User Manual

RT-400
Basic

RHO
Elektronik GmbH
THETA

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Note
Subject to Change Without Notice.

Content

1. Legend of Signal Words

Note

This symbol designates tips or additional notes that must be paid attention to and that make work easier.

Caution
means that ignoring the instructions may lead to property damage or loss of data.

Warning
Ignoring instructions may cause danger to health or life.

2. Safety

2.1 General Safety Information

RHOTHETA Elektronik GmbH is constantly updating their safety standards of their products and offer their customers the highest possible level of safety. RHOTHETA products are designed and tested in accordance with valid safety regulations. Compliance with these standards is continuously monitored by a quality assurance system.

This product is tested and left the factory in perfect technical and safety-relevant condition. To maintain this condition and to ensure safe operation, the user must pay attention to all instructions and warnings given. For any questions regarding these safety instructions, contact RHOTHETA International at any time.

The observance of the safety instructions will help to prevent personal injury, damage to equipment and to mitigate potential hazards. By strictly adhering to these guidelines, you contribute to the overall safety and efficiency of your operations. This requires that the safety instructions are fully understood before using the product, as well as observed when using the product. Additional safety instructions, such as for protecting people, appear in relevant parts of the product documentation and must also be adhered to.

The use of this product for other than its designated purpose or in disregard for the manufacturer’s instructions is the responsibility of the user. The manufacturer takes no responsibility for the misuse of the product. The manufacturer is not liable beyond the scope of legal rules.

This guide is part of the product RT-400 and must be kept with the product throughout its lifetime.

2.2 Basic Safety Instructions

Caution / Warning
Read and observe the following instructions, warnings, and safety instructions of the manufacturer!

During operation, all local and national safety and accident prevention regulations must be observed.

When installing or operating the product always follow the manufacturer's instructions.

Always place the product in appropriate locations.

Do not expose the product to environmental conditions (heat, humidity, wind load, etc.) that exceed the specified acceptable conditions in the manuals.

Use only the manufacturer’s prescribed components and/or use only recommended materials and do not modify them. Any other use or unauthorized modifications to the product will void the authorization to operate it.

Connect only approved accessories kits or additional equipment.

Ensure that the connections with information technology equipment, e.g., industrial computers, comply with the IEC 60950-1/EN 60950-1 or similar standards that apply in each case.

- The product may only be opened by authorized personnel. The connector must always be disconnected before opening.

3. Legal Information

3.1 EU Declaration of Conformity

RHOTHETA Elektronik GmbH hereby declares that the product RT-400 is in compliance with the essential requirements and other relevant provisions of:
- Directive 2014/53/EU relating to radio equipment
- Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment

The full text of the Declaration of Conformity can be found at:
https://www.rhotheta.com/products/rt-400
FCC Information (USA)
Changes or modifications not expressly approved by the party responsible for compliance (RHOTHETA) could void the user's authority to operate the equipment.

3.2 FCC information (USA) regarding the included Wi-Fi module

For Wi-Fi connectivity, this product includes an S2W485E-ESP32, Wi-Fi RS-422/485 adapter, compliant with:

I. ETSI EN 300 328 V2.2.2 (2019-07)
II. CE
III. RoHS
IV. Part 15C of the FCC Rules, Spread Spectrum Transmitter class
V. FCC Identifier XJ8S2XXCOMXVN

Its operation is subject to the following conditions:
• Device may not cause harmful interference.
• Device must accept any interference received including interference that may cause undesired operation of the device.

CAUTION

FCC RF Radiation Exposure Statement:
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and your body.

The Wi-Fi device has been tested and found to comply with the limits for a Class B digital device pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio / TV technician for help.

4. General Description

The RHOTHETA RT-400 is a precision wideband radio direction finder (RDF) intended primarily for professional SAR (search and rescue), law enforcement, and radio monitoring applications. It is designed to receive, track, and locate transmissions in the VHF/UHF frequency range including 121.5 MHz, 156.8 MHz, 243.0 MHz, COSPAS-SARSAT, and other international distress and application specific frequencies.

The **RT-400 Basic** system consists of:

- Radio direction finder:
  - **RT-400 RDF** (or Antenna Unit) PN RT-8405
- Control software:
  - **DF Scout** PN RT-8450
  - **SmartDF PRO** PN RT-15104
  - **DF Commander MK2** PN RT-8777

4.1 Radio Direction Finder (RDF, Antenna Unit)

The RT-400 RDF or Antenna Unit (AU) is designed to be lightweight and robust for typical portable use. Its excellent performance is possible due to our revolutionary, patented wideband antenna, with a sophisticated bearing analyzing algorithm which delivers quick and steady bearing information.

The RT-400 RDF features by default five frequency bands, any of which can be extended by ordering the corresponding optional extended band (bands marked as “Option” below).

VHF Air Band	118.000 - 124.000 MHz 118.000 - 136.992 MHz (Option)
Marine Band	154.000 - 163.000 MHz 137.000 - 224.995 MHz (Option)
UHF Air Band	240.000 - 246.000 MHz 225.000 - 399.975 MHz (Option)
COSPAS-SARSAT	400.000 - 406.092 MHz all 19 COSPAS-SARSAT Channels
UHF FM-Band	406.100 - 410.000 MHz 406.100 - 470.000 MHz (Option)

Additional Options		
Model	**Part Number**	**Description**
RT-400.F1	RT-8553-002	F1 Option: 118.000 - 136.975 MHz, AM, 8.33 kHz
RT-400.F2	RT-8553-003	F2 Option: 137.000 - 224.995 MHz, FM, 5.0 kHz
RT-400.F3	RT-8553-004	F3 Option: 225.000 - 399.975 MHz, AM, 25 kHz
RT-400.F4	RT-8553-005	F4 Option: 406.100 - 470.000 MHz, FM, 5 kHz

4.2 Control Software

DF Scout

smartDF

DF Commander MK2

DF Scout is an Android software application designed to control the RT-400 RDF via Wi-Fi. All DF information is conveniently displayed over maps, alongside bearing triangulation. See DF Scout user manual for additional information.

smartDF is an iPadOS software application, runs on Apple iPad tablets. PRO version is required to control the RT-400 RDF via Wi-Fi. All DF information is conveniently displayed on maps, alongside bearing triangulation. See smartDF user manual for additional information.

DF Commander MK2 is a Windows/Linux software application, runs on either server or client mode, and controls a network of multiple RDFs. All DF information is conveniently displayed on maps, including bearing triangulation. Interfaces with 3rd party applications using JSON and ASTERIX formats. See DF Commander MK2 user manual.

Note
In general, the RT-400 is optimized for mobile and portable operation, where the heading of the control computer and the antenna are identical. If the RT-400 is used in a fixed installation, its black-arrow marking should point towards North.

4.3 Ancillary Equipment

Depending on the intended configuration - manpack, vehicle, etc. - the RT-400 can be integrated with optional ancillary equipment:

- Car mounting kit PN RT-8420
- Manpack back frame PN RT-8415
- Power pack PN RT-8430
- Tablet/iPad holder

5. Ramptesting the RT-400 RDF

Before starting field operations of the RT-400 RDF, or as a maintenance procedure, to keep equipment within desired operational parameters, it is recommended to perform a static test of the status and performance of the system.

A Rhotheta Ramptester kit can be used to check the RT-400 statically. This checkup will allow verification of the status and performance of the RDF, by testing its bearing accuracy and RF sensitivity of the RDF.

5.1 Ramptester set PN RT-8556

The Ramptester set is a specialized test equipment designed for quick checkup of the RT-400 RDF. It consists mainly of an antenna measurement device - or adapter.

The Ramptester allows testing the bearing accuracy and RF sensitivity in all the RDF's operational frequencies, 360°, with 45° steps. See Ramptester set PN RT-8556 user manual.

An RF signal generator is required to work together with the ramptester.

5.2 RF Signal Generator PN RT-14400WP

The RT-14400WP RF signal generator has a frequency range from 35 to 4400 MHz, and a power level range from -80 to +10 dBm. Battery and charging circuit are built into the unit. See RT-14400WP user manual for additional information.

5.3 Control Software used with Ramptester

Use the control software to display the RDF data: status, bearing, receive signal strength indication, noise level.

6. Vehicle Configuration

6.1 Vehicle Installation

Installation of the car mounting kit on the vehicle roof may vary depending on the type of railing or luggage rack available. If spring-magnet legs or a custom roof mount is required contact Rhotheta.

The RT-400 is easily affixed using the quick clamps provided. The NORTH black-arrow marking should point towards the front of the vehicle.

Connect the RT-400 to a power supply, using the Power Pack supplied – already installed on the car mounting kit - or a DC power cable connected to a DC outlet.

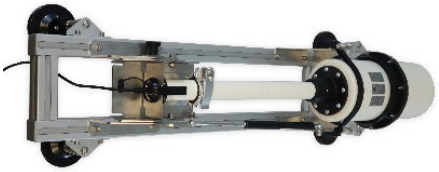
Ensure the Power Pack is switched OFF while not in use.

The Tablet or iPad may be installed using a windshield mount. Connection with the RT-400 is via Wi-Fi, so no interface cable is needed.

Note: when using a car DC outlet to supply the RDF, depending on the vehicle's electrical circuitry, DC power might be interrupted under different conditions (ignition off, etc.). Such interruptions will turn off the RDF and its Wi-Fi module. Wi-Fi reconnect might take up to one minute or more depending on the control software OS.

6.2 Vehicle Transport Position

The RT-400 can be moved to the horizontal position for non-operational transportation.



6.3 Vehicle Operation

Setup the RDF to its upright position for operation. Ensure the detent pin is securely locked. Verify the NORTH black-arrow marking on the antenna points towards the front of the vehicle, otherwise bearing indications will be inaccurate on the control software.

Turn the DC power ON using the power switch on the Power Pack or connecting the DC plug to a DC outlet.

For operation of the RT-400 see user manual of the chosen control software.

7. Backpack Configuration

7.1 Backpack Transport Position

For convenient backpack transportation, the RT-400 can be mounted upside-down on the back frame and secured with two quick clamps. This position's low center of gravity enhances the system's ease of transportation. The Power Pack must be installed on the carrying back frame.

7.2 Backpack Operating Position

Place the RT-400 in the upright position, ideally as high as possible, or at least as high as needed so the lower section of the antenna cylinder is positioned above the head of the operator. The cable from the Power Pack must be connected to the connector at the bottom of the RT-400.

7.3 Backpack Operation

The RT-400 is activated by switching ON the Power Pack.
For operation of the RT-400 see user manual of control software.

8. Backpack Operation (with lift option)

8.1 Backpack Preparation (with lift)

Lower the lift using the Up/Down switch on the Power Pack (Lift version).Place the RT-400 in its upright position and as low as possible (antenna part just above the padded ring, base of the mast pressed in the lower ring), and affix using the quick clamp.
Connect the power cable from the Power Pack to a DC connector on RT-400.
Note: Upside-down mounting of the RT-400 is only possible when using the back frame without the lift option.

8.2 Backpack Operation (with Lift)

Move the RT-400 up to the desired operating position, using the Up/Down switch on the Power Pack. The lift stops automatically if the maximum height is reached. The RT-400 should be placed as high as possible, or at least so that the lower section of the antenna cylinder is positioned above the head of the operator.

Activate the system by switching ON the Power Pack.
For operation of the RT-400 see user manual of chosen control software.

8.3 Backpack Deactivation (with Lift)

Deactivate the RT-400 backpack by switching OFF the Power Pack.
The RT-400 can be lowered to the transport position using the Up/Down switch on the Power Pack. The lift stops automatically if the minimum height is reached.

9. Service and Maintenance of the RT-400 Power Pack

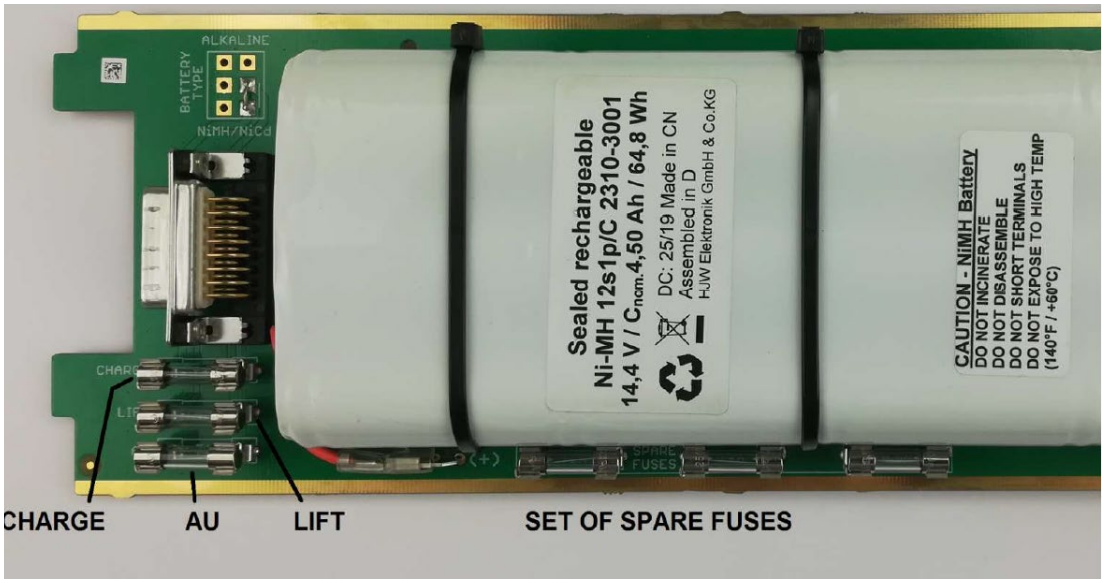
9.1 Installation of the Power Pack

The power pack can be plugged into, and removed from, the power pack rack of the carrying frame.

The power pack must be plugged into its rack as shown in the pictures above. As soon as the power pack is locked by the locking spring, it is automatically connected to the backward connector on the carrying frame and ready for use. To remove the power pack, pull the locking spring and unplug the power pack by pulling it forward.

9.2 Battery / Accumulator Replacement and Protection

The Power Pack operates with an internal 14,4 V NiMH accumulator package. Use a Torx (size TX10) screwdriver to remove the two screws on the back side of the Power Pack. The whole Battery Pack board can be removed from the housing and the accumulator may be replaced.



All input-and output connections are fused: Charge Input (CHARGE, 4 A slow-blow), Antenna Unit Output (AU, 1 A slow-blow) and Lift Output (LIFT, 0,5 A slow-blow). Additionally, spare fuses are provided.

Charging Accumulators
Connecting the RT-400 Battery Charger directly to the Power Pack, instead of the Antenna Unit using the Power Cable, allows charging the accumulators. Charging is done automatically, so no further user interaction is required.

10. Electrical Characteristics

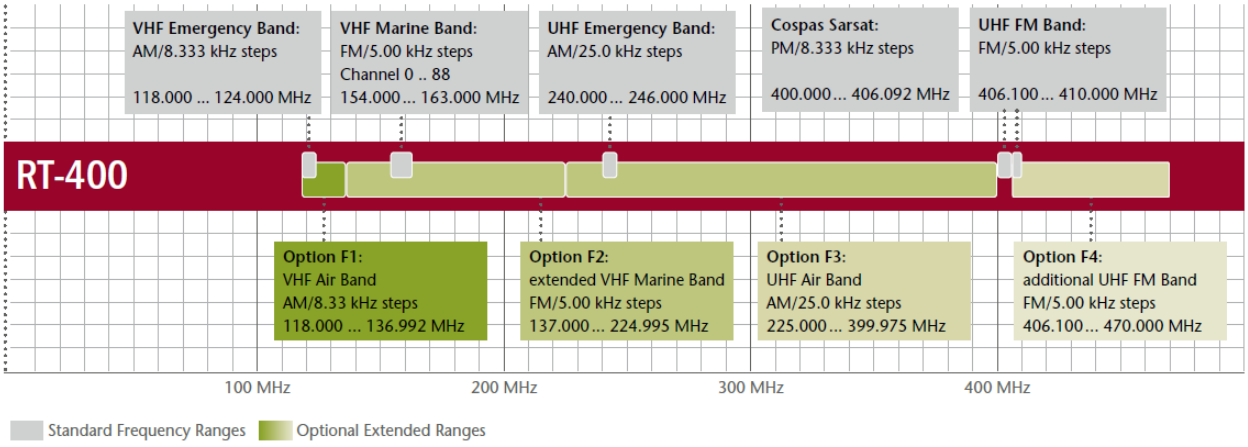
System Characteristics		
Parameter	**Condition**	**Data**
DF Method	-	Doppler (3 kHz rotation frequency)
Bearing Accuracy		5° RMS[1]
Display Resolution		1°
Minimum Signal Duration		100 ms
Frequency Range	VHF Air Band	118,000 – 124,000 MHz 118,000 – 136,992 MHz (Option)
	Marine Band	154,000 – 163,000 MHz 137,000 – 224,995 MHz (Option)
	UHF Air Band	240,000 – 246,000 MHz 225,000 – 399,975 MHz (Option)
	COSPAS-SARSAT	400,000 – 406,092 MHz
	UHF FM-Band	406,100 – 410,000 MHz 406,100 – 470,000 MHz (Option)
Receive Frequency Tuning Steps	VHF Air Band	8,33 kHz
	Marine Band	5 kHz
	UHF Air Band	25 kHz
	COSPAS-SARSAT	8,33 kHz
	UHF FM-Band	5 kHz
Bearing Sensitivity Continuous signal	VHF Air Band, ±5° bearing fluctuation	≤ 4 µV/m / 2,5 µV/m typical
	Marine Band, ±5° bearing fluctuation	≤ 3 µV/m / 2 µV/m typical
	Extended Marine Band above 174 MHz, ±5° bearing fluctuation	≤ 5 µV/m / 3 µV/m typical
	UHF Air Band, ±5° bearing fluctuation	≤ 6 µV/m / 4 µV/m typical
	COSPAS-SARSAT ±5° bearing fluctuation	≤ 6 µV/m / 4 µV/m typical
	UHF FM-Band ±5° bearing fluctuation	≤ 6 µV/m / 4 µV/m typical
Bearable Types of Modulation		A3E, F3E, A3X (distress signal modulation)

System Characteristics		
Parameter	**Condition**	**Data**
Polarization		Vertical
Scanning		Multiple scanning and monitoring functions available
COSPAS-SARSAT Functionality		Decoding of COSPAS-SARSA-Message: Shows beacon ID, GPS position[2] and whole message string (short and long message) Displays direction and distance[2]) to beacon.
Power Supply Antenna Unit	Input Voltage	12 … 30 V DC
Power Pack	Accumulator Batteries	14.4 V NiMH, 4500 mAh
Operational Time (Antenna Unit), 20°C	With 14.4 V NiMH, 4500 mAh	> 8 h
Data Interface	Tablet – Antenna Unit	Wi-Fi

[1] Measured with un-modulated, undisturbed wave field at field strength ≥ 20 dB above sensitivity level by changing the angle of incidence with the antenna rotating on a revolving table to eliminate environmental influences on the results.

[2] If GPS position available

11. Frequency Options



12. Environmental and Mechanical Characteristics

Environmental and Mechanical Characteristics				
Parameter	**Carrying Frame[1]**	**Antenna Unit**	**Power Pack**	**Car Mounting Kit[2]**
Weight	5.6 kg	2.3 kg	1.8 kg	5.6 kg
Operating Temperature	-40°C to +60°C	-40°C to +60°C	-20°C to +55°C[3]	-20°C to +80°C
Storage Temperature		-55°C to +80°C	-20°C to +50°C[4]	
Ingress Protection		IP 67	IP 67	
Dimensions	Approx. W x H x D: 350 mm x 820 mm x 295 mm[5]	∅ 270 mm x 185 mm	Approx. W x H x D: 111 mm x 45 mm x 320 mm	750 mm x 450 mm x 220 mm

[1] Version with lift, without Power Pack, without Antenna Unit, including tablet frame w/o Tablet.
[2] Without RT-400 RDF, retracted
[3] Temperature Range for discharge operation. During standard charge, ambient temperature should be between 0 and +45°C, for fast charge, it should be between 10 and 40°C.
[4] For 3 months of storage duration. If stored for more than 3 and up to 6 months, upper temperature should not exceed 40°C. For storage duration of up to two years, upper temperature limit is 30°C.
[5] Carring Frame only

Typical Mechanical and Environmental Characteristics, Complete System	
Parameter	**Complete System with lift option[6]**
Weight	10.6 kg

[6] Includes RT-400 RDF, Carrying Frame, Power Pack, Android Tablet.
Does not include car mounting kit.