emergency beacon corp.

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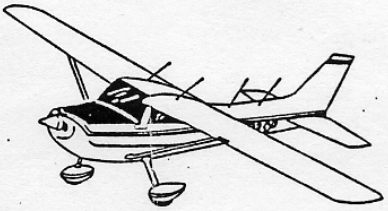
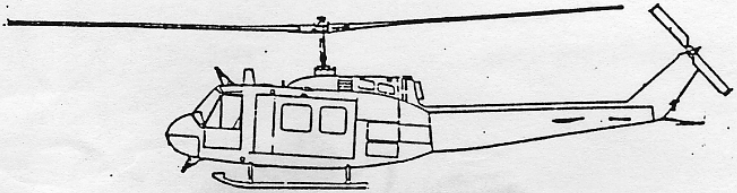
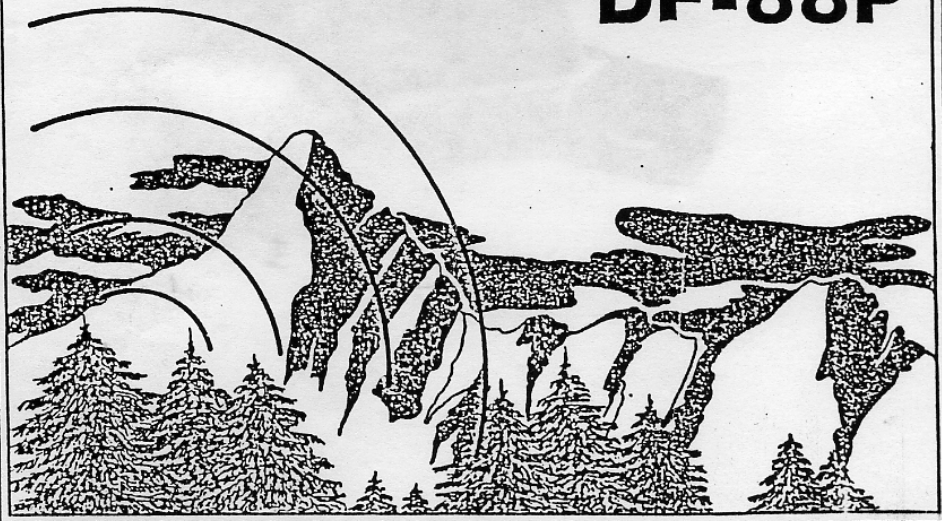




DF-88P



DF-88P

INSTRUCTION MANUAL

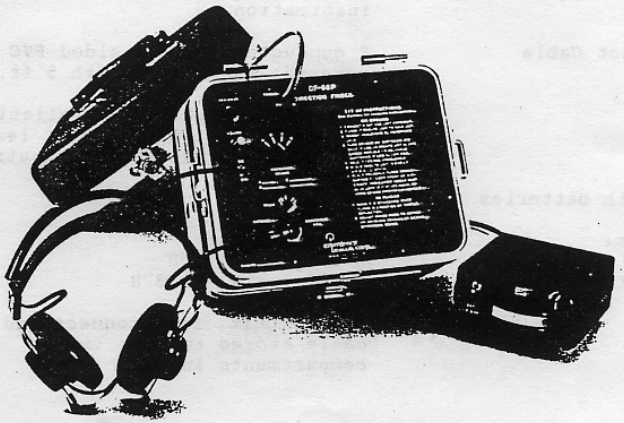


Figure 1

DF-88P SPECIFICATIONS

Case	RF shielded; ABS plastic with military type latches; color black
Receiver	Crystal controlled; can receive on any four selected frequencies between 118.0 MHz and 136.0 MHz; can provide DF information on signals down to -130 dbm
Audio	No internal speaker; requires standard head phones; patch cord to intercom system available
Amplifier	Dual active filters; AGC; 80 Hz switching rate
Antenna Phasing Network	Internal with strip line construction
Remote Unit	Provides DF and signal strength information
Interconnect Cable	8 conductor foil shielded PVC covered; standard length 5 ft.
Batteries	18 volt; commercially available primary cells; provides at least 24 hours of continuous operation
Weight with batteries	8 pounds
Dimensions:	
Case closed	8"L x 10"W x 8"H
Remote unit	5.2"L x 5"W x 2.3"H
Storage	Remote unit, interconnect and coax cable stored in foam lined compartments in case

STANDARD EQUIPMENT

Crystals	2; user specified
Interconnect Cable	5 foot length

OPTIONAL EQUIPMENT

Crystals	3rd and 4th user selected
Head Phones	600 ohm dual muff
Intercom Patch Cord	Specify length desired
Removable Antennas	Quick release, can be stored when DF not in use
Antenna Stubs	2 required per aircraft
Antennas (fixed)	2; low speed tapered stainless steel
Antenna Cables (for fixed antennas)	Length specified by user; must be a multiple of 32"

WARRANTY

The DF-88P is warranted to perform to specifications for 1 year from the date of shipment.

DF-88P DIRECTION FINDER

INSTRUCTION MANUAL

SECTION 1 - INTRODUCTION

The DF-88P is a self contained direction finding unit (figure 1) intended for use in aircraft. It's two part configuration provides a very convenient layout for using the equipment within the confines of an aircraft cabin. The DF-88P will accurately home in on any receivable signal in the aircraft band. It will accurately locate emergency locator transmitters, FSS control towers, other aircraft, etc.

The DF-88P requires no external power supply or interconnection with existing aircraft radios. It contains it's own battery pack, VHF receiver, antenna phasing network and amplifier board. The remote unit contains the signal source direction indicator, the signal strength meter with range control, and the indicator light control switch.

The main unit and the indicator head are connected by shielded 5 foot polyvinyl covered cord. This allows the main unit to be placed on the floor near the external antenna connections and the indicator head to be placed on the glare shield for easy viewing.

THEORY OF OPERATION

The DF-88P direction finder is essentially an interferometer that resolves the phase difference between signals arriving at two antennas placed perpendicular to the line of flight on an aircraft. The resultant output is displayed on the zero center direction indicator, which effectively points at the transmitted signal.

DESCRIPTION OF INTERFEROMETER PRINCIPLE

Figure 2 is a representation of the two direction finding antennas on the aircraft. The two antennas are a quarter wave length apart (24 inches in the case of 121.5 MHz). Since the signal is in the form of waves emanating from the transmitter, the wave will strike both antennas at exactly the same time only when the source is directly ahead or behind the aircraft. In the case where the signal is off to the right or left there will be a time difference between when the peak of the wave hits one antenna and the other. The delay creates a phase difference that can be used to infer the direction the signal came from.

The switches S1 and S2 are controlled by the 80 Hz switching square wave provided by the amplifier board. The 1/4 wave length strip line in the APN unit introduces a 90 degree delay.

The signal at A is the vector sum of the signal on the left antenna plus the signal on the right antenna. The signal on the right antenna has an additional 90 degrees of delay added in by

the 1/4 wave length strip line in the APN unit. The signal at B is the vector sum of the signal on the right antenna plus the signal on the left antenna. The signal on the left antenna has an additional 90 degrees of delay added in by the 1/4 wave length strip line in the APN unit.

The signals at A and B are sequentially sent to the receiver by the switching diodes S1 and S2. As the signal source moves to the side the relative strength of the signals at A and B changes due to the phase difference introduced by the antenna spacing and the 1/4 wave length strip line.

ELECTRONIC SWITCHING

The actual switching is accomplished by two diodes CR1 and CR2 mounted on the the quarter wave strip line board in the APN unit (figure 3). An eighty hertz square wave supplied by the amplifier board causes the diodes to turn off and on sequentially. When a diode is in the on state it allows the RF signal to pass through it and then on to the receiver board. By this method the signal at Point 1 and Point 2 can be sent to the receiver board sequentially.

GENERATING THE 80 HERTZ SQUARE WAVE

U7 (555 timer) on the amplifier board (figure 4) is set to produce a 320 hertz train of pulses. Potentiometer R18 is used to set U7 to this frequency. The pulse train is sent to U8 (a dual D flip flop) which outputs an 80 hertz square wave with an exact 50% duty cycle. This signal is sent through R25 to the base of Q3. Q3 acts as an emitter follower. C24 serves to block DC. R27 serves as a current limiter. The square wave to the switching diodes is held to approx. +.7 volts and to -.7 volts.

DETECTION PROCESS

The switched RF is sent to the built in receiver. (fig. 5) The output of the receiver's detector (ahead of the audio amplifier) is sent to the amplifier board (figure 4). Two 80 hertz active filters (made up of U1, C4 - C8, and R3 - R7) filter out the spurious audio and retain only the phase information at the switching rate. The output of the active filters passes through U2, an electronic attenuator which limits the output peak voltages when DF'ing on extremely strong signals. The output of the attenuator is fed to U3. OP amp 1 in U3 is used to invert the positive half of the signal. CR1 and CR2 act as a full wave rectifier with C13 acting to filter the output pulses. The negative voltage is then inverted and amplified by gate 2 of U3. The output of gate 2 of U3 is used as the control voltage to the electronic attenuator.

The output of the attenuator is also sent to a fixed gain amplifier U4. The output of this amplifier is capacitively coupled to the junction of R23 and R24. The signal is divided into two legs. The legs are connected to transistor switches Q1

and Q2. These switches are controlled by the Q and Q' outputs of U8. Whenever Q1 is turned on, Q2 is turned off and vice versa. Therefore, when Q1 is on the signal from Port 1 in the APN will charge C1 (located in the remote unit) in one direction. When Q2 is on the signal from Port 2 in the APN will charge C1 in the opposite direction. The zero center meter is connected across C1. Therefore, the relative strength of the vectorially added RF signals at Point 1 and Point 2 in the APN will determine which direction and to what degree the zero center needle will be deflected.

SIGNAL STRENGTH METER

The DF-88P uses a multiple range signal strength display (figure 6). This allows small changes in signal strength to cause a readily observable change in the position of the signal strength indicator.

The control for the signal strength meter is the AGC voltage on the receiver board. The AGC voltage is conducted to pin 10 of terminal strip 1 and then on to "AGC in" on the amplifier board.

The AGC voltage does not have a linear response to a linear increase in signal strength. As the signal strength increases the signal strength needle moves toward the full scale position. When the next higher range is selected a new zeroing voltage level is selected and a new gain level is selected. This allows a fairly linear needle response to the non-linear increase in AGC voltage. The 6 position 2 pole rotary switch selects both the resistance to zero the meter and the gain control resistance.

The AGC voltage is fed to fixed gain inverting op-amp 2 of U4 through input resistor R30. R29 is the feedback resistor. R28 and the resistance selected by the rotary switch in the remote unit form a voltage divider network which establishes a zeroing voltage which is applied to the non inverting input of op-amp 2 in U4. The output of op-amp 2 of U4 varies from -1.5 volts to -3.5 volts. This voltage is sent to the remote unit via pin 8 of the interconnect cord.

Op-amp 1 in U1, located in the remote unit, inverts the drive signal from U4. The range select rotary switch selects the feedback resistance to allow full scale meter deflection to correspond to a 10dbm change in signal strength.

Gain limiting diodes CR3 and CR4 prevent over driving of the meter movement if a strong signal suddenly is present on the target frequency.

SECTION II - ANTENNA MOUNTING

ANTENNA INSTALLATION MUST BE MADE BY A LICENSED AIRCRAFT RADIO TECHNICIAN.

GENERAL INFORMATION

The DF-88P will work on any air frame if the following conditions are closely adhered to. Failure to meet the following conditions will seriously effect the operation of the DF-88P.

CONDITIONS

1. The antennas must be installed on a typical high or low wing air frame as shown in figure 7. For any installations which are not considered standard, prior instruction should be obtained from the factory. Helicopters should be installed the same as on a low wing air frame.

2. The installation must be made in accordance with installation instructions and recommendations.

3. Both antennas must be mounted perpendicular to the center line of the aircraft (see typical installation figure 7).

4. The antennas must be mounted 24.0 inches apart (12.0 inches on each side of the aircraft center line).

5. Existing antennas such as VOR, COMM, Marker and ADF must be moved if they come within 30 inches of either of the DF-88P antennas as measured from the DF-88P antenna bases.

6. When installing a monopole antenna, you must have a good ground plane to operate against. A metallic aircraft skin provides such a ground plane; non metallic skin does not. For non metallic skins it is necessary to fabricate and install a piece of .020 aluminum sheet at least 30 inches wide and 18 inches long between the fabric and the air frame. Use doubler plates on 24 inch center for mounting the antennas as per F.A.A. 41.13-2. Make sure a good ground connection exists between the aluminum plate doubler and the aircraft.

ANTENNA INSTALLATION

After determining the proper placement of the antennas drill the mounting holes for the antenna bases (fig 8) . The matched pair of antenna coaxial cables supplied are 128 inches long. DO NOT CUT THESE CABLES. If longer cables are needed to reach the input terminals of the DF-88P in the position where it will normally be used then longer cables can be fabricated. Use RG58/U coaxial cable. Both cables must be exactly the same length and a multiple of 32 inches (1/2 wave length in coax).

Mount the antennas above the wing on a high wing aircraft as close as possible to the center of the chord of wing.

Mount the antennas below the wing on a low wing aircraft as close as possible to the center of the chord of the wing. On a helicopter mount the antennas on the under side of the craft as far forward as possible.

SECTION III - OPERATING INSTRUCTIONS

CONTROL FUNCTIONS (figure 9)

1. Power - Controls the power to the unit. Locking action of switch assures that unit cannot be accidentally turned on.

2. Volume - The volume control can be set to any level and will not effect the sensitivity of the DF or the signal strength needle.

3. Frequency Select - Controls the frequency the DF will receive on. There can be up to 4 crystal controlled frequencies.

4. Antenna Connectors - These two BNC type connectors input the signals from the right and left DF antennas. Use the coax cables supplied with the unit or replacements that are both the same length as the originals or a multiple of 32 inches. Intercom patch cord (optional); Connects the DF-88P audio output to the aircraft intercom system. Must be installed with the short lead toward DF-88P audio jack.

5. Boresight - A blade type tuning tool must be used to set the boresight trimming capacitor for center indication when the source is directly ahead.

6. Remote Unit (figure 10)

   A. Heading Indicator - Needle should be centered when the signal source is directly ahead or behind the aircraft. As the signal source moves further to the right or left the needle will deflect further in the direction of the signal.

   B. Signal Strength Meter and Range Select - The movement of the needle from left to right indicates an increasingly

strong signal. The range select expands the scale of the needle so that very slight changes in signal strength can be observed. The factory settings for the range select are:

Lo -130dbm to -120dbm

-120dbm to -110dbm

-110dbm to -100dbm

-100dbm to -90dbm

-90dbm to -80dbm

Hi -80dbm to -50dbm

C. Light - For night use. Results in approximately a 15% increase in battery load.

D. Battery condition indicator - The two-color LED on front panel of the Remote Unit will glow green until the battery voltage drops to about 14 volts. Below 14 volts the LED will glow RED and this is an indication that the batteries should be replaced or recharged. The unit will continue to operate for at least 2 hours after the LED begins to glow red. However, low battery voltage will degrade the operation of the signal strength meter.

USING THE DF-88P

Your DF-88P has been designed for ease of operation in the close quarters of an aircraft cabin. By following the the below steps each time you use the DF-88P it will lead you to the signal source every time.

GROUND CHECK

1. Place the unit on the floor behind the seat so as to be accessible.

2. Remove the top cover and connect the antenna leads to the DF-88P. Red lead to left input - green to right.

3. Remove the remote unit from the main case lid. Connect the remote unit to the main unit with the 9 pin interconnect cord.

THE FOLLOWING STEPS ARE STRONGLY RECOMMENDED TO BE FOLLOWED BEFORE EACH FLIGHT.

4. Audio output is provided at the headphone jack only. Either insert head phone into this jack or short lead of optional, intercom patch cord. Patch cord allows DF audio to be heard through the intercom system.

5. Turn the unit on and verify that battery indicator glows

green. Set frequency select switch to a frequency other than the emergency frequency.

6. Have someone stand directly in front of the aircraft about 100 feet away with a hand held transmitter tuned to the same frequency as the DF.

7. Key the transmitter directly ahead of the aircraft. The direction indicator should remain in the center. If it moves to the right or left, then adjust the bore sight adjustment (using a screwdriver type alignment tool) to bring the needle back to the center.

NOTE: IF THE DF ANTENNAS ARE MOUNTED ON THE BELLY OF THE AIRCRAFT THE NOSE GEAR MAY CAUSE SOME SLIGHT NEEDLE OFFSET WHEN AIRCRAFT IS ON THE GROUND

8. Have the person holding the transmitter move about 45 degrees to the right and note that the direction indicator moves to the right at least half scale. If the needle moves in the wrong direction then reverse the antenna leads and confirm that the needle now moves in the correct direction.

IN FLIGHT

1. The DF-88P can DF on a signal that is barely audible in the headset. Sometimes the signal will not be audible but you will still see a deflection on the direction indicator.

2. After the desired signal to DF on has been identified, note the direction indicator needle and make a gentle (1/2 standard rate) turn in the direction of the needle deflection. If during the turn the needle moves even further in the same direction, continue the turn because the signal source is behind you. (NOTE - low wing aircraft might block the signal during a steep turn and cause the DF needle to center even though the signal source is still off to the side).

3. Set the range switch to a position that brings the signal strength meter to an on-scale position. As you fly toward the signal source you will have to move the range switch to a higher position to keep the signal strength meter on scale.

4. Strong signals on adjacent frequencies may bleed over into the frequency you're DF'ing on. These signals will cause a deflection of the direction indicator. By listening on the DF-88P headset you'll know when these signals occur and you can ignore them. Simply maintain the heading that kept the needle centered until the adjacent transmission stops.

5. As you approach the signal source you will observe the signal strength increasing and the audio becoming clearer. When you are over the source the DF needle will deflect to the right or left. A turn toward the needle at this point will only produce further deflection. A continuous turn with the needle deflected in one direction means you are circling above the signal source.

SECTION IV - PREVENTIVE MAINTENANCE

The DF-88P should be stored with the case closed. The batteries (12 standard D cells) should be removed for long term storage or whenever the LED fails to glow green. When replacing the batteries special care must be taken to be sure each cell is installed properly.

When using the removable antennas the caps should be installed on exterior antenna stubs whenever antennas are removed.

SECTION V - TROUBLE SHOOTING

The following test instruments are required to completely trouble shoot the DF-88P on the bench:

Oscilloscope

Emergency Beacon Corp. Precision Phase Splitter (DFT-909)

RF signal generator

Audio signal generator

High Input Impedance Multimeter

OVERALL CHECK

Remove the electronic package from the center section of the case by removing the 8 screws around the perimeter of the face plate. Reattach the power leads to the battery or to an 18 volt DC supply. Connect the DF and associated test equipment as shown in figure 11. Verify that the DF-88P battery is connected correctly and that it's voltage is at least 14 volts with the unit turned on. Using the multimeter verify there is +12.5 volts and -12 volts on pins 4 and 5 respectively on terminal strip. Using the oscilloscope verify that the 80 hertz square wave is present at pin 9. Adjust 20 turn pot R18 so that the period of a single wave form is 12.5 milli-seconds.

FOR THE NEXT STEPS THE REMOTE UNIT MUST BE CONNECTED.

Turn on the RF signal generator and set to a frequency the DF-88P can tune to. Set the RF signal strength to -90db and add an audio tone to the carrier signal and confirm that the tone can be heard in the headset.

Adjusting Signal Strength Meter (SSM)

1. Remove lid of remote unit.
2. Plug in 8 pin connector and turn DF-88P on.
3. Test battery - reading will not be accurate with low battery
4. Set Range Select to lowest position.
5. Set RF generator to -130dbm and to a frequency the DF-88P can tune to.
6. Use coax 'Tee' to split signal - do not use phase splitter

FOR THE BELOW STEPS REFER TO FIGURE 6

7. Turn R2 to obtain an SSM input voltage of approx. .020 volts. This should result in an SSM reading just above the zero point.
8. Increase the RF signal strength to -118dbm.
9. Turn R8 to obtain a SSM input voltage of .150 volts.
10. Turn Range Select right one click to second position.
11. Set RF strength to -120dbm.
12. Turn R3 to obtain SSM input voltage of approx. .020 volts.
13. Increase RF signal to 108dbm.
14. Turn R9 to obtain SSM input voltage of approx. .150 volts.
15. Turn Range Select right one click to third position.
16. Set RF strength to -110dbm.
17. Turn R4 to obtain SSM input voltage of .020 volts.
18. Increase RF signal to -98dbm.
19. Turn R10 to obtain SSM input voltage of approx. .150 volts.
20. Turn Range Select right one click to fourth position.
21. Set RF strength to -100dbm.
22. Turn R5 to obtain SSM input voltage of approx. .020 volts.
23. Increase RF strength to -88dbm.
24. Turn R11 to obtain SSM input voltage of approx. .150 volts.
25. Turn Range Select right one click to fifth position.
26. Set RF strength to -90 dbm.
27. Turn R6 to obtain SUM input voltage of approx. .020 volts.
28. Increase RF strength to -78dbm.
29. Turn R12 to obtain SUM input voltage of approx. .150 volts.
30. Turn Range select right one click to sixth position (High)
31. Set RF strength to -80dbm.
32. Turn R7 to obtain SUM input voltage of approx. .020 volts.
33. Increase RF strength to -50dbm.
34. Turn R13 to obtain SSM input voltage of approx. .150 volts.
35. Recheck all values between -130dbm and -50dbm to make sure an on-scale reading can be obtained for any signal strength value.
36. Reinstall lid.

CHECKING DIRECTION INDICATOR

NOTE - WHEN USING THE DFT 909 PHASE SPLITTER KEEP IN MIND THAT IT INTRODUCES APPROX. 20dbm OF SIGNAL ATTENUATION.

1. Connect test equipment to DF-88P as shown in figure 12.

2. Turn on signal generator and set to a frequency the DF-88P can tune to.

3. Set the signal strength to -120dbm. Confirm that the DF-88P is receiving the signal by modulating the carrier with an audio tone and listening for it in the headset.

4. Adjust Boresight capacitor (figure 9) with a blade type tuning tool until the direction indicator needle centers.

5. Using the DFT Precision Phase Splitter (fig. 12) introduce some antenna phase delay by moving switch S1 toward the edge of the board. The direction indicator needle should move slightly off center.

6. Move S1 back to it's original position and move S2 toward the edge of the board. The direction indicator needle should move slightly off center in a direction opposite that of step 5.

7. Now move S1 and S3 toward the edge of the board. The needle should deflect further off center. Return S1 and S3 to original position and repeat moving S2 and S4 and note needle deflection in the opposite direction.

8. With S1 only moved toward the edge of the board the needle deflection should remain at approx. 1/3 deflection as the signal strength is increased from -120dbm up to -40 dbm.

9. With S1 and S3 moved toward the edge of the board the deflection should remain at approx. 2/3 deflection for the range of signal strengths used in step 8.

10. With S1, S3 and S5 moved toward the edge of the board the needle should move to full deflection for all ranges. (Full deflection may not be obtained at the lowest signal strength levels.)

11. Repeat steps 8, 9, and 10 using switches S2, S4 and S6 and note that the needle moves in the opposite direction.

TROUBLE SHOOTING

Indicator reads opposite of true direction.

Reverse the antenna leads. Permanently installed antenna leads in the aircraft should be marked RIGHT and LEFT so when connected to the DF-88F the indicator needle will point in the proper direction.

Signal Strength Meter goes to full scale whenever the unit is turned on.

This is often caused by a loss of the -12 volt supply. Check terminal 5 in the indicator head for -12 volts. If no voltage check for +12.5 volt on pin 8 of voltage converter (figure 4). If +12.5 volt is present on pin 8, then probable cause is defective voltage converter (U6 on amp board).

No movement of either signal strength meter or direction indicator.

This is probably due to loss of +12.5 volt supply. Check output of U5 (LM 317 voltage regulator - figure 4)

Signal strength meter moves correctly but direction indicator does not respond to changing signal position. Signal can be heard in headset.

This probably due to loss of 80 hertz switching square wave. Check that +12.5 volts is present on pin 8 of U7 (555 timer). Check that 360 hertz signal is present on pin 3 of U8. If no output replace 555 timer. Check pins 12 and 13 of U7 (Dual D flip-flop). If 80 hertz square wave not present then replace U7. Check base of Q3. If eighty hertz signal present then replace Q3. Check pin 9 of main unit terminal strip. If 80 hertz signal is present and is limited to plus and minus .7 volts then the switching square wave is not at fault. Check for freedom of movement of indicator needle. Check that there are no open leads in remote cord. Check the 'RADIO IN' terminal of the amplifier board. If the demodulated signal is present then perform the following:

1. Disconnect the 'Radio in' lead from the terminal strip.

2. Connect the output of an audio signal generator set to 80 hertz sinewave and .5 volts peak to the 'Radio in' terminal of the amplifier board.

3. Using oscilloscope observe pin 7 of U1 as frequency of audio generator is varied between 70 and 90 hertz. Peak output should occur at 80 hertz. If no output on pin 7 replace U1.

4. Check output of U2 on pin 7. If no output then either the attenuator chip is defective or the control voltage on pin 2 is too high. If there is no output on pin 7 of U2 then pin 2 should be at zero volts. If pin 2 voltage is approx. zero then replace U2.

5. If pin 2 of U2 is at +4 to +5 volts with no output on pin 7, then check diodes CR1 and CR2. If diodes are good then replace U3.

No signal is heard when DF-88P is turned on.

Check that battery is correctly installed and is adequately charged (at least 14 volts with unit turned on). Check that receiver is tuned to proper frequency. Check that battery voltage is present on receiver board.

Needle Indicates Erratically

If needle points to signal properly, but occasionally drifts or swings from side to side, you may have interference from another signal source, or you may not be following the instrument exactly. Other signals in the vicinity may cause the needle to momentarily swing around. You may not hear these transmissions, but the DF-88P will.

Needle always leans to one side.

See boresight adjustment. Also check for open or shorted antenna leads.

When crossing over target, needle swings more to one side than the other.

This is an indication that you are to one side of the target, as indicated by the needle. When you are directly over the target, the needle will swing fully to one side, fully to the other side and then back to center. You must be within a few feet of either side of the target for this to occur. The DF-88P is extremely accurate and will indicate a one foot variation at an altitude of 5,000 feet. If you are slightly to one side, the crossover will indicate this by swinging more in one direction. The needle might swing from one side to center and back to other side. This is because the needle was not lined up, and you did not pass directly over the target. However, for all practical purposes,

this minor error of a few feet to either side does not hinder location of the target. In fact, you will find this extreme accuracy of great advantage when trying to pinpoint the target location. Even though you may not get a perfect crossover indication, you will know that you are within a few feet of being directly over the target.

Irregular readings at low altitudes

On the ground, or in dense metropolitan areas, there may be many reflections from nearby objects as well as other signal interference. Best results will be obtained at high altitudes. You will still be able to use the DF-88P at low altitudes and around cities, but you will have to pay close attention to the signal strength needle to make sure you are going in the direction of increasing signal strength.

SECTION VI - DF-88P Sub Assembly List

Main unit
Case
Face Plate
Receiver board
APN Unit
Amplifier Board
12 Pin terminal strip
4 Position 1 pole rotary switch
9 pin socket
Head set socket
BNC connectors
Batteries D cells (12)
9 conductor interconnect cord
On-off switch
Volume control pot

SUBASSEMBLY PARTS LIST

AMPLIFIER BOARD

Resistors (all 1/4 watt 5% unless otherwise noted)

R1 1 MEG
R2 100 K
R3 120 K
R4 3.9 K
R5 100 K
R6 39 K
R7 10 K
R8 20 K
R9 20 K
R10 20 K
R11 10 K
R12 68 K
R13 22 K
R14 2. K
R15 10 K
R16 33 K
R17 1. K
R18 100 K Pot
R19 3.3 K
R20 3.3 K
R21 1.5 K
R22 1.5 K
R23 33 K
R24 33 K
R25 22 K
R26 2.2 K
R27 1. K
R28 100 K
R29 10 K
R30 100 K

Capacitors (all in microfarads unless noted)

C1 .01 tantalum
C2 .1
C3 33
C4 .1 Mylar
C5 .0.1
C6 .01 ceramic disc
C7 .1 Mylar
C8 .1
C9 1. tantalum
C10 .01 ceramic disc
C11 33 tantalum
C12 620 pf
C13 8.2 tantalum
C14 8.2
C15 1.
C16 8.2
C17 2.2
C18 33
C19 .1
C20 .01 ceramic disc
C21 .01
C22 .01
C23 8.2 tantalum
C24 .001
C25 8.2
C26 33
C27 8.2

Integrated circuits

U1 TL082
U2 MC 3340
U3 TLO82
U4 TL082
U5 LM 317
U6 LT 1054 or ICL 7660S
U7 555
U8 CD4013

Transistors

Q1 2N3569
Q2 2N3569
Q3 2N3569

Diodes

CR1 1N914
CR2 1N914
CR3 1N4002

REMOTE UNIT SUB ASSEMBLY LIST

Case
Face plate
Direction indicator
Signal Strength meter
6 Pos 2 pole rotary switch
8 pin terminal strip
9 pin socket
Signal Strength tuning board
Light switch
12 volt incadesent light bulb

REMOTE UNIT SUBASSEMBLY PARTS LIST

Resistors

R1 10k
R2 - R13 20K variable
R14 82K

R15 100K
R16 100K
R17 100K

R18 .22K

Capacitor

C1 1000uF

Diode

CR1 1N914
CR2 1N914
CR3 1N758

Integrated Circuit

U1 TL082

APN SUBASSEMBLY PARTS LIST

C1 2 - 10pf trimmer cap
L1 .33 uh choke
CR1 1N3404
CR2 1N3404