AGRELO ENGINEERING

DF Jr.

PROFESSIONAL RADIO DIRECTION FINDER

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Operators Manual

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Revision V1.21

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DFjr Assembly Warnings:

CAUTION!!!

Leave the radio power OFF during all connections.
On some radio models, installing the external speaker may cause a brief RF transmission to occur. **THIS WILL DAMAGE THE ANTENNA SWITCHING UNIT!**

CAUTION!!!

Do NOT plug the antenna's RJ-11 connector into the RS-232 jack and apply power to the DFjr, this will damage the antenna and/or the main control unit.

CAUTION!!

DO NOT TRANSMIT INTO THE ANTENNA SWITCHING UNIT!
DAMAGE WILL RESULT.

CAUTION:

CENTER PIN OF THE COAXIAL POWER PLUG IS POSITIVE.
THE SLEEVE IS GROUND. POLARITY MUST BE OBSERVED OR DAMAGE WILL RESULT.

INTRODUCTION

Figure 2 DFjr Control Unit

This manual provides a reference for new owners of the Agrelo DFjr. The manual describes the assembly process of the DFjr antenna and cabling. It also explains the operation and functions of the DFjr control (Figure 2)

Before you get started assembling the DFjr antenna, read through the manual and familiarize yourself with the assembly process. With this manual, the assembly process should be simple and trouble free.

At the end of the manual is a Frequently Asked Questions (FAQ's) section. This section will cover many of the questions presented by new DFjr owners.

At first glance, you may recognize this as a doppler unit display, but it's very different from any you've used before. Sure, there are familiar features that you've used in the past. The LOW LED (Figure 3) indicates the audio is too low and the HI LED indicates it's too high. You can select RAW mode where the direction LED's vary rapidly.

One of the first things you'll notice after power-up is the direction LED isn't lit. This is normal. The DFjr only displays its results after it has averaged many samples together.

When everything is working properly, a smooth 500Hz tone over lapping the received audio should be heard.

Figure 3 Control Head

Theory of Operation:

Here's how it works. Doppler shift is nothing new. You've probably heard the change in pitch of an automobile horn as it drives by. That pitch change from high to a low is called doppler shift. Doppler shift can be used to determine the location of objects and distance from them. These are just some of the tidbits of information that can be gleaned from that simple tone shift. The doppler radio direction finder (RDF) turns the scenario around a bit. It does the moving and the listening at the same time. By electronically spinning the antenna, the unit can determine the angle of intercept of an unknown signal. It's fairly high level math for most of us, but it has been proven to work both on paper and in reality.

As each antenna is turned on and off rapidly in succession, it causes a slight change in the received frequency. This slight change is tied back to which antenna was "on" at what time. The unit then displays its findings on a display by simply lighting one light which corresponds to the direction of the transmitted signal. The direction indicated can be interrupted by multipath reception and signal dropouts. With a good eye and attentive ear, you can "eyeball average" where the signal is coming from. Here's where the DFjr steps in. Although no unit can eliminate multipath and signal dropout, the DFjr simply ignores the effects. The DFjr takes into account the momentary dropouts and reflections that are typical of a moving DF unit. The DFjr takes only the best "samples" and averages them together for a resulting accuracy that is astounding. Keep in mind that the DFjr still has to abide by the laws of Physics. If the reflected signal is so strong, and the mobile DFjr is not moving (such as a parked car), the direction of the reflection can still be displayed.

With microprocessor power, the DFjr has opened new doors to accuracy and speed of radio direction finding. Combine this power with the ability to output the DF results and GPS position data, and you have one of the most advanced units ever professionally produced.

Stand Alone Operation:

With the unit installed on the vehicle and tested, it's time to DF a station. Tune the DF radio to the station to be found. Once the transmitter is heard, drive in any direction until the unit displays a bearing. The most basic method is to drive toward the transmitter following the bearing displayed on the DFjr. It may be helpful to mark these bearings on a map of the local area. This will assist you in finding the most direct path to the transmitter.

It's recommended that at least two people work together as a team when mobile direction finding. It's much safer for everyone if the driver is left to drive while the operator navigates them to the transmitter. Many needless accidents have occurred because of distraction from the task of driving.

Fixed Point Use:

If the DFjr is to be used in a fixed location such as a dispatcher's position or a repeater site, some items must be considered. First, all antennas in the immediate area will have some effect on the DFjr antenna unit. The DFjr should be located as far from other antennas as practical. Antennas in the area that are connected to transmitters are a special consideration since the output RF can damage the DFjr antenna switching system.

The next consideration is distance between the antenna unit and the main unit. The coaxial RF cable used from the DFjr antenna unit to the DF radio should be the highest quality affordable. Maximum shielding and minimum loss should be thoroughly considered before installation of the unit. Control cable form the DFjr main unit to the DFjr antenna unit is an important consideration as well. DC voltage is necessary for the operation of the DFjr antenna unit. Long cable runs will cause a significant loss of voltage at the antenna unit. Once again, the best quality cable must be used. All control cable conductors should remain nearly the same length and have no splices. Antenna synchronization problems will result in loss of accuracy in the DFjr.

With the unit mounted on a non-mobile platform, the DFjr is unable to minimize a local reflection. If the transmitter being tracked is moving, the DFjr will minimize the effects of multipath, considering no reflections near the DFjr antenna. If erroneous bearings are noted, make note of the weather and/or other conditions such as a large metal object near the DFjr antenna system. A reflector near the antenna unit may only affect one direction of reception. Check the system regularly when a reflection is suspected. It's a good idea to regularly check the fixed point DFjr against a known point of reference such as a National Weather Service radio site or a local repeater station.

Once a good site is selected for mounting the DFjr system, calibration and maintenance should be minimal. Recalibration should only be necessary if new metal objects such as additional antennas are added to or removed from the site. Occasional weather disturbances should not be the cause for calibration since the disturbance will normally pass when the weather passes.

GPS (Global Positioning System)

The DFjr will also take input from a GPS receiver. This input along with the DFjr's bearing can be displayed on a computer running APRS. Your present position and bearing data are transferred via the RS-232 link to the computer and program. That information is displayed in real time as you travel toward the transmitter. The combination of the DFjr, GPS and APRS makes a very formidable radio direction finding system. Your results can be remotely displayed with the addition of a transmitter and TNC in your car.

TNC (Terminal Node Controller)

A TNC will allow you to transmit your findings to other APRS users on the same frequency. This allows team hunting which will increase speed and accuracy of the triangulation. Each member of the team transmits their findings to each other as progress is being made. Two units converging at large angles to the transmitter will have a significant advantage over a single unit hunter.

An alternative is to connect the DFjr to a TNC directly. This eliminates the need for a computer in the car or at the local DF site.

With the DFjr, a GPS and a TNC connected to a transmitter, the location and bearing information of the mobile DFing station is transmitted to any system running the APRS display software. The mobile units can be directed to the transmitter via voice or cellular phone instead of equipping each unit with an additional computer. This scenario works well for law enforcement, Civil Air Patrol and team hunting where a single "dispatch" is being used.

DFjr Assembly

Cross arm Assembly

CAUTION: Before connecting the antenna unit to a receiver and DFjr, make sure that all components are properly installed and there is no direct short between the antenna stud assembly and the underside of the magnetic cup where the bare metal is exposed, which is ground.
Connecting the antenna unit while a short is present will result in permanent damage and void the 1 year manufactures warranty.

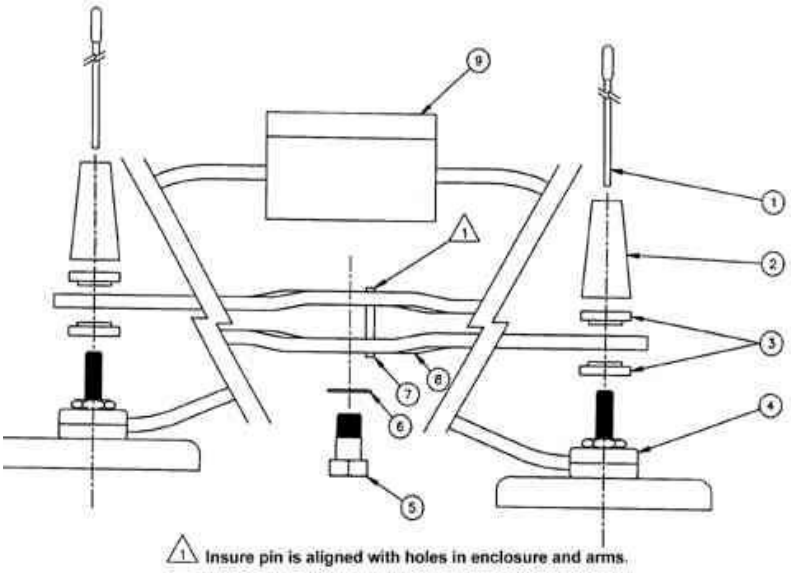


Figure 4 shows the DFjr antenna assembly as an exploded view of the major components.

Figure 4

The initial assemble begins by aligning the two pieces of flat stock. These are placed together to form an “X”. Use the guide pins to align the two pieces of the “X” arm (visible in Figure 5). The pin should extend through the overlapping cross arm.

Figure 5

Figure 6

The Antenna Switch Unit should then be placed over the “X” arm assembly so that the guide pin from the bottom arm is aligned and inserts into small hole in the bottom of the Antenna Switch Unit (Figure 6).

Position each coax along the nearest antenna arm. Route the antenna coaxial cables so that they do not cross one another.

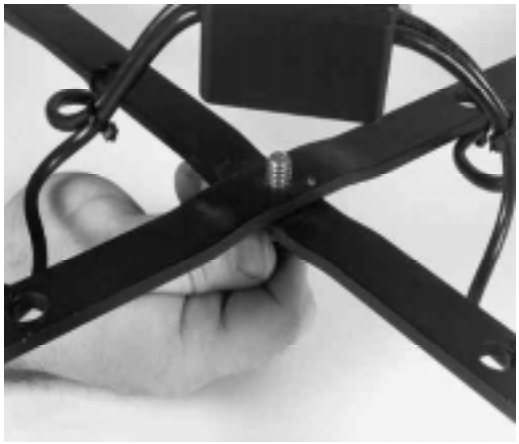


Figure 7

Place the 3/8” washer on the 3/8” bolt. The 3/8” bolt is placed through the “X” arms from the bottom and is screwed into the 3/8” hole in the bottom of the Antenna Switch unit. Tighten the bolt but not so much as to strip the threads (Figure 7).

Figure 8

Place the self adhesive Rubber Bolt Pad on the head of the 3/8” bolt (see Figure 8). The rubber pad will help prevent scratches to the surface that the DFjr Antenna Assembly is mounted to.

Figure 9

For appearance and mechanical stability (strain relief) you may want to use small included tie wraps to hold the antenna wire to the “X” arms (Figure 9).

Antenna End Assembly

Figure 10

The end of the DFjr Antenna Assembly uses:
four (4) 3” magnet assembly,
two (2) plastic spacers,
four (4) Antenna Whip Stud Assemblies, and four (4)Antenna Whips (Figure 10).

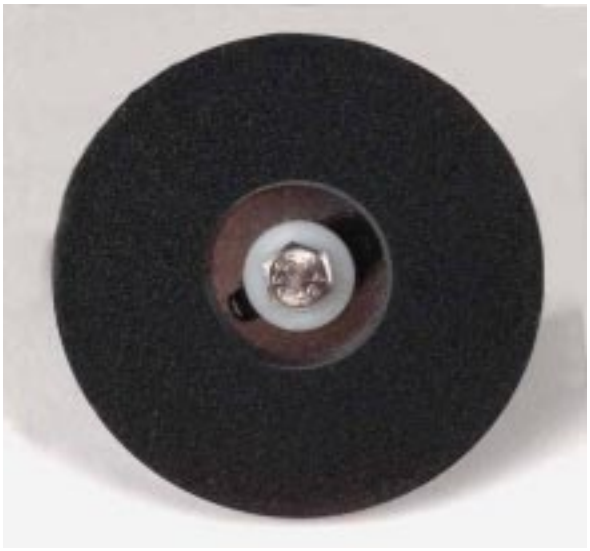


Figure 11

Figure 11 shows the bottom of the 3” magnet assembly. The magnet assembly comes pre-assembled with the magnet assembly already attached via cable to the Antenna Switch Unit. This will assure a proper electrical connection between the whip antennas and the Antenna Switch Unit.

Figure 12

Align the 3” magnet near the end of the “X” Arm (Figure 12). The Bolt on the magnet assembly will be installed in the hole from the bottom. The “X” Arms have three holes on each end. The Antenna Whips will be mounted in the same hole on each of the four arms. The holes from the center out will be used for:
440 MHz (70 cm)
220 MHz (1.25 meters), and
144 MHz (2 meters) respectively.

Figure 13

Place a plastic spacer over the bolt on the 3” magnet assembly. The spacer will have a smaller beveled edge on one side. Place the spacer so that the smaller end faces up as in the photo (Figure 13).

Figure 14

Figure 14 shows the 3” magnet with the plastic spacer correctly installed.

Figure 15

Place the bolt of the 3” magnet assembly through the appropriate hole of the “X” arm. Align the small end of the plastic spacer so that it slides inside the hole of the “X” arm (Figure 15).

Figure 16

Place another plastic spacer on the bolt so that it is located on the topside of the “X” arm and 3” magnet assembly (Figure 16).

The small end of the plastic spacer should be facing down. This will have the small end of both plastic spacers inside the hole. By doing this, you are assured that the Antenna Whip will make a proper electrical contact to the cables, but will not be grounded against the “X” arms
(Figure 17).

Figure 18

The Antenna Whip Stud Assemblies are now screwed over the top of the bolt of the 3” magnet assembly. Hand tighten only, DO NOT OVER TIGHTEN.

Install the Antenna Whips in the top of the Antenna Whip Stud Assemblies (Figure 18) and tighten the set screw. The length from the tip of the 2-meter whip antenna (17”) plus the length of the stud should be equal to the proper frequency length for 2 meter at a quarter wave.

2 meters (146 MHz) = 19.25”
1.25 meters (220 MHz) = 12.6”
70 cm (440 MHz) = 6.4”

CAUTION!!! EYE PROTECTION IS RECOMMENDED SINCE WHIP ANTENNAS MAY BE DIFFICULT TO SEE, AND CAN CAUSE SEVERE EYE INJURY.

Figure 19

Figure 19 shows the completed Antenna Whip and Stud assembly from a side view.

Figure 20

Figure 20 shows the exploded view of the Antenna Whip and Stud assembly. With this, you're able to visualize the antenna assembly orientation. Notice the orientation of the plastic spacers.

COMPLETED ASSEMBLY

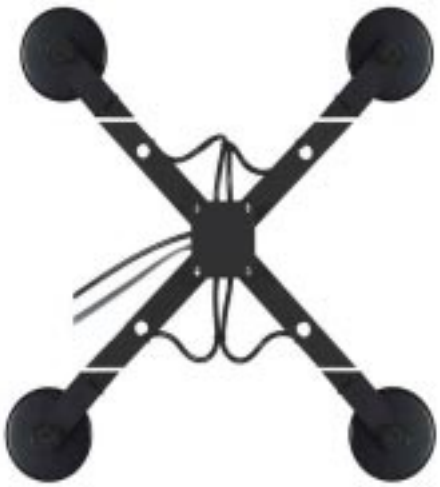


Figure 21

Figure 21 shows a top down view of the completed DFjr Antenna Assembly. Notice the two wires leading away from the Antenna Switch Unit. These wires will connect to a radio and the DFjr Control Head.

Figure 22 shows the same completed DFjr Antenna assembly from a slightly elevated angle.

Figure 22

Connections:

Connect the cable with the RJ-11 connector from the DFjr antenna switching unit to the DFjr main unit "antenna Port".

CAUTION!!! Leave the radio power OFF during all connections.
On some radio models, installing the external speaker may cause a brief RF transmission to occur. **THIS WILL DAMAGE THE ANTENNA SWITCHING UNIT!**

CAUTION!!! Do NOT plug the antenna's RJ-11 connector into the RS-232 jack and apply power to the DFjr, this will damage the antenna and/or the main control unit.

Connect the audio cable from the external speaker jack on the radio to the DFjr audio input.
Connect a user supplied 8-Ohm external speaker to the DFjr audio output.
Connect the RF cable from the antenna switching unit to the radio antenna input.

CAUTION!! DO NOT TRANSMIT INTO THE ANTENNA SWITCHING UNIT!
DAMAGE WILL RESULT.

CAUTION: CENTER PIN OF THE COAXIAL POWER PLUG IS POSITIVE.
THE SLEEVE IS GROUND. POLARITY MUST BE OBSERVED OR DAMAGE WILL RESULT.
Use the cable with the color stripe for the positive connection lead. If no color striped wire is available, use a multi-meter to Ohm the ends so you use the proper ends to the positive connections.

Connect 13.8 volts DC to the DFjr power jack input that's marked "DC 13.8".

Note: Power supplied to the DFjr should have a 1/4 amp fast blow fuse installed.

Note: Center LED on the DFjr main control unit will light to indicate a power ON condition. This also provides a reference for nighttime operation. With the radio off, the LOW LED will illuminate indicating insufficient audio present.

Note: The direction LED will not illuminate until audio is present and the DFjr has determined a line of bearing.

MOUNTING the DFjr Main Unit:

There are many ways the DFjr control head can be mounted. Most situations will depend on the type of vehicle or particular location/routing of cables that your situation presents..

You could use a cellular phone cradle where the sides are squeezed together. These are available at cellular vendors or they can often also be found hat hamfests. Velcro is recommended for vehicle dashboard mounting.

Use creativity in finding an appropriate mounting location. The DFjr antenna has been bolted upside down under an airplane in use for airplane tracking to stop drug trafficing across the border between the US and Mexico.

Be sure to mount the DFjr control in a manner that will not allow it to drop. For safety consideration, **do not mount it in any location that will obstruct or create a hazard to the driver's field of view.**

Optional mounting hardware will be available in the future. Contact Agrelo Engineering for more information

Mounting the Antenna Unit:

Mobile:

Use caution when deciding on a location. Try to keep any other antennas mounted on the vehicle away from the DFjr antenna. RF emitting from other antennas on the vehicle may affect the DFjr and desensitize it from the incoming signals.

The antenna unit can be placed on the roof of a vehicle with a metal body. If mounting on a convertible, you may be very limited to mounting locations. The trunk lid may be a preferred location on a convertible.

Base:

If using the array in a fixed base station is desired, a metal ground plane should be available to place the antenna unit on.

Obtain a square piece of metal (preferably steel) for the magnets to attach to, the metal should be at a minimum 30" square. This will require proper grounding as well so that each of the four antennas recieve its proper capacitive coupling mandatory for proper operation. A ground cable should be bolted to the metal plate and run from the plate to a real ground source.

To allow the DFjr to be mounted to a base, longer cable lengths can be purchased from Agrelo Engineering. Cables are available in increments of 25 feet from 25 to 100 feet (25', 50', 75', and 100').

CONTROL HEAD

Figure 23

Figure 24

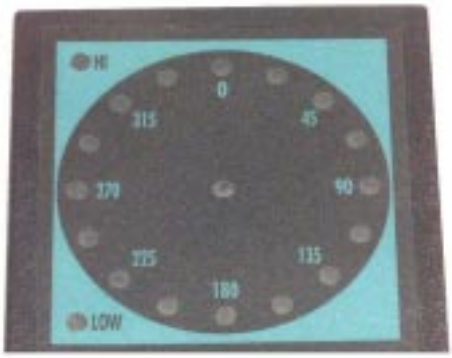


Figure 25

Figure 26

The DFjr control head is the user interface to the DFjr's functions. Pressing MENU, SUB or ENTER in specific combinations allow the user to access or change any of the functional capabilities of the DFjr.

The Center LED indicates a power ON condition and provides a reference for nighttime operation. With the radio OFF or no received signal, the LOW LED in the lower left will illuminate indicating an insufficient audio condition. When a signal is received, the HI LED will illuminate or flicker on.

The direction LED will not illuminate until sufficient audio is present and the DFjr has determined a line of bearing (Figure 25). With a received signal of sufficient strength, the DFjr will sample the signal and determine an averaged direction. The LED on the dial face closest to the direction will be illuminated. When a another new signal is received, once the direction has been determined, the display will again illuminate the LED in the closest direction to the new signal (Figure 24).

The middle section is the control settings and functions for the DFjr. By depressing a single or combination of keys, you can control and change the operation of the DFjr at any time (Figure 26).

Pressing MENU will initiate a change and illuminate the first light to the right of the "0" at the top of the DFjr. Pressing the MENU button more times will cause the light to move clockwise around the dial 11 times. On the 12th time, the "0" will light. To ease the possible confusion, remember the "0" is the last light as the indicator moves about the dial. Pressing MENU again will cause the first light (MENU 1) to come on again.

In situations where the SUB functions of a MENU item may need to be changed, after selecting the appropriate MENU function, depressing the SUB button will illuminate the first light to the left of the "0" light. The SUB light will move counterclockwise around the indicator dial. The first light left of "0" is considered number 1 and the last number is "0". This may take some getting used to, but as you practice you will follow the pattern easily.

Pressing "ENTER" saves settings to that point. The following chart will explain the basic function of each MENU and SUB function of the DFjr. The "*" will indicate a DEFAULT setting of the DFjr if the DFjr is placed into RESET mode.

Menu 1 **MENU then ENTER:**	Causes GPS and DF report to be sent VIA serial port. Pressing MENU then ENTER also stops the 500Hz tone. **NOTE: THIS OVERRIDES ALL PORT SETTINGS.**
Menu 2 **DF Communications Port** determines if data is sent to the RS-232 data port of the DFjr.	SUB 1: On **** (default settings)*** SUB 0: Off **NOTE: ENTER SAVES ALL SETTINGS**
Menu 3 **GPS Communications Port & NMEA Data Protocols.** Note: If your GPS has the $GPRMC sentence, $GPGGA will not be available and the $GPRMC setting must be used.	SUB 1: On SUB 2: $RMC SUB 3: $GGA & $VTG SUB 0: Off ****(default setting)*** **NOTE: ENTER SAVES ALL SETTINGS** **NOTE: MAKE SURE THE GPS PORT IS OFF WHEN NOT IN USE.** THIS WILL SAVE THE DFjr ABOUT 1 SECOND EACH TIME IT ATTEMPTS TO CHECK THE GPS PORT.
Menu 4 **DF to PC Baud Rate** determines the baud rate of the data output from the DFjr's RS-232 port.	SUB 1: 2400 bps SUB 2: 4800 bps ****(default setting)*** SUB 3: 9600 bps SUB 4: 19200 bps SUB 0: 1200 bps **NOTE: ENTER SAVES ALL SETTINGS**
Menu 5 **GPS to DFjr Baud Rate** determines the baud rate of any GPS data sent through the DFjr Multi Port Adapter (MPA).	SUB 1: 2400 bps SUB 2: 4800 bps ****(default setting)*** SUB 3: 9600 bps SUB 4: 19200 bps SUB 0: 1200 bps **NOTE: ENTER SAVES ALL SETTINGS**
Menu 6 **Increment Value For Calibration** Increments the values of degrees between angles of calibrations.	SUB 1: 2.81250 degrees SUB 2: 5.62500 degrees SUB 3: 11.2500 degrees SUB 4: 22.5000 degrees ****(default setting)*** SUB 0: 1.40625 degrees **NOTE: ENTER SAVES ALL SETTINGS**
Menu 7 **Minimum Quality Threshold** (The higher the quality bearing sent to the display/ RS-232, i.e. Q4 would send only Q5-Q8 quality threshold signal to the DFjr display).	SUB 1: Q1 (bearing quality must be 1 or better to Display) SUB 2: Q2 (bearing quality must be 2 or better to Display) SUB 3: Q3 (bearing quality must be 3 or better to Display) SUB 4: Q4 (bearing quality must be 4 or better to Display) ****(default setting)*** SUB 5: Q5 (bearing quality must be 5 or better to Display) SUB 6: Q6 (bearing quality must be 6 or better to Display) SUB 7: Q7 (bearing quality must be 7 or better to Display) SUB 0: Q0 (quality threshold off) **NOTE: ENTER SAVES ALL SETTINGS**

Menu 8 **GPS Output Delay Rate** (Selects how often a GPS POSIT is reported).	SUB 1: Every 10 seconds SUB 2: Every 15 seconds SUB 3: Every 20 seconds SUB 4: Every 40 seconds ***(default setting)*** SUB 5: Every 50 seconds SUB 6: Every 60 seconds SUB 7: Every 2 minutes SUB 8: Every 4 minutes SUB 9: Every 6 minutes SUB 10: Every 8 minutes SUB 11: Every 10 minutes SUB 12: Every 12 minutes SUB 13: Every 14 minutes SUB 14: Every 16 minutes SUB 0:Every 5 seconds **NOTE: ENTER SAVES ALL SETTINGS**
Menu 9 **PTT Input Logic.** (Selects input logic state from radio PTT line) This feature allows sensing of a packet transmitter so as not to DF yourself. The DFjr will ignore (stop DFing) during a 0-5 volt PTT logic. **WARNING: EXCEEDING 5 VOLTS WILL CAUSE DAMAGE.**	SUB 1: On SUB 2: Active high SUB 3: Active low SUB 0: Off ***(default setting)*** **NOTE: ENTER SAVES ALL SETTINGS**
Menu 10 **Auto Test/Factory Defaults**	ENTER **Note:** DFjr WILL GO THROUGH SELF-TEST AND RESET ALL SETTINGS TO FACTORY DEFAULTS AFTER ONE FULL CLOCKWISE ROTATION OF THE LEDS.
Menu 11 **Antenna Test** Note: Allows user to turn on each antenna individually. This is an aid to troubleshooting only. There will be a noticeable improvement in signal strength when any antenna is on as opposed to all antennas off, on weak signals	SUB 1: LED 337.5 indicates only antenna 1 is on SUB 2: LED 315 indicates only antenna 2 is on SUB 3: LED 292.5 indicates only antenna 3 is on SUB 4: LED 270 indicates only antenna 4 is on SUB 5: Resume normal operation ***(default setting)*** SUB 0: All off **NOTE: ENTER MAKES ALL SELECTIONS EFFECTIVE**
Menu 0 **Auto Calibrate to Zero**: Used to set the FRONT of the antenna orientation to zero (0) of the DFjr display. Decrement Bearing: Increment Bearing **Inver**t: will cause the phase shift and display to invert. Used to make the display track in the correct rotation direction. **Raw/Statistic Mode** (toggle): determines whether the DFjr display raw data or does STATISTICAL averaging of the received signal to determine direction better before displaying the direction.	Pressing the buttons: MENU, SUB, and ENTER simultaneously. Sub (-) Enter (+) Press MENU and ENTER simultaneously Press MENU and SUB simultaneously to toggle between the two modes. Break in tone every couple seconds indicates the STATISTIC mode.

Menu Select:	Press MENU key the number of times to select the Desired Menu. LED's increment **clockwise** to indicate MENU selection 0 LED = Menu 0.
Sub-menu Select:	After menu is selected, press SUB the number of times to select the desired sub-menu. LED's decrement **counter clockwise** to indicate **SUB**.

NOTE: Do NOT press ENTER while in MENU 0, enter is automatic upon selection.

Figure 27

The bottom segment of the DFjr control has five (5) inputs (Figure 27). This is where connections are made to the DFjr antenna and computer or the Agrelo Multi Port Adapter (MPA). The MPA will allow the DFjr to share data with other devices.

From left to right the connections are:

RS232:	This is the communication port to pass data to the PC and receive data from a GPS via the Multi-Port Adapter. This connector accepts the RJ-11 style connector From the DFjr antenna
Antenna :	RJ-11 connector of cable from the DFjr antenna.
Audio/Out :	This 2.5 mm/mono jack will pass through the 8 Ohm incoming audio of the DFjr Control to any 8 ohm impedance external speaker:
DC 13.8 Input:	This requires a 1.2/5.0-mm plug. Center pin is positive. Sleeve (outer shell) is ground. **POLARITY MUST BE OBSERVED OR DAMMAGE WILL RESULT.** The 13.8 power source should have a 1/4 amp fast blow fuse.
Audio/In :	This is a 2.5 mm/mono jack 8-Ohm for audio in from the Audio OUT of a ham radio source.

WARNING !!!!!!

DO NOT TRANSMIT INTO THE ANTENNA SWITCHING UNIT. DAMAGE WILL RESULT!

Do Not Have the Ham Radio ON when you connect the radio to the DFjr Control Head.

On some radio models, installing the external speaker may cause a short RF transmission through the Antenna Switching Unit. This will damage the Antenna Switching Unit and will not be covered under the normal warranty.

If you are having problems with the DFjr or think you may have possibly transmitted through the DFjr antenna, you may wish to place it on a scope. The proper signal on a scope will look similar to the figure 28 below. This is a waveform similar to what you would see with the antenna in reference to ground. If the waveform is flat or close to it, there is damage to the circuit.

If there is damage to the circuit at the antenna. The antenna harness will need to be removed and returned to Agrelo Engineering for repair

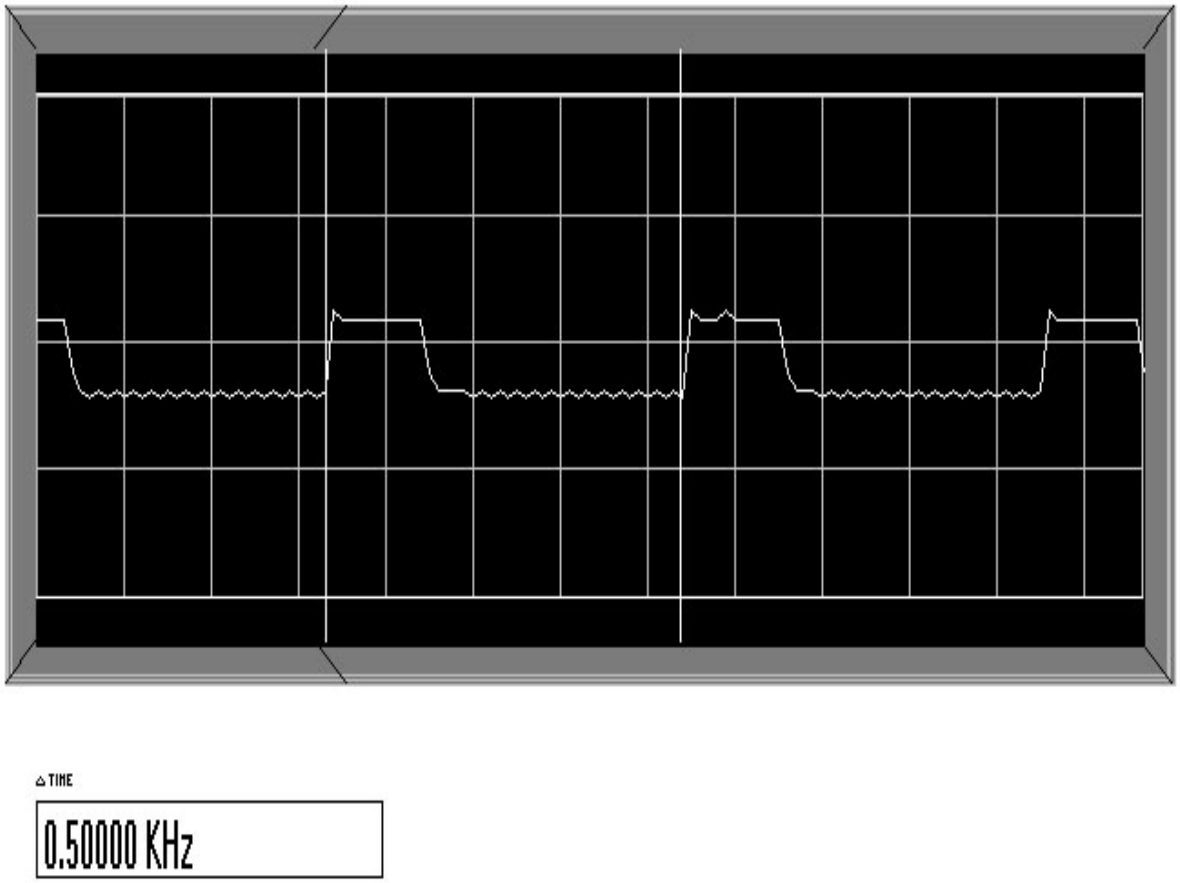


Figure 28 DFjr antenna amplifiers on a oscilloscope

Calibration:

Now that the DFjr is properly connected to the receiver, antenna, and power supply, it's time to calibrate it. Locate a known signal such as a repeater, beacon, or local National Weather Service transmission. Park in a nearby open field or parking lot so you can actually see the repeater tower or signal source. With the signal source in front of the vehicle, the DFjr display should be calibrated to read 0 degrees during a transmission from the source.

Calibration should be conducted at least ¼ mile from a repeater tower or signal source. If a repeater source is not available, then park in an open field and have a friend transmit while walking in a 360 degree circle around the vehicle. The less objects surrounding the vehicle, the better your results will be.

If you're in STATISTICAL mode and want to change the calibrate increment, the calibrate increment will not show up in real time because it is doing STATISTICS. It will figure out the increment value later.

When to invert:

During calibration, turn the vehicle 90 degrees to the left or counter clockwise. The display should read 90 degrees. If the display reads 270 degrees, use the invert feature (see Keys & Functions) to show the correct 90 degrees. If calibrating with an HT, while a friend walks clockwise around the vehicle, the display should follow in the same manner. If the display rotates in the opposite direction, use the invert feature.

Changing Antenna Receive Bands:

The DFjr antenna array has three sets of holes, three holes on each arm. The holes furthest away from the center are for the 121-174 MHz band, the middle holes are for 172-285 MHz range, and the holes closest to the middle are for the 350-550 MHz range.

The DFjr antenna whips are easily changed to operate on different bands, but do not mount more than one set of whips on a DFjr antenna assembly.

Although we have had reports of people getting excellent results DFing a 224 MHz signal with the 121-174 MHz antennas and 6 meters with the 121-174 MHz antennas (on strong signals only).

APRS (Automatic Position Reporting System)

APRS is a very powerful personal computer program for MAC's and PC's that allows input from a doppler DF unit. With nothing more than a computer and the DFjr, you can display bearing lines across a computer generated map of your area. With your known or approximate latitude and longitude, you can manually plot on the computer as you move.

APRS software and information can be obtained at the following locations on the Internet:

ftp://ftp.tapr.org/tapr/SIG/aprssig/files/winstuff/WinAPRS/
ftp://ftp.tapr.org/tapr/SIG/aprssig/files/macstuff/MacAPRS/
ftp://ftp.tapr.org/tapr/SIG/aprssig/files/dosstuff/APRSdos/
ftp://aprs.rutgers.edu/pub/hamradio/aprs

The Agrelo DFjr and Multi Port Adapter (MPA) can be used in combination with a computer and the APRS software to display the direction of the DF'ed signal on a map. Adding the DFjr in combination of a mobile APRS station or tracker can allow you or other APRS users to see the signals received by the DFjr. This will allow faster triangulation on a signal source.

If you wish to retransmit the information you receive from the DFjr to others over the packet data capable radio, the system begins to get a bit more involved. To retransmit this information, you will also need a Terminal Node Controller (TNC) and a second radio to transmit the signal, and a separate antenna for the frequency you wish to transmit on. Get the APRS part of the station operating first. You will use it to transmit the data from the MPA.

Make sure to keep the antenna used to transmit via APRS as far away from the DFjr antenna as possible. This is very important! DO NOT Transmit through the DFjr antenna. The MPA will be connected via DB-9 connector and cables BETWEEN the TNC and the computer. You will need to connect the DFjr RS-232 out to the RS-232 connector of the MPA (Multi Port Adapter). The MPA is clearly marked for the proper connections. Connect the TNC to the MPA. If you have a GPS, the signal from it can be sent to the computer via a connector on the MPA as well. Attach a cable from the GPS to the MPA using a 2.5mm Power type plug. Connect the audio cable from the DFjr to the DFjr receiver (***make sure it is not the APRS transmitter***). The MPA will also need 13.8 volts connected to it via the 1.3 mm power jack.

Figure 29

The DFjr is easily configured to allow WinAPRS and DOSAPRS to accept and retransmit signal directions calculated by the DFjr.

In WinAPRS you need to select the **S**ettings menu (Figure 29), then Serial Port from the pull down menu. The Serial Port Settings screen will look similar to Figure 29. You need to check the "ALLOW GPS" box. Then in the "RDF" box, set speed to 4800 and enter the correct serial port number that the DFjr/MPA is using in connecting to the computer. If you have a Global Position System (GPS) device connected to the MPA as well, you will need to select the port the GPS is connected to, and the speed the GPS is sending data at (usually 4800 baud). This will allow WinAPRS to see the GPS-DF-TNC data through one serial port (for mobile use only). If you have a second serial port, you could use it to connect one of the devices, just make sure the PORT setting reflects this correctly. The Data Bits, Stop Bits, and Parity are usually OK and there is no need to change them. Select "**OK**" to keep the changes and close the Serial Port screen. Then to activate the DFjr with WinAPRS, select the **S**ettings menu again and **OPEN RDF** port. If you wish to make WinAPRS connect the DFjr every time you run WinAPRS, select **S**ettings Menu, **APRS**, and then check the **GPS/NMEA** option on the **Automatic INPUT** box.

From the DFjr control panel, select MENU - 3, SUB - 1 , then ENTER. This will turn on the GPS port of the MPA.

Next, on the DFjr control panel, select MENU - 8, SUB - 0, and then ENTER. This will set the MPA to allow a GPS output rate to :05 seconds (this is how often the DFjr will allow the GPS data to be sent to the APRS program). You can change this setting as desired, but 5 seconds is a good place to start.

Unplug the TNC from the MPA and in WinAPRS select WINDOWS and TERMINAL WINDOW. In the opened window you should see the data stream from the MPA similar to:

%360/8
%358/8
%001/8
$GPRMC,164919,A,3743.39,N,09240.09,W,086.9,000.0,270696,002.3,E*63 (your position)
%360/8
%359/7

If you're not seeing data similar to this, something is wrong with the way data is leaving the GPS. Make sure the GPS is in NMEA - 0183 v 1.5 or greater mode. If you're using a Garmin GPS-20 board, there have been reports of having to make a modification to the data output line. If all is well, you can reconnect the TNC to the MPA and continue to calibrate the DFjr to a known transmitter. For the GPS to give the proper data to the DFjr, you should be moving at 10 miles per hour or greater for the RELATIVE/TRUE calculation to take affect. The RELATIVE/TRUE calculation is what gives the proper bearing info to APRS maps.

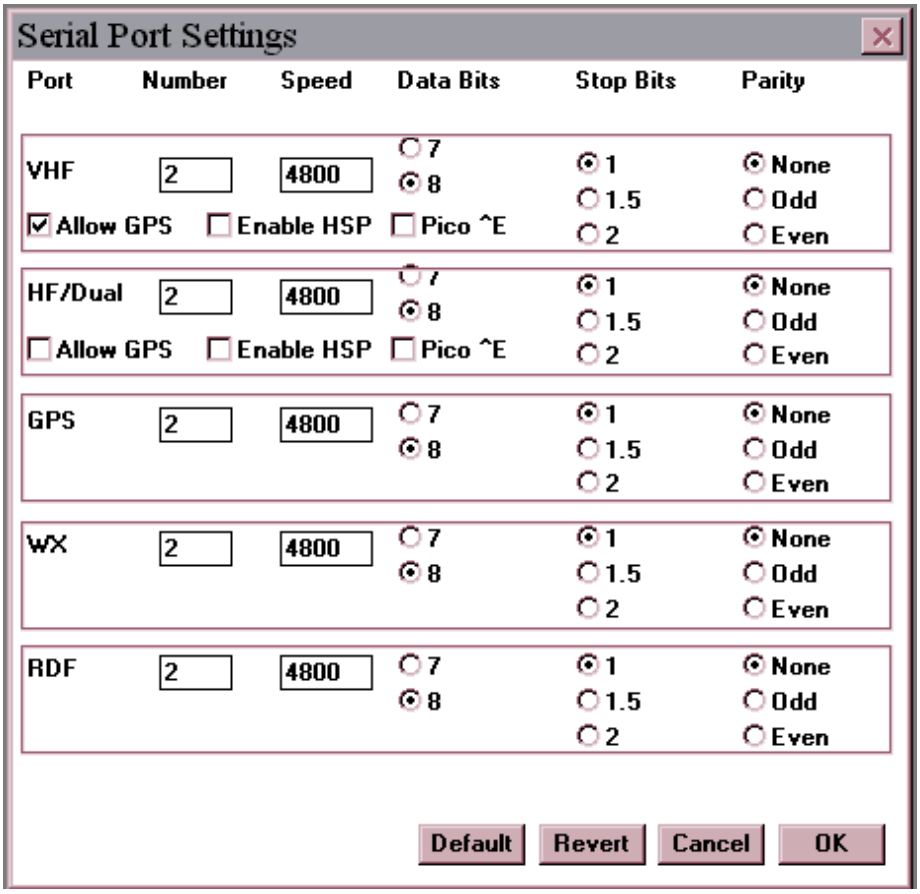


Figure 30

Using the DFjr with DOS APRS:

The DOS APRS program allows the Agrelo MPA to combine your TNC, DFjr and GPS data all to operate on the same PC COMM port. Using this adapter, configure DOS APRS for one port TNC operation (even if you are not using packet). Install DOS APRS per normal instructions. You will need to be a registered user of DOS APRS and have paid a validation fee to enable the DFjr and/or GPS functions of DOS APRS. Once the DOS APRS software is installed and configured for normal operation, then use **Alt**- **S**etup, **D**f menu to select the DFjr. This tells APRS to watch for DF data on the TNC Comm port. Then select the **Alt**-**S**etup, **G**ps, **M**ode, **S**PM mode menu so that APRS will also parse GPS data on the TNC port. When configuring these settings, you will be prompted to enter your validation number and select a APRSxxx.??? 3 letter file extension. This can be the default .APR extension or whatever you choose. Whenever you run DOSAPRS with your defined .APR extension, the features active when you saved the configuration will be active. Even if you normally run HSP mode with other TNC's, your HSP adapter is not being used. The DFjr is doing the switching so SPM mode should be selected. (If you have the dual port Pico-TNC, however, then you must select HSP.) The multi-port adapter normally passes TNC data straight through to the PC. But when the DFjr outputs a report, it sends out a POSIT followed by a DF report which are combined with the TNC data at the COMM port.

By pressing **O**ps, **C**omm, **D**F, you will be able to see the parse DFjr data being received on the serial port. It will look similar to: **%360/8**

If you have a GPS connected, active, and with a valid registration you will also see GPS data similar to that described above in the WinAPRS terminal window.

To send the DFjr position to the APRS software manually, turn OFF the GPS and DF ports, press MENU then ENTER on the DFjr control panel. This will over ride the port OFF settings and send your position to the computer, use this feature when you don't want to clutter up the screen with bearing lines and/or using a TNC. The screen will then display a line on the screen from your current position in the direction of the received signal.

When using a DFjr and APRS software without a GPS, APRS will orient "0" on the DFjr display as NORTH in relation to the maps. This is sometimes confusing and you will have to

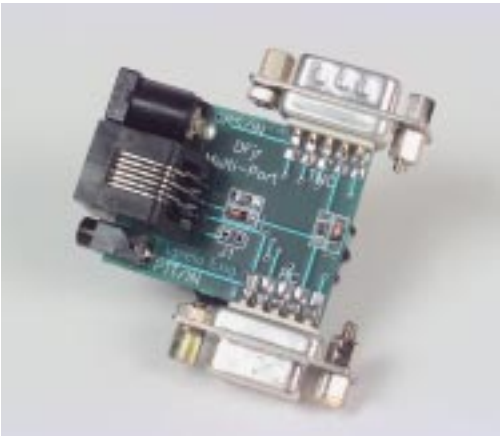
manually account for direction if you're travelling in any direction other than North. When including a GPS, APRS will account for the latest direction of travel indicated by the GPS. APRS will then display a line on the screen that would correlate to the correct direction of the signal source from your location. To better understand this, imagine you're traveling North with the DFjr and without a GPS, and your APRS screen says the source is at 360/North. If you turn to the West, the DFjr now points to the east which is in the opposite direction you are travelling. You will need to subtract 270 (which is the direction you're travelling) from the 360 (north) to get 90 which is the correct bearing for the signal. Using a GPS with the DFjr, the APRS software will handle these calculations for you and display the proper bearing for the signal.

If you are working with two DFjr's and APRS software on the same radio frequency, each APRS station will send it's received DF'ed signal indicator over the outgoing radio frequency. The second station will receive your signal and see your location on their map as well as the indicated direction of the signal you received. You will receive a similar signal from them, if they are transmitting, as well. When the two signals are displayed, both systems would see the received signals as a line from their location toward the direction of , and passing through the signal source location. Then source of the signal will be in the approximate location where the two lines converge and cross. This is known as triangulation. With consistent signal lines crossing in the same area, that would be the best area to concentrate to find source. The more signals the source sends, the more accurate the triangulation pattern should be.

But remember, you do not need a computer, GPS, or even an MPA for the DFjr to work effectively in finding signal locations. The DFjr was not designed solely for the purpose to use with APRS software. The DFjr outputs it's information via REAL RS-232 format. It's then up to software developers to write interfaces and support.

DFjr Accessories

DFjr Multiport Adapter



DFjr multi-port adapter (MPA):

The Multi-Port Adapter (MPA) (Figure 31) allows the connection of the DFjr, GPS, TNC, and PC/APRS to all run on one computer serial port. The data coming from the DFjr using the MPA & GPS looks like the following:

$GPRMC, 94616, A, 4306.37, N, 07448.67, W,000.0, 360.0, 010396, 013.9W*73 %279/8

First the GPS information gives your position, then the bearing and quality factor from that position. Also a TNC (Terminal Node Controller) can be plugged in for transmitting and receiving information using APRS.

Additional whip antennas for other bands:

2 Meter set
220 MHz set
440 MHz set

Figure 32 Assembled DFjr Antenna

Specifications and Features:

Output Format:	RS-232 compatible with APRS software
Output Baud Rates:	1200, 2400, 4800, 9600, 19,200 BPS
Sample Rate:	32 per second
GPS NMEA input String:	$GPMRC, $GPGGA & $GPVTG
Quality Thresholds:	0 (poor) to 8 (very high)
Resolution:	+/- 1.40625 degree (Statistic Mode Only)
Operating Temperature:	0 to +50 C (main unit) -20 to +85 C (antenna unit)
Display Type:	Bright LED
Supply Voltage:	13.8 VDC
Current Drain:	100 milliamps @ 13.8 VDC
Weight (main unit)	3.3 ounces
Frequency Range:	100 MHz - 1.0 GHz
Antenna Gain:	8.2 dB @ 100 MHz 8.2 dB @ 500 MHz 8.0 dB @ 1.0 GHz
Antenna Amplifier Noise	7.0 dB typical
Antenna Unit Frequency Ranges:	100 – 700 MHz, 700-1000MHz oprtional
Size: Main	2.78” (W), 4.60” (H), 0.90” (D) Antenna 20” x 20”, height varies with whip antenna length used

Modular Jack Pinout:

Looking from back of DFjr. Left to right.

Antenna

1-ANT1
2-ANT2
3-ANT3
4-ANT4
5-GROUND
6- +5V

RS-232

1-DTR (Future Enhancement)
2-GROUND
3- +5v @ 800mA (Extra power for external devices)
4-TX (Data Out)
5-GPS IN
6-PTT IN (5 Volts DC MAX)

RS-232 Data Formats:

The DFjr can output data in two different formats.

1. RAW bearing mode. Where A-@ represents the 16 LED's on the DFjr. 22.5 degree resolution max.

Example of format for data sent via RS-232 port:

AAAAAAAAABBBBBBBBBB@@@@@BBAAA

A=0
B=22.5
C=45
D=67.5
E=90
F=112.5
G=135
H=157.5
I=180
J=202.5
K=225
L=247.5
M=270
N=292.5
O=315
@=337.5

2. Statistic bearing Mode. 1.40625 degree resolution max. compatible with APRS.

Example:

%360/8
%359/8
%350/7

%= Symbolizes the DFjr
360= The averaged bearing
/8= The quality factor

Packing List -

Quantity:	Description:
1	DFjr Main Unit
1	Antenna “X” Arms
1	Antenna Switch Unit with 4 x 3” magnets
1	3/8” – 16 x 3/4" Bolt and 3/8” Washer Assembly
4	Whip Antennas
4	Antenna Whip Cones
4	Whip set screws
8	White nylon spacers
1	Audio Cable, 3/32” submini to 3/32” mini connectors
1	RJ-11 Data Cable
1	Package Tie-Wraps
1	Power Cable
1	Rubber Bolt Pad
1	Quick Menu Reference card
1	Operators Manual

DFjr Antenna Assembly
Parts List:

Item Number	Quantity	Part Number	Description
1	4	2005-01	Whip 146 MHz. (18”)
1	4	2005-02	Whip 224 MHz. (10 ¾”)
1	4	2005-03	Whip 440 MHz. (4 ¾”)
2	4	2003	Antenna Whip Stud Assembly Kit
3	8	DN212-347-18	Shoulder Washer
4	4	2009	3” Magnet
5	4	MM-91246A624	3/8-24x1” Bolt
6	1	MM-92198A622	3/8-16x3/4” Bolt
7	1	MM-98449A031	3/8” Lock Washer
8	2	1/8 x ½ Long TYPH	Groove Pin
9	2	RD-2002	Antenna Arm
10	1	RD-2009	Enclosure Assembly

Connector Sizes for DFjr and MPA (Multi-Port Adapter)

Description	Mouser Part Number	Mating Plug OD (mm)		Center Pin D(mm)	L(mm)
DFjr Power jack	161-201	1.3 mm	3.4	1.2	5.0
DFjr audio jack	161-2501	2.5 mm/ mono	N/A	N/A	N/A
MPA GPS jack	16PJ0312	2.1 mm/ Power	5.5	2.0	9.0
MPA PTT jack	161-2501	2.5 mm/ mono	N/A	N/A	N/A

Mouser Electronics (800) 346-6873

Symptoms and Solutions:

Check the following:

Unit Fails to power up:	1. Verify power is available at the source with a volt- meter or another accessory. 2. Check user supplied inline fuse.
Unit Fails to display bearing:	1. Verify radio is turned OFF during connections 2. Verify power is available. 3. Verify all cables are connected. 4. Verify DF radio is on. 5. Verify DF radio audio is loud enough for DFjr to process.
No audio from external speaker:	1. Verify DF radio is on. 2. Verify audio is loud enough to hear. 3. Verify the audio is routed to the DFjr. 4. Verify the external speaker is connected to the DFjr.
No switching tone is heard in the external speaker:	1. Verify the DFjr is on. 2. Verify the DFjr is in proper mode of operation. 3. Verify the DF radio is on and audio is routed to DFjr. 4. Verify antenna unit RF line is connected to DF radio. 5. Verify whips are installed in antenna unit. 6. Verify command cable is installed and connected.
Bearing to transmitter is not accurate:	1. Verify DF radio is tuned to proper transmitter. 2. Verify DF radio is on. 3. Verify DF radio volume is correct. 4. Verify antenna unit is connected to DFjr. 5. Verify antenna unit is oriented correctly. 6. Verify zeroing is correct. 7. Verify the antenna unit is not receiving a reflection. 8. Verify no other antennas near DFjr antenna are the cause.
Display bearings bounce all over the place during calibration:	1. Verify that each antenna stud assembly is properly constructed. 2. Verify there isn't a short between antenna and ground. 3. Verify the antenna unit is placed on a metal ground plane of at least 20"x20". 4. Verify the antenna modular cable is properly plugged in the correct jack. 5. Verify that the antenna modular cable isn't pinched between the vehicle door or window.

DF*jr.* ***FAQ***

Questions and Answers

Q. Is there a button test feature?

A. Yes, MENU-10, ENTER, when the clockwise LED rotation starts, press and hold any of the three buttons, the LED's should stop incrementing if the button is working properly, release and the rotation should resume.

Q. Which way is front on the antenna array?

A. It doesn't matter because the Dfjr has full 360 degree calibrating capability. However the antenna placed on the vehicle, "front" can be set when the antenna is calibrated.

Q. Is their any way to adjust the audio to LED balance?

A. Yes, inside the main control head there is one potentiometer R25, adjust it for the desired audio input level that makes the HI LED active.

Q. Can I transmit through the antenna array?

A. No, transmitting through the antenna will damage the switching amplifiers and possibly cause damage to the microprocessor. Also, when connecting the antenna to the radio, make sure the radio is off, some radios will transmit briefly when the radio is on and the antenna is connected.

Q. How do I know if I accidentally transmitted through the antenna?

A. You will notice sporadic readings.

Q. What is the best way to avoid accidental transmit through the antenna?

A. Some HT's (Handy Talkies) have a disable transmit feature that can help. The best way is, disconnect the coax to the radio before turning it on, and then connect the coax afterwards.

Q. Is there any way to test the antenna switching circuit for damage?

A. If you have access to an oscilloscope, reference ground then probe at the center conductor of each antenna where the coax leaves the antenna switching enclosure. Test for a nice square wave, if the wave seems flat, then there is damage. (**damage caused by transmit is not covered under the 1 year parts and labor manufacturers warrantee**).

Q. Is the antenna waterproof?

A. It is weather proof but, not submersible. You shouldn't have many problems in average weather. Some RTV silicone can be spread around the coax where it enters inside the enclosure if harsh weather is to be endured. Do not use anything that has conductive properties like epoxy.

Q. Why won't the buttons work on occasion?

A. Pressing the buttons too hard can cause the button next to it to be activated at the same time. The buttons do not require much pressure. You can familiarize yourself with how the buttons work by using the MENU-10 feature, while the LED's are rotating clockwise, press and hold any of the three buttons, if the button is working properly then the rotation will stop until the button is released, then the rotation will resume.

Q. Can I track a signal on the 6 meter band?

A. You can track a 6 meter signal with the 2 meter whips and spacing as long as the signal is strong, this is possible through the DFjr's superior filtering and wide band antenna switching design.

Q. I have everything hooked correctly and powered correctly but the DFjr doesn't always display a bearing that is heard transmitted, What's wrong?

A. The DFjr is working correctly, but is not receiving a strong enough signal to correctly calibrate the bearing. Check to see that the radio is on and that the audio (Volume) out of the radio is loud enough. The audio level should be set such that the LOW indicator light is on when no signal is present and the HI indicator is on when a signal is received. If the HI indicator stays on when there is no signal, the audio out (Volume) of the radio is to high or SQL is not correct. The HI indicator should flicker slightly during receive.

Q. Why can I hear the signal being received by the DFjr, but it takes several seconds for the DFjr to display a bearing?

A. If you're in STATISTICAL mode, the unit is waiting for more information (signals) to do STATS on. When it realizes that it has all the data it's going to get, it will split out what it has and display a bearing.

Q. Why won't the DFjr display a bearing from a short signal or kerchunk?

A. You're in STATISTICAL mode and the quality factor threshold is too high. Lower the quality factor threshold of STATISICAL mode or go into the RAW mode.

Q. What is the PTT connector for or how is it to be connected/ used?

A. The PTT sense feature is an INPUT from your packet radio's PTT line. If you are DFing with a separate packet transceiver for APRS, you don't want to desensitize yourself or the DF receiver.

Q. Is there a known range that the DFjr can operate or is?

A. There is no way to determine exactly what the receiving range of the DFjr antenna is because of the characteristics of RF transmissions. Also, doppler antenna users have long been aware that some desensitizing of doppler antennas occurs caused by the antennas being turned on and off at such a rapid rate, 500 Hz.

Q. I noticed the signal I hear through the DFjr's antenna is substantially weaker than hearing the same signal through a HT with a rubber duck, why?

A. It is not out of the ordinary to have a weaker signal through the doppler antenna array. The array will desensitize the signal during switching between individual whips in the array. To compensate for this effect, we use 8db amplifiers to do the switching.

Q. Is it possible to add an amplifier to the signal?

A. Yes.

Q. Can I use a scanner with the DFjr instead of a radio?

A. A scanner will work with the DFjr, but typically scanners are not the best receivers because of being so broad-banded they are not recommended for use in doppler systems.

Q. There is a TONE whenever the DFjr receives a signal. It only goes away when I press the MENU button, why?

A. The "TONE" should always be there when you receive a signal (squelch opens). The "TONE" should only go away when either nothing is received or when you leave the MENU-0 setting to go into another MENU function. Hearing the tone is a good thing, it lets you know everything is working properly.

Q. Why do I sometimes hear a single smooth tone and other times hear a double tone (not smooth)?

A. You should normally hear a single smooth tone on receiving a signal. A double tone indicates the DFjr is receiving multi-path.

Q. I am receiving a signal from a known direction. Why does the display bounce around so much and only show the actual direction about a third of the time?

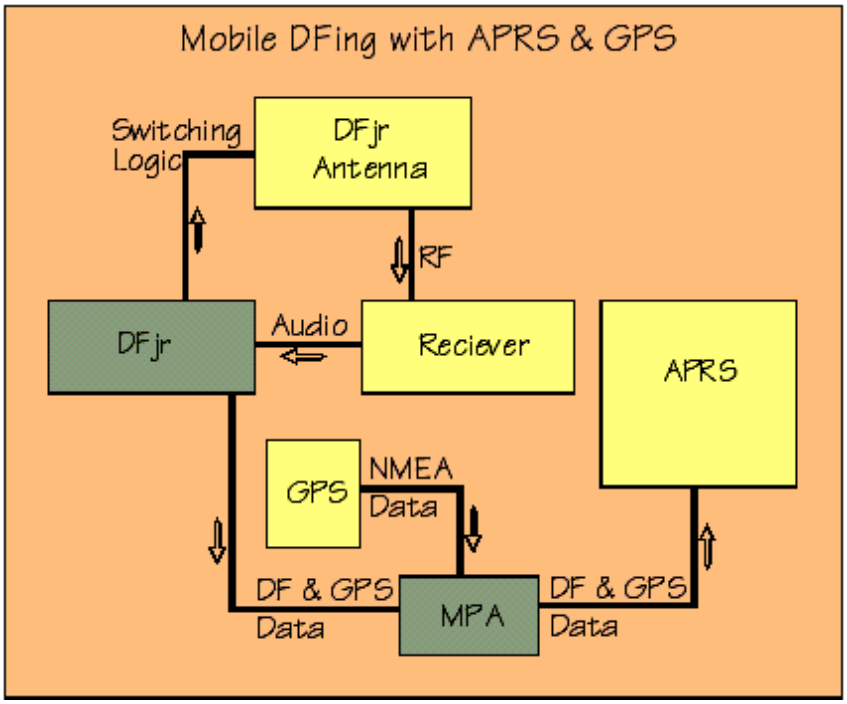
A. The DFjr has two modes, RAW and Statistical. Statistical mode should be used in areas of heavy multipath. RAW mode is just that, raw doppler information. If you're DFing in RAW mode in an area of multi-path, the signal will bounce from the various received signal. Switching to Statistical will average the signal and show the strong signal. If your DFjr display is still bouncing around, you may need to set the quality factor higher. A quality factor threshold of "7" will only display a signal with a quality factor of "8" or better. But this may still occur if the reflected signals are strong enough. If the DFjr sees too many reflections, it won't display anything at all.

Q. If the DFjr is normally in MENU 0 mode, why does the first light to either side of the 0 light come on when I press the function button the first time?

A. When you're DFing, you're in menu "0" mode. When you press the MENU key, you are telling the DFjr that you would like to go to the next MENU function. The next MENU function is 1, so the 1, or first light clock-wise from "0" will come on. You wouldn't want to leave MENU-0 to go to MENU-0. Pressing MENU once will light MENU function 2, pressing again will light MENU-3 function and so forth. Continuing to press the MENU button will have the indicator light continue through all functions available and then the display will jump back to MENU-0 again. This can repeat until you stop at your desired MENU option.

If you then press SUB, the first light counter clock-wise will come on indicating the first SUB -menu function. Pressing SUB again will continue the pattern in similar pattern to the MENU except the display will move in a counter clock-wise pattern till the SUB-0 option is reached.

Basic block diagram of mobile DF station using APRS and GPS



Warranty: 1 year parts and labor against manufacturer deffects.