is transmitting commercials on the right channel only (reverse everything if it is left only).
2. Connect an audio cable from Channel A output to an amplifier and a speaker.
3. Tune in the station carefully using the tuning meter. Set Selector to Stereo, Sub-channel filter out; Stereo Noise Filter to Out; ACG to Mono; Level to maximum.
4. When the announcer begins to talk, he should be barely audible in Channel A or the left channel signal. Carefully retune till you find the point where the sound is faintest (you should be quite close to the maximum meter reading position).
5. Carefully rotate the "Sep" pot on the multiplex adaptor until the voice is at its faintest. Keep the volume up on the amplifier.
6. If this does not provide sufficient improvement, take the detector alignment tool and insert it into the top of L-501. Rotate slowly for the best separation point. Then readjust the "Sep" pot.
7. If this does not help, the difficulty may be with the station or with some other part of the system. For more information, write to:

Technical Services Dept. • H. H. Scott, Inc. • 111 Powder Mill Road • Maynard, Massachusetts

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