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# **RHOTHETA RT-600 (SAR-DF 517) Wideband Precision Direction Finder**





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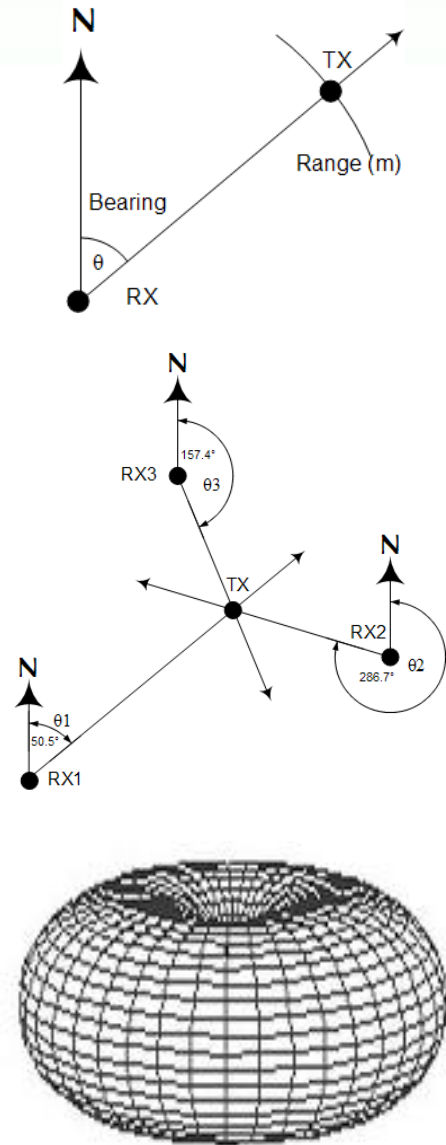
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# INTRODUCTION

The RHOTHETA RT-600 (SAR-DF 517) is a modern precision direction finder developed mainly for professional search and rescue and law enforcement tracking applications. It has the ability to bear and analyse conventional emergency RF signals in the UHF and VHF bands. This system incorporates our innovative and patented antenna (small, rugged and wideband), as well as sophisticated bearing analysis algorithms, allowing delivery of a quick and steady indication.

The direction finder was developed for working under stressing conditions such as in fixed-wing aircraft and helicopters.

Its method of bearing is based in the Doppler-principle with a 3kHz rotational frequency, and right / left rotation.





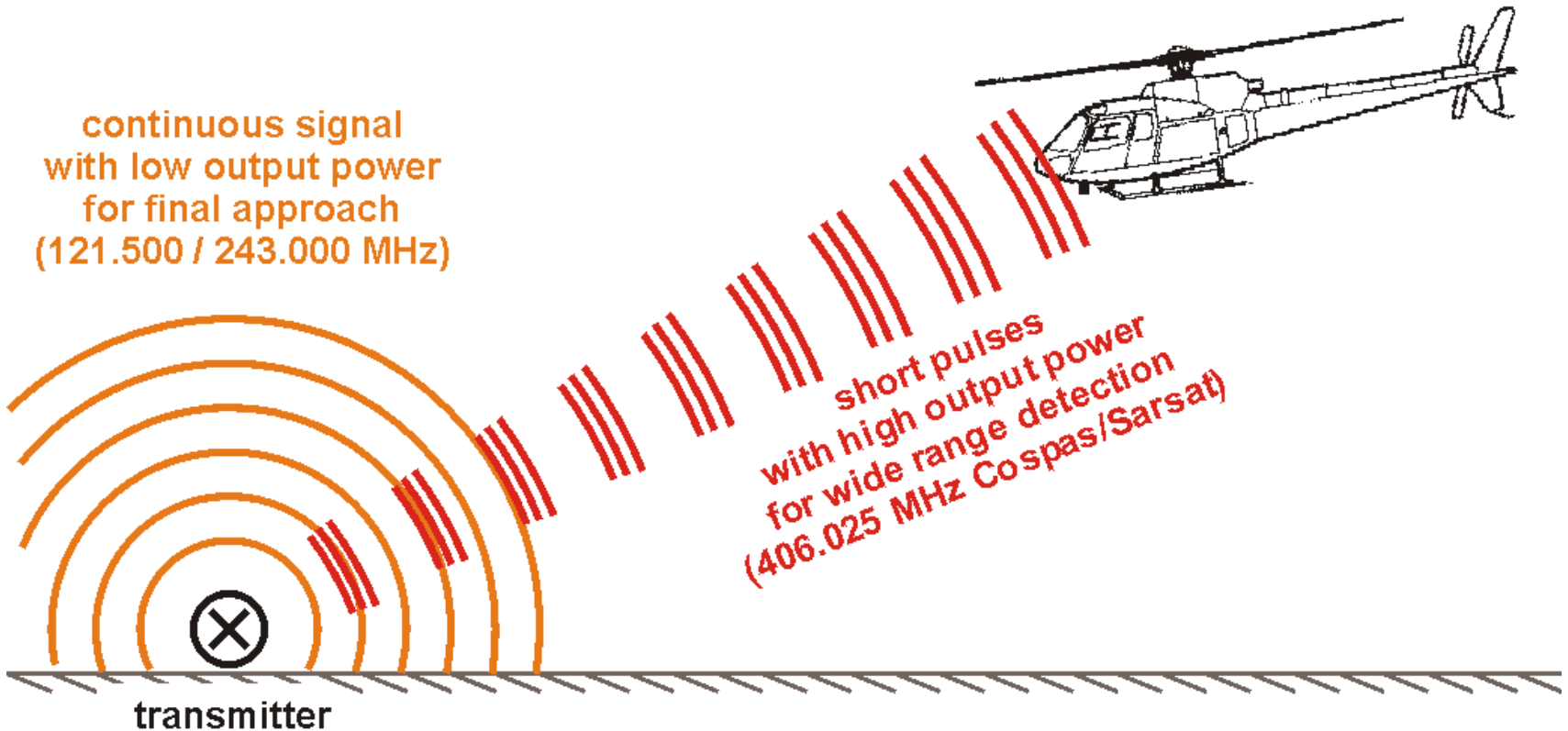
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## RT-600 (SAR-DF 517) Direction Finder Principles of Operation





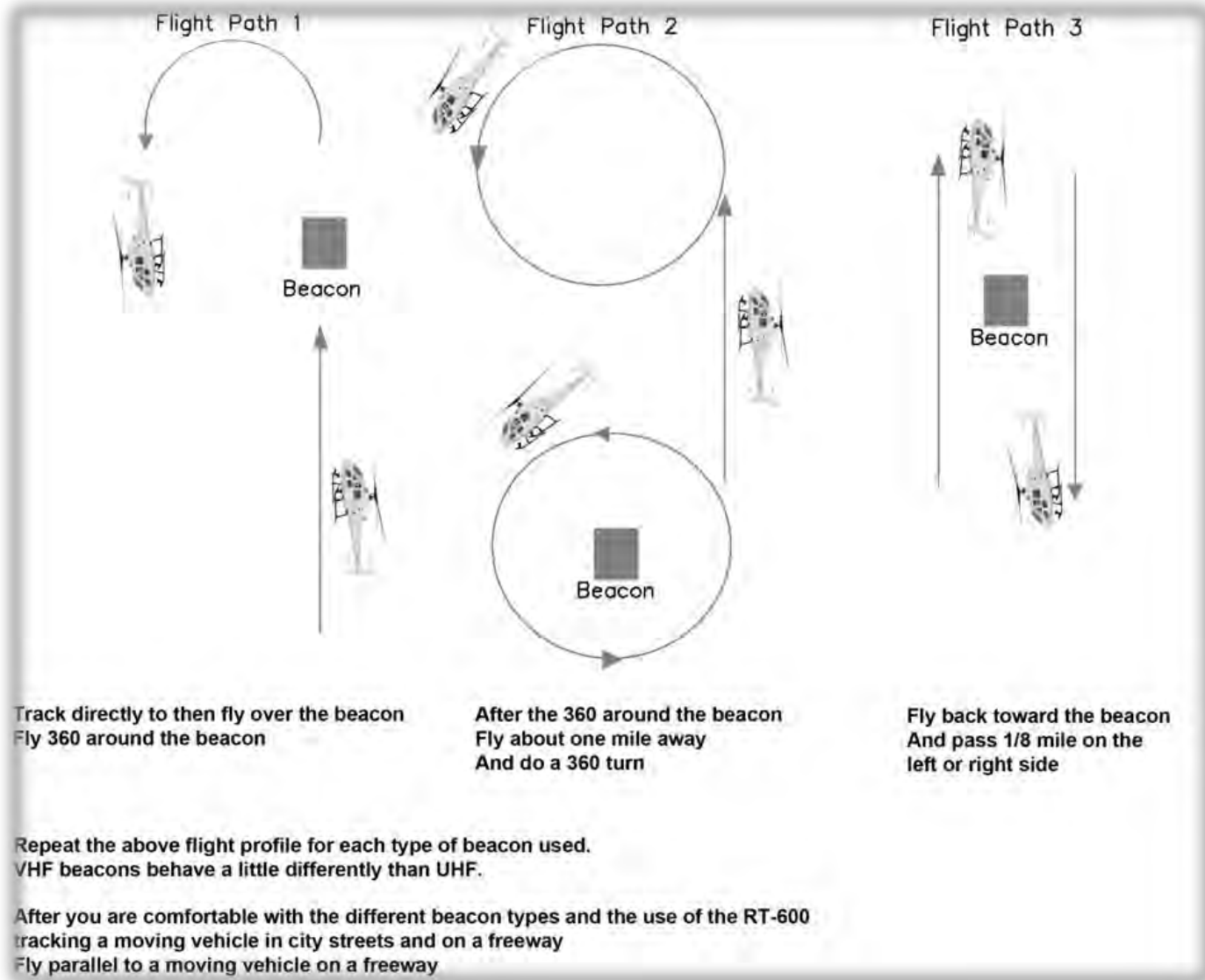
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# Flight Profiles





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## RT-600 (SAR-DF 517) Direction Finder

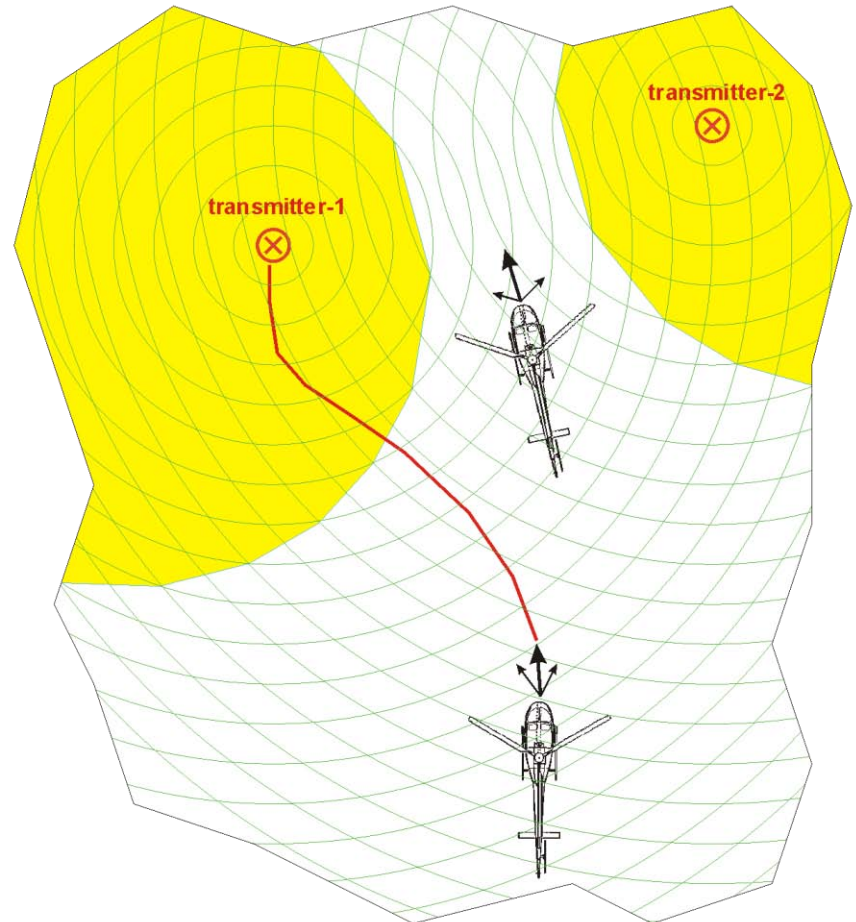
### Bearing more than one transmitter – “Garbling Cone”

- If bearing from a long distance, the DF will be pointing at the middle of the two transmitters
- Exactly in the middle between two transmitters, the DF will display an unusable bearing value
- Exactly over one transmitter the DF will be pointing to another („garbling cone“)



**Flight – tactics**

**Don't fly the approach exactly following the indicated averaged bearing-value, but about 20 degrees to the left or right**





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# RT-600 Versions

'A': Standard (Conventional) SAR

'LE': Law Enforcement Surveillance

Frequency Range	Step Size	Application Band	Applicable for:
118.000 – 123.000 MHz	8.33 kHz	Air VHF	Standard Version Law Enforcement Version
156.000 – 162.025 MHz	25 kHz	Maritime VHF	Standard Version Only
164.000 – 174.000 MHz	12.5 kHz	LE: LoJack	Law Enforcement Version Only
201.000 – 215.995 MHz	5 kHz	Med Track	Law Enforcement Version Only
216.000 – 218.9875 MHz	12.5 kHz	LE: ETS	Law Enforcement Version Only
219.000 – 220.000 MHz	10 kHz	LE: ETS	Law Enforcement Version Only
240.000 – 246.000 MHz	8.33 kHz	Air UHF	Standard Version Only
400.000 – 410.000 MHz	8.33 kHz	CP-SAR-SAT	Standard Version Law Enforcement Version



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# RT-600 Components:

- Display Control Unit (DCU)
- Antenna Unit (AU)\*
- Connector kit
- System cable AU-DCU (OPTIONAL)

\*the AU includes RECEIVER and CPU



AU Antenna Unit



DCU Display Control Unit



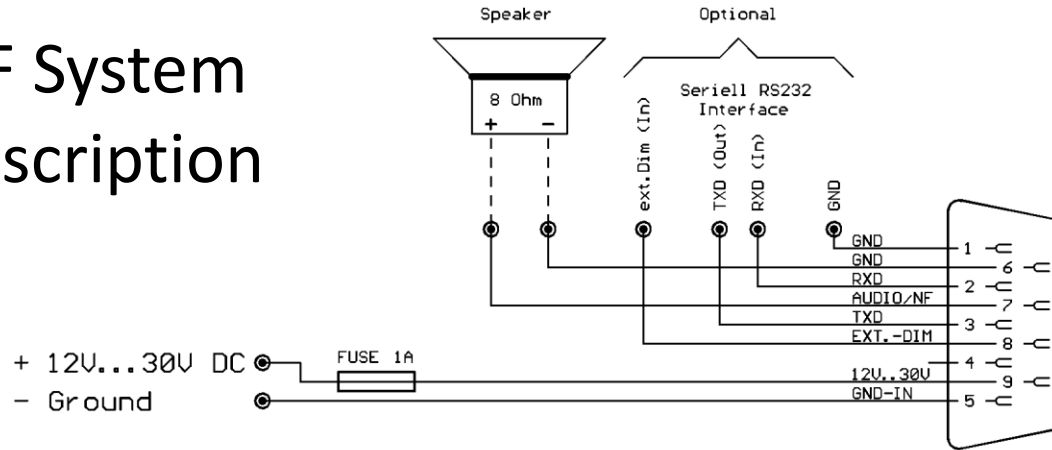
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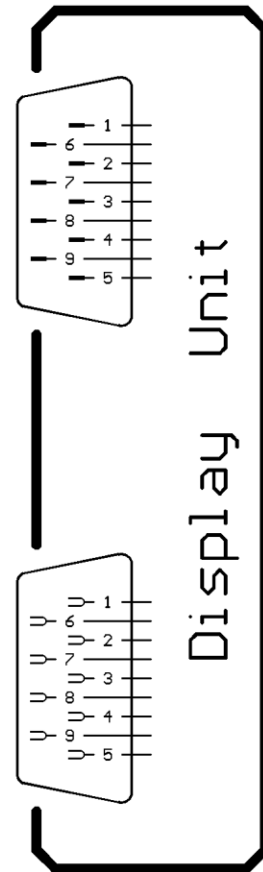
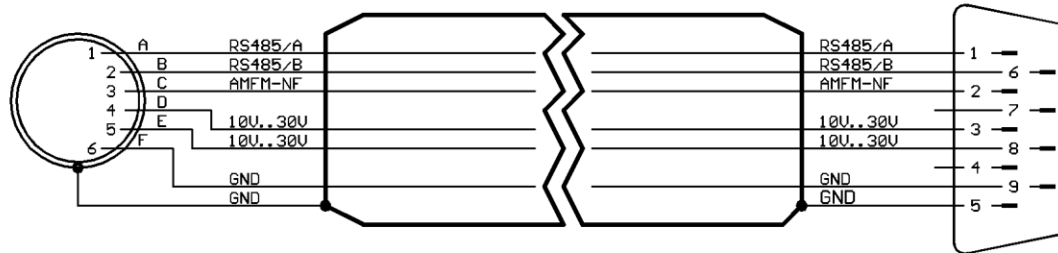
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# DF System Description

Power Supply



Antenna Unit





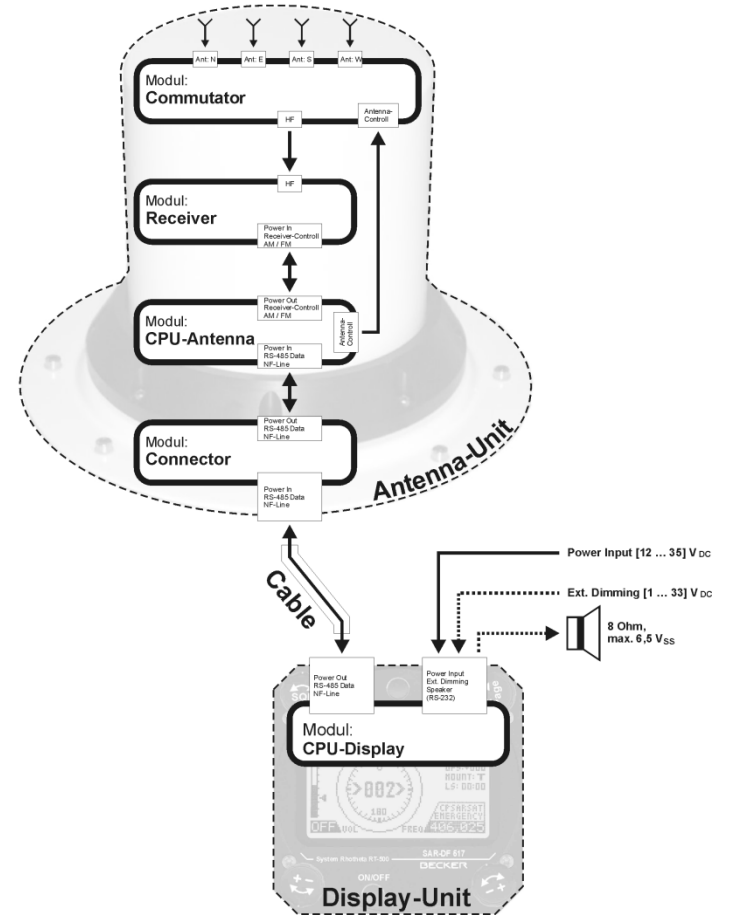
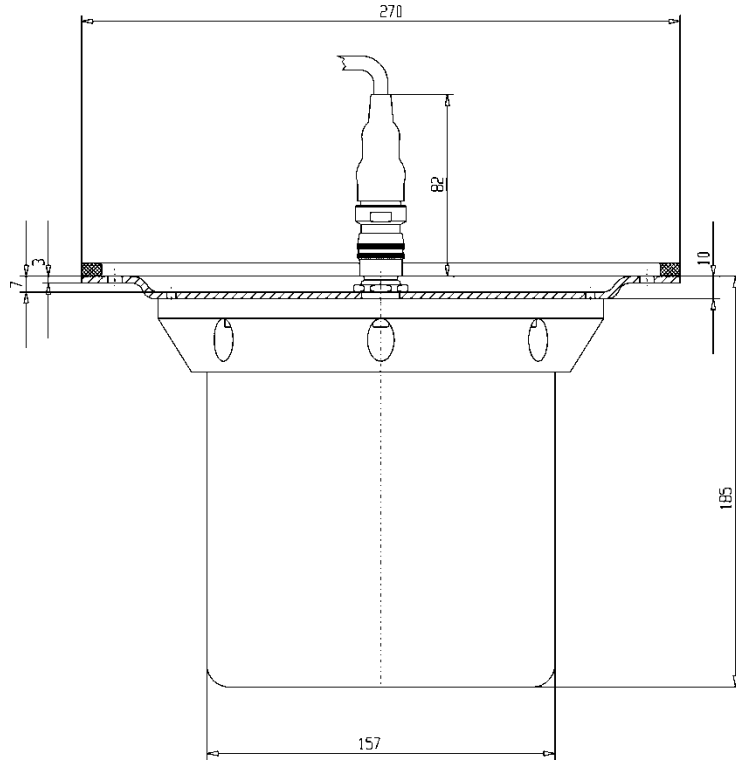


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# AU Description





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- (1) >LC Graphic Display< (128 x 64 dots dot-matrix display, dark blue on yellow-green background)
- (2) >Menu< options for rotary and push buttons: If a field with dark background and bright text is shown
- (3) >ON/OFF< Push-button to switch on / off the system.
- (4) >Volume< Rotary Switch, used, depending on the active page, to adjust the volume of the audio output or to select frequency values (MHz steps).
- (5) >SQL< Rotary Switch, used, depending on the active page, to adjust the squelch function or to select specific functions on a page
- (6) >CLR / F1< Push-button. If pushed for a short time, this button activates the function F1 described in the interactive menu on the display below. If pushed for a longer time (ca. 3 seconds), this button activates the CLEAR function.
- (7) >STORE / F2< Push-Button. If pushed for a short time, this button activates the function F2 described in the interactive menu on the display below
- (8) >Rep / DIM< Push-Button. If pushed for a short time it activates the setup of the display dimming function. If pushed for a longer time (>3 secs) it activates the repetition of the last valid bearing and signal level information.
- (9) >Page< Rotary Switch to select displayed main pages ("DF" or "MEM"). Together with the DIM button, it is used to set the display brightness
- (10) >Frequency< Rotary Switch to select frequencies.

## DCU Description





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## Power-On procedure

After switching on the system through the ON/OFF Push-Button in the DCU, a start screen is displayed for five seconds with the following information:

1. Name of the product: 'RT-600'
2. System Version : 'A' for Standard or 'LE' for Law Enforcement
3. Rhotheta website
4. Software version and electronic serial number for AU
5. Software version and electronic serial number for DCU

## DCU Description





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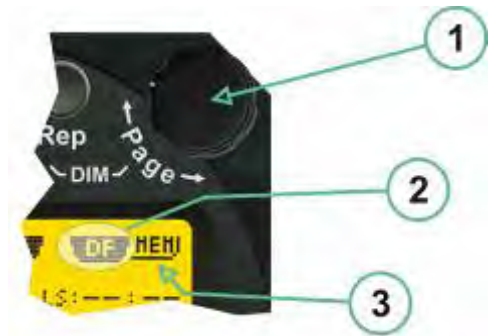
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## Main Pages Selection

- (1) The **>Page<** rotary switch is used to select the active page.
- (2) The **active page** is highlighted with dark background
- (3) The **inactive page**, which may be selected, is written in dark letters on bright background.



## Dimming function

- (1) Pressing the **>Rep/DIM<** button for a short time is activating the dimming setup mode.
- (2) **Brightness** information, as percentage value from 5 % to 100 % in steps of 5 % is displayed instead of the “Page” field in the upper right corner of the display.
- (3) The **>Page<** rotary switch can be used to adjust the display brightness. Right-hand turn will increase the value in steps of 5 percent, while a left-hand turn will reduce the value in steps of 5 percent.





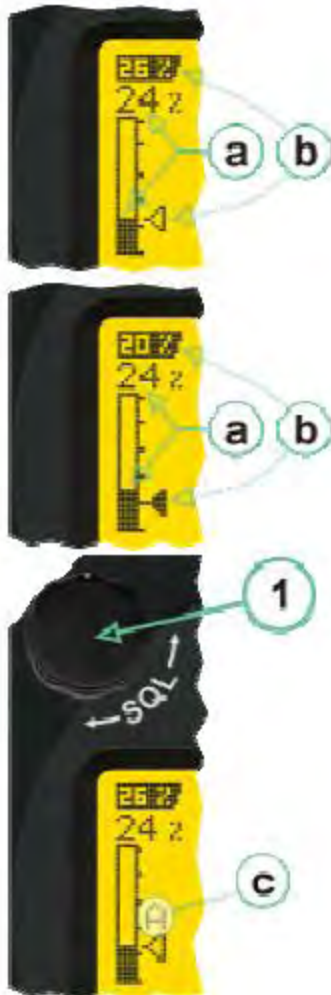
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## Squelch Operation and Settings



Without received signal, the noise level (a) is below the correctly chosen squelch level (b). The receiver audio output remains quiet, and no bearing is indicated.

With the same received noise level (a), but wrongly set squelch level (b), there will be an erroneous, noisy bearing available if there is no receive signal available at that time.

If the squelch is operating in automatic squelch mode, this is indicated by a sign "A" (c) above the squelch level marker. Depending on the SN-Ratio Setup, the squelch level is set slightly higher than the noise level. Using the SQL rotary switch (1), the user would be able to force the squelch level to a manual setting. Automatic setting can be re-entered by setting the manual setting to < 0 % or > 60 %.



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## Squelch Operation and Settings



Strong, short receive signals will not modify the squelch level setting.



If the squelch functionality is controlled by the system, without user interactions being allowed, this is indicated by a “X” sign (c) above the squelch level marker.



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## DF Mode

## Bearing Mode

- (1) **>FREQUENCY<** Rotary switch selects active freq. The last selected freq remains stored after switching off the DCU. The selected freq is shown on the graphic display bottom right
- (2) **>VOLUME<** Rotary switch to adjust the audio output level. The volume remains stored after switching off the DCU
- (3) **>Squelch Level<** adjusts the squelch level.
- (4) The **>CLR<** Push-button is used for erasing the internal bearing value averaging stored and the Last Signal Timer. Additionally, the CLR Push-Button is used to activate specific functions high-lighted in the menu below the button
- (5) **>STORE<** push-button: Without function except if a special function is high-lighted in the menu line of the display
- (6) **>REPEAT<** Push-button, when pressed, showing the last valid bearing value with corresponding receiving level
- (7) **>PAGE<** Rotary switch to leave the DF mode in order to switch to the MEMORY (MEM) Page / Mode.





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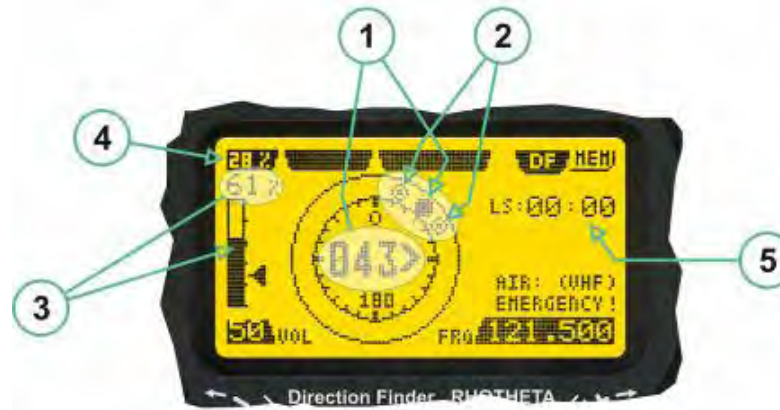
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## Standard Display in Bearing Mode

- (1) **>Relative Bearing value<** graphic and text in the range of 0°... 359°
- (2) **>Spread<** max deviation of un-averaged bearing values is an indicator of bearing quality. The wider the range the worse the received signal is
- (3) **>Receiving level<** (field strength) of the signal as a relative % value, visualized as bar-graph indication and as decimal value
- (4) **>Squelch level<** (independently adjustable and stored for each frequency). In receive modes where the squelch level is set automatically, an 'A' above the marker indicates the "Autosquelch" functionality
- (5) **>Last Signal<** timer showing the time since a signal has been received for the last time (i.e. since a signal has been stronger than the squelch level). Values are "minutes:seconds".







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- (1) >Auto Squelch< indication, squelch level is set automatically to be close to the noise floor.
- (2) >Decode< menu option, allows to open the C-S Decode sub-page by shortly pushing the F1 push-button
- (3) >121.500< menu option. The C-S signal in the 406 MHz band is transmitted every 50 sec as a short data burst of 440 or 520 ms. Approaching the transmitter, it will be received earlier than the 121.500 MHz continuous signal due to its high transmitter power. Direct return back from 121.500 to the C-S band is possible from the 121.500 MHz bearing window in C-S mode
- (4) >Frequency range< indication. C-S channel spacing is 3 kHz. Due to architecture of the DF it is possible to receive more than one channel at a time. Thus, channel spacing of DF is 8.33 kHz instead of 3 kHz. The receive freq covered by the current receive freq setting is shown in the display line above the receive frequency indication. Important: If the exact frequency of the C-S beacon is unknown, it is recommended to use the C-S scanning functionality for detecting the correct freq



## COSPAS-SARSAT Bearing mode



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(1) >Exit< push button (F1 button) allows to leave the decode window and to go back to the COSPASSARSAT bearing mode window.

(2) >Decode< in the upper right corner of the display indicates that the decode function is activated.

(3) >Country< displays the COSPAS-SARSAT Country Code coded into the received data message.

(4) >Last Signal< time since the last COSPAS-SARSAT message has been received in minutes:seconds format.

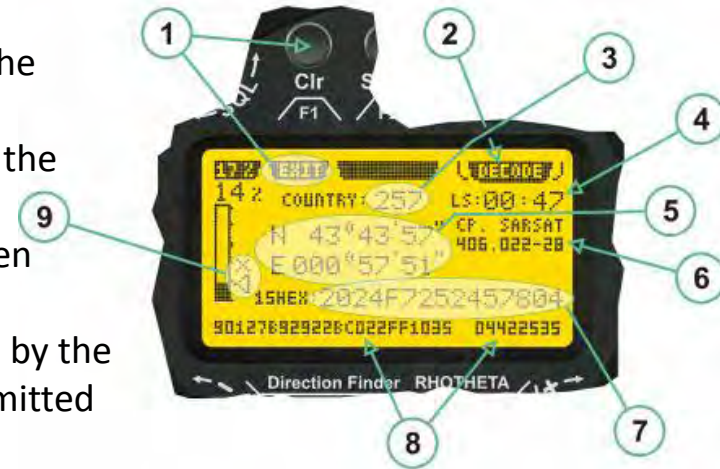
(5) >Position< field showing, in case of location protocols being used by the beacon, the encoded GNSS position data (latitude / longitude) transmitted by the beacon.

(6) >Range< field showing the range of COSPAS-SARSAT channels covered by the actual receive frequency setting.

(7) >15-HEX-ID< 15-HEX-ID of the beacon in hexadecimal format.

(8) >Data string< of the bits 25 to 112 of the COSPAS-SARSAT data burst in case of short messages, and bits 25 to 144 in case of a long message format. The last 8 Hex Values are separated by a blank. Bit- and Frame-synchronization hex values (Bits 1 to 24) are suppressed to increase the readability of the data message.

(9) >X< sign to indicate that the Squelch is controlled by the antenna unit for optimum sensitivity. The user has no access to the Squelch setting.



## COSPAS-SARSAT Decode Window



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### 121.500 MHz bearing Window in COSPAS-SARSAT mode

(1) >406.xxx< push button (F2 button) allows to switch back to the last used 406 MHz frequency. This allows to quickly check on 121.500 MHz if a beacon can already be received on VHF and, in the case that this is not possible, to cycle back to 406 MHz quickly.

(2) >CP-SAR-SAT< indication shows that the actual page belongs to the COSPAS-SARSAT page section.



(1) >SCAN< flashing indication notifying the user that the equipment is operating in scan mode.

(2) Frequency display indicating the COSPAS-SARSAT scanning frequency range.

(3) >X< sign showing that squelch settings are controlled autonomously by the receiver.

Scan mode can be left by entering a new frequency through the frequency or memory setup.

### COSPAS-SARSAT Scan Mode





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## Marine Ship Scan Mode

This chapter only applies for the standard version of the RT-600 / SAR-DF 517.

If the Marine Ship scan mode has been selected marine channels 1 to 88 (156.025 to 157.450 MHz) are scanned, including frequencies in between. After reception of a valid signal, the bearing mode is activated.

The frequency of latest signal that has been found using the scan mode is automatically transferred to the “AUX” memory channel.

Scan mode can be left by entering a new frequency through the frequency or memory setup.

In order to prevent the scan to stop on noise signals, it is recommended to start scanning operation with high squelch settings. Reduce the squelch level in steps until the scan stops on an invalid signal for the first time.

Then increase the squelch level only slightly. This will result in the highest possible scan sensitivity without reacting on noise source, e.g. resulting from disturbances generated by other equipment on the aircraft.



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## Law Enforcement and Medical Operation

(1) **>Automatic Squelch<** indication. It is strongly recommended to operate the receiver with automatic squelch sensitivity setting in case of LoJack operation. However, manual setup of the Squelch level would be possible. Please refer to the chapter “Squelch Operation” for details.

(2) **>ID Filter<** hotkey (F2 push-button): Allows activation of ID-only mode. This filter mode allows receiving one single LoJack transmitter identified by its ID. The shown text (FILT=OFF) indicates that no filter has been activated yet.



## LoJack Pages



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## LoJack Pages

After activation of the ID-only mode, the user is asked by the system to enter an ID:

**1) >EDIT<** hotkey (F1 push-button). This button opens the LoJack ID editing sub-page.

**(2) >ID only<** indication. The field indicated that the receiver is operating in the filter mode. By pressing the F2 button, IDonly mode can be left.

### LoJack ID-Only Mode Menu Options





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(1) >VALUE< Data field showing the last received LoJack ID of any active VLU within receive range. In case that no LoJack ID has been received, the value field is filled with dashes (“ - - - - -”).

(2) >Value to ID< hotkey (F2 push-button) allows to copy the received LoJack ID in the ID field.

(3) >ID< field showing the LoJack ID which shall be selected. If no LoJack ID has been selected, the ID field is filled with dashes (“ - - - - -”). Manual entry of data is possible. The position of the ID field which can be modified manually is high-lighted by dark background and bright values.

(4) >Select< rotary switch, allowing to select which position of the ID field shall be modified manually.

(5) >Value< rotary switch, allowing to modify the currently selected position within the ID field.

(6) >Exit< hotkey (F1 push-button), allowing to switch back to the LoJack bearing window.

## LoJack Pages

### ID Editing Sub-Page





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## Memory Page

- (1) **>Channel Name<** field: indicates the name of the channel, which is re-used in other displays as name of the currently used frequency: AUX, (1) ... (4).
- (2) **>Frequency<** field: shows the frequency stored for each channel. The memory channel currently selected for modification or for transfer to the DF mode is highlighted by dark background and bright digits on the frequency field.
- (3) **>Application Information<** field showing to which freq band and application a freq belongs to.
- (4) **>Channel selection<** rotary switch used to select which memory channel shall be active for modification or transfer into DF mode.
- (5) **>MHz<** rotary switch used to modify the selected memory in steps of 1 MHz
- (6) **>kHz<** rotary switch used to modify the selected memory in steps appropriate to the concerned freq band.







## ETS Pages

The Law Enforcement version of the RT-600 system is supporting the tracking of ETS transmitters.

If an ETS frequency has been selected, the bearing window for ETS opens. Its operational use is similar to the standard bearing window.

## Law Enforcement Scan Mode

If the Law Enforcement Scan Mode has been selected, the receiver scans ETS and LoJack frequencies for signals. Check each frequency squelch. Once scan stops it must be manually reset to scan

<b>Frequency</b>	<b>Application</b>	<b>Criterion</b>
LoJack-Frequency	LoJack	Valid LoJack ID
216.4875 MHz	ETS	Squelch Level
216.5125 MHz	ETS	Squelch Level
219.930 MHz	ETS	Squelch Level
219.960 MHz	ETS	Squelch Level



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- (1) **>Frequency<** information field, showing all necessary information on the selected freq such as frequency in MHz, memory channel, purpose of the selected frequency.
- (2) **>Marker<** showing the currently chosen frequency on the freq scale
- (3) **>Frequency scale<** on which a freq can be chosen. The freq scale is organized in freq blocks. The name of the freq block is indicated below the freq scale:
  - Law Enforcement scanning freqs (LE version only)
  - Memory Channels
  - Fix pre-programmed frequencies
  - COSPAS-SARSAT frequencies
  - COSPAS-SARSAT scanning frequencies.
- (4) **>Frequency selection<** rotary switch allowing to select a freq by moving the marker along the freq scale.
- (5) **>Exit<** hotkey (F2 push-button) allowing to directly switch back to the normal operating mode on the currently selected freq. If the exit hotkey is not pressed, the direction finder will fall back into the operating mode automatically after ca. 5 seconds of user inactivity.

## Frequency Selection Page





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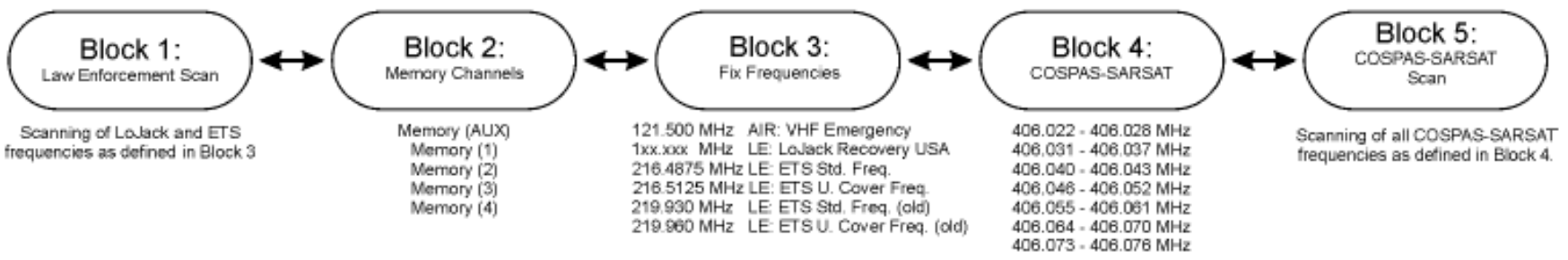
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# Frequency Selection Page

Frequency selection options for the standard version of the RT-600:



Frequency selection options for the law enforcement version of the RT-600:





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## Memory Page

(1) **>Channel Name<** field: indicates the name of the channel, which is re-used in other displays as name of the currently used frequency: AUX, (1) ... (4).

(2) **>Frequency<** field: shows the frequency currently stored for each channel. The memory channel currently selected for modification or for transfer to the direction finder mode is highlighted by dark background and bright ciphers on the frequency field.

(3) **>Application Information<** field showing to which frequency band and application a frequency belongs to.

(4) **>Channel selection<** rotary switch used to select which memory channel shall be active for modification or transfer into direction finder mode.

(5) **>MHz<** rotary switch used to modify the selected memory in steps of 1 MHz

(6) **>kHz<** rotary switch used to modify the selected memory in steps appropriate to the concerned frequency band.





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## Setup Page

The setup page can be accessed by holding down the **>CLR<** (1) and **>REP<** (2) buttons simultaneously and, in the same time, performing a left-hand turn on the **>Page<** rotary switch (3).





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# Setup Page

- (1) **>Store<** push-button must be pressed in parallel if a value of a setting shall be modified. If a value can be modified, the background stops to blink.
- (2) **>Select<** rotary switch used to scroll through the menu options. The value of the actually activated menu option is high-lighted with dark background and blinking.
- (3) **>Value<** rotary switch used to change values in menu options (>Store< (1) has to be pressed in parallel if a value shall be modified).
- (4) **>SN-Ratio<** menu option representing the necessary Signal-To-Noise-Ratio (Difference between signal and noise level) used as criterion for the automatic squelch function. Please refer to the chapter "Squelch Operation" for details. Default value is 6.0 dB.
- (5) **>Mounting Position<** menu option to select Top- or Bottom-Mounting of the DF antenna. In case of rooftop installation (e.g. on land vehicles), "Top" shall be selected. In case of bottom-down (upside-down) installation (e.g. on a helicopter), "Bot" shall be selected. If this option is not selected correctly, all bearing values will be mirror-inverted.
- (6) **>Bearing Offset<** menu option to include a constant offset correction to the bearing indication. Bearing values in degrees will be changed according to the offset value.
- (7) **>Maximum External Dimming Voltage for Legends<** menu option which sets the upper limit of the dimming input voltage for the legends-panel. Range=[1.5 ... 28]V
- (8) **>Minimum External Dimming Voltage for Legends<** menu option which sets the lower limit of the dimming input voltage for the legends-panel. Range=[1.5 ... 28]V
- (9) **>Page<** rotary switch to be turned right-hand to go back to the Direction Finder page. A left-hand turn on this rotary switch will show up an additional service page with debug information used for system checks.
- (10) **>Extended Serial<** It is possible to enable or disable the extended serial data protocol. Only of interest, if serial data is used by any connected control units like moving maps or computers. For detailed info see (Serial interface data protocol (short description)> at page 36). If there are compatibility problems with already existing older remote control software, it is recommended to switch OFF the extended serial data protocol.





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## Error Messages

Error message	Error, location	Reason
Error: (12) VOLT.DU	Main voltage supply	Main Voltage input too low ( $\leq 10.0$ V)
Error: (11) NO AU	Connection: antenna $\rightarrow$ display or Antenna Unit	No serial data (RS485) from Antenna Unit. No or damaged connection between antenna and display, or damaged antenna unit.
Error: (10) BAD AU	Connection: antenna $\rightarrow$ display	Incompatibility or bad data connection between display and antenna.
Error: (9) BAD RU	Remote Unit:	Incompatibility or bad data connection between display and external serial Remote Unit or PC
Error: (8) VOLT.AU	Antenna Unit:	Voltage supply at Antenna Unit too low ( $\leq 9.0$ V). Main voltage supply too low or considerable drop of voltage between display and antenna.
Error: (7) BAD DCU	Connection: Display $\rightarrow$ Antenna	Incompatibility or bad data connection between antenna and display.
Error: (6) NO DCU	Connection: Display $\rightarrow$ Antenna	No serial data from Display Control Unit to Antenna Unit.
Error: (5) PLL ERR	antenna	Error in synthesizer-oscillator of receiver in Antenna Unit.
Error: (4) FRQ+OFS	received transmitter	Received frequency too high (more than 6 KHz / error of transmitter)
Error: (3) FRQ-OFS	received transmitter	received frequency too low (more than 6 KHZ / error of transmitter)
Error: (2) DECODE	radio distance: transmitter $\leftrightarrow$ DF	Data Bits of decoded signal (COSPAS-SARSAT or LoJack) defective
Error: (1) DATARNG	Incompatibility of: data DCU $\leftrightarrow$ AU	Protocol data bytes out of valid range.
Error: (0) NO REC	Antenna Unit: receiver	Receiver board defective



**(1) Error message including error code (in brackets)**

**(2) Short description of the indicated error.**

In case of coincidence of various errors, the error with the highest priority will be displayed



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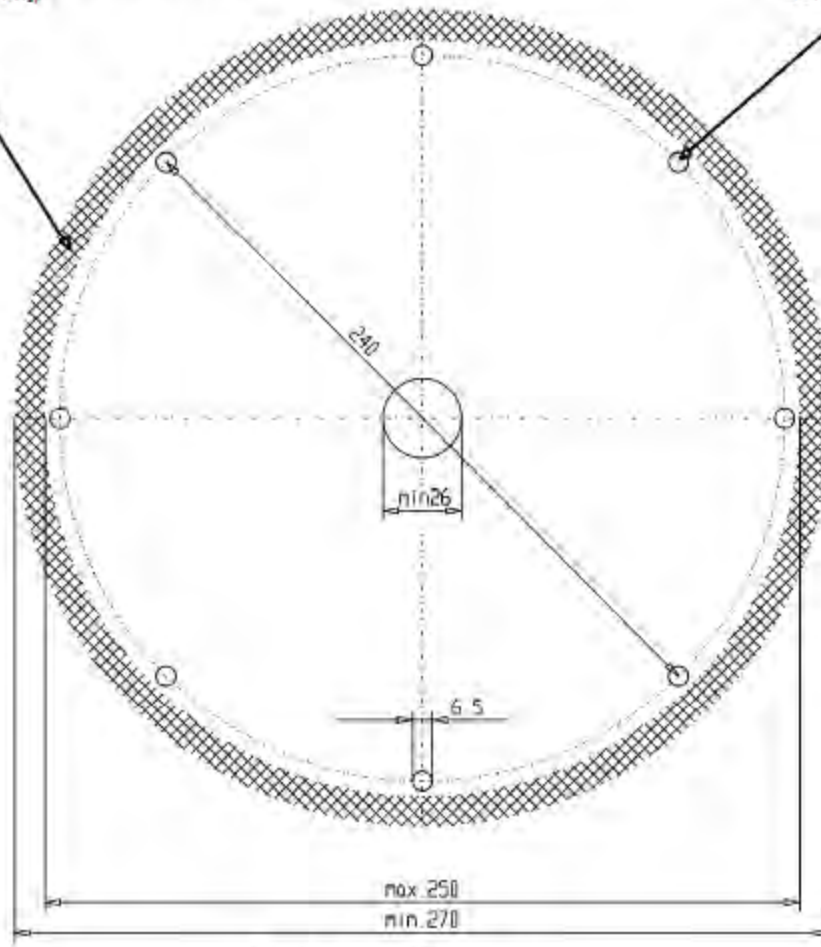
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In this hatched area, the antenna touches the body of the vehicle/aircraft. In order to obtain a good ground connection, the surface of the body should be bared. (Measuring unit [mm])

8 x holes for mounting the antenna unit to the vehicle / aircraft.



Mounting drawing of the antenna

# Installation





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Examples of properly installed direction finder antenna units:





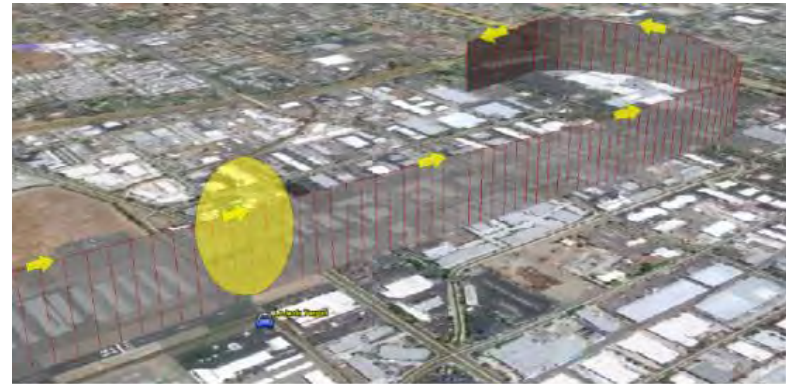
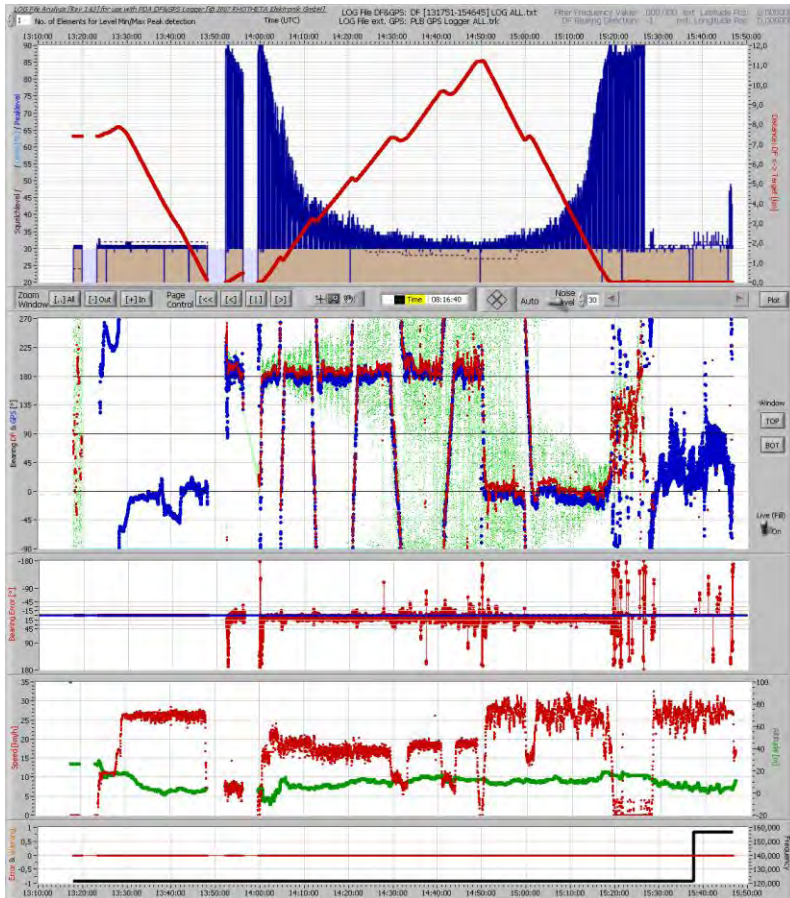
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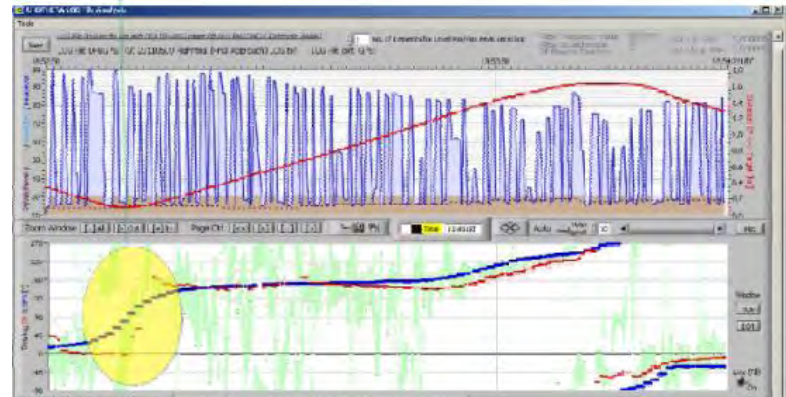
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# RT-600 Flight Testing



Fly Over





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# Thank You!

For more information contact Rhotheta USA at:

[info@rhothetausa.com](mailto:info@rhothetausa.com)

1-800-928-1072 / 1-435-578-1270

Lon Arnold 1-435-749-0188

Ventura Rigol 1-305-773-4448