User Manual

SmartDF

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Note

The manufacturer reserves the right to make modifications at any time and without previous information of the product described here.

Content

1 Overview

smartDF is specifically engineered for monitoring and controlling RHOTHETA direction finders. It accomplishes this through two primary means: a Bluetooth® Low Energy (BLE) link and Wi-Fi connectivity enabled by RS-485 or RS-232 connections.Optimized to run on iPadOS, users can turn their exisitng iPads into a intuitive RDF tool. This application harnesses the full potential of the iPad's integrated GPS/GNSS, compass, and accelerometer sensors, in combination with Mapbox™'s advanced library for geolocation, vectorized layers, and offline maps. The result is an immediate and powerful tool that offers unprecedented navigational capabilities.

smartDF is designed to swiftly guide users towards the origin of transmissions, such as search and rescue (SAR) beacons. The user might use the smartDF either to simply follow a Line of Bearing (LOB) / Line of Position (LOP), collect several LOBs to auto automatically create search zones, or to decode a possible target position from a COSPAS-SARSAT transmission.

2 Installation

2.1 System Requirements

This user manual is part of the product smartDF throughout its lifetime and will pass with the product.

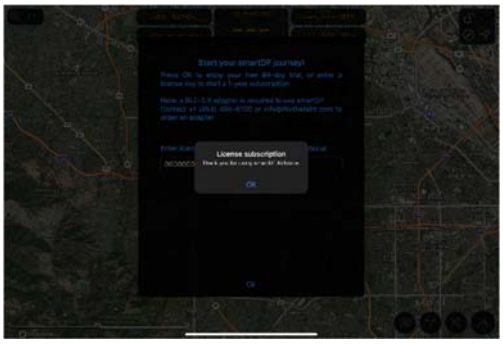
System Requirements	
iPad Compatibility	Requires iPadOS 15.0 or later.
Size	61.5 MB
Wireless module	Wi-Fi Bluetooth Low Energy (BLE)
Data Interface	Standard: RS-232 Pro: RS-485

2.2 Installing smartDF Application

smartDF is available directly from the App Store with a 90-day free trial for first time users.

2.2.1 Licensing

smartDF is a subscription-based application and requires a license key to use the software. A 7-digit license key will be provided to the user by RHOTHETA International. Without a license from RHI, the app will run in trial mode for 90 days, with Pro mode enabled. 30 days before expiration, the app will invite the user to reactivate the license. Upon entering the license number, RHI's Licensing Service validates the license fee has been paid for and enables the App to operate in either standard or Pro mode.



2.2.2 Mapping Data

The mapping feature in smartDF leverages the advanced capabilities of the Mapbox™ library, offering users a comprehensive geolocation experience combined with vectorized layers and offline map functionality. Within the smartDF application, users can access various types of maps, including Dark, Satellite, IFR Low, IFR High, and VFR maps. To enable these maps, an active internet connection is required, ensuring real-time access to map data.

One of the standout features of smartDF's mapping is its offline capability. Users can seamlessly save map data within the app, allowing them to access and navigate maps even when an internet connection is unavailable. This proves especially valuable in situations where reliable connectivity is limited.

2.3 Connecting to RDFs

Connecting RHOTHETA radio direction finders to smartDF is a swift and effortless process. The application comes in two versions, Standard and Pro. This allows users to establish connections either with a Display Control Unit (DCU) or Antenna Unit (AU). Connection to the smartDF app is facilitated over either Bluetooth Low Energy (BLE) or Wi-Fi data links, adapters provided by RHOTHETA International. User must define the version and connection type under the advanced settings page.

2.3.1 Standard Version

The Standard Version of smartDF interfaces with RHOTHETA's RT-600 Display Control Unit (DCU). By establishing a connection over an RS-232 link, smartDF functions as a secondary display, granting you comprehensive remote control over the DCU. This bi-directional communication ensures that any changes made on the DCU are instantly reflected in the smartDF app and vice versa.

2.3.2 Pro Version

The Pro Version of smartDF provides a connection to RHOTHETA's AU through an RS-485 connection. With this configuration, smartDF takes full control of the AU, enabling its usage as a wireless control unit. The Pro License also offers toggling between the Pro and Standard versions directly from the advanced settings page, allowing for flexible configurations.

3 SmartDF UI Interface

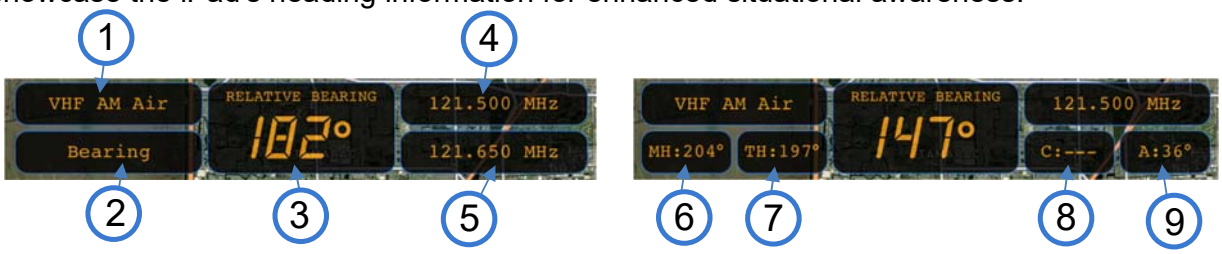
3.1 Dashboard

The dashboard provides a seamless view of essential parameters, such as bearing data, signal strength, and geolocation information. Its serves as the central hub for the operator and provides an immediate snapshot of critical data, enabling operators to rapidly assess and respond to radio direction finding scenarios. The dashboard offers a degree of customization, allowing individuals to tailor certain aspects to their specific preferences.

Main Elements of the Dashboard		
Number	**Meaning**	**Description**
1	Zoom level of the Map	Modify map zoom levels by pinch gestures on the map interface
2	The DF Control Panel	Shows information on operational band, DF mode, bearing value, active frequency, standby frequency.
3	Annunciator Panel	Shows the status of the Screen Lock, DF Connection, Compass, and GPS
4	User Location	The icon of the user's GPS location
5	Signal Level Indicator	Shows current Signal Squelch Level
6	Menu (Expanded)	Menu buttons
7	Map Scale	Dynamic Map Scale

3.1.1 DF Control Panel

e DF Control Panel provides real-time insights into the currently active frequency and its corresponding bearing to the source. Within this panel, operators have the flexibility to adjust the DF mode to align with mission demands. Furthermore, this panel can be customized to showcase the iPad's heading information for enhanced situational awareness.



Elements of the DF Control Panel		
Number	**Meaning**	**Description**
1	Active band	The band of the active frequency, includes VHF AM Air, VHF FM Marine, UHF AM Air, Cospas-Sarsat, UHF FM, LoJack, and ETS
2	Direction Finding Mode	Tapping changes the set mode. Modes include scanning, bearing, decode, filter OFF, and filter ON.
3	Average Bearing Value	Average Bearing of active frequency value. RELATIVE by default, MAGNETIC if magnetic heading is available
4	Active Frequency	Current active frequency. Operator can tap to input new frequency.
5	Standby Frequency	Tap to switch Active and Standby frequencies. Standby frequency is set in advanced settings page.
6	Magnetic Heading	Magnetic heading from the iPad’s internal compass
7	True Heading	True heading from the iPad’s internal compass
8	Course	Current Course of the iPad based off GPS position
9	Accuracy	Accuracy of the iPad’s internal compass

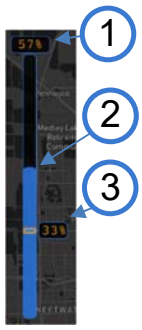
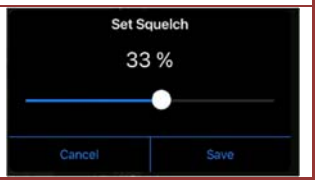
3.1.2 Annunciator Panel

The annunciator panel ensures operators stay informed about crucial system interfaces including data connection status to Rhotheta equipment, GPS and compass status, and if the screen lock is active to prevent unwanted inputs.

Elements of the Annunciator Panel			
Number	**Status**	**Meaning**	**Description**
1	locked unlocked	Screen Lock	Indicates Screen lock is active. If unlocked operator inputs will be accepted.
2	Connected Searching Failed	DF Connection	Indicates if connection is made to the RDF.
3	Valid Invalid	Compass	Indicates if internal compass is operating.
4	Valid Fix Invalid Fix	GPS	Indicates if a GPS fix was obtained.

3.1.3 Signal Level Indicator

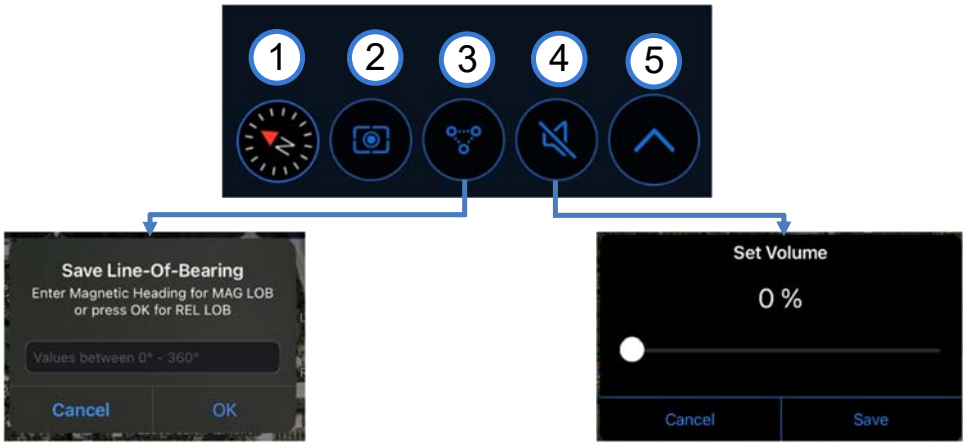
The signal level indicator on smartDF provides information about the received signal's strength both numerically and through a graphical bar graph. The indicator also displays the current squelch level. Squelch adjustment is vital as it eliminates background noise, enhancing accuracy by isolating stronger signals for more precise bearing calculations.

Elements of the Signal Level Indicator			
	**Number**	**Meaning**	**Description**
	1	Receive Signal Strength	Receive signal strength of the currently received signal as a numeric value.
	2	Receive Signal Strength	Receive signal strength of the currently received signal as a bar graph.
	3	Squelch level	Current set squelch level in %. Typically adjusted to 2 % above noise level 

3.2 Menu Functions

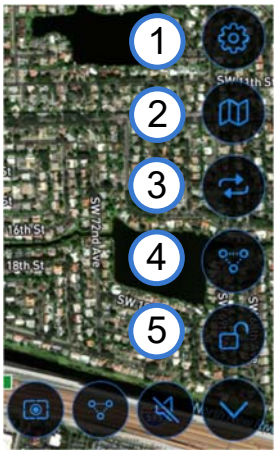
3.2.1 Quick Access Buttons

Located on the bottom right-hand corner of the display, the quick access buttons allows operators to quickly access the common actions.



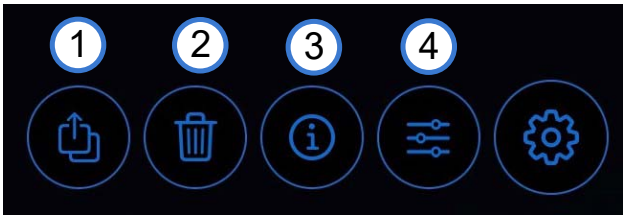
The Quick Access Buttons		
Number	**Meaning**	**Description**
1	Reset Map Orientation	Button becomes visible after rotating the map. When pressed, resets the map to its North Up orientation.
2	Center GPS Location	Recenters the map to current GPS location. Does not change map orientation.
3	Save LOB/LOP	Opens a menu to enter a value for the LOB or LOP and once saved, places a line over the map.
4	Set Volume	Opens a menu to set the volume for the DCU **NOTE**: Does not changes iPads volume
5	Sub-Menu	Expands or shrinks the sub-menu

3.2.2 Sub-Menu Buttons

The Sub-Menu Buttons			
	**Number**	**Meaning**	**Description**
	1	Settings Menu	Toggles options for settings
	2	Mapping Functions Menu	Toggles options for mapping functions
	3	Replay/Repeat Menu	Toggles options for replaying events
	4	Save/Delete LOB/LOP Menu	Toggles options for adding or removing LOBs or LOPs
	5	Screen Lock	Locks the screen to prevent inputs

3.2.3 Settings Menu

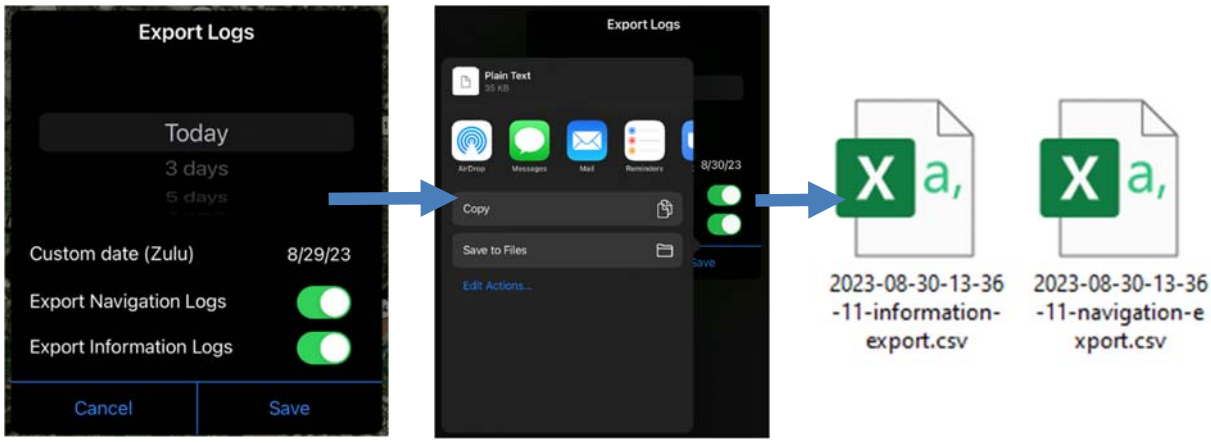
Accessing the settings menu in the smartDF application provides operators with the ability to configure and personalize various aspects of their experience. From exporting and clearing logs to adjusting app and direction finder information.



The Settings Menu Buttons		
Number	**Meaning**	**Description**
1	Export Log	Allows operators to export data with custom parameters
2	Clear Log	Deletes logs older than 30 days
3	App & AU Information	Shows information related to the application and antenna unit
4	Advanced Settings	Opens a menu to change major application functionality

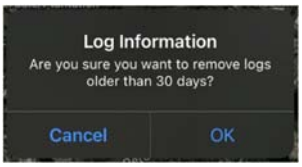
3.2.3.1 Export Log

The Export Log feature in smartDF enables operators to efficiently transfer data from the application to an Excel file for review. This function is particularly valuable for analyzing critical mission data. Users can customize the exported logs by selecting a specific data range. There are two logs available: the Navigation Log, which includes timestamps, coordinates, and bearings, and the Information Log, which records connection details, disconnections, errors, and more. This feature enhances operational precision by allowing systematic data capture and assessment.



3.2.3.2 Clear Log

To maintain the relevance of log files, operators have the option to delete logs that are older than 30 days. This helps keep exported files smaller and more manageable, promoting efficient data management.



3.2.3.3 App & AU information

The App and AU Info page within smartDF provides users with essential insights into both the application and the connected Antenna Unit (AU). Operators can quickly access details needed for maintance and troubleshooting without the need to physically inspect the antenna unit.

App & Antenna Unit Info	
App Version 3.4.8 - Pro	Application software version and subscription tier
AU ID AU	Antenna Identification
AU Temp/Voltage 47 °C / 11.9 V	Current temperature and voltage only for AU.
Variant Standard [A]	AU variant: [A] Standard or [LE] Law Enforcement
Software version 3.33	Software version for AU.
Frequency Options F1 | F2 | F3 | F4	Options that extend frequency ranges
Extra Options --	Options for additional features.
Serial Number 00014	Electronic Serial Number of the AU. **NOTE**: Can be different from serial number on label
Close	

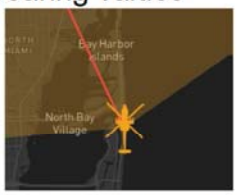
For additional information, please refer to the RDF system's respective user manual.

3.2.3.4 Advanced Settings

With the Pro license enabled, the operator gains the ability to toggle between the Pro and Standard versions.

Creates a cone for unaveraged single bearing values

Bearing Cone - Off



Bearing Cone - On

Updates the DF Control Panel to display heading information

Heading Info - Off

Heading Info - On

Sets the standby frequency on DF Control Panel

Sets a timer for displaying Magnetic Bearings

Enable the automatic generation of search areas when two or more LOB are saved. Operators can modify the size of the generated search area.

Changes the color of the generated search area

Changes the color of saved LOP

Wireless data link between the AU and smartDF. BLE will connect automatically when detected

Once connected to Wi-Fi network smartDF will connect with the set IP address and Port

Adds a constant offset correction to the bearing indication. Bearing values in degrees will be changed according to the offset value.

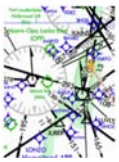
Mounting position of the AU

Changes the map type

Dark

Satellite

IFR Low



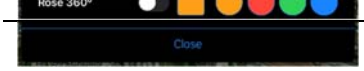
IFR High

VFR

Customizes the look and color of the user icon

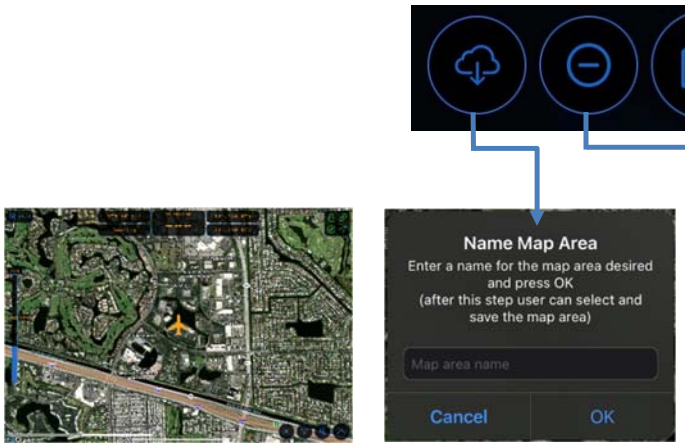
Customizes the color of the active average bearing line

Activates customizable a 360° rose around user icon

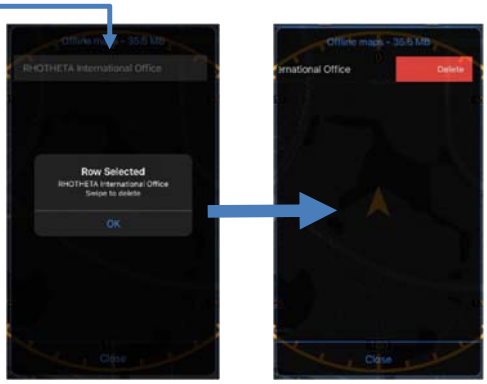


3.2.4 Mapping Functions Menu

The Mapping Functions menu provides convenient options for saving maps for offline use and deleting any unnecessary ones.This ensures uninterrupted functionality even when an internet connection is unavailable.



Position the map to desired area and press the map download button



Swipe to delete any maps saved

3.2.5 Replay/Repeat Menu

The Replay/Repeat offers valuable features to enhance analysis and accuracy. Operators can effortlessly review a single bearing line or many bearings over a set amount of time. This functionality provides a comprehensive overview of directional information, aiding in effective analysis and decision-making.

The Repeat/Replay Menu Buttons		
Number	**Meaning**	**Description**
1	Repeat Last Bearing	Repeats the last bearing received
2	Repeat Last 5 minutes	Replays the last 5 minutes of activity 
3	Repeat Last 10 minutes	Replays the last 10 minutes of activity 
4	Stop	Stops all replay activity

3.2.6 Save/Delete LOB/LOP Menu

The Save/Delete LOB/LOP menu allows operators to save or remove LOB/LOP information on the screen/map for future reference. When two or more LOBs/LOPs are saved and the intersection aera option is activated, a search area is automatically generated, providing valuable assistance in locating transmission sources with increased accuracy. With efficient control over their directional data, operators can manage and utilize critical information.

When receiving a bearing, operators can save a LOB, and if a magnetic heading is available, it can be inputted. Where the magnetic heading is unavailable, leaving the value blank generates a relative LOB.

Intersection area (red)
Saved LOB (magenta)
Active LOB (red)

Example of entering a Magnetic Bearing

MAG HDG = 35° while receiving a REL BRG = 240°, the app will display MAG LOB = 275°

4 Operation

4.1 Squelch Operation

The challenge in operating a direction finder lies in accurately calculating the target's bearing amidst noise and RF disturbances, which can lead to misleading indications. Squelch can be employed to suppress unwanted weak signals and noise. This involves setting a user-defined or automated threshold, where signals weaker than this threshold are disregarded and stronger ones trigger a bearing indication.

The squelch technique reduces receiver sensitivity to the set threshold, enhancing accuracy by distinguishing between desired and undesired signals. To calculate bearing, a signal must be notably stronger than noise or disturbances. Adjusting the squelch below noise level enables obtaining bearing information for weaker signals. Noise fluctuations tend to be minor even at low signal levels, but bearing indication reaction time can increase. Verifying whether a bearing indication results from white noise, internal disturbances, or a valid signal involves performing a slow turn. The bearing indication should adjust accordingly if it's due to an external signal like a SAR beacon. This procedure might not be practical for signals with short transmission times, like COSPAS-SARSAT transmission, but is well-suited for continuous

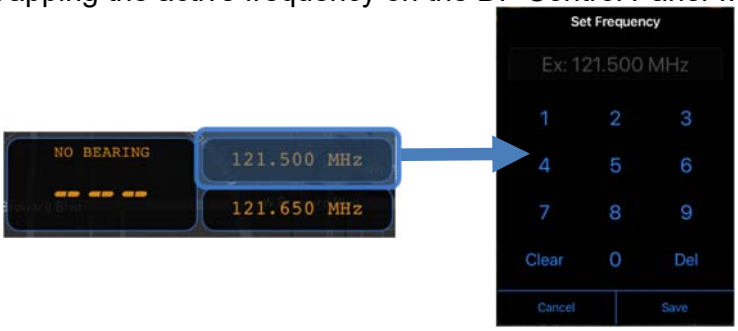
ELT signals and intermittently transmitted ELT signals. Pulsed signals trigger an automatic squelch that self-adjusts based on received signals, and users can switch to manual mode if necessary. In cases where the Antenna Unit autonomously validates signals, user interaction isn't possible, and the squelch follows internal rules aligned with the received signal type.

Correct Squlch Adjustment

Incorrect Squelch Adjustment

4.2 Adjusting Frequency

Tapping the active frequency on the DF Control Panel will open the frequency input page.



Selecting an unavailable frequency causes an error appears

A rapid was to swap to a frequently used frequency is to use the standby frequency feature. swapping active frequency to standby frequency is done simply by tapping the standby frequency box.

The standby frequency value can be modified in the advanced settings menu.

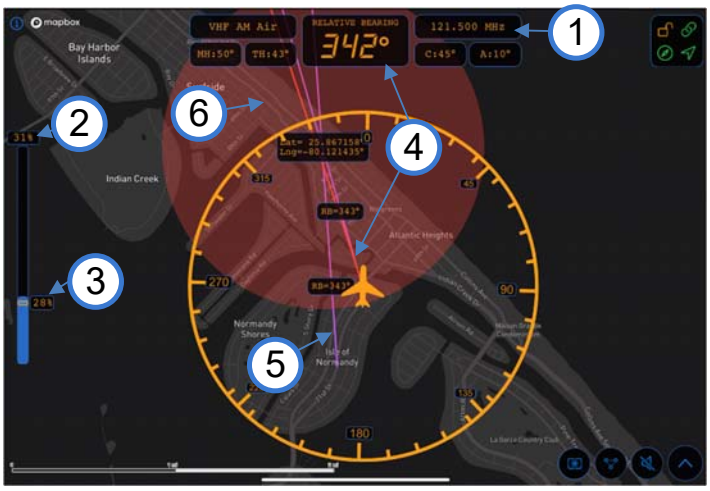
For full list of available frequency ranges please refer to the RDF system's respective user manual.

4.3 Bearing Mode

In Bearing mode, bearing direction is derived from signals received relative to the DF system. Once the active frequency and squelch level are configured, bearing operations commence. When a signal is received, its strength is shown numerically (0% to 99%) and graphically using a bar graph, with the squelch level indicated correspondingly.

The DF only process data when the signal level exceeds the chosen squelch level. Even without a signal, the system might display a noise-induced signal level. The bearing values, which can vary based on signal quality, and are depicted as a line on the map with a bearing cone around the bearing line (if active), and numeric value located in the DF Control Panel. This cone's size represents signal quality; a smaller cone signifies better quality, expanding as signal quality decreases. The bearing electronics utilize an internal algorithm to process bearing values over time, yielding consistent and dependable bearing indications, impervious to rapid reflections and noise.

Saving a LOB when receiving a bearing will place a fixed bearing line in a different color. Should a magnetic heading be accessible, it can be entered alongside the LOB. Alternatively, in cases where magnetic heading information is absent, leaving the value blank results in the creation of a relative LOB. Leveraging this functionality becomes particularly powerful when multiple LOBs/LOPs are saved and the intersection area option is engaged. With this option activated, the system automatically generates a search area that narrows a search area for locating transmission sources.



1.Frequecy: 121.500MHz

2.Signal Level: 31%

3.Squelch: 28%

4.Active bearing: REL 342° (red line)

5.Saved LOB: REL 343° (purple line)

6.Intersection Area: Lat 25.8 and Lng 80.1 (red circle)

4.4 Scan Mode

4.4.1 Scan Mode

To initiate a scan mode of any band, simply press the DF mode button located on the DF Control Panel. While in scan mode, the system continuously scans frequencies within a designated band until a signal is detected. To prevent the scan from stopping on noisy frequencies, it's advised to begin scanning with higher squelch settings. Gradually decrease the squelch level until the scan halts on a noisy frequency for the first instance, then slightly elevate the squelch level. This approach maximizes scan sensitivity, ensuring accurate results while minimizing the influence of RF disturbances, which can arise from other equipment.

4.4.2 COSPAS-SARSAT Scan Mode

When the active frequency falls within the COSPAS-SARSAT frequency range, selecting the Scan by pressing the DF Mode button on the DF Control Panel will trigger an automatic activation of the COSPAS-SARSAT scan. Within this scan mode, the direction finder continuously scans through all the channels within the COSPAS-SARSAT range until a signal is identified within one of the channel groups. Once a COSPAS-SARSAT frequency is detected, the scan mode stops automatically, transitioning the direction finder into bearing mode for that specific frequency. To stop the scan, press the DF Mode button to switch to either Decode or Bearing.

It is recommended to set 121.500MHz as the standby frequency because COSPAS-SARSAT usually transmits a strong long-range signal pulse approximately every 52 seconds. Typical COSPAS-SARSAT beacons emit a consistent low-range 121.500MHz signal, it's important to frequently monitor it for a continuous and accurate bearing.

4.5 Decode Mode

4.5.1 COSPAS-SARSAT Decoding

To Decoding COSPAS-SARSAT data pulses effectively, adjust the active frequency to the COSPAS-SARSAT frequency, often set at 406.025MHz. Then switching the DF mode to Decode. Decoding is automatically processed once a pulse is received. Upon successfully decoding a message, the message box at the bottom-left corner of the map and will populate country code, latitude, longitude, and a 15-digit HEX message. The Bearing Value box on the DF Control Panel will now display the distance to the target, using current position relative to the latitude and longitude of the COSPAS-SARSAT beacon.

NOTE: *Decoded messages are not retained when leaving the decode mode.*

It is recommended to set 121.500MHz as the standby frequency because COSPAS-SARSAT usually transmits a strong long-range signal pulse approximately every 52 seconds. Typical COSPAS-SARSAT beacons emit a consistent low-range 121.500MHz signal, it's important to frequently monitor it for a continuous and accurate bearing.

4.5.2 LoJack Decoding

LE version RHOTHETA antennas possesses the capability to track LoJack beacons. LoJack beacons are a Stolen Vehicle Recovery System. RHOTHETA antennas can decode these beacons to accurately track and identify their unique IDs. When tracking the ID will be displayed along the bearing line. In instances where more than one beacon is active a filter can be applied to only track a single ID. All IDs will be displayed on the bottom-left corner of the map and the active one will be displayed in green. Effective use of tracking allows law enforcement or recovery teams with precise information to locate stolen vehicles effectively.

5 Error and Warning Messages

smartDF tracks and reports any Errors and Warnings that may arise during its operation. These notifications are displayed through a blinking warning symbol ⚠, drawing the operator's attention to potential issues.

List of Errors & Warnings			
Error Code	**Description**	**Warning Code**	**Description**
0	Defective receiver module	0	DF-AU voltage input below ≤ 11 Volts
1	Data bytes out of range or Variant incompatibility		
2	Defective decoded data (Cospas-Sarsat, LoJack)		
3	Received frequency too low < 6 KHZ		
4	Received frequency too high > 6 KHZ		
5	Receiver oscillator PLL not locked		
6	No serial data received from smartDF		
7	Bad data connection between DF-AU and smartDF		
8	DF-AU voltage input ≤ 9 Volts		
9	DF-AU temperature below -40°C		
10	DF-AU temperature above +60°C		

6 Annex

Table H.2: Cospas-Sarsat 406 MHz Channel Assignment Table

Chan. #	Centre Freq. (MHz)	Status for Type Approval of New Beacon Models		Comments Table approved by the Cospas-Sarsat Council at the CSC-43 Session – October 2009 (see Note 1)
		Date open	Date closed	
	406.007	Not available		SARP-2 limitation
	406.010	Not available		Doppler shift limitation
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	406.019	Not available		Doppler shift limitation
A	406.022	C/S orbitography / reference		Reserved for System beacons
B	406.025	1982	1 Jan 2002	Open for beacon models submitted for TA before 01/01/02
C	406.028	1 Jan 2000	1 Jan 2007	Open for beacon models submitted for TA before 01/01/07
D	406.031	1 Jan 2016	TBD	Open for beacon models submitted for TA after 01/01/16
E	406.034			Reserved, not to be assigned
F	406.037	1 Jan 2004	1 Jan 2012	Open for beacon models submitted for TA before 01/01/12
G	406.040	1 Jan 2010	1 Jan 2017	Open for beacon models submitted for TA before 01/01/17
H	406.043			Reserved, not to be assigned
I	406.046			Reserved, not to be assigned
J	406.049	TBD	TBD	Available for future assignments / New developments
K	406.052	TBD	TBD	Available for future assignments / New developments
L	406.055			Reserved, not to be assigned
M	406.058			Reserved, not to be assigned
N	406.061	TBD	TBD	Available for future assignments / New developments
O	406.064	TBD	TBD	Available for future assignments / New developments
P	406.067			Reserved, not to be assigned
Q	406.070			Reserved, not to be assigned
R	406.073	TBD	TBD	Available for future assignments / New developments
S	406.076	TBD	TBD	Available for future assignments / New developments
	406.079	Not available		Doppler shift limitation
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	406.088	Not available		Doppler shift limitation
	406.091	Not available		SARP-2 limitation

Notes:
(1) Planned assignments may change if the Cospas-Sarsat Council determines that the beacon population in an active channel differs from the projected population.
TA Type approval
TBD To be determined

7 Notes