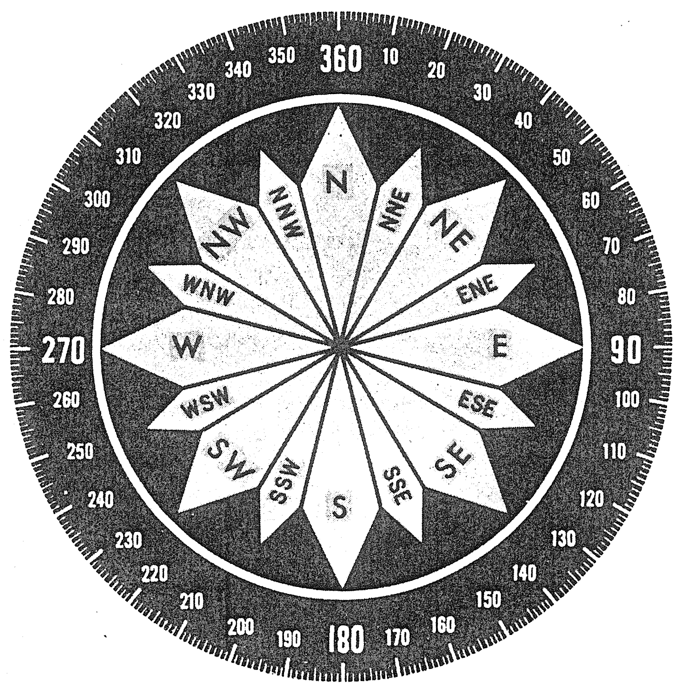
LH Series Portable Direction Finders

OPERATING & MAINTENANCE MANUAL



L-TRONICS®, Santa Barbara, CA

SPECIFICATIONS FOR THE LH SERIES "LITTLE L-PER"® PORTABLE DIRECTION FINDER

Receiver Type	Double conversion superhetrodyne with two separate RF tuners
Frequencies or Channels	Maximum of 4 per tuner, 6 total
Tuner Bandwidth (No Alignment)	±500 kHz full sensitivity ±4 MHz reduced sensitivity
IF Frequency, 1st IF IF Frequency, 2nd IF	10.7 MHz 455 MHz
DF Sensitivity, VHF DF Sensitivity, UHF	0.15 μV or better (0.05 μv typical) 0.2 μV or better
IF Bandwidth	15 kHz
Adjacent Channel Rejection	29 dB typical at ±25 kHz -53 dB typical at ±50 kHz -84 dB typical at ±100 kHz
Image Rejection, VHF Image Rejection, UHF	-55 dB minimum, -65 dB typical -40 dB typical
IF and Spurious Rejection	75 dB minimum
Audio Output	0.25W minimum into 8 ohms
DF Indication	Left/right homing or signal strength
DF Indication Dynamic Range	-130 to +10 dBm typical
Signal Strength Indicating Range	-125 to -5 dBm typical
Power, Internal Power, External	Two 9V dry battereis 10-28V negative ground internal regulation 17 mA low volume, 130 mA maximum volume
Antenna	Electrically switched twin dipole with folding mast
Antenna Gain	2.5 dBd minimum
Weight, with Antenna & Batteries	37 ounces
Operating Temperature Range	-20 to +140 degrees F

LH SERIES PORTABLE DIRECTION FINDER

"LITTLE L-PER"®

OPERATING AND MAINTENANCE MANUAL

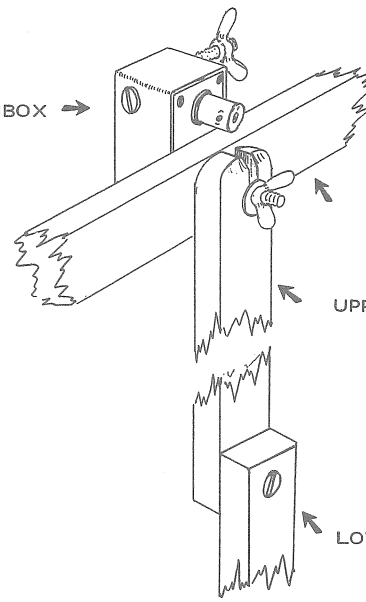
Section 1

General

Description

The LH Series Little L-Per® Portable Direction Finder consists of a sensitive, crystal-controlled receiver and a two-element directional antenna mounted on a wooden frame or mast. It is intended primarily for hand-held ground direction finding, but also gives excellent performance in aircraft, vehicles, or boats with appropriate accessories. All models assemble and operate in the same way.

The antenna consists of two folding wire dipoles and a switching network mounted on a wooden crossbar. This antenna will operate properly for about 10% either side of its designated frequency. Units with two tuners (121.5/243 MHz) are supplied with two antenna crossbars, one for each tuner frequency range. Effective in October 2002, units are supplied with the short mast only. While some illustrations in this manual show the long, folding mast, assembly is the same.The long, folding masts are available as an accessory.



Assembly

The LH Series unit is shipped with the mast, antenna crossbar(s) and receiver as separate pieces for compactness. To assemble in the normal mode on either standard or short mast (supplied), fully loosen the wing nut on the bolt that comes through the wood of the antenna crossbar. Hold the antenna with the wing nut slightly down so that the washer is just UNDER the nut, NOT between the wooden crossbar and the mast. Slide the crossbar bolt into the slot in the top of the mast. The fit is snug and may be very tight the first few times it is assembled. The bolt will usually seat with a definite "click." Tighten the wing nut (see Figure 1).

Lift the antenna rods from under the RF jack and plug in the mast cable. It is not necessary to remove the wing nuts for assembly. The receiver mounts over the foam strip on the mast by seating the keyhole slots of the receiver on the screws then pushing the receiver toward the bottom of the mast to lock it. The snugness of the receiver on the mast can be adjusted by screw height. Plug in the coax cable to the top of the receiver.

With the antenna and mast assembled in the normal mode, they can be folded rapidly for carrying or storage by folding the four aluminum antenna elements parallel to the antenna crossbar. Loosen the wing nut and fold the crossbar parallel to the mast by turning it either way 90 degrees. For the long, folding mast, loosen the wing nut on the mast and fold the lower mast section to the right 180 degrees until it parallels the upper mast section. (Folding to the left will cause it to bind on the coax cable.) The unit may be fastened in this position using the cloth hook and loop tape attached below the receiver. This tape may also be used to hold a spare antenna crossbar for storage.

When penetrating brush, hold the folded unit just under the receiver, with the receiver end forward (figure 2). In this manner, any impacts on either the receiver or compass will tighten them on their mounts and the two folded antenna rods which stick out slightly will be less likely to get caught on something.

To prepare for operation, unfold the LH Series unit to the position described earlier and shown in Figure 3 (long mast shown). The antenna elements should be kept folded except when taking bearings.

The wing nut at the joint between mast sections of the long, folding mast should be tightened firmly to prevent the mast from folding back. The joint has been treated with rosin, so a release with a "pop" at times is normal. If the joint becomes too lose, disassemble and add a bit more rosin to the facing wood pieces and occasionally apply a drop of lightweight oil to the wing nuts on the mast and crossbar. If the antenna rods become loose, tighten them with a nut driver, using a screwdriver ONLY to prevent the screws from turning. Do not overtighten, as the wood will split.

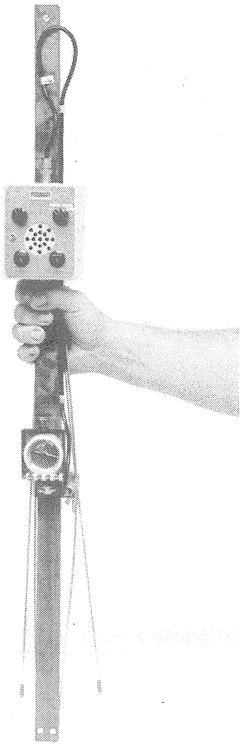


Figure 2. LH Series Little L-Per Portable Direction Finder in the Field-Carry/Storage Configuration.

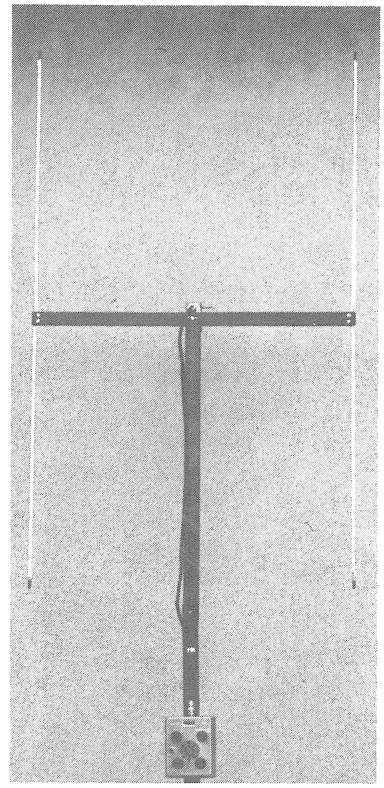


Figure 3. Operating Position.

Operation

More detailed information on operation of the LH Series equipment and on field DF techniques are in L-Tronics® book, "Basic E.L.T. Location Course," and L-Tronics® publications, "Air and Ground Direction Finding Techniques," and "Locating Non-distress ELTs and EPIRBs." Reminder stickers are on the sides of your receiver.

The following discussions use the Emergency Locator Transmitter (ELT) as a typical signal source to be located. The principles apply to any transmitter, including the marine Emergency Position Indicating Radio Beacon (EPIRB).

When taking bearings, move to an area as clear and as high as possible, at least 20 feet from vehicles, wires, or other large, conductive objects. For best accuracy, persons other than the operator should stand at least 10 feet from the antenna. The operator should raise the antenna as high as possible (look up slightly to see the meter) and keep the elements and mast vertical.

Your LH Series Portable Direction Finder has two modes of operation: Signal strength (RECeive) and left-right homing or Direction Finding (DF).

NOTE: The following paragraphs are crucial to understanding the operation of your DF. Read carefully!

In the DF mode, the meter's needle will point in the direction of the strongest signal so that when the meter is properly centered, the operator will be facing the signal source. In the RECeive mode, the meter becomes left-to-right reading signal strength (volume) with right being strongest. The antenna receives best in the direction of the arrows; therefore, the signal will be strongest (loudest) when the end of the antenna with the arrows is pointed toward the source. See Figure 4.

It is normal for the apparent direction of an ELT signal to vary because of the presence of nearby objects, such as trees, buildings, and hills. The left-right indication in the DF mode is much more sensitive to these small changes of direction than the signal strength indication in the RECeive mode. That is why it is common for the needle to swing left and right around the average bearing while homing on an ELT. Reducing the SENSitivity control will cause the amount of needle swing to decrease without loss of accuracy.

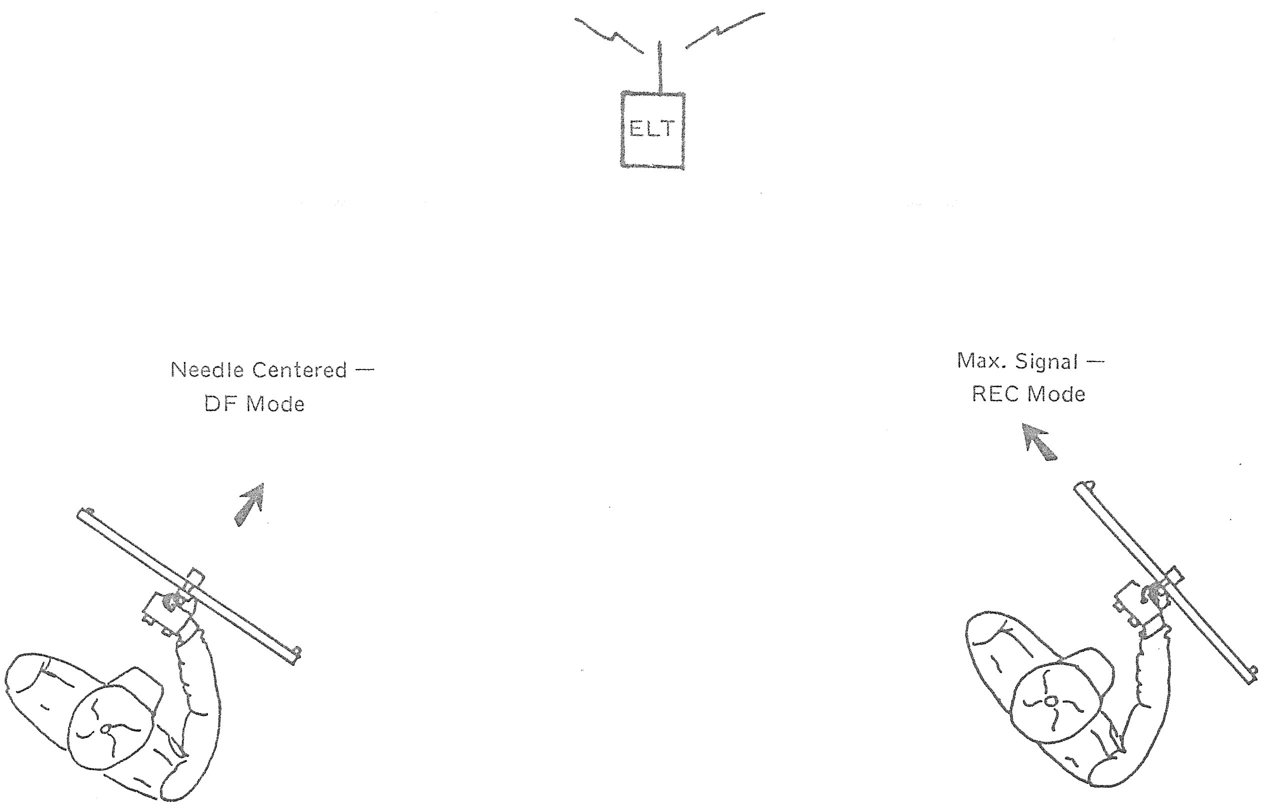


Figure 4. Using the LH Series Little L-Per® Direction Finder.

The D.F. Mode

To use the receiver in the DF mode, follow these procedures.

Set up the receiver, antenna, and mast as described earlier. Be sure you use the proper antenna for the frequency you are working (24" antenna for 121.5/121.6/121.775 MHz or 12" long antenna for 243 MHz). THIS IS VERY IMPORTANT! If you use the wrong antenna, the DF needle will move but the DF information WILL NOT be accurate and CANNOT be relied upon.

Select the frequency. Turn the mode switch to DF. Set the SENSitivity control to minimum (fully counterclockwise). Set VOLume control to about the 12 o'clock position.

Turn up the SENSitivity control (clockwise) until the ELT is heard and the meter deflects to the right and left as the antenna is turned.

You may have to adjust the volume. Once a comfortable volume control level is set, do not move it. When the ELT gets stronger; reduce the SENSitivity control instead. An increase in volume is really an increase in signal strength.

If the needle is to the left of center, turn left until it centers and any further leftward movement causes it to pass center and go to the right. If the needle is to the right of center, turn right to center it. With the needle centered, the operator will be facing the source of the signal.

Follow the average DF bearings to the target. Remember, this may not always be in a straight line. As the volume increases and/or the DF needle gets too sensitive and swings wildly, turn the SENSITIVITY (not volume) down. As long as there is slight left-right swinging and the signal can be heard, there is a usable level of signal strength. The signal strength (volume) increases slowly when far away, but as the operator gets closer, the rate of change will be very rapid. This is a much more reliable indication of distance to the ELT than the absolute signal strength reading.

NOTE: Any time turning the SENSitivity control UP results in a DECREASE of DF indication or signal strength, an overload condition has been reached. Turn the SENSitivity control DOWN.

To evaluate the quality of the bearing, stand in place while facing the signal source, as described earlier. Rotate to the right 360 degrees. The needle will go left, center again when you are 180 degrees off target (your back is to the signal source), then to the right until the meter centers again when you face the signal source. (A left turn will cause the needle to go right, center, then left.) This is a confidence check and the fact that the meter centered twice approximately 180 degrees apart shows that this is a good location and a reliable bearing can be taken. If the needle centers more than twice, you are seeing signal reflections and your bearing will not be as reliable; move to another location. Remember to turn in the direction of the needle to center the needle and face the signal source.

If the DF needle gives a positive indication to return the antenna to a particular direction, that indicated direction may be considered reliable even though the signal is too weak to be heard or the signal has no modulation such as a "carrier only" ELT or stuck mic. About 1/2 division of random needle motion not related to antenna position is normal. Use caution with inaudible signal bearings in the city; they may be due to noise from signs, power poles, TV sets, or cable TV radiation, or strong signals on an adjacent channel.

The RECeive Mode

As mentioned in the section for operating in the DF mode, use only the antenna that matches the frequency selected. In the RECeive mode, the meter reads signal strength, left side (weaker) to right side (stronger).

Select the frequency. Turn the mode switch to RECeive. Set the SENSitivity control to minimum (fully counterclockwise). Set the VOLume control to about the 12 o'clock position.

Turn the SENSitivity control up (clockwise) until the ELT signal is heard and the meter goes up scale. You may have to adjust the volume. Once a comfortable volume control level is set, do not move it. When the ELT gets stronger, reduce the SENSitivity control instead. An increase in volume is really an increase in signal strength.

Turn in a circle and note where the needle goes furthest upscale. Return to this position; the arrows on the left arm of the antenna point to the signal source.

Without changing the controls, move the antenna to a position over your head until it is horizontal with the ground. A noticeable increase in signal strength means that the transmitter is horizontal. Use the special antenna assembly shown in Figure 5 and explained later in this section.

As signal strength increases and/or the needle nears the right-hand stop, decrease the SENSitivity control (not the volume). The closer to the target, the more rapidly signal strength increases.

To evaluate the quality of a bearing, turn a full circle. If multiple readings of about equal up-scale movements result, you are in an area of many reflections; move to a better location.

NOTE: Any time turning the SENSitivity control UP results in a DECREASE of strength or DF indication, an overload condition has been reached. Turn the SENSitivity control DOWN.

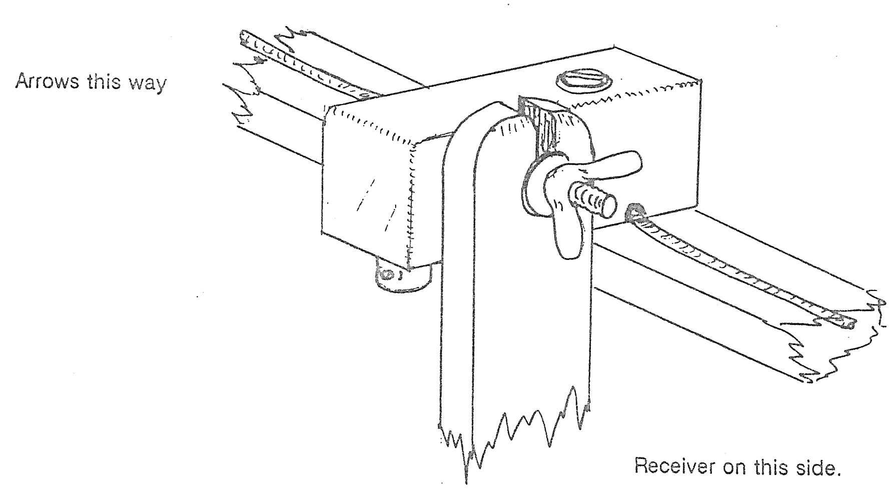


Figure 5. Special Assembly. May be set to either vertical or horizontal polarization. (Horizontal polarization shown.)

Special Antenna Assembly

The normal antenna assembly discussed so far is a vertically-polarized antenna. It gives reasonably good DF on horizontal signals, but with some loss of sensitivity. If weak, horizontal signals are encountered or if DF is to be done primarily by signal strength indication in RECeive mode, the alternate antenna mounting of Figure 5 may be used. Either vertical or horizontal polarization may be obtained by rotating the antenna around the mounting screw. The attached compass gives correct bearings in RECeive mode when the unit is used this way.

DF mode can be used with the alternate antenna assembly, but its meaning is different. If the needle swings left, the signal is in front of you, towards the arrows. A right needle indicates behind. This is not precision DF, but in highly reflective locations like harbors and around metal hangars, it is less confusing than the regular DF mode and will keep you going in the right direction.

D.F. Techniques

The above is all there is to the mechanics of operating the LH Series Little L-Per DF. The skill and practice required for successful transmitter location involves selecting locations for taking bearings and **INTERPRETING THE RESULTS**. The following is a brief description of DF techniques. More detailed information is contained in L-Tronics® publications, "Air and Ground Direction Finding," "Locating Non-distress ELTs and EPIRBs," and the "Basic E.L.T. Location Course." Please study the following material carefully. The time you spend will be amply repaid in field results when it counts most.

The basic problem is that the signal from the transmitter to be located will reflect or bounce off of almost all natural or man-made objects. The L-Per®, or any other directional receiving system, indicates the direction of arrival of the composite signal at the point where the operator is standing, which is often not the same as the direction to the transmitter. This composite signal is the sum of the one direct from the transmitter and all of the reflections in random combinations. The problem is rather like trying to find a single light in a hall of mirrors. If the reflections are not very bright or are few in number, the light can be found easily. If the reflections are bright or the light is obscured from direct view, the best that can be done is to move toward the brightest area and hope that from there the source can be seen directly. The same process is used in radio DF.

The following material outlines the principal effects applied to terrain features. All of the examples are drawn from field experience. Those who have done field DF will be familiar with most of them.

A key to the efficiency of the L-Per® is its ability to evaluate the quality of the bearings obtained. Beware of reflections; it is impossible in a practical sense to obtain bearings from some locations. The L-Per® will tell you quickly when this situation exists so a new site can be selected. Further, bearings of low quality can be identified and taken into account when conflicts occur in a triangulation problem.

We strongly recommend that you do initial practice with the unit in an open, clear area and then around buildings or other obstructions to become familiar with its operation with a known target before trying an unknown. A regular or practice ELT fitted with a dummy load in place of its regular antenna will provide weak signal simulation practice in walking range. The frequency 121.775 MHz is the authorized practice frequency in the USA. 121.6 can be used to tell the difference between a weak ELT signal and random noise.

To check for the existence and severity of reflected signals, take a reading, note its magnetic direction, then walk to a point ten or twenty feet away **WHILE CONTINUOUSLY OBSERVING THE INDICATED DIRECTION**. If no significant reflections are present, the indicated direction will remain steady to within five degrees. As reflected signals become prominent, the indicated direction will oscillate back and forth every four or five feet. A good estimate of the true direction of the signal can be made by taking an "eyeball average" of these variations while walking a baseline of up to 50 feet. A compass is not necessary when the L-Per® is used in this manner; simply observe fluctuations of the left-right needle. If the situation warrants, and no better location is available, a still better estimate can be made by writing down compass bearings taken at three to four foot intervals over as long a distance as possible and then taking a numerical average. Fluctuations of more than 60 degrees each direction indicates a very poor DF site.

An additional confidence check where reflections are severe is to rotate the antenna through a full 360 degrees while standing in one position and observing whether the needle centers at more than two directions approximately 180 degrees apart. If it does, bearings taken from that site should be considered unreliable and a new site selected. This difficulty is not uncommon while doing direction finding in rugged terrain or city areas. It is also common to lose the signal for substantial distances in rough terrain; continue the search on the last good bearings received.

Range or distance to an ELT is very difficult to judge based on absolute signal strength. However, the RATE of change in signal strength increases as you get closer to the ELT. The closer you get, the faster the strength reading will increase. The sweep RATE (how fast the ELT sweeps) will not get faster as you get closer (it will not change at all).

Sometimes more than one ELT will be operating at one time in the same area, particularly around airports. This situation can be recognized by the multiple sweeps heard or by whistles or heterodynes on communications signals. If the signals are of nearly equal strength, the L-Per® will be confused. To overcome this situation, try several locations for bearings until one is found in which one ELT signal predominates and a clear DF is obtained. Hunt that one down, shut if off, and then return to the one remaining. Good and bad DF readings can be recognized the same way as for reflected signals. Often buildings, hangars, or even hills and mountains can be used as shields to make one signal stronger.

The LH Series units will track a carrier-only signal (such as a stuck transmitter), or an ELT that is too weak to be audible on the speaker. To determine whether you have a signal to track, switch from 121.5 MHz to 121.6 MHz. If the meter readings stay pretty much the same, you have random background or broadband noise. If the readings change on 121.6, the L-Per® is receiving a signal on 121.5.

If your Little L-Per® is equipped with 121.5 MHz and 243 MHz, the ELT may be heard on both frequencies, but DF bearings MUST be taken with the proper antenna for the frequency used in order to be reliable. If you use the wrong antenna, the DF needle will move but the DF information WILL NOT be accurate and CANNOT be relied upon. Compare readings at both 121.5 and 243 MHz; reflections will often produce different bearings, while a direct signal will show the same bearing. The L-Tronics® LHBA-1 beam antenna can be used on both frequencies.

CAUTION: When taking magnetic bearings, hold the compass at least eight inches from the receiver because of the effect of the speaker magnet on it. However, the L-Tronics® compass that mounts on the mast need not be removed from its mount for taking bearings.

Signal strength increases rapidly in the immediate vicinity of an ELT. A search for the maximum strength is often quicker than using the DF mode in the last 200 feet, particularly if the ELT is in a metal building or other heavily obstructed location. Strength is indicated by a combination of the SENSitivity control setting and the meter reading in the RECeive mode. DO NOT use the receiver as a strength meter with NO ANTENNA. Without an antenna, the strength indication may be affected by how it is held as much as by distance to the ELT. In close quarters, a whip antenna (such as the L-Tronics® telescoping whip), or even a "rubber duck" borrowed from a handie-talkie will work. If the meter goes full scale with minimum SENSitivity, switch to 121.6 or 121.775 MHz or shorten the antenna to get the needle back on scale. You will find areas where the signal is particularly strong, but look for TRENDS of increasing strength as you enter rooms or move about a hangar. Keep up a visual search.

Harbors and marinas pose problems for the searcher primarily because of limited access and an incredible number of reflections that can be generated by masts, rigging, etc. If you have an EPIRB in a harbor,take a little extra time before you go in to find a couple of sites overlooking the area to take DF bearings. Notice some prominent features so you can recognize the area when you get down in among the boats. Once you start your foot search, turn the L-Per® to your right so the left side of the antenna (one with the arrows) is pointing forward. In the DF mode, needle positions predominately to the left indicate you're heading toward the EPIRB; to the right is away from it. This will enable the L-Per® to average out nearby reflections so the needle doesn't fluctuate so badly as it would in the normal left/right antenna position. You can use this fore/aft technique standing in the bow of a boat while you cruise the marina. Once you find you're very near the boat with the EPIRB, go back to the traditional left/right position. The DF should point to the boat from all sides you are able to get around. Remember to keep the SENSitivity control adjusted to keep a weak but audible signal. As you move away from the vessel, the signal will fade, just as it would when you move away from an airplane's ELT on an airport ramp. If you have a very strong signal, switch to 121.6 or 121.775 for more SENSitivity control range.

Internal Power

The L-Per® comes equipped with two alkaline 9V batteries of a size used in most small transistor radios. The alkaline type battery is more expensive than the common carbon-zinc cell, but will give superior service, particularly at low temperatures. Almost all cases of leaking and subsequent extensive corrosion damage to the circuit board are caused by cheap batteries. Repairing this damage can be costly! Lithium batteries are even better than alkaline for long shelf life and service. **HOWEVER**, the battery case is square on the sides and may jam on the power jack. If you want to use these batteries, trim the power jack mounting flange.

Battery life depends strongly on operating conditions. With low volume settings and little use of the dial light, up to 40 hours of operation can be obtained with alkaline batteries, or 15 hours with good quality carbon-zinc batteries. Continuous use of the dial light will reduce life by about 25%. High volume settings have a more drastic effect. Maximum volume operation will wear out alkaline batteries in less than eight hours. An earphone is suggested for noisy locations. Any 8 to 30 ohm phone with 2.5 mm (sub-mini) plug will work.

The receiver will work on one battery, but the life obtained will be less than half of that for two batteries. Put tape over the unused battery snap to prevent shorting if one battery is used. Do not mix old and new batteries or batteries of a different type (alkaline and carbon).

Remove the back cover to change batteries. The cover screws will be quite tight the first few times they are removed. For easier access, they can be replaced with L-Tronics® thumbscrews. ALWAYS turn the mode switch to OFF when changing batteries. Accidentally touching the battery clips to the battery the wrong way will damage early model receivers and the warranty will not cover such damage. Install batteries with the snap or connector ends up; if placed snap end down, they can catch on internal wires and damage the receiver. Install batteries is to place them in the receiver first, then connect the snaps. When removing, grasp the snap pad to remove; don't pull on the wires. Batteries should be removed for storage of more than six months, or one month for storage in a car trunk or other hot location.

Be sure the back cover is tightened thoroughly, especially on newer units, for proper RF shielding.

Battery Check

On older receivers, battery condition can be estimated in two ways. With maximum SENSitivity, crystal switch to the far left position, antenna connected, no signal, RECeive mode, the meter should read about 1/3 upscale with fresh batteries. A reading off-scale to the left indicates weak batteries. Another check is to observe the dial lights. They will not work if the batteries need replacement. The lamps will be hard to see in the daylight.

On receivers above SN 20120, the MUTE/BATTERY CHECK button (marked "Alarm Reset" on some units) is used to check battery condition. Select REC or DF on the Mode switch. New batteries or an adequate external power source will give a full-scale needle reading on the meter. When the needle falls to half scale (7V), the batteries are 2/3 expended. The receiver will fail when the needle reaches the left stop. The Battery Check capability can be added to older receivers (except those which have been modified by other than L-Tronics® with a series battery configuration).

External Power

Outside power can be supplied from either a 12V or 24V car or aircraft electrical system or a small 12V wall charger. The center terminal of the power plug is positive and the outer is negative (ground). The external power is internally regulated to 5V and has reverse polarity protection. The internal batteries are disconnected by plugging in the external power plug. Receivers below SN 20120 used 9V regulators and draw about 2 mA from external 12V power sources even with the switch off. This is unimportant on a wall charger or car battery, but an external dry battery should be disconnected when the receiver is not in use.

The buss voltage in some 24V aircraft systems can exceed 28V and cause the receiver to shut down.In new units. It will retorn to normal when the voltage goes below 28V. A 200 ohm, 2W series resistor in the external power cord will prevent this.

Operation With Other Antennas

The LH Series receiver will operate with any antenna, such as a yagi, quad, or dipole, that has a nominal 50 ohm impedance. Direction is found by selecting the RECeive mode and using the directivity of the auxiliary antenna and the L-Per®'s signal strength meter.

For aircraft operation, L-Tronics® offers several styles of antennas, described in our product catalog. An outside antenna is required for satisfactory aircraft use. All our antennas give automatic left-right DF indication. These kits can be placed on several aircraft and the receiver used on whichever is available for a particular mission. Connection of the LH Series receiver phone output to the aircraft audio system is recommended to give higher audio output and prevent feedback when using the aircraft transmitter.

With a pair of antennas, the L-Per® receiver, and a 5.5-wavelength coaxial cable, the system becomes an interferometer. This method of determining direction is extremely accurate for use when triangulation DF methods are needed in mountainous or impassable terrain or in bad weather.

D.F. In Motion

The antenna supplied with the L-Per® is not designed to be mounted on a vehicle. Some DF in motion can be obtained by holding the antenna out a window with the dipoles above roof level. A coaxial extension cable would permit keeping the receiver inside the car, making the meter easier to read.

The presence of the car close to and on one side of the antenna usually introduces a large DF error. This, combined with the rapidly shifting reflections from buildings, trees, wires, and other things that the car is passing make the usual DF procedure nearly useless. Fortunately, experience has shown that a signal can be located quite rapidly just by knowing "fore" and "aft" direction, particularly if one or two good initial bearings are taken by hand. Still further improvement can be obtained by adding "left-right" to "fore-aft."

Fairly good fore and aft response can be obtained by holding the L-Per® out of a car with the left side of the antenna (stencilled arrows) facing forward (Figure 6). This allows the receiver to face the operator. Switch to DF mode. If the needle goes left, the signal is ahead of the car. If it goes right, it is behind. In most cases, the needle will

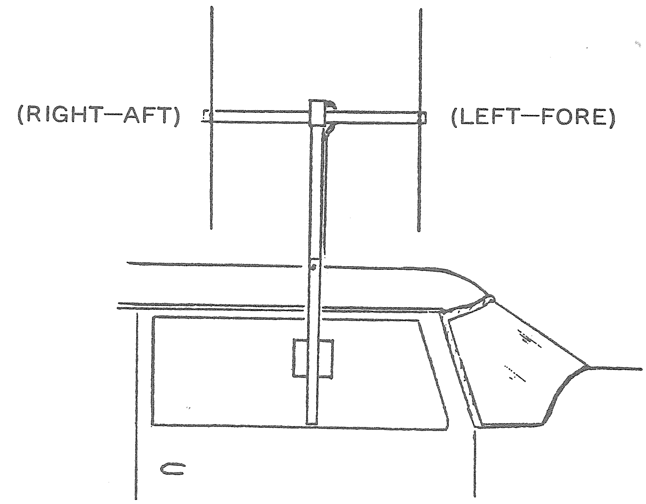


Figure 6. Using the Hand-held Antenna from a Vehicle.

hold these positions despite nearby reflections until the signal direction is off one side of the car. When the DF needle swings about equally fore and aft with the car in motion, the signal is approximately broadside the car. Turning the L-Per® antenna 90 degrees to the car at this point to determine which side the signal is on is not reliable due to the unsymmetrical presence of the car. Instead, turn the car while leaving the antenna fore and aft.

If more than occasional vehicle DF is anticipated, an external antenna can be permanently installed on the car roof. The LAA-10 or LAA-16 flexible whip antenna is quite suitable. If a single pair of antennas is used, they will be most useful oriented fore and aft just like the hand-held antennas described above. A second pair may be mounted for left-right operation, with a coaxial switch for selection of the proper feed cable. If the antennas are centered on the car roof, fairly good left-right discrimination can be obtained. Vehicles with plastic roofs will require installation of inside ground radials.

For temporary installations on steel-roofed vehicles, the L-Tronics® magnetically mounted antennas should be considered. Their roof layout is the same as described above. The antenna spacing is not critical, so the assembly can be quickly installed and removed. The holding power of the antennas may be marginal on vinyl covered roofs.

Good results can also be obtained with a three or four element yagi antenna mounted on a pole and used with the L-Per® in RECeive mode. The L-Tronics® LHBA-1 Beam Antenna can also be used this way. These antennas have the advantage of some antenna gain for weak signals. Both the yagi and L-Per® antennas can be adversely affected by the presence of other antennas on the vehicle, particularly those tuned to the same frequency as the DF.

The L-Per® receiver is fairly resistant to ignition noise, but a suppressed or shielded ignition system may be needed for best performance.

The section of this manual on Antenna Installations gives details of mounting and use of the various directional antennas.

Remote Meter

Receivers above SN 20120 have a jack for a remote meter located on the bottom of the unit. The L-Tronics® LRM-3 Remote Indicator is designed for this purpose. This meter indicates both strength and DF simultaneously and is heavily damped to minimize needle flutter in mobile operation. The connector can also be added to older receivers. A remote meter makes single-operator mobile DF easier and safer.

Other Information

Some L-Pers® have "ALARM" and "243" etched in their front panels. These were supplied covered if the Alarm or UHF circuits were not installed. The "Alarm" position can be used for an additional VHF crystal (socket 1). Unless a crystal or tuner is installed, these positions have no function and **WILL NOT** receive a signal.

The meter on the new units are not as "lively" as those on older receivers; however, accuracy and sensitivity are improved.

The L-Per® is water-resistant and will withstand moderate rain as supplied. If severe conditions are expected, water resistance can be improved by covering the back-to-case joint and the power and earphone jacks with tape. The speaker is waterproof. Still better protection can be had by slipping the receiver into a plastic bag with small holes punched for the mounting screws and the antenna lead. If the receiver is filled with water, it will quit. The most obvious outside signs of water are loss of signal and a high reading of the meter in RECeive mode. If this happens, turn the unit off and dry it out before operation. Pay particular attention to blowing the water out of the tuning capacitors. If salt water or other contaminated water entered the receiver, rinse with clean water before drying.

Periodically check the aluminum rods for signs of oxide buildup at the swivel end. This oxide could cause the antenna to have poor electrical connection and malfunction. If there is any corrosion (or suspected corrosion), spray a little electrical contact cleaner on the point where the rods swivel. (Do NOT use WD-40 or a similar substance.) Work the rods back and forth a few times to clear the corrosion.

The L-Per® does not have a squelch because it was found to be an operational hazard in most cases. For long-term monitoring, L-Tronics® offers a monitor version of the L-Per® with a sophisticated noise compensating squelch system.

Warranty And Repair

Two warranty forms are supplied with each piece of equipment, explaining the warranty in detail. Be sure to return one completed copy to the factory. This will place your name on our mailing list so you receive notice of new equipment, updated operational information, and periodic newsletter.

In case of any difficulty, ship the unit to the factory. Return authorization is not required. If the failure is not due to misuse, tinkering, or accidental damage within one year of the date of purchase, the unit will be repaired or replaced at the option of L-Tronics®. This repair or replacement will be free of charge, including return shipping charges. In all other cases, a nominal repair charge will be paid by the customer.

Repair service is also offered at low cost. Please include a note indicating the type of problem being encountered and a name and phone number of a person to contact during the day. A name and street address where the unit can be returned by United Parcel Service (no Post Office boxes, please) should also be given.

In case of difficulty, call or write L-Tronics® for assistance. We will try to help you with field problems as well as those related to the equipment by adding our experience to yours.

L-Tronics®
5546 Cathedral Oaks Road
Santa Barbara, CA 93111
Phone: 805-967-4859, Monday-Friday
9 a.m. to 5 p.m. Pacific Time
e-mail: bgordon@rain.org

Section 2

Antenna Installations

L-Tronics® offers a number of aircraft and vehicle antenna systems, as well as fixed-location antennas. They are available either for a single frequency range or band (single band) or for two different frequency ranges (dual band). Single band units consist of two whip antennas and a molded switchbox and cable assembly. Dual band units have a third whip mounted between the first two. Single band installations can be converted to dual band at any time by adding a suitable center antenna. Antenna kits for aircraft are offered using standard bent whips, or flexible whips. All antennas work with either LH Series portable or LA Series aircraft DF receivers. The following describes aircraft installation, but the principles also apply to vehicles. Following the section on aircraft antennas are instructions on installing and using magnetic and weatherproof antennas.

Switchbox assemblies are NOT interchangeable between antennas with different whip styles. Antenna whip length and the length of the cables between the antennas and switchbox cannot be changed without degrading or destroying DF performance. The center antenna for dual band assemblies must not have any electrical connection to it. A short tuning stub is provided with certain dual band models requiring it. This center antenna is NOT a "spare antenna" for use on other equipment.

Flight test ALL new aircraft installations.

Each receive frequency selected on the DF receiver may cause interference to one communications channel: for 121.5 the affected frequency is 132.2 MHz; for 121.6 it is 132.3; for 121.775 it is 132.475; and for 243 it is 126.85 MHz. If communications is required on these frequencies, TURN THE DF SET OFF.

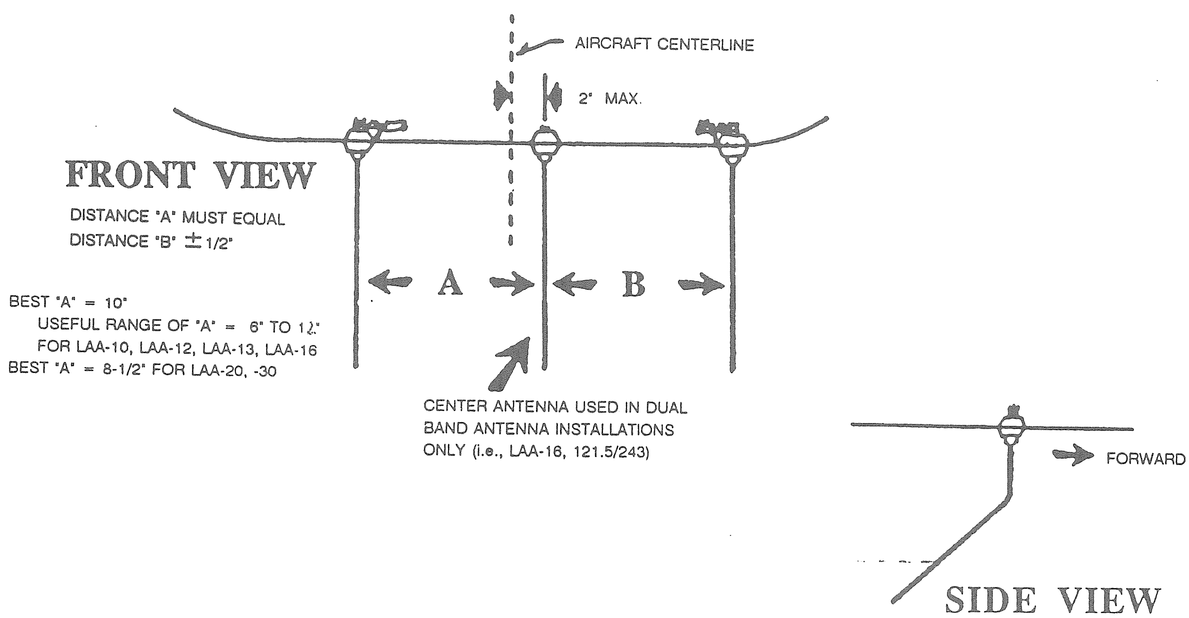


Figure 7. Antenna Installations.

Antenna Test Procedures

All left-right DF antennas can be checked for shorts and diode damage without disassembly by using either an analog ohmmeter with a test voltage above 1 volt or a digital meter with a diode test funtion. Both outboard or VHF rods should measure 470 ohms ±20% to the aircraft ground or the coax cable outer shield. The center, or UHF rod (if present) should measure open circuit. The center conductor-to-shell resistance of the cable to the receiver should be neither a short nor open and whatever number the ohmmeter or diode test meter reads should be the same (±20%) when the leads are reversed. If problems persist, call the factory for further assistance.

LAA Series Antennas

The performance of any DF set is absolutely dependent on the antenna installation. For locating ELTs and other transmitters on the ground, THE DF ANTENNAS SHOULD BE PLACED ON THE BELLY OF THE AIRCRAFT if possible.

No single installation method will work best for all aircraft. The following principles and suggestions should ensure a good installation. The further your installation departs from the standard, the more flight testing will be required to verify proper performance.

Belly installation is preferred because the aircraft structure does not come between the ELT and the antennas when passing overhead. It also prevents buzzing on comm signals that often occurs when comm and DF antennas are close together, and possible interference to GPS from comm transmissions.

The whip antennas and the aircraft structure work together to form the directive antenna patterns necessary to the operation of the DF set. A doubler plate or other skin reinforcement is usually required around the antenna mounting holes. The switchbox and antenna cabling must be adequately secured. Installation of the antennas and the permanently-mounted aircraft DF (LA Series) will usually require an FAA Form 337 signed off by a mechanic or radio repairman. The antennas are TSOed and the receiver is considered either portable or non-essential equipment by the FAA.

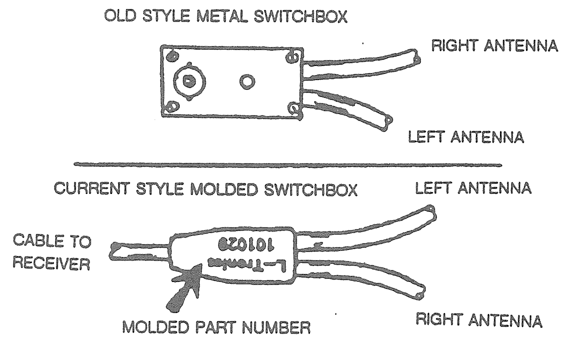


Figure 7a. Antenna Connections.

The antenna rods are installed on a line at right angles to the direction of flight, as shown in Figure 7. The coaxial cable supplied with the antenna kit should have one of its two short leads marked "left." This lead is connected to the left antenna, the other lead to the right one for either top or bottom installation. The center antenna usually has no connection, although some models have a short, open-ended tuning stub supplied. If the leads are not marked, the leads can be identified by placing the switchbox as shown in Figure 7a. If the leads are put on the wrong antenna, the meter readings on the DF set will be reversed.

Three things are critical to successful installation of the DF antenna system: (1) the length of the antenna rods, (2) the length of the cables from antenna rods to the switchbox, and (3) the symmetry and freedom from blockage of the mounting location.

Antenna damage which shortens the whips by more than 1/2 inch must be repaired by substituting new parts. The length of the cable from the switchbox to the receiver is not critical. Replacement parts are available from the factory.

Location and Clearance

As noted above, BELLY MOUNTING IS STRONGLY RECOMMENDED except for seaplanes or for aircraft with special equipment like cargo pods. Spacing between the antennas can be varied somewhat to suit the aircraft structure. The nominal spacing of the outer antennas is 10 inches from either side of the aircraft centerline. This can be made as far as 12inches and as little as 6 inches either side of center (12 to 24inches total). If a choice exists, narrower spacing should be chosen. If the center antenna cannot be placed exactly on the aircraft centerline, all three antennas can be shifted left or right by up to 2 inches. The spacing of the outboard rods to the center rod (or centerline) must be identical.

Mounting on a curved surface is OK as long as the outer antennas are not more than 40 degrees off vertical and are symmetrical. Mount the antennas to maintain spacing at a point 5 inches up the antenna from the base.

The DF antennas should be moucnted well forward on the aircraft. A good spot on Cessna 172s and 182s is just below the rudder pedals. Inspection plates in the floor give ready access and DF antenna patterns are good. This also works for Piper Cherokees, except that covers will have to be made to protect the cables above the honeycomb panels. Mounting further back, between the gear, has given poor antenna patterns on several installations.

Transponder, DME, and boat-type marker antennas commonly found on the belly do not cause interaction problems if they are one foot or more from the DF antennas. Sled type marker or ADF sense antennas, CB antennas, and 150 MHz comm antennas should be on the centerline.

The antennas can be bent near the tip for ground clearance, shown as a dotted line in Figure 7, as long as all rods are bent equally. Leave the initial bend unchanged. Contact the factory if the total distance of the antenna from the fuselage is less than 10 inches. Hot bending is required; cold bending will radically reduce fatigue life, even if immediate breakage does not result. For helicopter or other installations where ground contact is probable, the flexible whip antennas can be used. They may also be bent as long as all are identical. Flexible whips are not TSO, so they may require more effort for installation approval.

If the antennas must be installed on top, they should still be very near to the centerline of the aircraft. Nearby VHF antennas and other objects of similar size must also be symmetrical if an accurate homing course with no false courses is to be obtained. Figures 8, 9, and 10 show some layouts that have worked.

Figure 8 shows the best layout for multiple antennas on the top of an aircraft. The arrangement of Figure 9 is also usable and has the advantage of retaining a commonly-used location for communications antennas, which MUST be of the same type as each other, but not necessarily the same type as the DF antennas. The comm antennas must be connected to a radio or otherwise terminated; any unconnected comm antenna near the DF antennas can ruin DF performance.

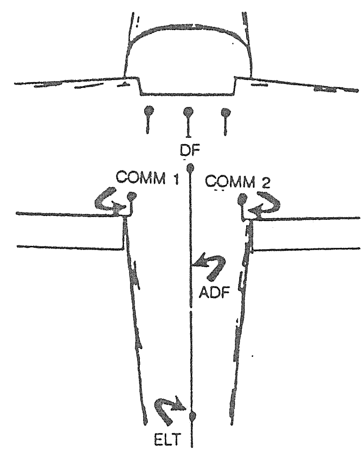


Figure 9.

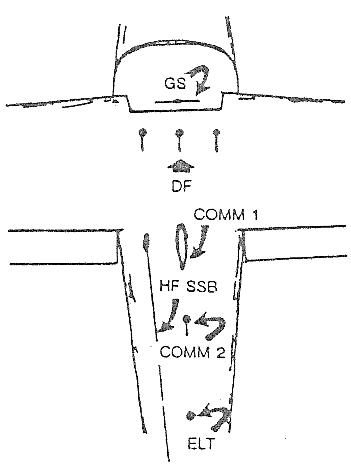


Figure 8.

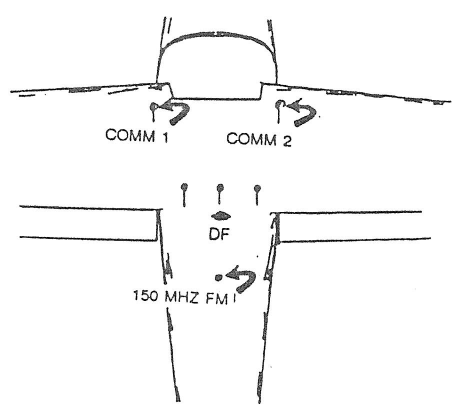


Figure 10.

There is considerable interaction between DF and comm antennas. **THE DF SWITCHING MAY PUT A STRONG TONE ON COMMUNICATIONS RECEIVER SIGNALS FROM SOME DIRECTIONS.** The DF will have to be turned off or the aircraft heading changed for good comm intelligibility.

Things to Avoid

A few things to avoid are: mounting on the engine cowl due to excessive radio noise, vibration, and propeller modulation of the received signals; mounting within four feet of a non-retracting step more than one foot long (especially Cessna 310); mounting any further aft than one foot forward of the main gear legs on Cessna 172/182 aircraft and Yankees. Check other narrow tread fixed gear installations carefully.

Glide slope antennas should not be placed behind a three-antenna DF array if a convenient forward location exists because of a small shielding effect. Glide slope, Loran, ADF, and Stormscope antennas have no observable effect when mounted near the DF antennas. ADF sense, 150 MHz comm and Citizens Band antennas should be located on the aircraft centerline if possible.

All transmitting antennas, including HF and CB, should be separated from the DF antennas using the minimum safe distances shown in the following table. The switching diodes can be damaged if transmitting antennas are too close. If damage occurs, the DF meter will deflect to one side only or stay centered.

5 watts	3 feet
10 watts	4.5 feet
25 watts	7 feet
40 watts	10 feet
80 watts	15 feet

Antenna Mounting Details

The length of the lead-in cable from the switchbox to the DF receiver is not critical. See Figure 15 for connector assembly. Many problems with the DF set can be traced to poor connector installation, especially a center pin that is too far below the connector end. The switchbox may be secured with cable clamps or ties. Be sure to attach the cables to the proper antenna, as shown in Figure 7a, or the DF needle sensing will be reversed. The threaded portion of the standard whip should be more than 1-1/2" long to accommodate all hardware. Occasionally the threaded ferrule supplied on the antenna must be tightened to give full thread length. The antenna mounting holes must be flat and burr-free and the fiber washers MUST be used to avoid breaking the ceramic insulators. We recommend coating the fiber washers with "RTV" rubber for improved cushioning and sealing. See Figures 14 and 16 for details. The inside of all antenna rods must clear surrounding structure by at least one inch and preferably two inches.

There is no electrical connection to the center rod of the LAA-16 antennas (121.5 MHz/243 MHz). The center rod is somewhat shorter than the outboard antennas. On some models, a short coaxial tuning stub is supplied for connection to the center antenna and all antenna rods are the same length. The free end of the stub should be tied down.

Flexible Whip Antenna Installations

These antennas are not TSOed and should be considered only for specialized aircraft and helicopter application or for use on vehicles. The flexible whip installation differs from the standard bent whip installation both in whip type and in cable length from the whips to the switchbox. The strip length is 1-1/2" rather than 2" on the antenna end as shown on the manufacturer's data sheet. Cables are supplied pre-stripped, ready for assembly. A doubler plate will be required in most light aircraft installations to take the stress at the antenna base clamp.

There are two identical antenna rods supplied for units operating on a single band (121.5, 121.6, 121.775). A third, shorter rod for the center position on dual band (121.5, 121.6, 121.775/243) installation, similar to the bent whip antennas described above. The antennas will perform well for 5% below and at least 10% above the cut frequency. The antenna rods may be bent back on a gentle radius starting 4 inches from the end of the whip socket to provide better ground clearance without affecting electrical performance significantly. Some course instability will be noticed in the homing course at times due to antenna vibration in the airstream. A small change in airspeed or engine RPM may reduce the effect.

If the antenna rods are to be removed when not in use, loosen the two Allen setscrews with the wrench provided. Do not remove the whip sockets, as this will damage the cable center conductor after a few times. The setscrews should be retightened after the antenna rods are removed to prevent their loss.

Fabric and Composite Aircraft

Antenna installation on composite or fabric-covered airplanes presents a problem in obtaining an adequate, symmetrical ground plane for the antennas. The sheet metal fairings on the wing leading edges above the cabin or aft of the firewall on the belly of many aircraft have been successfully used. An adequate ground can be constructed of four or more 24" lengths of 22 ga. copper wire or one-inch-wide strips of adhesive-backed copper foil fastened under the fabric or composite skin, evenly spaced around the antenna base and connected to the braid of the antenna coax cable. If a choice exists, this constructed ground plane should be used for the communications antennas and the sheet metal ground used for the DF due to the disturbing effect of the normally unsymmetrical tubing fuselage structure. A metal area of at least 18" x 36" is required. If the DF antennas are installed over a wire or tape ground plane, one wire or tape should run directly between the bases of all antenna rods. A fully enclosed DF antenna is possible on some composite aircraft; however, this project will require an extensive engineering project with substantial flight test followup.

Alternate Antennas

Antennas for frequencies other than those listed in the catalog can be supplied for Little L-Per® Portable DF sets having the capability.

Internally mounted antennas, such as wires taped to windows of a metal aircraft, generally give unsatisfactory results. The major problems are ambiguity and false courses, particularly to the rear of the aircraft, and sensitivity to the presence and movement of cabin occupants. Thus, such an antenna may seem to work on a limited test but have major problems on a real search.

Temporary Antennas

A satisfactory temporary installation can be made by mounting a flexible whip assembly on an aluminum hat or channel section as shown in Figure 11. The channel must be formed to fit close to the aircraft skin for a ground reference. It may be held in place using screws from inspection plates, bungee cords, etc. The forward edge of the metal should be taped with duct tape to prevent it from lifting in the airstream. The dimensions shown are about minimum for satisfactory ground coupling to the aircraft skin. Such a temporary antenna can be used to evaluate problem installations BEFORE drilling holes.

Vehicle Installations

If more than occasional vehicle DF is anticipated, a flexible whip antenna kit can be installed on the car roof. Plastic roofs will require a ground screen like that described for fabric-covered aircraft. If a single pair of antennas is used, it will be most useful oriented fore and aft as shown in Figure 12A.

In this configuration, with the receiver in the DF mode, a needle swing to the left of center indicates that the signal is in front of the vehicle and a swing to the right indicates location to the rear. This method of operation gives less meter confusion than left-right operation when driving in the presence of many reflecting objects (which is usually the case). A second pair may be mounted for left and right operation with a manual switch for pair selection. If the antennas are centered on the car roof, fairly good left-right discrimination can be obtained (Figure 12B). The illustrations of Figure 12 show these arrangements, which are also used for the magnetic antenna kits. For vehicles with emergency light bars, place the left/front antenna in front of the bar and the right/rear antenna behind it.

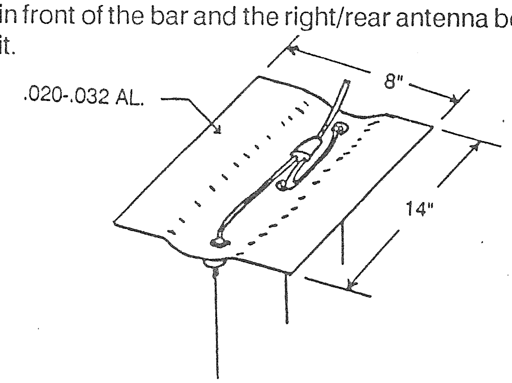


Figure 11. Temporary Installation.

LVA Series Magnetic Antennas

Magnetic antennas can make a temporary DF installation on any steel car roof. They will work electrically on vinyl covered roofs, but may blow off at modest speeds.

The antennas are optimized for gain and SWR at the design frequency and will provide a usable pattern with less than 3 dB sensitivity loss over the listed useful range. Optimum spacing is also listed, but differences of ±3 inches produce negligible performance change. If a four (or five) antenna (fore/aft, left/right) installation is used, the antennas should be moved apart until the optimum spacing is measured between adjacent corners. Dual band models have an additional center antenna, which determines the higher frequency range; the outside antennas determine the lower range. If operation is desired on only the lower range at a given time, the center antenna may be left off.

The magnetic antennas require a ground surface to operate., normally supplied by a car roof. The antennas will not operate properly over a ground surface smaller than twice the length of the antennas. A wire screen can be used for such a surface if steel plates larger than the antenna bases are attached to the screen to mount the antennas.

All transmitting antennas, including HF and CB, should be separated from the DF antennas using the minimum safe distances shown in the following table. The switching diodes can be damaged if transmitting antennas are too close. If damage occurs, the DF meter will defelct to one side only or stay centered.

5 watts	3 feet
10 watts	4.5 feet
25 watts	7 feet
40 watts	10 feet
80 watts	15 feet

The electronic switch on the LVA Series antennas is a waterproof molded assembly, repairable only at the factory. The resistance checks outlined at the beginning of this section also apply to this assembly. Should replacement be required, return the damaged antenna bases and cable (whips not needed) and state the model or frequency range of the antenna.

The antenna bases are covered with a plastic anti-scratch cover. Loss of this cover will degrade performance; however, tape or adhesive vinyl shelf paper can be used as a replacement. It is not recommended that these antennas be left on the vehicle for storage; the bases can deteriorate and crack from continued exposure to the elements.

Placement of antennas is described in the previous section. All comments pertain to both magnetic and permanent installations.

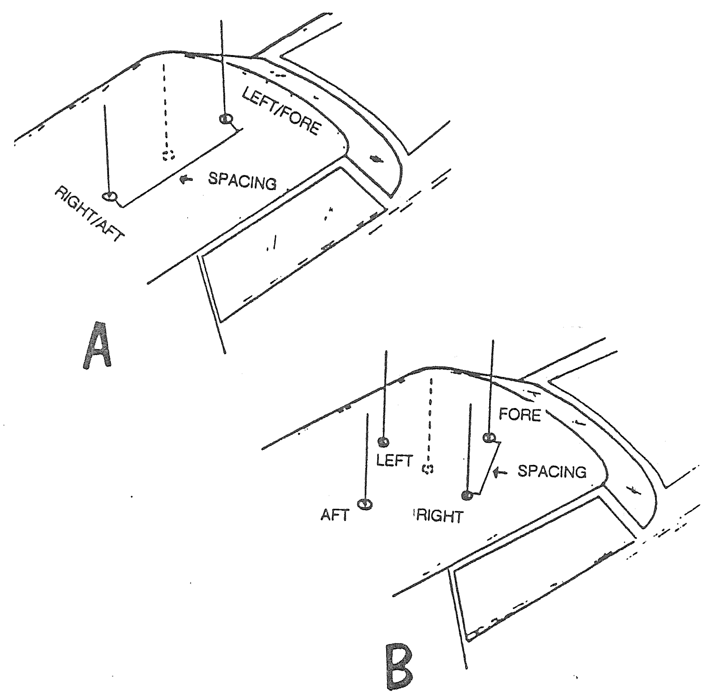


Figure 12. Vehicle Installations.

LVA ANTENNA SPECIFICATIONS

	Frequency		Antenna Spacing		
Model	Frequency	Useful Range	Design Center	Useful Spacing	Antenna Length
LVA-10	121.5 MHz	118-136 MHz	20"	12" - 26"	22.0"
LVA-20	146.0 MHz	144-155 MHz	16"	10' - 22"	18.5"
LVA-30	154.0 MHz	150-162 MHz	15"	9" - 20"	17.5"
LVA-40	163.0 MHz	158-174 MHz	14"	8" - 18"	16.5"

LWA Series Weatherproof Antennas

Weatherproff antennas are primarily used for fixed site DF mounted on rotators on towers. They are also used mounted left/right on masts for marine DF. The weatherproof antennas are shipped disassembled for compactness. To assemble, first thread the gray crossarms into the antenna elements, threading the coax cable through the pipe. Plug in the coax cable from an element into either jack on the hub. Form a loop and push the excess cable and the connector back into the crossarm until the crossarm can be screwed into the hub. Do the same with the other element and crossarm. The two elements are identical. The top of each element is marked by a red dot. Screw the crossarm assemblies together until both elements are parallel with the mast and center element (if any) with their red dots up. Hand tightening is sufficient. Don't use a wrench, as the plastic hubs may split.

The antenna hub as supplied is designed to fit a 1" plastic pipe mast. A 3/4" or 1/2" threaded pipe mast may also be used with one of the adapters provided. The adapters should be cemented in for mobile or shipboard use. Press fit may be OK for fixed installations. PVC pipe cement or DUCO household cement are recommended. For orientation, the left antenna is identified by a red dot on the hub. See Figure 13.

Locate the antenna in as clear a position as possible, particularly if it is to be rotated for DF. If the antenna is to be fixed, such as for a shipboard homing installation, make the mount as symmetrical as possible. The red-marked element should face the left side of the ship. For rotary installations, the orientation should be as shown in Figure 13. In any case, the red marked element corresponds to the element marked "MAX SIGNAL REC MODE" on the portable antenna.

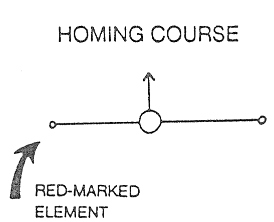
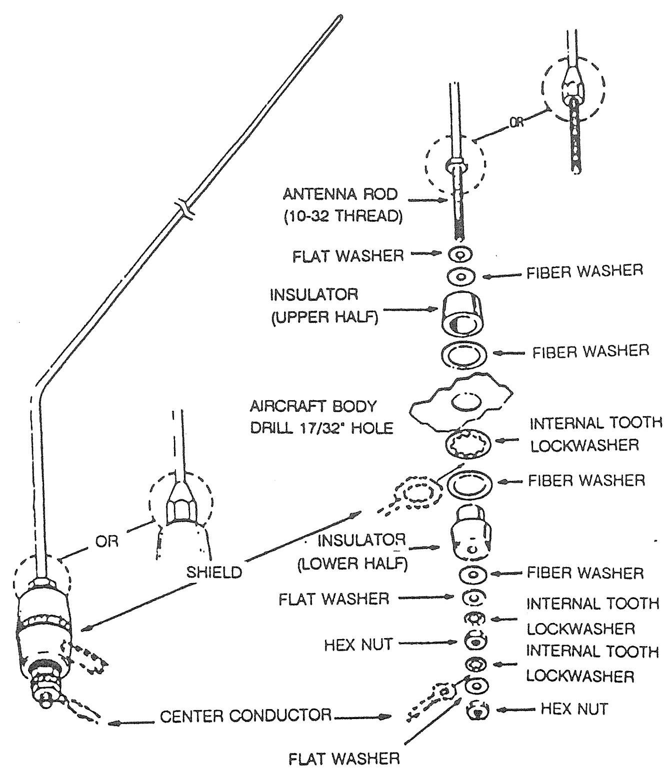


Figure 13. Rotary (Weatherproof) Installation.

If the antenna is used with a rotator, set the receiver to the DF mode. If the needle deflects to the right, turn the rotator control clockwise to center the needle. If the needle deflects to the left, rotate the antenna counterclockwise. There will be two center readings, 180 degrees apart, just as you have with the hand-held antennas. Ambiguity is resolved in the same manner.



NOTE: COAT FIBER WASHERS WITH RTV OR "BATH TUB CAULK" RUBBER AS ADDED CUSHION AND SEAL.

Figure 14. LAA Series Bent Whip Antenna Assembly.

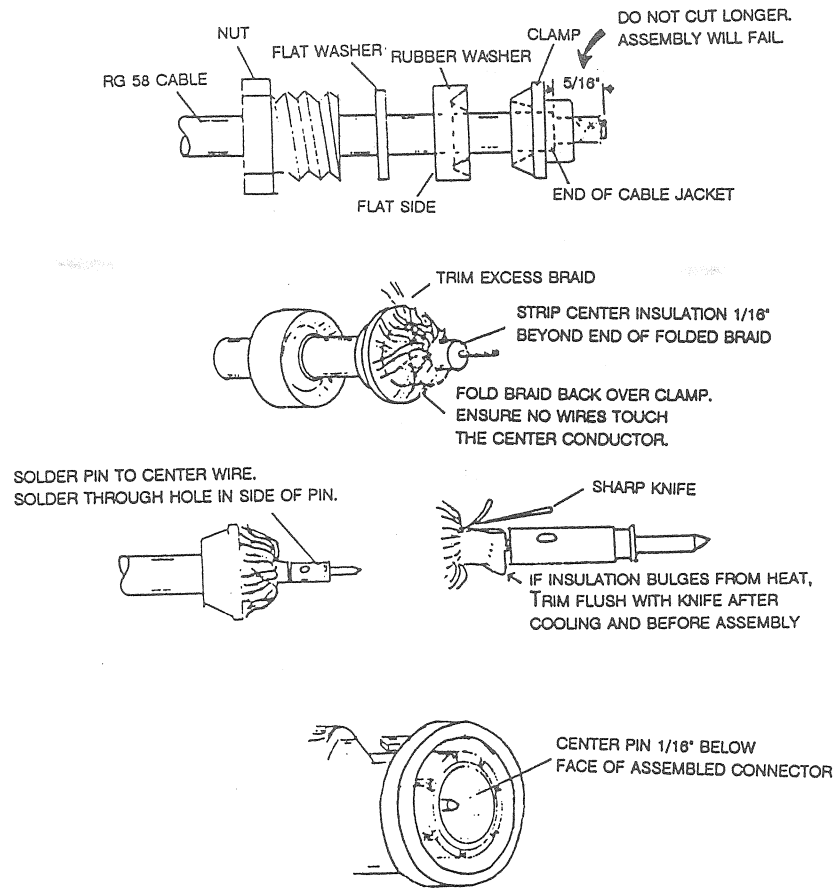
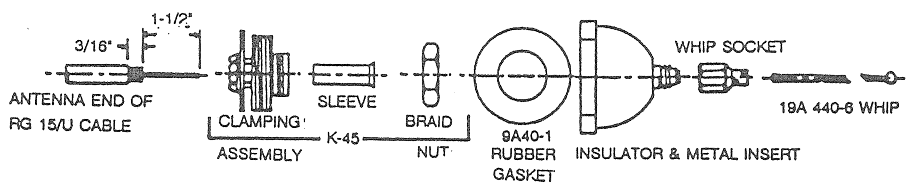
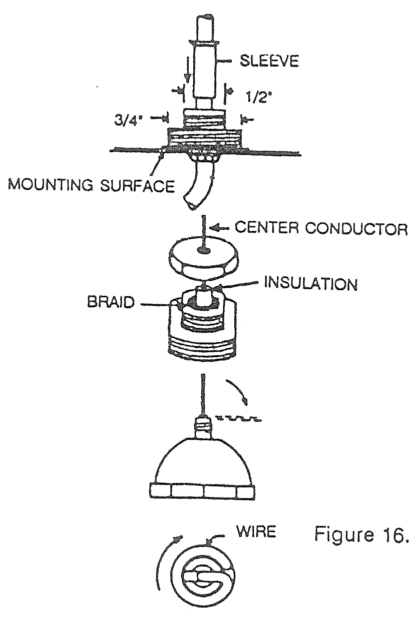


Figure 15. UG-88 Assembly.





1. Drill 3/8" hole in desired location. Attach reinforcing doubler plate inside if required for adequate stiffness.
2. Remove washer from clamping assembly by compressing spring fingers.
3. Insert clamping assembly into hole. Reinstall washer on the clamping assembly from the inside.
4. Thread the coax through the clamping assembly. Insert sleeve, plain end first, over the cable and into clamping assembly until its flared end is flush with the top of the clamping assembly.
5. Hold clamping assembly on 1/4" flats and tighten collar (3/4" flats) securely.
6. Put rubber gasket flat against aircraft surface and install braid nut.
7. Put rubber gasket flat against aircraft surface and install braid nut.
8. Pull coax center conductor through slot in the metal insert and wrap clockwise around the outside. Trim off excess wire.
9. Install whip. Check that setscrews are tight.

Figure 16. LAA Series Flexible Whip Antenna Assembly.

Section 3

Technical

THEORY OF OPERATION

All of the DF antennas used with the LH Series Little L-Per® receivers are directive. That is, they receive a signal better in one direction than another. If this variation with direction is drawn, a pattern of nearly cardioid shape, like the solid line in Figure 17, results. This pattern shows highest sensitivity to the right and near zero sensitivity (null) to the left. The pattern can be reversed to the dashed outline by a switch that is part of the antenna.

In DF mode, the patterns are switched back and forth, producing the DF tone and causing the meter to point to the side having the strongest signal; to the right for both Signal 1 and Signal 2 in the figure. When the signal comes in at a right angle to the antenna crossbar, the two patterns have equal sensitivity, the DF tone nearly disappears, and the DF needle centers.

This type of DF is known as an amplitude comparison homing system and has been in use as navigation aids since the early 1930s. Many automatic indicating DF systems employ an FM receiver and sense direction by pseudo-doppler frequency shift. This is a different principle. These systems track communications signals very well, but they have an inherent sensitivity disadvantage compared to AM systems such as the Little L-Per® and cannot track some non-coherent ELTs.

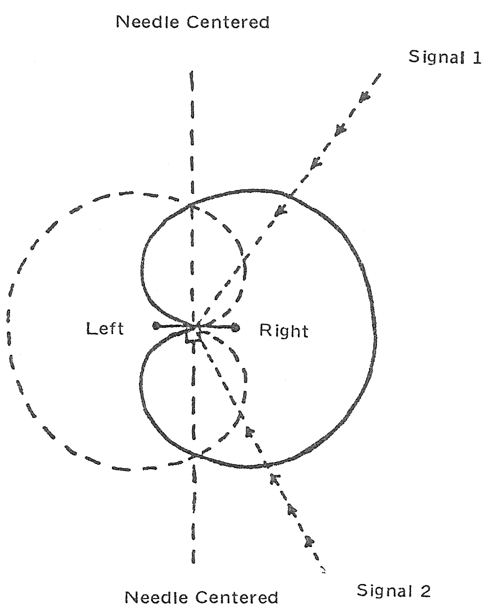


Figure 17. Switched Antenna Patterns

In the RECeive mode, the antenna switching is stopped on the left pattern and the meter is connected to the receiver AGC line to indicate signal strength. It will indicate a broad maximum when the signal source is off the left end of the antenna crossbar, as indicated by arrows stenciled on the bar.

About Antennas

The LH Series unit antennas are two-element yagi or parasitic antennas. The aircraft, vehicle, and weatherproof antenna systems have a third element added for dual band use. The patterns they produce are nearly identical to those produced by the more common dual driven or "phased" assemblies except that the pattern of the yagi is less dependent on element spacing and the impedance match is better, giving it 3 to 5 dB better sensitivity. Where signals are strong, no measurable performance difference exists.

The antenna pattern is switched by diodes located in the antenna switchbox driven by a switching signal on the center conductor of the coaxial cable. A much longer feed cable can be used if the signal loss can be tolerated, but most filters or attenuators will stop the switching and also make the regular antenna inoperative in the RECeive mode. A bias or switching signal would have to be provided to make the Little L-Per® antennas work with other receivers.

The Little L-Per® antenna is a compromise between good weak signal sensitivity and physical size. If the situation permits, the L-Tronics® folding yagi or a large, multi-element yagi or quad can give a worthwhile sensitivity improvement. DF switching circuits will not be damaged by the DC short on the feed line from these antennas.

The Receiver

Amplitude comparison DF systems need an amplitude (AM) receiver. The Little L-Per® is an AM receiver, although it will DF very well on an FM signal or random noise. It usually gives enough audio output from FM to identify the source. The receiver employs double conversion and a crystal filter to suppress false signals from adjacent channels and a wide range RF gain control which makes elaborate shielding unnecessary. The RF gain control does not change the meter scale factor in the RECeive mode. That is, if a 15 dB change in signal strength makes the meter swing over the full scale at maximum SENSitivity, it will do the same at any lower SENSitivity setting.

The DF information is derived from the audio amplifier output by a synchronous detector in older receivers or by a CPU running a digital signal processing program in current receivers. In either case, the result is a signal that causes the meter to point toward the strongest signal. The bandwidth of these metering circuits is less than 3 Hz. This narrow metering bandwidth is the reason the unit will DF on a signal too weak to hear.

ELT signals are pulsed. Supposedly, the on-time is at least 33%, but as low as 7% has been measured in the field. Under these conditions, the receiver may overload or clip on peaks and destroy the DF information, while the signal strength meter —which reads average—is only at half scale.

Starting with serial number 20119, the internal circuitry of the receiver was substantially changed. A separate parts list, layout, and schematic for the new version is included in this manual. The circuit boards are abviously different, so no confusion should result. In the following material, receivers below S/N 20119 are referred to as "old units;" those with higher numbers are "new units."

The recommended operating technique of advancing the SENSitivity control only so long as it produces an increase (as opposed to decrease) of DF needle swing will always avoid overload because overload clips the peaks of the signal pulses and thus reduces or removes the DF information on both old and new units.

The major changes on the new units are:

Changed to a 5V low dropout regulator for all circuitry that works with external and battery power. This stabilizes performance and extends battery life.

Substituted GaAs FETS for silicon FETs to improve stability and noise figure.

Substituted an A/D converter and CPU for mode switching, DF processing, meter drive, and monitor functions. This provides better meter dynamics and eliminates the audio gain and DF centering adjustments. Electronic "stops" have been put in the meter to prevent it from going off-scale.

Added a battery test pushbutton.

Added a connector for external strength and DF meters.

Added connectors so the circuit board can be unplugged from the box for servicing.

Changed to high brightness LEDs for the dial light.

Substituted individual tuner gain controls for the single IF gain control.

Added synchronous blanking to the IF amplifier to reduce DF switching noise.

FUNCTIONAL CHECKS & ADJUSTMENTS

CAUTION!
Use an insulated screwdriver
for all adjustments.

Set the Little L-Per® receiver up for operation: 121.5 MHz, RECeive mode, SENSitivity at MAXimum, antenna connected, and fresh batteries or external power. Old unit should indicate 2.5 to 3.5 divisions upscale from the left. On 243 MHz, the needle should go at least 1 division upscale. new units should indicate 1 to 2 divisions upscale on either frequency. Selecting an unused crystal position or turning the SENSitivity control down (counterclosiwise) should cause a substantial drop in meter reading and a decrease in noise on both old and new units. Some change in reading will often be noted when the antenna is disconnected. Readings may be higher if the DF is in a noisy (city) area.

On old units, maximum sensitivity is set by the upper trimming potentiometer on the right side of the circuit board (R42). On new units, the VHF and UHF gains are set separately by trimpots below each mixer (R13 and R27).

On old units, audio gain and DF sensitivity are set by the lower trimming potentiometer on the right side of the PC board (R44). It is factory set for maximum usable DF sensitivity. Distortion produced by further advancing of the control will produce DF errors. Maximum sensitivity can be set using an audio voltmeter (AC coupled or "output") connected to the arm of R54, RECeive mode, one half volume, VHF tuner, no signal. The noise peaks should be set to 0.5V RMS. A rough setting can also be obtained by adjusting for a total battery drain of 50 to 60 mA at MAXimum volume and the above conditions. If the sensitivity is too high for most of your work, this control can be turned down for a small resultant saving in battery drain, but DO NOT SET IT ANY HIGHER. This control also affects the speaker audio level.

On older units, centering of the meter in DF mode in the absence of signal is set by the trimming potentiometer in the lower center of the board (R54). This control is quite "touchy." It should be set for equal left and right deflection caused by noise with SENSitivity at MAXimum and no signal; a small deflection with change of the SENSitivity setting is normal. Audio gain and DF centering are not adjustable on new units.

Tuner alignment requires tuning of each of the five air-spaced trimmers in each tuner for maximum signal as indicated on the meter in RECeive mode. There is some reaction between the antenna tuning adjustments in LH Series units with two tuners. Adjust the higher frequency tuner first. On old style L-Pers® with two tuners, gain balance between tuners is set by adjustment of the Tuner 1 oscillator collector tuning capacitor, C16. On dual tuner units, adjust the higher frequency tuner for maximum gain and set R42 for an indication up two divisions in RECeive mode. Then adjust the lower frequency tuner for maximum gain and finally reduce the meter reading to about 3 divisions by opening (lower capacity) C16. A stable signal source is required for tuner alignment and alignment MUST be done with SENSitivity at MAXimum and with the unit operating on a fresh set of batteries, not external power. The internal regulator produces some small excess noise, which will affect this adjustment.

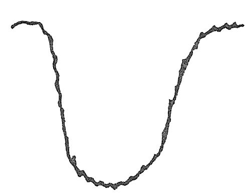
On new units, both tuners are aligned for maximum signal response on all settings and then trimmed slightly for best noise figure. If a noise figure meter is not available, listen for best apparent signal to noise with an input signal of 0.1 to 0.2 μV. Then set the noise level of each tuner for 1.5 division meter deflection with no signal. If a near maximum gain is needed, particularly on the UHF tuner, touch up the mixer gate tuning after setting the gain.

Field IF alignment IS NOT recommended. Tuning for maximum WILL NOT WORK. If alignment is required due to component replacement, an oscilloscope and a sweep generator capable of a stable sweep of 100 kHz P-P deviation at a 2-5 Hz rate will be required. A 60 Hz sweep rate typical of most sweep generators is not satisfactory. Alignment is made with the receiver in its case operating on the lower frequency tuner. Attach a 25 to 100 μf, 6V capacitor between test point 18 and ground. Pick up detected audio at test point 21 for old units. Set R42 at midscale if its setting has been moved during maintenance. Set SENSitivity to MAXimum and connect the sweep generator to the RF input. Adjust the sweep generator level so the IF response is just below the clipping level. Detected output is negative-going with a no-signal DC level about +5V on old units or +3V on new units. Adjust the slugs in T2, T3, and T4 to produce a flat-topped response about 15 kHz wide at -6 dB as shown in Figure 18. Adjustment of T1 affects both the slope and the squareness of the response. Adjust T1 in the desired direction in 1/8 turn increments and then readjust T2, T3, and T4 until the desired response is obtained. On some dual band units, a compromise adjustment may be required to obtain acceptable passband shape on both bands.

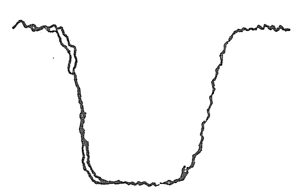
After alignment, gain should be set as in the first paragraph. This procedure optimizes bandpass at maximum SENSitivity. The passband distorts somewhat at lower SENSitivity settings.

Use of the DF mode will cause a low-pitched hum on any received signal when the antenna is not centered on the signal's direction. If the DF needle remains on one side of the meter and the tone is heard regardless of antenna position, the antenna is probably damaged. Check the connections at the base of the antenna rods for damage first.

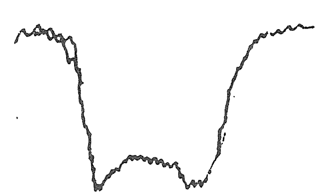
The antenna can be checked reliably with a non-electronic ohmmeter or one with a diode test function. 500 ohms ±20% should be measured from the top to the bottom half of each dipole. The two bottom halves are grounded. The center con-



Adjust T1 CW



Desired Shape



Adjust T1 CCW

Figure 18. Typical IF Passband Shapes

ductor-to-shell resistance of the receiver cable should be neither a short nor open and whatever number the ohmmeter reads should be the same (±20%) when the leads are reversed.

Disassembly of the switchbox for repair on older units may require sawing off the flattened end of the attaching screw to avoid stripping the threads in the crossbar. The switchbox contains two coiled-up coaxial cables. It is critical that these cable lengths not be changed by more than 1/2 inch during repair and that both lengths remain equal. Replace the switchbox cover carefully to avoid pinching and shorting the cables.

If the DF hum is not constant with antenna direction but the meter doesn't move, the mode switch or DF detector needs repair in the receiver.

If no DF hum is heard at all with a signal being received, check the antenna as described above and check the DF oscillator, test points 23 and 24. If an oscilloscope is available, the DF switching function is easily checked by monitoring the center conductor of the RF jack. With the antenna connected, a 2V P-P square wave around ground should be observed in DF mode and a steady +0.8V in RECeive mode.

Receiver troubles can usually be localized with a voltmeter without removing the receiver from the case. Key measurements are identified on both the schematic and component location drawing. These drawings show the parts layout effective for serial numbers from 185 to 20118, but all test points except 25 remain the same for earlier units.

Usually, inability to receive a signal at all with noise still present from the speaker indicates trouble in the crystal oscillator or the crystals themselves. Try switching the crystals to different sockets to verify. (Note: 121.5 MHz and 243.0 MHz crystals are soldered in on most units below serial 500.) Poor sensitivity usually can be traced to a defective RF amplifier transistor or to misalignment. A normal receiver will show an increase of meter reading of 1/3 of full scale with a signal level of -119 dBm or 0.2 μV VHF and -114 dBm or 0.5 μV UHF, or less.

If speaker noise is absent but the SENSitivity control still affects the meter reading in RECeive mode, check the audio amplifier, U2, and the speaker wiring. If the meter doesn't move, check the IF amplifier first.

If the unit has been dropped and is either silent or cuts in and out when it is shaken, the problem is often broken wires which secure the ends of the IF shield to the circuit board. These wires were designed to shear under shock to help protect the rest of the circuit board. Soldering new pieces of number 22 bus wire in place will fix it. Broken wires or cracked solder at their PC joints will be obvious after the circuit board is removed from the case.

To remove the circuit board from the case, first remove the battery clips and batteries. Then unsolder the wires to the RF jack and unscrew the jack from the case. Remove the two sheet metal screws from the sides of the case. With a knife blade or fingernail, bend the ends of the brass IF shield in slightly and fold the circuit board out toward the top of the case on older units. On new units, lift the right side of the circuit board and disconnect the 4-pin UHF crystal plug. Lift the board further and disconnect the 4-pin VHF crystal plug on the left side. These plugs can be removed with the fingers. The 11-pin plug is hard to remove by hand without bending the pins. The best procedure is to pry it up evenly with a thin screwdriver inserted between the plug halves. It can be put back on with the fingers. On replacement, tighten the BNC jack TIGHT. Use a 1/2" open end ignition wrench on the nut if possible, and take care not to damage adjacent components.

Component replacement is best made by removing existing solder with a vacuum tool. "Solder sucker" braid also works, but is more likely to damage the fine circuit traces. New units make extensive use of chip components. Removing them with an ordinary soldering iron, even with braid, usually destroys them. A used component should never be reused, so have replacements ready. This is also true for the CPU chip. The dial light assembly is fastened to the back of the meter with contact cement. It can be removed by unsoldering the meter leads and then prying slowly with a knife blade. The speaker and meter are also cemented in for water-tightness. Removal usually destroys them, so be prepared with a new component.

CRYSTALS

The receiver uses fifth overtone parallel resonant crystals in wire lead HC 18/U holders, with leads cut to 5/32" to act as plug pins. 20pf shunt capacity and .0025% tolerance and 40 ohms maximum series resistance should be specified for ordering special crystals from a crystal manufacturer. Crystals below 61 MHz crystal frequency are usually third overtone. Crystals must be in the same frequency range as the tuner (i.e., a 243 MHz crystal CANNOT be installed in a 121.5 MHz tuner).

Some variations in crystal output is normal and will be observed as a variation in noise or signal level between channels. In addition, the poorer

Some variations in crystal output is normal and will be observed as a variation in noise or signal level between channels. In addition, the poorer sensitivity of channels more than 500 kHz from the primary (for instance, 123.1 MHz on 121.5 MHz tuners), will also result in lower gain on these channels. To calculate crystal frequency, where FR is the desired receiver frequency, see Table 1.

For special frequencies, you can order from the L-Tronics factory or from a crystal manufacturer. We recommend Cal Crystal Lab., Inc., 1142 N. Gilbert St., Anaheim, CA 92801, phone 714-991-1580, or 800-854-XTAL.

Crystal switch wiring of older units is shown in Figure 19.

MODS

In some applications, it may be desirable to use an external meter. The LH Series units use the L-Tronics® LRM-3 Remote Indicator. Any 100-0-100 μA, 800 ohm meter with similar characteristics may be substituted for the internal meter. New units have a connector for this purpose.

Older style units can be modified at the factory for remote meter and battery check pushbutton.

L-Tronics® also offers a yearly modification schedule to upgrade units. Contact the factory for details.

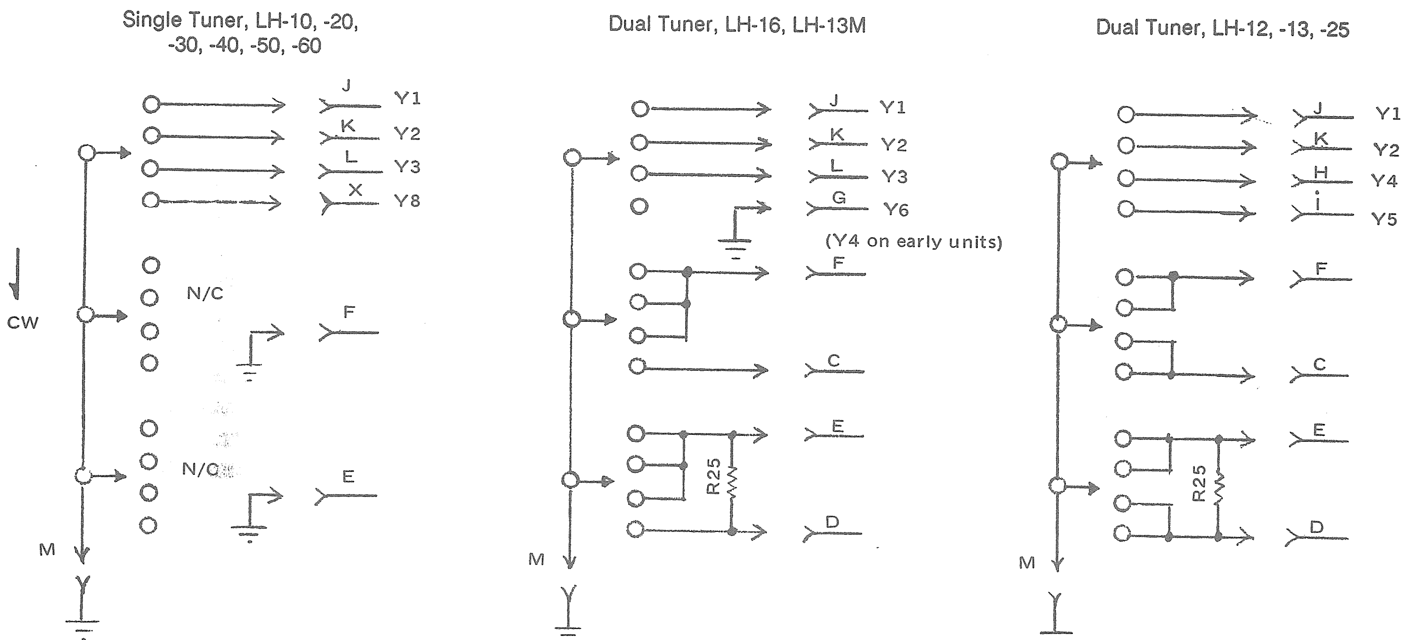


Figure 19. Frequency Switch Wiring, Older Units

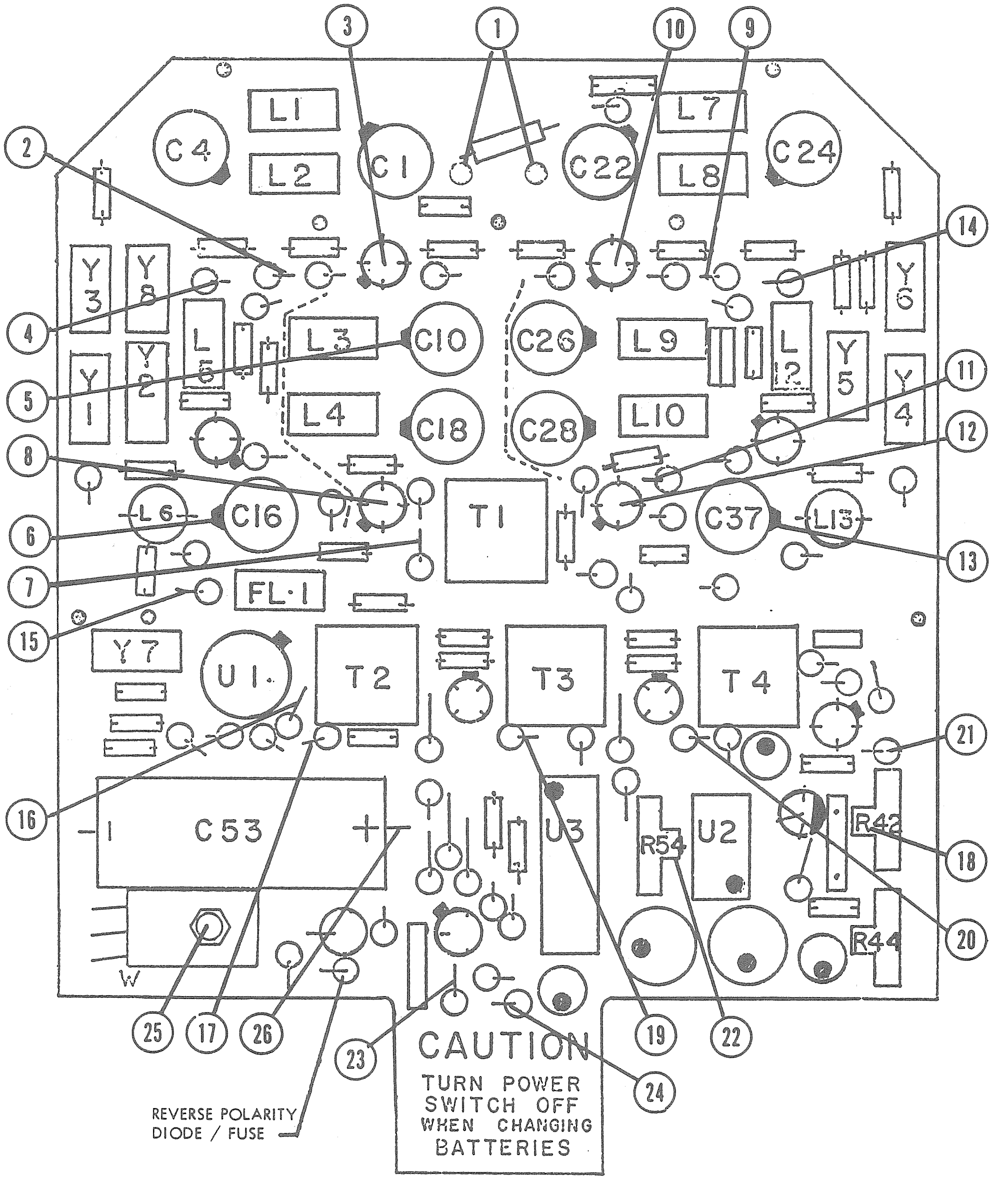
Table 1 Crystal Formulas

Receiver Frequency Range	Crystal Frequency Range	Formula	Bands
100 - 136 MHz	55.35 - 73.35 MHz	$\frac{FR + 10.7}{2}$	VHF Aircraft
136 - 160 MHz	62.65 - 74.65 MHz	$\frac{FR - 10.7}{2}$	2M Amateur; part Business; Marine
160 - 190 MHz	56.90 - 66.90 MHz	$\frac{FR + 10.7}{3}$	Part Business; VHF TV/Cable
190 - 235 MHz	59.77 - 74.77 MHz	$\frac{FR - 10.7}{3}$	220 Amateur
235 - 270 MHz	51.43 - 70.18 MHz	$\frac{FR + 10.7}{4}$	UHF Aircraft
270 - 320 MHz	64.83 - 77.33 MHz	$\frac{FR - 10.7}{4}$	UHF Aircraft

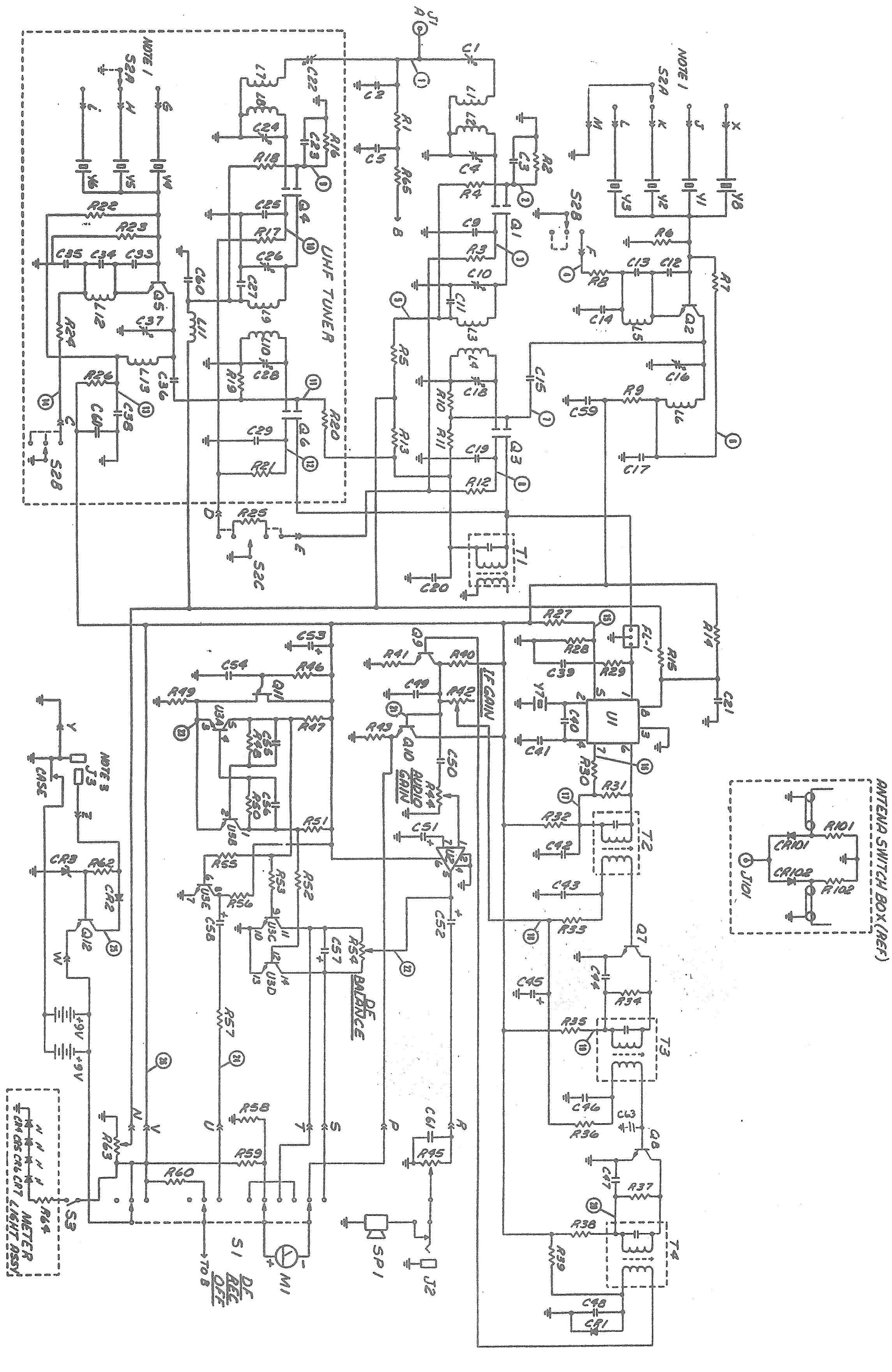
RECEIVER TEST POINTS. SERIAL, NUMBERS BELOW 20119

Conditions unless otherwise noted: external power at 12 VDC, RECeive mode, SENSitivity MAXimum, VOLume MINimum. No antenna connected. (Tuner 1 [VHF] selected [lower frequency range of all standard dual frequency units].) Supply input current 16-25 mA, increases to 60-80 mA at MAXimum VOLume, decreases 2-3 mA at MINimum SENSitivity.

TEST POINT	
1	Antenna connection. +9V. Becomes 9V PP 100-150 Hz square wave in DF mode. Becomes +0.8V and 1.6V PP square wave respectively with DF antenna connected.
2	0.3 to 1.4V
3, 8	0.15 to 0.55V becoming over 1.5V when Tuner 2 (UHF) is selected.
4	GND. Becoming more than 2V when Tuner 2 is selected.
5, 6	0.2 to 0.5V less than regulated supply (test point 26), becoming same as regulated supply when Tuner 2 is selected. Test point 5 falls to GRD as SENS control is turned toward MINimum.
7	0.8 to 1.0V
8	0.15 to 0.55V
9	0.4 to 1.4V with Tuner 2 selected.
10, 12	Over 1.5V becoming 0.15 to 0.55V with Tuner 2 selected.
11	0 to 0.55V with Tuner 2 selected, except if tuner 2 is below 200 MHz, 0.8 to 1.0V.
13	0.2 to 0.4V less than supply voltage with Tuner 2 selected.
14	More than 2V becoming GRD when Tuner 2 is selected.
15	4.8 to 6.0V
16	3.0 to 3.8V.
17	0.15 to 0.35V less than supply voltage.
18	AGC line 0.7 to 0.95V. Connection point for extra capacitor during alignment.
19, 20	0.5 to 1.5V below supply voltage
21	4.5 to 6V goes to 6.5V or more at MINimum SENSitivity. Connection point for 'scope during alignment.
22	One half of supply voltage. Connection point for 'scope when setting audio gain R44.
23	DF oscillator test point. 2.5 to 4.5V 10 usec triangular pulses at 200 to 300 Hz.
24	8-9V PP 100-150 Hz square wave.
25	Input power; 0.7V less than external power supply.
26	Regulated power 8.8 to 9.5V.



Receiver Test Points, Serial Numbers Below 20119.



LH Series Receiver Schematic, Serial Numbers 185-20118.

RECEIVER TEST POINTS & TROUBLESHOOTING, SERIAL NUMBER 20119 UP

The receiver schematic has numbered test points. These can all be measured without removing the circuit board from the case at points shown on the component location diagram.

Except as noted, the receiver is in RECeive mode, VOLume at minimum, dial light off, and VHF crystal 2 (normally 121.5) selected. The antenna jack is either open or connected to a mast and antenna crossbar with the elements open. No input signal.

Input current at 12.0V external power should be 14-19 mA. The dial light should add 4-8 mA. The dial light current will be 20-30 mA if an L-Tronics® dual external meter is connected.

Many measurements are related to the regulated power supply voltage of 4.6 to 5.4V measured at point 23. The exact voltage of the unit under test must be known to evaluate the other tests. Values are listed as "PS," the regulated voltage, minus the indicated voltage range.

The battery voltage indication (MUTE/BATTERY CHK button pressed) should show center scale at an input voltage of 6.8-7.2V; full scale for voltages above 8.7-9.0V, and zero for voltages below 5.0-5.3V.

1 Antenna input. 0.75-0.85V with antenna; PS- (0.1-0.5V) with antenna jack open. 0V in DF mode. In DF mode, a scope will show a square wave of about 100 Hz with ±9V P-P amplitude with the jack open and ±0.8V P-P with an antenna connected. If there is no voltage present, check for broken parts or shorted tuning capacitors C7 and C24 next to the antenna jack.

2 0.65-1.0V. Rises to 1.5-2.5V at minimum SENSitivity. High voltage here and at point 8 indicates an open SENSitivity control or wiring. 0 volts indicates a blown transistor (Q2)or no power to the stage. Measure the voltage on the transistor drain and at point 3.

3 PS- (0.15-0.25V) 0 volts here usually is a shorted tuning capacitor, C12.

4 1.2-1.5 V. Drops to 0 when a UHF crystal is selected. 0.7 to 1 V is usually a bad transistor (Q1). 0V is usually a bad crystal switch or wiring or a plug disconnected if the voltage at point 5 is OK.

5 PS- (0.1-0.2V). 0V here is usually a shorted oscillator tuning capacitor, C4.

6 0.7-1.5V depending on VHF tuner gain setting. Increases at minimum SENSitivity. 0V may be a bad transistor (Q3) or an open transformer T1 if point 7 is OK.

7 PS- (0.04-0.15V). Depends on tuner gain settings. 0V is usually a shorted T1.

8 0.65-1.0V. Rises to 1.5-2.5V at minimum SENSitivity. High voltage here and at point 2 indicates an open SENSitivity control or wiring. 0 volts indicates a blown transistor (Q5) or no power to the stage. Measure the voltage on the transistor drain and at point 9.

9 PS- (0.15-0.25V). 0 volts here usually is a shorted tuning capacitor, C27.

10 1.2-1.5V when a UHF (position 5 or 6) is selected. Drops to 0 when a VHF crystal is selected. 0.7 to 1V is usually a bad transistor (Q4). 0V is usually a bad crystal switch or wiring or a plug disconnected if the voltage at point 11 is OK.

11 PS- (0.1-0.2V). 0V here is usually a shorted oscillator tuning capacitor, C21.

12 0.7-1.5V depending on UHF tuner gain setting. Increases at minimum SENSitivity. 0V may be a bad transistor (Q6) or an open transformer T1 if point 7 is OK.

13 0V. Rises to 1.5-2.5V at minimum SENSitivity. An abnormal voltage indicates trouble with the SENSitivity control or its wiring.

14 3.05-3.30 V. A low voltage indicates a short around FL-1 or a bad U1 if point 15 is also off value.

15 2.7-3.0V. Should be at least 200mV less than point 14.

16 PS- ().15-0.3V). Low or 0V is usually a shorted T2.

17 Regulator input voltage. Should read battery voltage on internal power or power supply voltage on external power. Operating range is 5.05-28V. The regulator will cut off with input voltage above 28V and will go out of regulation and draw up to 100 mA excess input current below 5.05V. Neither condition is destructive. If battery voltage does not appear, check particularly the grounding contact on the external power jack.

18 AGC line. 0.65-0.8V. Bypass here for sweep IF alignment. Low or 0V here with near 4V at point 21 is usually a shorted transformer or bad Q9.

19 PS- (0.1-0.5V). An out of tolerance voltage here indicates a problem with T3 or Q7.

20 PS- (0.1-0.5V). An out of tolerance voltage here indicates a problem with T4 or !8.

21 Detected audio. 3.8-4.1V. Rises slightly at minimum SENSitivity. Scote connection for IF alignment. Voltage drops with increasing received signal.

22 2.35-2.65VDC. Should have 300-400 mV RMS noise on an AC coupled (output) meter. 4.5V P-P audio on a strong received signal.

23 4.6-5.4 V regulator output as noted above. 0V indicates a short somewhere on the supply bus or a bad regulator. Only a short or a bad audio amplifier U2 can draw enough current to cause the regulator to limit.

24 1.4-1.75V. Goes to 0 in DF mode.

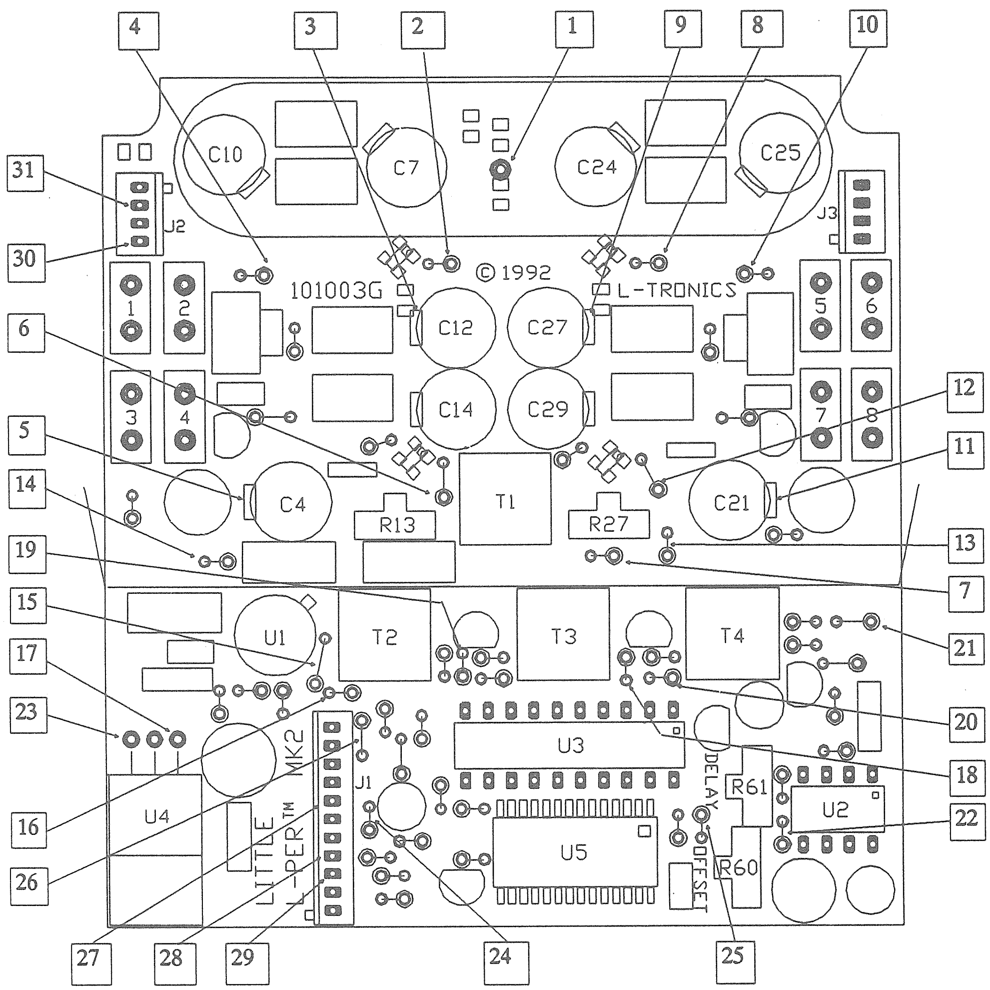
25 2.4-2.8VDC. 0.5-4.1V sawtooth at 1.5-2 MHz. CPU clock. Touching this point with a finger should cause an audible change in pitch of the DF switching frequency and will produce "birdies" or interference in the receiver. This is normal.

26 PS- 0.1V. Goes to 0V when the MUTE/BAT CHECK button is pressed.

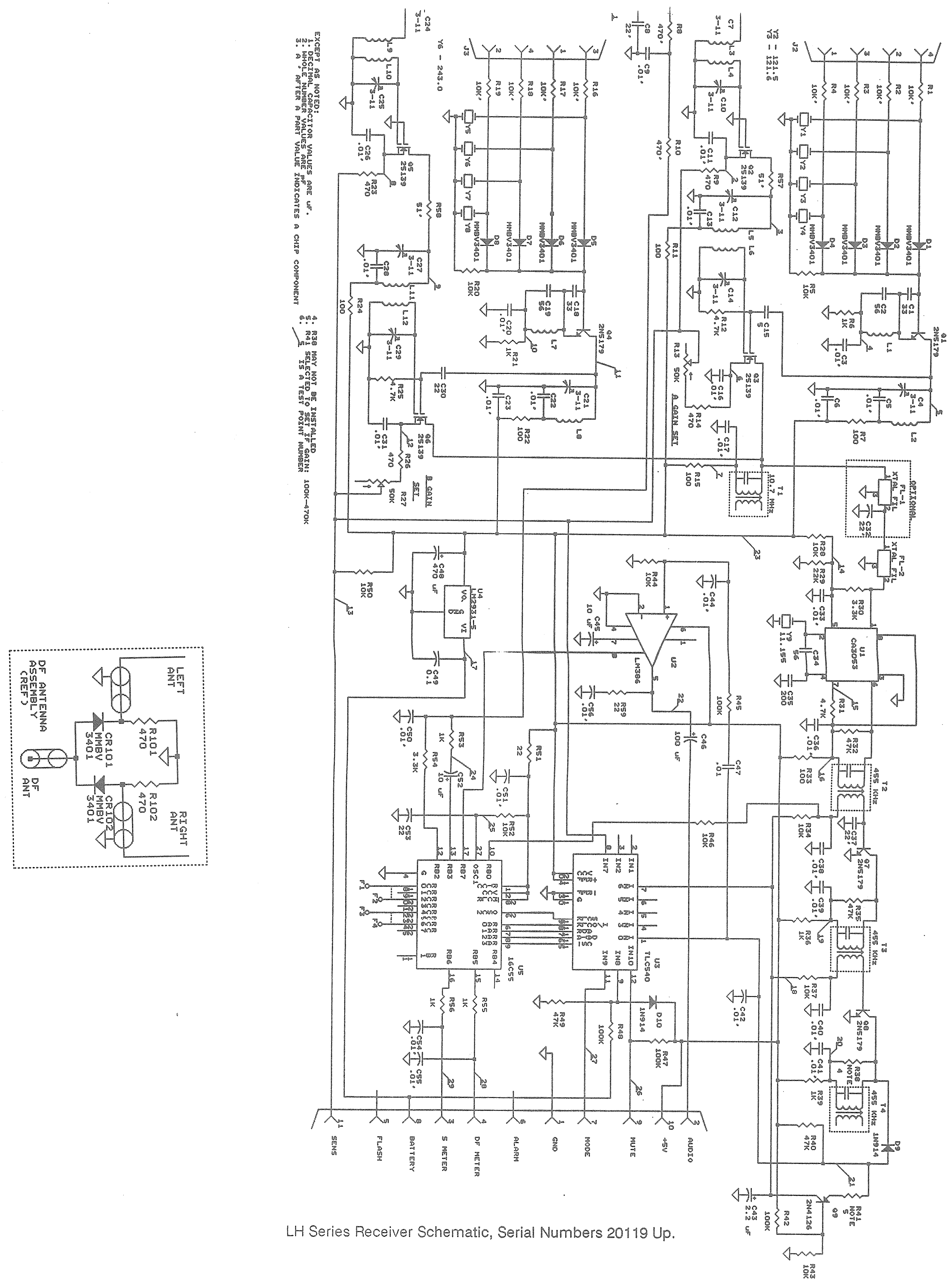
27 2.0-3.0V in RECeive mode. Goes to 0V in DF mode. If this is off, check the resistor network and wiring on the MODE switch.

28 0.2-0.6V. Changes to 2.4-2.6V in DF mode. On a scope, this is a variable duty cycle pulsed waveform with a period of about 6 mS. Pulses are between 0 and 2.5V if the meter is in the lower half scale and between 2.5 and 5V if the meter is in the upper half scale.

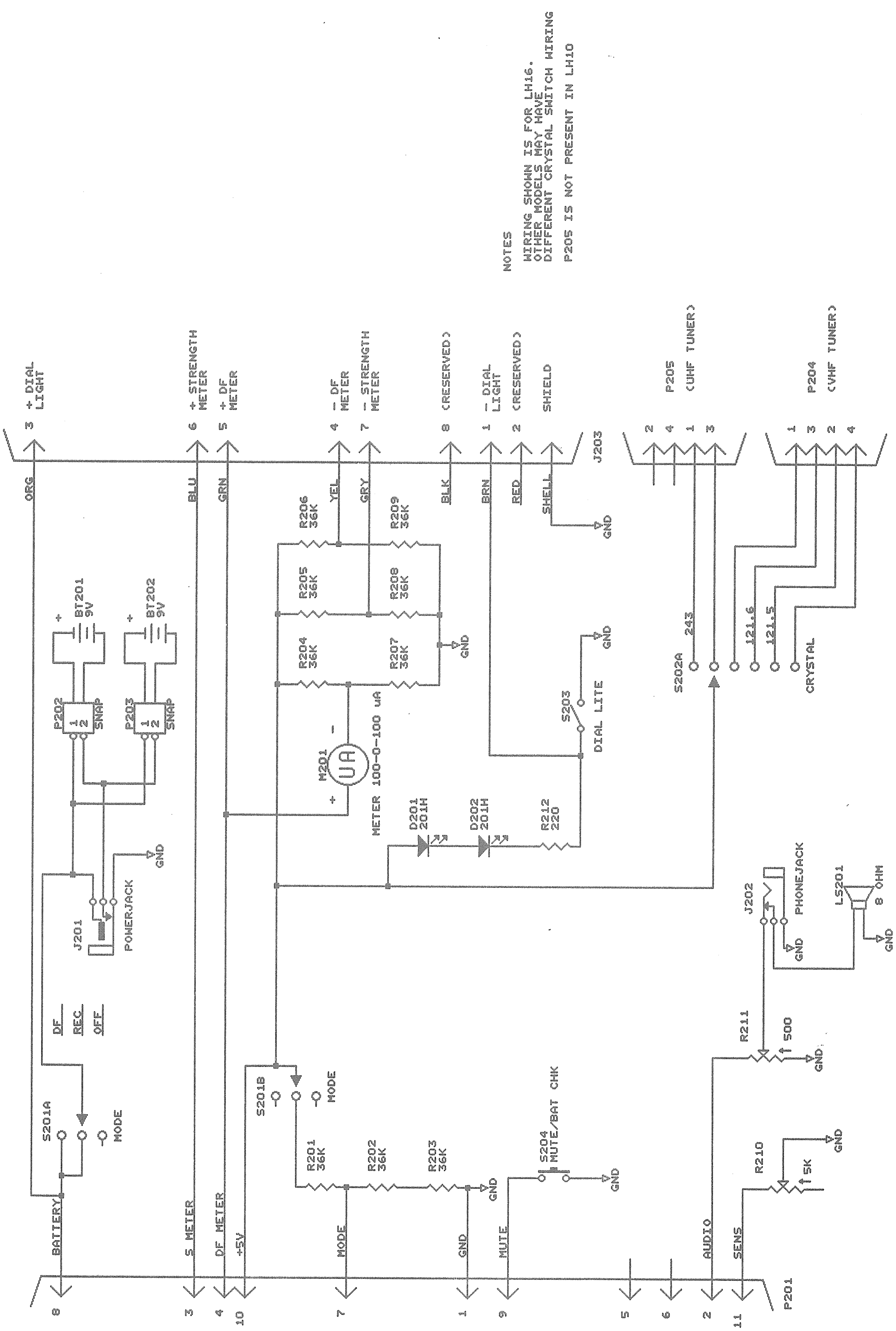
29 Same as 28 if an external meter is installed. Drives the STRENGTH movement. This is a meaningless indication with no meter installed.



Receiver Test Points, Serial Numbers 20119 up.



LH Series Receiver Schematic, Serial Numbers 20119 Up.



LH Series Receiver Box Schematic, Serial Numbers 20119 Up.

LH SERIES LITTLE L-PER® PORTABLE DIRECTION FINDER

ELECTRICAL PARTS LIST, SERIAL NUMBERS 20119 UP

REFERENCE	TYPE	PART NUMBER
C1,C18	33 pf Disk	21CB022
C2,C19,C34	56 pf Disk	21CB056
C3,C5,C6,C9, C11,C13,C16,C17, C20,CC22,C23,C26, C28,C31,C33,C36, C38,C39,C40,C41, C42,C44,C50,C51, C54,C55,C56	.01 pf Chip	220805103
C4,C7,C10,C12,C14, C21,C24,C25,C27,C29	,3-11 Trim Cap	241870106
C8,(C32),C37	22 pf Chip	220805220
C15	5 pf Disk	21CB005
C30,C53	22 pf Disk	21CB022
C35	200 pf Disk	21CB200
C43	2.2 µf 50V	20XR002
C45,C52	10 µf 16V	20WH010
C46	100 µf 10V	20XF100
C47	.01 µf disk	21KC010
C48	470 µf 10V	20YF470
C49	0.1 µf Film	21V1104
D1,D2,D3,D4,D5, D6,(D7),(D8)	PIN Diode	50MMBV3401
D9,D10	Signal Diode	501N914
FL-1,(FL-2)	Xtal Fil	61-2195F
J1	11 Pin 2mm Jack	402MM11S
J2,J3	4 Pin 2mm Jack	402MM4S
L1,L2,L3,L4,L5,L6, L7,L8,L9,L10,L11,L12	RF Coils	101014-()
Q1,Q4,Q7,Q8	Transistor, RF	522N5179
Q2,Q3,Q5,Q6	Transistor, FET	5225139
Q9	Transistor, PNP	522N4126
R1,R2,R3,R4,R16, R17,(R18),(R19)	10K Chip Res	31CP10K
R5,R20,R28,R34, R37,R43,R44,R46, R50,R52	10K 1/4 W Res	30SJ10K
R6,R21,R36,R39, R53,R55,R56	1K 1/4W Res	30SJ1K
R7,R11,R15,R22, R24,R33	100 Ω 1/4W Res	30SJ100
R8,R10	470 Ω chip Res	31CP470
R9,R14,R23,R26	470Ω 1/4W Res	30SJ470
R12,R25,R31,	4.7K 1/4W Res	30SJ4.7K
R13,R27	50K Trimpot	32PT50K
R29	22K 1/4W Res	30SJ22K
R30,R54	3.3K 1/4W Res	30SJ3.3K
R32,R35,(R38), R40,R494	7K 1/4W Res	30SJ47K
R41	SEL 100K-470K	30SJ( )
R42,R45,R47,R48	100K 1/4W Res W	3SJ100K
R51	22 Ω 1/4W Res	30SJ22
R57,R58	51Ω Chip Res	31CP510

REFERENCE	TYPE	PART NUMBER
T1	10.7 MHz IFT	64IF123
T2,T3,T4	455 KHz IFT	64IF303
U1	CA3053 Diff Amp	53CA3053
U2	LM386 Audio Amp	53LM386
U3	TLC540/541 ADC	53TLC540
U4	LM2931-5 Reg	532931
U5	16C55 CPU	53C55
Y1,Y2,Y3,(Y4),Y5,	Channel Xtals	60-(channel)
Y6,(Y7),(Y8)Y9	11.155 Crystal	60-11.155
---	RF Shield	101007-1
---	IF Shield	101007-2
---	PC Board	101003E
---	Xtal Socket	4475315001

Note: Parts in parenthesis are optional and not normally installed.

LH SERIES LITTLE L-PER® PORTABLE DIRECTION FINDER

PART LIST, BOX ASSEMBLY, SERIAL NUMBERS 20119 UP

REFERENCE	TYPE	PART NUMBER
BT201,BT202	9V Battery	69MN1604
D201,D202	201H LED	51201H
J201	Power Jack	40PJ121
J202	Phone Jack	40PJ100
J203	8 Pin mini-DIN	40DIN8S
LS201	8 Speaker	69SP002
M201	Meter 100-0-100 A	101031
P201	11 Pin 2mm Plug	402MM11P
P202,P203	Battery Snap	40BC005
P204,P205	4 Pin 2mm Plug	402MM4P
R201,R202,R203, R204,R205, R206, R207,R208,R209	36K, 1/8 W Res	3429936K
R210	5K Pot	33502UA
R211	500 Pot	33501UA
R212	220Ω 1/4W Res	30SJ220
S201	4P3T Rotary Switch	45WW043
S202	2P6T Rotary Switch	45WW026
S203	SPDT Toggle Switch	46TA830
S204	SPST Pushbutton Sw	47PA013
---	Panel Overlay	101001D
---	Foam Pads	8231
---	Bar Knob (switch)	741510
---	Skirt Knob (pots)	741910D
---	Meter Light Pc Board	101006-4

LH SERIES LITTLE L-PER® PORTABLE DIRECTION FINDER

ELECTRICAL PARTS LIST, SERIAL NUMBERS 185 - 20118

REFERENCE	TYPE	PART NUMBER
R1, R10, R19, R56, R57	4.7K, 5% car, 1/4W	30BJ250-4.7K
R2*, R7, R16*, R22, R28, R43, R58	22K, 5% car, 1/4W	30BJ250-22K
R3, R5, R9, R13, R17, R26, R32, R49, R65	100Ω, 5% car, 1\4W	30BJ250-100
R4, R18, R20,** R25, R39, R48, R50	100K, 5% car, 1/4W	30BJ250-100K
R6, R14, R15, R23, R27, R30, R33, R36, R47, R51, R60	10K, 5% car, 1/4W	30BJ250-10K
R8, R35, R38, R41	1K, 5% car, 1/4W	30BJ250-1K
R11, R31, R34, R37, R40, R46, R52, R53, R55	47K, 5%car, 1/4W	30BJ250-47K
R12, R21	220Ω, 5% car, 1/4W	30BJ250-220
R24	820Ω, 5% car, 1/4W	30BJ250-820
R29	3.3K, 5% car, 1/4W	30BJ250-3.3K
R42	1 Meg Trimpot	32RM601
R44, R54	5K Trimpot	32RM305
R45	500W, 1/2W Pot AB	WA2G0565 501UA
R59	33K, 5%car, 1/4W	30BJ250-33K
R61	DELETED	
R62	1.2K, 5%car, 1/2W	30BJ500-1.2K
R64, R101, R102	470Ω, 5% car, 1/4W	30BJ250-470
R63	5K, 1/2W Pot AB	WA2G056S-502UA
C1, C4, C10, C16, C18, C22, C24, C26, C28, C37	1.7-11 PF Trimmer	Johnson 1870106005
C2, C63***	22 pf NPO 10% 50V Disc	21CB022
C3, C9, C11, C14, C17, C19, C35, C59	100 pf, 25V Disc	21CK001
C5, C20, C21, C39, C42, C43, C44, C46, C47, C48, C49, C60, C61	.01µF, 25V Disc	21KC010
C6, C7, C8, C30, C31, C32	DELETED	
C12, C33	33 pf, 10%, 50V NPO Disc	21CB033
C13, C34, C40, C55, C56	56 pf, 10%, 50V NPO Disc	21CB056
C15, C36	5 pf, 10%, 50V NPO Disc	21CB005
C23, C25, C27, C29, C38, C41, C60	200 pf, 10%, 50V NPO Disc	21CB200
C45	2.2µf, 25V Electrolytic	20UK002
C50, C54	0.1µf, 12V Disc	21ER100
C51, C58	10µf, 10V Electrolytic	20UF010
C52, C57	100µf, 10V Electrolytic	20UF100
C53	470µf, 16V Electrolytic	20UH470
Q1, Q3, Q4, Q6	Dual Gate FET	40820, 40673, 3N204, 3N201
Q2, Q5, Q7, Q8, Q9	Transistor, NPN RF	40897, 2N5179
Q10	Transistor, NPN	2N5172
Q11	Transistor, Unijunction	2N2646

REFERENCE	TYPE	PART NUMBER
Q12	Transistor, NPN	MJE520
U1	Diff. Amp. IC	CA3053, CA3028
U2	Audio Amp. IC	LM386
U3	Multiple Transistor IC	CA3086
L1	Coil, 10T	LT101009-6
L2, L4	Coil, 7T	LT101009-3
L3	Coil, 8T	LT101009-4
L5, L12	Coil, 9T	LT101009-5
L6	Coil, 6-1/2T	LT101009-8
L8, L10	Coil, 3T	LT101009-1
L7, L9	Coil, 5T	LT101009-2
L11	Coil, 1µH	77LQ106
L13	Coil, 2-1/2T	LT101009-7
T1	10.7 MHz IFT	801F123
T2, T3, T4	455 kHZ IFT	801F103
Y1, Y2, Y3, Y4, Y5, Y6	Channel Crystals See Sect 3 For Formula	
Y7	11.155 MHz Fundamental Crystal	LTIFX2
FL 1	15 kHz BW Crystal Filter	2195F
J1, J101	RF Jack, BNC	UG1094/U
J2	Phone Jack, 2.5mm	16PJ100
J3	Power Jack, 2.5mm	16PJ121
SP-1	2" Round Speaker, 8Ω	25SP002
M-1	100-0-100µA Meter	3X9200M
CR1, CR2	Diode, GP	1N914, 1N4148
CR3	Zener Diode	1N758
CR4, CR5, CR6, CR7	LED	MV 50, 579-235R
CR101, C4102	Diode, PIN	MPN3401, MMBV3401
S1	4 Pole, 3 Pos. Rotary Switch	10WS043
S2	3 Pole, 4 Pos. Rotary Switch	10WS034
S3	SPDT Toggle Switch	10TA830
CY-1	Antenna Cable Assy, 34-1/2"	LT101101-1

MISC PARTS

Circuit Board, Rcvr	LT101008
Circuit Board, Meter Light	LT101006-1
Circuit Board, Ant Switch	LT101006-2
IF Shield	LT101007-1
RF Shield	LT101007-2
Knob, Switches	512-1510
Knob, Pots	512-1910D
Remote Power Plug	17PP121

NOTES:

*R2 and R16 may be a lower value to compensate for improved RF amplifier transistors in serial numbers above 3199. Typical range 4.7K to 22K.

**R20 may be omitted.

***C63 is a 39 pf chip capacitor in serial numbers above 4799, model LH-16 only.

C23 and C25 may be paralleled with .01 µf chip capacitors on the foil side of the PC board.