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# OPERATOR'S MANUAL DFP-1000B DF BEARING PROCESSOR/DISPLAY



Rev C03/09-11/dfp1000b_opm_04**x**



Original Writing:  April, 2005

# DANGER

Although the DFP-1000B is completely safe to operate, the user must comply with the following basic rules of safety and common sense:

1. **SAFE DRIVING ISSUES** - *Two* people (a driver and DF operator) are required to safely run a mobile DF mission. It is essential that the driver be required *only to drive the vehicle*. One person cannot simultaneously operate the DFP-1000B and safely drive. *Failure to observe this two-person rule can result in traffic accidents causing property damage, injury, and even death.*

2. **DF ANTENNA MOUNTING ISSUES** - *It is solely the user's responsibility to verify that a mobile DF antenna is securely mounted to the vehicle so that it won't fall off while the vehicle is in motion.* It is likewise solely the user's responsibility to verify that the aerials (elements) are securely attached to the antenna aerial connectors. Mast-mounted DF antennas must be securely mounted and properly guyed as required. Such installations must be in full compliance with all applicable local ordinances as well as state and federal regulations as discussed in Section II-B-2-e. *Never install an antenna near electrical power lines.*

3. **AIRCRAFT OPERATION ISSUES** - If DF antennas are to be aircraft mounted, *the installation must be done and formally approved by an FAA certified aircraft mechanic for reasons of public safety* as discussed in Section II-B-2-c. In addition, it is *imperative* that the pilot be assigned no duties other than safely flying the aircraft.

4. **REPLACEMENT FUSE ISSUES** - If it is necessary to replace the fuse, *always* use the specified GMA 4 ampere 5 x 20 mm fast-acting type. *Never attempt to defeat this important safety feature by substituting a slow-blow fuse or one rated for higher current*.

5. **GPS RECEIVER/DIGITAL COMPASS ISSUES** - *Do not connect a GPS receiver or digital compass to the DFP-1000B before taking the steps called for in Section VII-D. Failure to heed this warning may result in damage.*

*Check RDF Products' website at www.rdfproducts.com for product updates and service bulletins.*
*Can we improve this manual? Contact us at mail@rdfproducts.com to offer suggestions.*

# ** ADVISORY **

We ask that users pay particular attention to the following important points:

1. When the DFP-1000B is powered-up, the display should illuminate within a few seconds. Occasionally, this may not happen (i.e., the display might remain dark). Should this occur, manually start the display by pressing the **Display On/Off** button (located to the immediate left of the display - see front-cover photo or Figure 6).

2. When the DFP-1000B is powered-up for **Local** (manual) operation, a 45 second “boot-up” time will elapse before the bearing display appears. ***Do not attempt to operate the display touch-screen during this boot-up process***. When the DFP-1000B is powered-up for **Remote** operation, the required boot-up time is under 10 seconds.

3. The DFP-1000B employs modern, maintenance-free, solid-state electronic components with indefinite service life. Even so, we suggest that the DFP-1000B always be powered-down when not in use for maximum longevity. Likewise, we also suggest that the display be disabled for unmanned **Remote** operation. This can be done by pressing the **Display Restart** button.

   Current model DFP-1000Bs (those having serial numbers AB235 and higher) now employ the Dell Axim X51 (a small hand-held computer used as the bearing display; also commonly referred to as a “PDA” or “Pocket PC”) rather than the Dell Axim X5 used in earlier model DFP-1000Bs. For the benefit of users having experience with these earlier model DFP-1000Bs, we list the following resulting improvements in the current model:

1. Since the X51 can be booted-up directly from its non-volatile memory, the PDA main battery and back-up batteries required in the earlier model DFP-1000Bs have been eliminated. The maintenance issues and various operational and storage inconveniences associated with these batteries (battery discharge/replacement and memory crash issues) are now also eliminated.

2. Since the current model DFP-1000B contains no batteries, there is no longer any need for an AC battery charger.

3. When earlier model DFP-1000Bs were turned-off, the display would not automatically shut-down unless the 11-16 VDC external power source was disabled or disconnected. With current model DFP-1000Bs, the display now immediately

shuts-down when the **VOLUME** control is rotated to its detented **PWR OFF** position.

4. Since the processing speed of the X51 PDA is superior to that of the X5, the bearing display video update rate has been increased from 50 to 60 frames per second.

5. Unlike the X5, the X51 requires no operating system selections (i.e., brightness, dim-out time, processor speed, etc.). Users should therefore not attempt to change any Windows Mobile operating system settings.

In very rare cases, a **“To restore factory settings...”** error message may appear on the PDA screen that does not clear when the DFP-1000B is powered-down and then again powered-up. Should this occur, ***do not attempt to follow the instructions on the PDA screen***. Instead, power-down the DFP-1000B, wait 30 minutes, and then power it back up to restore normal operation. See Appendix P for more information.

Current model DFP-1000Bs are fully compatible with the earlier models in all respects. Since no changes have been made to the RS-232 protocol, software written for the earlier models is fully compatible with the current models. <>

## GLOSSARY OF COMMONLY USED ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AC - | alternating current |
| ADF - | automatic (radio) direction finder |
| A.I.D. - | Audio Intelligence Devices (1) |
| AGC - | automatic gain control |
| ALRM - | alarm |
| AM - | amplitude modulation |
| amp - | ampere |
| ANT - | antenna |
| AWG - | American Wire Gauge |
| BNC - | bayonet naval connector |
| C - | Centigrade, Celsius |
| CH - | channel |
| CHNL - | channel |
| cm - | centimeters |
| COMP - | compensation |
| CRT - | cathode ray tube (display) |
| CW - | continuous wave |
| DC - | direct current |
| dB - | decibels |
| dBm - | decibels referenced to 1 milliwatt |
| DF - | (radio) direction finding |
| DFP - | shorthand for RDF Products Model DFP-1000B DF Bearing Processor |
| DFR - | shorthand for RDF Products Model DFR-1000B DF Receiver/Processor |
| DIP - | dual in-line package |
| EXT - | external |
| FAA - | Federal Aviation Administration (U.S.) |
| FCC - | Federal Communications Commission (U.S.) |
| FM - | frequency modulation |
| FREQ - | frequency |
| GHz - | gigahertz (formerly gigacycles) |
| GND - | ground |
| GPS - | global positioning system |
| HxWxD - | height x width x depth |
| HF - | high frequency (officially 3-30 MHz) |
| Hz - | Hertz (formerly cycles per second) |
| IF - | intermediate frequency |
| INT - | internal |
| kHz - | kilohertz (formerly kilocycles) |
| lbs - | pounds |
| LCD - | liquid crystal display |
| LED - | light emitting diode |
| LxWxD - | length x width x depth |
| m - | meters |
| MED - | medium |
| MHz - | megahertz (formerly megacycles) |
| mm - | millimeters |
| mph - | miles per hour |
| ms - | millisecond |
| mW - | milliwatt |
| mV - | millivolt |
| NOR - | normal |
| PC - | personal computer |
| PDA - | personal digital assistant (also handheld computer or pocket PC) |
| pF - | picofarads |
| PM - | phase modulation |

| | |
|---|---|
| PWR - | power |
| ppm - | parts per million |
| RCV - | receive or receiver |
| RCVR - | receiver |
| RCP - | reciprocal |
| RDF - | radio direction finding |
| RF - | radio frequency |
| RMS - | root mean square |
| S/N - | serial number |
| sec - | second |
| SPKR - | speaker (loudspeaker) |
| SSB - | single sideband |
| TNC - | threaded naval connector |
| T&H - | track and hold |
| UHF - | ultra high frequency (officially 300-3000 MHz) |
| us - | microsecond |
| uV - | microvolts |
| uV/m - | microvolts per meter (electric field strength) |
| V - | volts |
| VAC - | volts AC |
| VDC - | volts DC |
| VPP - | volts peak-to-peak |
| VHF - | very high frequency (officially 30-300 MHz) |
| VRMS - | volts RMS |
| W - | watts |
| w/ - | with |
| w/o - | without |

Notes:

1. A.I.D. is a registered trademark of Audio Intelligence Devices of Fort Lauderdale, FL

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## LIST OF ILLUSTRATIONS

# SECTION I - GENERAL DESCRIPTION

## A. INTRODUCTION

The RDF Products Model DFP-1000B is a DF bearing processor/display unit that, in conjunction with an appropriate RDF Products DF antenna, economically adds DF capability to almost any host receiver. The DFP-1000B is compact, rugged, and easy to operate.

DF receivers traditionally have been very expensive as a result of low-volume production. With the "add-on" DF bearing processor concept as embodied in the DFP-1000B, however, DF capability can be achieved far more economically by using either an existing receiver or one of the many excellent wide frequency coverage low-cost consumer-market receivers.

The DFP-1000B easily interfaces to most receivers via its standard 10.7 MHz IF interface. The unit can also interface to the host receiver via an optional custom IF interface or even by connection to that receiver's AM audio output. As a result, the DFP-1000B can interface to virtually any receiver with excellent results.

Unlike many competing add-on DF bearing processors, the bearing accuracy of the DFP-1000B is nearly impervious to host receiver anomalies associated with group delay variations and AGC characteristics. As a result, there is no need to implement difficult and expensive modifications to the host receiver to make it "DF-ready".

In addition to its 3-1/2 digit numeric bearing with 0.5° resolution, the DFP-1000B employs a 360° real-time polar TFT bearing display that is unsurpassed in dynamic DF environments where either the signal source or the DF station is in motion. This highly intuitive display format greatly aids the user in discriminating valid bearings from reflections and interference, and is far superior to the inexpensive non-polar azimuth ring displays employed by competing units.

The DFP-1000B can accept the output of NMEA digital compasses so that the compass headings can be used to offset bearings so as to provide absolute rather than relative bearings for digital mapping applications. It can also accept the output of NMEA GPS receivers and present the DF station latitude/longitude coordinates on the mapping display.

Full remote capability is provided via a single 19200N81 RS-232 serial port. With the software provided, all features can be controlled and outputs displayed at the host computer. Additional serial ports are provided for connection of a host receiver, digital compass, and GPS receiver so that all of these peripheral system components can be managed at the host computer via the single RS-232 connection without the need for cumbersome external data multiplexers or hubs. The “open” RS-232 protocol is published in detail for the benefit of users who wish to write custom software. In addition to operating the DFP-1000B, the accompanying user interface software can also control supported host receivers to allow seamless operation as a virtual DF receiver.

The DFP-1000B features excellent listen-through capability. With most signal formats, undistorted signal audio output is obtainable simultaneously with DF operation. Demodulators are included for AM, FM, CW/SSB with built-in speaker or external headset audio output.

Other features include 6/15/30/200 kHz selectable IF bandwidths, bearing display Track & Hold, multiple selectable bearing integration times, pulse response down to 35 milliseconds, an audible ranging indicator ("Range Tone"), and the ability to interrogate the new RDF Products "B-series" DF antennas to download model and band selection information for presentation on the DFP-1000B display.

The DFP-1000B replaces the earlier DFP-1000/DFP-1000A, employing an all-new modernized design with enhanced features, performance, and versatility unmatched by any single-channel DF processor at any price.

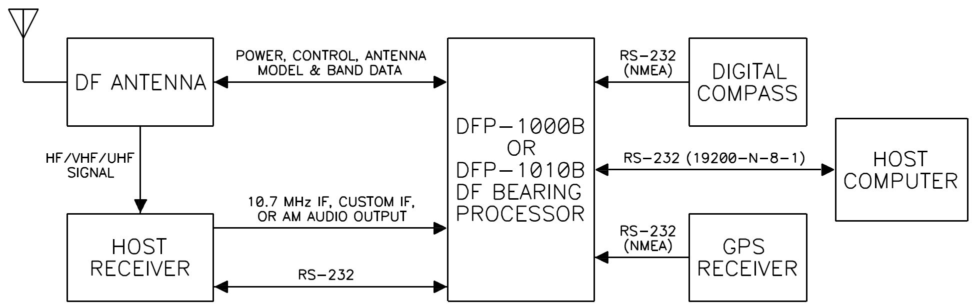


**Figure 1 - Overall DF System Functional Block Diagram**

## B. EQUIPMENT SUPPLIED

The following equipment is supplied:

1. DFP-1000B DF Bearing Processor/Display (P/N P100-1101; 1 ea.).

2. DPC-030B 3-meter +13.8 VDC power cable w/cigarette lighter plug (P/N P100-2007; 1 ea.).

3. 11-16 VDC power jack 4-pin female mating connector (P/N 502-027; 1 ea.).

4. 6' DB9 male to DB9 female "straight-through" serial computer interface cable (P/N 523-013; 1 ea.).

5. 3' 50 ohm BNC male to BNC male IF signal interface cable (P/N 523-017; 1 ea.).

6. BNC female to phono male IF cable adaptor (P/N 503-022; 1 ea.).

7. DFP-1000B Operator's Manual (P/N P100-9001; 1 ea.).

8. Publications CD w/DefCon2b user software (P/N P100-2002; 1 ea., located inside DFP-1000B Operators Manual).

## C. EQUIPMENT REQUIRED BUT NOT SUPPLIED

A suitable RDF Products mobile or fixed-site DF antenna appropriate for the desired frequency range(s) is necessary (see Appendix E & F for a detailed discussion of RDF Products DF antennas, as well as the appropriate product data sheets available from the RDF Products Publications CD or website). In addition, a suitable host receiver with the appropriate frequency coverage is required.

If the unit is not to be powered from an 11-16 VDC negative-ground vehicle power source, then an appropriate power supply capable of providing 11-16 VDC (negative ground) at up to 2.5 amperes must be used. For 28 VDC aircraft applications, a suitable 28-to-12 VDC regulated power converter must be used. For applications where the unit is to be powered from the 115 VAC 50/60 Hz power mains, we recommend the Astron Model RS-7A or similar models.

For remote operation, a suitable Windows host computer with an uncommitted serial port is required for RS-232 operation. If a serial port is not available, a USB port can be used via an appropriate adapter that converts the USB output to a standard serial port. We recommend the Keyspan (www.keyspan.com) USA-19HS USB serial in-line adaptor based on our first-hand experience with this unit, its modest price, and ease of set-up. Similar and equally capable adaptors are also made by other manufacturers. We recommend a computer display having at least 1024x768 pixels.

## D. SPECIFICATIONS

| | |
|---|---|
| DF Technique: | Single-channel Watson-Watt |
| Frequency Coverage: | Limited only by the frequency coverage of the host receiver and DF antenna |
| Antenna Band Control: | Up to 15 antenna bands using 4-bit parallel antenna code (bands selectable with front-panel control) |
| Bearing Displays: | Real-time 360° polar TFT and 3-1/2 digit numeric display |
| Bearing Update Rate: | 60 frames per second |
| Bearing Integration: | 35/50/80/100/160/200/275/400 milliseconds nominal |
| Bearing Resolution: | 0.5°/0.1° (local/remote) |
| Bearing Accuracy: | 0.5° RMS |
| Host Receiver Signal Interface: | 10.7 MHz IF, custom IF, or AM audio output |
| IF Signal Input Requirements: | -23 to -127 dBm into 50 ohms |
| AM Audio Signal Input Requirements: | 15 mV-1.5V RMS with 0-600 ohm source impedance |
| Host Receiver Delay Compensation: | Up to 5000 microseconds of host receiver group delay can be accommodated |
| IF Bandwidths: | 6/15/30/200 kHz (independently selectable) |
| Adjacent Channel Rejection: | 70 dB typical (using National Institute of Justice measurement procedure) |

| | |
|---|---|
| AGC Figure-of-Merit: | 65 dB typical (for 6 dB output reduction) |
| Maximum Undistorted Audio Output: | >3 watts RMS into 4 ohms (external speaker impedance must be 4 ohms or higher) |
| Audio Frequency Response: | 250-3300 Hz nominal @ -3 dB (measured at headset jack) |
| Line Audio Output: | 600 ohms nominal (unbalanced) |
| Track & Hold: | 2.5 second nominal holding time (when enabled) |
| Power Requirements: | 11-16 VDC @ 1.0 amperes maximum (negative ground). See notes below. |
| Over- And Reverse-Voltage Protection: | 18 volt shunt power zener diode blows fuse |
| Operating Temperature: | 0 to +50 degrees C |
| Storage Temperature: | -40 to +70 degrees C |
| Humidity: | 0-95% (no condensation) |
| Dimensions: | 4.5"x8.25"x10.6" (HxWxD) |
| Weight: | 6.5 lbs (less cables) |

Notes:

1. Specifications are subject to change without notice.
2. Typical DFP-1000B operating current in Local operation is 860 mA at minimum audio volume and 1.25 A maximum at full audio volume. Typical operating current in Remote operation is 580 mA for Remote (when PDA is powered-down).
3. Typical DFP-1010B operating current is 580 mA.

## E. APPLICABILITY

As of this writing, this manual is applicable to DFP-1000Bs having serial numbers AB235 and higher. It is also applicable to DFP-1010Bs having serial numbers AP032 and higher.

# SECTION II - INSTALLATION

## A. UNPACKING AND INSPECTION

Carefully examine the shipping carton for damage before it is opened. If damage is evident, have the carrier's agent present, if possible, when the equipment is unpacked. If the carrier's agent cannot be present, retain the cartons and packing material for the carrier's inspection if the equipment is subsequently found to be damaged after unpacking.

To ensure that the shipment has been received complete, inventory all items against the packing list. If a discrepancy is found, immediately notify us.

The equipment was thoroughly inspected and factory adjusted for optimum performance prior to shipment and is therefore ready for immediate use. If evidence of damage during shipment is found, immediately notify us.

## B. INSTALLATION

### 1. OVERVIEW

Installing the DFP-1000B is very straightforward as illustrated in the DF system functional interconnect diagram of Figure 2. Essentially, the following steps are required:

1. Install the DF antenna.

2. Connect the DF antenna RF cable to the RF input jack of the host receiver.

3. Connect the DF antenna control cable to the DFP-1000B rear-panel **ANTENNA CONTROL** jack.

4. Connect the host receiver 10.7 MHz IF output to the DFP-1000B **SIGNAL INPUT** BNC jack using a short length of 50 ohm coaxial cable.

5. Connect the 3-meter DC power cable from the *lower* DFP-1000B rear-panel 11-16 VDC power connectors to an 11-16 VDC (negative ground) power source.

6. Connect the host receiver to an appropriate power source (if the receiver can be powered from an 11-16 VDC power source, this power can be tapped from the *upper* DFP-1000B rear-panel 11-16 VDC power connector).

Installation is virtually fool-proof, with all DFP-1000B rear-panel jacks clearly marked and keyed against improper cable connection. The installation process is discussed in greater detail in the paragraphs that follow.

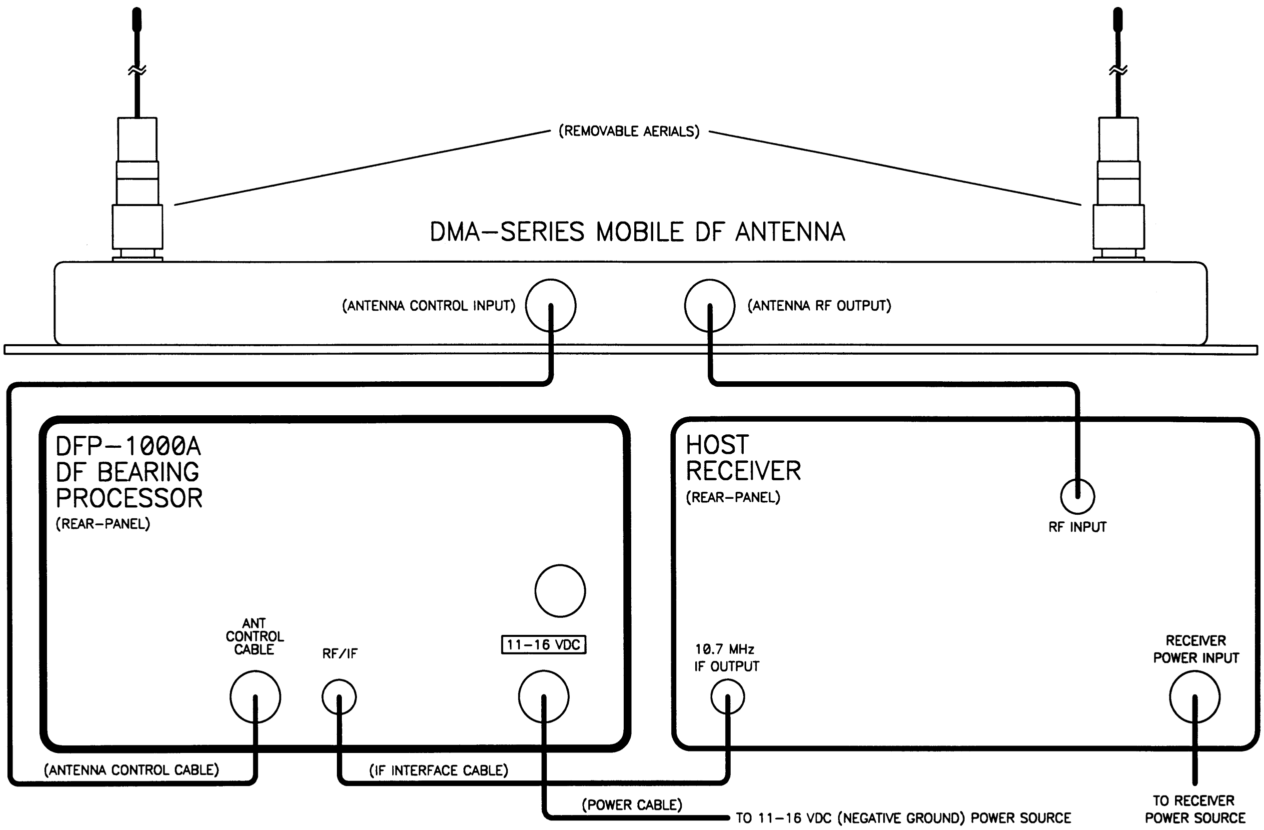


**Figure 2 - DF System Functional Interconnect Diagram (10.7 MHz IF signal interface)**

## 2. DF ANTENNA INSTALLATION

### a. Mobile DF Antennas - Standard Vehicle Roof-Top Mounting

For standard car/truck/van vehicle roof-top mounts, center the DF antenna on the metallic portion of the vehicle roof and align it so that the black reference arrow points "dead ahead". Secure the antenna to the vehicle rain gutters using the provided rain gutter hooks and nylon straps, looping the straps through the captive slots on the antenna baseplate as well as the slots on the rain gutter hooks. **Note:** If the vehicle cannot accommodate the supplied rain gutter hooks, check local automotive supply stores for styles more suitable. Kar-Rite International also offers a wide variety of rain gutter hook styles (see Appendix A).

Be sure to orient the plastic strap buckles so that they are *rightside up* and positioned on the *upper segment* of the strap loop. Also be sure that they are positioned so that the excess (the "tail" that is pulled to tighten the strap) runs *away from* the antenna (i.e., when the straps are correctly installed, they are tightened by pulling the "tail" *away from* the antenna). Tighten each strap in succession until the antenna is both securely mounted and still correctly positioned. If antenna misalignment occurs, loosen and re-tighten the straps as required to re-establish correct alignment. Wrap the excess tails around the tightened straps so that they won't flap around when the vehicle is in motion. If the antenna is not likely to be installed on a vehicle with a wider roof, cut the tails to 6" or so.

Next, install the aerials at the antenna TNC aerial connectors. For single-band antennas, four (or sometimes five) identical aerials are used. For multi-band antennas, install the four *tall* aerials at the *outer* TNC connectors and the *short* aerials at the *inner* TNC connectors. When installing the aerials, *firmly finger-tighten only*. *Using pliers or a wrench is not necessary and the excess force will likely rotate the TNC connectors and damage the weather-seal.*

Mobile DF antennas are supplied with a cable set consisting of two detachable cables (a power/control cable and a signal output cable). Attach the signal output cable (with the TNC male connector) to the mating TNC female connector on the side of the antenna chassis. Similarly, attach the power/control cable (with the 8-pin female connector) to the mating 8-pin male connector. **Note:** This connector sometimes does not fully insert into the mating connector without significant resistance. To ensure that the connector is fully inserted, wiggle the body side-to-side slightly as the connector threaded ring is tightened.

Finally, directly route the antenna cables into the vehicle through the most convenient passenger-side window. Do not leave slack in the portion of the cables between the vehicle entry point and the DF antenna as this may cause the wind to batter the cables against the roof-top when the vehicle is in motion. Once this slack has been taken out, the cables can be held in place by *gently* closing the passenger-side window to the point where it clamps the cables. *Be sure not to close the window so tightly that it crushes or severs either cable.* A typical mobile DF antenna installation is illustrated in Figure 3 below.

***** DANGER *****

> An improperly secured DF antenna can result in injuries and property damage if the antenna falls off the vehicle. It is the user's responsibility to properly secure the DF antenna to vehicle for safe operation. *Be sure to inspect the installed antenna periodically during the course of a DF mission to verify that the Nylon straps remain tight.*

If the vehicle has other roof-top antennas (e.g,. for entertainment or communications radios), we strongly recommend that these be removed for best DF performance. Similarly, roof-top lights and flashers should also be removed.

**Installation Hint** - When installing the antenna, twist each strap approximately three turns. This greatly reduces “strumming” noise that is frequently experienced as a result of wind-induced strap vibration when the vehicle is in motion.

**De-installation Hint** - If the antenna is to be temporarily de-installed, loosen the two straps *on the driver’s side only*. When the antenna is re-installed on the same vehicle, the passenger-side straps will already be pre-adjusted to their correct length, and it is only necessary to retighten the driver’s side straps to complete reinstallation. With this time-saving shortcut, there is no need to loosen and re-tighten straps as discussed above to restore alignment. Since the antenna strap slots are captive, the straps will not fall off the antenna during storage.

b. Mobile DF Antennas - Custom Vehicle Installation

Mobile DF antennas can also be installed on vehicles by other means. If a semi-permanent installation is desired, the antenna can be directly bolted to the vehicle roof-top via the eight 1/4" mounting holes provided on the antenna baseplate flange. Some users have concealed

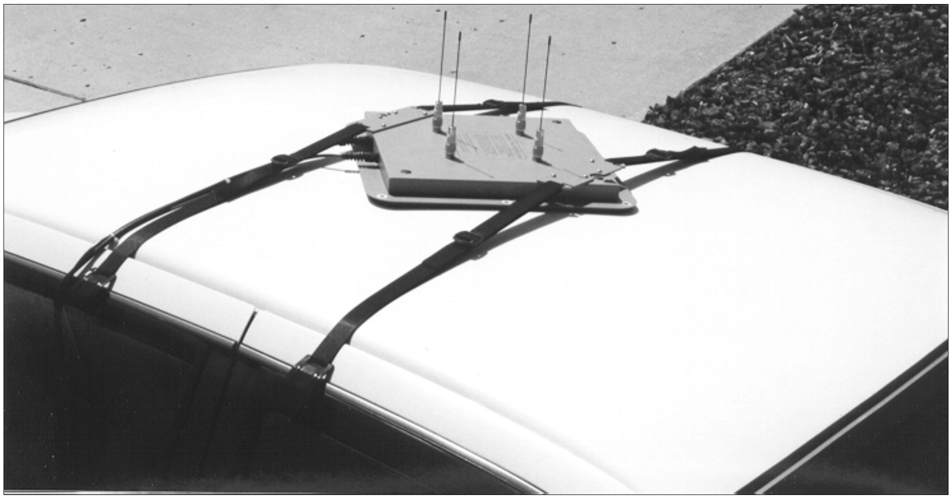

**Figure 3 - Car-Top Mobile DF Antenna Installation (front to the right)**

antennas in roof-top luggage carriers as well. Other users have installed bulk-head aerial connectors on the roof of the vehicle (with the correct spacing and orientation) that were then connected to the antenna box (located *inside* the vehicle) via phase-matched cables. Contact us if you have special antenna installation requirements.

c. Mobile DF Antennas - Aircraft Installation

Mobile DF antennas can also be installed on aircraft *but since RDF Products mobile DF antennas have not been designed for aircraft installation, the installation must be done and formally approved by an FAA certified aircraft mechanic for reasons of public safety.*

***** DANGER *****

*Unauthorized and improper DF antenna installations on aircraft can result in property damage, injury, and even death. It is mandatory for aircraft installations that the DF antenna be installed in full compliance with FAA advisory circular 43.13 - 1A & 2A, FAR part 65, sub-parts A, D, and E, and all other applicable FAA regulations for safe operation. Never mount the DF antenna with nylon straps. Always use the appropriate aircraft aerials (equipped with safety wires to prevent aerials from rotating loose) and ensure that the installation is in strict conformance with FAA regulations. Maximum safe airspeed must be determined on a case-by-case basis in strict conformance with the formal recommendations of a qualified airframe professional in strict compliance with all applicable FAA regulations.*

When mounting mobile DF antennas upside down on the underside of an aircraft, the DFP-1000B **GND/AIR** configuration setup dip-switch must be set to **AIR** as discussed in Section III-B-3 to compensate for an east-west axis bearing reversal that would otherwise occur.

d. Mobile DF Antennas - Ground Plane Requirements

Mobile DF antennas designed for vehicle roof-top or aircraft mounting must be installed on sizeable metal ground planes to function properly. The metal roofs of most compact cars are usually adequate. The larger metal roofs of full-sized cars and vans are even better. Do not attempt to install the antenna atop a vehicle having a roof constructed of fiberglass or other non-conductive material, as this will result in poor and erratic DF antenna performance. Also keep in mind that the imperfect ground planes provided by vehicle roof-tops do not permit the DF antenna to achieve the same bearing accuracy as can be obtained on an ideal site (although the resulting accuracy is nearly always good enough for most mobile DF missions). Mast-mounted DF antennas should be used in applications where best bearing accuracy is required as discussed below. Most fixed-wing aircraft having aluminum fuselages provide excellent ground planes. Aircraft with fiberglass or other non-metallic undersides (many helicopters, for example), do not easily accommodate mobile DF antennas. In addition, landing struts, searchlights, landing skids, and navigation/communication antennas all tend to degrade DF performance.

e. Fixed-Site DF Antennas

Fixed-site DF antennas are employed at stationary locations for applications where best DF bearing accuracy is required. These antennas are normally mounted atop towers or masts, and do not require ground planes. Refer to the Operator's Manual for the specific fixed-site DF antenna you wish to install for more information, or contact us.

**** WARNING ****

> Fixed-site DF antennas must be safely installed in full compliance with all local ordinances as well as any applicable state and federal regulations. Such ordinances and regulations may specify mounting and guying requirements for supporting towers or masts, impose height restrictions, require the use of aircraft obstruction warning lights, and specify lightning protection requirements. *Never install an antenna near electrical power lines.*

## 3. DFP-1000B INSTALLATION

### a. Overview

Once the DF antenna has been installed as discussed above, the DFP-1000B can be installed simply by connecting it to the DF antenna and host receiver as illustrated in the functional interconnect diagram of Figure 2. Refer to Figures 2 and 4 (DFP-1000B rear-panel photo) as required to facilitate the following discussion.

### b. Connecting The DF Antenna To The DFP-1000B And Host Receiver

First, locate the two antenna cables (normally tied together with nylon tie-wraps). Connect the RF cable (the one with the BNC male connector) to the RF input jack of the host receiver. If the host receiver does not employ a BNC female connector, an appropriate adaptor must be used. Next, connect the antenna control cable (the one with the 8-pin female mobile radio plug) to the mating 8-pin male mobile radio connector (labeled "**ANTENNA CONTROL**") immediately to the left of the **SIGNAL INPUT** connector.

**Figure 4 - DFP-1000B Rear-Panel**

c. Connecting the DFP-1000B To The Host Receiver (Signal Interface)

The DFP-1000B can accept either an IF (10.7 MHz, or optional custom frequency) or AM audio signal from the host receiver, depending upon the settings of the relevant configuration setup switches as discussed in Section III (as well as the capabilities of the host receiver). If an IF signal interface is used, the IF signal from the host receiver is connected to the DFP-1000B **SIGNAL INPUT** BNC signal input jack as illustrated in the DF system functional interconnect diagram of Figure 2. Although Figure 1 illustrates a 10.7 MHz IF interface (the most typical configuration), a custom IF interface would employ the same connection to the DFP-1000B. In either case, a 50 ohm coaxial cable should be used for this connection, since the input impedance at the DFP-1000B **SIGNAL INPUT** signal input jack is 50 ohms regardless of the IF signal interface frequency.

If an AM audio signal interface is employed, the AM audio signal from the host receiver is also connected to the DFP-1000B **SIGNAL INPUT** connector. The source impedance of the host receiver AM audio output should be 600 ohms or less.

Refer to Appendix C for a more detailed discussion regarding the relative merits of the different signal interfacing techniques. This information is especially important if an AM audio signal interface is contemplated.

d. Connecting The DFP-1000B To An 11-16 VDC Negative Ground Power Source

The DFP-1000B must be powered from an 11-16 VDC (negative ground) power source capable of supplying up to 2.5 amperes of current. The supplied 10' power cable (with cigarette lighter power plug) is provided for this purpose. If a vehicle cigarette lighter receptacle is not to be used as the power source, it will be necessary to either remove the cigarette lighter power plug or use a different power cable.

## * CAUTION *

In some vehicles, the cigarette lighter receptacle is wired to the battery through a current-limiting resistance element. Since this resistance element causes excessive voltage drop, cigarette lighter receptacles with this wiring configuration cannot be used to power the DFP-1000B. For such installations, an alternative method must be employed to gain access to the vehicle electrical power source. Also keep in mind that the voltage available at any point in the vehicle's electrical wiring system may be significantly less than the battery terminal voltage due to wire resistance. *It is therefore the user's responsibility to ensure that a minimum of 11 VDC is available to the DFP-1000B under all combinations of vehicle and DFP-1000B operating conditions, regardless of the method chosen to connect to the vehicle's electrical system.* In extreme cases, it may be necessary to connect a power cable directly to the vehicle battery terminals. In all cases, the battery and other components of the vehicle electrical system should be verified to be in proper working order.

For such installations, first connect the end of the cable having the 4-pin female power plug to the mating 4-pin male power connector (labeled "**11-16 VDC**") at the bottom right of the DFP-1000B rear-panel. Note that there are two power connectors - be sure to use the *lower* one (without the chain-tethered connector cap). Next, insert the other end of the cable (having the male cigarette lighter power plug) into the vehicle cigarette lighter receptacle.

A spare 4-pin male power connector is provided for users who wish to construct their own power cables (see Appendix D for pin-out information). These connectors are also readily obtainable from Radio Shack and other sources (see Appendix A). For power cable lengths up to 15', 16-gauge wire is sufficient to minimize voltage drops.

## ** WARNING **

Although the DFP-1000B is equipped with over-voltage and reverse-polarity protection circuitry, the warranty does not cover damage to the unit caused by improper connection to power sources or connection to power sources supplying voltages outside the specified 11-16 VDC range. Double-check all power cable connections and verify correct power source voltage to avoid damage.

The DFP-1000B employs extensive filtering and regulation of the DC input power, thus making it virtually immune to hash, alternator whine, voltage transients, and other irregularities typical of vehicle power sources (provided that the source voltage remains within the specified 11-16 VDC range). It is not necessary to power-down the DFP-1000B when starting the vehicle (although this may be necessary for the host receiver).

Special care should be exercised when connecting the DFP-1000B to an aircraft power source. Since most aircraft employ 28 VDC power sources, a power converter is necessary to transform this voltage down to the 11-16 VDC level required for the DFP-1000B.

**** WARNING ****

Many aircraft have cigarette lighter receptacles identical to those found in vehicles, but *supplying 28 volts rather than the nominal 12 volts supplied by most cars, trucks, and vans. To avoid possible damage to the DFP-1000B, never directly connect it to such a receptacle - always use an appropriate 28-to-12 volt power converter.*

## 4. HOST RECEIVER POWER ISSUES

Unless the host receiver employs internal batteries, it will also require a power source. Since many receivers can be powered from +13.8 VDC supplies, the DFP-1000B has *two* parallel-wired DC power connectors so that DC power can be "daisy-chained" from the DFP-1000B to the host receiver power input connector. The *lower* connector is used for DC power *input*, leaving the *upper* connector free for use as an auxiliary DC power *output* connector capable of supplying up to 3 amperes of current for the host receiver and/or other accessories. This second DC power connector has been included as a convenience feature so that it is not necessary for the user to have to make two connections to the primary DC power source (a requirement that is frequently awkward in mobile installations). A spare 4-pin female mobile radio mating power connector is provided for users who wish to construct their own receiver power cable to take advantage of this feature (see Appendix D for pin-out information). These connectors are also readily obtainable from Radio Shack and other sources (see Appendix A).

**** WARNING ****

*DC power that is "daisy-chained" from the DFP-1000B to the host receiver as discussed above is not protected by the DFP-1000B fuse* (a necessary condition since the current requirements of host receivers can widely vary). Although this is unlikely to be a problem for the host receiver or other accessories (which should have their own fuse or circuit breaker), there is no fuse protection if the power cable interconnecting the DFP-1000B and the host receiver develops a short circuit. *It is therefore the user's responsibility to construct this power cable very carefully.* If the reliability of this user-constructed cable is in question, the power cable from the DC power source to the DFP-1000B should employ in-line fuses with a current rating commensurate with the combined current requirements of both the DFP-1000B and the host receiver. Finally, the current drawn from the DFP-1000B *must not exceed 3 amperes*. *Be sure to re-install the chain-tethered connector cap to the upper power connector when it is not in use.*

Although the DFP-1000B is capable of accepting input voltages from 11-16 VDC, the host receiver and accessory equipment may not (and probably will not) be able to accommodate such a wide DC input voltage range. The DC input voltage rating of such equipment can be found in their respective operating manuals, and the user must then verify that the available DC input voltage is within the specified ranges of *all* equipment to be run from that voltage.

Finally, verify that the 11-16 VDC power source can supply sufficient current to accommodate *all* equipment powered by that source. The DFP-1000B current rating does not take into account the current requirements of the host receiver and/or other accessories.

## 5. SELF-CONTAINED SPARE FUSES

To facilitate convenient field fuse replacement, the DFP-1000B has self-contained spare fuses. To gain access to the primary spare fuse, *first disconnect the DFP-1000B from its power source* and then remove the configuration setup cover plate from the rear-panel (secured by a single #4 screw as illustrated in Figure 4). The spare fuse can then be easily pried out of its two end-clamps using a flat-bladed screwdriver, prying from the left. Be sure to replace this spare fuse with the specified GMA 4 ampere 5 x 20 mm fast-acting type at the earliest opportunity.

An additional identical spare fuse is available inside the DFP-1000B. To gain access to this fuse, *first disconnect the DFP-1000B from its power source* and then remove the six #4 Phillips screws securing the *upper* cover to the main chassis. Next, carefully lift off the upper cover. This fuse and its retaining clamps are located on the right side of the uppermost printed circuit board.

## 6. MISCELLANEOUS INSTALLATION CONSIDERATIONS

If possible, avoid installing the DFP-1000B in confined locations that restrict ventilation. Similarly, do not stack equipment on top of the DFP-1000B, as this can cause unnecessary temperature rise. Likewise, do not mount the DFP-1000B on top of warm surfaces (i.e., other equipment exhibiting significant temperature rise).

It is also good practice to avoid installing the DFP-1000B so that its weight is supported by the rear-panel. To do so causes excessively sharp bending of the attached cables that can eventually result in cable or connector failure. Similarly, do not let the DFP-1000B "hang" by its cables.

# NOTES

# SECTION III - PRE-OPERATION CONFIGURATION SETUP

## A. GENERAL

Before operating the DFP-1000B, the unit should be configured so that it is optimized for anticipated DF mission requirements. In most cases where such configuration setup has already been done at the factory, little or no action on the part of the user is necessary unless mission requirements significantly change. Configuration issues are discussed in the paragraphs that follow.

## B. CONFIGURATION SETUP

### 1. OVERVIEW

The DFP-1000B has configuration setup switches (located beneath the rear-panel configuration setup cover plate) that select the interface method to the host receiver and allow users to customize the unit for their specific DF applications. *These switches are preset at the factory based upon our knowledge of the intended user application at the time we receive the order, and it is very likely that these factory settings need not be changed.* If customized configuration setup is required, however, refer to the paragraphs below.

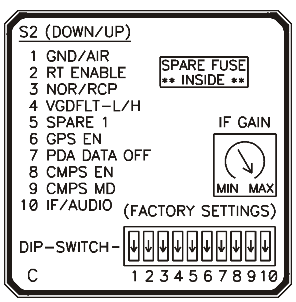


**Figure 5 - Configuration Setup Label**

To gain access to the configuration setup switches, remove the configuration setup cover plate from the rear-panel (secured by the #4 Phillips screw as illustrated in Figure 4). The locations of these switches are pictorially illustrated on the configuration setup label attached to the configuration cover plate (see Figure 5). For user convenience, the factory settings of these switches are also marked on this label (indicated by the arrows for the dip-switches) so that these settings can be restored if the user inadvertently sets these switches to unintended positions.

Note that the configuration setup process, if necessary at all, is ordinarily done *prior to an actual DF mission.* Once properly configured, *it is almost never necessary to re-configure the unit during the course of a DF mission.*

### 2. **IF GAIN** ADJUSTMENT

The purpose of the **IF GAIN** adjustment is to accommodate the variation in host receiver RF input to 10.7 MHz IF output thru-gain among different host receiver models. Optimum host receiver thru-gain for the DFP-1000B is 10-12 dB, but host receiver thru-gains can often be much higher.

If host receiver thru-gain is too high, strong signals can result in 10.7 MHz output amplitudes that can exceed the signal handling capability of the DFP-1000B. In earlier DFP-1000B revisions lacking this feature, this issue had to be dealt with by installing an appropriate in-line RF coaxial attenuator between the host receiver 10.7 MHz IF output and DFP-1000B 10.7 MHz IF input. With the current DFP-1000B revision, this matter can be far more conveniently handled with the **IF GAIN** adjustment. This adjustment is capable of reducing IF gain in excess of 30 dB.

For DFP-1000Bs that are not shipped with an accompanying host receiver, the factory setting of this adjustment is fully clockwise (maximum gain). For these units, the best way to set this adjustment is to observe the DFP-1000B S-meter on strong signals and reduce gain as required to ensure that the meter indication does not go over-range (as indicated by the normally yellow indicator bar becoming red).

If such over-ranging is observed, rotate the **IF GAIN** adjustment counter-clockwise slightly until the over-ranging ceases. If IF gain is reduced just enough to prevent S-meter over-ranging, there will be no loss in overall system sensitivity.

For DFP-1000Bs that are shipped with an accompanying host receiver, the **IF GAIN** adjustment is factory preset as required for any necessary IF gain reduction. This factory setting is indicated by a small reference calibration mark on the adjustment.

## 3. CONFIGURATION SETUP SWITCH

The configuration setup switch is a 10-section dip-switch located beneath the **IF GAIN** adjustment. As illustrated in Figure 5, each of the 10 dip-switch sections is a miniature slide switch that can be set either UP or DOWN. The sections are numbered 1 through 10 from left to right. The dip-switch assignments are as follows:

#1 - (**GND/AIR**)

This switch configures the DFP-1000B for either ground (**GND**) or aircraft (**AIR**) operation. In aircraft operation where the DF antenna is mounted on the underside of the airframe, the east-west axis is effectively reversed. By setting the **GND/AIR** switch to the **AIR** position, this reversal is accommodated by the DFP-1000B so that the proper bearing is displayed. The standard factory setting of this switch is **GND** (DOWN).

#2 - (**RT ENABLE**)

This switch enables/disable the Range Tone feature (UP for enable). The standard factory setting is DOWN.

#3 - (**NOR/RCP**)

This switch configures the DFP-1000B for either a *normal* or *reciprocal* (reversed) bearing display. When set to **RCP** (UP), the displayed bearing is reversed (offset by 180°). A reciprocal bearing display is sometimes preferred in air traffic control applications where the air traffic controller calls out the incoming aircraft's *heading to the tower* rather than its *bearing from the tower*. The standard factory setting of this switch is **NOR** (DOWN). This function can also be accomplished in software (for remote operation) if the user interface program allows user-selectable bearing offsets. If the software approach is preferred, the **NOR/RCP** switch should be left in **NOR** (DOWN).

The **NOR/RCP** switch can also be useful where an AM audio signal interface with the host receiver is employed. In some cases, the host receiver AM audio output is phase-inverted (reversed in phase by 180°). This causes an undesired bearing reversal that must be corrected. Such correction can be conveniently accomplished with the **NOR/RCP** switch. Although this function once again can be accomplished in software, using the **NOR/RCP** switch during configuration setup is often more convenient and less likely to cause user confusion.

#4 - (**VGDFLT-L/H**)

This switch (**V**ideo **G**ain **D**efault - **L**ow/**H**igh) selects the default state of the front-panel **HI/LO** video gain selector push-button (see description of this control in Section V-C-3) when the DFP-1000B is powered-up. If this switch is set to DOWN (the standard factory setting), the DFP-1000B will power-up in the **LO** video gain mode (indicated by **LGAIN** on the display). If set to UP, the DFP-1000B will power up in the **HI** video gain mode (indicated by **HGAIN** on the display.

This switch is inactive for the DFP-1010B or when the DFP-1000B is operated remotely via its RS-232 port.

#5 - (**SPARE 1**)

This switch is currently non-functional. The standard factory setting is DOWN.

#6 - (**GPS EN**)

This switch enables the GPS receiver. If a GPS receiver is connected to the DFP-1000B rear-panel **GPS RECEIVER** DB9 connector, it can be enabled by setting this switch to UP. This applies +11 VDC power to the GPS receiver and enables the DFP-1000B GPS receiver interface circuitry. This switch should be set to DOWN (the standard factory setting) when GPS operation is not desired or if no GPS receiver is connected to the DFP-1000B.

If accessing this switch is operationally inconvenient (e.g., if the DFP-1000B is mounted in a console with no easy access to the rear-panel), a more conveniently located switch can be placed in the +11 VDC line from the **GPS RECEIVER** DB9 connector (see Appendix D for the pin-out of this connector). Disabling the +11 VDC supply to the GPS receiver has the same effective as setting the **GPS EN** switch to DOWN.

#7 - (**PDA DATA OFF**)

This switch disables the bearing data stream to the PDA display when set to UP (required for certain maintenance operations). The standard factory setting is DOWN.

#8 - (**CMPS EN**)

This switch enables the digital compass. If a digital compass is connected to the DFP-1000B, it can be enabled by setting this switch to UP. This applies +11 VDC to the digital compass and enables the DFP-1000B digital compass interface circuitry. This switch should be set to DOWN (the standard factory setting) when digital compass operation is not desired or if no digital compass is connected to the DFP-1000B.

If accessing this switch is operationally inconvenient (e.g., if the DFP-1000B is mounted in a console with no easy access to the rear-panel), a more conveniently located switch can be placed in the +11 VDC line from the **DIGITAL COMPASS** DB9 connector (see Appendix D for the pin-out of this connector). Disabling the +11 VDC supply to the digital compass has the same effect as setting the **DIGITAL COMPASS** switch to DOWN.

#9 - (**CMPS MD**)

This switch selects the digital compass mode. If this switch is set to DOWN (the standard factory setting), the digital compass heading offsets *both* the polar and numeric bearing displays. If it is set to UP, *only* the numeric bearing display is offset. This switch is non-functional if no digital compass is connected to the DFP-1000B or if the **CMPS EN** switch is set to DOWN.

#10 - (**IF/AUDIO**)

This switch selects the signal interface mode (DOWN for IF and UP for AM audio). If an audio signal interface is contemplated, be sure to carefully study Appendix C to become familiar with the subtleties associated with this interface method. Although an audio signal interface works well when properly implemented, it is less straightforward than the more commonly used (and forgiving) IF signal interface. The standard factory setting of this switch is **IF** (DOWN).

# SECTION IV - DFP-1000B OPERATION

## A. OVERVIEW

Once properly configured and installed, the DFP-1000B is very straightforward to operate. Essentially, the user must do the following:

1. Power-up the unit.

2. Select the host receiver operating frequency and DF antenna band.

3. Select the desired signal reception mode.

4. Set other front-panel controls to suit personal operating preferences.

In the paragraphs that follow, these steps are discussed in greater detail after a preliminary discussion of the DFP-1000B front- and rear-panel controls, indicators, jacks, and connectors. Refer to Figures 4 and 6 (DFP-1000B rear- and front-panel photos) as appropriate to facilitate the following discussion.


**Figure 6** - **DFP-1000B Front-Panel**

## B. DISPLAY

### 1. OVERVIEW

The DFP-1000B relies on a bright, high-contrast high-resolution color TFT display to present DF bearings (see Figure 6). This display is actually part of an internal PDA (a Dell Axim X51), which also contains all the software necessary to accept data from a microprocessor inside the DFP-1000B and convert this into useful display information.

In addition to the DF bearings, this display also presents all other necessary information associated with the operation of the DFP-1000B. The display is organized so as to present all necessary operating information in a tight, unified, and easy-to-interpret cluster.

### 2. BEARING DISPLAYS

Bearings are presented simultaneously in two different formats. The first of these is the real-time polar bearing display, which is presented as a line-of-bearing on an emulated compass rose with 5° calibration marks. This display is updated 60 times per second for true real-time operation, and is most heavily relied upon for tracking and homing DF missions.

Bearings are also presented in 3-digit numerical format (000-359), with a decimal point suffix indicating half-degree increments. (As a case in point, the bearing presented in Figure 6 is 22.5°.) The numeric display is most useful in triangulation, mapping, and other applications that can benefit from its higher resolution and ease of interpretation.

Unless a digital compass is connected to the DFP-1000B, both the polar and numerical bearing displays present relative azimuths (i.e., relative to the orientation of the DF antenna), which is indicated by the letters **REL** (relative) beneath the numeric bearing display. When a digital compass is connected to offset the DF bearing for true-north reference, the letters **ABS** (absolute) appear. In order for the digital compass feature to be enabled, appropriate rear-panel dip-switch settings are required (see Section III-B-3).

### 3. S-METER

A progressive vertical bar-graph real-time emulation of an analog signal-strength meter (or "S-meter") is displayed to the immediate right of the bearing displays. This S-meter indicates relative signal strength of the received signal, and is particularly important for tracking and homing applications as a relative ranging indicator. The meter is approximately dB-linear for maximum useful dynamic range.

### 4. TUNE METER

A single vertical bar-graph real-time emulation of an analog tuning meter is displayed to the immediate right of the S-meter. This tune meter is a convenient tuning aid designed to help the user correctly tune in a received signal.

5. MODE & IF BANDWIDTH

The mode and IF bandwidth indicators are located immediately beneath the S and tune meters. The mode indicator corresponds to the setting of the front-panel **MODE/DF RESPONSE** switch, which in turn simultaneously selects the reception mode and DF bearing integration (e.g.., **FM/SLOW**).

The IF bandwidth indicator corresponds to the setting of the front-panel **IF BANDWIDTH** switch. The DFP-1000B has four selectable IF bandwidths (6/15/30/200 kHz).

6. DF ANTENNA

For DF antenna with "personality" modules, the DF antenna model number and frequency coverage of the selected DF antenna band is presented in the lower right corner of the display. For DF antennas without personality modules, the selected DF antenna band number (01-15) is displayed.

A DF antenna orientation icon (ground/air) is presented in the lower left corner of the display. To explain, if a DF antenna is mounted upside-down on an aircraft, it is necessary to set the rear-panel **GND/AIR** dip-switch to **AIR** to correct for the east-west axis reversal that would otherwise occur. The setting of this **GND/AIR** switch is appropriately indicated by the DF antenna orientation icon.

7. MISCELLANEOUS INDICATORS

A low/high video gain indicator (**LGAIN/HGAIN**) is presented in the upper left corner of the display. (See Section IV-C-3 for a complete explanation of this feature.)

Immediately beneath the video gain indicator is the local/remote indicator (**LCL/RMT**). The DFP-1000B remains under local control unless the front-panel **MODE/DF RESPONSE** switch is set to **REMOTE**.

8. DISPLAY START-UP

When the DFP-1000B is powered-up, the display (a Dell Axim X51 PDA employed for this purpose) initially "boots-up" into Windows Mobile (the operating system employed by this PDA). When this process is completed, the PDA launches its DF program (i.e., the program that generates the DF bearing display). This entire sequence typically requires 45 seconds (during which time the DFP-1000B is non-functional). Users familiar with earlier DFP-1000Bs (S/Ns AB234 and below) will notice that this 45 second boot-up period is significantly longer than that of the earlier models.

For remote operation, however, the PDA is not used (to reduce power consumption and extend PDA display life) with the result the DFP-1000B boots-up in under 10 seconds.

Earlier DFP-1000Bs had a shut-down issue where the PDA display would remain illuminated when the unit was turned-off unless the 11-16 volt DC power source was also turned-off (or unless the PDA **DISPLAY RESTART** button was pushed.) This is not the case with current model DFP-1000Bs, where the PDA immediately shuts down when the unit is turned-off.

Instances have been reported where the PDA display does not illuminate when the DFP-1000B is powered up. If this occurs, press the **DISPLAY RESTART** button to start the PDA.

## C. FRONT-PANEL DESCRIPTION (Figure 6)

### 1. VOLUME/PWR OFF

The **VOLUME** control sets speaker (or headset) volume (loudness) and turns the entire unit on or off. With this control rotated fully counter-clockwise until a "click" is heard (to **PWR OFF**), the DFP-1000B is powered-down. The unit is powered-up by rotating the **VOLUME** control slightly clockwise (again until a "click" is heard), as evidenced by the illumination of the signal strength meter and frequency channel indicator. Volume is increased by further clockwise rotation.

### 2. SQUELCH/RANGE TONE

The **SQUELCH** control sets a signal strength threshold below which the speaker (or headset) audio output is muted. The further clockwise the **SQUELCH** control is advanced, the stronger the signal required to "break" the squelch and produce audio output. The **SQUELCH** control is highly useful in eliminating annoying background noise when no signal is received, particularly in FM. In typical operation, the **SQUELCH** control is rotated clockwise just far enough to mute the receiver audio output when no signal is received. Periodic readjustment of this control is often necessary as reception conditions change.

The **SQUELCH** control is also used to activate one of two "Range Tone" modes (provided that the **RT ENABLE** configuration setup dip-switch has been set to UP as per Section III-B-3). Range Tone is fundamentally an audible signal strength indicator that allows the user to audibly monitor relative received signal strength by means of the pitch (frequency) of an audible tone. To explain, a low Range Tone pitch corresponds to a weak signal while a high range-tone pitch corresponds to a strong signal.

In most cases, the user would rely on the S-meter as the primary relative ranging indicator. However, for tracking and homing DF missions where the chase vehicle is very close to the target transmitter, the user may need to be looking for the target transmitter (or at least the vehicle to which it is attached) rather than at the DFP-1000B display. In such cases, Range Tone can serve as a very effective DF tracking aid for close-in work that allows the user to simultaneously monitor relative range and conduct a visual target search.

See Section IV-F-3 for a more detailed discussion of this feature.

## 3. VIDEO GAIN/DF OFF

The **VIDEO GAIN** control provides a means to adjust the signal level presented to the bearing display. To put this into a graphical context, this visual effect of adjusting this control is to change the length of the bearing vector on the real-time polar bearing display.

For some DF applications, the **VIDEO GAIN** control can be rotated fully clockwise to its maximum gain position and left there. This is quite suitable for fixed-site DF missions where the DF station is not in motion and non-dynamic DF environments in general where the dynamic capabilities of the real-time polar bearing display are not necessary.

In dynamic DF environments (which include nearly *all* mobile DF environments), the real-time polar bearing display is an indispensable tool that allows the user to discriminate between legitimate bearings on the one hand, and noise and multipath-induced bearings on the other. Essentially, this information is embodied in the polar bearing vector length.

By way of brief explanation and summary, if the user places greatest reliance on longer rather than shorter bearing vectors (as most users will do intuitively), he will automatically tend to discount noise- and multipath-induced bearings in favor of legitimate bearings. In fact, it is no exaggeration to state that the real-time polar bearing display is the critical feature that makes the DFP-1000B mission-effective for mobile DF tracking and homing in urban environments (environments where competing DF systems relying on numerical bearing displays, azimuth ring displays, or any other bearing display that does not present the bearing as a real-time vector quantity) are for the most part mission-ineffective).

In order for the real-time polar bearing display to be effective, however, it is necessary for the user to “ride” the **VIDEO GAIN** control to keep the polar bearing vector on-screen so that changes in vector length can be seen. (If the **VIDEO GAIN** control is left at maximum, the polar bearing display becomes mostly ornamental, becoming only marginally more effective than an inferior azimuth ring display.)

The polar bearing vector line remains yellow as long as it does not extend off-screen. When its length reaches the inner azimuth calibration ring, however, the vector line becomes green. Operationally then, *the user should adjust the* ***VIDEO GAIN*** *control as required to keep the vector line yellow (i.e., on-screen) in order to derive maximize the effectiveness of the real-time polar bearing display.*

A supplemental **HI/LO** video gain selector push-button is located to the immediate right of **VIDEO GAIN** control. When the **LO** video gain mode is enabled, a 12 dB video attenuator is switched in to further reduce video gain. We strongly recommend enabling this attenuator during mobile DF applications, disabling it only when signals are very weak. When **LO** video gain is selected, the letters **LGAIN** appear in yellow in the display upper left corner. When **HI** video gain is selected, **HGAIN** appears in red.

If the **VIDEO GAIN** control is rotated fully counter-clockwise to its detented **DF OFF** position, the DF antenna axis encoding tones are disabled, causing the system to function in a "receive-only" mode with no DF capability. This feature is included to accommodate special mission requirements where the intelligibility of the received signal may temporarily become more important than DF capability. To further explain, this feature addresses a performance trade-off that can sometimes occur as a consequence of the fact that the DF antenna axis encoding tones can reduce the listen-through capability (intelligibility) of certain signal types. Although AM and FM listen-through is very good, SSB listen-through is marginal. If intelligibility sounds compromised and if listen-through capability becomes more important than DF capability, use **DF OFF**.

## 4. MODE/DF RESPONSE

The **MODE/DF RESPONSE** control simultaneously selects the reception mode (e.g., AM, FM, CW, or SSB) and the associated DF bearing response time (where /S, /M, and /F respectively designate "slow", "medium", and "fast"). As an example, **FM/S** designates the FM reception mode with slow bearing integration.

In general, it is best to use the slowest integration time consistent with the duration of the received signal since this strategy provides best noise filtering (which translates into less bearing jitter and better DF sensitivity). Minimum signal durations (in milliseconds) for the various modes are listed below:

| | | | |
|---|---|---|---|
| **FM/S -** | **400 ms** | **CW/F1 -** | **80 ms** |
| **FM/M -** | **200** | **CW/F2 -** | **50** |
| **AM/S -** | **400** | **CW/F3 -** | **35** |
| **AM/M -** | **200** | **SSB/S -** | **400** |
| **CW/S -** | **400** | **SSB/M -** | **275** |
| **CW/M -** | **160** | | |

In most instances where voice-modulated signals are being intercepted, slow bearing integration yields the best results since the durations of such signals are nearly always in excess of 400 milliseconds. On the other hand, pulsed beacons usually require faster integration time for best results. Since optimum bearing integration time can also be influenced by circumstances and individual preferences, users should feel free to experiment.

The DFP-1000B has been specifically designed to respond to signals with much shorter durations than was possible with its DFP-1000A predecessor. To facilitate this, there are 3 high-speed modes (**CW/F1**, **CW/F2**, and **CW/F3**) specifically set up for handling signals with very short durations.

## 5. FINE TUNE

The **FINE TUNE** control is provided as a convenience feature to provide users with an easy means of netting the DFP-1000B precisely onto the desired frequency. Although this can be done at the host receiver (which is usually the preferred method), this can sometimes be inconvenient.

As a case in point, it is often convenient to set the host receiver tuning increment to match the assigned channel spacing of the frequency band of interest (e.g., 10 kHz, 25 kHz, etc.) If this is the case, it is inconvenient to have to change the host receiver tuning increment to allow fine tuning of a signal of interest that is slightly off-frequency. When this is the case, the DFP-1000B **FINE TUNE** control provides a much more convenient way to net the system on frequency.

The **FINE TUNE** control is almost essential in cases where the host receiver does not have fine tuning provisions (e.g.., receivers that tune in 10 kHz increments). Also, some host receivers (the AR8600 Mk2 being a good case in point) accomplish the fine tuning in frequency converters subsequent to the 10.7 MHz receiver IF (intermediate frequency). Since the IF signal interface to the DFP-1000B is taken from the host receiver 10.7 MHz IF output, it would not have the benefit of any host receiver fine tuning capability derived in subsequent host receiver conversions (typically the 10.7 MHz to 455 kHz converter).

The **FINE TUNE** control allows for a minimum of +/-5 kHz of frequency offset. When the control's white marker line is vertical, the DFP-1000B is set very close to its 10.700 MHz center frequency. If the **FINE TUNE** control is rotated fully counter-clockwise to its **OFF** position, the **FINE TUNE** feature is disabled and DFP-1000B tuning is automatically centered at 10.700 MHz. When **FINE TUNE** is enabled, the yellow **ON** warning indicator blinks approximately once every 2 seconds.

## 6. IF BANDWIDTH

As mentioned, the DFP-1000B has selectable IF bandwidths of 6/15/30/200 kHz. The IF bandwidth is selected using the **IF BANDWIDTH** switch. This control is a center-off toggle switch with momentary left/right positions. To increment the IF bandwidth, this switch is momentarily pressed to the right. To decrement the IF bandwidth, this switch is momentarily pressed to the left. Two-way wrap-around occurs between 6/200 kHz. The selected IF bandwidth is presented on the PDA display as discussed above.

In general, the narrowest IF bandwidth that contains the transmitted bandwidth of the received signal should be selected since this will improve sensitivity and reduce adjacent-channel interference. For most narrow-band FM signals in the VHF/UHF range, this would be 15 kHz, although there are still some wider-bandwidth FM transmitters in use that require a 30 kHz IF bandwidth.

We recommend the 6 kHz IF bandwidth for CW signals. 6 kHz is also suitable for voice-modulated AM signals, although this may require periodic retuning if the host receiver or transmitter drifts in frequency. If such retuning is impractical or the frequency drift is excessive, then the 15 kHz IF bandwidth should be used.

The 30 kHz and 200 kHz IF bandwidths are useful for various digital communication modulation formats. The 200 kHz IF bandwidth is also suitable for FM broadcast signals in the 88-108 MHz band.

## 7. ANTENNA BAND

If the attached DF antenna is multi-band, the antenna band (01-15) must be selected using the **ANTENNA BAND** switch. This control is a center-off toggle switch with momentary left/right positions. To increment the antenna band, this switch is momentarily pressed to the right. To decrement the antenna band, this switch is momentarily pressed to the left. Two-way wrap-around occurs between bands 01/15.

As of this writing, there are no RDF Products DF antennas having more than four bands. DF antenna frequency coverage and antenna band frequency assignments are listed on the DF antenna serial number label located on the antenna underside for the user's reference.

With older RDF Products DF equipment (i.e., the DFP-1000A and its associated DF antennas), the user was required to assume the burden of ensuring correct DF antenna band selection. A major improvement in the DFP-1000B and its associated "B-series" DF antennas is the addition of DF antenna "personality modules" to substantially remove this burden from the user's shoulders and simplify DF antenna band selection so that there is much less likelihood of the user inadvertently selecting the wrong band.

To explain, the new RDF Products "B-series" DF antennas are equipped with small microprocessors that contain the DF antenna model number plus band/frequency coverage information (i.e., "personality modules"). When polled by the DFP-1000B, the personality module returns a 300N81 RS-232 read-back string to the DFP-1000B, which then parses this information and presents it in the lower right corner of the display.

As a case in point, the DMA-1276B-1 mobile Adcock DF antenna covers 27-88/88-250/250-520 MHz (in 3 bands). To take advantage of the DMA-1276B-1 personality module, the user pushes the **ANTENNA BAND** switch either to the left or right and holds it in place. This initiates the polling sequence. The DMA-1276B-1 then sends its model/band information back to the DFP-1000B. After a few seconds, the following antenna information appears on the display (after which the user should release the momentary switch):

**DMA-1276B-1**
**27-88 MHz**

This indication shows that the DFP-1000B has recognized the DF antenna and has set it to its default (lowest) frequency band (27-88 MHz), which is Band 01. If the user increments the **ANTENNA BAND** switch, the next higher band (88-250 MHz) will appear, which is Band 02. If the user again increments the **ANTENNA BAND** switch, the next higher band (250-520 MHz) will appear, which is Band 03.

The advantage of this scheme is obvious – the user does not need to keep a record of the DF antenna frequency band assignments since the frequency coverage of the selected DF antenna band is already presented on the DFP-1000B display (i.e., **250-520 MHz** appears rather than **BAND 03**). This powerful feature thus almost guarantees that the user will not inadvertently select the wrong DF antenna band.

If the user does not initiate the DFP-1000B DF antenna polling sequence, the following antenna information appears on the display:

**ANT UNKNOWN**
**BAND XX**

(where **BAND XX** is the currently selected DF antenna band).

This same indication also appears if the sequence is initiated but the DFP-1000B does not recognize the DF antenna (this would be the case for an older-style DF antenna lacking a personality module). When this occurs, the user must determine the DF antenna frequency band assignments independently (by looking at the DF antenna serial number label if necessary) and then selecting the appropriate DF antenna band.

The selected DF antenna band in either of the above two formats is stored in non-volatile memory so that it if the DFP-1000B is powered-down, the antenna band information will be “remembered” when the unit is again powered-up.

*** CAUTION ***

> Regardless of whether the DF antenna is single- or multi-band, *the user must accept the responsibility to verify that the host receiver frequency is set within the DF antenna band limits.* This requires a certain degree of care, since the DFP-1000B has no means of "knowing" the host receiver frequency and therefore cannot warn the user of any frequency incompatibility (although this feature does exist when using the DefCon2b user interface software package to simultaneously control the DFP-1000B and host receiver). Setting the host receiver at frequencies outside the specified band limits of the DF antenna will result in unreliable and erratic DF system performance. Since this diminished performance may not be immediately obvious, users may rely upon such diminished performance to their detriment.

## 8. TRACK & HOLD

Track & Hold is a feature that allows the bearing to be “frozen” on the display for 2-3 seconds. It is useful for capturing an infrequent or short-duration signal that might otherwise be overlooked by a busy user.

The track & hold circuit comprises a peak detector that examines the amplitude of a pulsed signal as it is being received. The DFP-1000B responds normally as long as the signal amplitude is increasing. When the amplitude begins to decrease, however, a command is sent to the display to freeze the bearing for 2-3 seconds (or until a new signal appears, whichever occurs first).

Although some novice users like Track & Hold because it creates the illusion of a more stable bearing, we do not recommend that excessive reliance be placed on this feature. A serious disadvantage of Track & Hold is that it can capture an erroneous noise- or multipath-induced bearing that would otherwise be quickly forgotten, thus causing the user to place false reliance on a bad bearing. Also, Track & Hold is mostly ineffective for long-duration signals.

We therefore recommend that Track & Hold be used only for its intended purpose of capturing an infrequent short-duration signal that might otherwise be missed. Having said that, we also recognize that the effectiveness of Track & Hold for certain applications may be influenced by personal preference and therefore encourage users to experiment.

The Track & Hold feature is activated by setting the **TRACK & HOLD** toggle switch to **3 SEC**. To disable Track & Hold, return this switch to **OFF**.

9. **GPS ON/OFF**

The DFP-1000B can display GPS coordinates received from a connected GPS receiver. To enable this feature, press the **TRACK & HOLD** switch to the right to its momentary **GPS ON/OFF** position and then let go. This will cause the polar bearing vector to disappear and be replaced by a table listing the GPS latitude/longitude coordinates. (Although the polar bearing display will be inactive, the numeric bearing display will remain functional.)

To disable the GPS feature, again press the **TRACK & HOLD** switch to the right and release it. The latitude/longitude coordinates will then disappear and the polar bearing vector will reappear.

In order for the GPS feature to be enabled, appropriate rear-panel dip-switch settings are required (see Section III-B-3). Of course, a suitable GPS receiver must be connected to the DFP-1000B.

10. **HEADSET JACK**

The headset jack accommodates a standard 1/4" phone plug and can be used either for a 600 ohm headset or an 4-16 ohm external speaker. The internal speaker is automatically disconnected when a 1/4" phone plug is inserted.

****WARNING****

*Do not use a low impedance headset (<600 ohms) since the resulting volume level will be too loud for safe listening.*

## D. REAR-PANEL DESCRIPTION (Figure 4)

1. DC POWER

Two parallel-wired connectors are provided for DC power connection (see Section II-B-3-d). The lower connector is designated as the DC power input connector from the 11-16 VDC negative ground power source. The upper connector is designated as the DC power output connector (3 amperes maximum; unfused) that can be used to “daisy-chain” DC power to the host receiver (a convenience feature that eliminates the requirement of having to make 2 connections to the DC power source).

2. **FUSE** HOLDER

The **FUSE** holder accepts 5 x 20 mm fuses. Use GMA-type 5 x 20 mm 4 ampere fast-acting fuses *only*. *Never attempt to defeat this important safety feature by substituting a slow-blow fuse or one rated for higher current.* The DFP-1000B has one spare fuse located behind the configuration setup cover plate and 2 additional spare fuses mounted inside the unit on the top-most circuit board with the alkaline batteries. See Section II-B-5 for more information.

### 3. SIGNAL INPUT

The BNC **SIGNAL INPUT** connector accepts either the IF signal output (normally 10.7 MHz) or the AM audio output from the host receiver (subject to the setting if the **IF/AUDIO** configuration setup dip-switch (see Section III-B-3).

### 4. ANTENNA CONTROL

The **ANTENNA CONTROL** connector is an 8-pin mobile radio male type that provides +13.8 VDC power, X-Y axis encoding tones, and bandswitching information to the DF antenna.

### 5. LINE AUDIO

The BNC **LINE AUDIO** connector conveniently provides low-level listen-through audio to an external tape recorder or other audio monitor. The audio signal available at this connector is identical to that available at the front-panel **HEADSET** jack, except that it is lower in amplitude, higher in impedance, and not affected by the setting of the front-panel **VOLUME** control (although it is subject to being muted by the setting of the front-panel **SQUELCH** control). The output impedance is 600 ohms, and audio monitoring devices connected to this jack should have input impedances of 600 ohms or higher.

### 6. HOST COMPUTER

The **HOST COMPUTER** connector is a standard DB9 type that allows the DFP-1000B to be connected to 19200N81 PC serial port for remote operation.

### 7. DIGITAL COMPASS

The **DIGITAL COMPASS** connector is a standard DB9 type that allows the DFP-1000B to accept an NMEA digital compass output to allow absolute (rather than relative) bearing outputs (see Section IV-F-5 and Appendix H).

### 8. GPS RECEIVER

The **GPS RECEIVER** connector is a standard DB9 type that allows the DFP-1000B to accept an NMEA GPS receiver output to allow GPS latitude/longitude coordinates to be displayed (see Section IV-F-6).

### 9. HOST RECEIVER

The host receiver connector is a standard DB9 type that allows the host computer to control the host receiver on a “pass-through” basis. To elaborate, the DFP-1000B does not include any software allowing it to communicate directly with the host receiver (this would be impractical given the large number of different host receivers that can be used).

Instead, the DFP-1000B can be instructed to serve as a conduit to allow the host computer to directly control the host receiver. To do this, the host computer first sends a 19200N81 command string to the DFP-1000B (**7B4Z9Y3X6Q<CR><LF>**). Upon receipt of this command string, the DFP-1000B connects the **HOST COMPUTER** connector to the **HOST RECEIVER** connector (in a null-modem configuration) so that the host computer and host receiver can communicate directly (at any normal serial baud rate). At this point, the DFP-1000B becomes inert and will not respond to commands. The only exception is that if the host computer sends the command string **Q6X3Y9Z4B7<CR><LF>**, the DFP-1000B will break the connection between the host computer and host receiver and will again respond normally to assigned commands.

### 10. REMOTE DISPLAY

This **REMOTE DISPLAY** connector is a standard DB9 type that is a "transmit only" version of the **HOST COMPUTER** connector. It is intended as a one-way data output port for connection to a PC or other device to be used as a receive-only remote display.

### 11. CONFIGURATION SETUP

The **CONFIGURATION SETUP** controls are accessed by removing the rear-panel configuration setup cover plate (see Section III-B). These controls are normally set during pre-operation configuration setup, and seldom need to be changed during the course of a DF mission.

## E. BASIC DFP-1000B OPERATING PROCEDURES

### 1. OVERVIEW

As mentioned above, once the DFP-1000B has been properly configured and installed, the essential steps necessary for operating the unit are as follows:

a. Power-up the unit.

b. Select the host receiver operating frequency and DF antenna band.

c. Select the desired signal reception mode.

d. Set other front-panel controls to suit personal operating preferences.

These steps are discussed in detail in the paragraphs that follow, and assume standard factory configuration.

## 2. POWERING UP THE UNIT

To power-up the unit, rotate the **VOLUME** control clockwise from the **PWR OFF** position until a click is heard and set it to about 11 o'clock. The display should immediately illuminate and a boot-up sequence should commence lasting approximately 45 seconds. **Note**: If the display fails to illuminate at power-up, press the **DISPLAY RESTART** button.

As a preliminary step, set the remaining controls as follows:

| | |
|---|---|
| **VIDEO GAIN** - | Maximum (fully clockwise) |
| **SQUELCH** - | 8 o'clock (but do not click to **RANGE TONE 1**) |
| **MODE** - | **CW/MED** or as appropriate |
| **IF BANDWIDTH** - | **15 kHz** or as appropriate |
| **TRACK & HOLD** - | **OFF** |
| **FINE TUNE** - | **OFF** |

## 3. SELECTING THE OPERATING FREQUENCY & ANTENNA BAND

The operating frequency must be selected at the host receiver, and it must be within the limits of the selected DF antenna band. Coordination of the host receiver frequency with the selected DF antenna band is extremely important, and users not completely familiar with this issue should study Section IV-E-6 and Appendix F in detail.

DF antenna band selection is greatly simplified when using the new "B-series" antennas with their built-in personality modules. As discussed in detail in Section IV-C-7 and Appendix F, the DFP-1000B can interrogate the attached DF antenna to determine its model number and frequency/band information. This information is then presented on the display so that the user can see at a glance the frequency coverage of the selected DF antenna band.

## 4. SELECTING OPTIMUM SIGNAL RECEPTION MODE

Two steps are required for optimum DF and audio listen-through performance. First, the **MODE/DF RESPONSE** switch must be set to accommodate the modulation format and duration of the received signal. Second, the **IF BANDWIDTH** switch (discussed in the following paragraph) must be appropriately set to accommodate the transmitted bandwidth of the received signal. Both selections are presented on the display.

Addressing first the reception mode, the **MODE/DF RESPONSE** switch simultaneously sets the reception mode (i.e., AM, FM, CW, or SSB) and an associated DF bearing response (integration) time (where /S, /M, and /F respectively designate "Slow", "Medium", and "Fast"). As an example, **FM/S** designates the FM reception mode with slow bearing integration.

The reception mode is normally set to match the modulation format of the received signal so that the user can take advantage of the DFP-1000B's excellent listen-through capability and audibly monitor any resident voice modulation. Most voice modulation in the VHF and UHF range is FM and AM.

The DF response (bearing integration) time should match the duration of the received signal. Since most voice-modulated signals are of long duration (usually >1 second), slow bearing integration time is most appropriate. For typical voice-modulated FM signals, for example, the **MODE/DF RESPONSE** switch should therefore be set to **FM/S** (FM/Slow). In some mobile DF scenarios where the bearing is changing very rapidly, **FM/M** (FM/Medium) might be a more appropriate setting so that these changes can be more easily followed. Since the appropriate setting can also be influenced by individual judgment and personal preference, users should feel free to experiment.

Most pulsed tracking beacons have much shorter pulse durations, typically 150-250 milliseconds. For such beacons, medium integration should be selected. Since it is usually best to track pulsed beacons in the CW mode for best listen-though sensitivity, **CW/MED** is often a good choice.

The DFP-1000B has 3 high-speed response modes (**CW/F1**, **CW/F2**, and **CW/F3**), having response times of 80, 50, and 35 milliseconds, respectively. The modes are effective for very short-duration signals.

In general, it is best to use the slowest integration time consistent with the duration of the received signal since this technique provides best noise rejection (which translates into less bearing jitter and better DF sensitivity). Minimum signal durations (in milliseconds) for the various modes are listed in Section IV-C-4.

### 5. SELECTING OPTIMUM IF BANDWIDTH

the DFP-1000B has selectable IF bandwidths of 6/15/30/200 kHz. The IF bandwidth is selected using the **IF BANDWIDTH** switch. This control is a center-off toggle switch with momentary left/right positions. To increment the IF bandwidth, this switch is momentarily pressed to the right. To decrement the IF bandwidth, this switch is momentarily pressed to the left. Two-way wrap-around occurs between 6/200 kHz. The current IF bandwidth is presented on the PDA display.

In general, the narrowest IF bandwidth that contains the transmitted bandwidth of the received signal should be selected since this improves sensitivity and reduces adjacent-channel interference. On the other hand, selecting an IF bandwidth too narrow for the received signal will cause distorted listen-through audio, bearing jitter, and bearing errors. For most narrow-band FM signals in the VHF/UHF range, this would be 15 kHz, although there are still some wider-bandwidth FM transmitters in use that require a 30 kHz IF bandwidth.

We recommend the 6 kHz IF bandwidth for CW signals. 6 kHz is also suitable for voice-modulated AM signals, although this may require some care in tuning as well as periodic retuning if the host receiver or transmitter drifts in frequency. If such retuning is impractical or the frequency drift is excessive, then the 15 kHz IF bandwidth should be used.

The 30 kHz and 200 kHz IF bandwidths are useful for various digital communication modulation formats. The 200 kHz IF bandwidth is also suitable for FM broadcast signals in the 88-108 MHz band.

### 6. HOST RECEIVER OPERATIONAL CONSIDERATIONS

Although listen-through audio can be monitored at either the DFP-1000B or the host receiver, we strongly recommend monitoring it at the DFP-1000B in the absence of compelling reasons to monitor it at the host receiver**,** especially if a 10.7 MHz IF signal interface is employed.

First, monitoring listen-through audio at the DFP-1000B is more convenient. Since the user already must exercise the DFP-1000B controls relevant to obtaining bearings, exercising adjacent controls relevant to audio listen-through (**VOLUME** and **SQUELCH**, for example) is far more convenient than having to locate and exercise similar controls on another unit.

Second, the IF bandwidths of the DFP-1000B and host receiver may be different. If this is the case, confusion may result if the DF and listen-through IF bandwidths are significantly different. (i.e., what you see may not be what you hear).

Another potential host receiver issue is its tuning resolution. Although modern receivers (even modestly-priced consumer-market receivers) are capable of very fine tuning resolution (typically down to 100 Hz, or even 10 Hz), in some cases this fine resolution may not be available at the receiver IF output (the signal interface port for the DFP-1000B) as discussed in greater detail in Section IV-C-5. If the IF output tuning resolution is too coarse, the DFP-1000B **FINE TUNE** control should be used to accurately net the system onto frequency.

## F. ADVANCED DFP-1000B FEATURES

### 1. OVERVIEW

The DFP-1000B has advanced operating features that, while not strictly required for many DF missions, can improve performance and enhance user convenience. These features are discussed below.

### 2. TRACK & HOLD

Track & Hold is a feature that, when enabled, "freezes" the bearing display for approximately 2.5 seconds or until updated by a new bearing (whichever occurs first). Intended primarily for beacon transmitters, Track & Hold is useful for users who are unable to devote their full attention to the bearing display (because of other conflicting duties) and who might otherwise miss a bearing as a result. Track & Hold is also useful for signals that occur infrequently.

On the down-side, Track & Hold can exaggerate the significance of a short but intense noise spike that otherwise would be soon forgotten. Similarly, it may cause the user to place too much reliance on an erroneous bearing caused by a strong reflection. In the end, the use of Track & Hold is mostly a matter of personal operating preference.

To enable Track & Hold, set the 3-position **TRACK & HOLD** toggle switch to **3 SEC**. When signals become very weak, Track & Hold will eventually stop working. If the received signal is not sufficiently strong to move the S-meter, the Track & Hold should be disabled.

When the DFP-1000B is powered-up, the Track & Hold *will always be disabled regardless of the switch setting*. This feature has been included to prevent erratic bearings if the user is unaware that the **TRACK & HOLD** switch has been inadvertently left on from the previous operating session. To activate Track & Hold under these circumstances, first set the **TRACK & HOLD** toggle to **OFF** and then to **3 SEC**.

### 3. RANGE TONE

Range Tone provides an alternative listen-through mode that substitutes a variable-pitched tone in place of the normal audio output. The pitch (frequency) of this tone is determined by the received signal strength (as indicated by the S-meter). Range Tone can be thought of as an audible S-meter, and can be a very effective mobile DF tracking aid.

There are two Range Tone modes. **RANGE TONE 1** is the *pulsed* Range Tone mode which is intended for tracking pulsed transmitters (e.g., vehicle or locating beacons). When **RANGE TONE 1** is enabled, the tone sounds only when the transmitter pulse is detected. **RANGE TONE 1** is activated by rotating the **SQUELCH** control fully counter-clockwise to its detented **RANGE TONE 1** position.

**RT2** (Range Tone 2) is the *continuous* Range Tone mode which is intended for tracking transmitters that are on continuously (or at least for substantial durations). When **RT2** is enabled, the tone sounds continuously at approximately 2 beeps per second. **RT2** is activated by rotating the **SQUELCH** control fully clockwise.

Neither Range Tone mode is functional unless configuration dip-switch #2 (**RT ENABLE**) is first set to **UP**. (If this switch setting is changed, the DFP-1000B must be powered-down and then again powered-up for the unit to recognize the changed setting.)

For both Range Tone modes, the tone is disabled when the signal strength falls below the level necessary to activate the S-meter. When the signal strength reaches the level where the S-meter is nearly full-scale, the Range Tone output double-beeps to alert the user that he is very close to the target transmitter.

When either Range Tone mode is activated, normal audio output is disabled in favor of the Range Tone output. The Range Tone volume level is set by the **VOLUME** control.

We do not recommend using Range Tone unless the received signal is at least moderately strong. With weak signals it is much better practice to rely on direct CW listen-through. To elaborate, when the received signal is very weak and masked by noise, it can be very difficult to obtain useable bearings. If direct listen-through using the CW mode is employed, however, the signal can often be heard even though the bearing is not immediately apparent. In other words, the audible detection threshold of a CW signal is lower than the detection threshold of that same signal for a useable bearing. This detection threshold disparity can be used to great advantage if the user places heaviest reliance on the bearing indication appearing on the polar bearing display *only at the same time the signal is audibly detected*.

This phenomenon is well-explained in demodulation theory, which tells us that the more that is known about a received signal, the higher the probability of detection. By this reasoning, relying on the direct CW listen-through to provide the user with a priori knowledge of the occurrence of the signal improves the probability of recognizing a useable bearing.

## 4. HIGH-SPEED RESPONSE MODES

As mentioned, the DFP-1000B has three high-speed response modes (**CW/F1**, **CW/F2**, and **CW/F3**), having response times of 80, 50, and 35 milliseconds, respectively. Although the earlier DFP-1000/DFP-1000A was capable of responding to pulses with durations down to 80-100 milliseconds, the ability of the DFP-1000B to obtain lines of bearing on pulses down to 35 milliseconds is a new feature, and one usually associated with much more expensive multi-channel DF systems.

Although we emphasize elsewhere in this manual the importance of "riding" the **VIDEO GAIN** control so as to keep the bearing vector on-screen (i.e., yellow rather than green) to maximize the ability of the polar bearing display to help the user discriminate against noise and reflections, this same technique is also very helpful when intercepting very short-duration signals. When operating in the **CW/F2** and **CW/F3** modes in particular, keeping the bearing vector on-screen minimizes DF processor response time. With this technique, it is possible to obtain usable bearings on signals as short as 25 milliseconds in the **CW/F3** mode.

## 5. DIGITAL COMPASS

If a suitable NMEA-0183 digital compass has been connected to the DFP-1000B and activated using the appropriate rear-panel configuration setup dip-switch settings, the compass heading will offset (correct) bearings so that *absolute* (referenced to true north) rather than *relative* (reference to the DF antenna orientation) bearings are displayed. This can be a very useful feature in mapping applications where it would otherwise be awkward and time-consuming for users to have to manually convert relative into absolute bearings.

There are two digital compass operating modes. In the first, both the polar and numeric bearing displays are offset by the digital compass heading. In the second, only the numeric display is offset. This latter mode is often very effective in that it allows users to read absolute bearings from the numeric display for mapping functions while simultaneously allowing reliance on relative bearings from the polar display (for tracking and homing applications, bearings relative to the forward direction of the vehicle/boat/aircraft are usually more operationally convenient). See Section III-B-3 for configuration information. Also see Appendix H for additional important digital compass information.

## 6. GPS RECEIVER

If a suitable NMEA-0183 GPS receiver has been connected to the DFP-1000B and has been activated using the the appropriate configuration dip-switch setting (see Section III-B-3), the GPS latitude/longitude coordinates can be brought up on the display by pressing the **TRACK**

**& HOLD** switch to the right to its momentary **GPS ON/OFF** position and releasing it. As per Section IV-C-9, this will cause the polar bearing display to disappear and be replaced by a table listing the GPS latitude/longitude coordinates. (Although the polar bearing display will be inactive, the numeric bearing display will continue to function.)

The purpose of this feature is to provide a rudimentary (but nonetheless effective and capable) mobile DF mapping capability. With the location of the mobile DF station known from the GPS coordinates and the line of bearing is referenced to true north with the aid of a digital compass, an user can draw an appropriate line-of-bearing on a map to facilitate mobile location. The user can then drive to a new location and repeat this procedure to perform single-station mobile triangulation. This technique can often result in more effective mobile DF location capability than that obtainable from tracking and homing alone.

For fixed-site or more advanced mobile DF applications, the GPS coordinates along with bearing data are continuously available in RS-232 format at the rear-panel **HOST COMPUTER** connector. This data can be used for more elaborate digital mapping programs.

The polar bearing display can be restored by again pressing the **TRACK & HOLD** switch to the right to its momentary **GPS ON/OFF** position and releasing it. If the GPS receiver is still connected and enabled, GPS coordinates will still be available at the rear-panel **HOST COMPUTER** connector. Also, the GPS receiver and digital compass can be run concurrently.

### 7. MISCELLANEOUS FEATURES

#### a. Aircraft Operation

If a mobile DF antenna is to be mounted on the underside of an aircraft, the east-west axis is effectively reversed. To correct this, use the **GND/AIR** configuration setup dip-switch (#1) as discussed in Section III-B-3.

#### b. Air Traffic Control Operation

When DF systems are employed for air traffic control applications, reciprocal bearing displays are sometimes preferred where the air traffic controller calls out the incoming aircraft's *heading to the tower* rather than its *bearing from the tower*. This requires that the displayed bearing be reversed (offset by 180°). This can be accommodated by the **NOR/RCP** configuration dip-switch (#3) as discussed in Section III-B-3.

## G. DF TRACKING TIPS

### 1. OVERVIEW

Mobile DF tracking is a specialized DF application where a mobile DF unit is required to locate a transmitter (frequently a pulsed beacon transmitter attached to another vehicle) by physically homing in on it. Although many DFP-1000B users may participate in such DF missions only infrequently, we present the following discussion not only for the sake of completeness, but also to illustrate certain aspects of and issues involved in DF operation that apply to other types of DF missions as well.

## 2. REALISTIC EXPECTATIONS

DF tracking is an art as much as a science, and it is important that users have realistic expectations of the capabilities of mobile DF systems. Users should keep in mind that the very best that can be asked of a compact DF system is that it accurately report the *apparent* angle of arrival of the received signal. If this apparent angle of arrival is confused as a result of multi-path reception (reflections), the DF system can only report what it sees. Although mobile DF systems cannot provide (fictitious) "James Bond-style" precision, the DFP-1000B is a remarkably effective mobile DF unit that can be relied upon to find both stationary and mobile target transmitters when properly operated, and it does not take long for novice users to become experts.

## 3. SAFETY CONSIDERATIONS

*Do not attempt to simultaneously drive the vehicle and operate the DF system*, since neither task will be done very well. For reasons of safety, as well as effectiveness, we strongly recommend that *two* people run the mission - one to drive and the other to operate the DFP-1000B. This safety rule is doubly important for airborne DF missions.

## 4. TRACKING RANGE

Tracking range for low-power (typically 1-watt or less) vehicle beacons can greatly vary depending upon terrain and degree of urban build-up. In the downtown section of major cities, VHF tracking range can be as little as 0.5 miles. In suburban areas, 2-3 miles is more typical. In open terrain, 10-15 miles is quite possible. For airborne units, tracking range in excess of 50 miles has been accomplished. UHF tracking range is somewhat less than what can be expected for VHF (due to increased "space loss" of radiated signals at higher frequencies). For higher-powered transmitters, tracking range is far greater.

## 5. BASIC MOBILE DF TRACKING TECHNIQUE

Fundamentally, the two essential components of mobile DF radio location is to first acquire the target transmitter and then to home in on it. The most serious obstacles encountered in locating the target transmitter are signal drop-out (i.e., temporary loss of signal acquisition) and bearing errors (the most serious source of which is reflections). When the target transmitter is first acquired, signal strength is likely to be weak. Bearings are therefore likely to be less reliable, with a high probability of signal drop-out. As the mobile DF unit gets closer to the target transmitter, however, signal strength improves, bearings become more reliable, and the probability of signal drop-out rapidly decreases. This improved acquisition in turn allows the mobile DF unit to more rapidly close the distance to the target transmitter, resulting in still better acquisition. The process is thus self-reinforcing, with the uncertainty factors (signal drop-out and bearing errors) progressively diminishing as the mobile unit homes in on the target transmitter.

## 6. MAINTAINING SIGNAL ACQUISITION

If the target transmitter is stationary (i.e. the beacon-tagged vehicle is parked), location is usually very straightforward once the DFP-1000B has acquired the signal. Once acquisition has been established, simply drive in the general direction indicated by the polar bearing display. This results in the signal continually becoming stronger and thus improves acquisition. If acquisition is suddenly lost (i.e., the signal "drops out" due to a hill or other obstruction), the target can usually be re-acquired by continuing in the same general direction as indicated by the last good bearing. If the signal does not reappear, drive the vehicle to higher ground to improve tracking range.

If the target transmitter is moving (i.e., the beacon-tagged vehicle is in motion), location is more difficult, although the same general principles apply. It is particularly important under these circumstances that two people run the mission, and that the driver be familiar enough with the area to avoid cul-de-sacs, dead-ends, canyons, and other time-consuming obstacles that increase the risk of losing signal acquisition. Particularly heavy reliance should be placed on bearings obtained at intersections and overpasses in built-up urban areas. It is also helpful to drive along routes that are high as possible.

The probability of maintaining signal acquisition can be improved if a second mobile DF unit is employed (coordinated with the first by means of cellular telephone or direct mobile radio link). With this arrangement, it is far less likely that both units will simultaneously lose acquisition of the target transmitter. When acquisition is lost, one of the units can drive to high ground, re-acquire the target transmitter, and vector the other unit toward it.

The probability of maintaining signal acquisition can be improved even further if an airborne DF unit is employed (coordinated with one or more ground mobile units by means of cellular telephone or direct mobile radio link). Airborne units are extremely effective for maintaining acquisition with their extended tracking range and are less troubled by reflection-induced bearing errors.

## 7. MAXIMIZING THE BENEFIT OF THE POLAR BEARING DISPLAY

Although there is no "magic bullet" available that solves all the problems of mobile DF tracking, the real-time polar bearing display comes closer to this ideal than anything else. Unlike the inexpensive azimuth ring displays employed by competing units, the DFP-1000B employs a real-time polar bearing display that provides magnitude as well as azimuth information in a unified and highly intuitive format. Essentially, the magnitude information (polar bearing vector length) is an indication of bearing *quality* and provides a means by which the user can distinguish valid bearings from interference and reflections. For a truly professional-quality mobile DF tracking system, a real-time polar bearing display is essential.

Reflections tend to be associated with shorter polar bearing vector lengths, so users can minimize false reliance on erroneous bearings by placing greater reliance on bearings associated with longer vector lengths. As a hypothetical case in point, if the user observes several bearings in a short period of time having short vector lengths and pointing in different directions, these bearings are likely to be caused by reflections. When a long, steady bearing then appears, this one is much more likely to be valid, and is the one on which the user should place greatest reliance. Such user discrimination would not be possible with an azimuth ring display.

The magnitude information presented by the polar bearing display is also very helpful in discriminating the desired signal from background noise that may be present between beacon pulses as a result of the fact that the bearings produced by the beacon pulses result in long vector lengths while those produced by background noise between beacon pulses produce short vector lengths. Again, such user discrimination is not possible with an azimuth ring display, since noise-induced bearing indications appear no different than those caused by a legitimate signal.

To realize the full benefit of the polar bearing display, it is important that the **VIDEO GAIN** not be set so high that all bearings (both weak and strong) result in full-scale vector lengths, since this would yield results little different than that which could be obtained from an inferior azimuth ring display. Operationally, this means that the user should “ride” the **VIDEO GAIN** control (reduce video gain as necessary) whenever the polar bearing vector changes from yellow to green (indicating that the vector length has attempted to reach beyond full-scale but has been truncated). By riding the **VIDEO GAIN** control in this fashion, the user can more easily identify the shorter vector lengths associated with reflections and thus better discriminate against them. To facilitate this, we strongly recommend that the **LO** video gain mode be selected for mobile DF applications as discussed in Section IV-C-3.

Finally, keep in mind that the polar bearing vector length is primarily a relative *quality* indicator rather than a *ranging* indicator. The best relative ranging indicator is the **SIGNAL STRENGTH** meter (or alternatively, the Range Tone as discussed in Section IV-F-3).

## 8. USING LISTEN-THROUGH TO IMPROVE BEACON TRACKING PERFORMANCE

Novice users tend to think of DF tracking as primarily a visual "scope-dope" exercise in observing the bearing display. While this is essentially true, DF tracking can be made more effective when signals are very weak by also relying upon the superior listen-through capabilities of the DFP-1000B.

When signals are very weak, background noise and interference creates uncertainty in interpreting the polar bearing display. If the user knows exactly when the beacon is transmitting , however, he can correlate this knowledge with his concurrent observation of the bearing display to make a better estimate of the signal bearing. This comports with a fundamental rule of information theory in that *the more information that is known about a received signal, the higher the probability of detecting that signal,* a rule that also connects well with common sense.

In fact, the DFP-1000B does provide the user with the means to know when the beacon pulse occurs by virtue of its direct listen-through capability, particularly in the CW reception modes (**CW/SLOW**, **CW/MED**, **CW/F1**, **CW/F2**, or **CW/F3**, depending upon beacon pulse duration). In addition, the audible detection threshold of a signal in the CW reception modes is significantly better than the DF bearing display detection threshold (or in plainer language, you can hear it better than you can see it). For best beacon tracking performance at weak signal levels, we therefore strongly recommend audibly monitoring the signal in the CW reception mode, even though this may require fine tuning the host receiver or DFP-1000B.

Some users prefer to audibly monitoring the beacon FM or AM tone modulation (where such modulation is present) since the signals often seem more distinct. Although this is the case when the received signal is moderate to strong in amplitude, neither of these alternative listen-through modes work nearly as well as CW when signals are weak. For this reason, we strongly recommend using CW when signals are weak. Once this is done, the alternative listen-through modes (including Range Tone) can be activated with nothing more than the throw of a switch once the signal has become stronger.

## 9. BEACON MODULATION ISSUES

The issue of beacon modulation must also be addressed in conjunction with the listen-through discussion above. Some beacons are FM tone modulated so that users can better hear the beacon when it pulses on. This is beneficial for DF receivers that offer only FM listen-through capability since the tone is more distinctive than a squelch break (that is, a momentary period of quieting when the beacon pulses on). At the risk of belaboring the issue, however, we again emphasize the vastly superior listen-through capability of direct CW listen-through as provided by the DFP-1000B in its CW mode. When using CW listen-through, *best performance is obtained when the beacon pulses are unmodulated.* Beacon FM tone modulation should only be employed for the explicit purpose of facilitating FM listen-through, and should be disabled, if possible, for CW listen-through.

## 10. VEHICLE BATTERY ISSUES

The typical combined current drain of the DFP-1000B processor, host receiver, and a mobile DF antenna is typically 2-3 amperes. While this current drain does not come close to taxing the capabilities of a typical vehicle electrical system as long as the vehicle is running, it can discharge the vehicle battery when the vehicle is not running (as would be the case during an extended duration DF surveillance mission where the beacon-tagged vehicle is parked overnight). Although a good battery with a full charge should have no trouble supplying 2-3 amperes of current for eight hours or more, an older battery or one that is not fully charged can easily become discharged during this same interval to the point where it might not be able to crank the engine. Battery performance further deteriorates in cold weather.

A related problem is that the battery voltage gradually drops as the battery discharges. Although the DFP-1000B will operate satisfactorily down to 11 volts input, the host receiver may not be as capable of operating at such a low voltage. The problem is further compounded if there is a significant voltage drop between the positive battery terminal and the equipment power pick-off point (not unusual if the vehicle cigarette lighter receptacle is employed as a power outlet). This latter problem can be alleviated by connecting the equipment directly to the battery terminals through heavy-gauge wire.

It is therefore important to be sure that the vehicle battery and charging system are in good order prior to such missions. If the condition of the battery is in doubt once the mission is already underway, the next best solution is to park the car sufficiently far from the beacon-tagged vehicle so that the engine can be run periodically to charge the battery without alerting the subjects under surveillance.

## H. MOBILE DF SYSTEM INTEGRATION ISSUES

Mobile DF systems must often be deployed in small vehicles on short notice without the benefit of the conveniences and amenities avail-able in semi-permanent install-ations. When this is the case, it is important that the DF system be as compact as possible and that there be a minimum of interconnection hook-ups. Unfortunately, this ideal is hard to meet as a result of the size of many host receivers, as well as the interconnections required between the host receiver and the DFP-1000B. Although such "2-box" systems are convenient when they can be semi-permanently installed in a custom work-station in a truck or van, they are far less convenient for temporary use in a compact car.

To address this issue, RDF Products offers the DFR-1000B. This unit is actually a combo system comprising a DFP-1000B that has been electrically and mechanically integrated with an AOR AR8600 Mk2 compact communications receiver (see Figure 7). Electrical integration is achieved by means of a supplied power/signal interface cable interconnecting the two units. Mechanical integration is achieved by means of a Velcro attachment. The DFR-1000B is thus effectively a "1-box" system that is very compact and easy to install.

Installation is very straightforward. Once the mobile DF antenna has been installed on the car-top by means of its supplied nylon straps, the DFR-1000B can be quickly installed with just three easy cable connections. First, the DF antenna RF cable is connected to the AR8600 Mk2 RF input. Next, the DF antenna multiconductor control cable is connected to the DFP-1000B **ANTENNA CONTROL** jack. Finally, the DC power cable is connected between the vehicle cigarette lighter and the DFP-1000B **11-16 VDC** power input jack.

We strongly recommend the DFR-1000B where compactness and ease of deployment is the highest priority. For more information, refer to the DFR-1000B product data sheet.

RDF Products also offers the DFR-1200B, which comprises a DFP-1000B and an AOR AR5000A receiver. Although the DFR-1200B is somewhat larger and heavier than the DFR-1000B, its performance is enhanced as a result of the superior performance of the AR5000A receiver (as compared to the AR8600 Mk2 employed in the DFR-1000B).


**Figure 7 - DFR-1000B Wideband DF Receiver**

# NOTES

# SECTION V - MAINTENANCE AND TROUBLESHOOTING

## A. OVERVIEW

The DFP-1000B requires no periodic maintenance other than normal external inspection and cleaning as required. If the unit is deployed in a salt-water or other corrosive environment, we recommend more frequent inspection and cleaning. If external corrosion is observed, we recommend that the unit be opened and carefully inspected for evidence of internal corrosion. If internal corrosion is found, we further recommend that the operating environment be improved to provide better protection. (This may require that the unit be placed in a protective enclosure.)

Under normal operating conditions, the DFP-1000B will not require recalibration over its service life. Recalibration may be required in instances where the unit has been exposed to a corrosive environment, excessive heat, or abnormal mechanical shock. Such recalibration (and any associated repairs) should be done at the factory.

## B. TROUBLESHOOTING GUIDE

| SYMPTOM | POSSIBLE CAUSE |
|---|---|
| Unit "dead"; no display and no sound. | 1. Defective power source.<br>2. Defective power cable.<br>3. Power plug not pushed all the way in to cigarette ligher (1).<br>3. Blown or missing fuse.<br>4. **VOLUME** set to **PWR OFF**. |
| Unit powers up, but no signal received. | 1. One or both DF antenna cables disconnected.<br>2. Wrong host receiver frequency selected.<br>3. Wrong **ANTENNA BAND** selected.<br>4. Wrong DF antenna installed.<br>5. **IF/AUDIO** dip-switch improperly set. |
| Signal received, but no bearing vector. | 1. **VIDEO GAIN** control set too far counter-clockwise or to **DF OFF**.<br>2. Antenna control cable disconnected.<br>3. **PDA DATA OFF** dip-switch set to **UP** (S/N 215 and higher only). |
| Signal received, but bearing vector missing, very short, or reversed. | 1. **VIDEO GAIN** control set too far counter-clockwise.<br>2. Wrong **ANTENNA BAND** selected. |

| SYMPTOM (cont'd) | POSSIBLE CAUSE (cont'd) |
|---|---|
| Signal received, bearing OK, but no audio output. | 1. **VOLUME** control too far counter-clockwise.<br>2. **SQUELCH** control too far clockwise or in one of the Range Tone modes (**RT1** or **RT2**). |
| Audio output weak or distorted. | 1. **MODE/DF RESPONSE** switch improperly set.<br>2. Wrong **IF BANDWIDTH** selected.<br>3. Host receiver frequency mistuned. |
| Poor sensitivity and tracking range. | 1. Host receiver set to wrong frequency.<br>2. Wrong aerial set installed on DF antenna.<br>4. Wrong **ANTENNA BAND** selected.<br>5. Wrong **IF BANDWIDTH** selected.<br>6. Wrong DF antenna installed. |
| Bearings are reversed (180° out). | 1. **NOR/RCP** switch improperly set (2).<br>2. Wrong **ANTENNA BAND** selected.<br>3. Frequency outside of antenna range. |
| Polar bearing display appears “herky-jerky” rather than smooth and continuous. | 1. **TRACK & HOLD** unintentionally set. |
| Bearings OK front/rear, but seem to be reversed right/left. | 1. **GND/AIR** switch improperly set (3). |
| Bearings are very erratic with mobile DF antenna. | 1. DF antenna not mounted on metallic ground plane or ground plane too small. |
| Erratic operation, display does not respond to control changes, display text or graphics appears corrupted. | 1. Microprocessor or PDA “crash”. Disconnect the DFP from its power source, wait 30 sec., then power-up the unit. |
| PDA will not load DF program. | 1. DF program lost from PDA non-volatile memory. See memory restoration procedure in Appendix O. |
| Poor results obtained when tracking A.I.D. beacons or other short-duration signals. | 1. **MODE/DF RESPONSE** set for operating mode where bearing integration time too slow.<br>2. Host receiver AGC attack time too slow. |
| Alternator whine heard from speaker during mobile operation and/or generally erratic performance. | 1. DC supply voltage too low. (4) |
| “Motor-boating” sound heard from speaker. | 1. 11-16 VDC power source unable to supply sufficient current. (5) |

| SYMPTOM (cont'd) | POSSIBLE CAUSE (cont'd) |
|---|---|
| Beep frequently present. | 1. Range Tone unintentionally set. |
| Unit powers-up, audio present, but no display on PDA (or display “blanks-out” after initially appearing). | 1. Turn DC power off, wait a few seconds, then turn back on.<br>2. Depress PDA On/Off button. (6) |
| Unit powers-up, display present, but cannot change Mode, IF Bandwidth, Antenna Band. | 1. Unit powered-up in Remote mode. (7)<br>2. System “freeze-up”. (8) |
| Remote mode does not work. (Def-Con2b user interface software does not “handshake” with DFP and/or host receiver.) | 1. **MODE** switch must be set to Remote before unit is powered-up.<br>2. Cable problem, wrong baud rate, etc. |
| Difficulty experienced when trying to poll the DF antenna “personality module”. | 1. **ANTENNA BAND** switch held to the right or left for too long or short a period of time.<br>2. Older “R-series” DF antenna is being used.<br>3. DF antenna disconnected or defective antenna control cable. |
| GPS latitude/longitude screen appears unexpectedly. | 1. Press **TRACK & HOLD** switch to the right (to its momentary **GPS EN** position) and then release. (9) |
| Continuous “clicking” sound heard. | 2. Bad start-up. Power-down, wait 5 seconds, then again power-up. |

Troubleshooting Notes:

1. Cigarette lighter power plugs are non-locking and thus prone to intermittency. Be sure to firmly insert this plug fully into the cigarette lighter.

2. Other than for certain air traffic control DF missions, the **NOR/RCP** configuration setup dip-switch (#3) should normally be set to **NOR** (DOWN). Exception: If an audio (rather than IF) signal interface is employed and the host receiver AM demodulator output is phase-inverted, this will also result in bearing reversals. This can be corrected by setting the dip-switch to **RCP** (UP).

3. Unless the DF antenna is mounted upside down (i.e., on the underside of an aircraft), the **GND/AIR** configuration setup dip-switch (section 10, located behind the rear-panel configuration setup cover plate) should always be set to **GND** (DOWN).

4. Vehicle DC electrical power typically has a significant "ripple voltage" component caused by the charging of the battery by the alternator. The DFP-1000B has voltage regulators that eliminate this ripple voltage and provide "smooth" filtered DC voltage to all modules.

If the vehicle supply voltage drops below 11 VDC, however, these voltage regulators begin to drop out of regulation and lose their ability to provide filtered DC voltage. When this happens, alternator whine may become audible, along with other performance degradations. Always verify that the vehicle electrical system is in good operating order and that the voltage supplied to the DFP-1000B is maintained within its specified 11-16 VDC limit.

5. "Motor-boating" manifests itself as a "putt-putt" sound from the speaker that frequently occurs when the 11-16 VDC power source cannot supply the peak current required by the DFP-1000B. It is most likely to happen at high volume levels.

6. On occasion, the PDA display may not illuminate, even after the DFP-1000B is powered-down and then again powered-up. If this occurs, restart the PDA by momentarily depressing the recessed front-panel **DISPLAY RESTART** button (in some cases it may be necessary to hold this button down for a second or two). This button is directly accessible through the small front-panel access hole to the immediate left of the display.

7. If the **MODE/DF RESPONSE** switch is set to Remote when the DFP-1000B is powered-up, the unit will be under remote rather than local control. If this is an unintended result, power-down the DFP-1000B, set the **MODE/DF RESPONSE** to any Mode other than **REMOTE**, and again power-up. Similarly, the **MODE/DF RESPONSE** switch *must not* be set to Remote when the DFP-1000B is powered-up if local control is desired.

8. On occasion the DFP-1000B may “freeze-up”, with typical symptoms being that one or more of the controls are inoperative and erratic operation. This can sometimes happen if the unit is turned off and then back on in rapid succession. In most instances, normal operation can be restored by powering-down the unit, leaving it off for at least 5 seconds, and then powering back up.

9. On occasion, the GPS latitude/longitude screen will spuriously appear on the PDA display (in most instances shortly after the DFP-1000B is powered-up). To clear the screen and allow normal operation, press **TRACK & HOLD** switch to the right (to its momentary **GPS EN** position) and then release it.

## C. REVERSE-POLARITY AND OVER-VOLTAGE DIAGNOSIS AND REPAIR

The DFP-1000B employs a robust DC power input protection circuit to prevent the unit from being damaged by the application of excessive DC input voltage (i.e., > +16 VDC) or reverse-polarity DC power input. This circuit employs a DC power fuse and an 18 volt power zener protection diode that clamps the DC input voltage at +18 VDC (providing over-voltage protection) and also at -1.0 VDC (providing reverse-polarity protection).

In most instances, the application of reverse-polarity power will just blow the fuse and not cause any additional damage. In such cases, it is necessary only to replace the fuse. If substantial over-voltage is applied (e.g., the DFP-1000B is inadvertently connected to a +28 VDC power source), on the other hand, the protection diode will also blow (along with the fuse).

If over-voltage or reverse-polarity power has been applied to the DFP-1000B, we suggest that the user conduct the following simple diagnostic steps:

1. Confirm that the 4 ampere fuse (F1) has been blown. If the fuse is good, the unit has probably not been exposed to over-voltage or reverse-polarity DC power. In this case, power-up the unit with an appropriate 11-16 VDC negative ground power source and confirm proper operation.

2. If the fuse is blown, disconnect the DFP-1000B from its power source and replace the fuse with the specified GMA 4 ampere 5 x 20 mm fast-acting type.

3. Probe between pin 4 of either 11-16 VDC power connector and chassis ground with an ohmmeter (see Appendix D for the pin-out for this connector). If the ohmmeter reading indicates a dead-short (or nearly a dead-short), this means that the 18 volt input power protection zener diode is blown and must be replaced (confirm that this dead-short is also indicated when the ohmmeter probes are reversed).

4. If the 18 volt protection zener diode is good, power-up the unit with an appropriate 11-16 VDC negative ground power source and confirm proper operation.

If the 18 volt zener diode is blown (as indicated by a dead-short ohm-meter reading in step 3 above), it will be necessary to replace the damaged 1N5355B 18 volt 5 watt zener diode. This diode (D1) is located on the rear-panel, with its cathode (banded end) connected to fuse holder (F1) pin A and its anode connected to power connector (J4) pins 1 & 2 (both of which are connected to chassis ground). See the main chassis schematic of Figure 14 for reference.

Fortunately, this diode is easily accessible and easy to replace. To replace this diode, proceed as follows:

1. Disconnect the DFP-1000B from its 11-16 VDC power source.

2. Remove the 6 #4 Phillips screws securing the DFP-1000B top cover.

3. Carefully lift the top cover away from the chassis. Be sure not to pull the wires connected

to speaker (attached to the right side of the top cover).

4. After locating D1 as per the above paragraph, clip it out with diagonal cutters or some other suitable wire cutting tool. Again check this diode with the ohmmeter to verify that it is a dead-short in both directions.

5. A spare diode is located on the right end of the front-panel board immediately adjacent to the **VIDEO GAIN** and **SQUELCH** controls (this diode is also labeled as D1). Clip this diode off the front-panel board and install it in place of the diode removed in the step above, soldering the cathode lead (on the banded end) to F1-A and the anode lead to J4-1/J4-2.

6. Again probe between pin 4 of either 11-16 VDC power connector and chassis ground with an ohmmeter and confirm that there is no longer a dead short. A high resistance should be indicated in one direction and the lower resistance associated with a diode junction should be indicated in the other direction (probes swapped).

7. We strongly recommend that the spare diode removed from the front-panel board be replaced at this time if one is available. If not, a replacement diode should be procured and installed at the earliest opportunity.

8. Reinstall the top cover.

9. Reconnect the DFP-1000B to its 11-16 VDC power source, power-up the unit, and confirm proper operation.

## SECTION VI - SIMPLIFIED THEORY OF OPERATION

In the most general sense, all non-rotating radio direction finding systems employ a DF antenna having an array of spatially-displaced aerials (three or more are required for unambiguous operation) that are illuminated by the received signal wavefront. The resulting voltages produced by these aerials exhibit characteristics (phase, amplitude, or both) that are then measured. Since these characteristics are unique for every received azimuth in a properly designed DF antenna, the wavefront angle-of-arrival (bearing) can be ascertained by appropriately processing and analyzing the aerial output voltages.

The specific DF technique employed by the DFP-1000B and its associated antennas is known as the *single-channel Watson-Watt DF technique*. A single-channel Watson-Watt DF system can be broken down into the following four basic functional blocks:

1. DF Antenna
2. DF Receiver
3. DF Bearing Processor
4. DF Bearing Display

Essentially, the DF antenna intercepts the incoming wavefront, appropriately processes the signal and feeds it to the DF receiver. The DF receiver further processes the signal, demodulates it, and feeds it to the DF bearing processor. The DF bearing processor then further processes the signal and converts it into a format suitable for driving the DF bearing display.

A standard Watson-Watt DF system employs either Adcock or loop DF antennas, with Adcocks usually preferred because of their superior performance. Actually, the DF antenna is really an array of three separate but co-located antennas. Referring to a 4-aerial Adcock configuration, the first of these antennas is the N-S bi-directional array comprising the north and south aerials. As illustrated in Figure 8 below, the resulting figure-of eight gain pattern consists of circular lobes with maximum sensitivity to the north and south and nulls to the east and west. This figure-of-eight gain pattern is obtained by applying the N and S aerial voltages to a *differencing* network that vectorially subtracts them (N-S).

The second of these antennas is the E-W bi-directional array comprising the east and west aerials. Again as illustrated in Figure 8, its gain pattern is identical to that of the N-S bi-directional array, but orthogonally oriented (as a consequence of the fact that the two arrays are physically at right angles to each other). This pattern is again obtained by applying the E and W aerial voltages to a differencing network that vectorially subtracts them (E-W).

The third of these antennas is the omni-directional sense antenna. In early Adcock designs, a *central* sense antenna was implemented using a single aerial physically centered in the Adcock array. Most modern Adcock antennas employ a *derived* sense antenna configuration whereby the omni-directional pattern is derived by vectorially *summing* the output voltages of all four aerials. This omni-directional sense gain pattern is illustrated in Figure 8. The sense antenna is required to resolve a 180° bearing ambiguity that would otherwise result. Early Watson-Watt DF systems required three separate but very carefully matched receivers to process the three DF antenna outputs. Since this was expensive and it was operationally difficult to maintain the precise gain and phase matching among the three receivers necessary for good bearing accuracy, an antenna axis tone encoding (modulation) scheme was developed so that all three DF antenna outputs could be combined into a single composite output that could be fed to a single receiver. Essentially, this is done by amplitude modulating the N-S bi-directional output with one tone and the E-W bi-directional output with another. The receiver then processes this composite signal in the standard fashion and recovers the two tones (whose respective amplitudes are now proportional to the two bi-directional antenna outputs) from its AM demodulator. These two tones are then fed to the DF bearing processor where they are separated and converted into proportional DC voltages, which in turn drive the bearing display.

Analog bearing displays are typically two-phase devices such as a CRT or magnetically controlled mechanical pointer. For a CRT display, these two DC voltages drive the CRT X and Y deflection amplifiers, resulting in a true real-time polar bearing display. For a mechanical pointer display, these two DC voltages drive the X and Y deflection coils.

Bearings can also be computed in software and then displayed in a variety of different formats. This is typically accomplished by first converting the two DC voltages to a digital format using an analog-to-digital converter. The resulting digitized representation of the DC voltages is then fed to a microprocessor, which in turn computes the bearing in software using a 4-quadrant arc-tangent algorithm. Once the bearing has been computed, the microprocessor can then drive one or more of several different bearing displays, including azimuth rings, numeric displays, or even computer-generated representations of analog bearing displays (as is done in DFP-1000B).

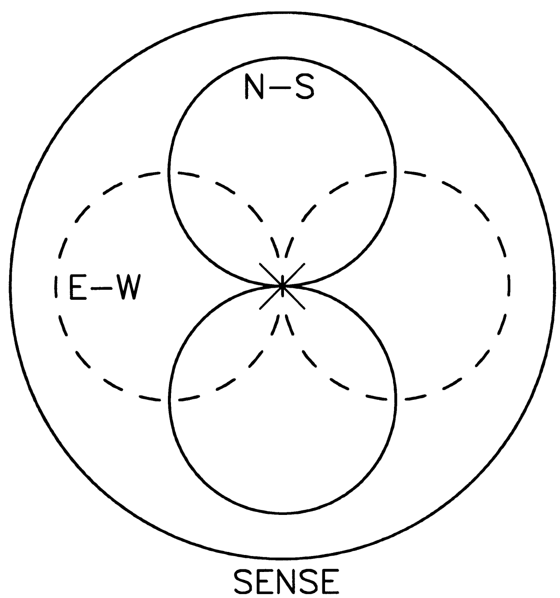


**Figure 8 - Adcock DF Antenna Gain Patterns**

For a more detailed explanation of the Watson-Watt DF technique, see RDF Products Web Note WN-002 ("Basics Of The Watson-Watt DF Technique"). WN-002 can be downloaded from the RDF Products website at www.rdfproducts.com and is also included on the RDF Products Publications CD.

# SECTION VII - APPENDIX

## A. VENDOR LIST

During the course of installing, operating, and maintaining DF systems, it is sometimes necessary to obtain additional or replacement plugs, connectors, cables, and miscellaneous other components. We have found the following vendors (listed in alphabetical order) to be convenient to do business with based on their low minimum order requirements, willingness to accept telephone orders and credit cards, and prompt response:

1. Digi-Key Corporation
   701 Brooks Ave. South
   Thief River Falls, MN 56701
   1-800-344-4539

2. Hosfelt Electronics, Inc.
   2700 Sunset Blvd.
   Steubenville, OH 43952-1158
   1-800-524-5414

3. Jameco Electronics
   1355 Shoreway Road
   Belmont, CA 94002-4100
   1-800-831-4242

4. Kar-Rite International
   3737 N. Acorn Ave.
   Franklin Park, IL 60131

5. Mouser Electronics
   958 North Main Street
   Mansfield, TX 76063-4827
   1-800-346-6873

6. Radio Shack
   (worldwide)

We particularly recommend Hosfelt Electronics for mobile radio connectors and Kar-Rite International for vehicle rain gutter hooks. These hooks can also be obtained locally in many cases from automotive and sporting goods stores.

## B. FIRMWARE UNLOCK CODE

In some instances the DFP-1000B is shipped with a firmware timer that allows the unit to run normally for a specified period (approximately 4 hours) after which the unit "times-out" and is no longer functional. To restore operation, an unlock code must be sent to the DFP-1000B from a host computer. When the unlock code is entered, the time-out is permanently lifted to allow the unit to function normally. *This unlock code must be obtained from RDF Products.*

The appropriate unlock procedure depends upon whether the DFP has already timed-out or not. If the DFP has *already timed-out*, use the procedure that begins on the following page. If the DFP has *not yet timed-out* (i.e., if it is still functioning normally), proceed as follows:

1. Set the DFP-1000B MODE/DF RESPONSE switch to REMOTE and then power-up (or restart) the unit (for a DFP-1010B, just power-up normally). Allow 10 seconds to boot-up.

2. Connect a Windows PC to the DFP HOST COMPUTER port using the supplied "straight-thru" DB9 serial cable. Once done, start DefCon2b (the Windows graphical user interface program included on the RDF Products Publications CD supplied with this manual). If DefCon2b has not yet been installed on the PC, install it at this time as per the installation instructions provided in the DefCon2b Operator's Manual (also included on the Publications CD). *Be sure to use DefCon2b V1.2.9 or higher*.

3. Verify that DefCon2b is communicating with the DFP by clicking the **Status** button and verifying that both lights are green. If there is a problem, check the cable connection and the DefCon2b com port settings. Refer to the DefCon2b Operator's Manual as required.

4. Once communications have been established, click **Configure** followed by **Chat Mode...** and then **OK**.

5. When the chat mode screen appears, select an appropriate com port, a 19200 baud rate, and then click **Open** to establish communications as per Section VI of the DefCon2b Operator's Manual. (An error message will appear if an incorrect com port is selected).

6. Enter **MODEL** and verify that the DFP returns: **DFP-10x0B/FIRMWARE REV. B.xx.xx**. (*Important! - Do not skip this essential step.*)

7. Enter **UNLOCK**. This will generate the following prompt: ***ENTER AUTHORIZATION CODE (6-DIGIT ALPHA-NUMERIC)**. Enter this 6-digit code at this time (all uppercase).

8. If the correct authorization code is entered, the following prompt will appear: ***DFP IS NOW UNLOCKED - POWER DOWN AND RESTART**. The DFP will then function normally after it is restarted and the time-out restriction will be permanently lifted.

9. If an incorrect authorization code is entered, the following prompt will appear: ***INVALID AUTHORIZATION CODE - POWER-DOWN DFP AND REPEAT PROCEDURE**. To reenter the authorization code, power-down the DFP, leave it off for several seconds, and then again power-up. After allowing 10 seconds for the DFP to boot-up, repeat this procedure starting from step 6.

10. If an unexpected result occurs, verify all settings and connections, restart the DFP, and repeat this procedure starting from step 6.

If the DFP has *already timed-out* (i.e., if it is non-functional), proceed as follows:

1. Set the DFP-1000B MODE/DF RESPONSE switch to REMOTE and then power-up (or restart) the unit (for a DFP-1010B, just power-up normally). Allow 10 seconds to boot-up.

2. Connect a Windows PC to the DFP HOST COMPUTER port using the supplied “straight-thru” DB9 serial cable. Once done, start DefCon2b (the Windows graphical user interface program included on the RDF Products Publications CD supplied with this manual). If DefCon2b has not yet been installed on the PC, install it at this time as per the installation instructions provided in the DefCon2b Operator’s Manual (also included on the Publications CD). *Be sure to use DefCon2b V1.2.9 or higher*.

3. Since the DFP has already timed-out, it will not be able to communicate with DefCon2b. As a result, the **COMMUNICATION ERROR** message will appear within 30 seconds or so. When this message appears, click the **DEMO MODE** button. After another 30 seconds or so, DefCon2b will launch into its Demo mode. Refer to the DefCon2b Operator’s Manual as required.

4. Once DefCon2b enters its Demo mode, click **Configure** followed by **Chat Mode...**.

5. When the chat mode screen appears, select an appropriate com port, 19200 baud rate, and then click **Open** to establish communications as per Section VI of the DefCon2b Operator’s Manual. (An error message will appear if an incorrect com port is selected).

6. Enter **MODEL** (this command will elicit no response). *Important! - Do not skip this essential step.*

7. Enter **UNLOCK**. This will generate the following prompt: ***ENTER AUTHORIZATION CODE (6-DIGIT ALPHA-NUMERIC)**. Enter this 6-digit code at this time (all uppercase).

8. If the correct authorization code is entered, the following prompt will appear: ***DFP IS NOW UNLOCKED - POWER DOWN NOW AND RESTART**. The DFP will then function normally after it is restarted and the time-out restriction will be permanently lifted.

9. If an incorrect authorization code is entered, the following prompt will appear: ***INVALID AUTHORIZATION CODE - POWER-DOWN DFP AND REPEAT PROCEDURE**. To reenter the authorization code, power-down the DFP, leave it off for several seconds, and then again power-up. After allowing 10 seconds for the DFP to boot-up, repeat this procedure starting from step 6.

10. If an unexpected result occurs, verify all settings and connections and repeat this procedure from the beginning.

## C. INTERFACING THE DFP-1000B TO THE HOST RECEIVER

### 1. OVERVIEW

There are three methods available to establish a signal interface between the DFP-1000B and the external host receiver:

1. 10.7 MHz IF interface

2. Custom IF interface

3. AM audio interface

The relative merits of these interface options are discussed below. Since interfacing methods may require modifications to the host receiver, the necessarily brief discussion below can only highlight the issues involved. Contact us if you need additional technical information.

### 2. 10.7 MHz IF INTERFACE

Overall, the 10.7 MHz IF interface is generally the most satisfactory option. Many host receivers already have 10.7 MHz 50 ohm IF outputs (often intended for use with external signal monitors). If this is the case, no host receiver modifications are necessary (a very compelling advantage for most users). If a 10.7 MHz IF output port must be added to the host receiver, the signal pick-off point should be far enough along the signal path to where there is sufficient gain to establish the noise figure, but prior to any switched selective IF filters or major AGC action. The interface circuitry should be designed so that it brings out the 10.7 MHz IF without adding significant noise while at the same time not disrupting receiver operation. The signal pick-off point should never be preceded by non-linear amplifier stages (an FM limiter, for example). The 10.7 MHz IF output should be connected to the DFP-1000B rear-panel **SIGNAL INPUT** BNC connector via a short 50 ohm coaxial cable.

Some receivers have excessively high gain 10.7 MHz IF outputs. Although these are usable, best performance is obtained when the net gain between the host receiver RF input and 10.7 MHz IF output port (with any AGC disabled) is 0-10 dB.

### 3. CUSTOM IF INTERFACE

Since some host receivers have IF outputs other than 10.7 MHz, the DFP-1000B can be ordered with a custom IF interface to accommodate such receivers. As a case in point, high-end surveillance receivers often have 21.4 MHz IF outputs. The DFP-1000B can be ordered with custom IF interface frequencies from 20-75 MHz. As per Section III-B-3, configuration dip-switch #4 allows users to select either the custom or 10.7 MHz IF. Performance with the custom IF is the same as that for the standard 10.7 MHz IF.

## 4. MISCELLANEOUS IF INTERFACE ISSUES

If the host receiver signal pick-off point follows the selectable IF filters, DF performance degradation will likely occur when the IF bandwidth is changed. This occurs as a result of the fact that the group delay of the various IF filters is generally different, and delay compensation can be optimized for only one IF bandwidth.

For best DF performance, IF bandwidths under 6 kHz should not be used. In addition, the host receiver AGC is unlikely to be optimized for best DF performance, which in turn can cause some degradation in bearing accuracy or ability to DF on short duration signals. If the host receiver has selectable AGC, best bearing accuracy is obtained when the AGC is set for slow decay. Ability to DF on short duration signals is enhanced when the AGC has a fast attack and settling time.

## 5. AM AUDIO INTERFACE

An AM audio interface usually requires that a signal pick-off point be created at the AM demodulator output (without loading it down) to provide an AM audio output port (since few host receivers have an AM demodulator output port, it almost invariably must be added). The interface circuitry must preserve flat frequency and linear phase response from approximately 100-3000 Hz (this requirement usually precludes using the standard receiver audio output, since most receivers roll-off the audio frequency response below 250 Hz).

Many receivers disable the AM demodulator when other reception modes are selected. This requires either circuit modifications to prevent AM demodulator shut-down, or the inconvenient operational requirement of switching the receiver to AM for DF purposes. This latter requirement is particularly undesirable, since it precludes simultaneous DF and listen-through capability for all but AM signals. This same shortcoming exists for host receivers having a single demodulator output that is switched with reception mode (i.e., if the receiver is switched to FM mode, the demodulator output port becomes an FM audio output which is not useable for an audio signal interface).

Regardless of whether the AM demodulator output is brought out of the host receiver via a provided demodulator output port or by means of user-added circuitry, another issue that must be addressed is any possible phase inversion of the AM audio signal. A phase inversion can be caused either by a phase-reversed AM demodulator or an inverting post-AM demodulator signal amplifier. Such a phase inversion will result in bearing reversals (i.e., bearings will be 180° out). If a phase inversion cannot be conveniently avoided, the resulting bearing reversal can be corrected via the **NOR/RCP** dip-switch (#3). See discussion of bearing reversals in the Troubleshooting Guide (Section V-D).

If the host receiver has selectable IF bandwidths, DF performance degradation can occur when the IF bandwidth is changed. This occurs as a result of the fact that the group delay of the various IF filters is generally different, and delay compensation can be optimized for only one IF bandwidth. IF bandwidths under 6 kHz should not be used. In addition, the host receiver AGC is unlikely to be optimized for best DF performance, which in turn can cause some degradation in bearing accuracy and ability to DF on short duration signals. If the host receiver has selectable AGC, best bearing accuracy is obtained when the AGC is set for slow decay. Ability to DF on short duration signals is enhanced when the AGC has a fast attack and settling time.

The receiver AM demodulator output should be connected to the DFP-1000B rear-panel **SIGNAL INPUT** BNC jack. Although the input impedance is high, the receiver AM demodulator output impedance should be 600 ohms or less.

## 6. RECOMMENDATIONS

The 10.7 MHz (or custom) IF interface is nearly always the best choice. If the 10.7 MHz pick-off point precedes any switched IF filters, and if there is little or no AGC action prior to the 10.7 MHz pick-off point, and if the 10.7 MHz pick-off circuitry is such that the signal-to-noise ratio at the 10.7 MHz IF output port is not degraded, DF sensitivity, bearing accuracy, and ability to DF on short duration pulses will be identical to that which can be achieved using an integrated DF receiver/bearing processor that has been specifically optimized for DF performance.

## 7. HOST RECEIVER ISSUES AND RECOMMENDATIONS

Host receivers can be found that sell for as little as a few hundred dollars at the low end to up to tens of thousands of dollars at the high end (with corresponding levels of quality and performance). Most users will want a host receiver that is economical, yet with quality commensurate with that of the overall DF system and also suitable for the anticipated applications.

Fundamentally, most candidate host receivers fall into the three following cateogies:

1. Surveillance Receivers - Surveillance receivers are very high-quality units designed for electronics warfare, wideband spectrum monitoring, and other high-end applications. In addition to their excellent sensitivity and selectivity, surveillance receivers also have excellent spurious response rejection (e.g., image and IF rejection) and a minimum of internally generated spurious signals (i.e., “birdies”). Furthermore, these receivers also have excellent adjacent channel rejection and exceptional strong-signal handling capability. Although surveillance receivers work spectacularly well as host receivers for the DFP-1000B, their high cost (typically in excess of $20,000) places these units out-of-budget for all but the most high-end applications.

2. Communications Receivers - Consumer-market communications receivers have been on the market for over 20 years and now offer wide frequency coverage, good sensitivity, and many features. Even the high-end consumer-market communications receivers are relatively inexpensive (with typical pricing in the $1,800 - $2,600 range). Although high-end communications receivers offer frequency coverage and sensitivity comparable to that of surveillance receivers, they are not nearly as good with respect to some of the more subtle receiver specifications including spurious response rejection, internally generated spurious signals, adjacent channel rejection, and strong-signal handling capability. Even so, these high-end communications receivers are excellent values and extremely cost-effective for all but the most demanding applications.

3. Scanner Receivers - Scanner receivers are actually low-end communications receivers. Like their high-end counterparts, they offer wide frequency coverage and many features. Unfortunately, since these receivers are designed for a highly budget-conscious market, they suffer from many serious performance compromises. Although these units are extremely cost-effective for low-end applications, they are plagued by poor spurious response rejection, large numbers of internally-generated spurious signals, inferior adjacent channel rejection, and poor strong-signal handling capability.

   Most scanner receivers are also designed for compactness, which further contributes to these performance trade-offs. Even so, overall system compactness is often important in mobile DF applications where the system must be deployed in a small vehicle. It is for this reason that appropriately selected scanner receivers are often good candidates as host receivers in mobile DF applications.

## 7. RECOMMENDED HOST RECEIVERS

There are a wide variety of modestly priced consumer-market receivers available having wide frequency coverage that are suitable as external receivers for the DFP-1000B. The ICOM R7000, R7100, and R8500 are especially well recommended for VHF/UHF applications. The AOR AR5000A also works very well in this same frequency range. The R8500 and AR5000A also work well for applications under 30 MHz. In fact, almost any receiver that can meet the interface requirements discussed above will work well.

With regard to frequency coverage capability, it is also necessary to procure one or more appropriate RDF Products DF antennas whose frequency coverage is commensurate with mission requirements.

## D. DFP-1000B REAR-PANEL MULTI-PIN CONNECTOR PIN-OUTS

Refer to Figure 9 below for illustrated pin-outs of the DFP-1000B rear-panel multi-pin connectors.

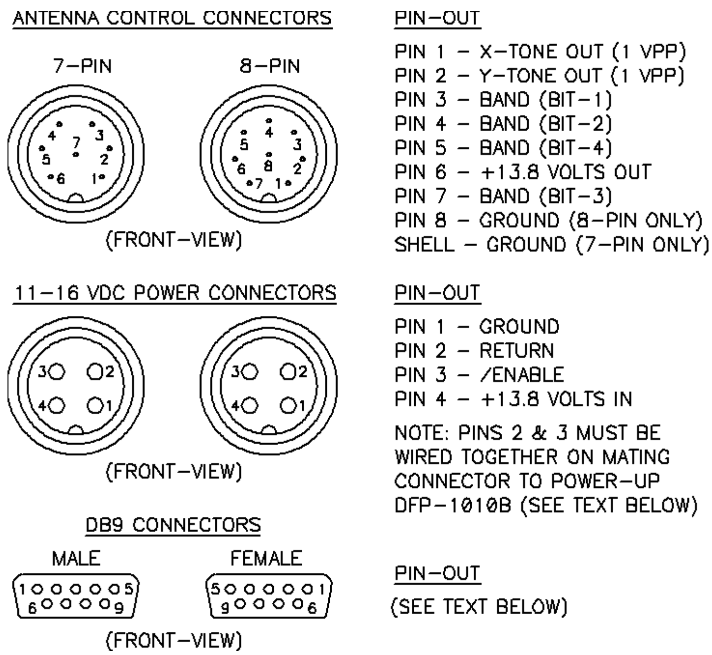


**Figure 9 - DFP-1000B Rear-Panel Multi-Pin Connector Pin-Outs**

With regard to the Antenna Control connector, both 7- and 8-pin versions are illustrated. Although the 8-pin version is standard for the DFP-1000B, some units are supplied with the 7-pin version (used on the earlier DFP-1000/DFP-1000A models) upon customer request for reasons of compatibility.

The DB9 connectors are employed for interfacing with the host computer, host receiver, digital compass, GPS receiver, and remote display. The DB9 pin-outs associated with these interfaces are presented in the table below (note that TXD = data out; RXD = data in).

| DB9 Pins ........................ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | M/F |
|---|---|---|---|---|---|---|---|---|---|---|
| Host Computer - | NC | TXD | RXD | NC | GND | NC | NC | NC | NC | F |
| Host Receiver - | NC | RXD | TXD | NC | GND | NC | NC | NC | +11V | M |
| Digital Compass - | NC | RXD | NC | NC | GND | NC | NC | NC | +11V | M |
| GPS Receiver - | NC | RXD | NC | NC | GND | NC | NC | NC | +11V | M |
| Remote Display - | NC | TXD | NC | NC | GND | NC | NC | NC | NC | F |

**Note:** +11V power is applied to pin 9 of the GPS receiver and digital compass DB9 connectors by setting configuration dip-switches #6 (GPS EN) and #8 (CMPS EN) to UP.

**** WARNING****

GPS receivers and digital compasses are supplied with various interface cable termination styles. Before connecting the interface cable to the DFP-1000B rear-panel GPS Receiver or Digital Compass connectors, it is *essential* that the user take the necessary steps to ensure a proper interface. *Failure to take this precaution may result in damage to the GPS receiver or digital compass.*

If the GPS receiver or digital compass is unterminated, the user must install a DB9 male connector wired in conformance with the pin-outs listed in the above table. If the cable is already terminated, it is likely that the user will have to re-terminate the cable or construct a suitable adaptor. *It is solely the user's responsibility to wire the cable or adaptor correctly. RDF Products is not liable for any damage that occurs as a result of any wiring error made by the user.*

As per the above table, +11 VDC is available at pin 9 of the DFP-1000B GPS Receiver and Digital Compass rear-panel connectors. The purpose of this provision is to allow more convenient connection of DC power to the GPS receiver or digital compass (i.e., to avoid the inconvenience of the requirement for an additional connection to the DC power source). Since most GPS receivers and digital compasses do not accommodate a DC power connection through the DB9 interface (many models have a separate DC power cable), users will have to wire their own DB9 terminations to take advantage of this feature.

If the user intends to take advantage of this +11 VDC output feature, *it is essential that the GPS receiver or digital compass be rated for +12 VDC operation.* Although many models are, other models are rated for +5 VDC operation and therefore could not be safely run from +11 VDC.

Most host computer serial ports are DB9 male. Such computers require a DB9 male-to female "straight-thru" type cable to connect to the rear-panel Host Computer connector. This cable is supplied with the DFP-1000B.

Host receivers typically employ DB9 female remote control connectors, which typically require a DB9 male-to-female "straight-thru" type cable to connect to the rear-panel Host Receiver connector.

As per Section II-B-4, the two 4-pin DC power connectors are parallel-wired to facilitate a convenient DC power outlet for the host receiver. A subtlety associated with the *DFP-1010B only* is that pins 2 &3 must be wired together (inside the mating connector) to power-up the unit (see Figure 9). This is not an issue if the supplied DPC-030 DC power cable is used (since pins 2 & 3 are internally connected inside the mating connector), but users assembling their own cables must wire these two pins together in order for the DFP-1010B to power-up. The rationale for this requirement is explained in detail in Appendix K. These pins need not be wired together for DFP-1000Bs.

## E. RDF PRODUCTS MOBILE & FIXED-SITE DF ANTENNAS

The RDF Products DMA-Series of mobile DF antennas comprise a family of VHF/UHF monopole Adcock single-channel radio direction finding antennas covering one or more bands in the 20-1600 MHz range. These rugged, compact, light-weight, weather-sealed units are specifically designed for mobile DF applications and are easily installed on cars, vans, aircraft, or any platform having a sizeable metallic ground plane (see Section II-B-2 for detailed installation instructions for RDF Products DF antennas). A foam pad on the underside prevents marring or scratching of cosmetic surfaces. Typical single- and multi-band DMA-Series mobile DF antennas are illustrated in Figures 10-12 below.

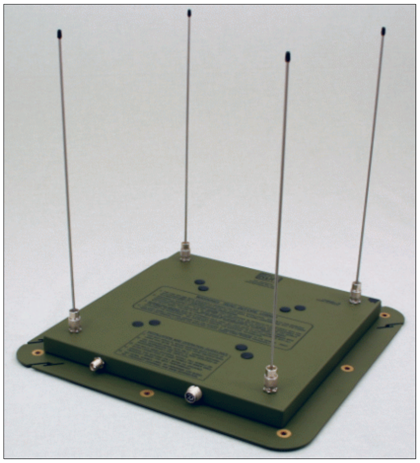

**Figure 10 - DMA-1310B1 75-300 MHz Mobile Adcock**

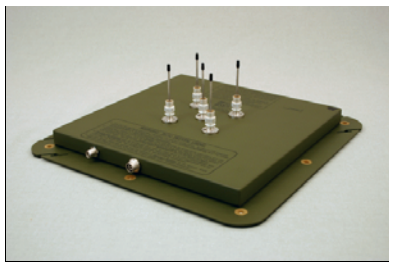

**Figure 11 - DMA-1418B1 370-1000 MHz Mobile Adcock**

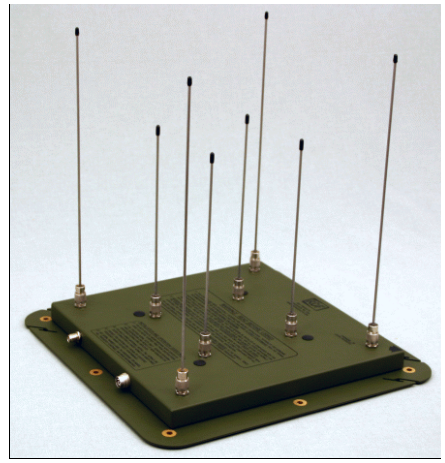

**Figure 12 - DMA-1276B1 27-520 MHz Mobile Adcock**

All DMA-Series DF antennas have been designed with superb signal handling capability for reliable performance in the dense signal environments typically encountered in urban areas.

All DMA-Series DF antennas directly interface with all RDF Products DF receivers and bearing processors via a detachable 4.5 meter interface cable set. Bandswitching is accomplished via a 4-bit static parallel code sent from the DFP-1000B.

Although we strongly recommend RDF Products mast-mounted DF antennas for permanent or semi-permanent fixed-site DF installations, users have reported some success using DMA-Series antennas in these applications. For best results in such applications, observe the following guidelines:

1. Mount the DF antenna on the largest metallic ground plane feasible. For best bearing accuracy, the ground plane should be round or square with the DF antenna at the center.

2. Directly connect the DF antenna baseplate to the ground plane. Eight mounting holes from which paint has been cleared for good electrical contact are provided for this purpose on flanged baseplates.

3. Locate the DF operator's console beneath the ground plane, and locate the entire site in such a fashion that it is as free as possible from surrounding obstructions.

For additional important information regarding RDF Products DF antennas, also see Appendix

F (DF Antenna Frequency Coverage Information) and the appropriate RDF Products DF antenna product data sheets.

RDF Products also supplies fixed-site DF antennas designed to be permanently installed on towers or masts (see Figure 13). These units are H- or sleeve-dipole Adcocks that are supplied with special isolation masts that decouple the antenna from the tower or other support structure for best performance. Refer to the associated product data sheets and operator's manuals for these antennas for detailed installation and operating information.

**Figure 13 - DFA-1310B1 75-300 MHz Fixed-Site H-Dipole Adcock**

## F. DF ANTENNA FREQUENCY COVERAGE INFORMATION

### 1. CURRENT DF ANTENNA MODELS & FREQUENCY COVERAGE

A list of RDF Products DF antenna model numbers (as of this writing) and corresponding frequency coverage is presented below:

| DF Antenna Model | Frequency Coverage (MHz) | Mobile/Fixed-Site |
|---|---|---|
| DFA-1248B1 | 20-88/88-174 | Fixed-Site |
| DFA-1310B1 | 75-300 | Fixed-Site |
| DFA-1325B1 | 80-300/300-1000 | Fixed-Site |
| DFA-1405B1 | 300-1000 | Fixed-Site |
| DMA-1248B1 | 20-88/88-200 | Mobile |
| DMA-1254B1 | 20-88/88-200/200-470 | Mobile |
| DMA-1265B1 | 20-88/88-200/200-450/450-1000 | Mobile |
| DMA-1272B1 | 27-88/88-300 | Mobile |
| DMA-1276B1 | 27-88/88-250/250-520 | Mobile |
| DMA-1276B2 | 27-88/88-250/250-520 | Mobile |
| DMA-1286B1 | 27-88/88-350/350-1000 | Mobile |
| DMA-1309B1 | 80-220 | Mobile |
| DMA-1310B1 | 75-300 | Mobile |
| DMA-1310B2 | 75-300 | Mobile |
| DMA-1315B1 | 80-250/250-520 | Mobile |
| DMA-1315B2 | 75-300/300-520 | Mobile |
| DMA-1325B1 | 75-350/350-1000 | Mobile |
| DMA-1325B2 | 80-300/300-1000 | Mobile |
| DMA-1349B1 | 148-470 | Mobile |
| DMA-1366B1 | 220-520 | Mobile |
| DMA-1418B1 | 370-1000 | Mobile |

Since new models are added regularly, check the RDF Products website for the most current listing.

All RDF Products DF antennas have their frequency coverage and band selection information listed on their serial number labels. Aso, all of the above listed models contain “personality modules” that store model, frequency coverage, and band selection information that can be polled by the DFP-1000B. See Section IV-C-7 for a fuller explanation of this feature.

The earlier RDF Products “R-series” DF antennas (e.g., the DMA-1315R0, DMA-1418R0, DFA-1310R0, etc.) can also be used with the DFP-1000B with the following caveats:

1. The 7-pin mobile radio connector terminating the antenna control cable must be replaced with an 8-pin version (or an adapter must be made) for compatibility with the DFP-1000B.

2. Since the earlier antennas do not contain personality modules, the DFP-1000B will not be able to take advantage of this feature.

3. The band selection information listed on the serial number labels of these earlier antennas is not valid when these antennas are used with the DFP-1000B (see below).

## 2. DFP-1000B DF ANTENNA BAND SELECTION CONVENTION

For the RDF Products "B-series" DF antennas, DFP-1000B band selection always begins with Band 01 for the lowest frequency band, followed by Band 02 for the next higher band, Band 03 for the next higher band, etc. To illustrate this convention by example, consider the DMA-1276B-1, which covers 27-88/88-250/250-520 MHz in three bands. The band assignments are as follows:

| DMA-1276B-1 Band | DFP-1000B Band Selection |
|---|---|
| 27-88 MHz | Band 01 |
| 88-250 MHz | Band 02 |
| 250-520 MHz | Band 03 |

If the user inadvertently selects a band higher than the highest valid antenna band, the DF antenna will default to its highest band. Again using the above example, DFP-1000B Bands 04-15 will be read by the DMA-1276B-1 as Band 03.

Of course, if the user takes advantage of the DMA-1276B-1 antenna personality module by first enabling the DFP-1000B ANT CHECK feature, the actual frequency bands (rather than band numbers) will appear on the display. We strongly recommend that this powerful feature be used since it will greatly reduce the likelihood of improper DF antenna band selection. For single-band DF antennas (e.g., the DMA-1310B-1 and DMA-1418B-1), it does not matter which band is selected.

As mentioned above, the band selection information listed on the serial number labels of the earlier RDF Products "R-series" DF antennas is not valid when these antennas are used with the DFP-1000B. The correct band numbers are listed below:

| "R-series" Antenna Band | DFP-1000B Band Selection |
|---|---|
| Band 03 | Band 01 |
| Band 04 | Band 02 |
| Band 05 | Band 03 |
| Band 06 | Band 04 |
| Band 07 | Band 05 |
| Band 08 | Band 06 |
| Band 09 | Band 07 |

Similarly, if a "B-series" antenna is used with a DFP-1000A:

| "B-series" Antenna Band | DFP-1000A Band Selection |
|---|---|
| Band 01 | Band 03 |
| Band 02 | Band 04 |
| Band 03 | Band 05 |
| Band 04 | Band 06 |
| Band 05 | Band 07 |
| Band 06 | Band 08 |

Band 07 Band 09

## G. HUNTMASTER DIGITAL MAPPING SOFTWARE

HuntMaster is a technically sophisticated digital mapping software package expressly written for use with RDF Products DF equipment. When used in conjunction with a DFP-10x0B DF processor, a GPS receiver, and an optional digital compass, it is capable of generating a moving map display showing the position of one or more DF stations and their associated lines-of-bearing to the intercepted signal source. This information can then be used to locate the signal source by means of triangulation.

HuntMaster can accommodate a virtually unlimited number of DF stations and includes capabilities for networking these stations together via TCP/IP. For a more detailed explanation of HuntMaster's capabilities, users can download the HuntMaster Brochure from the RDF Products website.

Unlike RDF Product's DefCon2b DF system operating software (See Appendix N-2) which is supplied at no additional charge, HuntMaster is supplied as an extra-cost option.

## H. DIGITAL COMPASS ISSUES

A difficulty is encountered in mobile digital mapping applications in that the DF bearings must be *absolute* (with respect to the map coordinates) rather than *relative* to the DF antenna orientation (which is constantly changing in any mobile DF application). In other words, *the DF bearings are only useful for mapping applications if the vehicle is oriented so that the DF antenna points toward north.* Of course, requiring that the vehicle have a specific orientation is an unrealistic constraint, so it is necessary that a method be found that can convert the relative bearing to an absolute bearing.

In principle, this can be done manually with an ordinary hand-held compass. To accomplish this, the compass would be oriented so that its 0° direction matches the 0° direction of the DF antenna (which would normally be coincident with the forward direction of the vehicle). Absolute DF bearings could then be computed by subtracting the compass bearing from the DF bearing, regardless of vehicle orientation.

Although this manual correction technique is conceptually correct, it would be far too slow and cumbersome for real-time mobile DF applications. A more practical approach is to employ an electronic compass that outputs its bearings in digital format to the DF processor that has the capability to implement these corrections automatically.

The DFP-1000B has this capability. When a standard NMEA-0183 output digital compass is connected to the rear-panel **DIGITAL COMPASS** jack, the DFP-1000B can automatically offset the relative DF bearings to convert them to absolute bearings.

There are some practical difficulties, however, that users must address. First, it is necessary that the digital compass physical orientation match that of the DF antenna as discussed above. A more troublesome issue is that of digital compass calibration and accuracy. Digital compasses are used mostly in marine applications where the unit is typically mounted atop a mast with few metallic obstructions. Unfortunately, such ideal siting conditions are very difficult to obtain in a typical mobile DF installation. As a result, inaccuracies are likely to occur.

If the vehicle is in motion, absolute bearings can alternatively be computed in the mapping software based on successive positioning information from the GPS receiver. In other words, the GPS inputs can be used to plot the line of vehicle travel on the map. Once this travel line is established, the orientation of the vehicle is then known (without the need for a digital compass).

As long as the vehicle is in motion, the GPS-based solution is preferred since it avoids the above-mentioned siting and calibration issues associated with the digital compass. If it is necessary that the vehicle must obtain corrected bearings when the vehicle is stationary, however, then the digital compass will have to be relied upon to obtain these corrections.

For DF tracking and homing applications, mapping software, GPS receivers, and digital compasses are usually unnecessary.

# I. RDF PRODUCTS TECHNICAL LITERATURE

## 1. APPLICATION NOTES

RDF Products believes that the best customer is an informed customer and therefore publishes Application Notes from time to time in an effort to illuminate various aspects of DF technology. A listing and synopsis of current Application Notes is presented below. These Application Notes are included on the RDF Products Publications CD or can be conveniently downloaded from the RDF Products website at www.rdfproducts.com. The following Application Notes are currently available:

**AN-001** "A User's Guide: How To Shop For A Radio Direction Finding System" (March, 2000). ***A "must read" for the serious DF system customer***. Helps the prospective buyer untangle the mysteries of the DF equipment selection process so that informed and cost-effective purchasing decisions can be made. Topics include budgetary considerations, fundamental DF system configurations, mobile versus fixed-site DF systems, attributes of professional-quality DF systems, plus evaluating and dealing with the DF equipment vendor.

**AN-002** "A Comparison Of Loop And Adcock Antennas For Single-Frequency Fixed-Site RDF Applications" (June, 1994). Discusses the relative merits of Adcock and loop DF antennas for fixed-site applications using a 30 MHz installation as an example. Illustrates in detail the inferiority of both ferrite and brass loops in comparison to Adcocks in terms of both bearing accuracy and sensitivity.

**AN-003** "Measuring Bearing Accuracy Of Mobile Adcock RDF Antennas" (October, 1994). Provides an in-depth discussion of the concepts and principles underlying DF system bearing accuracy measurement. Also discusses techniques and procedures that technical users can refer to as a guide for conducting their own bearing accuracy tests. Offers important insights as to how to interpret manufacturer's bearing accuracy specifications, as well as how to avoid "specsmanship" traps.

**AN-004** "Measuring Sensitivity Of Mobile Adcock RDF Antennas" (January, 1995). Provides an in-depth discussion of the concepts and principles underlying DF system sensitivity measurement. Includes detailed information that technical users can refer to for constructing their own reference antennas and test ranges. Offers important insights as to how to interpret manufacturer's DF sensitivity specifications, and how to avoid "specsmanship" traps.

**AN-005** "An Introduction To Dipole Adcock Fixed-Site DF Antennas" (December, 1999). Provides an in-depth discussion of the philosophy underlying dipole Adcock DF antennas for mast-mounted fixed-site applications. Explains the reasons for the vast superiority of dipole Adcocks over elevated ground-plane monopole Adcocks. Discusses the serious problems associated with the presence of the support mast for dipole Adcocks and how RDF Products has overcome these problems.

## 2. WEB NOTES

RDF Products also publishes "Web Notes", which are short papers covering topics of general interest to DF users. These Web Notes are written in an easy-to-read format for users more focused on the practical (rather than theoretical) aspects of radio direction finding technology. These Web Notes are included on the RDF Products Publications CD or can be conveniently downloaded from the RDF Products website at www.rdfproducts.com. The following Web Notes are currently available:

**WN-001** Questions & Answers: A User's Guide to DF Basics

**WN-002** Basics of the Watson-Watt DF Technique

**WN-003** Questions & Answers: A User's Guide to DF Receivers and Bearing Processors

**WN-004** A Comparison of The Watson-Watt and Pseudo-Doppler DF Techniques

**WN-005** Questions & Answers: A User's Guide to Radio Direction Finding System Bearing Accuracy

**WN-006** Questions & Answers: A User's Guide to Radio Direction Finding System Sensitivity

**WN-007** Questions & Answers: A User's Guide to Using Loop Versus Adcock Radio Direction Finding Antennas

**WN-008** Questions & Answers: A User's Guide to Radio Direction Finding Antenna Selection.

**WN-009** Questions & Answers: Selecting the Right DF Receiver/Processor

## 3. OPERATOR'S MANUALS

RDF Products publishes extensive, detailed, and well-illustrated Operator's Manuals for all of its major DF products. We strongly encourage prospective customers to study these manuals as an evaluation aid when considering RDF Products radio direction finding equipment. These Operator's Manuals are included on the RDF Products Publications CD or can be conveniently downloaded from the RDF Products website at www.rdfproducts.com.

## 4. PRODUCT DATA SHEETS

RDF Products publishes Product Data Sheets with detailed technical specifications for all of its major equipment and accessories. These Product Data Sheets are included on the RDF Products Publications CD or can be conveniently downloaded from the RDF Products website at www.rdfproducts.com.

## 5. PUBLICATIONS CD

The RDF Products Publications CD includes all Product Data Sheets, Operator's Manuals, Application Notes, Web Notes, User Functional Test Procedures, Operator's Guides, and Service Bulletins in Adobe Acrobat PDF format, as well as equipment photographs in JPEG format. This CD also includes JPEG equipment photographs as well. To obtain this CD at no charge, we ask that you fax your formal request printed on company letter-head to RDF Products at +1-360-892-0393.

## 6. WEBSITE

RDF Products maintains a comprehensive website at www.rdfproducts.com to provide users with convenient access to information. All Product Data Sheets, Web Notes, Application Notes, Operator's Manuals, User Functional Test Procedures, Service Bulletins, and equipment photographs can be downloaded.

## J. RETURNING EQUIPMENT TO FACTORY FOR REPAIR

Before returning any equipment, it is necessary to first obtain an RMA (return material authorization) number. To obtain this RMA number, fill out the RMA form provided below, sign it, and return it to us via fax or mail.

We request that the RMA form be filled out completely. It is especially important that the "Failure Symptoms" section be filled out in detail, listing all symptoms, along with any background information regarding the circumstances that may have led to the failure (e.g., over-voltage applied to the DC power input). If a problem occurs intermittently or only in specific modes of operation, this should be noted as well. Upon acceptance of this form, we will issue an RMA number.

# *Return Material Authorization (RMA) Form*


***RDF PRODUCTS***

***17706 NE 72nd Street***

***Vancouver, Washington, USA 98682***

*Tel: +1-360-253-2181 Fax: +1-360-892-0393*

*E-Mail: mail@rdfproducts.com*

*Website: www.rdfproducts.com*


## General Instructions:

**RMA # (issued by RDF Products):** ____________________

1. This form must be completed and faxed or mailed to RDF Products prior to returning any equipment for repair. Upon acceptance of this form, RDF Products will provide an RMA number authorizing the user to ship the equipment to RDF Products at the above address. *RDF Products will refuse all repair shipments for which no RMA number has been issued.*
2. A separate RMA form must be prepared for each equipment item to be repaired (e.g., if both a DF processor and DF antenna are to be returned for repair, a separate RMA form must be prepared for each unit).
3. A $120 evaluation charge will be applied to each unit returned for repair. Upon examination of the equipment by RDF Products, a quotation will be submitted for the repair. If the customer accepts the quotation and authorizes the work order, all evaluation charges will be credited toward the quoted amount. If the customer declines the quotation, it will be invoiced for all evaluation charges and returned to the customer freight collect. If in RDF Products' opinion the equipment cannot be reliably or economically repaired, RDF Products will return the equipment to the customer freight collect without action and waive all evaluation charges.
4. For international customers, payment for all charges must be made in advance prior to return shipment.

---

## Customer Identification:

Submit requested customer information below.

Customer Name:

Contact Person:

Date Of Purchase:

Purchase Order Number:

Telephone Number:

Fax Number:

E-Mail Address:

Billing Address:

---

## Equipment Identification:

List the equipment Model and Serial numbers below. This information can be found on the equipment serial number label (typically affixed to the rear-panel of DF receivers/processors or on the underside of DF antennas).

Model Number:

Serial Number:

Warranty Repair? Yes__ No__

---

## Accessories:

List all accessories returned with the above equipment (power cables, interface cables, aerials sets, manuals, spare connectors, etc.). Use the back of this page as required. *RDF Products is not responsible for undeclared accessories*.

## Failure Symptoms:

Provide a detailed description of the equipment malfunction. By making this description as complete as possible, you can help us reduce billable troubleshooting time. Use the back of this page or another sheet of paper as required.

---

## Return Shipping Information:

For domestic repair orders, repaired equipment is returned via UPS ground unless otherwise specified. Freight and insurance charges will be invoiced along with the repair charges. For international orders, equipment will be returned via the customer's specified carrier, with all freight, insurance, and any related shipping charges billed to the customer's account. Be sure to package the equipment in accordance with standard commercial shipping practices for high-value items.

Return Shipping Address (provide full address):

Declared Value For Insurance (US Dollars):

Note: Customer *must* specify insured value for return shipment. If this space is not filled in, RDF Products cannot accept equipment for non-warranty repairs. Check with your carrier's agent for insurance rates.

---

## Customer Authorization:

I hereby authorize RDF Products to proceed under the terms and conditions specified above and in the RDF Products limited warranty below.

Signature______________________________ Title______________________________ Date ____________

# *Limited Warranty*
## *RDF PRODUCTS*

***17706 NE 72nd Street***
***Vancouver, Washington, USA 98682***
*Tel: +1-360-253-2181 Fax: +1-360-635-4615*
*E-Mail: mail@rdfproducts.com Website: www.rdfproducts.com*

**A. WARRANTY OF QUALITY**

1. RDF Products warrants that goods sold to the buyer shall be free from defects in workmanship and materials. In the event that any goods or parts thereof shall prove to be defective in workmanship or materials within a period of one (1) year from the date of shipment, RDF Products shall repair or replace, at its sole discretion, the same at no cost to the buyer provided that the buyer first completes and submits RDF Products' standard RMA (return material authorization) form and obtains an RMA number. RDF Products will refuse all repair shipments for which no RMA number has been issued. An RMA number must be obtained for both warranty and non-warranty repairs.
2. For warranty repairs, the buyer agrees to pay one-way freight and insurance charges for return of equipment to the factory, while RDF Products agrees to pay return freight and insurance charges to the buyer. Any associated duties, tariffs, taxes, and miscellaneous charges shall be paid by the buyer.
3. Except as stated herein, RDF Products shall not be liable for any damages or for the breach of any warranty, expressed or implied, or for any other obligation or liability on account of the goods.

**B. WARRANTY OF CONFORMANCE**

1. RDF Products warrants that at the time of delivery the goods will conform substantially to their published descriptions and specifications only. RDF Products makes no warranty that the goods are suitable for the buyer's intended application.
2. RDF Products' liability and buyer's remedy under this warranty are limited at RDF Products' discretion to replacement of goods returned which are shown to RDF Products' reasonable satisfaction to have been non-conforming or to refund of the purchase price, provided buyer shall have given notice of such non-conformance within 30 days of delivery of goods and that the goods are undamaged.

**C. OUT-OF-WARRANTY REPAIRS**

1. RDF Products warrants that goods returned for out-of-warranty repair shall be free from defects in workmanship and materials for a period of 90 days from the date of return shipment.
2. This warranty applies only to those components or sections of the equipment associated with the malfunction(s) in question.
3. The customer agrees to pay two-way freight and insurance charges, and to specify in writing the insured value for return shipment. Any associated duties, tariffs, taxes, and other charges shall be paid by the customer.
4. The customer agrees to itemize in writing all accessories returned with the goods (power cables, interface cables, aerial sets, manuals, spare connectors, etc.). RDF Products accepts no liability for undeclared accessories.

**D. EQUIPMENT UPGRADES/ IMPROVEMENTS**

1. RDF Products reserves the right to change product specifications and prices without notice, and has no obligation to incorporate product improvements into previously-sold items.
2. At its sole discretion, RDF Products may offer equipment upgrades/improvements. Again at its sole discretion, RDF Products may or may not charge the buyer for these upgrades/improvements.
3. In cases where RDF Products offers upgrades/ improvements at no charge to the buyer, the buyer will be required to pay two-way freight and insurance charges for return of equipment to the factory.

**E. EXCEPTIONS**

1. This limited warranty does not apply to goods that have been damaged as a result of misuse, mistreatment, negligence, modification, or whose serial number label has been altered, moved, removed, or obscured, or for which complete payment has not been received.
2. This limited warranty is also voided for DF antennas that have been opened without written consent from RDF Products.
3. This limited warranty is voided in all cases where the goods have been used in violation of the laws of the United States of America.
4. This limited warranty is voided in all cases where the goods have been diverted to a country or location other than that stated by the customer as the country of ultimate destination. **<>**

## K. DFP-1000B/DFP-1010B MAIN CHASSIS SCHEMATIC DIAGRAM

The DFP-1000B main chassis schematic is presented in Figure 14 below (next page). Note that this schematic is actually common to both the DFP-1000B and DFP-1010B, with annotations included specifying the modules and miscellaneous other components that are deleted for the DFP-1010B. To briefly summarize these deletions:

1. The PDA (A3) and interface cable set is not included in the DFP-1010B.

2. The Front-Panel Board (A6) and its associated cables are not included with the DFP-1010B.

3. The headset jack (J1) and speaker (SP1) and their associated cables are not included with thhe DFP-1010B.

A more subtle difference is that the DFP-1010B includes provision for low-level remote power-up. Referring to main schematic parallel-wired jacks J3 and J4 (the 4-pin 11-16 VDC power connectors), note that pin 3 of these jacks is a power enable pin (/EN) and pin 2 is wired to ground. In order to power-up the DFP-1010B, pin 3 must be connected to ground. If the supplied DC power cable is used, this happens automatically since pins 2 and 3 of the mating power plug are internally connected together (thus automatically grounding pin 3 as soon as the power cable is plugged into J3 or J4).

Users wanting to implement the low-level remote power-up feature can do so using the supplied spare mating power connect plug (which does *not* include a wire jumper connecting pins 2 and 3). With pin 3 left unconnected and floating, the open-circuit voltage on this pin is just under +5 VDC and the DFP-1010B will not power-up. If the voltage at this pin, however, is lowered to 0.7 VDC or less (i.e., a TTL logic “low”), the DFP-1010B will power-up. Since the short-circuit current at pin 3 is just slightly over 1 mA, this pin can be used as a low-level remote power enable input that can be conveniently controlled by a small-signal open-collector transistor or any 5V CMOS logic gate that can sink 1.5 mA.

Unlike the earlier DFP-1010, the DFP-1010B does not have a physical power On/Off switch. The DFP-1000B, of course, does have a power On/Off switch, which is connected to this low-level enable line, grounding it to power-up the unit.

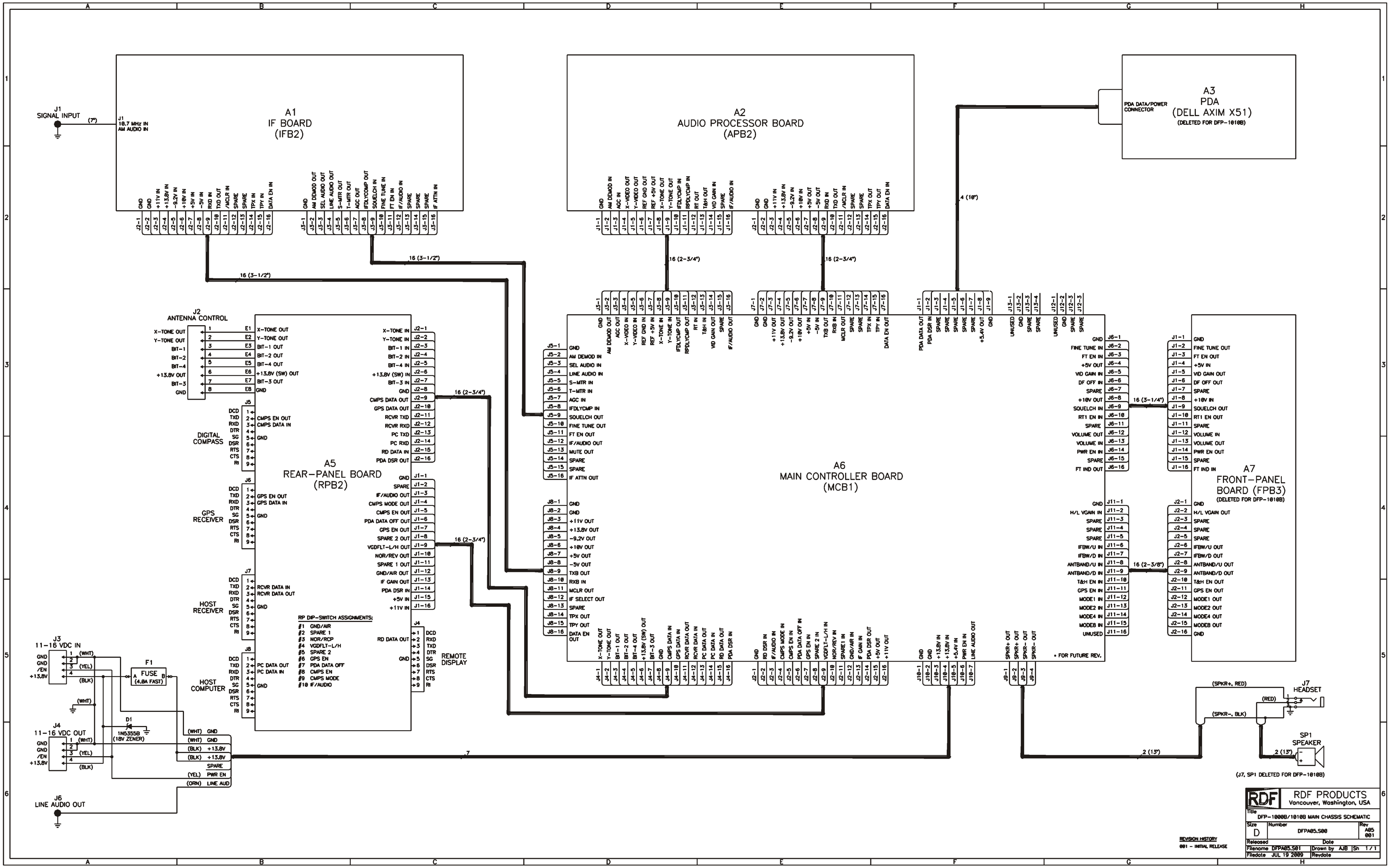


**Figure 14 - DFP-1000B/DFP-1010B Main Chassis Schematic Diagram**

## L. LOCAL & REMOTE CONTROL OPERATION

With the exception of the **SQUELCH/RANGE TONE** and **VOLUME/PWR OFF** control functions, the DFP-1000B is fully remote controllable from a host computer via a 19200N81 RS232 interface. To run the DFP-1000B remotely, proceed as follows:

1. Power-down the DFP-1000B and connect the rear-panel Host Computer DB9 connector to a suitable host computer serial port (i.e., COM1, COM2, etc.). A 6' DB9 male-to-female "straight-thru" cable is supplied for this purpose. (If the host computer serial port connector is anything other than a DB9 male, an appropriate adaptor or different cable must be used.) The only lines used are TXD (transmit data), RXD (receive data), and SG (signal ground). The host computer must be loaded with DefCon2b or suitable user-supplied software.

2. Set the front-panel **MODE/DF RESPONSE** switch to **REMOTE**.

3. Set the front-panel **FINE TUNE** control fully counter-clockwise to its detented **OFF** position.

4. Power-up the DFP-1000B and launch the host computer software. The DFP-1000B will now function in its remote control mode.

While operating in the remote control mode, the following points should be kept in mind:

1. The DFP-1000B boots-up much faster in remote than in local (10 versus 45 seconds).

2. The front-panel controls (with the exception of **VOLUME/PWR OFF**, **FINE TUNE**, and **SQUELCH**) will be "locked-out" (non-functional).

3. Although the TFT display will illuminate, it will be non-functional. We strongly recommend that the display be disabled for remote operation to prevent unnecessary usage of its fluorescent back-light and also to reduce power consumption. To do this, press the recessed front-panel **DISPLAY RESTART** button.

4. Changing the **MODE/DF RESPONSE** switch position from **REMOTE** to any other mode *will not* revert the DFP-1000B back to local control. To revert back to local control, set the **MODE/DF RESPONSE** switch to any position other than **REMOTE**, power-down the unit for a few seconds, then again power-up.

5. Since the rear-panel **LINE AUDIO** output can still be muted by **SQUELCH** control setting, the squelch should be disabled by setting the **SQUELCH** control fully counter-clockwise (but not to its detented **RANGE TONE 1** setting).

While operating in the local control mode, the following points should be kept in mind:

1. Although the remote control features are "locked-out", real-time bearing, signal strength meter, and tune meter data are still being continuously sent to the host computer.

2. Setting the **MODE/DF RESPONSE** switch to **REMOTE** *will not* change the DFP-1000B

from local to remote control. Since several seconds are required for the DFP-1000B to change from local to remote operation, allowing the unit to change from local to remote every time the **MODE/DF RESPONSE** switch is rotated through the **REMOTE** position would be a serious operational inconvenience. By requiring that the DFP-1000B be powered-down to activate remote operation, this problem is avoided.

See Appendices M and N below for a detailed discussion of the DFP-1000B RS-232 protocol.

## M. DFP-1000B/DFP-1010B RS-232 PROTOCOL

### 1. OVERVIEW

The DFP-1000B/DFP-1010B has a bi-directional RS-232 interface that allows full control of this unit with the ability to accommodate inputs from a digital compass and GPS receiver. In addition, this interface also allows the user full remote control of a host receiver capable of standard RS-232 operation. This is all accomplished using a single host computer serial COM port, thus avoiding the awkward requirement for host computers with multiple COM ports or cumbersome USB-to-serial multi-port conversion hubs.

The DFP-1000B/DFP-1010B firmware has been written to achieve the following goals:

1. All DFP-1000B/DFP-1010B functions are remotely controllable.

2. All commands and read-back strings are English plain-text and are straightforward to use and understand.

3. The interface protocol is organized so that commands can be rapidly sent and read-back strings quickly returned to facilitate real-time user interface software.

The details of the DFP-1000B/DFP-1010B remote protocol are presented in the paragraphs that follow, which are equally applicable to both models. To facility this generality, both of these units are hereinafter referred to as the "DFP".

### 2. GENERAL DFP/HOST COMPUTER COMMUNICATIONS INFORMATION

The DFP employs an "open" RS-232 communications protocol that allows full computer control of all unit operating features via the computer's standard serial (COM) port. All command and read-back strings are sent as English plain-text ASCII strings. The communications protocol is straight 19200N81 (19,200 bits/sec., no parity, 8-bit word, 1 stop-bit) with no pacing. The computer serial port is connected to the DFP **HOST COMPUTER** DB9 connector via the provided "straight-through" DB9 cable. The only lines used are TXD (transmit data), RXD (receive data), and SG (signal ground).

Although the communications protocol is straightforward, there are many details that must be considered. We therefore ask that the user study the following paragraphs carefully. We also strongly recommend that a suitable PC terminal emulator be available so that the user can conveniently exercise the commands and observe the read-back strings first-hand. We further recommend that the means be available to simultaneously monitor both the command and read-back strings. Refer to the discussion at the end of this Appendix for a more detailed discussion of PC terminal emulators with regard to their suitability for communicating with the DFP.

It is particularly important that the control software be organized so that all commands sent to the DFP are validated by the appropriate read-back strings to confirm that the DFP successfully receives the command. Since the DFP interface microprocessor must perform additional tasks in addition to waiting for a command string, it will occasionally miss a command. It is therefore essential that the control software be sufficiently robust to repeat the command until the appropriate acknowledgment is received.

All commands must be sent as upper-case text and be immediately followed by <CR><LF>. In addition, commands must be sent without pauses between the individual characters. More specifically, when commands are sent from a PC, the terminal emulator must be configured so that the individual characters are buffered and then sent all at once when the <Enter> key (i.e., <CR><LF>) is pressed. Furthermore, commands may not be concatenated (only one command may be sent at a time, with the following command not sent until after an appropriate acknowledgment has been received).

Since the DFP requires a certain amount of time to process a command and then recover so as to be ready to receive the next command, succeeding commands must not be sent too soon lest they not be "heard" by the DFP. More specifically, the succeeding command should be sent no sooner than 30 milliseconds after receipt of the acknowledgment or read-back string returned by the DFP for the previous command. In cases where an "A-string" (see next paragraph) follows this acknowledgment or read-back string, this 30 millisecond delay should commence following the completion of the A-string. For commands for which there is no acknowledgment or read-back string, the succeeding command should be sent no sooner than 130 milliseconds following the completion of the previous command. *It is extremely important that these timing constraints be observed.*

An important point to keep in mind during the following discussion is that the organization of the DFP is such that certain outgoing data strings are sent simultaneously to the host computer and the remote display DB9 outputs. (The DFP-1000B also contains an internal PDA display driven by the same data stream.) As a result, there will be a number of instances when the host computer will receive responses that are actually intended for the remote display/PDA. These responses (e.g., the "A-string") should be disregarded.

## 3. INITIALIZATION AND SETUP

When the DFP first powers-up, the following start-up message will appear:

**CLS<CR><LF>**
**CANT UNKNOWN<CR><LF>**
**(A-string)<CR><LF>**
**(B-strings)<CR><LF>**
**(A-String)<CR><LF>**
**(B-strings)<CR><LF>**
**OK<CR><LF>**

The above sequence is completed approximately 3 seconds after power-up. *We recommend that only the* **CLS<CR><LF** *and* **OK<CR><LF>** *be used as validation messages by the host computer. The A-strings and B-strings in the above sequence should be ignored.* Once this message is received and confirmed, the initialization process below must be implemented.

If the DFP is already running at the time the host computer software is initiated, then of course, the above startup message will not appear. In this case, first enter the command string:

**MODEL<CR><LF>**

and verify that the read-back string:

**DFP-1000B/FIRMWARE REV. B.03.05<CR><LF>** or
**DFP-1010B/FIRMWARE REV. B.03.05<CR><LF>**

(depending upon the specific model) is immediately returned. (B.03.05 is the current firmware revision level as of this writing.)

In either case, once the appropriate validation message is received and confirmed, the following initialization process must be implemented:

A. Enter the **START** command (keeping in mind that this and all commands must immediately be followed by <CR><LF> as discussed above). This will cause the DFP to immediately begin sending "B-strings" (continuous bearing strings) with a typical appearance as follows:

   **B20482048S00999P<CR><LF>**

   A more detailed discussion of this bearing string format is provided in the "Bearing String Format" section below.

B. When valid B-strings are detected, enter the **STOP** command and verify that the B- strings immediately cease. Note that regardless of when the **STOP** command is sent, the final B-string will be sent complete without truncation.

C. Once the B-string transmissions have ceased, enter an appropriate operating mode command (e.g., **MODE=07**). The operating mode command simultaneously sets the DFP demodulation mode (AM/FM/CW/SSB), antenna axis encoding tone frequencies, and bearing integration time. The 15 standard modes (**MODE=00** - **MODE=14**) will optimally accommodate most signal formats. To provide users with additional flexibility, however, the antenna axis encoding tone frequencies (**TONE=xx**) and bearing integration time (**BINT=xx**) can be modified for any selected operating mode (although such modification requires a certain professional insight and must be done carefully). *Note, however that the standard default* **TONE=xx** *and* **BINT=xx** *parameters are already embedded in the* **MODE=xx** *commands, and users relying on the 15 standard operating modes should not enter* **TONE=xx** *or* **BINT=xx** *unless they specifically wish to create custom operating modes.* When **MODE=xx** is entered, the following acknowledgment will be returned:

   **OK<CR><LF>**
   **ASSB/SLOW,IFBW/030K,GND,LCL,HGAIN,4,DFP,BRT<CR><LF>**

   The actual A-string text depends upon the specific operating mode, IF bandwidth, and other selected operating parameters. However, it is a constant length string always ending in **BRT<CR><LF>**.

We do not recommend that the interface software rely on <CR><LF> to signify the end of the A-string. Since it is possible that additional variables may be added between BRT and <CR><LF> to accommodate new features in subsequent DFP firmware revisions, we strongly recommend that the interface software rely on BRT as the most reliable A-string terminator and ignore any following characters.

D. Once the **OK<CR><LF>** acknowledgment is received (it is not necessary to wait for the subsequent A-string), enter the appropriate IF bandwidth (**IFBW=xx**), video gain (**GAIN=xx**), track & hold (**THLD=xx**), mute (**MUTE=xx**), DF On/Off (**DOFF=xx**) and DF antenna band **(BAND=xx)**. The initial settings for these miscellaneous commands would typically be **THLD=00** (track & hold disabled), **MUTE=00** (line audio output enabled), and **DOFF=00** (antenna axis encoding tones enabled). The fine tune status will already be at its default center-tune value **(FT=0100)**.

E. Enter **START** to resume the B-strings.

A more detailed discussion of the above command strings is provided below.

All of the above steps must be performed in sequence each time the DFP is powered-up or following a master reset. Once done, however, changing an operating parameter is much simpler. As an example, the following steps would be performed to change the IF bandwidth:

1. Enter the new IF bandwidth (e.g., **IFBW=01** for 15kHz).

2. Enter **START**.

All other operating parameters remain unchanged.

For DFP firmware revisions B.03.02 and higher, definition of the operating parameters at start-up (i.e., volatility and initilization values) have been defined (see paragraph 15d below). This in turn permits a more streamlined start-up sequence if desired.

## 4. RESETS

Resets are sometimes necessary to restore proper DFP operation following any anomalous event that causes the unit to temporarily malfunction. There are 3 reset options available for the DFP:

1. General Hardware Reset - If the DFP is on-site, the DC power can be cycled to implement a hardware reset. Once done, it will be necessary to redo the initialization procedure discussed above.

2. General Software Reset - If the DFP is deployed at a remote unmanned site, a hardware reset cannot be implemented unless there is some means to remotely cycle the DFP's DC power source. To accommodate this, an equivalent software reset option is also available using the **MRESET** command.

Since anomalous DFP behavior can, in principle, prevent the DFP from responding to the **MRESET** command, considerable thought and design effort was invested in order to make this feature as fail-safe as possible to prevent a remote DFP from becoming "locked-up" (i.e., unresponsive to commands). To accomplish this, the **MRESET** command is applied to two separate DFP microprocessors. Since only one of these microprocessors needs to successfully process this command to accomplish the software reset, the probability of the DFP being unable to respond to the **MRESET** command is extremely low. For even further protection, both of these microprocessors have their watchdog timers and brown-out protection features enabled so that events likely to disrupt microprocessor operation will automatically trigger a software reset. We strongly recommend that the **MRESET** command always be followed by the **ANTRESET** command (see below).

3. Antenna Reset - All RDF Products B-series DF antennas include "personality modules". These modules employ a small microprocessor to store DF antenna model/band information (which can be polled by the DFP as discussed below) and (for multi-band DF antennas) appropriately decode the 4-bit parallel band codes sent by the DFP.

   Since it is possible for the personality module microprocessor to lock-up, there needs to be a straightforward means of resetting it. If the DF system is under local control, this can be accomplished by cycling the DC power to the DFP. If the DF system is deployed at a remote unmanned site, however, cycling the DC power remotely may not be possible. If this is the case, the **ANTRESET** command can be used.

   When the DFP receives the **ANTRESET** command, it opens a set of relay contacts connecting DC power to the DF antenna for 2.0 seconds. This resets the DF antenna personality module, but does not reset the DFP. The **ANTRESET** command should be sent whenever there is any doubt regarding the performance of the DF antenna. It should also be used if the DFP is unable to poll the model/band information from the DF antenna personality module (see discussion below). The DFP does not require re-initialization following the **ANTRESET** command. Note that the **ANTRESET** command automatically resets the DF antenna to Band 01.

## 5. STATUS STRING

The status string is a constant-length string beginning with the letter S (for convenient identification) followed by 11 space-delimited 7-character fields. These fields report operating parameter status in a format mirroring their associated command strings. A typical status string would have the following appearance:

**S MODE=12 IFBW=01 BAND=05 GAIN=16 THLD=00 MUTE=00 DOFF=00 TONE=00 BINT=07 IFAU=00 DCV=138 FT=0100 VATN=00<CR><LF>**

This status string would be interpreted to mean that the reception mode is FM/Slow, the IF bandwidth is 15 kHz, the current DF antenna band is 05, the video gain is 16 (maximum), the Track & Hold feature is disabled, the line audio is enabled, the DF Off function is disabled, the antenna axis encoding tones are 137/172 Hz ("low" tones), the bearing integration time is 400 milliseconds, the selected signal interface with the host receiver is IF, the voltage at the DFP DC power input terminals is +13.8 VDC, the Fine Tune variable is set to 0100 (its default value corresponding to center frequency), and the video attenuator is disabled.

With the exception of the IFAU and DCV fields, all fields indicate the status of the most recently received command string associated with the field. Addressing the two exceptions, the IFAU (IF/AUDIO) field reports the status of the selected signal interface (between the DFP and its host receiver). This signal interface is hardware-selected using configuration-setup dip-switch #10, and cannot be set remotely.

The DCV field reports the DC voltage at the DFP DC power input terminals. This feature is particularly useful in remote site applications where the DC power is supplied from a wind- or solar-charged battery, allowing the battery voltage to be conveniently monitored. Also, this feature allows the host computer software to verify that the DC input voltage is within the specified 11-16 volt range.

The status string provides a convenient means by which DFP operating parameters can be verified. Users should rely on this important tool as often as necessary to confirm DFP operating parameters.

The means by which the status string is parsed by the user software is worthy of mention. To facilitate the addition of new DFP commands and read-back strings with a minimum of impact on existing user software, the status string will be modified so that new read-back strings are appended at the end (i.e., between FT=0100 and <CR><LF> using the above example). We therefore recommend that the status string parsing algorithm not rely on any characters following the last field (FT=0100 in the above example).

## 6. COMMAND STRING DEFINITIONS

For convenience of reference, all DFP command strings and their associated definitions are listed below:

| | |
|---|---|
| ANTRESET | Reset DF antenna personality module (interrupts DC power to DF antenna for 2.0 seconds) and resets the DF antenna to Band 01. |
| BAND=00 | Poll DF antenna for model/band information. |
| BAND=xx | Select DF antenna band (xx=01-15). |
| BINT=00 | Select 35 milliseconds bearing integration. |
| BINT=01 | Select 50 milliseconds bearing integration. |
| BINT=02 | Select 80 milliseconds bearing integration. |
| BINT=03 | Select 100milliseconds bearing integration. |
| BINT=04 | Select 160 milliseconds bearing integration. |
| BINT=05 | Select 200 milliseconds bearing integration. |
| BINT=06 | Select 275 milliseconds bearing integration. |
| BINT=07 | Select 400 milliseconds bearing integration. |
| DOFF=00 | Select DF ON. |
| DOFF=01 | Select DF OFF (disables tones to DF antenna for improved listen-thru). |
| FT=xxxx | Select Fine Tune offset (xxxx=0050-0150; see note below). |
| GAIN=xx | Select video gain (xx=00-16). |

| | |
|---|---|
| IFBW=00 | Select 6 kHz IF bandwidth. |
| IFBW=01 | Select 15 kHz IF bandwidth. |
| IFBW=02 | Select 30 kHz IF bandwidth. |
| IFBW=03 | Select 200 kHz IF bandwidth. |
| | |
| MODE=00 | SSB/Medium operating mode (BINT=06, TONE=01, slow AGC). |
| MODE=01 | SSB/Slow operating mode (BINT=07, TONE=01, slow AGC). |
| MODE=02 | CW/F3 (ultra-fast) operating mode (BINT=00, TONE=03, very-fast AGC). |
| MODE=03 | CW/F2 (very-fast) operating mode (BINT=01, TONE=02, fast AGC). |
| MODE=04 | CW/F1 (fast) operating mode (BINT=02, TONE=01, medium AGC). |
| MODE=05 | S2 (special) operating mode. |
| MODE=06 | S1 (special) operating mode. |
| MODE=07 | CW/Medium operating mode (BINT=04, TONE=00, slow AGC). |
| MODE=08 | CW/Slow operating mode (BINT=07, TONE=00, slow AGC). |
| MODE=09 | AM/Medium operating mode (BINT=05, TONE=00, slow AGC). |
| MODE=10 | AM/Slow operating mode (BINT=07, TONE=00, slow AGC). |
| MODE=11 | FM/Medium operating mode (BINT=05, TONE=00, slow AGC). |
| MODE=12 | FM/Slow operating mode (BINT=07, TONE=00, slow AGC). |
| MODE=13 | S3 (special) operating mode. |
| MODE=14 | S4 (special) operating mode. |
| | |
| MODEL | Retrieve Model/Firmware Rev. string (e.g., “DFP-1000B/REV. B03a”). |
| | |
| MRESET | Master reset (equivalent to cycling DC power to unit). |
| | |
| MUTE=00 | Disable line audio output. |
| MUTE=01 | Enable line audio output. |
| | |
| RXTOUT | Temporarily disables 10 second time-out for Q6X3Y9Z4B7 command. (Used only during production testing.) |
| | |
| SQUIRT | Initiate 170 milliseconds duration real-time bearing string transmission (see note below). |
| | |
| START | Start continuous real-time bearing string transmission. |
| STATUS | Retrieve Status string. |
| STOP | Stop continuous real-time bearing string transmission (see note below). |
| | |
| THLD=00 | Disable Track & Hold |
| THLD=01 | Enable Track & Hold |
| | |
| TONE=00 | Select low axis encoding tone pair (137/172 Hz). |
| TONE=01 | Select medium axis encoding tone pair (526/657 Hz). |
| TONE=02 | Select high axis encoding tone pair (974/1217 Hz). |
| TONE=03 | Select super-high axis encoding tone pair (1533/1917 Hz). |
| | |
| VATN=00 | Disable video attenuator (see note below). |
| VATN=01 | Enable video attenuator (see note below). |
| | |
| Q6X3Y9Z4B7 | Enable data pass-thru mode (for direct receiver control). |

7B4Z9Y3X6Q Disable data pass-thru mode.

Notes:

1. The **FT** (Fine Tune) command allows the DFP center frequency (normally 10.700 MHz) to be offset by up to +/- 5 kHz. Although it is best that frequency control be accomplished exclusively at the host receiver where possible, some receivers do not have sufficient frequency resolution for good tuning (i.e., the tuning steps are too large to guarantee that the received signal can be adequately centered in the DFP IF filter passband). A case in point is the AOR AR8600 Mk2. Although this receiver has very good tuning resolution overall, the tuning resolution at its 10.7 MHz IF output (the signal interface connection point to the DFP) is 10 kHz, which is too coarse for many DF applications.

   This serious problem can be corrected with the DFP Fine Tune feature. Again using the AR8600 as a case in point, the operational procedure would be to first set the AR8600 to the closest 10 kHz increment, then use the DFP Fine Tune feature to add an appropriate frequency offset to center the received signal in the DFP IF filter passband.
   The range of the Fine Tune command variable is FT=0050 to FT=0100, which provides +/-50 tuning increments. The default value is 0100, which sets the DFP at its center frequency of 10.700 MHz. Since each increment is 100 Hz, FT=0150 results in a +5 kHz DFP tuning offset (i.e., 10.705 MHz, while FT=0050 results in a -5 kHz DFP tuning offset (i.e., 10.695 MHz). The current value of FT is reported by the status string.

   If FT<0050 or FT>0150 (i.e., if FT is out of its specified 0050-0150 range), then the DFP frequency will be re-centered to (or remain at) 10.700 MHz.

   A user contemplating the use of the DFP Fine Tune feature should carefully study the conversion scheme of the host receiver to fully understand its tuning behavior. Of particular concern is the manner of “sideband inversions”. In modern wide-coverage receivers such as the AR8600 Mk2, different conversion schemes are employed throughout the frequency range. As a result, there will likely be a net sideband inversion in some frequency ranges but not in others. This in turn will require that a positive DFP Fine Tuning offset be used to raise the effective net receiver frequency in some bands and that negative DFP Fine Tuning offset be used to raise the effective net receiver frequency in other bands.

2. The **SQUIRT** command is similar to the **START** command in that it initiates real-time bearing string transmissions. Unlike the **START** command, however, the bearing string transmission self-terminates after 170 milliseconds (which allows 10 B-strings to be sent). The **SQUIRT** command is useful in applications where a line-of-bearing is required only occasionally on demand, and where the presence of the continuous bearing strings initiated by the **START** command would clutter up the host computer or peripheral device with excess data.

   Note that the final B-string is sent complete without truncation. Of the 10 B-strings, we suggest that the user place heaviest reliance on whichever one has the largest computed bearing magnitude (See “Bearing String Format” section below for details regarding bearing magnitude computation). **SQUIRT** commands may be used in succession as many times as desired (i.e., without the requirement for other intervening commands).

No acknowledgment string is returned following the 10th (final) B-string. If the **SQUIRT** command is sent while B-strings are already in progress, the B-strings will self-terminate after 10 additional B-strings are sent.

3. Although the **STOP** command is specifically provided to terminate the bearing strings, all other commands (with the exception of **START**, **MRESET**, and **7B4Z9Y3X6Q**) will automatically terminate the bearing strings. (An unrecognized command will also terminate bearing strings.) It is therefore unnecessary to enter the **STOP** command prior to entering command string (aside from the above three exceptions). With the exception of the **GAIN=xx** and **VATN=xx** commands, it is necessary to enter **START** to resume the B-strings. (The B-strings will restart automatically following the **GAIN=xx** and **VATN=xx** commands and their read-back string acknowledgments.)

4. The **VATN** (video attenuator) command is volatile. When DC power to the DFP is cycled, the DFP will automatically power-up with the video attenuator disabled (**VATN=00**).

## 7. READ-BACK STRINGS

The read-back strings associated with the above command strings are listed and discussed below:

ANTRESET - Acknowledged by **OK<CR><LF> (A-string)<CR><LF> OK<CR><LF> OK<CR><LF> (A-string)<CR><LF>**. This command also causes the antenna power control relay to audibly click and resets the DF antenna to Band 01.

BAND=00 - Model/band query to DF antenna personality module - see discussion below.

BAND=xx - Acknowledged by **OK<CR><LF> (A-string)<CR><LF>** (for xx=01-15).

BINT=xx - Acknowledged by **OK<CR><LF>**.

DOFF=xx - Acknowledged by **OK<CR><LF> (A-string)<CR><LF>**.

FT=xxxx - Acknowledged by **OK<CR><LF>**.

GAIN=xx - Acknowledged by **OK<CR><LF>**. (As discussed above, the B-strings will resume immediately following this acknowledgment.)

IFBW=xx - Acknowledged by **OK<CR><LF> (A-string)<CR><LF>**.

MODE=xx - Acknowledged by **OK<CR><LF> (A-string)<CR><LF>**.

MODEL - Acknowledged by **DFP-10x0B/FIRMWARE REV. B.03.04<CR><LF>**. (B.03.04 is the current firmware revision level as of this writing.)

MRESET - Acknowledged by same sequence that appears at power-up (see "Initialization and Setup" section above).

MUTE=xx - Acknowledged by **OK<CR><LF>**.

SQUIRT - Acknowledged by a transmission of 10 B-strings.

START - Acknowledged by commencement of continuous B-strings.

STATUS - Acknowledged by the status string (see "Status String" paragraph above).

STOP - Acknowledged by termination of continuous B-strings (if present). If no B-strings are being sent, there is no acknowledgment.

THLD=xx - Acknowledged by **OK<CR><LF>**.

TONE=xx - Acknowledged by **OK<CR><LF>**.

UNRECOGNIZED COMMAND - An unrecognized command causes the DFP to return an ASCII "bell" (007) immediately followed by **<CR><LF>**. If B-strings are being transmitted, they will be terminated prior to this response and will not automatically restart.

VATN=xx - Acknowledged by **OK<CR><LF> (A-string)<CR><LF>**. (As discussed above, the B-strings will resume immediately following this acknowledgment.)

Q6X3Y9Z4B7, 7B4Z9Y3X6Q - Data pass-thru commands for host receiver - see paragraph 13 ("Host Receiver Control") below.

Notes:

1. See paragraph 8 ("DFP Recovery Time") below for important information on the DFP processing time that must be allowed between command strings.

2. The DFP occasionally will not "hear" a legitimate command due to microprocessor tasking constraints. It is therefore important that the control software be written so that it will re-send the command if it does not receive the appropriate acknowledgment. We recommend three retrys.

3. It is also possible that the DFP will not recognize a legitimate command and return an ASCII bell (see "Unrecognized Command" discussion above). If this happens, the control software should re-send the command.

## 8. DFP RECOVERY TIME

The DFP requires a certain amount of time following receipt of a command string to process the information and return the appropriate read-back string(s) as required. If a follow-on command string is sent too soon, the DFP will not be able to properly process it. This will result in unnecessary retries and slow operation.

This issue is best illustrated with the following simple QBASIC program listing. This routine, when run on a QBASIC-compatible computer having a conventional serial port output, allows the programmer to conveniently instrument a test setup whereby a command string can be sent to the DFP. The resulting read-back string(s) can then be confirmed using an appropriate terminal emulator monitoring the DFP output (the DFP REMOTE DISPLAY DB9 output connector is a particularly convenient monitoring point):

```
10 ‘SNDCMND1.BAS (05-07-10)
20 ‘SENDS COMMAND STRING TO DFP
30 COMPORT1$ = "COM1:19200,N,8,1"             'define comport
40 OPEN COMPORT1$ FOR RANDOM AS #1 LEN = 128  'open comport
50 PRINT #1, "BINT=04"; CHR$(13); CHR$(10)    'select bearing integration time
60 GOSUB 200                                  '100 ms delay
70 PRINT #1, "STATUS"; CHR$(13); CHR$(10)     'DFP status command
100 END

200                                           '100 ms delay routine
210 T1 = TIMER
220 T2 = TIMER
230 IF T2 - T1 < .1 THEN GOTO 220 ELSE RETURN
```

Referring to the above listing, lines 30 & 40 define and open a 19200-N-8-1 COM port. Line 50 sends the command string “BINT=04" (followed by a <CR> <LF>) to the DFP, which selects a 160 millisecond bearing integration time (see “Command String Definitions” in paragraph 6 above).

Line 60 is a 100 millisecond delay loop subroutine (the purpose of which is to allow the DFP time to fully process the command and return the appropriate read-back strings). Line 70 sends the “STATUS” command to the DFP (since this command will return the status string that in turn will allow confirmation that the DFP both received and correctly processed the “BINT=04" command).

The appropriate read-back strings in response are as follows:

```
OK
S MODE=07 IFBW=01 BAND=02 GAIN=16 THLD=00 MUTE=00 DOFF=00 TONE=00 BINT=04 IFAU=01
DCV=134 FT=0100 VATN=01
```

Note that many of the various status string fields will likely be different than indicated (depending on the current values stored in the DFP), but we would expect BINT field to be 04 as per the command. In any case, as per the read-back strings information in paragraph 7 above, the correct response to the “BINT=04" command is an OK acknowledgment and the correct response to the “STATUS” command is the status string. Since both of these strings appear, we confirm that the 100 millisecond delay in line 60 allows sufficient time for the DFP to process the “BINT=04" command. (As a practical matter, this program should be run a sufficient number of times so that the programmer is convinced that the allotted delay time is not borderline.)

As an experiment, we could remove the 100 millisecond delay (by changing ".1" in line 230 to "0"), re-run the program, and see what happens. The result would be as follows:

```
OK
```

Although the "OK" acknowledgment to the BINT=04 command is returned, the status string response to the "STATUS" command does not appear due to the fact that this command was *sent too soon after the BINT=04 command, thus not allowing the DFP sufficient recovery time to process the follow-on STATUS command.*

An ambitious programmer would likely want to try different delays between 0 and 100 milliseconds in an effort to see how much the 100 millisecond delay time can be shaved down. Unfortunately, QBASIC is not a very good tool for this effort since its TIMER command resolution is only 100 milliseconds, but other programming languages with better temporal resolution can also be used. The 100 millisecond delay is no doubt very conservative, and while it can likely be cut by 50 milliseconds or even more, this improvement will not be noticeable operationally.

Conservative delay times (milliseconds) for the DFP command strings are as follows:

| | |
|---|---|
| BAND=xx (01-15) - 300 | BINT=xx - 100 |
| DOFF=xx - 300 | FT=xxxx - 100 |
| GAIN=xx - 300 | IFBW=xx - 300 |
| MODE=xx - 300 | MODEL - 200 |
| MUTE=xx - 100 | SQUIRT - 400 |
| START - 200 | STATUS - 200 |
| STOP - 100 | THLD=xx - 100 |
| TONE=xx - 100 | VATN=xx - 200 |

Since the timing issues associated with the Q6X3Y9Z4B7 (receiver data pass-thru enable) and 7B4Z9Y3X6Q (receiver data pass-thru disable) commands are more subtle and require more attention, these commands are discussed separately in paragraph 13 ("Host Receiver Control") below. This discussion includes an additional QBASIC code listing for clarity.

## 9. DF ANTENNA PERSONALITY MODULE

RDF Products B-series DF antennas contain personality modules that store DF antenna model and band information. This information can be retrieved by the DFP so that it will know the following information:

1. The DF antenna model (e.g., "DMA-1265B-1").

2. The number of assigned DF antenna bands.

3. The DF antenna frequency coverage associated with each band.

4. Any possible azimuth offset associated with each band.

This information is extremely useful in that it can help prevent the user from inadvertently selecting an incorrect DF antenna band. In cases where a graphical user interface is employed to simultaneously control both the DFP and a host receiver (i.e., a “virtual DF receiver” as implemented in RDF Products’ DefCon2b user interface software), having this information will allow the software to automatically change DF antenna bands when the user tunes the host receiver across an antenna band-edge boundary. Similarly, this information will allow the software to alert users if they tune the host receiver outside the specified DF antenna frequency range.

The protocol associated with the DF antenna personality module is best explained by example. For the purpose of this discussion, we will assume that a DMA-1265B-1 DF antenna is connected to the DFP. To query the personality module, the following command is sent to the DFP:

**BAND=00<CR><LF>**

This command signals the DMA-1265B-1 personality module to return a 300N81 message to the DFP, which is then processed and re-transmitted to the host computer as the following 19200N81C-string:

**CDMA-1265B-1, 20-88, 80-174, 174-470, 470-1000/-450<CR><LF>**

This C-string is followed by two A-strings that should be ignored. Given the slow data rate of the personality module message, up to several seconds may be necessary for a response.

This C-string should be interpreted as follows:

1. The DFP recognizes the DF antenna as a “DMA-1265B-1".

2. The DMA-1265B-1 frequency coverage is divided into 4 selectable bands.

3. The assigned frequency coverage of Bands 01-04 is 20-88 MHz, 88-174 MHz, 174-470 MHz, and 470-1000 MHz, respectively. (Band number assignment is always in ascending order in relation to frequency coverage beginning with Band 01.)

4. Band 04 (470-1000 MHz) is assigned an azimuth offset attribute of -45.0° (indicated by the /-450 suffix). This tells the user to apply a -45 degree azimuth offset for all bearings obtained when the DMA-1265B-1 is set to Band 04. For bands without this suffix, the azimuth offset is 0° by default.

If the DFP does not successfully receive the personality module message, the following C-string message is returned to the host computer:

**CANT UNKNOWN<CR><LF>**

This C-string is followed by 2 A-strings that should be ignored.

If this “unrecognized antenna” message is received, it could mean that the DF antenna is disconnected, the DF antenna is an older model that does not include a personality module, or that there is a malfunction.

Whether the DF antenna is recognized or not, the DFP will automatically set the antenna to Band 01 immediately following receipt of the C-string.

## 10. BEARING STRING FORMAT

The bearing string (also referred to as the B-string) is an 18-byte string that conveys bearing data, signal-strength meter data, tuning meter data, and digital compass heading data to the host computer. The B-string is sent continuously in real-time at a rate of 60 strings per second.

The B-string format is as follows:

**Bxxxxyyyy(s/t)mmcccn <CR><LF>**

where **B** identifies the string as the bearing output string, **xxxx** is the numerical representation of the X-axis voltage (0000-4095), **yyyy** is the numerical representation of the Y-axis voltage (0000-4095), **mm** is the meter output voltage (00-99, where **s/t** is a continually alternating toggle that identifies **mm** as either an S or tune voltage), **ccc** is the heading reported by an optional digital compass (000-359 when the digital compass is enabled or 999 when it is disabled), and **n** is a variable defining how the digital compass offset is displayed on the remote display/PDA (**n** can be ignored by the host computer, other than to mark the end of the bearing string for parsing purposes).

For the purpose of azimuth computation, values of **xxxx** and **yyyy** from 0000-2047 are treated as negative numbers, 2048 is zero, and 2049-4095 are treated as positive numbers. To convert **xxxx** and **yyyy** to an azimuth, 2048 must first be subtracted from each number (to create **xxx2** and **yyy2**. The azimuth can then be computed by performing a 4-quadrant arc-tangent routine on the quotient **xxx2**/**yyy2**.

To provide a numerical example for clarification, if **xxxx** and **yyyy** are respectively equal to 3000 and 1500, the effective value of the X-axis voltage should be interpreted as 3000-2048 = 952, the effective value of the Y-axis voltage should be interpreted as 1500-2048 = -548, resulting in a computed azimuth of 119.9 degrees (on a geographic coordinate plane) and a bearing magnitude of 1098 (this magnitude subject, of course, to appropriate scaling).

Bearing magnitude is computed by first taking the absolute values of **xxx2** and **yyy2** and then computing the square root of the sum of the squares. Bearing magnitude is very important in programming applications where the user wishes to create an emulated real-time polar bearing display as part of the graphical user interface (the bearing magnitude corresponds to the polar bearing vector length). A real-time polar bearing display is essential for mobile DF applications.

The various subtleties and details associated with these computations are even better illustrated by the sample QBASIC code listing:

```
10 'ARCTAN4.BAS (07-14-07)
20 'DFP-1000B/DFP-1010B 4-QUADRANT ARCTANGENT BEARING COMPUTATION ROUTINE
30 '
40 '
100 CLS
110 INPUT "*ENTER X-AXIS MAGNITUDE (0000-4095) ", XXXX
120 INPUT "*ENTER Y-AXIS MAGNITUDE (0000-4095) ", YYYY
130 '
140 '
150 XXX2 = XXXX - 2048          'Normalize XXXX & YYYY to 2048
160 YYY2 = YYYY - 2048          '
170 '
180 '
190 IF YYY2 = 0 THEN YYY2 = .0001       'Protect against division-by-0
200 '
210 '
220 AZIMUTH = ATN(XXX2 / YYY2) * 57.29578      'ArcTan computation (degs)
230 IF YYY2 < 0 THEN AZIMUTH = AZIMUTH + 180   'ArcTan for 4 quadrants
240 IF AZIMUTH >= 360 THEN AZIMUTH = AZIMUTH - 360  'Keeps azimuth < 360
250 IF AZIMUTH < 0 THEN AZIMUTH = AZIMUTH + 360     'Keeps azimuth > 0
260 '
270 '
280 PRINT "*AZIMUTH= ";                 'Prints azimuth to 0.1
290 PRINT USING "###.#"; AZIMUTH;       'degree resolution
300 PRINT " DEGREES"
310 '
320 '
330 MAG = SQR(XXX2 * XXX2 + YYY2 * YYY2)  'Compute bearing magnitude
340 '
350 '
360 PRINT "*MAGNITUDE= ";        'Print bearing magnitude
370 PRINT USING "####"; MAG
380 END
```

The X and Y axis magnitudes (integers in the range of 0-4095 corresponding to B-string variables **xxxx** and **yyyy**) are user-entered at lines 110 and 120 respectively. 2048 is subtracted from these values to convert them into zero-referenced numbers (-2048 to +2047) in lines 150 and 160 (**xxx2** and **yyy2**).

To provide protection against division by zero in the subsequent arc tangent computation, a zero value of **yyy2** is changed to .0001. The resulting inaccuracy for some computations is negligible and can be disregarded for all practical purposes.

The arc tangent computation is performed in line 220. Since the QBASIC ATN (arc tangent) function returns results in radians, the result is multiplied by 57.29578 to convert it to degrees.

Since the arc tangent of any quotient is defined only in the $1^{st}$ and $4^{th}$ quadrants (-90 to +90 degrees), **yyy2** must be examined in line 230 to determine if results are in the $2^{nd}$ and $3^{rd}$ quadrants. If **yyy2** < 0, then 180 degrees is added to accommodate results in these undefined quadrants. Lines 240 and 250 ensure that results will always be >0 and <360 degrees. The bearing magnitude computation is performed in line 330.

If the **xxxx** and **yyyy** values used in the earlier example (3000 and 1500, respectively) are entered into the program, the following results are returned by ARCTAN4.BAS:

```
*ENTER X-AXIS MAGNITUDE (0000-4095) 3000
*ENTER Y-AXIS MAGNITUDE (0000-4095) 1500
*AZIMUTH= 119.9 DEGREES
*MAGNITUDE= 1098
```

Both ARCTAN4.BAS and its compiled version ARCTAN4.EXE are provided in the Software folder of the RDF Products Publications CD. These files require an MSDOS-compatible platform to run. The .BAS version must be run under GW-BASIC, QBASIC, BASICA, or other similar version of BASIC. The executable .EXE version runs directly.

If a qualified NMEA-0183 digital compass is connected to the DFP, **ccc** is the heading reported by the digital compass (000-359), which can be used to appropriately offset the computed bearing (based on **xxxx** and **yyyy**) to provide an absolute bearing (as opposed to a relative bearing based on the orientation of the DF antenna N-S axis). If **ccc** is 999, this signals that no digital compass is connected. Digital compasses typically update at approximately 10 headings/sec. Since the compass heading is directly embedded into the B-string, enabling the compass slightly reduces the number of bearings/sec (although this is not noticeable for most applications).

The alternating toggle **s/t** identifies the subsequent **mm** value (00-99) as being either a signal-strength (S) meter voltage (**s**) or a tuning meter voltage (**t**). When **mm** is a signal-strength meter voltage, 00 and 99 respectively designate minimum and maximum signal strength. When **mm** is a tuning meter voltage, 00-48 designates that the DFP signal input is <10.700 MHz, 50-99 designates that the input signal equals 10.700 MHz, and 49 designates that the input signal is at 10.700 MHz. The tuning meter is useful for verifying that received signals have been correctly tuned by the host receiver.

## 11. B-STRING OUTPUT EXAMPLES

To help clarify the above statements regarding the B-string format, we provide some examples for illustration. The following sequence illustrates the basic concept:

```
B33741514S38999P<CR><LF>
B33741514T49999P<CR><LF>
B33741514S38999P<CR><LF>
B33741514T49999P<CR><LF>
B33741514S38999P<CR><LF>
```
(etc.)

The above sequence is parsed as follows:

| | |
|---|---|
| B | Identifies the sequence as the bearing string. |
| 3374 | Raw X-axis voltage. |
| 1514 | Raw Y-axis voltage. |
| S or T | Alternating S- or Tune-meter toggle. |
| 38 or 49 | Alternating S- or Tune-meter voltage. |
| 999 | Digital compass status or bearing. |
| P (or N) | End of B-string. |

Since other data strings (beginning with different letters of the alphabet) can also be sent by the DFP to the host computer, it is important that the interface software attempt to parse only B-strings for bearing data. Strings beginning with "A" should always be ignored. (A-strings are intended for use inside the DFP only.) The C-string provided DF antenna model/frequency band information as discussed above. The D-string provides the GPS latitude/longitude coordinates as discussed below.

To compute the bearing azimuth (as reported by the DFP), 2048 must first be subtracted from the raw X- and Y-axis voltages in order to yield the corresponding zero-centered values (X' and Y'). For the present example, X'=3374-2048= +1326 and Y'=1514-2048= -534. The azimuth can then be computed by performing a 4-quadrant arc-tangent routine on the quotient X'/Y', or -534/1326 for a result of 111.9°. Note that if X' and Y' are both positive, the azimuth is 0-90°. If X' and Y' are both negative, the azimuth is 180-270°. If X' is positive and Y' negative, the azimuth is 90-180°. If X' is negative and Y' positive, the azimuth is 270-360 (0)°.

The X' and Y' voltages are also used to compute the bearing magnitude (corresponding to the vector length on a polar bearing display). As discussed above, the bearing magnitude is computed by taking the square root of the sum of the squares of X' and Y'. For the present example this magnitude would be the square root of (1326 x 1326) + (-534 x -534), or 1429. In most instances, an appropriate scaling factor would then be applied to fit the application at hand (i.e., to match the available number of pixels on the display device).

S and T is an alternating toggle that signals whether the subsequent 2-digit numeral (00-99) is the S- or Tune-meter voltage. In the present example, these 2-digit numerals (38 and 49) should be interpreted to mean that the signal strength is 38% full-scale and that the receiver is exactly center-tuned.

The remaining three numerals pertain to the digital compass input. If these numerals are 000-359, this value should be interpreted as the digital compass heading. If these numerals are 999 (as is the case in the present example), this should be interpreted to mean that digital compass is disabled (which is to say that these numerals should be ignored. To illustrate by example:

**B33741514S38032P<CR><LF>**
**B33741514T50032P<CR><LF>**
(etc.)

These strings are identical to the previous ones except that the 999 is replaced by 032. This should be interpreted to mean that the digital compass is now active and is reporting a 32 degree heading.

The final alphanumeric in the B-string is P (or sometimes N). Either letter signifies the end of the B-string. P and N are DFP internal variables that are not meaningful to the host computer other than to mark the end of the B-string.

We do not recommend that the interface software use <CR><LF> to signify the end of the B-string. Since it is possible that additional variables may be added following P or N to accommodate new features in subsequent DFP firmware revisions, we strongly recommend that the interface software rely on the P or N variable as the most reliable B-string terminator and ignore any following characters.

## 12. GPS RECEIVER COORDINATES

If a GPS receiver is connected to the DFP, its latitude/longitude coordinate output is transmitted to the host computer (and remote display/PDA) as D-strings interspersed among the B-strings (bearings). The general form of the D-string format is as follows:

**Dxxxxxxxxxyyyyyyyyyyz<CR><LF>**

where **xxxxxxxxx** represents the latitude, **yyyyyyyyyy** represents the longitude, and **z** is a suffix that signals the remote display/PDA whether to display or ignore the GPS coordinates. (If **z** is **"G"** the remote display/PDA displays the GPS coordinates. If **z** is **"P"**, the remote display/PDA ignores the GPS coordinates and displays polar bearings in the standard fashion.) The **z** suffix should be ignored by the host computer. As an example, the GPS coordinates for RDF Products would be presented as follows:

**D+45405120-122293758G<CR><LF>**

Regarding the presentation of the GPS coordinates on the remote display/PDA, these coordinates will be displayed using *both* standard display conventions *simultaneously* as follows:

**45° 40' 30.7" N, 122° 29' 22.5" W**

**45° 40.5120' N, 122° 29.3758' W**

This remote display/PDA display information is presented for reference only.

We do not recommend that the interface software use <CR><LF> to signify the end of the D-string. Since it is possible that additional variables may be added between G or P and <CR><LF> to accommodate new features in subsequent DFP firmware revisions, we strongly recommend that the interface software rely on the G or P variable as the most reliable D-string terminator and ignore any following characters.

Some GPS receivers output lower precision latitude/longitude coordinates (i.e., one less digit in both the **xxxx...** and **yyyy...** strings). DFPs with firmware revision levels of B.03.01 or higher can accept these lower precision outputs. In such cases, however, the DFP will automatically insert a "0" (zero) at the end of each of these strings so that the resulting D-string length (number of characters) remains unchanged.

When the D-string is transmitted, it preempts a B-string that otherwise would have been transmitted during that time slot. Since GPS receivers typically update once per second, this effectively reduces the B-string throughput from 60/sec. to 59/sec., which has no noticeable effect on DF performance. Also, the GPS receiver can be operated concurrently with the digital compass with no reduction in performance.

## 13. HOST RECEIVER CONTROL

As mentioned, the DFP RS-232 protocol allows the host computer to control the host receiver. Unlike the digital compass or GPS receiver (where the NMEA-0183 standard guarantees device data output uniformity and compatibility, thus allowing this data to be encapsulated with the DF bearing string output), there is no similar standard governing the more complex RS-232 protocols of the various host receiver models.

To accommodate this standardization issue, a "pass-thru" technique is employed. When it is necessary to communicate with the host receiver, the host computer sends the DFP a unique code-word that connects the DFP **HOST COMPUTER** connector to the **HOST RECEIVER** connector in a null-modem configuration that allows the host computer to directly communicate with the host receiver at any standard RS-232 serial baud rate. While this connection is in force, the DFP will ignore all normal RS-232 commands.

When the host computer has completed its communication task with the host receiver and wants to reestablish normal communication with the DFP, another unique code-word is entered. This code-word instructs the DFP to break the connection between the host computer and host receiver and restore normal communication between the DFP and host computer.

The underlying concept that allows this technique to work is that it is never necessary that the host computer control the DFP and host receiver simultaneously. Typically, the host computer will spend most of its time operating the DFP, only occasionally needing to control the host receiver (primarily to change its frequency). When this happens, the short interruption in DF operation will be mostly unnoticed and of no consequence.

To enable direct data pass-thru between the host computer and host receiver, the following command is entered:

**Q6X3Y9Z4B7<CR><LF>**

The only acknowledgment to this command is the termination of the bearing strings, so we strongly recommend that user software be organized such that bearing strings are always being transmitted immediately prior to this command (as would normally be the case).

Commands can then be sent to the host receiver after a delay interval sufficient in length so that the DFP has time to process the "Q6X..." command and establish a direct communication link to the host receiver. To exit this pass-thru mode and restore normal communication between the DFP and host computer, the following command is entered:

**7B4Z9Y3X6Q<CR><LF>**

This command automatically resumes B- (bearing) strings (even if no B-strings were being sent prior to the last Q6X3Y9Z4B7<CR><LF> command). These bearing strings should therefore be relied upon as the acknowledgment that the DFP has successfully exited the pass-thru mode. Commands can then be sent to the DFP after a delay interval sufficient in length so that the DFP has time to process the "7B4..." command and reestablish a direct communication link to the host receiver.

There are some timing subtleties associated with exiting the pass-thru mode that the user should consider carefully:

1. The “7B4...” exit command should not be sent until the host receiver has fully completed its response to the last command sent by the host computer (i.e., if the host receiver returns acknowledgments or other information required by the host computer, the “7B4...” exit command should not be sent until all host receiver data has been received).

2. The host computer should wait a minimum of 100 milliseconds after the last command sent to the host receiver before sending the “7B4...” exit command. This delay is necessary to allow the DFP communications microprocessor to recover from having received unrecognized data from the host computer that was intended for the host receiver.

In most instances, the second of the above two constraints will be the pacing item, but it is possible that a host receiver could return a lengthy acknowledgment data packet exceeding 100 milliseconds. If this is the case, then the “7B4...” exit command should not be sent until this data packet has been received.

To further clarify the issues associated with the receiver pass-thru mode, we ask that programmers study the following QBASIC code listing very carefully:

```
10 ‘SNDCMND2.BAS (05-07-10)
20 ‘SENDS RECEIVER PASS-THRU COMMANDS TO DFP AND HOST RECEIVER
30 COMPORT1$ = "COM1:19200,N,8,1"                'define comport
40 OPEN COMPORT1$ FOR RANDOM AS #1 LEN = 128     'open comport
50 PRINT #1, "Q6X3Y9Z4B7"; CHR$(13); CHR$(10)    'Q6X pass-thru command
60 GOSUB 1000                                    '200 ms delay
70 PRINT #1, "RF0108710000"; CHR$(13); CHR$(10) 'AR5000 freq. command
80 PRINT #1, "RX"; CHR$(13); CHR$(10)            '"
90 GOSUB 1100                                    '100 ms delay
100 PRINT #1, "7B4Z9Y3X6Q"; CHR$(13); CHR$(10)   '7B4 restore command
110 GOSUB 1100                                   '100 ms delay
120 PRINT #1, "STATUS"; CHR$(13); CHR$(10)       'DFP status command
900 END

1000                                             '200 ms delay routine
1010 T1 = TIMER
1020 T2 = TIMER
1030 IF T2 - T1 < .2 THEN GOTO 1020 ELSE RETURN

1100                                             '100 ms delay routine
1110 T1 = TIMER
1120 T2 = TIMER
1130 IF T2 - T1 < .1 THEN GOTO 1020 ELSE RETURN
```

Referring to the above listing, lines 30 & 40 define and open a 19200-N-8-1 COM port. Line 50 sends the command string “Q6X3Y9Z4B7" (followed by a <CR> <LF>) to the DFP, which instructs the DFP to enter its host receiver pass-thru mode.

Line 60 is a 200 millisecond delay loop subroutine (the purpose of which is to allow the DFP time to fully process the command and enable the receiver pass-thru mode). Line 70 sends a frequency set command to the AR5000 receiver. Line 80 sends a frequency verification command to the AR5000 receiver (this command elicits a receiver frequency confirmation to verify that it properly received and processed the frequency set command sent in line 70). Note that the commands sent in lines 70 & 80 must be ones that are part of the AR5000 receiver command set. Also note that depending upon the host receiver selected, there may be a requirement for a delay between successive commands (although this is not the case for the AR5000). Programmers should therefore carefully study the host receiver RS-232 protocol carefully to determine whether or not such a delay is required.

Line 90 is 100 millisecond delay loop subroutine, which is necessary to allow the AR5000 receiver time to process the commands sent to it in lines 70 & 80 and return a frequency change confirmation. Once again, programmers should observe the host receiver behavior carefully to verify that the delay is sufficient to accommodate the immediately preceding commands (i.e., the commands sent in lines 70 & 80 in this example).

Line 100 sends the command string “Q6X3Y9Z4B7" (followed by a <CR> <LF>) to the DFP, which instructs the DFP to disable its host receiver pass-thru mode and return the unit to normal command control. Line 110 is a 100 millisecond delay loop subroutine, which is immediately followed by the “STATUS” command string of line 120. For the purpose of this exercise, the purpose of these two lines is to determine how much recovery time the DFP needs following the “Q6X...” command before it can send another command (the “STATUS” command in this case).

Although the host receiver RS-232 communication parameters do not have to be the same as those of the DFP (19200-N-8-1), it is usually most convenient that they be the same. (Most modern receivers can be configured for a number of different baud rates.) Of course, the “Q6X...” and “7B4...” commands must conform to DFP protocol (19200-N-8-1).

To prevent the DFP from getting “stuck” in the receiver pass-thru mode, a time-out feature is included that automatically exits the unit from the pass-thru mode after 10 seconds and resumes bearing strings. Also, while the receiver pass-thru mode is in force, the DFP will not respond to any of its normal command strings (with the exception, of course, of the “7B4...” exit command).

Note that the direct data pass-thru mode will work only for receivers that require the use of the RS-232 TXD, RXD, and SG (ground) lines only. Fortunately the vast majority of candidate host receivers meet this requirement.

## 14. CUSTOM OPERATING MODES

In most instances, the 15 standard operating modes (**MODE=00** - **MODE=14**) will optimally accommodate any signal format likely to be encountered. For added flexibility, however, users can pre-empt (modify) the bearing integration time (**BINT=xx**) and DF antenna axis encoding tone frequencies (**TONE=XX**) to effectively create custom operating modes.

To do this, first select one of the standard operating modes that is the best fit for the signal format of interest. This selection would typically be based on the desired demodulation mode (e.g., AM/FM/CW/SSB). Next, modify this standard operating mode by specifying different bearing integration times and/or DF antenna axis encoding tone frequencies.

Since doing this process constructively involves understanding certain subtleties and requires a certain element of technical astuteness and professional insight, it should not be undertaken casually. Also, any new customized operating modes should be validated by actual testing.

Regarding bearing integration times, the 8 standard hardware-implemented bearing integrations times (ranging from 35 milliseconds to 400 milliseconds) should be sufficient to handle most requirements. If additional bearing integration times are desired, however, these can easily be obtained by using software averaging to extend the standard hardware-implemented bearing integration times.

The most typical requirement in this respect would be to create additional bearing integration times longer than 400 milliseconds. As a case in point, assume that an application arises that requires a bearing integration time of 1 second for best results. The correct approach would be to select the longest available hardware-implemented bearing integration time (400 milliseconds) and then use a software moving average routine to effectively extend the 400 millisecond integration time to 1 second.

When implementing this technique, always select the longest available hardware-implemented bearing integration time that falls within the desired bearing integration time and then add the balance using software extension. Selecting a hardware bearing integration time that is too short can result in X-Y axis cross-talk, which in turn can cause bearing flutter.

Although bearing integration time can, in principle, be software-extended without limit using the above technique, bearing integration times in excess of 1 second are seldom useful.

## 15. MISCELLANEOUS ISSUES

### a. Azimuth Offset

Unlike the original DFP-1010 and DFP-1010A, the DFP-1000B/DFP-1010B has no provision for accepting an azimuth offset. Such a provision would be highly impractical for the DFP since it does not compute the azimuth (it only reports the X and Y axis voltages to the host computer, where the azimuth is then computed). Also, this feature is unnecessary since it can be more conveniently handled directly in the host computer software.

b. Ground/Air Dip-Switch

When set to AIR (up), the GND/AIR configuration setup dip-switch (#1) is intended to reverse the E-W axis to correct the axis reversal that would otherwise result when the DF antenna is mounted upside-down on the underside of an aircraft. (In other words, setting dip-switch #1 to AIR would cause a 45° bearing to become 315°.) Although this dip-switch is effective for the remote display/PDA, it does not affect the bearing output as reported to the host computer. This feature should therefore be included in the host computer software if aircraft operation is anticipated.

c. Normal/Reciprocal Dip-Switch

When set to RCP (up), the NOR/RCP configuration setup dip-switch (#3) is intended to reverse the bearing (offset it by 180°). Although this dip-switch is effective for the remote display/PDA, it does not affect the bearing output as reported to the host computer. This feature should therefore be included in the host computer software if the requirement for reciprocal bearings is anticipated.

d. Start-Up Operating Parameters (for DFP firmware Rev. B.03.02 and higher only)

For DFPs with firmware Rev. B.03.02 and higher, the following operating parameters are non-volatile (i.e., if the DFP is powered-down, these parameters will remain unchanged when DFP power is restored) for remote operation:

**MODE=xx IFBW=xx BAND=xx TONE=xx BINT=xx**

The remaining parameters automatically re-initialize as follows when the DFP is powered-up:

**GAIN=16 THLD=00 MUTE=00 DOFF=00 FT=0100 VATN=00**

The rationale for these re-initialization defaults is to prevent the user from inadvertently and unknowingly trying to operate the DFP with operating parameters that might cause erratic operation and confusion. As a case in point, if the DOFF (DF Off) operating parameter was set to 01, the DFP would not obtain bearings.

16. PC TERMINAL EMULATORS

As discussed at the beginning of this Appendix, a suitable PC terminal emulator should meet the following criteria:

1. It should allow simultaneous viewing of both the command (send) and read-back (receive) strings.

2. It should have the provision to buffer (store) individual characters as they are entered at the keyboard and then send these characters all at once when the <Enter> key (i.e., <CR><LF>) is pressed.

Unfortunately, many modern Windows PC terminal emulators do not well meet these requirements. In most cases, these emulators are not intended for applications that require the ability to type in a command string and then transmit this string using the <Enter> key. In many cases, these emulators are designed to send a file rather than characters entered manually from the keyboard.

If the user has access to a true MS-DOS-capable computer, the terminal emulator program "ProComm V2.4.2" (supplied on the RDF Products Publications CD included with this manual) is an excellent software utility for communicating with the DFP. In addition to being very simple to install and use, ProComm has a very convenient "chat mode" that is ideal for sending command strings to and receiving command strings from the DFP. This particular implementation of ProComm is a stripped-down freeware version but has all the terminal emulation features necessary for communicating with the DFP. We highly recommend ProComm for users having convenient access to an MS-DOS-capable computer.

ProComm V2.4.2 can be found in the "Software" folder on the Publications CD. To install it, create a suitable folder on the MS-DOS computer (e.g., "C:\PROCOMM") and copy all the ProComm files from the Publications CD into this folder (there is no installation program that has to be run). The executable file is "PROCOMM.EXE". When launched, ProComm is already configured for operation with the DFP. To control the DFP, go to the chat mode by entering <ALT-O>. See the included "README.TXT" file for more information.

Be advised, however, that Windows PCs often do not work well for MS-DOS applications. The Windows 95/98 "MS-DOS Prompt" is actually a Windows MS-DOS emulator that does not permit access to the PC COM ports. The Windows 95/98 MS-DOS *Mode*, however, is a true DOS operating environment that works well and is suitable for running ProComm.

If the user is constrained to a Windows PC solution, the "chat mode" of DefCon2b (the RDF Products Windows software package designed to simultaneously run the DFP and a suitable host receiver) is also a suitable option. DefCon2b and its Operating Manual are also available on the Publications CD. Section VI of this manual describes the use of the chat mode in detail. Although this approach is somewhat less straightforward than ProComm, it does not require an MS-DOS-capable computer.

**Post Note:** Beginning with Version 1.2.9, DefCon2b has an improved chat mode that eliminates the source of confusion that was reported for earlier revisions. With these improvements, most users will likely find the DefCon2b chat mode to be the most convenient PC terminal emulator for interactive communication with the DFP.

## N. PROGRAMMING TIPS

### 1. OVERVIEW

This Appendix is written to offer specific suggestions for users who wish to write their own application software for the DFP-1000B/DFP-1010B. Unlike Appendix M (which is focused narrowly on the details of the RS-232 protocol), this Appendix is focused on how to best take advantage of the many features of the DFP.

Our primary assumption is that the programmer is experienced and competent, but someone who may not have specific experience with radio direction finding in general and RDF Products equipment in particular. With this in mind, the purpose of this Appendix is not to tell the user how to program, but instead to offer insights based on our own many years of experience in the design, manufacture, and application of our equipment.

Another assumption is that the user has thoroughly studied Appendix M and fully understands all issues associated with the RS-232 protocol. A further assumption is that the user has actually exercised the various command strings using a suitable terminal emulator, received the appropriate read-back strings, and has resolved any possible communications issues.

Our primary motive for writing this Appendix is that we have heard feedback from users who wrote their own DFP application software and then discovered that it did not work as well as expected in field applications. In the course of our conversations with these users, we found in all cases that their software was written in a fashion that did not take full advantage of one or more of the DFP's features. With this in mind, this Appendix as been written primarily to alert users to these issues to help them avoid these problems. With this in mind, we hope that users will find this Appendix to be constructive.

### 2. DEFCON2B

DefCon2b is RDF Products' Windows user-interface software package that simultaneously can run the DFP and an appropriate selected host receiver using a single host computer serial port. The purpose of DefCon2b is to emulate a "virtual DF receiver" in software. DefCon2b is capable of exercising all of the DFP's major features and providing bearing displays, an S/Tune meter, and other indications. In addition, it is capable of emulating all of the host receivers features necessary for most DF applications. DefCon2b's main screen is illustrated in Figure 15.

Although many users find that DefCon2b well meets their remote operation requirements, we understand that there are many applications for which DefCon2b is unsuited. Nonetheless, we recommend that users thoroughly study DefCon2b (both by reading its Operator's Manual and actually exercising it) in order to gain important insights regarding issues that are potentially relevant to their applications. Since DefCon2b is a field-proven software package that incorporates the benefits of many years of first-hand operational experience, we hope that users will "stand on its shoulders" to give themselves a head-start that will save time and effort in their own software development.

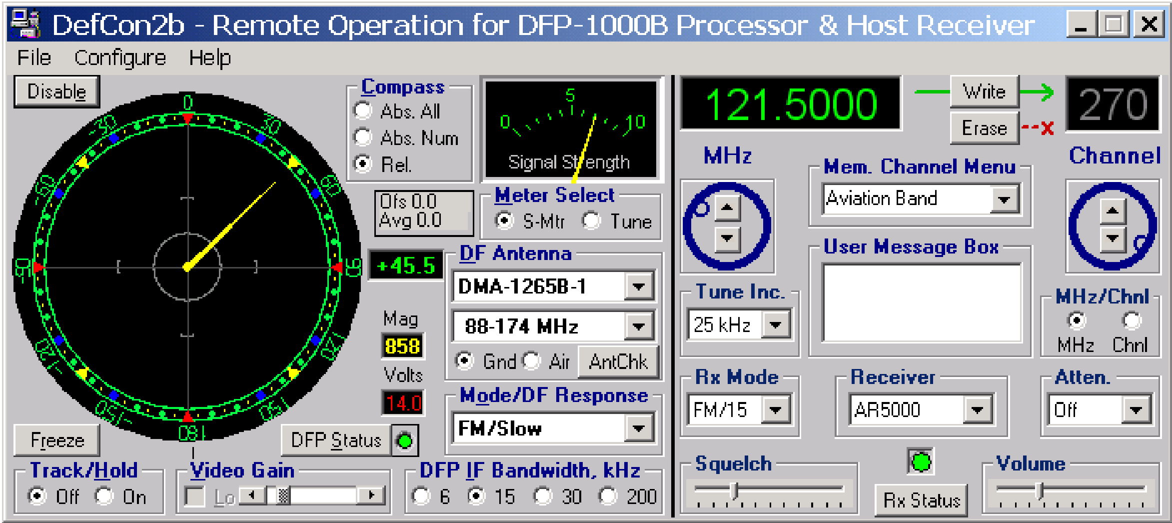


**Figure 15 - DefCon2b Main Screen**

We particularly recommend that users carefully study the features below (see the DefCon2b Operator's Manual for more details):

a. Real-Time Polar Bearing Display - In addition to a 4-digit numeric bearing display, DefCon2b also closely emulates the real-time polar bearing display feature of the DFP-1000B. A real-time polar bearing display is *essential* for mobile DF tracking and homing applications, and is the primary feature that makes RDF Products mobile DF equipment superior to that of its competitors. If users intend that their software be effective for mobile DF applications, the real-time polar bearing display is a *"must have"* feature.

Furthermore, we suggest that it be implemented in a fashion very similar to the way it is done in DefCon2b to be sure that the full benefit of this essential feature is captured. At the risk of belaboring this point, the importance of the real-time polar bearing display cannot be over-emphasized. To further assist the user, important implementation issues are discussed in greater detail in a subsequent paragraph.

b. Real-Time S/Tune-Meter - DefCon2b includes a real-time emulation of an analog meter that is selectable for either signal strength or center tuning. A more detailed discussion of the S-meter is presented in a subsequent paragraph.

c. Mode/DF Response Selection - DefCon2b employs a simplified "Mode/DF Response" selector that simultaneously selects the appropriate DFP audio demodulator, AGC response time, and bearing integration time. As a case in point, selecting "FM/Slow" concurrently selects the FM demodulator, slow AGC, and a 400 millisecond bearing integration time. This not only eliminates unnecessary controls, but also relieves the user of the need to have the required technical insight to make these various individual selections manually.

Although DefCon2b is supplied with a standard Mode/DF Response script, it also allows users with special requirements to define their own custom script. Of course, the standard settings can be easily restored.

A further refinement is the capability of DefCon2b to match the host receiver's operating mode and IF bandwidth to those of the DFP. Keeping in mind that both the DFP and host receiver contain selectable IF bandwidths and demodulators, it is usually desirable that they match each other as closely as possible. As a case in point, selecting the DFP "FM/Slow" Mode/DF Response and a 15 kHz IF bandwidth would automatically cause the host receiver to select the best match for its "Rx Mode" (which would be "FM/15" for an AR5000A host receiver).

Furthermore, the matching process works both ways. As another case in point, if the user selects an AR5000A host receiver Rx Mode of "AM/6", for example, DefCon2b would automatically command the DFP to select "AM/Slow" as its Mode/DF Response setting and a 6 kHz IF bandwidth.

The matching process is defined by a user-editable "OpMode" file. Although a standard OpMode file is provided that is likely to be satisfactory for most applications, users with special requirements can edit this OpMode file for custom matching scripts.

d. DF Antenna Band Selection - DefCon2b includes an "AntChk" button that when clicked causes a query to be sent to the DF antenna. The DF antenna then reads back an ASCII text string that returns the DF antenna model number (e.g., "DMA-1315B2") and its band information (e.g., "75-300 MHz" and "300-520 MHz"). This feature helps eliminate user confusion as to the DF antenna frequency band (i.e., users can tell at a glance whether the selected host receiver frequency is in-band or out-of-band and thus avoid out-of-band operation).

To further reduce the possibility of out-of-band operation, DefCon2b automatically changes the selected DF antenna band so that it is appropriate for the selected host receiver frequency. More specifically, if the user tunes the receiver frequency across a DF antenna band-edge boundary, DefCon2b automatically selects the correct DF antenna band. If the user sets the receiver to a frequency outside the capability of the DF antenna, a warning message appears.

e. Host Receiver Channelization

DefCon2b allows the user to select the host receiver frequency either by direct frequency selection or by channelization. The channelization feature is frequently important in applications where all the frequencies of interest are channelized (i.e., the signals of interest are on known assigned frequencies). Cases in point would include the civil aviation band, VHF marine band, FM broadcast band, and CB band.

Users can program memory channels directly from the main screen. Furthermore, DefCon2b allows users to create and store memorized channel lists that can be selected as required.

## 3. REAL-TIME POLAR BEARING DISPLAY

As strongly emphasized elsewhere in this manual, the real-time polar bearing display is the premier feature of RDF Products' DF systems that provides them with their unique ability to find signals when either the mobile DF unit or target transmitter is in motion. Without this display format (and its carefully designed dynamic features), RDF Products DF systems would be only marginally superior to competing units (with their generally poor ability to function in mobile applications due to their inferior bearing displays and poor dynamic performance in general).

It is thus extremely important that user's writing their own application software be very careful not to inadvertently design-out (or "dumb-down") this essential feature. With this in mind, we ask that the users study the following related issues very carefully:

a. Display Update Rate - Unlike the numeric bearing display (where an update rate of 2-5 updates per second is appropriate), a useful real-time polar bearing display requires a video-quality update rate in order to provide a smooth, responsive, real-time presentation. As a point of reference, early 20th century movies were shot at 16 frames per second, whereas current movies are shot at 24 frames per second. Turning to television, PAL television (the European standard) is shot at 25 frames per second whereas NTSC television (the USA standard) is shot at 30 frames per second.

   The DFP outputs 60 bearing strings per second, and we strongly recommend that users write their software with a real-time polar bearing display update rate that takes full advantage of this (i.e., the display should update for every bearing string received from the DFP as is the case for DefCon2b), resulting in a 60 frame per second update rate. Although some users might wonder if such a fast update rate is really necessary, the reality is that a 60 frame per second update rate is necessary to capture the short-duration pulses the DFP is capable of processing. Also, there is little reason to use a slower rate since 60 frames per second does not come close to taxing the capabilities of modern computers and programming languages.

b. Video Gain Control Issues - For effective use in mobile DF applications, *it is essential that the software include an easy-to-operate video gain control that reduces the DFP video gain*. The reason for this is explained in detail elsewhere in this manual, but to restate this important matter succinctly, *the real-time polar bearing display is useful only if the operator has the means to "ride" (manually vary) the video gain to keep the vector length "on-screen"* (i.e. less than full-scale). To explain, the vector length serves as a bearing "quality indicator" where longer vector lengths tend to signify "legitimate" bearings (as opposed to multi-path signals or noise, which tend to be associated with shorter vector lengths).

   In competing systems employing inferior mechanical pointer or azimuth ring displays that provide no magnitude information, the user has no means to make this all-important discrimination between desired legitimate bearings on the one hand and undesired multi-path or noise-induced bearings on the other. As a result, erroneous bearings produced by noise and multi-path reception appear no different than legitimate bearings with the result that accurate interpretation of the display indication is very difficult.

   Clearly then, if the DFP video gain is so high that all bearing display indications are full-scale, the essential magnitude information is lost, which in turn forfeits the premier competitive advantage of the real-time polar bearing display.

   The video gain control concept can best be explained by first discussing the DFP-1000B manual video gain controls (see Figure 6 or the front cover illustration). As per this illustration, note that the DFP-1000B actually has two video gain controls. The most important of these two is the one labeled **VIDEO GAIN**. This control is a potentiometer that allows the user to smoothly vary the video gain by controlling a 0-30 dB variable (hardware) attenuator. When this attenuator is exercised, the display bearing vector becomes longer or shorter.

As discussed elsewhere in this manual, proper use of this control requires that the user adjust it as required to prevent the bearing vector length from exceeding full-scale. When the user “rides” the **VIDEO GAIN** control in this fashion, bearings generated by noise and multi-path tend to appear as shorter vector lengths, whereas legitimate bearings appear longer.

To assist the user in this process, the DFP-1000B bearing vector appears *yellow* when its length is less than full-scale and *green* when it reaches or exceeds full-scale. This feature provides a very helpful visual aid to users to alert them when the **VIDEO GAIN** control is set too high. Operationally, the user simply adjusts this control as required to keep the vector mostly yellow.

The second video gain control is the **HI/LO** button. This button is a toggle that selects or deselects an additional 12 dB of supplemental hardware attenuation. For most mobile DF applications, this attenuator should be enabled (**LGAIN**, as indicated by the **LGAIN/HGAIN** display indication). **HGAIN** should be used only for very weak signals. The default setting at DFP-1000B power-up is **LGAIN**.

c. DefCon2b Video Gain Control Features - With this background in mind, it is important that a software video gain control capture the full functionality of the DFP-1000B hardware video gain control features as is done in DefCon2b. Referring again to the DefCon2b main screen illustration (Figure 15), the **Video Gain** slider directly corresponds to the DFP-1000B **VIDEO GAIN** control. When this slider is moved, DefCon2b sends the appropriate video gain commands (GAIN=00 through GAIN=16) that control the afore-mentioned 0-30 dB DFP video attenuator.

Similarly, when the **Lo Video Gain** box is selected (corresponding to the DFP-1000B **HI/LO** video gain button), the afore-mentioned 12 dB supplemental video attenuator is enabled. (When this box is selected, DefCon2b sends the command VATN=01. When it is deselected, it sends the command VATN=00.)

Finally, the DefCon2b bearing vector is yellow when less than full-scale and turns green when the bearing vector reaches or exceeds full-scale. Thus, DefCon2b captures all the features of the DFP-1000B real-time polar-bearing display, and is thus fully suitable for the demanding requirements of mobile DF operation.

As a final note on this topic, *we strongly discourage users from attempting to implement these attenuators in software (i.e., by just shortening the vector length on the display)*. If this is done, *the result will be cosmetic only and the benefit of the real-time polar bearing display will be lost.*

To explain, when both of the DFP-1000B attenuators are set for maximum gain (i.e., the **VIDEO GAIN** knob set fully clockwise and the **HI/LO** button set for **HGAIN**), a full-scale bearing vector length will be reached at a very low video signal level. More specifically, when the DFP-1000B is running at maximum video gain, a full-scale bearing vector length will be reached when the video signal input is only 1.25% of the maximum specified video signal input. Once the full-scale vector length is reached, the B-string xxxx and yyyy magnitudes truncate (actually, they automatically proportionally down-scale in such a fashion to keep them just within their 0000-4095 permissible range and to maintain the correct bearing).

Looking at this another way, if the maximum specified video signal input is applied to the DFP-1000B, the bearing vector length would be 80x full-scale (were it not for the proportional down-scaling truncation process mentioned above and the fact that the vector length cannot exceed the bearing display perimeter).

It is clear then that if the hardware attenuators are not used, *nearly all received signals will be strong enough to yield full-scale truncated bearing vectors*. As a result, the magnitude information would be effectively lost (along with the primary benefit of the real-time polar bearing display as explained above).

d. Display Magnitude Scaling Factor - Another important issue is the scaling factor selected for the polar bearing display vector length. *It is very important that this scaling factor be selected so that the bearing display vector reaches its full on-screen length for a bearing magnitude of 2046* (where bearing magnitude is derived from the B-string as formally defined in Appendix M). This recommended full-scale magnitude threshold is the same as that used in DefCon2b.

The user should study the bearing angle and magnitude computation example in Appendix M very carefully. See in particular the ARCTAN4.BAS QBASIC code listing. This routine computes bearing azimuth and magnitude using the xxxx and yyyy DFP B-string variables as program inputs. ARCTAN4 is also included on the RDF Products Publication CD as an executable program (ARCTAN4.EXE) than can be run on any MS-DOS capable computer. We strongly recommend that users run this routine and exercise it if there is any uncertainty as to how the xxxx and yyyy variables should be processed to compute bearing azimuth and magnitude.

A related issue is how to select the best criteria at which to trigger the “over-range” indication (i.e., the criteria that signals the change from a yellow vector to a green one in DefCon2b). Since magnitude alone might be an unreliable criterion in some instances, we recommend using three followng criteria:

1. The over-range indication should activate if the bearing magnitude exceeds 2040.

2. The over-range indication should activate if the xxxx or yyyy variable is 0002 or less.

3. The over-range indication should activate if the xxxx or yyyy variable is 4094 or greater.

If *any* of the three above criteria or met, the over-range indication should activate.

## 4. DTI-100B DF BEARING SYNTHESIZER


**Figure 16 - DTI-100B DF Bearing Synthesizer**

To do effective programming, it is necessary to have a reliable means of generating stable, repeatable bearings at various azimuths and magnitudes. Since this is very difficult to do outdoors using a DF antenna with actual signals, we strongly recommend that users procure the DTI-100B DF Bearing Synthesizer (see Figure 16). The DTI-100B was designed both to facilitate convenient system testing and DF software development in an indoor laboratory environment. With its modest pricing, this unit pays for itself in a very short time for programming applications. For more information, see the DTI-100B product data sheet and Operator's Manual (both available from the RDF Products Publications CD and website).

## 5. S-METER

A signal-strength meter is another important component of a good mobile DF system. Although not as important as the real-time polar bearing display, the S-meter is the DF system's best relative ranging indicator and serves the important purpose of alerting the user that the DF system is getting close to the target transmitter. See Figure 15 for the virtual S-meter display employed by DefCon2b (this meter can also be selected as a center-tune meter). Although this DefCon2b S-meter display is rather elaborate, a simple bar graph display is equally effective. In any case, we strongly recommend that programmers incorporate an S-meter into their software since it is a useful indication and easy to implement.

Significant effort went into the design of the DFP to linearize the S-meter presentation. To explain, while nearly all communications receivers have S-meters, their indications tend to greatly compress above half-scale or so. Operationally, the S-meter indication appears "lively" for low to moderate signal strengths but then appears much less dynamic for stronger signals. This is disadvantageous from the standpoint that once signals become moderate in strength, this compression at higher signal strengths makes the S-meter far less useful as a relative ranging indicator for strong signals. In DF tracking and homing indications, this can be a very serious disadvantage since the relative ranging indication is especially important for strong signals (i.e., the mobile DF system user often needs this information to avoid getting too close to the target transmitter in covert surveillance applications).

In contrast, the DFP provides a linearized S-meter presentation that works equally well for both weak and strong signals, resulting in a much improved relative ranging indication. A representation of this linearized S-meter voltage is transmitted as part of the B-string as discussed in detail in Appendix M, with a range of 00-99 (minimum to maximum). Note also in Appendix M that this information is time-shared with the tune-meter voltage (also with a range of 00-99, with 49 corresponding to center-tune). Since the S/Tune meter voltage indications are sent alternately, each one is transmitted only 30 (rather than 60) times per second.

Even so, 30 times per second is fast enough for a real-time S-meter display. We recommend that the S-meter be updated at this maximum rate for best real-time response.

## 6. FIXED-SITE VERSUS MOBILE DF APPLICATIONS

For DF systems that are intended for use only in fixed-site applications, there is less requirement that the DF system (and the software controlling it) have the same dynamic capabilities that are necessary for the more demanding requirements of mobile DF operation. This is mostly due to the fact that the DF system is stationary, and if the target transmitter is moving at all, its distance and azimuth change relatively slowly.

Also, since the fixed-site DF antenna is typically mounted atop a tower or building with few nearby obstructions, multi-path issues are far less of a problem than in mobile DF. Nonetheless, we still recommend implementing a real-time bearing display. Since even fixed-site DF applications require the ability to obtain lines of bearing on short duration signals, it is best to have a real-time polar bearing display to capture them. <>

## O. RESTORING THE X51 PDA DF PROGRAM USING A MEMORY CARD

### 1. OVERVIEW

Although the Dell Axim X51 PDA in current-production DFP-1000Bs has a non-volatile program memory, it is possible that a user might inadvertently erase the DF program (this would be most likely to occur if the user accidentally presses the Reset button). This memo is written to assist such DFP-1000B users by providing a summary procedure that allows them to reload the DF software from a readily available compact memory storage card. The advantage of this technique is that it offers a means by which users can reload the DF program on-site without the need for returning the X51 PDA to the factory for reprogramming.

### 2. MEMORY STORAGE CARD

To reload the DF software, the user will need a suitable memory storage card and the means to write the DF program onto it. As of this writing the DF software and associated installation files are in the zipped file "2577-Axim X51.zip" (available at no charge and included on the current RDF Products Publications CD, which also includes the unzipped version). This file can also be sent to the user as an e-mail attachment upon request.

The X51 has two memory slots located at the top of the unit. The larger of these two slots supports CompactFlash Type II memory cards. The smaller slot supports Secure Digital (SD) memory cards, Secure Digital I/O (SDIO) cards, and MultiMediaCards (MMC). Although the X51 owner's manual is not specific as to card memory capacity supported by the X51, it does mention that all three memory card types are available in sizes "from 64 MB to 1 GB or 2 GB".

Card memory capacity may be an issue since the X51 was designed at a time when memory storage card capacity was more limited than is the case today. As a result, it is possible that the X51 may not support high memory capacity cards. We successfully validated the procedure presented below using a 2 GB SanDisk (SD) memory card (this was the lowest capacity card we were able to find in our local office supply store).

Most modern Windows computers have memory card slots capable of accepting one or more of the above-mentioned memory cards. Once the card is plugged-in, Windows will recognize the card as a storage device and allow files to be written to it in the standard fashion.

Once this zipped file and a suitable memory card have been obtained, do the following steps:

1. Unzip the file "2577-Axim X51.zip". This will result in a file folder named "2577-Axim X51" containing 4 sub-files. (The unzipped version of this file is already included on the current RDF Products Publications CD for users' convenience).

2. Copy this folder (with its 4 sub-files) into the selected memory card root directory.

3. *Do not yet insert the memory card into the X51* - this will be done as part of the reload procedure that follows.

## 3. SUMMARY PROGRAM RELOAD PROCEDURE

1. Conduct a *hard reset*. This is accomplished by powering-up the X51, holding down the Power On/Off button (located on the front of the unit just to the right of the DELL logo), and then pressing the reset button (located in a recessed hole on the back of the unit and accessible using the PDA stylus or other suitable pointed object). *Note that the Power On/Off button must be held down while the reset button is pressed.*

2. Once the hard reset is done, a warning message will appear on the screen. Follow the instruction to *restore factory settings* by pressing the indicated button.

3. The X51 will then re-boot into its set-up mode (allow at least 30 seconds for the initial Windows Mobile set-up screen to appear).

4. Tap the screen with the PDA stylus as per the on-screen instruction. This will bring up the Align Screen. When this screen appears, follow the screen alignment instructions.

5. Once the screen alignment procedure is completed, the Location screen will appear. When this happens, skip this step and tap Next (don't worry about time zones - this is not relevant for the X51 operating as a bearing display).

6. At this point, the Stylus screen will appear. When this happens, tap Next to bring up the Pop-Up Menus screen. When this screen appears, follow the tap-and-hold instructions and then tap Next.

7. At this point, the Password screen will appear. When this happens, tap Skip (no password is necessary).

8. At this point, the Complete screen will appear. Tap this screen to continue.

9. At this point, the Wireless screen will appear. Follow the instructions to *disable* the wireless feature as required.

10. At this point, tap the screen again to bring up the main (Start) menu.

11. Plug the memory card (as loaded per the previous Section) into the X51.

12. Within a few moments, an autorun.exe dialog box will appear asking the user whether to proceed with the autorun.exe program. Tap Yes.

13. An e-PocketSetup 2003 dialog box will then appear. Tap Ok.

14. A ...PC.STRONGARM.cab dialog box will then appear. Tap Yes.

15. A new window will then appear querying the user as to where to install "RDF Products DFP-1000B Ctrl. The Device option should already be selected by default. When this is confirmed, tap Install.

16. An e-PocketSetup 2002 dialog box will then appear. Tap Ok.

17. The program will then install as evidenced by the progress bar. When the installation is complete, the X51 will reboot and auto-load the DF program (as evidenced by the appearance of the compass rose bearing display). Allow at least 60 seconds for the X51 to install the DF software, reboot, and load the DF program.

18. Power-down the X51 and remove the memory card. The X51 is now fully programmed and can be reinstalled into the DFP-1000B.

## P. X51 PDA BOOT-UP ERROR RECOVERY

In very rare cases, a **"To restore factory settings..."** error message may appear on the PDA screen when the unit is powered-up that does not clear when the DFP-1000B is powered-down and then again powered-up. This error screen is illustrated in Figure 17.


**Figure 17 - PDA Error Screen**

This error is caused by some undetermined anomaly of the X51. It appears to occur only in circumstances where the DFP-1000B is powered-up/down many times in succession during a short period of time. The only way to recover from this condition is to power-down the DFP-1000B, wait 30 minutes, and then again power-up. When this is done, the unit will boot-up normally.

*Do not attempt to follow the instructions on the screen to restore factory settings since this will erase the DF program from the PDA memory. Similarly, do not attempt a hard reset. If this cautionary is not heeded, it will be necessary to reload the DF program as per Appendix O.*

Even with this error condition present, the DFP-1000B can still be operated normally in its Remote mode. <>