

USER'S GUIDE



# **DDF7011 AND DDF7012 USERS MANUAL**



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## WARRANTY INFORMATION

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Doppler Systems will repair or replace, at their option, any parts found to be defective in either materials or workmanship for a period of one year from the date of shipping. Defective parts must be returned for replacement. In the US, contact the factory, or overseas your local distributor, for advice about returning any defective parts or equipment.

If a defective part or design error causes your radio direction finder to operate improperly during the one-year warranty period, Doppler Systems will service it free of charge if returned at owner's expense. If improper operation is due to an error on the part of the purchaser, there will be a repair charge.

Doppler Systems are not responsible for damage caused by the use of improper tools or solder, failure to follow the printed instructions, misuse or abuse, unauthorized modifications, misapplication of the unit, theft, fire or accidents. This warranty applies only to the equipment sold by Doppler Systems and does not cover incidental or consequential damages. Doppler Systems radio direction finding equipment is designed for locating interfering radio signals. It is not intended for use as a navigation aid, and in particular, it is not to be used for aircraft or marine navigation.



# Chapter 1

## INTRODUCTION

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The Doppler Systems DDF7011 and DDF7012 contain all the necessary components required to locate a radio frequency source. Both systems utilize the same core module shown in Figure 1 below.



*Figure 1: The DDF7011 and DDF7012 utilize the same Core Module*

The DDF701 I is primarily used as a fixed site system and consists of the following:

- ▶ A core module
- ▶ A fixed site direction finder antenna system (one to three bands)
- ▶ A fixed site radio modem antenna (optional)
- ▶ A GPS receiver
- ▶ A self-test generator (optional)
- ▶ Antenna cabling
- ▶ 12 V Power Supply
- ▶ A laptop computer (optional)
- ▶ Carrying cases for all the components

Figure 2 shows the block diagram of a typical DDF701 I three band configuration.

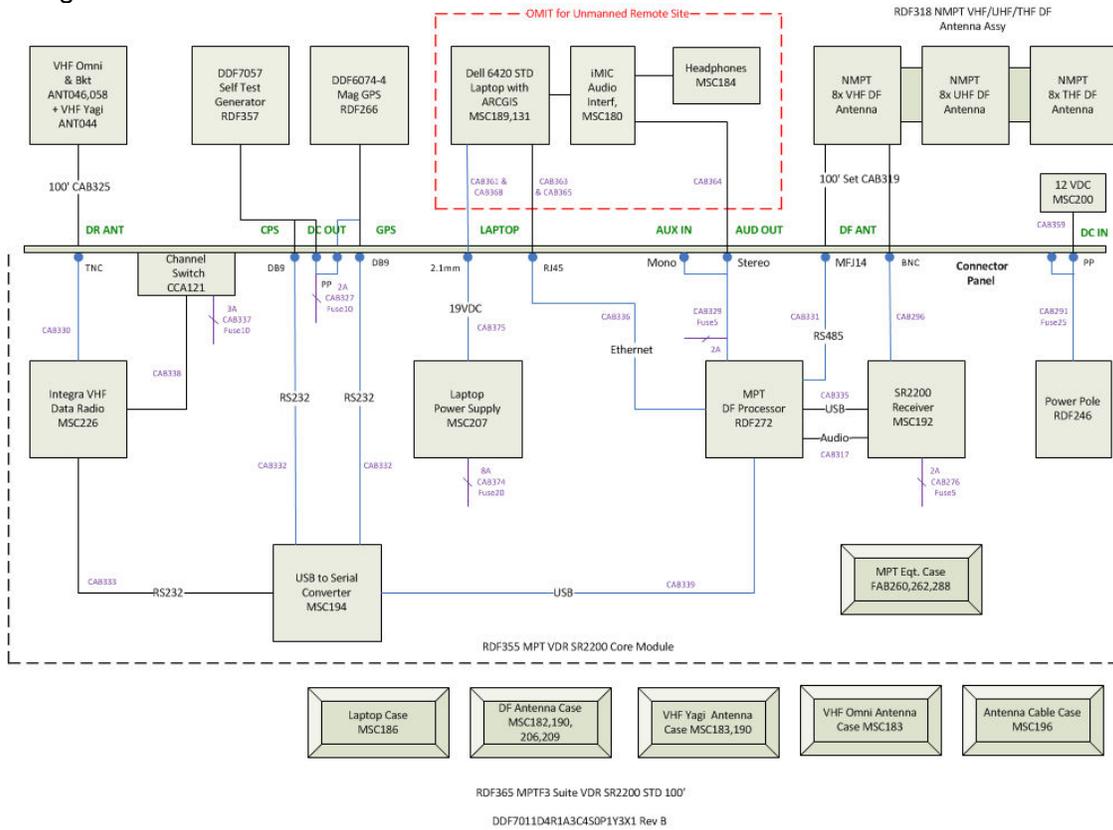


Figure 2: Block Diagram of Three Band Fixed Site Direction Finder (DDF701 I)

The DDF7012 is used in mobile systems and utilizes the same core module and contains the following components:

- ▶ A core module
- ▶ A mobile direction finding summer assembly
- ▶ Four 1/4 wave whip antennas
- ▶ A GPS receiver
- ▶ A radio modem antenna
- ▶ A compass (optional)
- ▶ A yaw rate sensor (optional)
- ▶ A laptop computer (optional)
- ▶ Antenna cabling
- ▶ Power cabling
- ▶ Carrying cases

Figure 3 depicts a typical DDF7012 configuration.

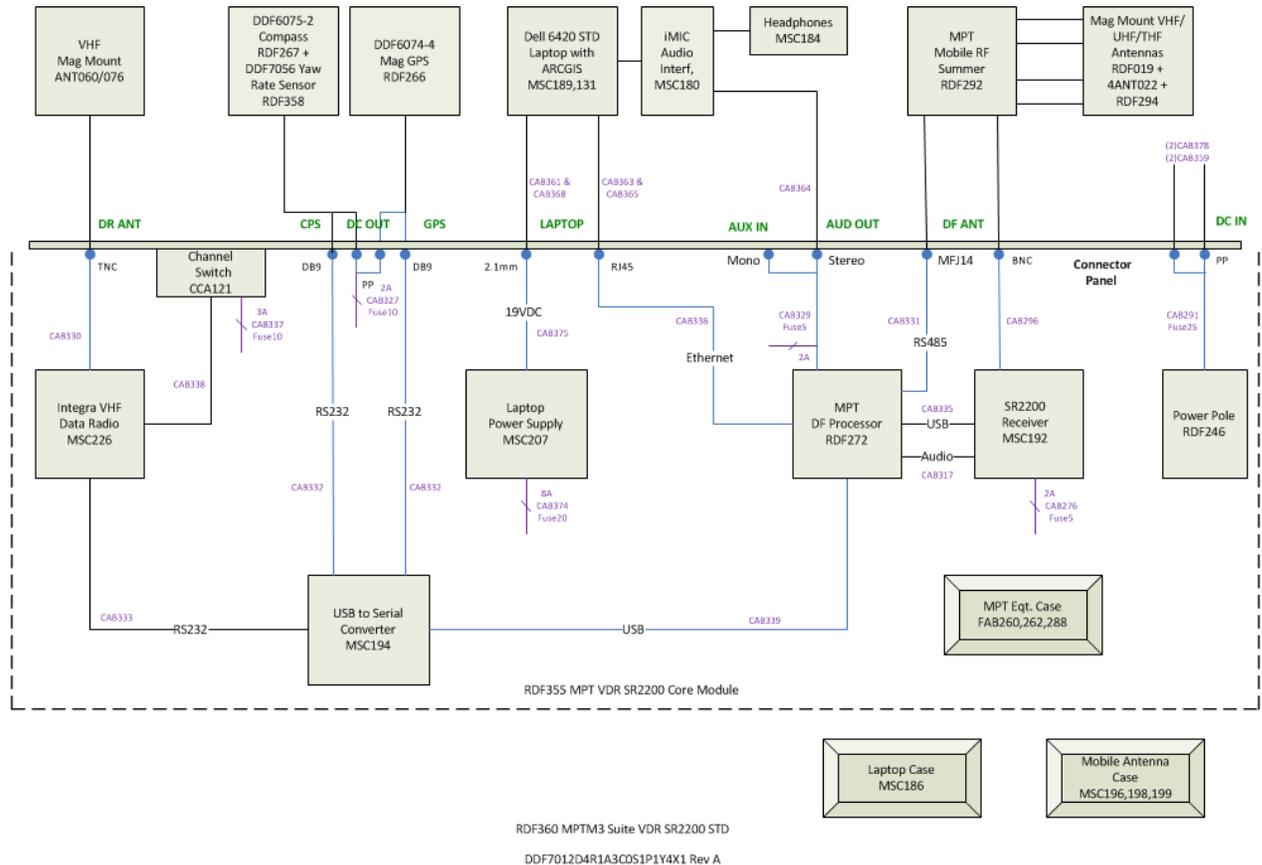


Figure 3: Mobile Direction Finder (DDF7012)

This manual will describe the installation and setup of the DDF7011 and DDF7012. For details on operating the system, see the TargetTrack 4 software user's manual and the MPT User Interface Software Guide.

# DDF7011 INSTALLATION AND SETUP

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## GETTING STARTED

As delivered the DDF7011 suite consists of the following

- ▶ One Pelican case containing the core module
- ▶ One Pelican cases containing cabling
- ▶ One case containing the fixed site antennas and connecting masts
- ▶ Two long cases containing data radio antennas (optional)
- ▶ One laptop computer case (optional)

### Initial Setup

- 1) Select locations for the radio modem and the direction finder antennas. Try to maintain as much separation between these two antennas as possible and make sure the cables will reach to the location of the direction finding equipment.
- 2) If this site is to be used as the control site remove the vertical radio modem antenna from one of the long antenna cases. If it is to be used as a remotely connected site, remove the radio modem yagi antenna from one of the long antenna cases.
- 3) Assemble the radio modem antenna
- 4) Connect the radio modem antenna to an antenna mast or tower.
- 5) Remove the coaxial cable with an N connector on one end and a TNC connector on the other and connect the N connector to the radio modem antenna.
- 6) Secure the cable to the mast in several places using zip ties
- 7) If the yagi antenna is being used, rotate the antenna to point the antenna at the control location.
- 8) Assemble the fixed site antenna using the hardware provided in the DF antenna case.
- 9) Connect one control cable and one coaxial cable to each antenna.
- 10) Use the mounting hardware to connect the direction finder antenna to the mast.
- 11) Use zip ties to secure the cables to the inter connecting antenna hardware and the mast

- 12) Open the core module case.
- 13) Connect the radio modem antenna to the TNC connector on the core module.
- 14) Connect each of the direction finder antenna and control cables
- 15) Remove the laptop computer from its case
- 16) Connect the laptop power cable from the connector panel to the laptop computer
- 17) Connect the Ethernet crossover cable between the laptop and the core module.
- 18) Connect the GPS receiver to the core module. Position the GPS receiver so it can easily acquire the GPS satellites.
- 19) Connect 12 V power to the unit using the supplied cable and power supply.
- 20) Apply power to the core module.
- 21) Check to make sure the direction finder and the receiver are powered
- 22) Turn on the laptop and start the MPT User Interface software.

## ANTENNA MOUNTING

For optimum results it is necessary to mount the fixed site antenna as high as possible above the average terrain. It is also required that the antenna be mounted at the top of any metallic structure (tower or mast) so that there is no metal in the antenna pattern. Do not mount the antenna near any transmitting antenna. Serious damage can occur if large rf fields are applied to the antenna. If you are using a radio modem, maintain maximum separation of the radio modem antenna from the direction finding antenna. Horizontal and vertical separation is best if possible. See <http://www.dopsys.com/appnotes/Interference.html> for more information.

## SINGLE BAND ANTENNA INSTALLATION

This section details the assembly of a single band fixed site antenna. The photographs are for a VHF antenna but all the antennas use identical mounting hardware.

### MOUNTING THE MAST TO THE ANTENNA

All of the antenna assemblies come with a bottom mast, one or more antenna frames, and antenna elements.

- ▶ At the base of the antenna frame there are a number of longer screws protruding from the bottom connector plate as shown in the photo below. Remove these screws.



Figure 4: : Remove the loose cap screws to install the lower mast

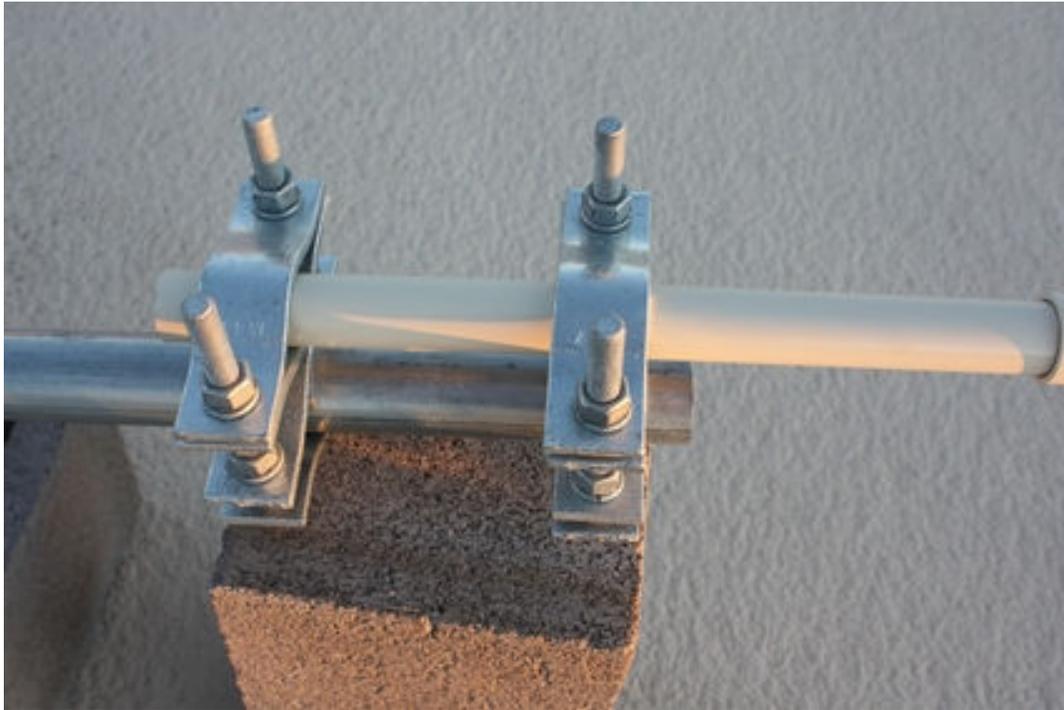
- ▶ Next position the bottom mast to fit over the connectors and drain plug and fasten the mast to the antenna frame using the screws from step 1. The figure below shows the mast connected to the frame.



*Figure 5: Secure the lower mast to the frame using the cap screws*

### ATTACHING THE BOTTOM MAST TO A YOUR MAST

The fixed site antennas are furnished with a mast clamp for installation on a pipe or pole. The diameter of the pipe or pole can be between 1.25 in. and 3.5 in. The figure below shows how the mast clamp is installed.



*Figure 6: Attach the lower mast to your mounting mast with the mast clamp*

## ATTACHING THE CABLES

Unroll the control and coax cables being careful not to damage the ferrites or to crimp the coax. Be careful to keep the connectors clean from dirt. Fasten the control cable by aligning the key and turning the outer locking ring until it just meets the red line on the mating connector. Fasten the TNC connector until it is tight. Use the supplied cable ties to fasten the cables to the masts.

At this point the assembly should look similar to the photo below.



*Figure 7: Cables connected to the VHF Antenna*

## ATTACHING THE ELEMENTS

### **Four Wire Biconical Antennas**

The antenna elements are mounted to baluns at the end of the frame arms using an o-ring, a 5/16-24 cap screw, and a lock washer. The arrangement of the hardware is shown in the photo below.

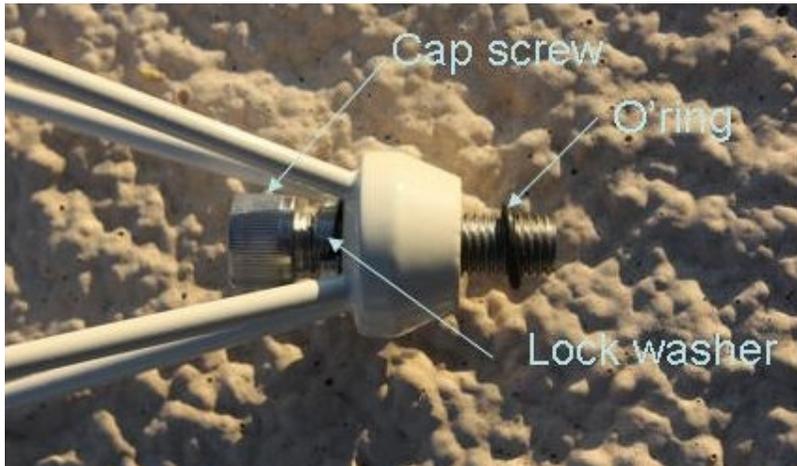


Figure 8: Arrangement of the antenna element mounting hardware

### Three Wire Biconical Elements

The antenna elements are mounted to baluns at the end of the frame arms using a 5/16-24 cap screw, a flat washer and a rubber washer. The arrangement of the hardware is shown in the photo below.

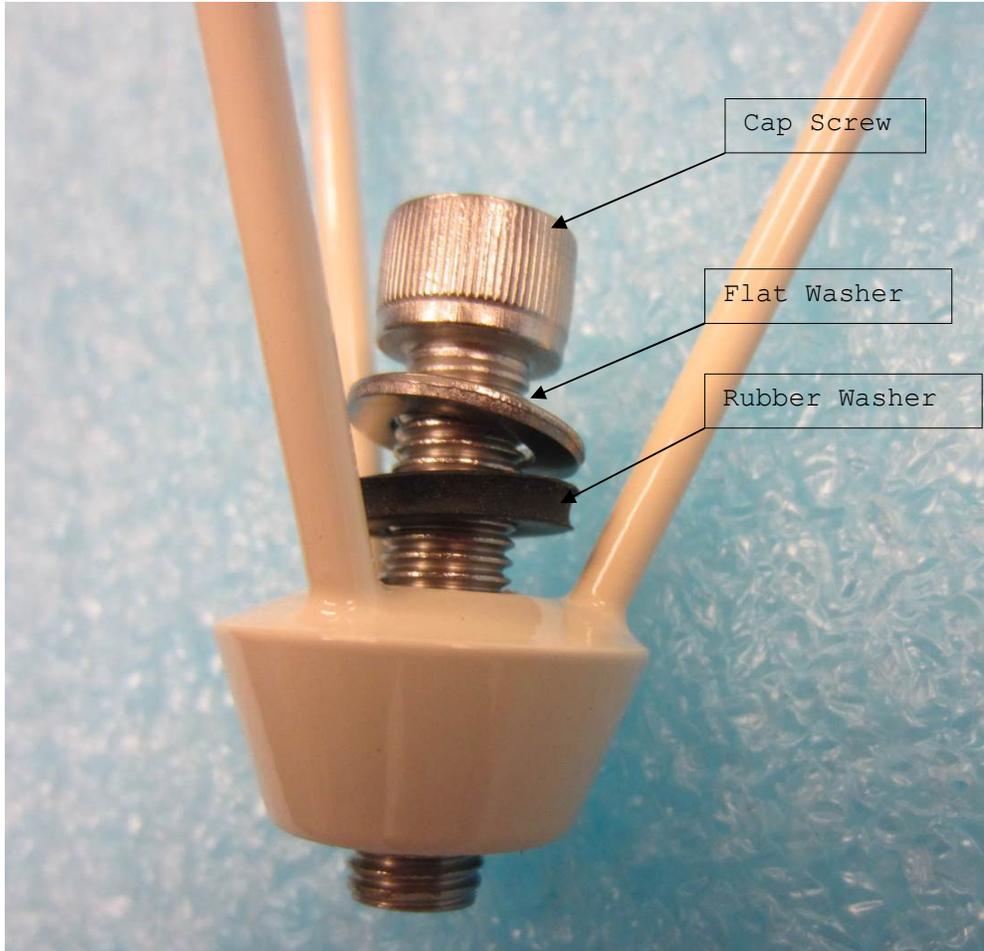


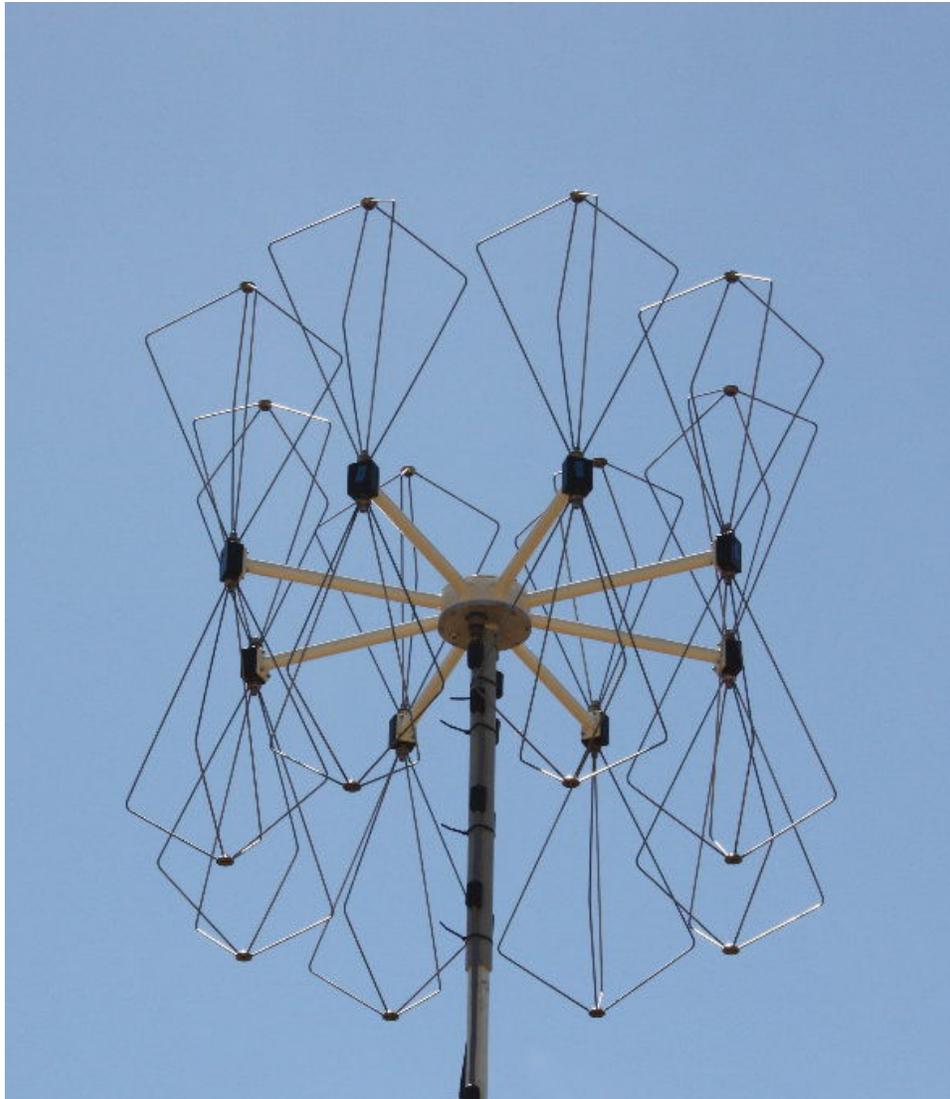
Figure 9: Three Wire Element Mounting Arrangement

Thread the cap screw into the balun being careful not to cross thread the screw. Tighten the cap screw until the lock washer is fully compressed. Do not over tighten the cap screw or the brass threads in the balun may be stripped. Mount all sixteen elements. Align the biconical elements so that all elements are symmetric. The photo below shows two elements connected to the balun.



*Figure 10: Antenna element mounted on the balun*

After all the elements are attached the antenna is ready to be erected. The assembled antenna will look like the photo below.



*Figure 11: Fully Assembled VHF Antenna*

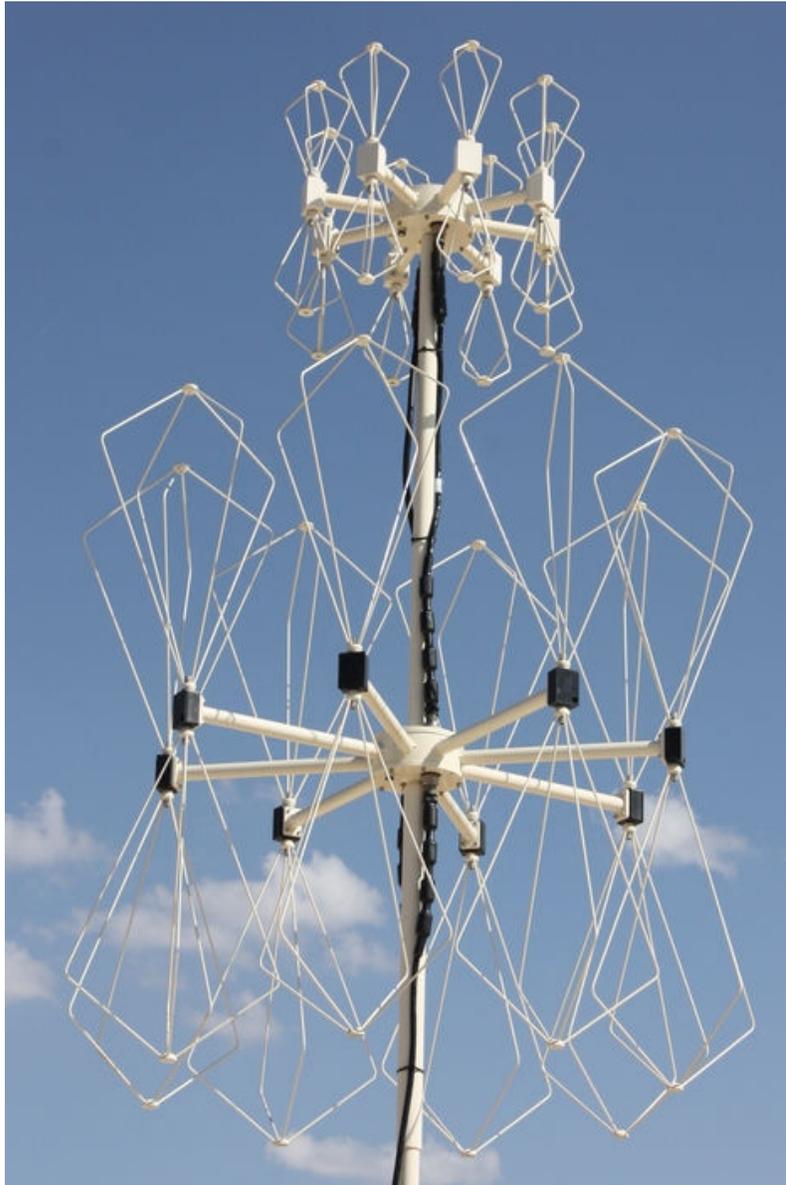
## TWO BAND ANTENNA INSTALLATION

To assemble the two band antenna perform the steps detailed above; however, before attaching the antenna elements install the connecting mast and cables. The connecting mast is installed similarly to the base mast. When installing the coaxial cable make sure the end of the cable with the most ferrite beads is connected to the lower antenna. The photo below shows the upper mast and the cables connected to the lower mast.



*Figure 12: Upper mast and cables installed for two antenna installation*

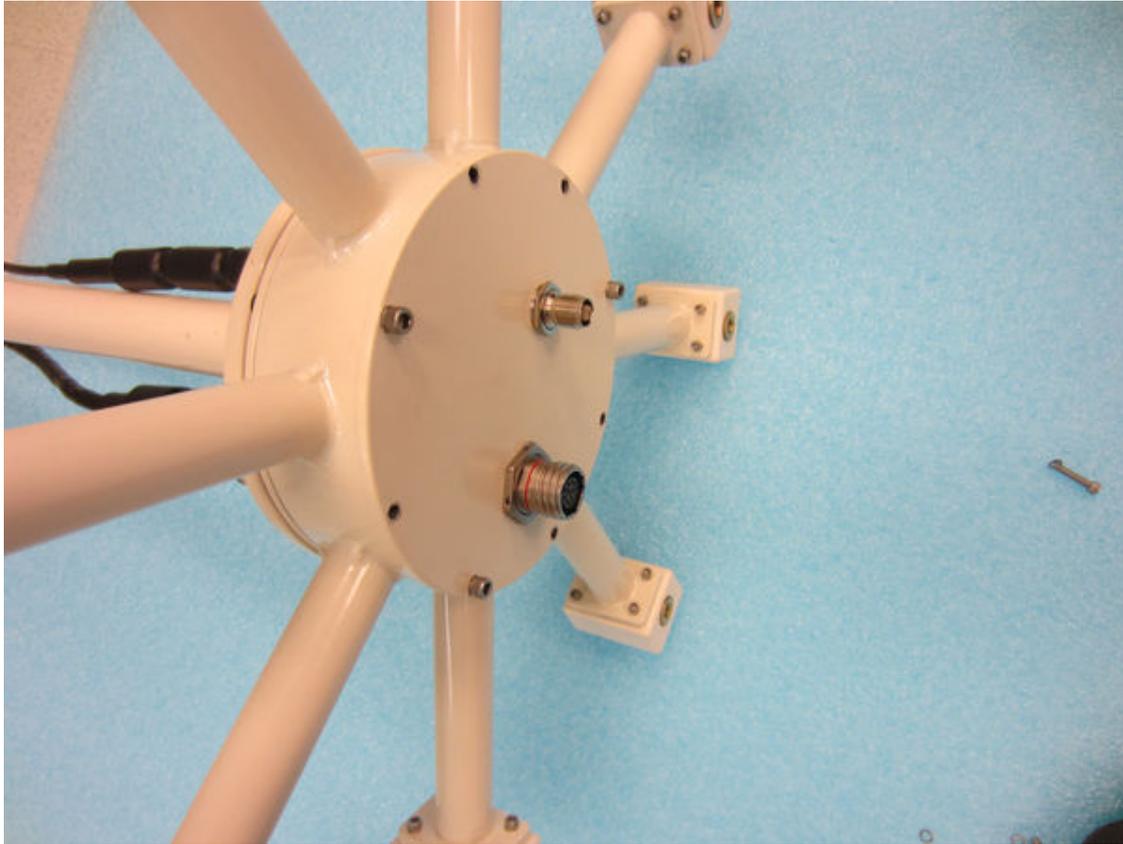
Next connect the UHF antenna frame to the upper mast and connect the cables and then install the antenna elements on all the frames. The completed antenna stack is shown below.



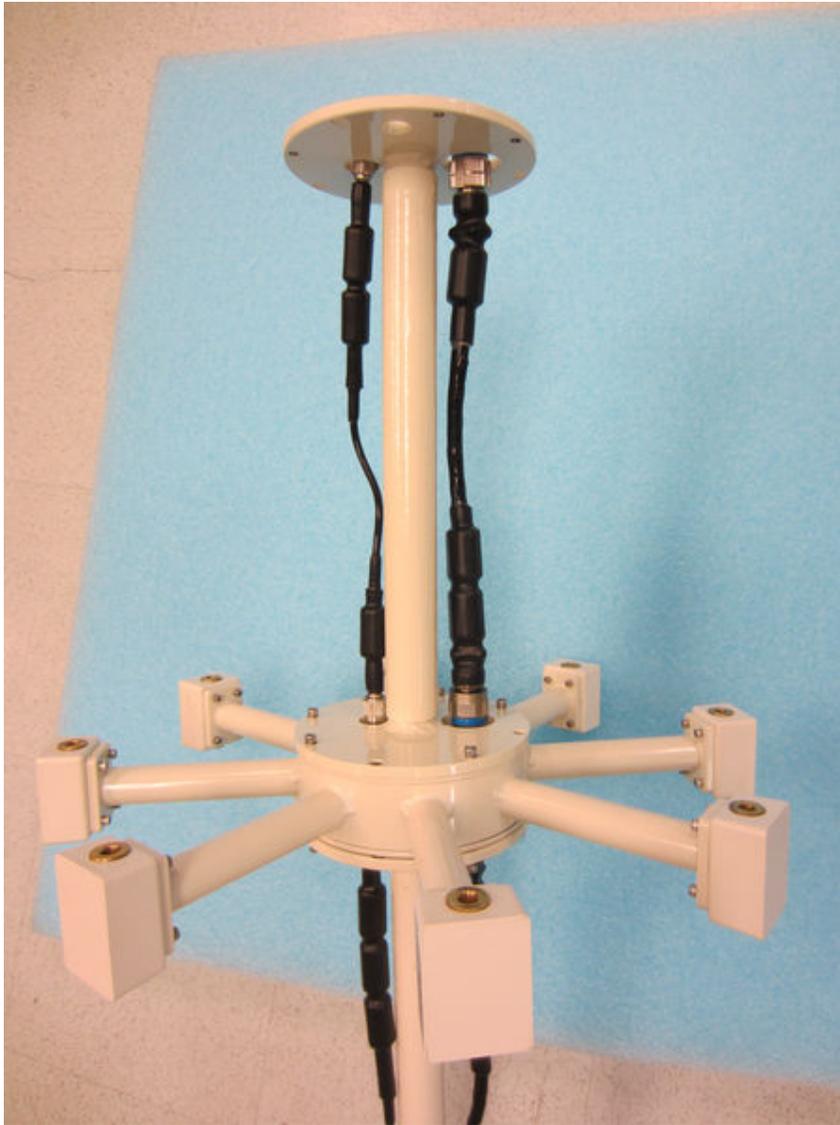
*Figure 13: Assembled UHF-VHF Antenna*

### THREE BAND ANTENNA INSTALLATION

Follow the steps above to install the three element antenna and simply install the third antenna using the short connecting mast supplied.



*Figure 14: UHF Antenna Frame Installed on Mast*



*Figure 15: TU Antenna Mast Installed*

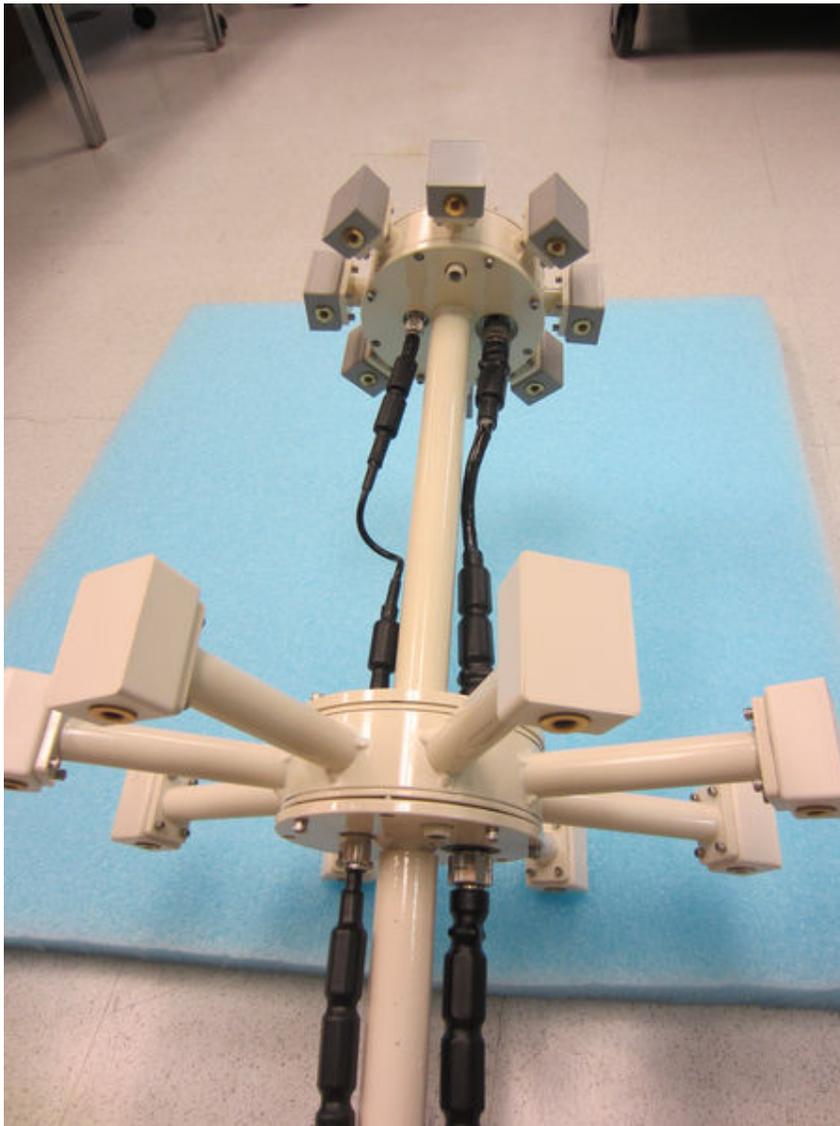


Figure 16: THF Antenna Frame Installed on Mast

There are two styles of THF elements. One style of elements mount similar to the other elements except that they have longer cap screws. The other style shown in Figure 16 below have a rubber washer installed to preload the elements and to keep moisture out of the threads. Do not over tighten the elements or you may strip the brass inserts in the balun.

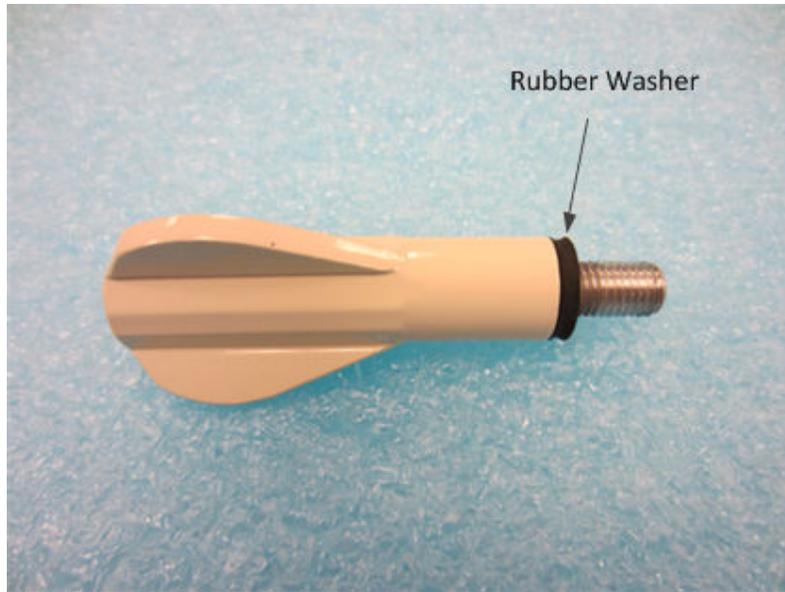
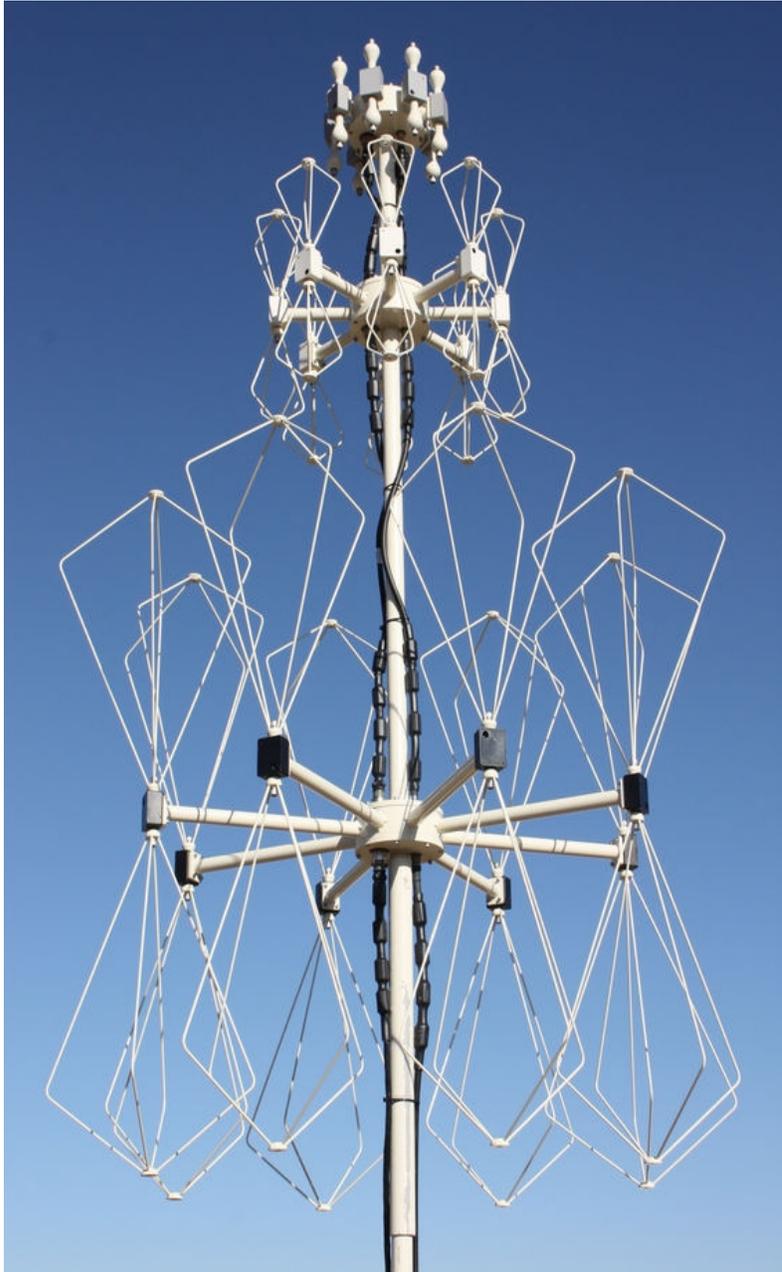


Figure 17: THF Antenna Mounting Hardware

The final assembly will look like the photo below.



*Figure 18: Assembled THF-UHF-VHF Antenna*



## CORE MODULE CONNECTIONS

Figure 19 below shows the front panel of the Core Module.



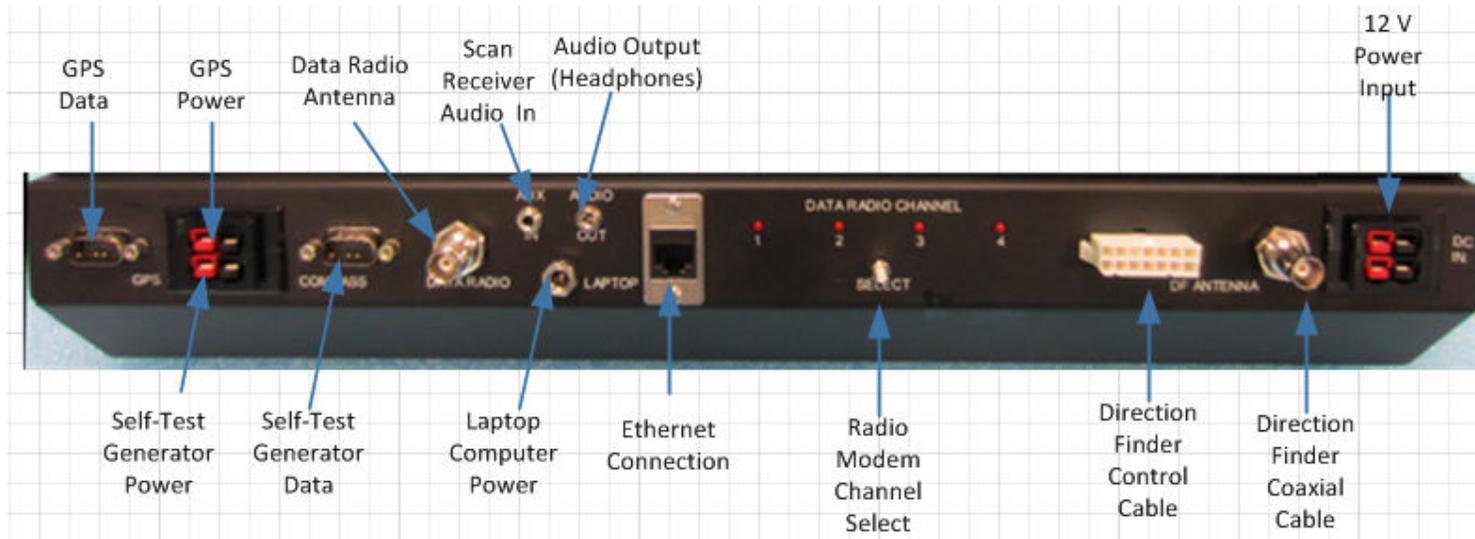


Figure 19: Fixed Site Core front panel connections



Three cables will come from outside into the location where the Core Module will be installed; the DF antenna coaxial cable, the DF antenna control cable, and the radio modem coaxial cable. Connect these cables to the proper connectors on the core module.

Connect the GPS and Self-Test generator cables. Position the GPS where it will receive signals from the GPS satellites. If this is not possible then do not connect the GPS receiver.

Connect the Self-Test Generator cables to the core module and the Self-Test Generator. Position the Self-Test Generator 20 - 250 feet from the direction finder antenna in an area where it is not exposed to the elements. Instructions on using the Self-Test Generator can be found in the MPT Software Users Guide.

If you are using an external scan receiver connect the external speaker output of the receiver to the AUX IN connector and connect the audio output connector to the line input of the computer using the 1/8 inch stereo cable supplied with the unit. If you purchased a computer with the DDF701 I, it will come furnished with an iMic (USB-to-Audio) converter that has a line input. If your computer does not have a line input and you are going to use an external scan receiver then you will need to purchase an audio interface.

The radio modem is used to communicate with other Doppler radio direction finders in the event that the other direction finders cannot be networked on an Ethernet (IP) network. Each radio modem has four preprogrammed channels. Set all the direction finders on the radio modem network to the same channel.

The Ethernet connection can be connected directly to the computer using a crossover cable or if being used remote it can be connected to a switch or hub using a standard Ethernet cable.

The unit is powered using 12 volts. The DDF701 I without a laptop draws requires 13 watts. If a laptop is connected to the laptop power supply the unit can draw up to 100 watts depending on the battery's level of charge.

Once all the connections are made, power up the unit and start the software.



## DDF7012 INSTALLATION AND SETUP

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### GETTING STARTED

**NOTE: Do not use a transmitter near the DF summing unit when antennas are attached to it. Transmitting near the summing unit may cause permanent damage to the summing unit. Damage can occur even if the direction finder is unpowered. See our application note "In-band Interference from a Nearby Transmitter" for further guidance.**

As delivered the DDF7012 suite consists of the following

- ▶ One Pelican case containing the core module
- ▶ One Pelican case containing the antennas and all the accessories
- ▶ One laptop computer case (optional)

#### Initial Setup

- 1) Install the summer assembly and antennas on roof of the vehicle.
- 2) Install the radio modem antenna on the roof of the vehicle.
- 3) Install the GPS receiver on the roof of the vehicle
- 4) Install the compass (optional) on the roof of the vehicle.
- 5) Route all cables through a window opening in the vehicle. Do not route cables where they can be crushed.
- 6) Securely mount the yaw rate sensor (optional) anywhere within the vehicle. The wide side of the sensor must be mounted parallel to the floor of the vehicle.
- 7) Open the core module case.
- 8) Connect the radio modem antenna (optional) to the TNC connector on the core module.
- 9) Connect the direction finder antenna and control cables
- 10) Remove the laptop computer from its case
- 11) Connect the laptop power cable from the connector panel to the laptop computer

- I2) Connect the Ethernet crossover cable between the laptop and the core module.
- I3) Connect the GPS receiver to the core module.
- I4) Connect the Yaw Rate sensor (optional) or compass (optional) to the core module
- I5) Connect 12 V power to the unit using the supplied cable and cigar lighter plugs. If you are using the laptop power supply it is suggested that you use two cigar lighter plugs and two power cables.
- I6) Check to make sure the direction finder and the receiver are powered
- I7) Turn on the laptop and start the MPT User Interface software.

## ANTENNA MOUNTING

Four antenna elements are used for mobile operation. At frequencies below 500 MHz, magnetically mounted quarter wave whips are used. These antennas must provide a good coupling to the ground plane, and must be of exactly the same type. It is especially important that the coaxes used have the same length. Precut antennas are provided that cover the 125 - 250 MHz band and the 250 MHz to 500 MHz band.

For frequencies above 500 MHz quarter wavelength, "stubby" antennas are provided.

*Note: To avoid damage to the input circuitry used in the RF summer, touch the antenna to the ground plane before attaching the whips to the magnetic mounts.*

It is important that the vehicle provides at least 1/4 wavelength of ground plane outboard of the antennas. As such, try to centralize the antenna install location on the vehicle's roof.

Space the antennas between 1/8 and 1/4 wavelength apart on the car's roof. Secure the four antenna cables together with nylon ties so that they are not free to move around and touch the antenna elements.

Place the RF summer on the car with the cables oriented towards the rear of the car. Connect the magnetic mount antenna cables to the corresponding TNC connectors on the RF summer. (That is, the left front antenna to the left front connector, etc. as shown in Figure 20). Locate the summer near the back of the car (the lid of the trunk or boot) so that the magnetic mount antenna cables do not have excessive slack.

Route the control and RF cables through a rear window.

For mobile operation in the 500-1000 MHz band, the antenna with summer assembly should be mounted directly on top vehicle. This antenna provides an extended ground plane, a wind shroud, and four stub type antennas built into TNC connectors. Place the assembled RF summer/antenna in the center of the car roof. Be sure to use the safety straps provided with the antenna as shown in Figure 21 below.

Mount the radio modem antenna near the front of vehicle roof and try to maintain as much separation as possible between the radio modem antenna and the direction finder antennas.

The GPS receiver and compass will not interfere with the direction finder antennas and can be mounted on the roof in any available space. It is recommended to keep the compass as isolated from ferrous metal as possible to ensure accurate readings.

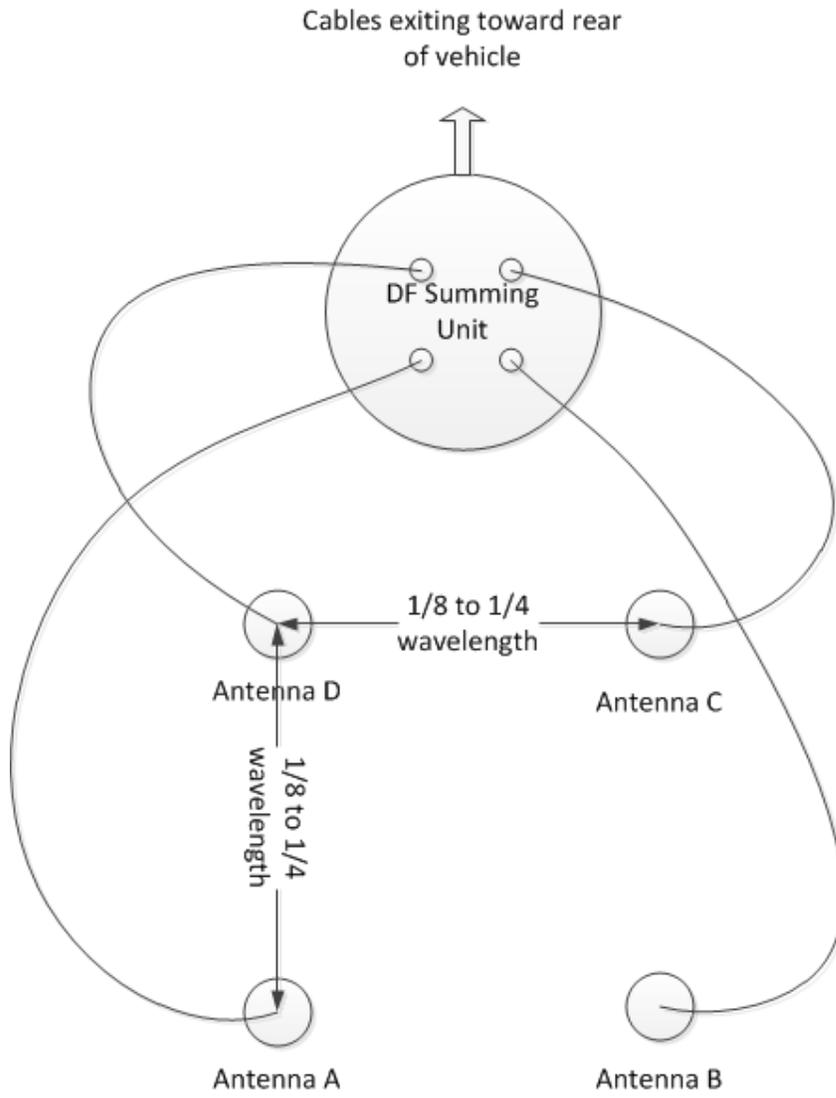
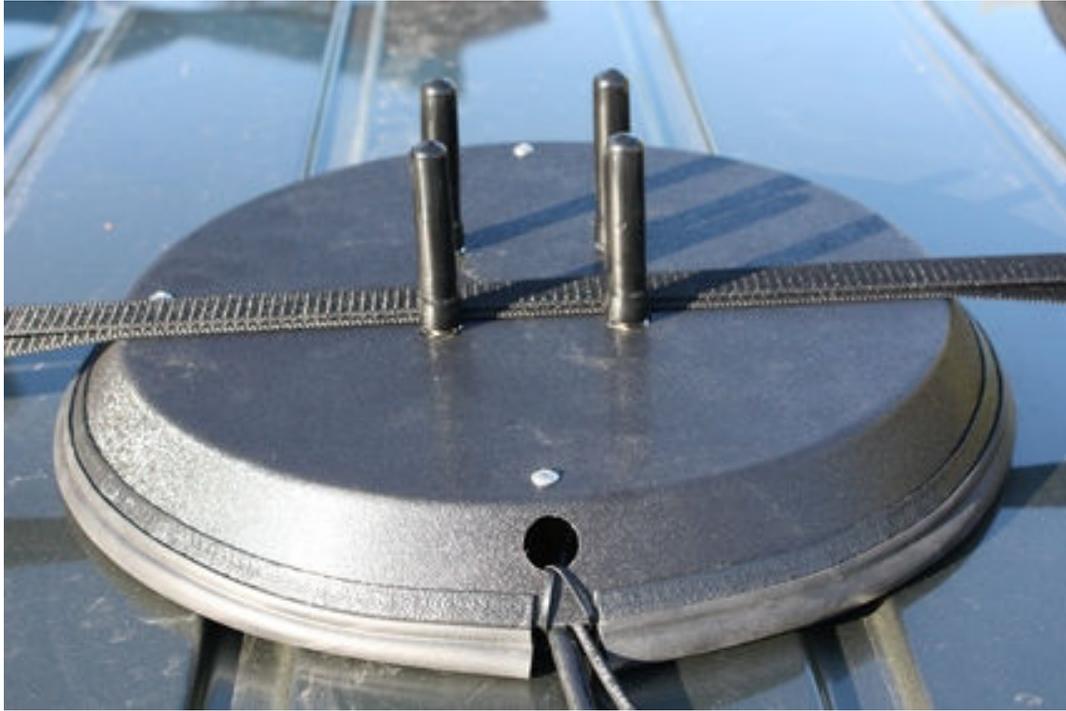


Figure 20: VHF and UHF antenna arrangement



*Figure 21: THF Mobile Antenna Installation (cables exit toward rear of vehicle)*

## CORE MODULE CONNECTIONS

Figure 22 below shows the front panel of the Core Module.



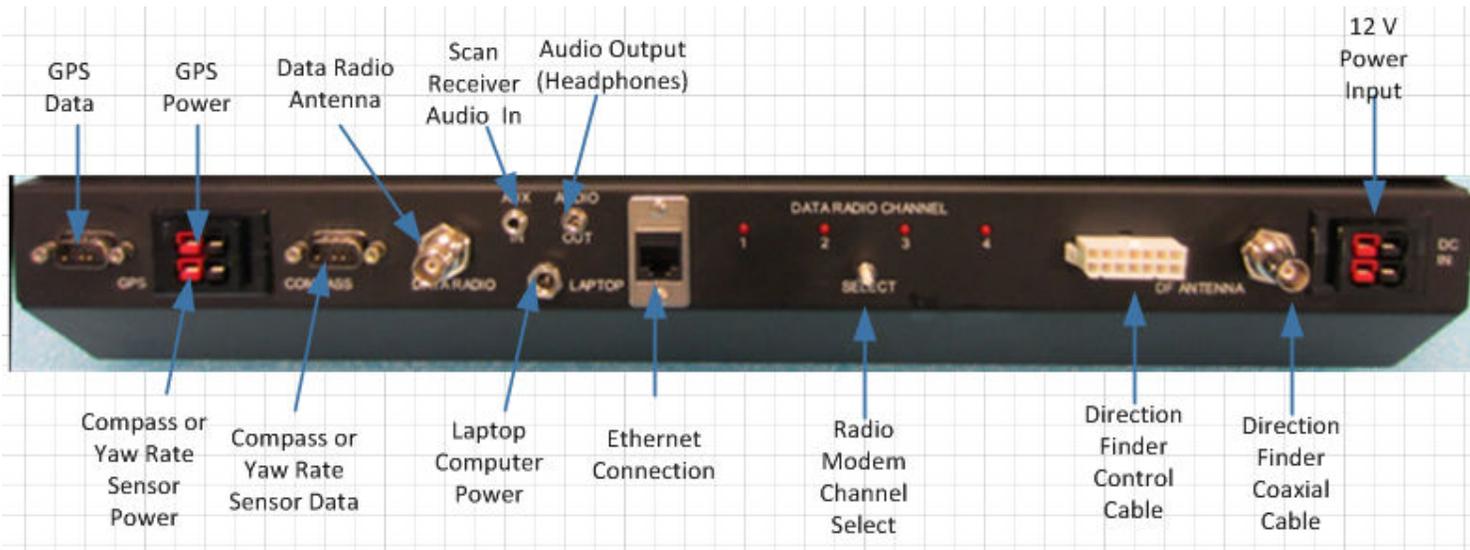


Figure 22: Mobile core module connections



Up to 5 cables will come from the roof of the vehicle into the vehicle where the Core Module will be installed; the df antenna coaxial cable, the df antenna control cable, the GPS receiver cable, the radio modem coaxial cable, and the compass cable. Connect these cables to the proper connectors on the core module.

You cannot use the compass and yaw rate sensor at the same time. If using the yaw rate sensor, mount it securely in the vehicle parallel to the floor of the vehicle and connect to the compass input. It is also necessary to use the MPT User Interface software to set the compass port (port 2) data rate to 38.4 kBaud.

If you are using an external scan receiver, connect the external speaker output of the receiver to the AUX IN connector and connect the audio output connector to the line input of the computer using the 1/8 inch stereo cable supplied with the unit. If you purchased a computer with the DDF7012, it will come furnished with a iMic (USB-to-Audio) converter that has a line input. If your computer does not have a line input and you are going to use an external scan receiver, then you will need to purchase an audio interface.

The radio modem is used to communicate with other Doppler radio direction finders in the event that the other direction finders cannot be networked on an Ethernet (IP) network. Each radio modem has four preprogrammed channels. Set all the direction finders on the radio modem network to the same channel.

The Ethernet connection is connected directly to the computer using a crossover cable (orange cable).

The unit is powered using 12 volts. The DDF7012 without a laptop draws requires 13 watts. If a laptop is connected to the laptop power supply, the unit can draw up to 100 watts depending on the battery's level of charge. It is recommended that two cigar lighter plugs and two power cables be used. Failure to use 2 cables may result in an under voltage (particularly when starting the vehicle) causing the direction finder to reset.

## SPECIFICATIONS

DDF7012 SPECIFICATIONS	
DF Method	<a href="#">Synthetic-Doppler</a> with patented "Smooth Summing"
Frequency Range	100 - 1000 MHz
Accuracy	< 2.5 deg rms (100 - 1000 MHz)
Resolution	0.1 deg
Sampling Rate	2 samples per second
Sensitivity	-123 dBm
Averaging	Adjustable from 1 to 20 samples
RF pulse detection	100 ms minimum
Commutation frequency	Adjustable (250, 500, 1000, 2000 Hz)
Voltage Range	11 - 14 VDC
Power	15 W @ 12 VDC
Temperature Range	-25 °C to 85 °C (antenna)
CE Compliant	Per EN 61000-6-2, EN 61000-6-4 AND EN 301 489-1

DDF7011 SPECIFICATIONS	
DF Method	<a href="#">Synthetic-Doppler</a> with patented "Smooth Summing"
Frequency Range	115 - 1000 MHz
Accuracy	< 1 deg rms (115 - 500 MHz) < 1.6 deg rms (500 - 1000 MHz)
Resolution	0.1 deg
Sampling Rate	2 samples per second
Sensitivity	-123 dBm (FM receiver dependent)
Averaging	Adjustable from 1 to 20 samples
RF pulse detection	100 ms minimum
Commutation frequency	Adjustable (250, 500, 1000, 2000 Hz)
Voltage Range	11 - 14 VDC
Power	15 W @ 12 VDC (processor and antenna)
Temperature Range	-25 °C to 85 °C (antenna)
CE Compliant	Per EN 61000-6-2, EN 61000-6-4 AND EN 301 489-1

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