LA Series Aircraft Direction Finders

OPERATING & MAINTENANCE MANUAL

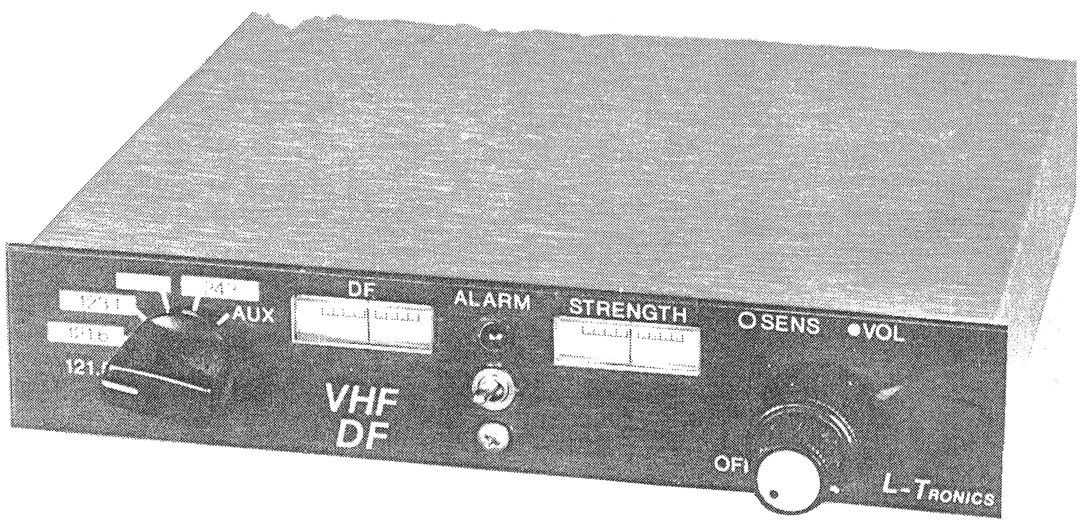
L-TRONICS, Santa Barbara, CA

SPECIFICATIONS FOR MODEL LA-16A

Receiver Type	Double conversion superhetrodyne with two separate RF tuners and common antenna
Frequencies or Channels	3 VHF, 2 UHF
Tuner Bandwidth (no alignment) Tuner Bandwidth	500 kHz full sensitivity 4 MHz reduced sensitivity
Frequencies Supplied	121.5, 121.6, 243.0 MHz
IF Frequencies, 1st IF 2nd IF	10.7 MHz 455 kHz
DF Sensitivity, VHF DF Sensitivity, UHF	0.15 μV or better (0.08 μV typical) 0.3 μV or better
IF Bandwidth	15 kHz
Adjacent Channel Rejection	-29 dB typical at $\pm$25 kHz -53 dB typical at $\pm$50 kHz -84 dB typical at $\pm$100 kHz
Image Rejection, VHF Image Rejection, UFH	-55 dB minimum, -65 dB typical -40 dB typical
IF and Spurious Rejection	75 dB minimum
Audio Output	0.4W minimum into 8 ohms
DF Indication	Left/right steering or signal strength
DF Indication Dynamic Range	-130 to -10 dBm typical
Signal Strength Indicating Range	-125 to -25 dBm typical
Alarm	Tone coded squelch and light with delay
Power	10-32 VDC 300 mA maximum
Antenna	Electrically switched twin monopole
Antenna Gain	2.5 dBd minimum
Weight, Including Antennas	31 ounces
Operating Temperature Range	-20 to +140 °

LA SERIES AIRCRAFT DIRECTION FINDER

OPERATING & MAINTENANCE MANUAL



OH ~~82~~ MIL ~~82~~ MIL

US Department of Transportation
Federal Aviation Administration

MAJOR REPAIR AND ALTERATION (Airframe, Powerplant, Propeller, or Appliance)

Form Approved
OMB No.2120-0020

For FAA Use Only
Office Identification

INSTRUCTIONS: Print or type all entries. See FAR 43.9, FAR 43 Appendix B, and AC43.9-1 (or subsequent revision thereof) for instructions and disposition of this form. This report is required by law (49 U.S.C. 1421). Failure to report can result in a civil penalty not to exceed $1,000 for each such violation (Section 901 Federal Aviation Act of 1958).

1. Aircraft	Make: Cessna	Model: 172RG
	Serial No.: 172RG0028	Nationality and Registration Mark: N1850T
2. Owner	Name (As shown on registration certificate): Santa Barbara County Sheriffs Department	Address (As shown on registration certificate): 4334 Calle Real Santa Barbara, CA. 93110-1002

3. For FAA Use Only

The data identified herein complies with applicable airworthiness requirements and is approved only for above described aircraft subject to conformity inspection by a person authorized in FAR 43.7
FAA Inspector, Van Nuys FSDO: [signature] Date: DEC 3 1993

4. Unit Identification / 5. Type

Unit	Make	Model	Serial No.	Repair	Alteration
AIRFRAME	(As described in Item 1 above)				X
POWERPLANT					
PROPELLER					
APPLIANCE	Type Manufacturer				

RECEIVED
NOV 19 1998
VAN NUYS FSDO

6. Conformity Statment

A. Agency's Name and Address	B. Kind of Agency	C. Certificate No.
ASB Avionics, LLC 303 Donaldson Pl. Hangar 3 Santa Barbara, CA. 93117	[ ] U.S. Certificated Mechanic [ ] Foreign Certified Mechanic [X] Certificated Repair Station [ ] Manufacture	UMDR221L Radio Class 1, 2, 3 Ltd Inst/Airframe

D. I certify that the repair and/or alteration made to the unit(s) identified in item 4 above and described on the reverse or attachments hereto have been made in accordance with the requirements of Part 43 of the U.S. Federal Aviation Regulations and that the information furnished herein is true and correct to the best of my knowledge.

Date	Signature of Authorized Individual
May 5, 1998	[signature] Thomas E Smothermon

7. Approval for Return To Service

Pursuant to the authority given persons specified below, the unit identified in item 4 was inspected in the manner prescribed by the Administor of the Federal Aviation Administration and is [X] APPROVED [ ] REJECTED

BY				
[ ] FAA Flt Standards Inspector	[ ] Manufacturer	Inspection Authorization	Other (Specify)
[ ] FAA Designee	[X] Repair Station	Person Approved by Transport Canada Airworthiness Group	

Date of Approval or Rejection	Certificate or Designation No.	Signature of Authorized Individual
DEC 7 1998	UMDR221L	[signature] THOMAS E SMOTHERMON

Computer Generated FAA Form 337

Notice

Weight and balance or operating limitation changes shall be entered in the appropriate aircraft record. An alteration must be compatible with all previous alterations to assure continued conformity with the applicable airworthiness requirements.

8. Description of Work Accomplished

(If more space is required, attach additional sheets. Identify with aircraft nationality and registation mark and date work completed.)

N1850T 5-5-98

Installed an L-tronics LA series DF system in the space provided in the copilot instrument panel.

Installed the antenna system on the belly of the aircraft under the pilot and copilot seats.

All equipment was installed in accordance with the aircraft maintenance manual, AC43.13-1A & 2A and L-tronics installation manual document number LOM-2, Revision 2, Section 2.

The system was installed and tested per the recommendations called out in AC 25.10.

A placard was placed on the panel stating "Not approved for navigation. Turn DF off for com on: 126.85, 132.2, 132.3, 132.47".

The aircraft was inspected and test flown and the system was found to operate within the parameters set forth within the L-tronics installation manual. See attached FAA Form 8110-3.

Instructions for Continued Airworthiness Document No. ASBICAW4833 was placed in the aircraft flight manual.

The equipment list, weight and balance were updated to reflect this installation.

--END--

☒ Additional Sheets Are Attached

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

STATEMENT OF COMPLIANCE WITH THE FEDERAL AVIATION REGULATIONS

DATE 5/05/98

AIRCRAFT OR AIRCRAFT COMPONENT IDENTIFICATION

MAKE	MODEL NO.	TYPE (Airplane, Radio, Helicopter, etc.)	NAME OF APPLICANT
CESSNA AIRCRAFT CO.	172RG	AIRPLANE	ASB AVIONICS

LIST OF DATA

IDENTIFICATION	TITLE
	THE FOLLOWING DATA ARE REVIEWED/APPROVED AS THEY PERTAIN TO ELECTRICAL/ELECTRONIC AND PITOT-STATIC SYSTEMS & EQUIPMENT, ONLY.
ASB DATA	
WO #4833, REV NC DATED 4/28/97	[INSTALLATION – L-TRONICS DIRECTION FINDING SYSTEM]
	———— *NOTHING FOLLOWS* ————
	THIS APPROVAL INDICATES THE DATA LISTED ABOVE DEMONSTRATES COMPLIANCE WITH THE REGULATIONS SPECIFIED BY PARAGRAPH & SUBPARAGRAPH LISTED BELOW AS "APPLICABLE REQUIREMENTS." COMPLIANCE TO ADDITIONAL REGULATIONS NOT LISTED HERE MAY BE REQUIRED. THIS FORM DOES NOT CONSTITUTE FAA APPROVAL OF ALL THE DATA NECESSARY FOR SUBSTANTIATION OF COMPLIANCE TO NECESSARY REQUIREMENTS FOR THE ENTIRE ALTERATION.
	PAGE 1 OF 1

PURPOSE OF DATA: SUPPORT FIELD APPROVAL OF NON-ESSENTIAL, AVIONICS SYSTEM FOR USE IN VFR CONDITIONS,ONLY. FOR DETAILS, SEE FAA FORM 337 AGAINST C172RG, S/N 172RG0028.

APPLICABLE REQUIREMENTS (List specific sections): FAR PART 23.1301(a-d);.1307(c);.1309(b);.1351(a); .1353(a);.1357(a-g);.1431(c).

CERTIFICATION - Under authority vested by direction of the Administrator and in accordance with conditions and limitations of appointment under Part 183 of the Federal Aviation Regulations, data listed above and on attached sheets numbered ________________ have been examined in accordance with established procedures and found to comply with applicable requirements of the Federal Aviation Regulations.

I ~~(We)~~ Therefore ☐ Recommend approval of these data

☒ Approve these data

SIGNATURE(S) OF DESIGNATED ENGINEERING REPRESENTATIVE(S)	DESIGNATED NUMBER(S)	CLASSIFICATION(S)
[signature] MARK OSTENDORF	NM-797	SYSTEMS & EQUIP

FAA Form 8110-3 (11-70) SUPERSEDES PREVIOUS EDITION

ASB Avionics, LLC
303 Donaldson Place
Hangar 3
Santa Barbara, CA 93117

Document No. ASBICAW4833
Registration No. N1850T
Revision NC

Instructions for Continued Airworthiness
For a Cessna 172RG with an L-Tronics LA Series
Direction Finding System

This major alteration to this aircraft obligates the aircraft operator to include the following maintenance information provided by this document in the owner/operator's Aircraft Maintenance Manual and the owner/operator's Aircraft Scheduled Maintenance Program. The L-Tronics Direction Finding System Line Replaceable Unit (LRU) maintenance is on the condition and there is no periodic preventative or scheduled maintenance required for the continued operation of this unit. Should any failure of the L-Tronics Direction Finding System occur, it should be properly noted, and the unit should be removed from the aircraft. Once a failure has occurred, it is advisable to do a visual inspection of the L-tronics Direction Finding System. This inspection should include, but is not limited to the L-Tronics Direction Finding System, antenna system, associated wiring, and any related hardware. This inspection should be performed through elementary means.

1. Maintenance, repaired, reinstall, and testing information for the L-Tronics Direction Finding System in this aircraft are contained in the L-Tronics Direction Finding System Installation Manual (Manual No. LOM-2, Rev 2)

2. The Line Replaceable Unit (LRU) part numbers and other necessary part numbers contained in the installation data documentation for this modification should be placed into the aircraft's owner/operator's appropriate Illustrated Parts Catalog (IPC).

3. Wiring Diagram information contained in the installation data documentation for this modification should be placed into the aircraft owner/operator's appropriate airplane Wiring Diagram Manual, if applicable.

4. The selected Maintenance task required by this modification are added to the aircraft owner/operator's appropriate airplane maintenance program are as follows:

   a. Perform on at least an annual basis a periodic inspection of the equipment rack, equipment mountings, associated wiring, cables, connectors, hardware, antenna and related aircraft structure for integrity, security, wear, chaffing, and etc.. Special attention should be given to the aircraft primary structure with regards to fatigue and stress cracking, corrosion, and etc..

   NOTE: These inspections may appear as part of opportunity inspections or recommended zonal inspection task.

5. Should it become necessary to remove the L-Tronics Direction Finding System, secure the associated cables and wiring, collar the applicable circuit breakers, placard the aircraft that the unit has been removed, revise the weight and balance and the equipment list and make a logbook entry the unit has been removed for service. (Refer to section 91.213 of Title 14 of the Code of Federal Regulations and/or the aircraft's MEL)

6. The L-Tronics Direction Finding System and its related primary components can only be repaired at a factory authorized repair center or an appropriately rated FAA Part 145 repair station.

   NOTE: Should structural repairs be necessary to the airframe they should be performed in accordance with FAA approved data, the Structural Repair Manual from the Airframe manufacturer (SRM) or guidance contained in the Advisory Circular (AC) 43.13-1A, if applicable.

Dated 5-5-98

General

Description

The L-Tronics® LA Series Aircraft Direction Finder is a complete, independent, crystal-controlled receiver and indicator designed for permanent panel mounting in light aircraft and helicopters. It operates with an external antenna array that is supplied.

The LA-16A model, which is the most widely used of the series, has crystals on 121.5, 121.6, 121.775, and 243 MHz. One additional crystal in the VHF band and one in the UHF band may be added. The model LA-16A is described in the following material. Other models differ only in the values of a few components in the tuners.

Current production receivers, and older models which have been modified, have two panel meters. One gives left-right homing and the other shows signal strength. Earlier units have a single meter with these two functions selected by a switch.

A tone-coded squelch circuit, called the Alarm Mode, permits continuous, annoyance-free monitoring for Emergency Locator Transmitters (ELTs) and Emergency Position Indicating Radio Beacons (EPIRBs) on all models with 121.5 MHz.

Many units allow connection to an external AM communications receiver so that direction finding can be done on any frequency covered by that external receiver and the DF antennas. This is standard on all current production units and is called the Auxiliary DF option or mode. Some older units do not have this capability. Check the rear of the receiver; there are three BNC connections on units with the AUX DF capability, one BNC connector on units without it.

A remote indicator with dual meters is offered as a separate accessory that can be attached to any LA Series receiver. It repeats the indications of the front panel meters and the alarm light. It is small enough to be suitable for a variety of mounting locations. It will supply simultaneous strength and DF indication with either single meter or dual meter receivers.

Warranty and Repairs

Two warranty forms are supplied with each LA Series unit, explaining the warranty in detail; copies are available upon request. One completed warranty form should be returned to the factory to ensure receipt of free educational materials, new product releases, and updated operational announcements. The mail list is not released to any other company or organization.

If any L-Tronics® product fails during the warranty period, return it to the factory. If the failure is not due to misuse, improper installation, or accidental damage within one year of the date of purchase, the unit will be repaired or replaced at the option of the factory, free of charge.

Factory repair of equipment no longer in warranty is also offered at low cost. Equipment sent for repair should include a description of the problem, name and phone number of a contact person, and name and address for return shipping. Repair parts are also available.

L-Tronics® will not be held responsible for consequential damage as a result of equipment failure or installation.

Write or call the L-Tronics factory for repair or installation assistance. Inquiries about models for special frequencies or applications are welcome.

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

Section 1

Receiver Installation

General Information

Installation of the LA Series Direction Finder consists of mounting and connecting the panel-mounted receiver/indicator and the antennas. Because the performance of the DF set is critically dependent on proper antenna installation, a complete section is devoted to this subject.

Both the DF receiver and the optional remote indicator have magnetic fields that can affect the aircraft compass. Check for adverse compass effects by holding the unit in its planned position-before starting the installation.

The DF receiver may cause interference to communications on 132.2 MHz when operating on 121.5 MHz (132.3 MHz when using 121.6 MHz 132.475 for 121.775 MHz, and 126.85 for 243.0 MHz). If communications is required on these turn the DF receiver off.

The DF receiver is held in its case by a single Phillips head 4-40 x 3/8 screw in the lower center of the front panel. The screw is not retained in the panel. The case is the correct width to fit in most radio "stacks," and is short enough to use the shallow positions at the top and bottom of many stack mounts. The DF receiver produces no significant heat and does not need any cooling air. Four screws placed through the narrow sides of the case will support the unit without need of a back brace. There is ample clearance on the sides for screw heads without the need for countersinking. See the cover drawing, Figure 1. Unless a remote meter is to be used, the mounting should be made so that the meters can be easily seen by the pilot. The receiver wiring should have sufficient slack so that the receiver can be slid out of its case without disconnecting wires, both for access and troubleshooting.

NOTE: Never slide the receiver in or out of the case with the power on.

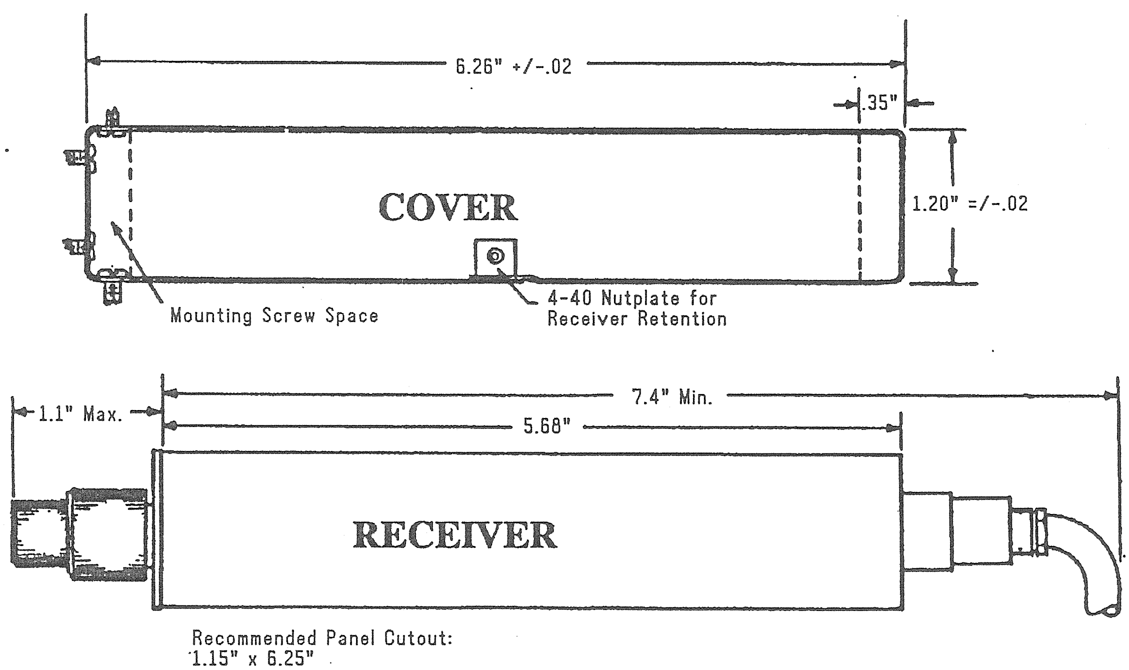


Figure 1. Installation Dimensions.

Power Requirements

The LA Series unit was shipped with a matching power connector and a 3-foot long harness, which will be satisfactory for most installations. Unused wires may be trimmed off or tied out of the way. Connections are given in Figure 2. For custom harnesses, the connector is a Waldom-Molex 03-06-1091 and the pins are .062 dia. male, P/N 02-06-2103.

An in-line fuse holder and fuse is provided because the power drain of the DF set is well below that of most circuit breakers. A 1/2 amp fuse should be used for either 12V or 24V systems. Average power drain is about 100 mA. The chassis of the DF set is grounded, but the ground wire should be attached to the airframe ground to avoid noise due to small mechanical motions between the case and chassis of the receiver. Except for the dial light change, there is no wiring or other changes needed for operation in 12V or 24V aircraft systems.

Dial Lights

> **Note: Operation of a 12V receiver on a 24V power system will cause the dial lights to burn out.**

All LA Series receivers with serial numbers above 1300 are supplied wired for 24V internal dial light operation. Serial numbers are located on the right chassis side rail. No damage will occur if operated with a 12V system, but the dial light will be very dim. Modification of the LA Series receiver to change from one voltage to another varies with the date of manufacture and with subsequent modifications made to the equipment. Figure 3 shows the different ways used to make this modification. Select the one appropriate to the unit being modified.

If it is desired to run the meter light from the aircraft panel light dimming system, cut the jumper marked "cut for external dial light dimming" shown on the circuit board component layout, Figure 22. Connect pin 3 on the rear connector to the aircraft dimming bus. Failure to cut this jumper will blow the DF receiver fuse or cause the receiver to run with its power switch turned off.

Connect the optional remote meter dial light wire to pin 3 in any case. If remote dimming is not used, the remote meter light will come on when the DF set is turned on.

Audio Requirements

Connection to the aircraft audio system is not absolutely required, but it is highly recommended so the pilot can verify the signal being tracked. The audio connection will also give an audible as well as a visual alarm when the ELT is received in ALARM mode. The DF receiver has sufficient output to drive a headset directly, but will not adequately drive a speaker. The output impedance is about 2 ohms, so a connection directly across an existing headphone line will short out the other sources. A series resistor of 330 to 680 ohms should be used with the usual 600 ohm systems. Such a resistor is already a part of most audio panels. Figure 4 shows typical earphone connections.

1. +12/24V INPUT POWER
2. GROUND
3. DIAL LIGHT/DIMMING BUS
4. KEY LEAD (AUX. DF ONLY)
5. AUDIO IN (AUX. DF ONLY)
6. AUDIO OUTPUT
7. REMOTE METER +
8. REMOTE METER -
9. REMOTE ALARM LIGHT +

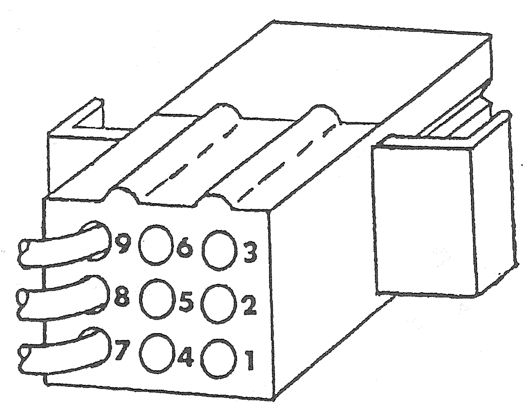
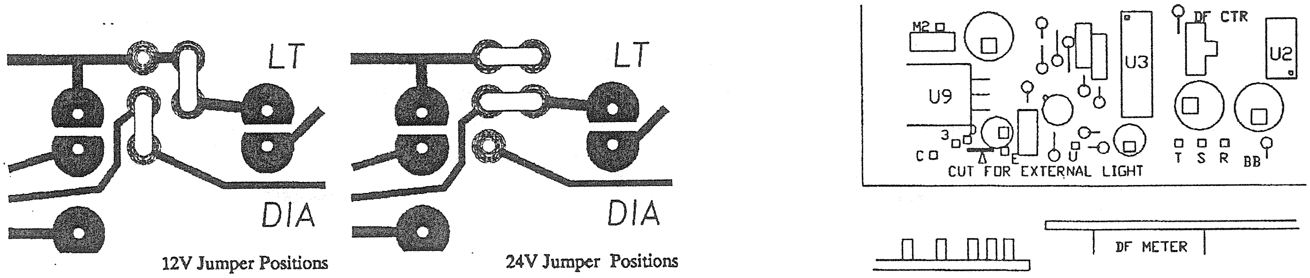


Figure 2. Rear Connector Pin Connections.



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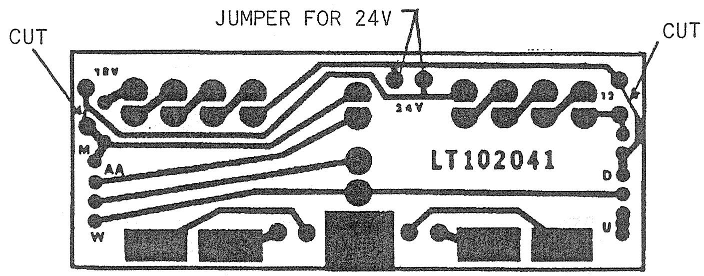
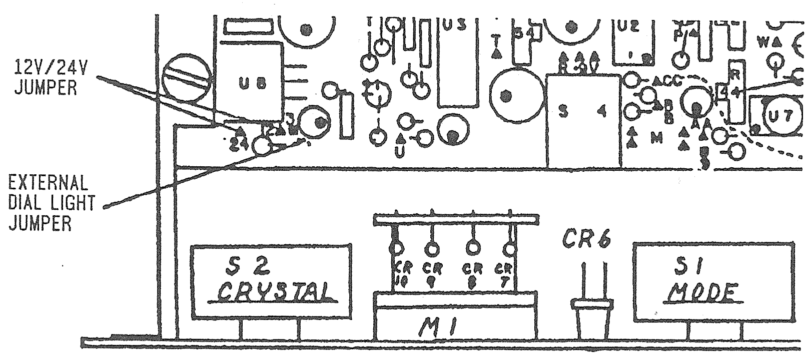


B



C

Starting with S/N 1300, there are five socket contacts and two movable wire jumpers on the meter light PC board to set the proper voltage. Figure A shows the proper jumper positions for each voltage. Small needle nose pliers or tweezers can be used to change the jumper positions. Units are shipped set for 24V. If the dial lights are to be run from the panel light dimming bus, a jumper on the main circuit board just behind the DF meter must be cut as shown. Failure to cut this wire will cause the DF fuse to blow.

Dual meter units with S/N below 1300, except for some units that have been converted to dual meters, use a different meter light PC board. These units were designed for 12V. To convert to 24V operation, cut the two thin traces on the board shown in Figure B with a sharp knife. Then solder a wire jumper between the two pads marked "24V" on the board. To reverse the conversion, remove or cut the "24V" jumper and install jimpers to replace the two cut traces.

Single meter receivers have either a "12" or "24" hole on the main circuit board for the positive wire from the meter lights, see Figure C, or a bare wire jumper in this same location. Cut the jumper or solder the wire into the "24" hole for 24V operation.

Older units that have been converted to dual meters will have voltage change options on both the meter light board and the main board. Set the proper voltage on the meter light board and leave the main board set for 12V.

Figure 3. 12V/24V Dial Light Modifications.

Speaker operation can be provided by connection to an auxiliary audio input provided on most radios or to an input to an isolation amplifier. Provision must be made to cut off the audio from the DF from any cabin speaker while transmitting to avoid feedback. An isolation amplifier or a proper connection to a receiver aux audio input will usually provide this function.

Note: Do not connect the DF audio output directly across an aircraft cabin speaker. Such a connection will quickly burn out the DF audio amplifier and result in loss of left-right DF indication.

Remote Meter/Alarm Light

The LA Series receiver power harness is supplied with a jumper between connector pins 7 and 8, the remote meter connections. Any 200 μA zero center meter with 2000 ohms or less internal impedance may be connected to these terminals to serve as a remote indicator. The internal DF meter will NOT work if these pins are left open.

Pin 9 of the DF set power connector provides drive for a remote alarm light. It is designed to operate an LED lamp at about 30 mA. Ground is used as a return.

Approvals and Placards

Under current rules, the installation of this DF equipment will require completion of an FAA Form 337 as well as log entries and an updated weight and balance. For critical applications, the receiver weighs 15 ounces and the antenna and cable weigh 16 ounces.

Copies of a Form 337 and a form 8110-3 from a Cessna 172 installation that was flight and ground tested and approved by an FAA Designated Engineering Representative (DER) are available. These forms cannot be used directly but should be useful as a guide and for qualifying other installations by similarity. Key points to note in approving the installation of this non-TSO receiver is that it is considered non-essential equipment and it is not approved for navigation. The standard bent whip antennas are TSO approved. This sample DER does NOT cover any connection or use of the optional Auxiliary DF funtion.

A placard with the words, "Not approved for navigation. Turn DF off for com on: 126.85, 132.2, 132.3, 132.47" MUST be placed on or near the receiver or a remote meter if one is installed. The supplied placard will fit under the strength meter.

The com frequency which may be affected is directly related to the frequency being used on the DF receiver. 121.5 on the DF may affect 132.2, 121.6 may affect 132.3, 121.775 may affect 132.475, and 243 may affect 126.85. If your DF has other frequencies installed, you can calculate which com frequency may be disturbed by taking the VHF receive frequency and adding 10.7. For example, 123.1 + 10.7 = 133.8. For UHF, take the result and divide by 2 (243.2 + 10.7 = 253.9 divided by 2 = 126.95). If non-standard frequencies are installed in the DF, the numbers on the placard should be changed accordingly. Interference is usually an open squelch or a whistle on a received signal.

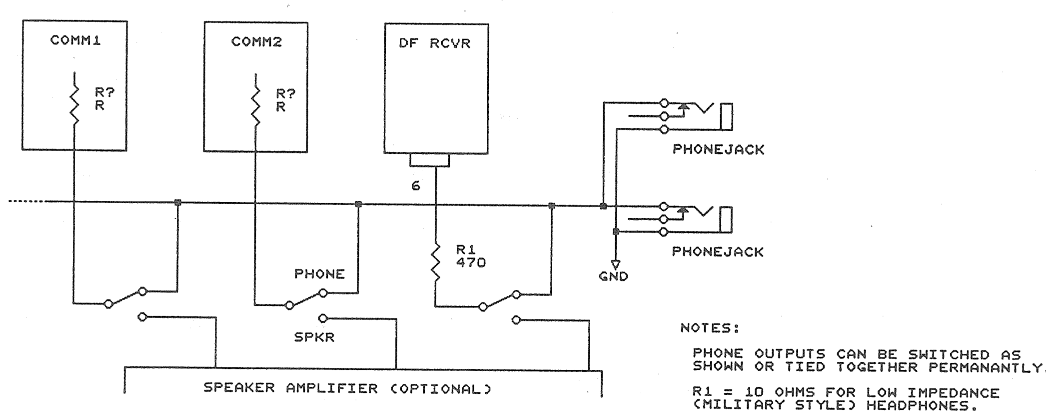


Figure 4. Typical Earphone Connections.

Auxiliary DF Installation

All current production receivers and most earlier models have provision for auxiliary DF; that is, DF on signals received by one of the aircraft comm receivers. Connection of this function is optional. The internal receiver is fully functional with the auxiliary circuits unconnected. Detailed instructions for various model radios are given later.

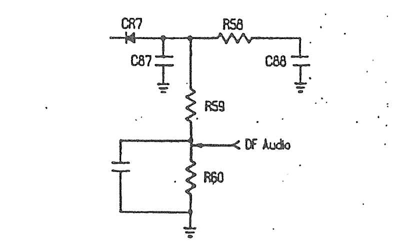
Three connections are required for auxiliary DF. First, the coaxial cable from the communications antenna to the communications radio must be broken and run through the DF receiver. The existing cable can be cut if enough slack exists, or a new piece of cable can be inserted. Connectors for the two DF receiver ends of these cables are provided. Use RG 58C/U cable. Be sure to label these new connectors and the connector for the DF antenna so that they can be reconnected to the correct jacks on the receiver after maintenance.

The second connection is to the key or push-to-talk (PTT) line of the communications transceiver. The wire from pin 4 on the DF power connector is tied in parallel with the existing key lead. This connection controls the internal relay to prevent inadvertent transmission through the DF antennas.

The third connection is made to the audio output of the communications receiver through the twisted pair connected to pin 5 of the connector and ground (pin 2). For good DF performance, the connection must be made at a point in the receiver circuit before any significant roll-off of frequencies below 300 Hz has occurred. If pulsed signals such as the ELT are to be tracked in the AUX mode (we don't recommend it), the connection must also be made before the noise limiter. Recommended connections for the more commonly used aircraft radios are shown at the end of this section. A little circuit analysis using the above principles should give a suitable connection for radios not listed. If the radio being used for AUX DF is also being used to drive a cabin speaker through an auxiliary audio input, a stage of amplification should separate the DF output and the auxiliary audio input. Lack of such an isolation stage will result in oscillation.

For detailed information on installing the Auxiliary DF function, the following radios are listed in alphanumeric order. Unless noted, A and B models are covered under the basic number. Some listings refer to partial schematics for clarity. Whenever possible, the DF audio connection should be run through a spare connector pin so that it does not make subsequent servicing awkward.

ARC R34 and similar series. Take DF audio from the Tuning Meter connection J4-4 or equivalent connection. No aux audio input.
ARC RT513. Connect DF to P3-CC Nav Output. Key P3-R, Aux input P4-R, V, T.
ARC RT 514, RT517, RT 525, RT 540. Schematic A. Key P3-M, Aux audio input P3-D, J, N, T.
ARC RT 524. Schematic B. Key P3-M, Aux audio input P3-D, J, N, T.
ARC RT 432, RT 442, RT 522. Schematic C. Key A5J2-B, Aux audio inputs A5J1-12, 13, 14, 10, 11.
ARC RT 328, RT508. Schematic AA.
ARC RT 385, RT 485. Schematic AB.
ARC RT 422A, RT 432, RT422. Schematic AC.
Bendix RT 221. Schematic D.
Collins 618MI. Schematic E. Key P1A-31. No Aux input.
Collins "Microline" 250, 251. Schematic F. Key pin 9, Aux audio pinput pins 17-20.
Collins VHF 20. Schematic G. Key P101-8. No Aux audio input.
Collins VHF 250, VHF 251. Schematic AE.
Edo Aire 551, 661. Schematic H, except change R numbers to R 150 and R 151. Key J601-12, Aux audio input J601-8.
Edo Aire 553. Schematic H. Key J801-12. Aux audio input J801-8.
Edo Aire RT 563. Schematic H, Except change R numbers to R450 and R451 and CR 108 to CR 408. Key J1301-12. Aux audio input J1301-8.
Edo Aire RT 771. Connect DF audio to the high side of the volume control. Key pin BB. Aux audio input pin V, W, X, Y.
Escort 110. Schematic AF.
Genave Alpha 10/Alpha 100. Schematic I. Key P101-4. See schematic for modification for Aux audio input.
Genave Alpha 200. Schematic J. Key pin 4. Aux audio input pin 4.
King KX 145. Connect DF audio to VOR/LOC audio, P402-11. Aux audio input P402-14, 15, 16.
King KX 150, KX 150A. Schematic K.
King KX 150B. Schematic L.
King KX 160. Connect DF audio to detector output J601-3.
King KX 170, KX715. Schematic M. Key P171--40. Aux audio input P171-15, 16.
King KY 90, KY 95. Schematic N.
King KY 92. Schematic O. Key P921-8. Aux audio input P921-J, K, L. Aux audio input will require a 470 ohm series resistor. Or see Schematic AE.
King KY 96A, KY 97A, KY 196A, KY 197E. Schematic AH.
King KY 196/KY 197. Schematic P. Key P1961-4. No Aux audio input.
King KY 196, KY 197, KY 196E, KY 197E. Schematic AI.
King KX 170A, KY 170B, KX 175, KY 175B, KX 195, KX 195B, KX 195BE. Schematic AJ.
King KX 155. Audio input to AGC test point at rear plug. On LA-16A receiver, add 47K resistor from pin 5 of rear connector to ground on PC board. Adjust "Aux DF Sensitivity" pot, R63, on DF receiver to maximum, or to obtain positive DF meter deflection when test transmitter is 30 degrees off aircraft center (see Fig. 22).
King KX 155 Alternate. See Schematic AK.
King KTR 900. See Schematic AL.
King KTR 905. See Schematic AM.
King KTR 908. See Schematic AN.
Narco Comm 11. Connect DF audio to "Det Out," pin 11. Trim gain using R659 on receiver board. Key Pin 4. Aux audio input pin 7.
Narco Comm 120. Schematic Q. Key J401-4. Aux audio input J401-7.
Narco Comm 120. Schematic AO.
Narco Escort 110. Schematic R. Key P801-12. Aux audio input P801-10.
Narco Mark 3 and Mark 8. Schematic S. Key P401-6. No Aux audio input. The reference designations may differ from the schematic shown on some models.
Narco Mark 5. Key pin R. Aux audio input pin U. Use pin T, omni signal out, for the DF audio signal connection.
Narco Mark 6. Schematic T. There is no key and no Aux audio input.
Narco Mark 7 and Mark 10. Key P402-B. Aux audio input P402-M, P, U. Use P101-17, the VOR output signal, for DF audio.
Narco Mark 12. Schematic U1. Key pin 4 on power supply or white wire in cable. Aux audio input white/blue wire in cable.
Narco Mark 12A/Mark 12B. Schematic U2. Otherwise same as Mark 12.
Narco Mark 12D. Schematic AP.
Narco Mark 16. Schematic V. Key pin 10. The Aux audio requires external components; see Narco instruction manual.
Narco Mark 24. Schematic W. Key P501-42 (wire 36). Aux audio input P501-47 (wire 40).
Narco VTR 1, VTR 2, VHT 3, Mark 4. Schematic X.
Sunair SA 360. Schematic Y.
Sunair SA 1036. Schematic Z.



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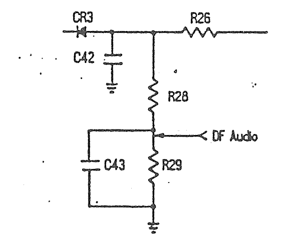

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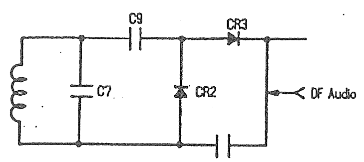

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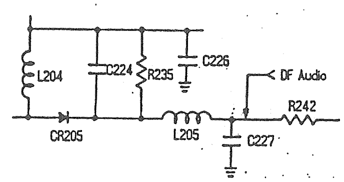

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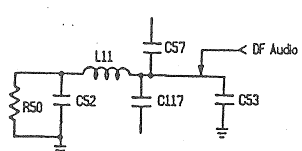

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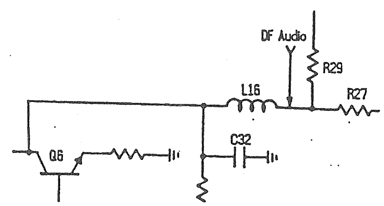

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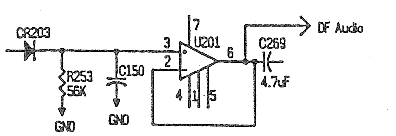

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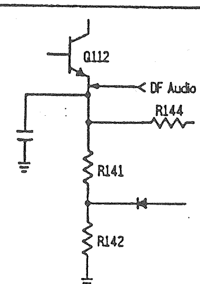

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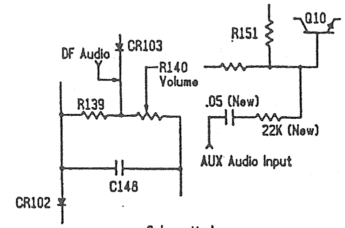

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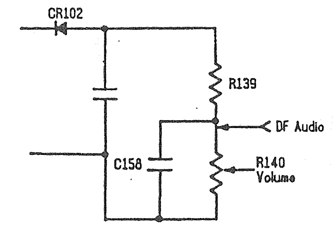

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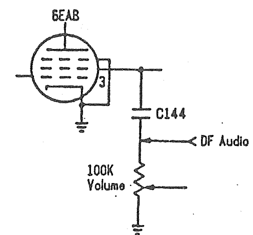

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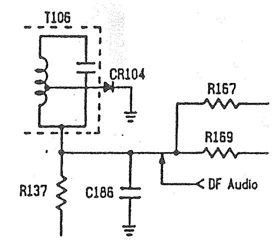

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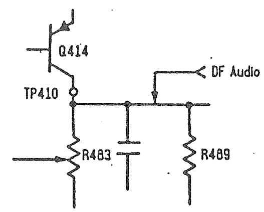

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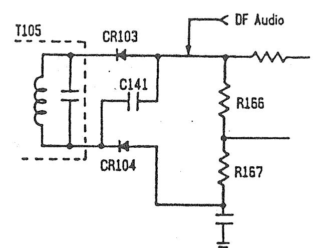

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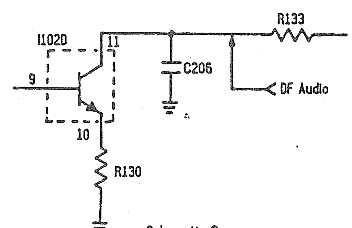

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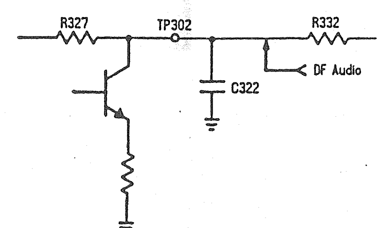

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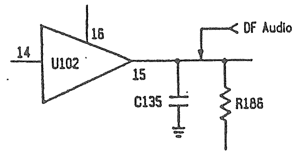

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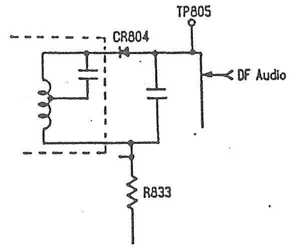

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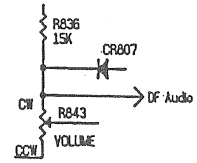

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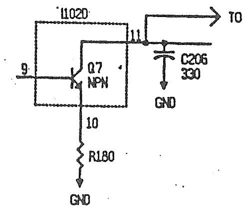

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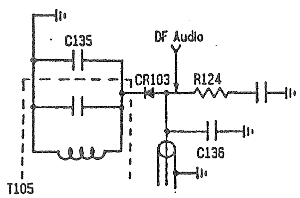

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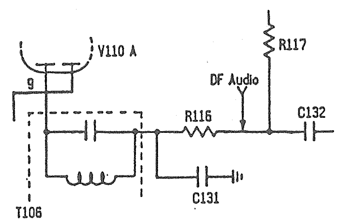

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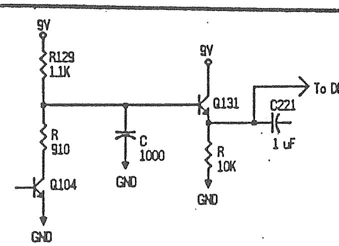

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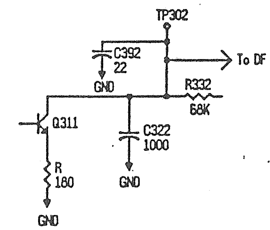

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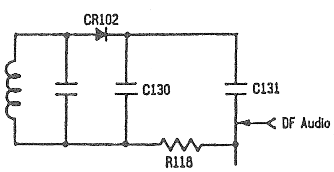

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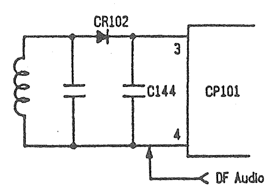

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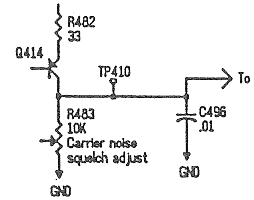

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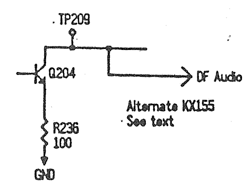

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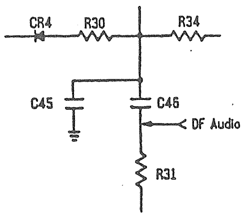

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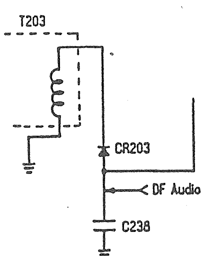

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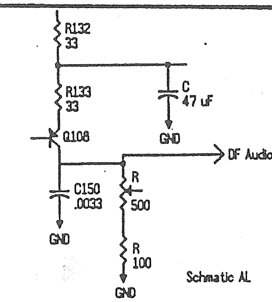

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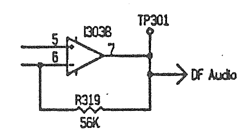

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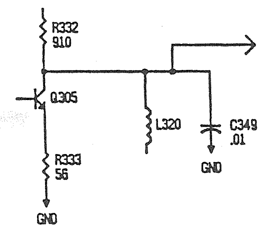

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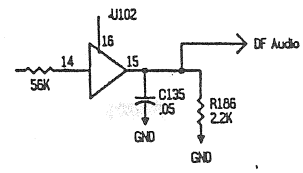

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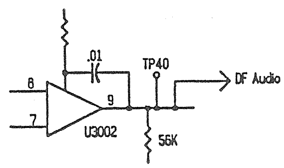


Schematic AP

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.

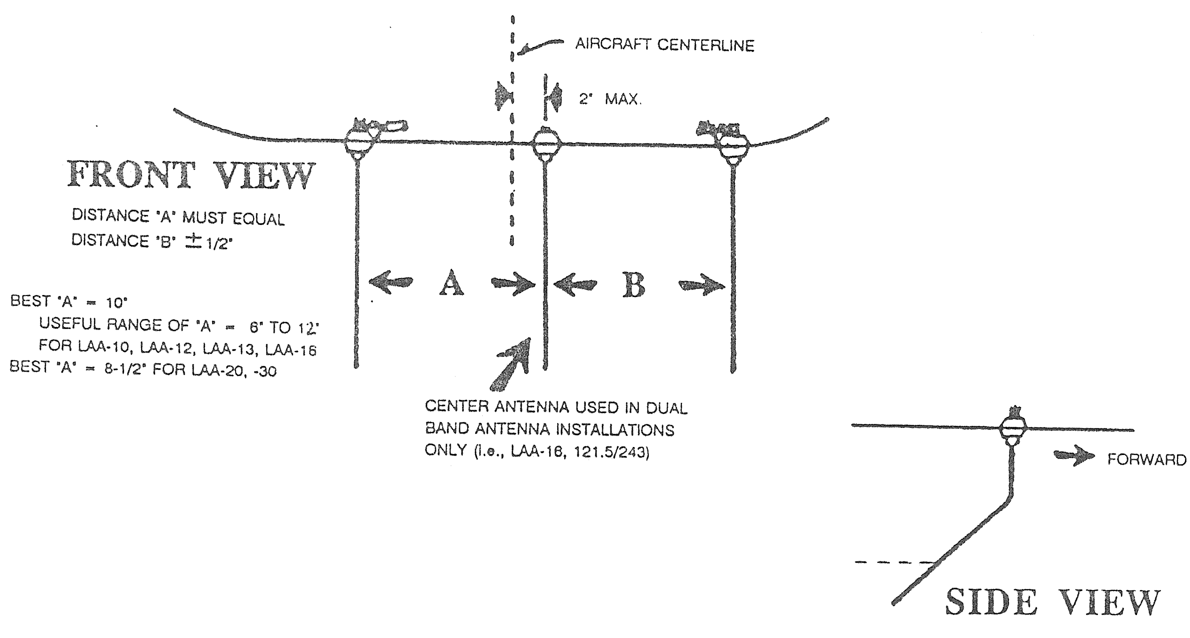


Figure 7. Antenna Installations.

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.

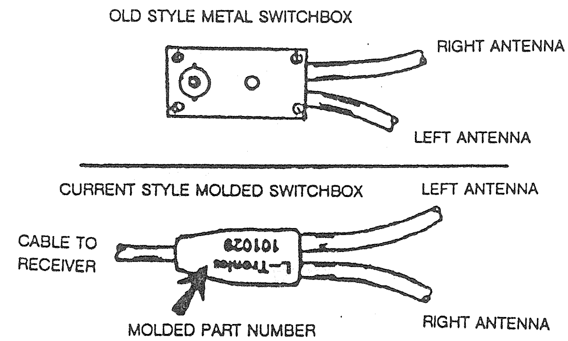


Figure 7a. Antenna Connections.

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.

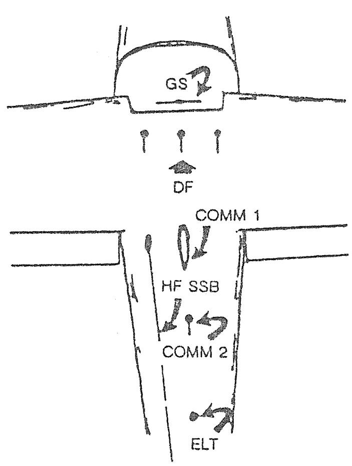


Figure 8.

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.

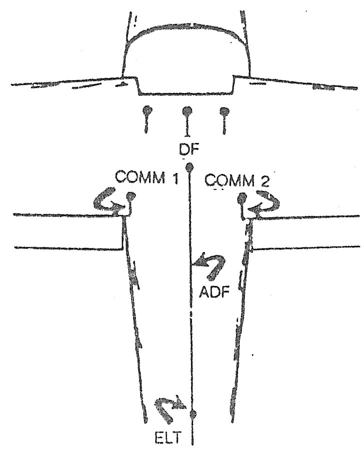


Figure 9.

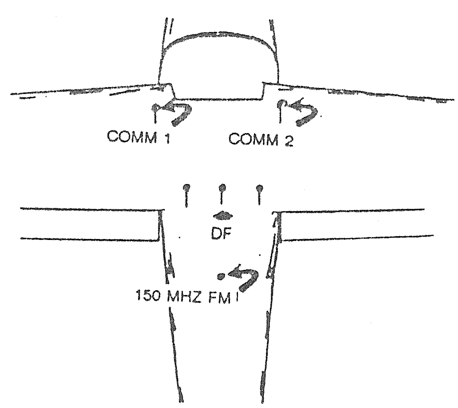


Figure 10.

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.

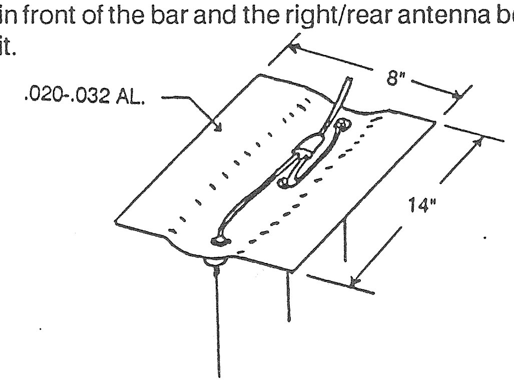


Figure 11. Temporary Installation.

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.

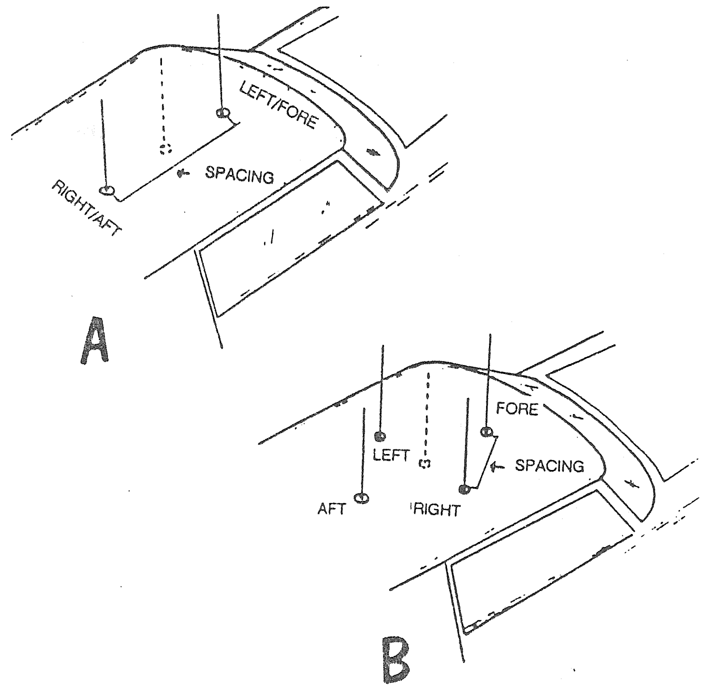


Figure 12. Vehicle Installations.

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.

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.

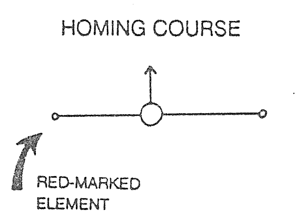
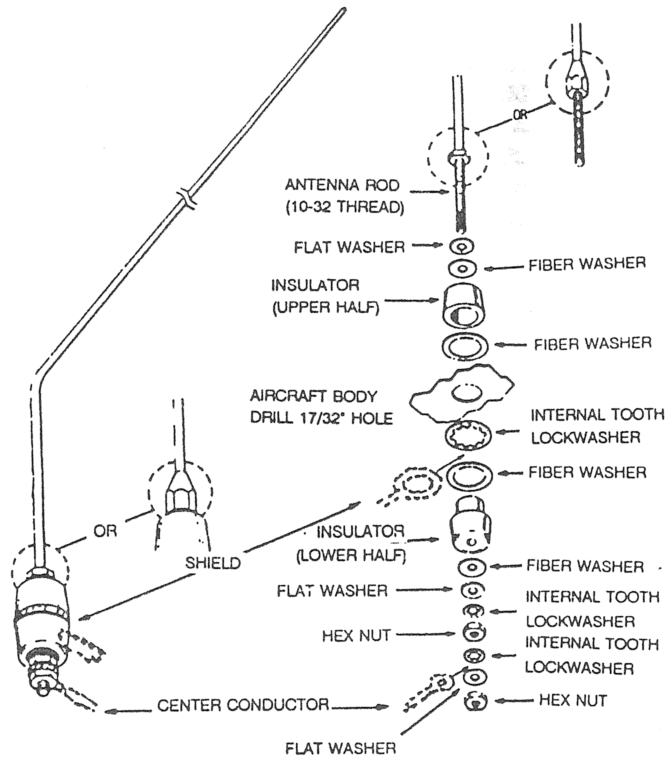


Figure 13. Rotary (Weatherproof) Installation.



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

Figure 14. LAA Series Bent Whip Antenna Assembly.

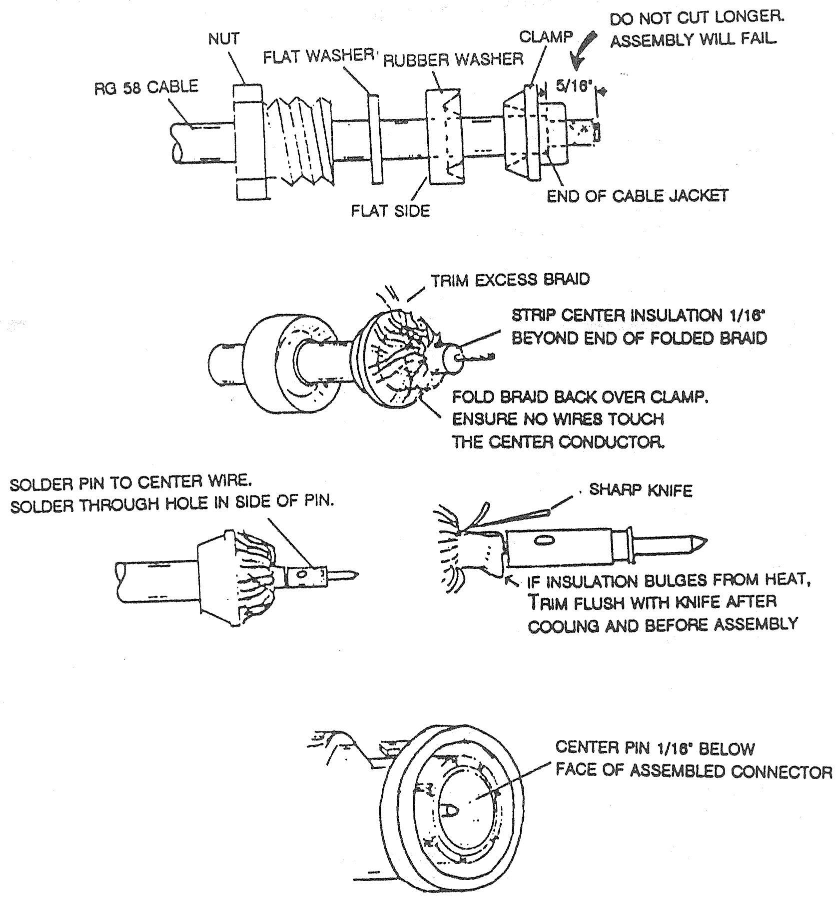
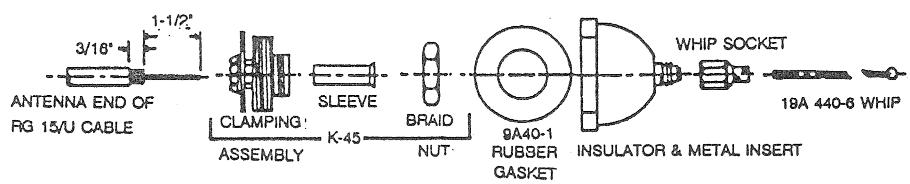
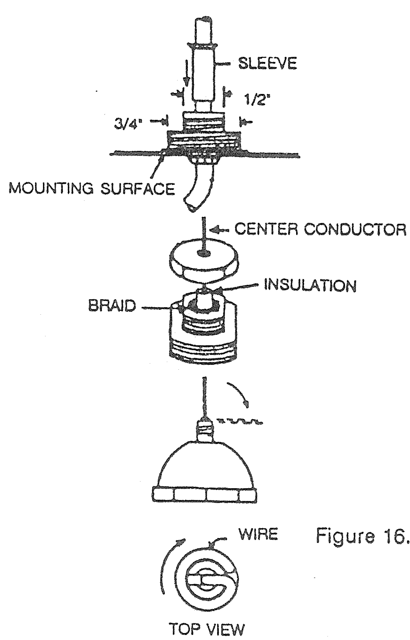


Figure 15. UG-88 Assembly.





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.

Page 19-20 omitted.

Section 4

Checkout and Operation

Functional Check - No Transmitter

This is a quick check that can be made part of a preflight routine to assure that a previously checked unit is still working. Select 121.5 MHz on the crystal switch. Turn the Alarm toggle switch OFF (down) on dual meter units (on single meter units, set the Mode switch to RECeive). Turn the SENSitivity control (outer knob) fully clockwise to maximum. Turn on power to the radio system. Turn on the DF by advancing the VOLume control (inner knob).

A hissing sound should be heard through the audio system and the Strength needle will be between 1/4 and 1/2 of the way between the center of the scale and the left hand end. On dual meter models, the DF needle will stay roughly centered. If an internal dial light connection is used, it should come on, but might be difficult to see in the daytime.

Now turn the SENSitivity control counterclockwise toward minimum. This will cause a decrease in sound volume and a decrease in the Strength meter reading. The needle should move to the left-hand stop. Some sound may be heard even when the SENSitivity control is at minimum.

On single meter models, turn the mode switch to DF. The meter needle should center.

For both single and dual meter units, turn the SENSitivity control to maximum. The DF needle should move randomly back and forth one or two needle widths about the center in response to receiver background noise. Movement will be slow and may be difficult to see on the dual meter models.

Turn the Mode switch to Alarm on single meter units, or turn the toggle switch ON (up) on dual meter models. The Alarm light should flash for 10 to 20 seconds and then stop. The receiver noise should also cut off at the same time. The Alarm is now set and will respond to a steady ELT signal. This Alarm setting period occurs each time the Alarm function of the DF is turned on. It tests the Alarm circuits and reminds the pilot that the DF receiver is on.

Functional Check Using a Transmitter.

All features of the LA Series DF except the Alarm circuit can be checked using a signal generator or a transmitter on 121.6 MHz, such as another aircraft's radio, a portable transceiver, or a practice ELT.

Park the aircraft in the open, away from metal buildings. The transmitter should be at least 25 yards in front of and 15 to 30 degrees to one side of the plane.

Set the Frequency switch to 121.6 MHz. Rotate the SENSitivity control fully counterclockwise to minimum. Set the VOLume control to about the 12 o'clock position. Set the Mode switch to DF on single meter units or the Alarm toggle switch OFF (down) on dual meter models. Turn on the DF and the 121.6 transmitter. If necessary, rotate the SENSitivity control clockwise until the signal or the DF buzz is heard.

On both single and dual meter models, the needle on the DF meter should point toward the transmitter (to the left of center if the transmitter is on the left side of the aircraft or to the right if it is on the right side). Move the transmitter to the other side of the aircraft. The needle should deflect in that direction. On the ground, it is normal for the needle to be uncertain about centering with the test transmitter directly fore or aft. The DF is OK if the needle points correctly when the transmitter is on the sides.

On dual meter models, the Strength meter needle will move slowly up-scale to the right as the SENSitivity is increased.

For single meter models, change to RECeive on the Mode switch. The meter needle should come upscale to the right.

On both models, move the SENSitivity control clockwise. The Strength needle will move further to the right, with dual meter models having slower response to control movement. Single meter receivers with dual meter remote indicators installed should be left in the DF mode. The remote meters should then respond just like the panel meters in a dual meter receiver.

Functional Check - Auxiliary DF Mode

If the Auxiliary DF function has been installed, tune the communications receiver to which it is attached to any active signal, such as the tower or ATIS. Turn the Frequency switch to AUX. Any signal now received by the auxiliary receiver should also be heard through the DF set. To check this, turn down the volume of the comm receiver and turn up the volume on the DF set. The selected signal should still be heard at a comfortable volume. (The signal will not be heard using the recommended installation with the King KX155 but the DF needle will react.) If the DF mode is selected, the humming DF switching signal should be heard on all transmissions and the DF needle should react. The Strength needle does not work in AUX mode and should stay to the left. To check for proper DF sensing, tune the comm receiver to the test signal. Again, the DF needle should point to the transmitter. If it points the wrong way, reverse the Aux DF Sense wires on the DF receiver PC board. Do not reverse the antenna leads if the DF sense is correct with the internal receiver.

Functional Check - Alarm Mode

The Alarm function can be checked only with an ELT. A practice ELT on 121.6 MHz or a 121.5 MHz ELT with a dummy load in place of the antenna can be used. Do not extend the antenna on the practice ELT. A very strong signal will sometimes cause a normal alarm circuit to fail the test.

Select 121.6 (or 121.5 as appropriate) on the Frequency switch. Rotate the SENSitivity control full clockwise to maximum. Set the VOLume control to about the 12 o'clock position. Set the Mode switch to ALARM on single meter units or the toggle switch ON (up) for dual meter models. Turn power ON. The red LED Alarm light will flash and the audio will come on with a hissing noise. After a short time, both the audio and light will go off.

Wait one minute to allow the Alarm circuit to fully reset, then turn on the ELT. On either single or dual meter unit, the Strength meter needle will swing to the right and may fluctuate with the sweep of the ELT (the fluctuation won't be as noticeable with dual meter units). On dual meter models, the DF meter will remain in the center, regardless of the ELT's location. (The DF function does not operate in the Alarm mode.) In about 20 seconds, the Alarm light will flash and the audio will come on.

This completes the functional check of the Alarm mode. Turn off the ELT and the DF.

Flight Check

All DF installations should be flight checked against a known target before search use to verify correct operation and note any operating peculiarities. An air check should be done using a practice ELT or test signal or, for units with the auxiliary DF capability, any steady signal, such as the ATIS. A stable laboratory signal generator, modulated for identification and supplying 0 to +10 dBm (1 to 10 milliwatts) to a simple ground plane antenna on a roof is a suitable source of a test signal. Tracking for up to 10 miles should be possible.

Place the test transmitter as high and clear as possible in open terrain. Fly about 3 to 5 miles away at 2000 to 3000 feet AGL. Make several full circles, starting with no more than 10 degrees bank angle. The DF needle should cross zero only twice during the turn at shallow bank. More than two crossings indicates an unsatisfactory installation, which can be confusing in actual search conditions. Most installations show errors in steep banks when the aircraft structure gets in the way of the signal path. Pilots should note how the DF performs at steeper bank angles for future reference. Note also where wing shadows occur, indicated by a decrease of strength meter reading or audio volume during steep turns. This can be a useful verification of DF indications.

To determine direction to the ELT, turn in the direction of DF needle deflection. If the needle is to the **left** of center, turn **left** until it centers and any further leftward turn 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 aircraft will be flying toward the source of the signal. (If you are flying away from the ELT, a turn away from center (**left**) will cause the needle to deflect in the direction of the turn (**left**). Simply follow the needle.)

Next, follow the DF course inbound and compare it to the visual heading to the target transmitter. In a good installation, they will agree to ±5 degrees; up to ±15 degrees error is quite usable. Note the error on a placard near the DF receiver. Finally, compare the inbound and the outbound courses using the DG. They should differ by 180 degrees degrees. If the flight test is done on a frequency more than 2 MHz from 121.5 or other working frequency, the course calibration part should be redone as soon as a suitable known signal at the working frequency is available.

Course errors of up to 30 degrees are usually due to unsymmetrical installation or, on the ground, to nearby reflecting objects (such as cars or buildings). Asymmetry usually causes both front and rear courses to be bent toward the same side of the aircraft and usually toward the source of the problem.

Severe errors or one-sided needle indications are usually due to a damaged antenna-to-switchbox cable or to poor grounding at the antenna or a skin joint nearby. Poor skin joint contact may well indicate structurally significant corrosion and should be investigated by a mechanic.

Operation

Alarm Mode

The Alarm mode is the normal mode for routine flying. It enables the pilot to monitor the emergency frequency without dedicating a communications radio to do so. THE ALARM MODE SHOULD NOT BE USED DURING A SEARCH MISSION. The ear will hear a weak signal far sooner than the Alarm will function.

For Alarm mode, set the SENSitivity to maximum and the VOLume to a comfortable level. Turn the Mode switch to Alarm on single meter units or turn the Alarm toggle ON (up) on dual meter units.

When an ELT activates the Alarm, select the DF mode on single meter units or turn the Alarm toggle OFF (down) on dual meter receivers to track the signal.

Flying A Mission

Set the DF for mission operation: 121.5 on the Frequency switch, Mode switch to DF on single meter units or the Alarm toggle OFF (down) on dual meter units. SENSitivity at maximum (fully clockwise). Volume where comfortable.

Climb to an altitude 3,000 to 4,000 feet above the terrain if possible. Fly to the area of the reported ELT signal. If no probable area exists, fly to the area where other aircraft have reported hearing the ELT.

Unless the beacon is known to be a 406 MHz EPIRB (which does not transmit on 243 MHz) or a military beacon (which does not transmit on 121.5 MHz), switch between 121.5 and 243 at least once each minute until a signal is heard. Undamaged ELTs can usually be heard further on 121.5 MHz than they can on 243 MHz. The reverse is often true for damaged units. All civil beacons except 406 MHz EPIRBs and some military beacons transmit on both frequencies. If the ELT can not be heard in the expected area, climb to a higher altitude. If this fails to acquire the signal, start a methodical search, such as an expending square.

When first heard, the ELT will probably build slowly in strength over a period of several minutes. Continue flying until a reasonable level of signal is acquired. The DF needle should deflect to one side and the Strength needle (on dual meter units) should come upscale. Resist the urge to turn immediately and follow the needle. Instead, make a 360-degree turn at no more than a 30-degree bank to ensure two needle centerings approximately 180 degrees apart, indicating a valid direction. When the turn is complete, properly center the DF needle (as described on page 22 under Flight Check) for a course toward the ELT. If the ELT is heard on both 121.5 and 243 MHz, compare the headings. If they differ by more than 45 degrees or if the turn produces multiple cross-overs, try a new location or climb to a higher altitude to escape from the reflections.

If DF is good, note the magnetic heading and fly in the indicated direction toward the ELT. The DF needle may wander back and forth around center at 10- to 30-second intervals. This is caused by flying through weak reflections and should be ignored. Fly in a direction that keeps needle swings about equal in number left and right.

Don't become concerned if the signal slowly fades out. Continue on the initial heading for at least six minutes. If you are still headed toward the ELT, it should slowly build back up in strength in three or four minutes and be somewhat stronger than before. If it does not reappear, return to where the signal was heard and try a different altitude.

As the signal builds in strength, or if the DF needle gets too sensitive, decrease the SENSitivity control until the signal disappears, then increase it until the Strength meter has an on-scale reading and the DF needle gives slight left-right deflection when the aircraft is yawed. DO NOT decrease the VOLume control to reduce signal strength! Overload of the receiver could result.

A "station passage" is often seen as a rapid fluctuation in signal strength and confused DF readings. Yaw the aircraft to see if the course has reversed (needle goes in direction of aircraft turn). If so, continue on an outbound course for a few minutes. Turn and make several confirmation passes at different angles, then make a visual search for the target, if it has not already been seen.

More detailed information on aerial direction finding techniques can be found in L-Tronics' "Basic E.L.T. Location Course."

Section 5

Technical

Theory of Operation

The antenna systems provided for use with the LA Series Aircraft DF have controlled directivity when properly mounted on the aircraft. That is, they receive a signal better from some directions than from others. If this variation with direction is drawn, a pattern of nearly cardoid shape, like the solid line in Figure 14 results. This pattern shows highest sensitivity to the right and near zero sensitivity (null) to the left. The pattern is reversed (the dashed outline) by the diode switch in the switchbox that is part of the antenna cabling.

In the DF mode, the patterns are switched back and forth about 125 times per second, producing the DF tone or hum and causing the meter to point to the side of the aircraft having the strongest signal. The meter would point to the right for both signals 1 and 2. When the signal comes in at a right angle to the line between antennas (that is, straight ahead or behind the aircraft), the two patterns have equal sensitivity, the DF tone will disappear from the received signal and the DF needle will center.

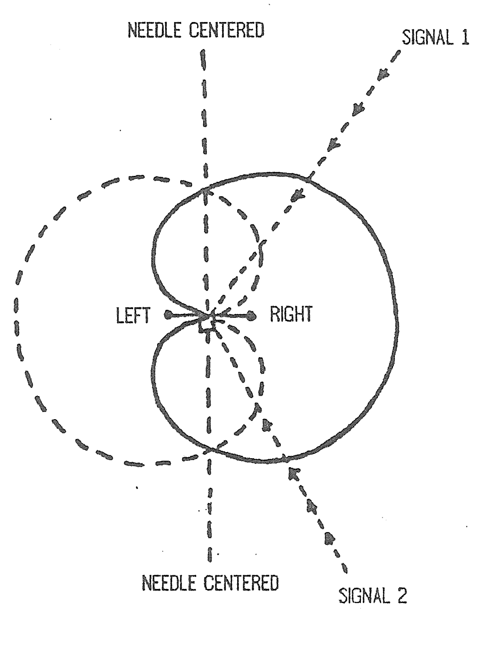


Figure 14. Switched Antenna Patterns.

This type of DF is known as an amplitude comparison homing system. Such systems have been used as navigation aids since the early 1930s. An auxiliary FM receiver cannot be used directly with this system because it will not reproduce the antenna amplitude patterns.

The L-Tronics aircraft antennas are two element yagis consisting of a driven element and a reflector. Dual band arrays make use of a third element in the center tuned to act as a reflector at the higher of the two frequencies covered. The patterns produced by these antennas 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 gives 3 to 5 dB better sensitivity. Where signals are strong, no measurable performance difference exists between the two antenna types.

Circuit Description

The LA Series equipment are self-contained receivers with added circuitry for left-right amplitude comparison homing DF and for tone-coded squelch (Alarm) designed to respond to sustained ELT swept tone modulation on a received signal.

The receiver is a double conversion superhetrodyne of relatively conventional design. Two independent tuners, consisting of an RF amplifier, mixer, and local oscillator connected to a common antenna and IF amplifier can be fitted to provide reception of signals in two independent frequency ranges, one at a time.

The following component references are taken from the schematic. All model receivers are similar. The VHF signal enters the receiver from the DF antenna at J1. The signal is inductively coupled between L1 and L2 and applied to RF amplifier Q1. The output of Q1 is coupled through L3 and L4 to the gate 1 of mixer Q3. The local oscillator signal is applied to gate 2 of Q3. T1 and FL-1 form the 10.7 MHz first IF filter and provide a major share of the receiver selectivity. Q2 is the first local oscillator. A crystal is selected by applying a positive bias to one of the terminals, J, K, or L. This forward biases one of the PIN diodes, connecting the corresponding crystal and also provides bias for the transistor. L5 and C13 resonate near the 5th harmonic of the crystal and force oscillation in this mode (58-75 MHz). C16-L6 is tuned to two or three times this frequency, depending on the tuner frequency range, to provide the injection signal for the mixer. Emitter current through Q2 turns on Q13, which in turn grounds the sources of Q1 and Q3 to activate the corresponding tuner. Variable drain voltage for Q1 and Q3 is provided through the SENSitivity control R61, which sets the tuner gain.

The UHF tuner is the same as the VHF tuner, except that the local oscillator drain is tuned to 3, 4, or 6 times the crystal frequency. Some units have an extra multiplier stage. On units with the Auxiliary DF option, point i is not connected because this switch position activates the Auxiliary circuit.

U1 contains a differential amplifier which acts as the 10.7 MHz amplifier and second converter and a third transistor which, with Y7, forms the second conversion oscillator. Q7 and Q8 are high gain tuned amplifiers at 455 kHz. They provide the bulk of the receiver gain. Bias for these stages is provided by the AGC line through the IF gain control R42. Increasing bias increases stage gain. Q9 is biased by R39 and CR1 to form an active detector. The collector of Q9 goes negative with increasing signal. Q10 is an emitter follower driver for the signal strength meter. U2 is the audio amplifier which drives both the audio output through the volume control R45 and the DF meter through a synchronous detector, R54, U3c, and U3d.

This synchronous detector configuration is also known as a product detector or phase detector. Its function is to extract amplitude changes that are synchronous with the antenna switching and drive the meter in the direction of the strongest signal. This separation is not perfect, so some meter oscillation due to the ELT sweep or to speech on the received signal is normal. The bandwidth of the meter and C57 is less than 3 Hz. This narrow metering bandwidth is one reason the DF can track a signal too weak to hear.

ELT signals are pulsed. Supposedly, the on-time or duty cycle is 33% or more, but as low as 7% has been observed in the field. With low duty cycle signals, sensitivity is lost, overload is more likely and full-scale left-right indications may not be possible at any orientation. Meter centering will still give an accurate track, however. Figure 15 shows the loss of sensitivity under pulse conditions. Curve A shows performance on signals with

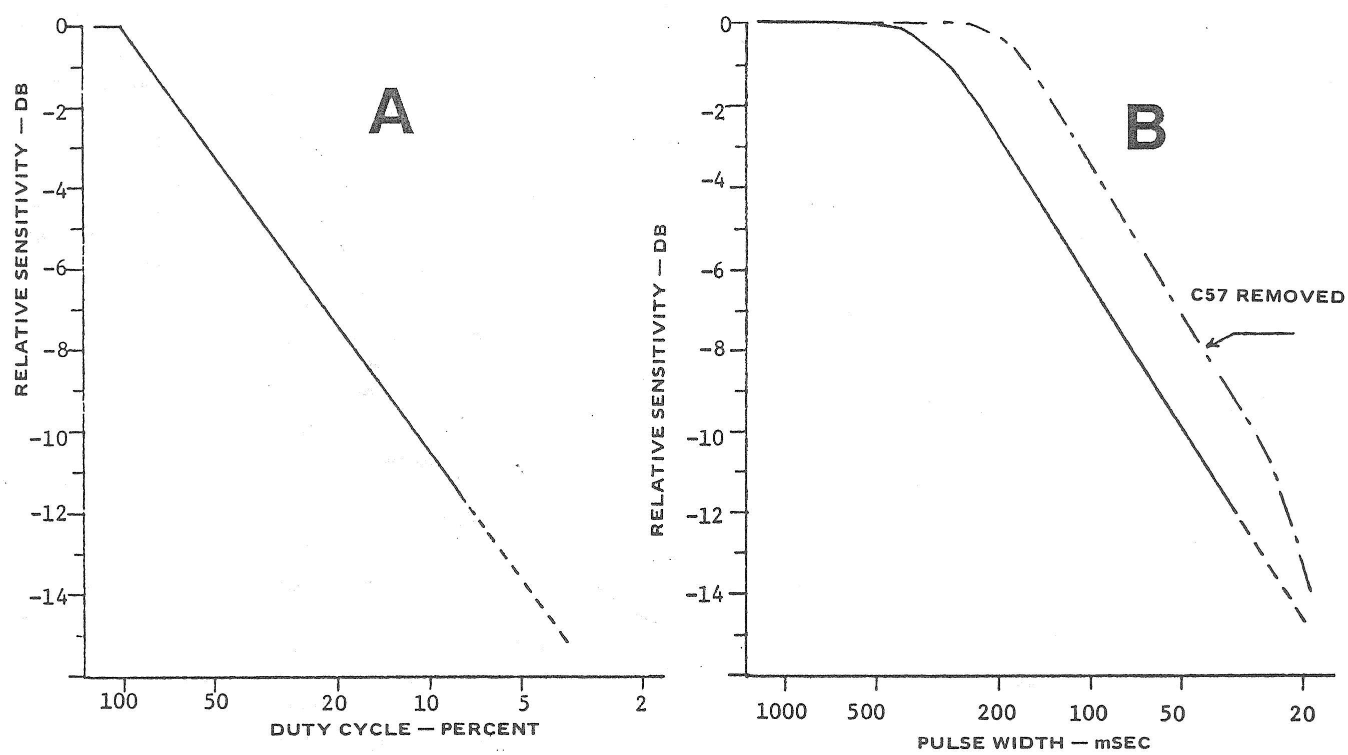


Figure 15. Loss of Sensitivity Under Pulsed Conditions.

pulse rates above 10 Hz, such as the ELT. Curve B shows response to isolated pulses, such as those encountered in animal tracking transmitters. For isolated pulses, some improvement may be obtained by removing C57 to widen the meter bandwidth.

Q11 is a unijunction oscillator operating at about 250 Hz. This drives emitter coupled flip-flop U3a and U3b to generate the 125 Hz DF switching square wave. U3e is a driver for the switching diodes located in the antenna switchbox. This antenna drive signal is routed to point 'B' and through R82 and R1 to the center of the DF coaxial cable at J1. Note that in Alarm mode, and, in older receivers in RECeive mode, a steady positive bias is applied to the center of the coax (left direction).

The detected audio signal is also applied to the input of the tone detector IC, U5 (type 567). Turning the Alarm on applies power to U5 and the rest of the alarm circuitry, U6, Q15, and U7. C7, the Alarm timing capacitor is initially uncharged. This gives a low output at pin 6 of operational amplifier U6 (type 741), which turns Q15 off. U7, a type 555 timer, oscillates and flashes the alarm light. When C71 charges to about 4 volts through R71, U6 turns Q15 on, which stops U7 and also disables audio amplifier U2 through pin 7. U5 is set to recognize a tone of about 1 kHz. An ELT signal will sweep through this frequency 2 to 4 times a second, triggering the tone detector each time. This triggering discharges C71 through the intervening network faster than R71 can charge it. After a delay of 5 to 20 seconds, depending on signal strength and sweep rate of the ELT, the threshold is reached and the audio amplifier and flasher are enabled.

Selecting AUX on the frequency selector knob activates the auxiliary DF by applying +8V to U4 and relay K1. The relay connects the DF antenna to the input of the auxiliary communications receiver in place of its normal antenna. The audio signal from the auxiliary receiver is applied to the input of audio amplifier U4 through gain control R63 and the reversing jumpers. The output of U4 is connected to the regular audio amplifier, U2, and thus to the DF circuitry. The internal receiver is cut off by disabling the tuners (no crystal selected) and by shorting the AGC line.

All aircraft microphones ground their key or push-to-talk (PTT) lines to transmit. Grounding the DF key line turns off Q14 and allows K1 to reconnect the communications transceiver to its regular antenna for transmitting. Turning off the DF set also returns the communications transceiver to its regular antenna regardless of the setting of the other DF set controls.

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 or load capacity and .0025% tolerance should be specified for ordering special crystals from a crystal manufacturer. L-Tronics stocks some commonly used crystals. A few of the very early units had 121.5 and 243 MHz crystals soldered in place. Some variation 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 frequency will also result in lower noise level on these channels. To calculate the crystal frequency, where FR is the desired receive frequency, see Table 1.

TABLE 1. CRYSTAL FORMULAS

Receive 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, Business, Marine
160 - 190 MHz	56.90 - 66.90 MHz	$\frac{FR + 10.7}{3}$	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

Product Variations

Several changes and improvements have been made to the LA Series DF equipment. All models and serial numbers are mechanically and electrically interchangeable with each other despite internal changes. The serial number is stamped on the right side of the receiver chassis on all current units. A few early units did not have a number stamped on them.

The principal changes between revisions are:

1. Crystal switching was changed from direct to diode type.

2. Tuner switching was changed from direct to transistor switching through Q12 and Q13.

3. Auxiliary DF switching was changed from switched ground to switched +8V, eliminating a transistor.

4, A buffer-doubler was added to the UHF local oscillator to improve gain and noise figure. Later, it was removed when better RF transistors were installed.

5. The 12/24V dial light was changed from a solder to a jumper cutting operation and then to plug-in jumpers.

6. A shunt capacitor, C76, was added to improve audio stability.

7. Diodes were changed from MPN3401 to MMBV 3401.

8. Earlier units used a tubular relay; this was changed to a rectangular relay either wired to rear panel on intermediate units or secured in the circuit board on later units.

Separate parts lists, schematics, and PC board layouts are included for the two principal revisions. The front and rear panel layouts shown for the early revision remains the same for later units. Separate circuit diagrams are provided, showing the wiring of the crystal switch for the most common models of the two revisions (see Figure 23). A number of receivers were also built with custom crystal switch wiring. Variants are most common with dual tuner units. Wiring attach points to the circuit board are identified by numbered squares for rear panel connections and by lettered triangles for all others. Units above serial 0448 use trimpots with narrower lead spacing. Replacement parts on earlier boards must have their leads bent to fit. Leads on replacement meters may also have to be bent to fit older meter light boards. Early meter lights were .050 dia. axial type MV 50. Later units use T1 radial lead lamps. They are interchangeable for repair purposes.

Troubleshooting and Alignment

The preliminary checkout procedure in the installation section should be performed before removing any equipment from the aircraft. Some additional voltmeter tests can also be made on the aircraft if the receiver can be slid out of its case without disconnecting the cables.

CAUTION: Do not put the receiver in or out of its case with the power on! It is very easy to short the circuit board on the retaining nut on the case.

The remaining tests will require a bench check. Figure 16 shows a suggested bench test setup. Figure 17 is the schematic of an antenna simulator that is used for production tests. It is not required for most maintenance, but is included for those who would like a complete bench check of DF circuitry. The circuit is easily built directly on two BNC connectors, 3/4" apart, mounted in a small metal box, such as a Pomona 2397. The simulator has an insertion loss of about 10 dB and simulates a signal about 30 degrees to the left of course.

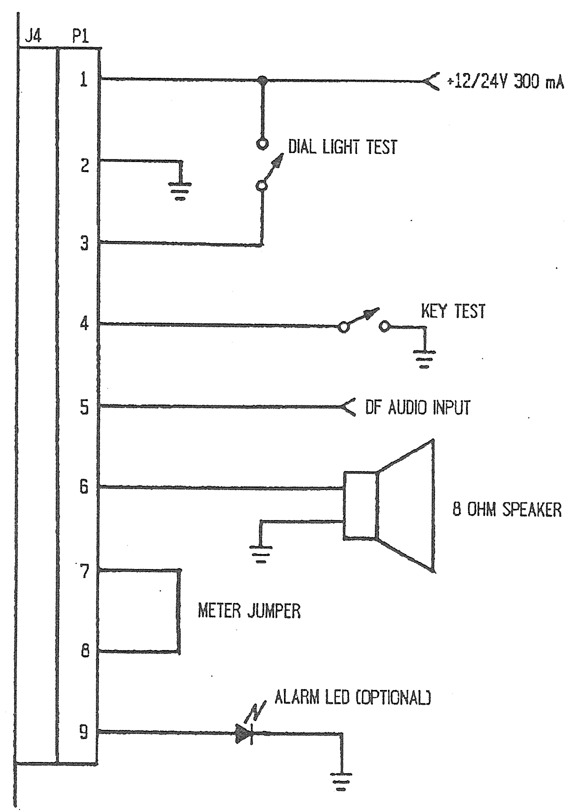


Figure 16. Bench Test Setup.

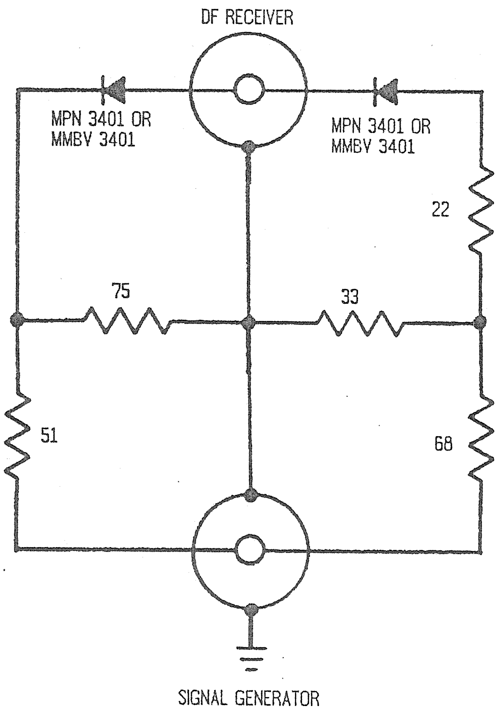


Figure 17. Antenna Simulator.

Power

If the DF makes no sound when turned on, check to see that the alarm light flashes. If it does not, check the fuse and aircraft wiring. The parts layout and circuit diagrams later in this section identify test points. Input power can be measured at TP25 with the set out of its case. The dial lights should also come on when the set is turned on unless they have been connected to the external dimming system. if the set often blows fuses, make sure the proper jumper is cut for external dial lamp operation. This is a common problem. If input voltage is being received at TP25, check TP26 for approximately +8V. A low voltage at TP26 indicates either a blown regulator or a short on the 8V line. Shorts are rare and can usually be spotted by visual inspection. U2 or, in the AUX mode U4, are the only ICs that can draw enough power to drag the regulator down. If they become hot to the touch, replacement is indicated.

No Dial Lights

If the dial lights do not come on, but other receiver functions work, check for voltage at the 220 ohm resistor on the dial light circuit board on the back of the meter. A burned out lamp can be found by taking voltage readings down the lamp chain. Normal voltage drop is 1.5 to 1.9V across each lamp. If a lamp is replaced, note proper polarity and check for 24V jumper cut on 24V aircraft. If the Alarm circuit cuts off the audio normally but the light does not flash, check the lamp itself or U7.

No Sound

If the meter comes upscale at full SENSitivity setting but no sound can be heard, check the external audio wiring. Check for +4V ±0.3V at TP22. If incorrect, U2 has been blown. Check the audio wiring carefully for interconnection to a high power speaker source before replacing U2. No signal audio level at TP22 is about 0.5V RMS with SENSitivity at maximum. Measure with an "output" meter so the DC level will not affect the reading.

No DF Meter Movement

The DF meter will not function in the Alarm mode. If signals can be heard and the meter comes upscale in RECeive mode (on single meter models) but the meter does not move in DF mode while receiving a test signal, listen for the DF switching tone superimposed on the received signal. If no tone is heard, check the antenna system with an ohmmeter as described below. The schematic of the antenna assembly is shown on the receiver schematic diagram. If the receiver can be operated outside of its case, check the voltages at TP1 (Figure 20). Lack of AC voltage or square wave here with the antenna disconnected indicates a blown antenna driver or a defect in the mode switch and its wiring. No AC voltage present with the antenna connected usually indicates antenna switchbox problems. A DC VOLTAGE on this point in DF mode with the antenna connected but not with the antenna off also indicates a problem with the antenna. These problems will also show up with a careful ohmmeter check of the antenna.

DF Meter Off Center

If the DF needle is a little off center in DF mode with no signal being received, but reacts normally to a received signal, readjust the DF balance control, R54, to center the needle with no signal. If the needle is offscale left or right with no signal and adjustment of R54 between its 10 o'clock and 2 o'clock positions will not recenter it, the DF oscillator and flip flop, Q11 and U3, are not operating properly.

DF Meter Points One Way Only

If the DF needle always points one way upon receipt of a signal, damage to the antenna system is usually indicated. If the ohmmeter does not indicate any problem, check very carefully for a good ground at both left and right antenna rods. A missing ground cannot be found with an ohmmeter, but will produce a severe DF unbalance.

No Sound and No Strength Meter Movement

Be sure AUX position is not selected; the strength meter is not active in AUX mode. If the receiver +8V power line is OK, but no sound is heard and the meter will not come off the left hand stop in REC mode, a failure in the RF or IF amplifiers is likely. If background noise is heard but no signals can be received or the meter needle will not come upscale in REC mode, a channel crystal or the local oscillator Q2 is usually the problem. Check crystals in more than one socket. A marginal crystal will sometimes operate alone but fail when other crystals are plugged in. Check the voltages on TPs 26, 6, 3, 8, 5, 20, 19. 17, 16, 18, 15, 21, and 2, in that order. Almost all receiver problems will produce an abnormality in one or more of these readings. TP19 and 20 with TP26 indicate the current drawn by the IF stages. TP3 and TP8 (and TP10 and TP12 for the UHF tuner) indicate source current drawn by the RF and mixer stages. TP6 and TP26 indicate local oscillator current. TP21 is the detector output. TP15 is the input bias network for the 10.7 MHz IF amplifier. If a high frequency 'scope is available, check pin 2 of U1 for 11.155 (occasionally 10.243 MHz) second LO signal. Lack of this signal with other voltages correct usually indicates a bad crystal.

Alarm Not Working

Be sure Alarm toggle is on (up). Check for broken wires on the Alarm toggle switch. Most apparent failures of the Alarm circuitry are due to receiver overload caused by using full sensitivity on a nearby ELT. The Alarm is designed to work with weak signals. Bench test of the Alarm circuitry U6, U7, and Q15 can be done by observing its performance as the Alarm mode is turned on and off. Excess leakage of C71 has sometimes caused obscure problems. U5 should show an 800 to 1500 Hz square wave at pin 5. Pin 8 should pulse to ground every sweep of an ELT test signal. A steady tone of the same frequency as the square wave at pin 5 should produce a steady low at pin 8 and should trip the alarm.

Antenna Measurements

The circuit of the antenna is quite simple and is shown in the upper right corner of the receiver schematics. Each antenna rod to ground should measure about 470 ohms. Variations of 20% are acceptable. The center conductor to ground at the DF set connector should measure the same value with either polarity. The resistance value indicated will vary between meters and between R ranges chosen. measuring between the center conductor at the DF set and the left antenna rod should give a lower reading with the rod negative. Note: The common lead is not negative on ohms for all meters; check your equipment.

Alignment

Realignment of the receiver should not be necessary unless a substantial frequency change is made or parts are replaced in the tuners. IF alignment should be necessary only if an IF transformer or FL-1 is replaced.

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 receivers with two tuners. Adjust the higher frequency first. Turn off the signal but keep the antenna input properly terminated. Turn the Mode switch to DF on single meter units, Alarm toggle off (down) on dual meter units. If there is a tendency for the DF needle to move off center by more than two needle widths as the SENSitivity is increased to maximum, retouch the two input tuned circuits on the affected tuner slightly to remove the effect.

Gain is balanced between two tuners by adjusting local oscillator injection. Usually, maximum injection is used on the high frequency tuner, with adjustment made on C16 in the low frequency tuner. If a major realignment of tuners is made or if RF or mixer transistors are replaced, a larger adjustment may be made by adjusting the coupling (spacing) between L3 and L4 in the low frequency tuner or L9 and L10 in the high frequency tuner. A stable signal source is required for tuner alignment and alignment MUST be done with the SENSitivity control at maximum.

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 operating on the lower frequency tuner. Attach a 25 to 100 μf, 6V capacitor between TP 18 and ground. Pick up detected audio at TP 21. Set R42 at midscale if its setting has been moved during maintenance. Set SENSitivity control 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. Adjust T4 to maximum and then turn the slug l/2 turn clockwise and leave it alone. Adjust the slugs in T2 and T3 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 and T3 until the desired response is obtained. On some dual tuner units, a compromise adjustment may be required to obtain acceptable passband shape on both bands.

After tuner and IF alignment are complete, set IF gain with R42 so that the meter reads about 1/3 upscale in RECeive mode (single meter units) on the lower frequency tuner with no signal, antenna input terminated and SENSitivity at maximum. The higher frequency tuner usually produces a little lower reading. Some variation from crystal to crystal is usual.

Audio gain and DF sensitivity are set by trimmer 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 oscilloscope connected to the audio output, TP22. With the receiver in RECeive mode at maximum SENSitivity, VHF tuner, no signal, the noise peaks should be set to half the voltage that causes clipping to begin. A rough setting can also be obtained by adjusting for 0.5V RMS at the arm of R54 using an output meter. If the sensitivity is too high for most of your work, this control can be turned down. This control also affects the speaker audio level.

Centering of the meter in DF mode in the absence of signal is set by the trimming potentiometer R54. This control is quite sensitive. It should be set for equal left and right deflection caused by noise with SENSitivity control set at maximum and no signal, a small deflection with change of SENSitivity setting is common.

Repair Notes

All components of the LA Series Aircraft DF are accessible with the unit out of its case without further disassembly.

Component replacement is best made by removing existing solder with a vacuum tool. "Solder sucker" braid also works well, but is more likely to damage the fine circuit traces. The meter, the meter light board, and the alarm light are all attached using contact cement. The remote meter is also held in place this way. Parts can be separated by steady pressure assisted with mineral spirits, paint thinner, or contact cement solvent. Do not use acetone, lacquer thinner, or MEK, as these will attack the meter case and other components.

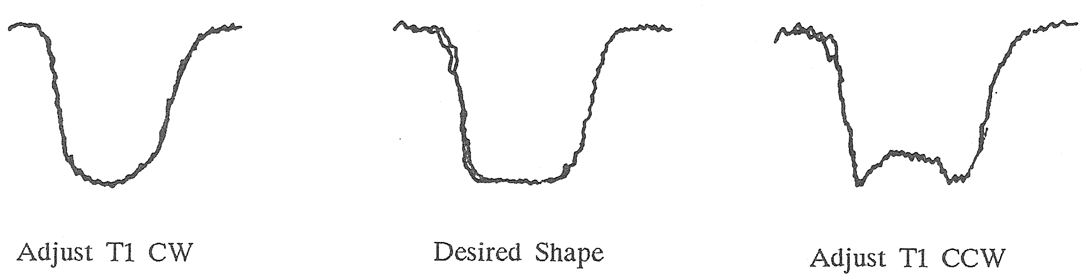


Figure 18. Typical IF Passband Shapes.

Receiver Test Points

Conditions unless otherwise noted: external power at 12 VDC, RECeive mode, SENSitivity maximum, VOLume minimum. No signal. No antenna connected. Tuner 1 selected (lower frequency range of standard LA-16A receivers). Supply input current 40-50 mA, increases to 80-100 mA at maximum volume, decreases 2-3 mA at minimum Sensitivity. Values in parentheses refer to early serial numbered units where there is a significant difference.

TEST POINT	
1	Antenna connection. +8V PP 100-150 Hz square wave in DF mode. Becomes +0.8V and 1.6V PP square wave respectively with DF antenna connected.
2	1.3 to 1.7V.
3, 8	0.15 TO 0.55V becoming over 1.5V when Tuner 2 (UHF) is selected.
4	0.1V (GRD), 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 SENSitivity control is turned toward minimum. 7 0.8 to 1.1V.
8	0.15 to 0.55V.
9	1.3 to 1.6V with Tuner 2 selected.
10, 12	Over 1.5V becoming 0.15 to 0.55V with Tuner 2 selected.
11	0.35 to 0.4V less than supply voltage with Tuner 2 selected, except if tuner is below 200 MHz, 0.8 to 1.1V.
13	0.2 to 0.4V less than supply voltage with Tuner 2 selected.
14	More than 2V becoming 0.1V (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 0.95. Connection point for extra capacitor during alignment.
19, 20	0.5 to 1.5V below supply voltage. Varies substantially with setting of R42.
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 μsec triangular pulses at 200 to 300 Hz.
24	8-9V PP 100-150 Hz square wave.
25	Input power, same as external power supply.
26	Regulated power 7.8 to 8.2V.
27	One half of supply voltage. Has amplified auxiliary audio signal.
28	0V. +8V with AUXiliary mode selected. 0.1V in AUX mode when external key lead is grounded.
29	0V, except in ALARM mode. +8V for no ELT signal pulses to ground for 30-70 mSec followed by a 200-400 mSec RC recharge.
30	Triangle waveform. 1.5V PP 900-1200 Hz with no ELT signal input in ALARM mode. Frequency varies ±15% with noise or an ELT signal input.
31	Alarm integrator signal. Starts near zero when ALARM mode is turned on. Rises to above 6V after one minute. Alarm cuts off when the voltage equals the threshold voltage, test point 32. The voltage drops when an ELT signal is received.
32	Threshold voltage. 3.8-4.2V in ALARM mode.
33	6.5V PP pulses 4-7 Hz alarm light flashes.

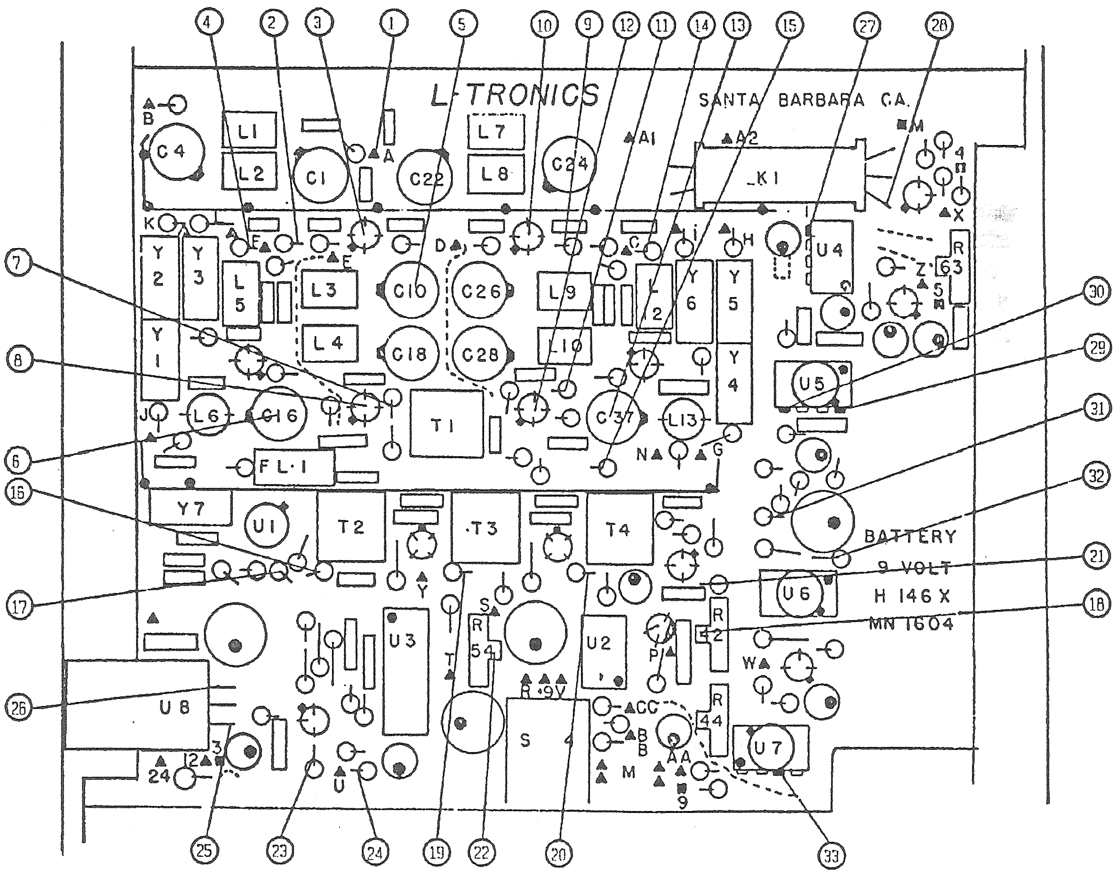


Figure 19. Test Point Locations, Early Units.

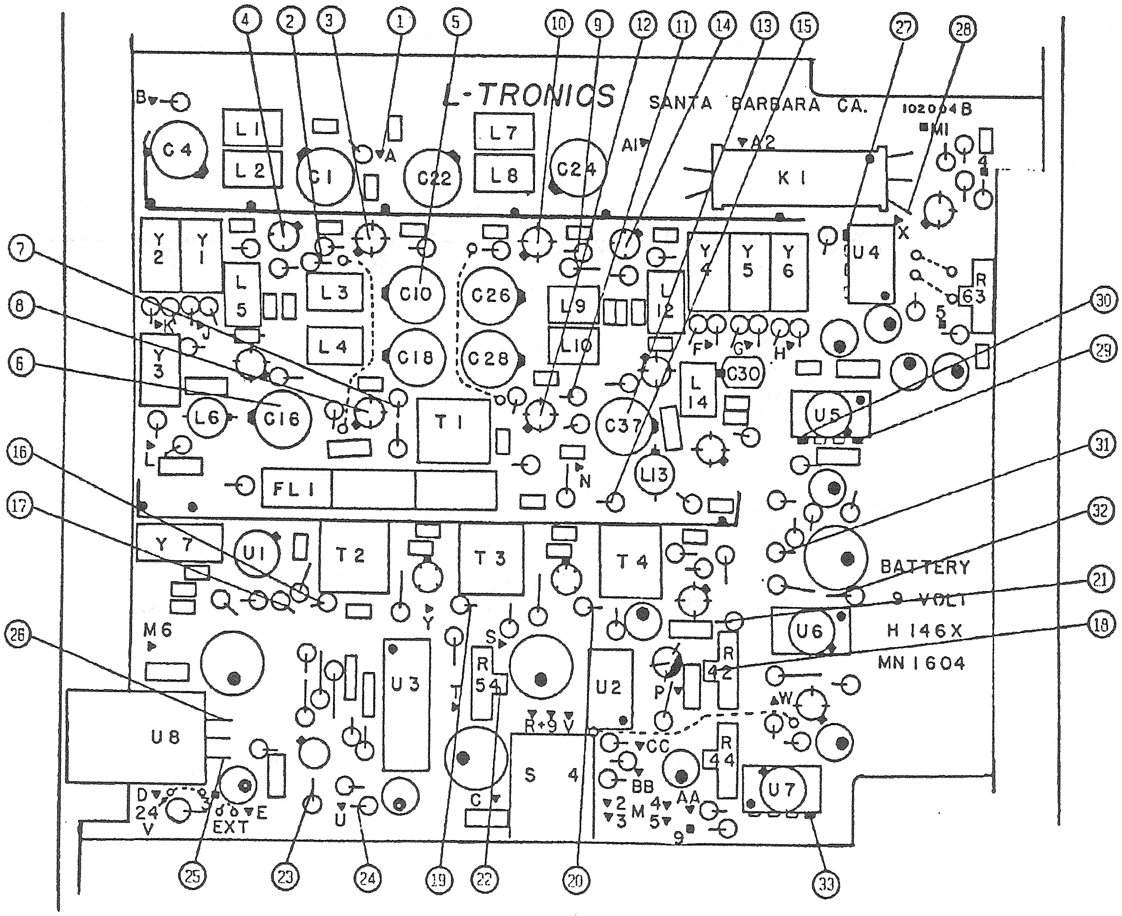


Figure 20. Test Point Locations, Later Units.

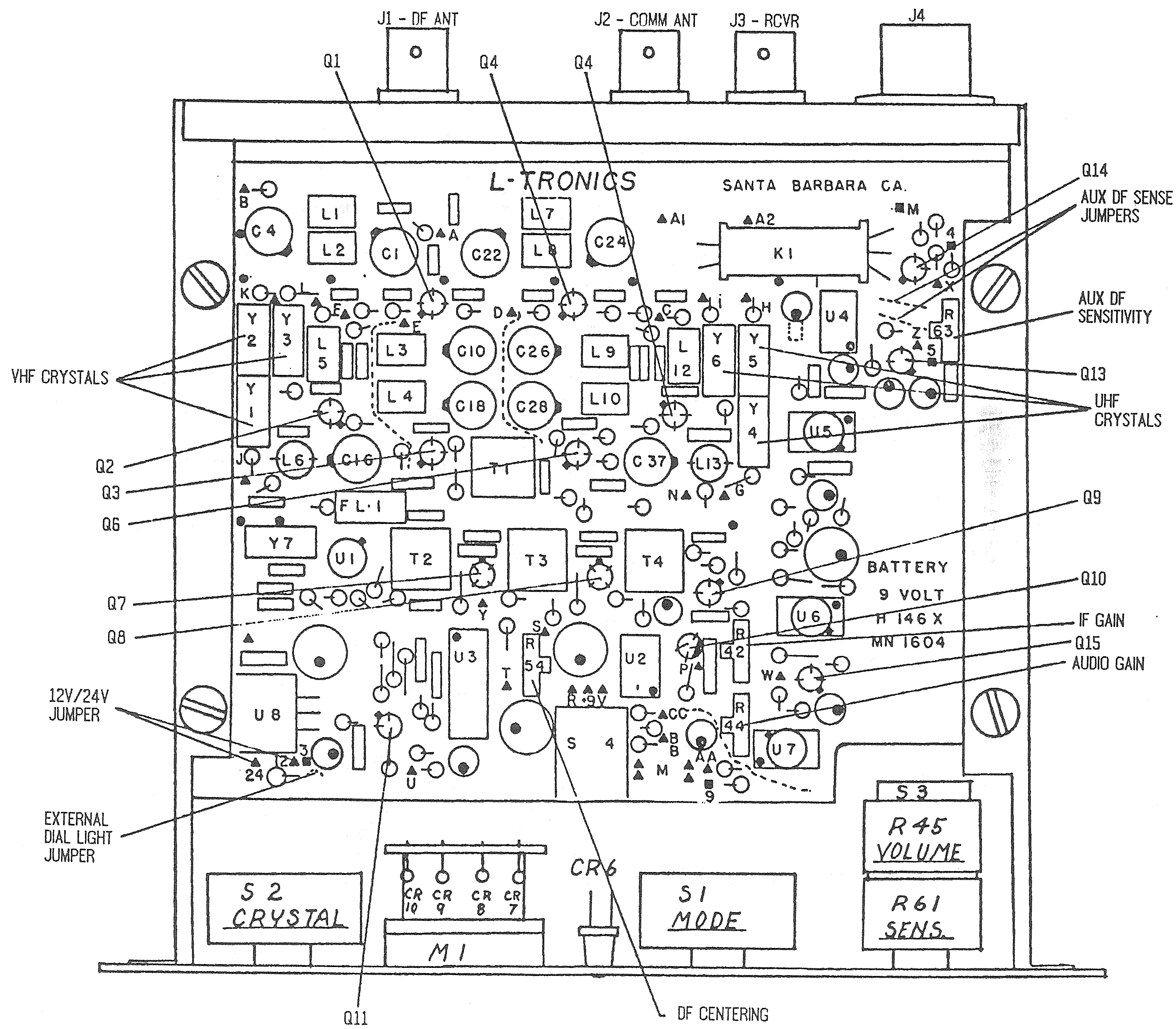


Figure 21. Circuit Board Control and Transistor Locations, Early Units.

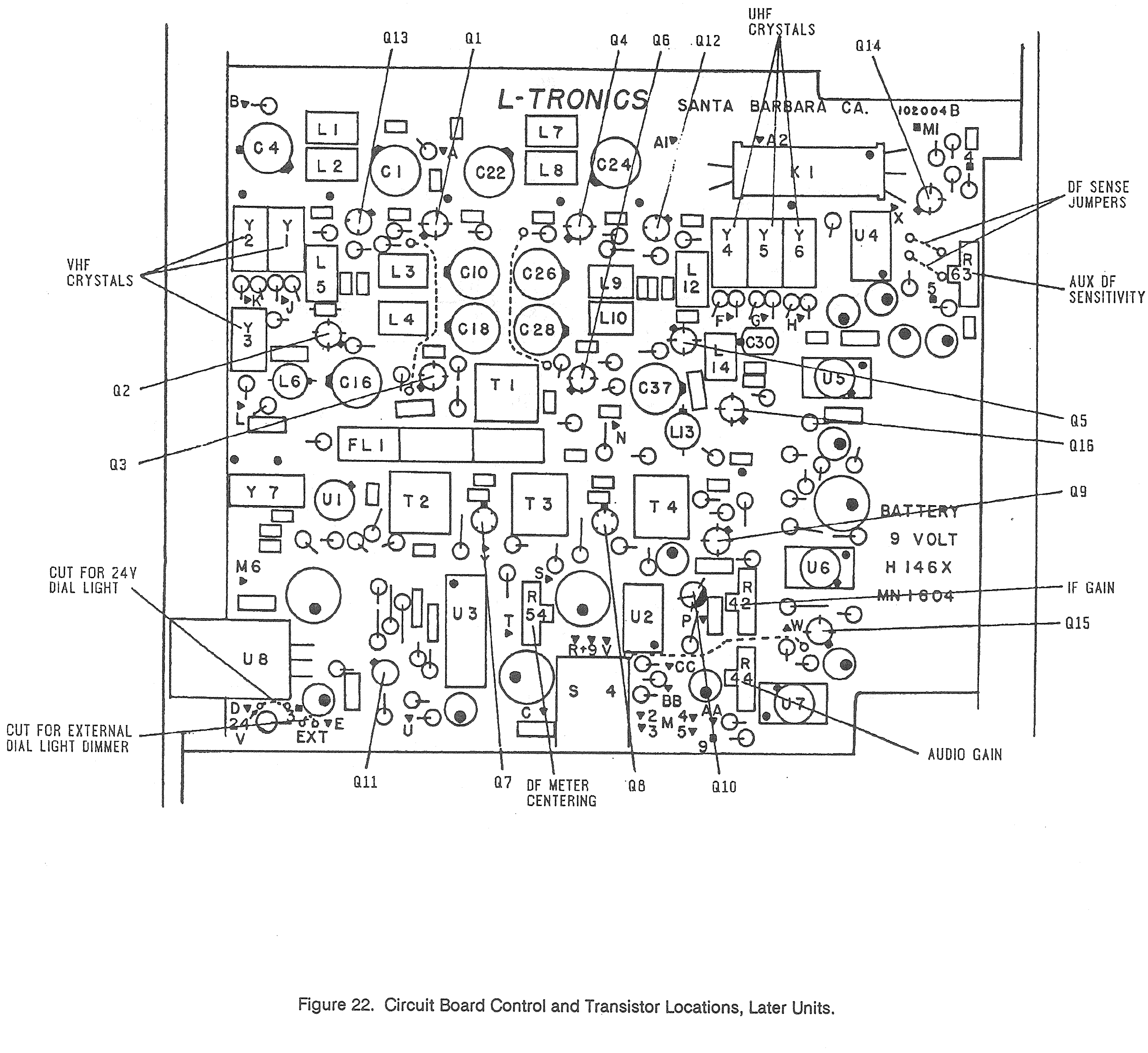


Figure 22. Circuit Board Control and Transistor Locations, Later Units.

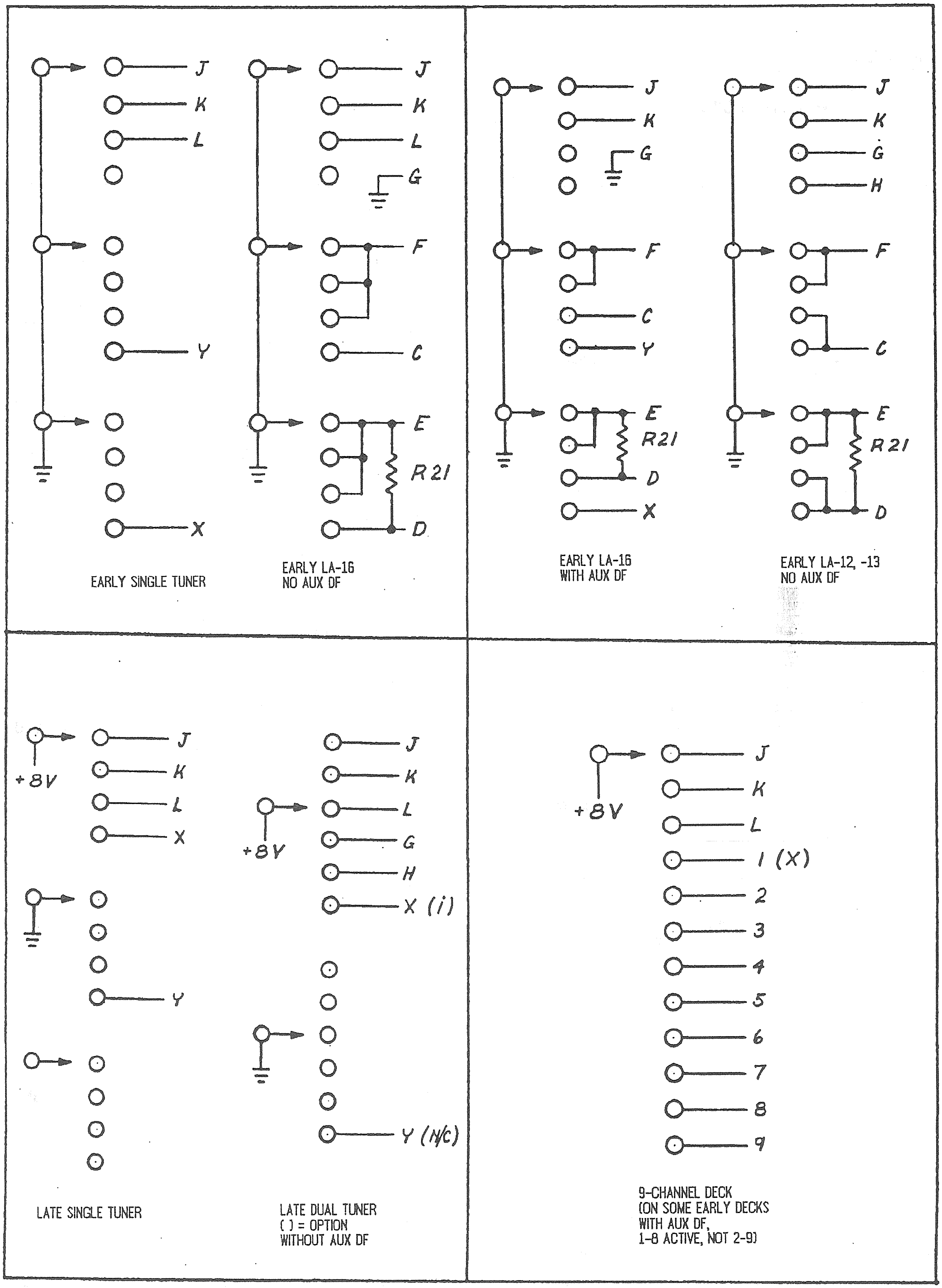


Figure 23. Frequency Switch Wiring.

Parts List

Serial Numbers up to 0145

REFERENCE	DESCRIPTION	PART NUMBER
R1, R10, R19, R56, R57, R66, R74	4.7K, 1/4W, 5%	29SJ250-47K
R2, R7, R16, R22, R28, R43, R58, R59, R64, R70	22K, 1/4W, 5%	29SJ250-22K
R3, R5, R9, R13, R17, R26, R49, R82	100 Ohm, 1/4W, 5%	29SJ250-100
R4, R18, R20, R21, R39, R48, R50, R71	100K, 1/4W, 5%	29SJ250-100K
R6, R14, R15, R23, R27, R30, R33, R36, R47, R51, R65, R66, R69, R72, R73	10K, 1/4W, 5%	29SJ250-10K
R8, R32, R35, R38, R41, R75	1K, 1/4W, 5%	29SJ250-1K
R11, R31, R34, R37, R40, R46, R52, R53, R55	47K, 1/4W, 5%	29SJ250-47K
R12, R25, R78, R79, R81	220 ohm, 1/4W, 5%	29SJ250-220
R24, R68	470 ohm, 1/4W, 5%	29SJ250-470
R29	3.3K, 1/4W, 5%	29SJ250-3.3K
R42, R63	1M trimpot	564PT10V-1M
R44, R54	5K trimpot	564PT10V-5K
R45	500 ohm pot (front of dual control)	CTS BB 54003
R61	5K pot (back of dual control)	CTS BB 54003
R62	Optional for gain increase – not used	
R67*	13K, 1/4W, 5%	29SJ250-13K
R76, R77	33K, 1/4W, 5%	29SJ250-33K
R80	470 Ohm, 1/2W, 5%	29SJ500-470
L1, 2, 3, 4, 6, 7, 8, 9, 10, 13	Coil, RF, air wound. Turns vary with model	
L5, 12	9T, no. 24 wire on 10-32 screw	
L11	1μh choke	L13LQ106
C1, C4, C10, C16, C18, C22, C23, C26, C28, C37	3-11pf air trimmers	187-0106-005

REFERENCE	DESCRIPTION	PART NUMBER
C2, C64	22pf, 100V disc	21CB022
C3, C9, C11, C17, C19	.001μf, 100V disc	21KC001
C5, C14, C20, C21, C35, C39, C42, C43, C44, C46, C47, C48, C49, C63, C65, C66	.01μf, 25V disc	21KC010
C12, C33	33pf, 100V disc	21CB033
C13, C34, C40, C55, C56	33pf, 100V disc	21CB033
C15, C36	5pf, 100V disc	21CB056
C23*, C25*, C27*, C29*, C38*, C41*, C60*	200pf, 100V disc	21CB200
C45, C53, C69, C74	2.2μf, 50V radial leads	21YR002
C50, C54, C67, C68, C73	0.1μf, 12V disc	21ER100
C51, C58, C62, C70, C72, C75	10μf, 10V radial lead	21YH010
C52, C57, C71	100μf, 10V radial lead	20YF100
Q1, Q3, Q5, Q6	Transistor-FET (replace with 3N204)	40820
Q2, Q5, Q7, Q8, Q9	Transistor-RF (replace with 2N5179)	40897
Q10	Transistor, GP	2N5172
Q11	Transistor, Unijunction	2N2646
Q13, Q14, Q15	Transistor, GP	2N2222
U1	IC Differential amp	CA3053
U2, U4	IC audio amp	LM386N
U3	IC transistor array	CA3086
U5	IC tone decoder	LM567N or T
U6	IC operational amp	LM741N or T
U7	IC timer	LM555N
U8	IC 8V positive regulator	LM340T or MC7808
T1	10.7 MHz IF transformer	80IF123

REFERENCE	DESCRIPTION	PART NUMBER
T2, T3, T4	455 kHz IF transformer	80IF103
FL1	Crystal filter, 2 pole	2195F
FL1 high selectivity	Crystal filter, 6 pole	1472
Y1, Y2, Y3, Y4, Y5, Y6	Channel crystal	
Y7	IF crystal	11.155 MHz or 10.245 MHz
S1	4 pole 3T rot switch	10WS043
S2	3 pole 4T rot switch	10WS034
S3	Power switch (on back of R45/R61)	See R45
S4 (battery option only)	SPDT slide switch	10SM001
J1, J2, J3, J101	BNC panel jack UG1094	31-221
J4	9 Pin jack, .063 pin	03-06-2091
K1	Relay SPDT, 8V	NIC01210
M1	100-0-100μA meter	SK23C
CR1, CR2, CR3	Diode, silicon GP	1N914A, 1N414B
CR6	–	M5024
CR7, CR8, CR9, CR10	LED	MV50
CR101, CR102	Diode, PIN	MPN3401 or MMBV3401

Serial Numbers Above 0145

REFERENCE	DESCRIPTION	PART NUMBER
R1, R10, R19, R21, R56, R57, R66, R74	4.7K, 1/4W, 5%	29SJ250-4.7K
R2, R6, R16, R23, R28, R43, R58, R59, R64, R70	22K, 1/4W, 5%	29SJ250-22K
R3, R5, R9, R13, R17, R22, R26, R49, R82	100 ohm, 1/4W, 5%	29SJ250-100
R4, R18, R20, R39 R48, R50, R55, R71	100K, 1/4W, 5%	29SJ250-100K
R8, R68, R101, R102	470 ohm, 1/4W, 5%	29SJ250-470
R11, R31, R34, R37, R40, R46, R52, R53 R55	47K, 1/4W, 5%	29SJ250-47K

REFERENCE	DESCRIPTION	PART NUMBER
R12, R24, R25, R78, R79, R81	200 Ohm, 1/4W, 5%	29SJ250-200
R14, R15, R27, R30, R33, R36, R47, R51, R60, R69, R72, R73, R83, R84, R85, R86, R87, R88	10K, 1/4W, 5%	29SJ250-47K
R29	3.3K, 1/4W, 5%	29SJ250-3.3K
R32, R35, R38, R41, R75	1K, 1/4W, 5%	29SJ250-1K
R42, R63	1M trimpot	564PT10V-1M
R44, R54	5K trimpot	564PT10V-5K
R45	500 ohm pot (front of dual pot)	See R45
R62	Optional gain increase	
R6 (SN 0146-0447)	13K, 1/4W, 5%	29SJ250-13K
R67 (SN 0448 up)	120K, 1/4W, 5%	29SJ250-120K
R76, R77	33K, 1/4W, 5%	29SJ250-33K
R80	470 ohm, 1/2W, 5%	29SJ500-470
L1, 2, 3, 4, 6, 7, 8, 9, 10, 13, 14	Coil, RF–varies with model	
L5, 12	9T no 24 on 10-32 screw	
L11	1 μh choke	43LQ106
U3	IC transistor array	CA3086
U5	IC tone decoder	LM567N or T
U6	IC operational amplifier	LM741N or T
U7	IC timer	LM555N
U8	IC 8V positive regulator	LM340T or MC7808
CR1, CR2, CR3, CR4, CR5	Diode, GP	1N914A, 1N4148
CR6	LED, .185 dia	M5024
CR7, CR8, CR9, CR10	LED, T1 or .050 axial	MV50 or 579-235R
CR11, CR12, CR13, CR14, CR15, CR16, CR101, CR102	PIN diode	MPN3401 or MMBV3401
T1	10.7 MHz IFT 10mm	80IF123
T2, T3, T4	455 kHz IFT	80IF103

REFERENCE	DESCRIPTION	PART NUMBER
FL-1 (standard)	Crystal filter, 10.7 MHz 2 pole	2195F
FL-1 (narrow band)	Crystal filter, 10.7 MHz 6 pole	1472
Y1, Y2, Y3, Y4, Y5, Y6	Channel crystals	
Y7	IF crystal	11.155 MHz or 10.245 MHz
S1	4P3T, rot, mode SW	10WS043, 10WW043
S2 (single tuner)	3P4T rot switch	10WS034
S2 (dual tuner)	2P6T rot switch	10WS026
S2 (9-channel)	1P12T rot switch	10WS112
S3	Power switch (rear of dual pot)	See R45
S4	SPDT slide switch	10SM001
J1, J2, J3, J101	UG1094 BNC jack	31-221
J4	.063 pin, 9 pin Molex jack	03-06-2091
K1	Form C reed relay 8V coil	NIC01210
M1	200 μA zero center meter	SK23C
C1, C4, C10, C16, C18, C22, C24, C26, C28, C37	3-11 pf air trimmer cap	187-0106-005
C2, C30, C64	22pf 100V disc	21CB002
C3, C9, C11, C17, C19, C32, C59, C65	.001μf, 100V disc	21KC001
C5, C14, C20, C21, C35, C39, C42, C43, C44, C46, C47, C48, C49, C63, C66	.01 μf, 25V disc	21KC010

REFERENCE	DESCRIPTION	PART NUMBER
C12, C33	33pf, 100V disc	21CB033
C13, C34, C40, C55, C56	56pf, 100V disc	21CB056
C15, C36	5pf, 100V disc	21CB005
C23*, C25*, C27*, C29*, C38*, C41, C60	200pf, 100V disc	21CB200
C31	3-12pf ceramic trimmer	24AA021
C45, C53, C69, C74	2.2 μf, 50V elect	.214R002
C50, C54, C68, C73, C76	0.1μf, 12V disc	21ER100
C51, C58, C61, C62, C70, C72, C78*	10μf, 10V elect.	21YH010
C52, C57, C71	100μf, 10V elect.	21YF100
C67 (SN 0148-0447)	0.1μf, 12V disc	21ER100
C67 (SN 0448 up)	0.01μf, 100V mylar	23BJ310
Q1, Q3, Q4, Q6	Transistor, FET	40820, 40673, 3N204
Q2, Q5, Q7, Q8, Q9, Q16	Transistor, RF/IF Amp	40897, 2N5179
Q10	Transistor, GP	2N5172
Q11	Transistor, unijunction	2N2646
Q12, Q13 Q14, Q15	Transistor, GP	2N2222
U1	IC diff. amp.	CA3053
U2, U4	IC audio amp.	LM386

*Notes: 200pf capacitors are changed to .001μf disc for second tuners in 140-190 MHz ranges
R62 and C61 are used only if the normal gain of U4 is insufficient for AUX mode. R62 = 1.3K will double gain.
R63 = 0 (short) raises the gain 10 times.
R62 and C61 are not factory installed.

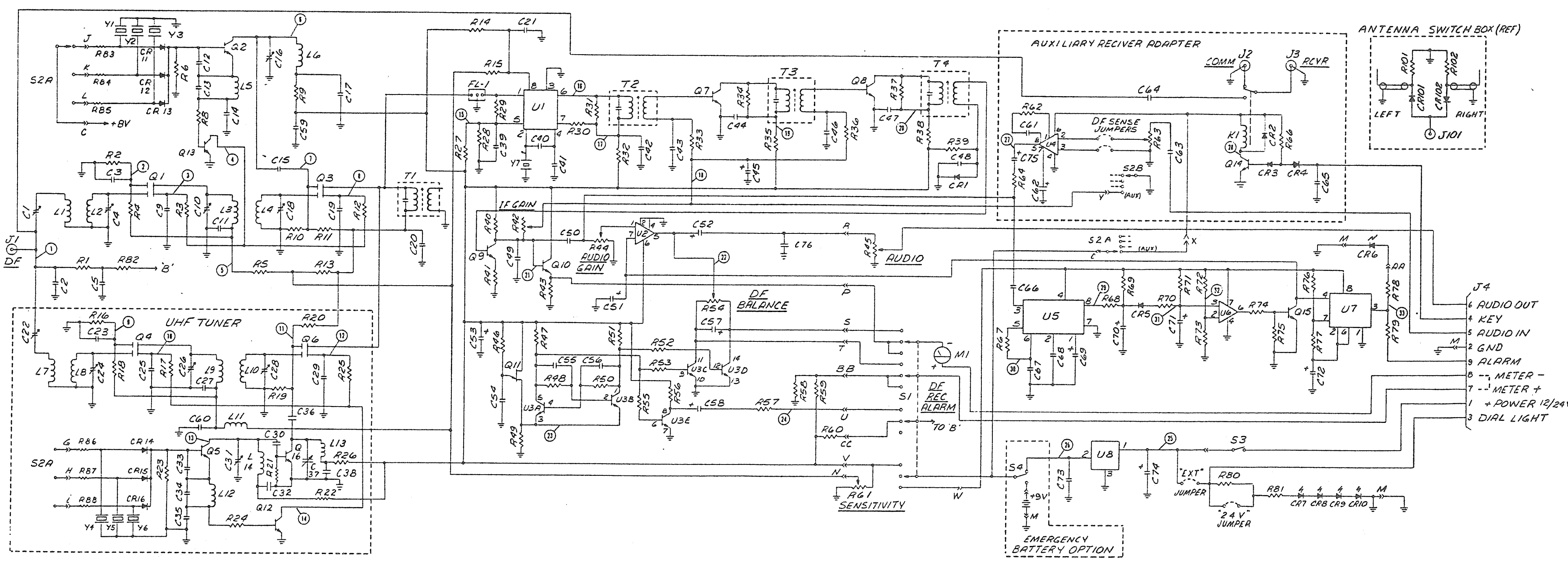


Figure 25. Schematic for LA Series Direction Finder Units, Serial Numbers Up To 1300.

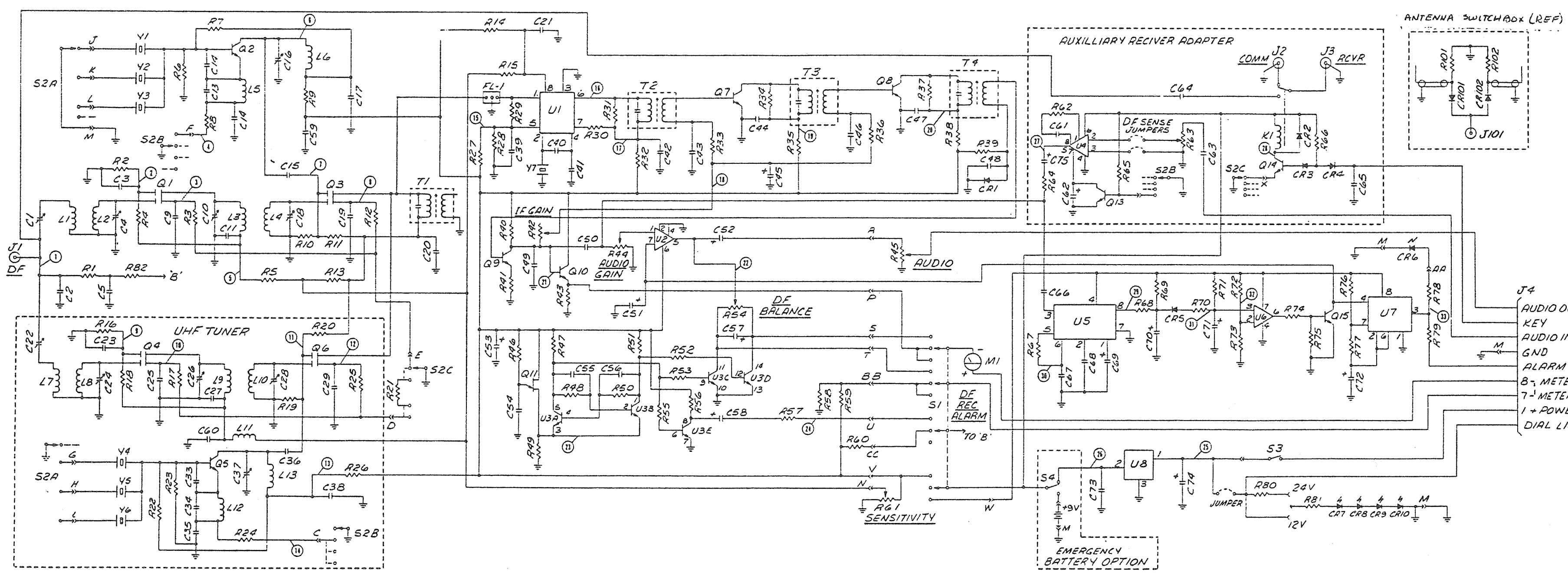


Figure 24. Schematic for LA Series Direction Finder Units, Serial Numbers Up To 0145.

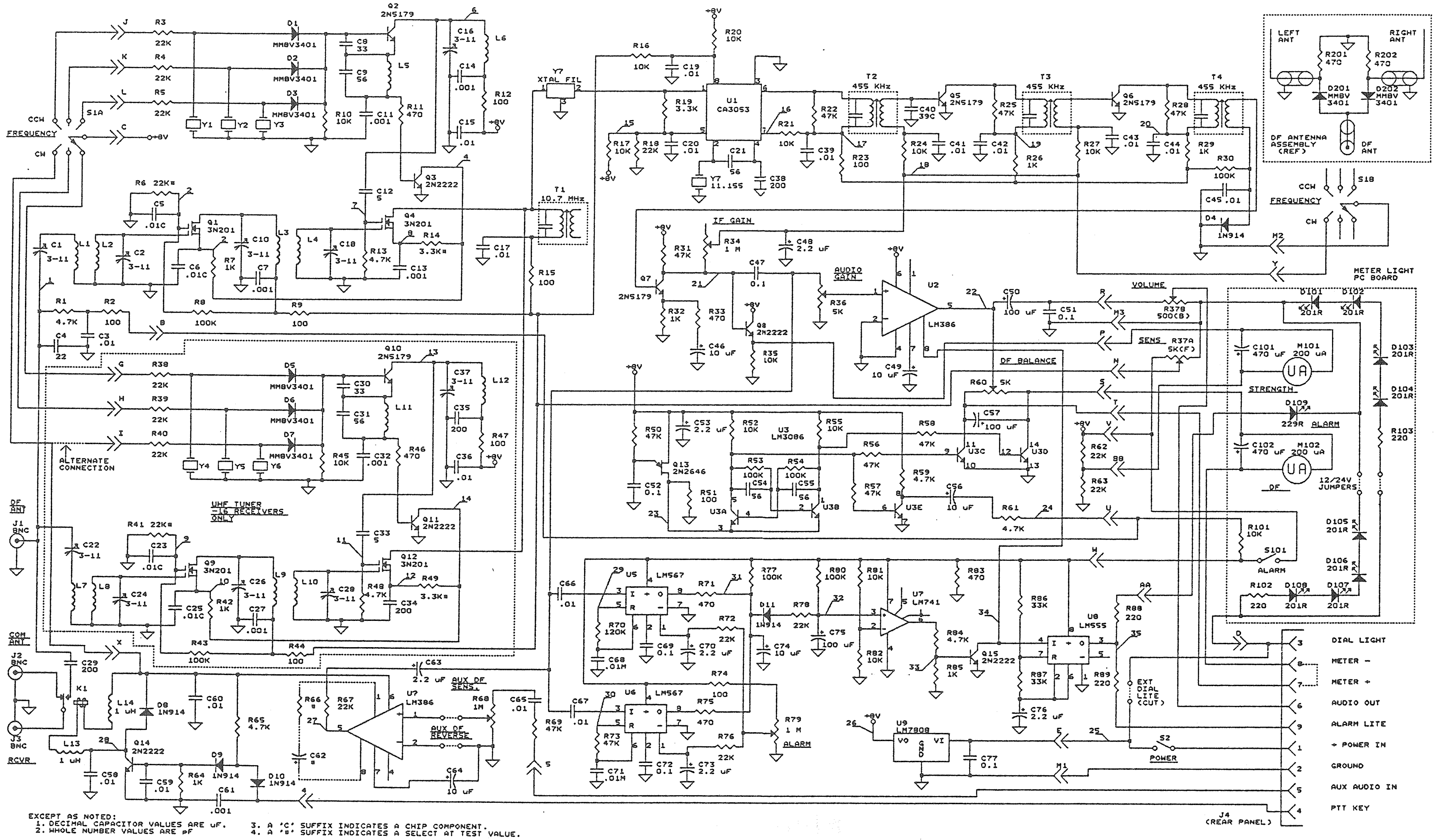


Figure 26. Schematic for LA Series Direction Finder Units, Serial Numbers Above 1300.