User Manual

VHF Direction Finder System
RHOTHETA RT 1000.C

RHOTHETA Elektronik GmbH; Neuegling 7; 82418 Murnau, Germany;

Tel.: +49 8841 / 4879 – 0; Fax: +49 8841 / 4879 – 15; Email: email@rhotheta.de; Web: www.rhotheta.de

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1 GENERAL INFORMATION

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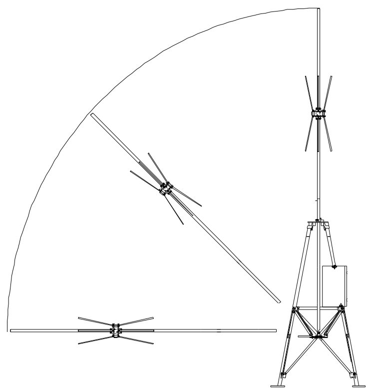
1.1 General Description

1.1.1 Antenna Mast (Option)

The special Mast RTA 1306 is recommended for the antenna system. The mast has a fixture which makes it possible to tilt the antenna down to working level to facilitate assembly and maintenance of the antenna. The integrated rotating stand makes it possible to rotate the antenna in 10° steps to effectively check the direction finding system. In addition, there is a weatherproof housing for the receiver unit.



1.1.2 Flexible System Configuration

All known radio direction finding methods are based on the utilization of the electromagnetic wave field generated by the transmitter to be found. Good results are only possible if this wave field at the direction finding position is largely undisturbed. Regrettably, incoming wave fields are distorted significantly in the tower area due to reflections and shadows from surrounding buildings. Even large and costly antenna systems can only solve these problems, resulting from physical facts, unsatisfactorily.

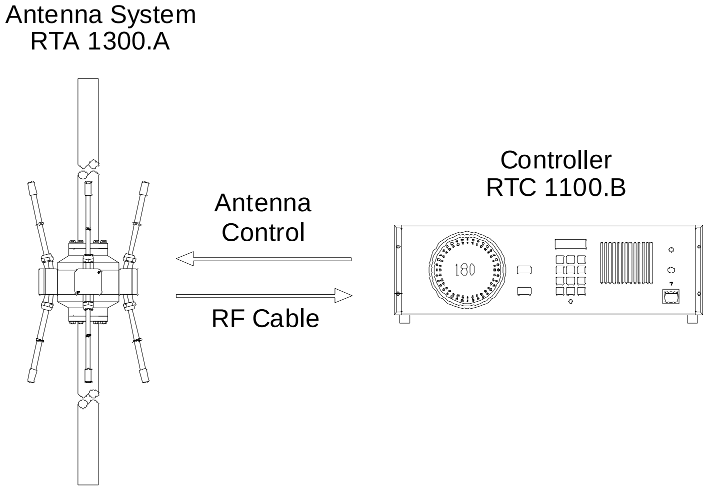
With "remote operation" the direction finder system RT 1000 realizes a concept permitting an antenna position to be chosen, which is almost totally independent from the controller's position. Hence, the antenna with its weatherproof receiver unit may be installed at a location within the airport area which is optimal for direction finding. The connection to the controller is made through a 6-wire line. Expensive equipment and costly infrastructures are eliminated in contrast to usual direction finding systems.

The Direction Finder System RT 1000 realizes an equipment family which can be utilized in a flexible manner. Apart from the advantage of being service-friendly, the consequent modular design makes it possible to have several system components variously equipped, so that the optimum system configuration is available with a minimum of equipment, depending on the application. There are four major variants for the traffic direction finding area.

1.1.3 Configuration A

The antenna is installed at the evaluation position. Receiver, demodulator and antenna control module are integrated in the controller unit.

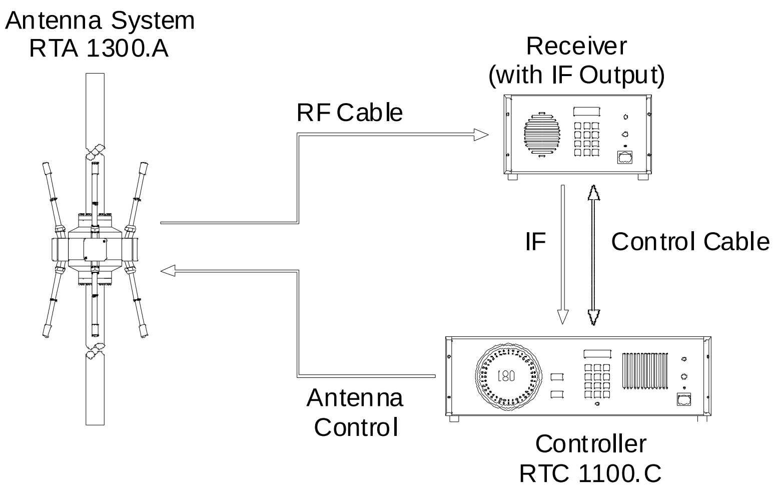
Application: For applications, where the evaluation position is also suitable as antenna position.



1.1.4 Configuration B

Like A, however, with an external receiver. Any receiver with an IF output may be used. If it has a serial data interface it is possible to control the receiver from the controller.

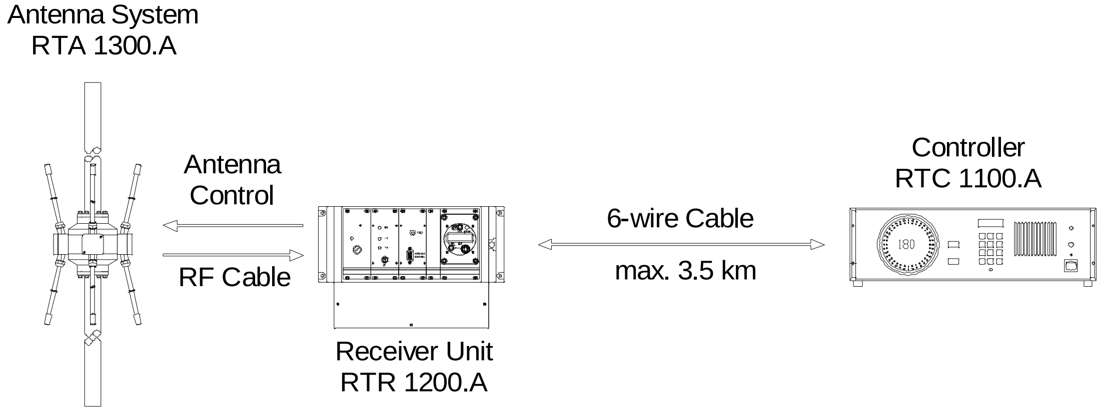
Application: For applications described under A, where the direction finder is part of the existing receiver system.



1.1.5 Configuration C

The system operates in "remote mode". The direction finding antenna is installed remotely from the controller, at a location favourable for direction finding. Receiver, demodulator and antenna control module are integrated in the receiver unit located at the antenna position. They are connected to the controller by means of a 6-wire line.

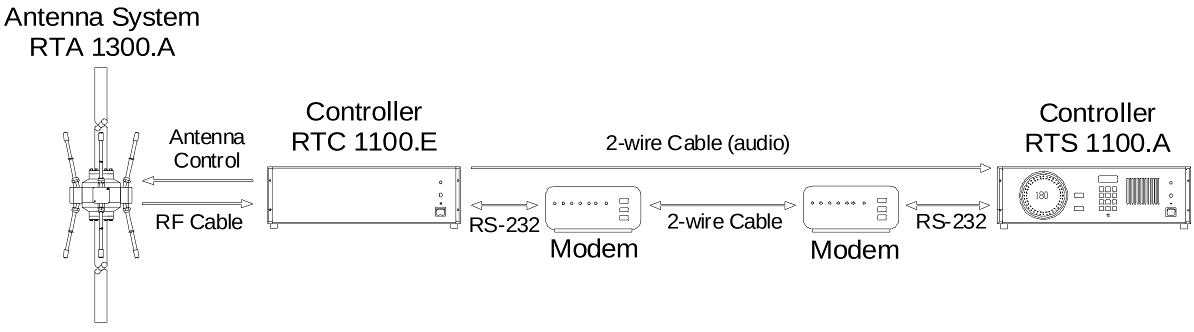
Application: For applications, where the evaluation position does not provide for satisfactory direction finding conditions.



1.1.6 Configuration D

The direction finding functions (bearing value output, receiver control, etc.) are transmitted between controllers over any distance by means of a modem line. This mode may be combined with any of the above system configurations.

Application: For applications where the evaluation position is far away from the antenna position.



1.2 Technical Data

Frequency range air band [1]	118 to 136.975 MHz
Frequency range marine band [1]	156 to 174.000 MHz
Operating channels air band	760; 10 preselected
Channel spacing	25 kHz
Type of modulation to be detected	A3E, F3E, A2X (ELT modulation)
System accuracy [2]	±2° RMS (with antenna)
Sensitivity [3]	≤2 µV / m (without antenna amplifier)
Polarisation	vertical
Polarisation error	≤1° (with field vector rotation up to 45°)
Cone of silence	approx. 35° referred to the vertical
Power supply	
AC	115 / 230 V ±15 %; 47 to 63 Hz
DC	24 V -10 % / +20 %; automatic switch-over to DC voltage in case of AC mains failure
Power consumption	
Controller unit	max. 15 VA
Receiver unit	max. 10 VA (52 VA with heater)
Temperature ranges	
Operating temperature	
Antenna	-40° to +80°C
Receiver unit	-40° to +60°C
Controller unit	-20° to +55°C
Storage temperature	-40° to +60°C
Interfaces	serial V.24 (RS-232-C) parallel

Bearing display..Response time ≤0.3 s

A)

Digital ....3 digits with 7-segment LED indicator
Resolution...1°
Bearing reference..QDR
Updating rate ....approx. one indication / s

B)

Dual compass dial ....2 concentrical circles of LED points
Resolution...10°
Bearing reference..QDR
Updating rate
Outer circle..approx. one indication / s
Inner circle...47 indications / s

Monitoring

Built-in loudspeaker
Modulation mode...A3E
Monitor output...approx. 500 mW 4 to 8 Ω
Line output..600 Ω, balanced, 0 dBm, m = 0.6

Ground transmitter suppression..with external contact to ground

Dimensions / Mass

Controller ....19"-desk-top model 3 UH, prepared for rack installation
Dimensions (H x W x D)......................................132.5 x 448 x 370 mm
Mass ....7.2 kg (9.9 kg [4)])

Receiver unit ....Non-metallic cabinet for wall mounting (IP 65)
Dimensions (H x W x D)......................................250 x 340 x 285 mm
Mass ....6.5 kg

Antenna system
Dimensions (Diameter x H)...................................400 x 1120 mm
with lightning rod and mast...........................400 x 3400 mm
Mass ....3.6 kg

Lateral thrust due to wind

with constant wind speed

150 km / h...approx. 135 N

180 km / h...approx. 195 N

(data with lightning rod and mast)

Notes:

1) Depend on the software configuration
Not for configuration B (dependent on the type of receiver).

2) For undistorted wave reception and sufficient field strength. Measurement is made at constant frequency by changing the angle of incidence; in order to exclude site errors, angle variation is done by rotating the DF antenna on a rotator.

3) System sensitivity for ±1° bearing fluctuations (cable attenuation of less than 2 dB between antenna and the receiver, received signal vertically polarised).

4) Controller Configuration A.

1.3 Supplied Accessories

- Set of antenna cables
- AC cable
- Operating instructions
- Adapter for rack installation of controller
- Interface connector
- Antenna rod
- Lightning rod

1.4 Options

- Special antenna mast
- Mast extension
- Hazard light
- Dummy antenna
- Service kit
- Service manual
- Slave display
- Set of cables
- Antenna amplifier
- DC heating for receiver unit

2 CONTROLLER RTC 1100.A

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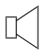
Key to Front and Rear Views

All the position numbers refer to operating elements shown in the front and rear views (Figure 2-1 and Figure 2-2).

No.	Designation	Function	see Section
1	DIM / ☼	Dimmer	2.3.8
2	QDM	Heading (Ref.: QDM)	2.3.1
3	N/E/S/W	Bearing direction (Ref.: QDR)	2.3.1
4	N/E/S/W	Live bearing direction (Ref.: QDR)	2.3.1
5	>·<	Frequency deviation	2.3.6
6	!	Error indication	2.3.7
7	TEST	Test function	2.3.2
8	Frequency	Display of frequency, north adjustment and error code	2.3.4/5/7
9		Volume control	2.3.9
10		Headphones connection	2.3.10
11	STANDBY	Control lamp for STANDBY mode	2.2.8 2.3.11
12	OFF / ON	ON/OFF switch	2.3.12
13		Keypad for entering frequency	2.3.4
14	REPEAT	Repetition of bearing indication	2.3.3
15	121.500 MHz	Call-up of distress frequency 121.500 MHz	2.3.7
16	STOP/SCAN	Termination or selection of scan mode	2.3.6
17	Line	Mains switch	2.3.13
18	F1	24-V DC fuse	2.2.4
19	OK	Power supply control lamp	2.3.14
20	Data-Port	Data interface	2.3.15
21	Sync	Control indication: synchron. NOK	2.3.16
22	Sync	Control indication: synchron. OK	2.3.16
23	R/L	Test plug R/L signal	2.3.18

No.	Designation	Function	see Section
24	DF-Signal 2	DF signal (filtered)	2.3.17
25	PTT	Connection jack for ground transmitter suppression	2.2.11
26	North-Adj. +	Positive variation of north adjustment value	2.2.10
27	North-Adj. -	Negative variation of north adjustment value	2.2.10
28	Ser. Port	Serial port	2.3.19
29	Par. Port	Parallel port	2.3.20
30	fine	Rotary switch 1 for fine phase adjustment	2.2.9
31	coarse	Rotary switch 2 for coarse phase adjustment	2.2.9
32	Phase-Adj.	Control lamp for phase adjustment	2.2.9
33	⏚	Earth connection (M6)	2.2.1
34	Power Select	Mains voltage selector (115/230 V)	2.2.2
35	24V DC +	+24-V battery connection	2.2.4
36	24V DC -	0-V battery connection	2.2.4
37	F2, F3	Mains fuse holder	
38		Mains connection	
39	RF-Ant	Dummy panel	

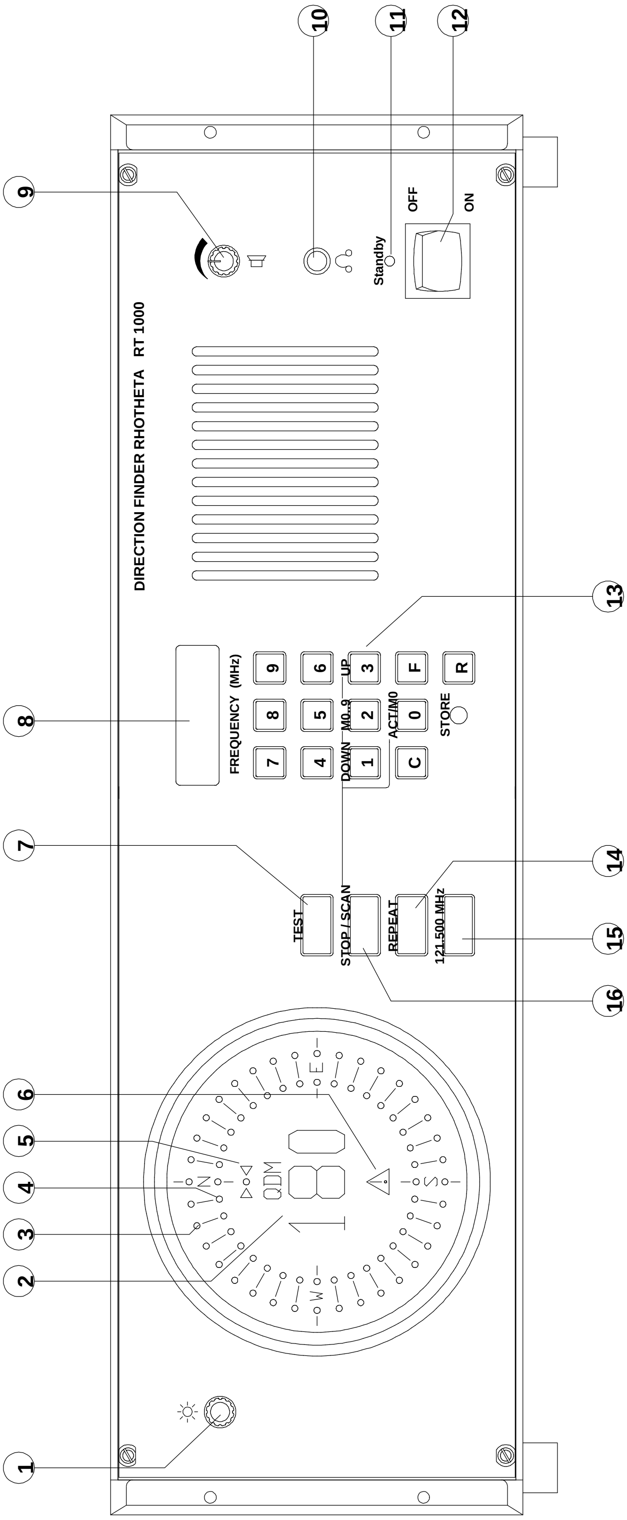


Fig. 2-1 Front view

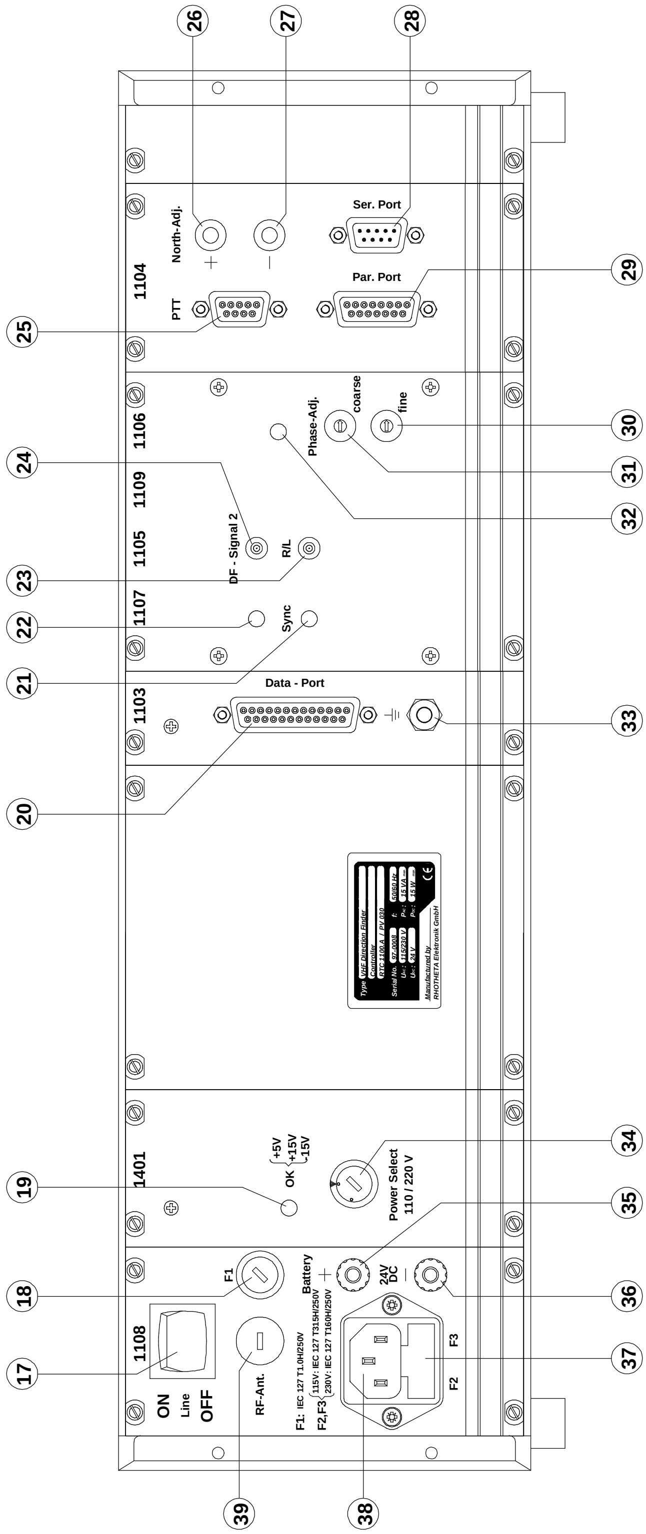


Fig. 2-2 Rear view

2.1 Preparation for Use

2.1.1 Earthing

The RTC 1100 Controller housing is earthed by means of the earthing contact in the mains plug. At the rear of the housing there is an earthing screw 31 (M 6). This should be used to make a low-impedance and low-inductivity connection between the unit and earth potential (system earth). Connect the controller to earth using the same connection as for the other equipment at your workplace, in order to avoid dangerous voltage peaks between the different units in case of a lightning strike. If using the direction finder as a portable unit, it must be earthed using an appropriate earthing rod, surface earth or earthing plate. If possible, connect the unit to the metal operating environment (vehicle or shelter).

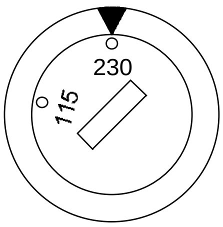
WARNING:

Observe all local safety regulations.

2.1.2 Mains Voltage

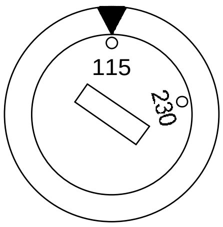
The RTC 1100 Controller can be operated using mains voltage of 115 V or 230 V ±15 %. The unit is factory-set to 230 V mains voltage.

Before using the unit, check that the correct operating voltage range is set. Use a screw-driver to move the mains voltage selector (32, Fig. 2-2) on the front panel of the RTX 1401 Power Pack module.



Selector position for 230 Volt range :

Permissible operating voltages: V_{min} = 195.5 V_{rms}
V_{max} = 264.5 V_{rms}



Selector position for 115 Volt range:

Permissible operating voltages: V_{min} = 97.75 V_{rms}
V_{max} = 132.25 V_{rms}

Fig. 2-3 Mains voltage selector

After setting the mains voltage, make sure that the appropriate mains fuses F2 and F3 are in the mains fuse holder (35).

CAUTION:

If the mains voltage selector is not set correctly, the unit may be damaged beyond repair.

2.1.3 Mains Fuse

The mains fuses are contained in the mains power connection (36, Fig. 2-2). There is a separate fuse for phase and the neutral wire. The fuse holder (35) can be easily unlatched by inserting a screwdriver into the slot in the upper part of the fuse holder. Insert fuses F2 and F3 into the fuse holder according to the selected mains voltage :

115 V : IEC 127 T315H / 250V
230 V : IEC 127 T160H / 250V

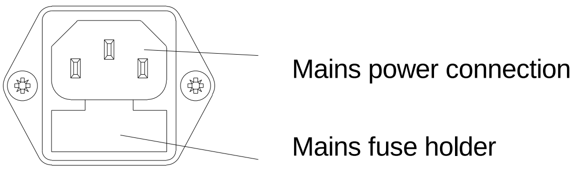


Fig. 2-4 Mains power connection, mains fuse holder

> ## **WARNING**:
>
> **Before opening the fuse holder, make sure that the unit is dis-connected from the mains supply.**

2.1.4 DC Voltage Connection

The RTC 1100 Controller is fitted with a DC supply connection. This allows the unit to be operated using batteries or a 24-V DC mains connection. Connection is through the red pole terminal (33, Fig. 2-2) to the positive pole and blue pole terminal (34) to the negative pole of the power supply. The pole terminal (34) connection is connected to the housing earth inside the unit.

Fuse F1 inserted in the fuse holder (16) protects the unit during DC operation. Use a IEC 127 T1.0H / 250-V fuse. The supply voltage range for DC voltage is 24 V DC, with a permitted tolerance range of -10 / +20 %.

CAUTION:

Voltages greater than 30 V may lead to the unit being damaged beyond repair.

2.1.5 Power Supply

The unit can be alternatively used with mains power or 24-VDC supply.

When connecting the unit to a power supply, ensure that the mains ON/OFF switch (15, Fig. 2-2) at the rear of the unit and the ON/OFF switch (12, Fig. 2-1) at the front are both switched off.

In order to operate the unit off the mains, plug the mains cable into the mains power connection (36, Fig. 2-2) to connect the unit to the mains supply. In order to operate the unit using DC, connect the unit to the DC supply via pole terminals (33) and (34).

WARNING:

Only connect the unit to the mains using an earthing contact socket outlet.

If the unit is connected to both power supply types and the mains ON/OFF switch (15) is switched on, the unit is normally operated off the mains. If mains supply is interrupted, the unit switches over to DC supply internally. This allows an automatic change-over to a DC emergency power source. If mains supply is switched off at the mains ON/OFF switch (15), the DC supply only is effective.

2.1.6 Connection of the Receiver Unit

The RTC 1100 Controller is connected to the RTR 1200 Receiver Unit by means of a six-wire communications cable. On the RTC 1100 Controller, use the 25-pole D-SUB jack, "Data-Port" (18, Fig. 2-2). See section 3.2.6 and section 5.2 for plug allocations.

2.1.7 Rack Mounting

Use the adapters (supplied) to mount the RTC 1100 Controller in 19" racks. When mounting in a rack, ensure that permissible ambient temperatures are not exceeded. This is especially important when mounting with other units which give off heat.

2.1.8 Switching on / Reaction from Unit

Ensure that the mains ON/OFF switch (15, Fig. 2-2) and the ON/OFF switch (12, Fig. 2-1) are both switched off. If the unit is to be operated off the mains, connect the unit to the mains supply and move the mains ON/OFF switch (15, Fig. 2-2) at the rear of the unit to "ON". The unit is now in standby mode. The yellow control lamp "STANDBY" (11, Fig. 2-1) lights up. The unit is ready to operate when the ON/OFF switch (12) at the front of the unit is moved to "ON".

If the unit is to be operated off a DC source, connect the unit to the DC supply. The unit is ready to operate when the ON/OFF switch (12) is moved to "ON".

In both cases, the power supply control lamp (08) lights up to show that the unit is ready to operate.

The test function is now activated automatically. All positions in the digital displays of the bearing (02) and frequency (08) show the figure "8". The individual lamps of bearing direction displays (03) and (04) light up one after the other. The frequency deviation (05) and error indication (06) lamps light up.

After the test function is completed, the bearing frequency selected before the unit was last switched off appears on the frequency display (08).

2.1.9 Phase Adjustment

A special feature of the RTC 1000 Direction Finder is its phase compensation by left / right rotation of the antenna. This allows complete compensation of direction finding errors caused by signal phase variations in the reception channel. However, it is only possible to compensate for a limited phase value. For this reason, make a pre-adjustment to the centre of the variation range.

The adjustment can be made either using the RTM 1500 Dummy Antenna or aligning of the labelled antenna radiator (North dipole) onto a transmitter.

2.1.9.1 Adjustment Using RTM 1500 Dummy Antenna (Option)

- Connect the dummy antenna instead of the RTA 1300 Direction Finder Antenna (see description of RTM 1500 Dummy Antenna).

- Feed in a VHF signal in the ATC band range with a signal level of approx. 100 mV at the dummy antenna RF input and adjust the receiver to the appropriate frequency. Move the antenna signal switch on the dummy antenna to the 180° position.

  Since the direction finder was pre-set in the factory, the bearing display must show QDM 180° and QDR 0° on condition that the north adjustment is se t to 0° (see 2.2.10). QDM 0° and QDR 180° may also be displayed if the phase is completely misaligned.

- Phase adjustment can be set using the two rotary switches, (28, Fig. 2-2) "fine" and (29) "coarse". The total of 256 steps (8 bit) on the coarse switch are divided into 16 steps, and these coarse steps are sub-divided into a further 16 steps on the fine switch. Use these rotary switches (28) and (29) to find the middle of the range where the green control lamp (30) lights up. The QDM display should then show 180°.

2.1.9.2 Adjustment Using a Transmitter

Position a test transmitter (e.g. walkie-talkie) approx. 100 m away, exactly to the north of the direction finder antenna (dipole north with label pointing towards the transmitter). The bearing display should show QDM 180° and QDR 0°. The north adjustment on t he controller should be set to 0° (see 2.2.10). Phase adjustment is set as described in 2.2.9.1.

2.1.10 North Adjustment

The bearing display (QDM/QDR) is relative to magnetic north, on condition that the antenna is mechanically adjusted towards north (see section 3, Antenna).

Perform exact adjustment using the north adjustment on the controller. The correction value for north adjustment appears on the frequency display (08, Fig. 2-1) when buttons TEST (07) and REPEAT (14) are pressed simultaneously.

Example : Display indicates correction value +3.5° :

N +03.5

Correction is possible in 0.5° steps in a ±90° range. Press the following buttons simultaneously to perform the adjustment:

TEST (07), REPEAT (14), NORTH-ADJ.+ (24, Fig. 2-2) or
TEST (07), REPEAT (14), NORTH-ADJ.- (25, Fig. 2-2).

During this procedure bearings must be taken of a transmitter located in a known direction referred to the antenna position. Correct the bearing display (02, Fig. 2-1) to this direction (QDM) using the north adjustment.

2.1.11 Ground Transmitter Suppression

If you do not want to take the bearing of the ground transmitter, connect the PTT jack (23, Fig. 2-2) on the rear of the unit with a normally open contact of the transmit button. See Figure 2-5 for wiring diagram.

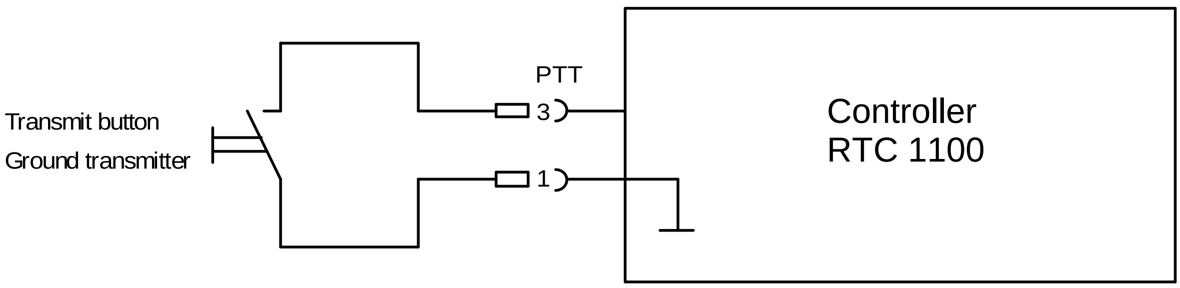


Fig. 2-5 Wiring diagram for ground transmitter suppression

If the normally open contact is not floating, arrange the wiring according to Figure 2-6.

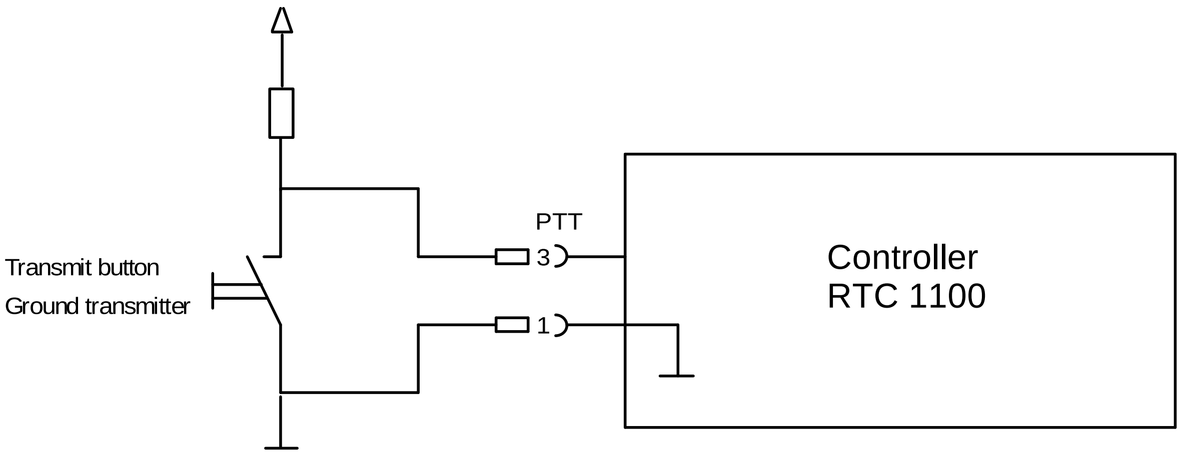


Fig. 2-6 Wiring diagram for ground transmitter suppression with non-floating contact

Ground transmitter suppression is operative when contacts 1 and 3 of the PTT jack (23, Fig. 2-2) are connected and thus contact 3 is connected to earth potential.

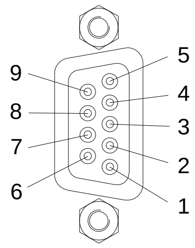


Fig. 2-7 D-sub-jack 9-way

2.2 Display and Operating Functions

2.2.1 Bearing Display and Bearing Quality Analysis

The bearing (QDM) is displayed on a luminous, 3-figure digital display (02, Fig. 2-1) which may be dimmed for use in darkened rooms (01). The resolution is 1°. Additionally, there is a display (QDR) in 10° steps using light dots arranged around a compass scale (03).

To obtain an optimally settled display, the bearing signal is averaged and then processed using a special algorithm. In order to infer the quality of the displayed bearing, there is a second concentric circle of light dots (04) in the display area which displays the actual, i.e. not averaged ("live") bearing direction in a 20-ms rhythm.

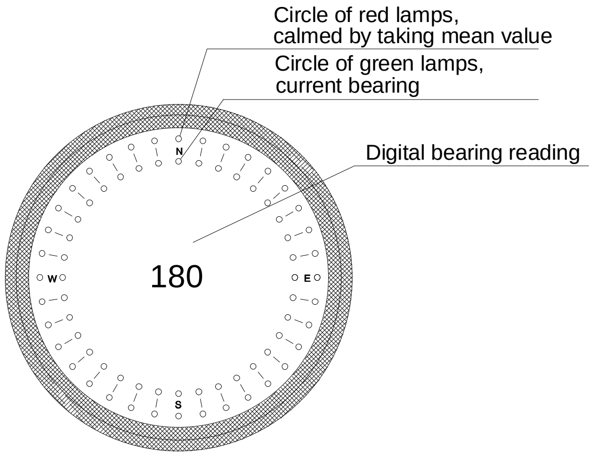


Fig. 2-8 Bearing display

This dual compass scale allows optimum bearing quality analysis because the non-average bearing is displayed in direct relation to the mean bearing.

If the "live" bearing display (04, circle of green lamps) shows considerable variations or differences to the averaged mean bearing display (03, circle of red lamps), the operator can see that the direction finder is being affected by noise, shadowing reflections or strong modulation.

2.2.2 Test Function

After switching on the controller, the unit automatically performs a test routine. If the system is used continually over longer periods, we recommend activating the test function every day.

The test function is activated using the test button (07, Fig. 2-1). The test routine runs through the internal self-test functions and controls the displays for bearings (02, 03, 04) and frequency (08): numerical display (02) shows 888, the orientation displays (03) and (04) are switched on in 10° steps and the frequency display (08) shows 8888888. The lamps for frequency deviation (05) and error (06) are illuminated.

Additionally the evaluation of the bearing is inhibited when the test function is activated. When releasing the test key (07) the bearing evaluation is started again.

2.2.3 Repetition of Bearing Indication

The repeat function, called up using the REPEAT button (14, Fig. 2-1), is used to display the last bearing calculated. In addition, when the REPEAT button is pressed, the current bearing is retained. In this function, the "live" bearing direction indication (04) is not active.

2.2.4 Frequency Selection

Range: 118.000 to 136.975 MHz and /or 156.000 to 174.000 MHz

Resolution: 25 kHz

Frequencies may be entered directly using the key pad or may be called up from the frequency memory. The unit makes available 10 frequency memories which are retained when the unit is switched off. The display (08, Fig. 2-1) indicates the active frequency.

2.2.4.1 Direct Frequency Selection

Frequencies can be entered directly using buttons C (Clear) and 0 to 9 on the keypad for entering frequencies (13, Fig. 2-1).

Example: Entering a frequency of 118.975 MHz

Input	Frequency display (08)
C	_ _ _ . _ _ _
1	1 _ _ . _ _ _
1	1 1 _ . _ _ _
8	1 1 8 . _ _ _
9	1 1 8 . 9 _ _
7	1 1 8 . 9 7 5

It is not necessary to input the last figure (kHz figure), because the controller generates this automatically.

If the frequency is not entered correctly within 10 secs., the controller switches back to the last frequency set.

2.2.4.2 Calling up Frequency Memory

Frequencies may be called up from frequency memories 0 to 9 using the R (Recall) button and buttons 0 to 9 in the key pad for entering frequencies (13, Fig. 2-1). First press the R button and then number 0 to 9 as required.

Example: Call up frequency memory 0

Input		Frequency display (08)
R		R C L _
0	e.g.	1 2 1 . 5 0 0

If the frequency has not been called up from the frequency memory within 10 secs. after pressing the R button, the controller switches back to the last frequency set.

2.2.4.3 Programming the Frequency Memory

The current frequency set can be entered into the frequency memory position 0 to 9. This is done by pressing the store button and buttons 0 to 9 in the key pad for entering frequencies (13, Fig. 2-1). Press the store button and the button for the desired memory number simultaneously.

Example: Program frequency memory 0

STORE 0

The last frequency set is automatically programmed into an additional frequency memory. Thus the frequency set is retained even after the unit is switched off.

Note:
It is also possible to store channel numbers for maritime radio communication into the frequency memory. This may be useful for scanning of frequency memories 0 to 9 (see section 2.3.6)

2.2.5 Direct Selection of Channel Number in Maritime Radio Communication

Channel number ranges in	duplex operation:	01 to 07,	18 to 28,	60 to 66 and 78 to 88
	simplex operation:	08 to 17,	and 67 to 77	

For direct channel number selection (for maritime radio communication only), use the buttom C (Channel) and keyes 0 to 9 of the keypad (13, Fig. 2-1).

The last digit of the channel display (08) shows the selected mode in the upper and lower sidebands.

- S = (Sea) bearing of sea station (lower sideband)
- C = (Coast) bearing of a coast station (upper sideband)
- X = channel number in simplex operation (upper sideband = nlower sideband)

Selection of the upper or lower sideband (coast or sea station) is made by repeatedly pressing button C when entering the channel number.

Example: Enter channel number 78 (bearing mode, reception of a sea station)

Input	Channel display (08)
[C]	C H _ _ S
[7]	C H 7 _ S
[8]	C H 7 8 S

If the channel number is not entered correctly within 10 secs., the controller switches back to the last frequency or channel set.

2.2.6 Scanning

In scan mode the frequency is changed continually. While a signal is being received the current frequency stays turend. When reception stopps scanning resumes after approx. 2.5 secs.

2.2.6.1 Selection of Scan Mode

In order to start scanning first press button STOP/SCAN (16,Fig. 2-1) and then one of the four possible scan mode keys (key: 1= DOWN, 3= UP, 2 = M0..9, 0 = ACT/M0).

Scan modes:

- **DOWN** = The entire currently active frequency band (aeronautical or maritime radio communication) is scanned continuously in downward direction. The frequency increment is 25 kHz. Once the lowest frequency of the band has been reached, scanning restarts at the highest one.
- **UP** = the frequency band is scaned in upward direction (otherwise as in DOWN scanning)
- **M0..9** = The ten frequency memories (see section 2.3.4.3) are scanned continuously.
- **ACT/M0** = Two frequencies are scanned, namely the active frequency and that in memory 0.

Example: Scanning frequency memories 0 to 9

STOP/SCAN M 0..9

Remarks:

- While scanning is in progress the display (08, Fig. 2-1) briefly shows the message SCANNING every tow seconds
- While scanning is in progress, the scan mode is only changed by pressing the relevant mode key. If, for example, you wish to change from UP to DOWN scanning, just press the DOWN key.
- If you wish to continue scanning although a signal is being received, press the relevant scan mode key and keep pressing untila new frequency is set. (Example: In UP scanning a signal is being received at 125.000 MHz and scanning stops. If you still wish to continue UP sxanning, press key UP until 125.025 MHz appears and UP scanning continues automatically)
- You may also store channel numbers for maritime radio communication in frequency memoryies 0 to 9 for scanning.

2.2.6.2 Ending Scanning

To stop all active scanning processes immediately press the STOP/SCAN button (16) or any other function key.

2.2.7 Calling up the Distress Frequency 121.500 MHz

By pressing button 121.500 MHz (15,Fig. 2-1) this frequencyis immediatedly activated (international distress frequency in civil aviation)

2.2.8 North Adjustment

The correction value set for north adjustment is shown on the frequency display (8, Fig. 2-1) when the buttons TEST (7) and REPEAT (14) are pressed simultaneously. Corrections can be made in 0.5° steps in a range of ± 90°.

2.2.9 Frequency Deviation

The RTC 1100 controller incorporates a measuring device to monitor the frequency deviation of the signal being received. If the frequency drift becomes excessive (±5 kHz), bearing evaluation is interrupted. This condition is signalled by the LED (05, Fig. 2-1) in the display field.

2.2.10 Error Indication

The equipment has a wide range of self-test devices. If an error is discovered, lamp (06, Fig. 2-1) in the bearing display field lights up. Additionally, the error code is shown flashing at 1 sec. intervals in the frequency display (08).

Display: **E R R 7**

Error code	Error type
1	Processor
2	EPROM
3	RAM
4	Power supply
5	EEPROM
6	Synchronisation
7	Phase measurement
8	Data transfer or power supply or receiver unit
9	Receiver control

CAUTION:

If an error message appears, the unit no longer functions.

2.2.11 Dimmer (01) "DIM"

The dimmer (01, Fig. 2-1) is used to change the brightness of the QDM display (02), line of bearing display (03), line of "live" bearing display (04), error display (06) and frequency deviation display (05). The dimmer has no effect on the frequency display (08). When set to minimum, the line of bearing display (04) is almost completely extinguished.

2.2.12 Volume Control (09)

The volume control (09, Fig. 2-1) is used to change the volume of the AF signal (speech signal) which can be monitored in the speaker or headphones. When set to minimum the AF signal is no longer audible.

2.2.13 Headphones Connection (10)

Headphones can be connected to jack socket (10, Fig. 2-1) for monitoring the AF (speech) signal. The speaker in the controller is silenced when the jack plug is inserted.

Suitable jack plug : 6.35 mm

Terminal allocation :
Centre terminal : + (audio signal)
Outer connection : - (ground)

2.2.14 "STANDBY" Indicator (11)

With power applied, power switch (12, Fig. 2-1) set to "ON" and the controller is in STANDBY because voltage is present at the power transformer. This state is indicated by the yellow "STANDBY" indicator (11).

2.2.15 ON / OFF Switch (12)

This switch (12, Fig. 2-1) is used to switch the controller on and off. The switch activates or blocks the power supply regulator. In the OFF position it also cuts off the DC power supply. The transformer is not disconnected from mains supply.

2.2.16 "Line" Mains Switch (15)

Mains switch (17, Fig. 2-2) provides a double-pole disconnection of the power supply module from the mains. The DC power supply is not affected, which means that with the switch in the "OFF"-position the power supply module is switched to the DC power supply.

Modes:

Mains switch setting (17, Fig. 2-2)	DC power supply	ON / OFF switch setting (12, Fig. 2-1)	Controller	"Standby" Indicator (11)
OFF	not connected	ON	OFF	OFF
OFF	not connected	OFF	OFF	OFF
OFF	connected	OFF	OFF	OFF
OFF	connected	ON	operates in DC mode	ON
ON	not connected	OFF	OFF	ON
ON	not connected	ON	operates in mains mode	ON
ON	connected	OFF	OFF	ON
ON	connected	ON	operates in mains mode	ON

2.2.17 Power Supply "OK" Indicator (19)

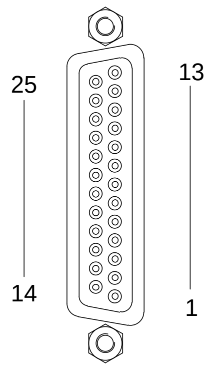
After switch-on the green indicator (19, Fig. 2-2) lights up. This indicates that the power module is operating correctly.

2.2.18 "Data-Port" Data Interface (20)

The data port is used to connect the RTR 1200 Receiver Unit to the controller. Additionally, the internal power supply voltages and the AF signal (audio signal, floating, via a separate amplifier) are applied to this connector.

Plug type: D subminiature female multipoint connector, 25-way

Plug wiring:



D-sub-jack 25-way

Pin	Signal	Meaning
01	NF 2	AF audio signal (floating)
02	PHI-1	Bearing signal 1
03	PHI-2	Bearing signal 2
04	PHI-2	Bearing signal 2
05	Data-1	Data communication line 1
06	Data-1	Data communication line 1
07	-15V	-15-Volt power supply
08	Data-2	Data communication line 2
09	Data-2	Data communication line 2
10	48kHz-1	Reference signal 1
11	48kHz-1	Reference signal 1
12	48kHz-2	Reference signal 2
13	48kHz-2	Reference signal 2
14	NF1	AF audio signal (floating)
15	TXD-5V	Serial 5-V interface
16	RXD-5V	Serial 5-V interface
17	RXD	RS-232 interface (receive)
18	TXD	RS-232 interface (transmit)
19	NF-X2	AF input
20	PTT-X2	Input for ground transmitter suppression
21	SQU	Squelch input
22	GND	Ground
23	GND	Ground
24	+15V	+15-V power supply
25	5V	+5-V power supply

2.2.19 "Sync" Synchronisation Indicators (21, 22)

The green indicator (22, Fig. 2-2) lights up if in the controller the electronics in the Frequency Processing module RTC 1107 is synchronised with the reference signal from the Antenna Control module RTR 1201.
The red indicator (21) lights up if the above mentioned synchronisation is not achieved.
When this indicator is on it indicates the following possible malfunctions :

- Receiver unit not ready for operation (e.g. switched off)
- Data line defective
- RTR 1201 Antenna Control module defective
- RTC 1107 Frequency Processing module defective

2.2.20 "DF Signal 2" Test Plug (24)

The test signal for bearing determination is applied to the test connector (24, Fig. 2-2). The signal can be monitored using an oscilloscope. It indicates the quality of the bearing value (refer to section 4.4.3.1).

Plug type: SMB

2.2.21 "R/L" Test Connector (23)

The signal for changing over the fictitious antenna rotation from clockwise to counter-clockwise is applied to the test plug (23, Fig. 2-2). This signal is used for triggering the oscilloscope when monitoring the DF signal described in 2.3.17.

Plug type: SMB

2.2.22 "Ser. Port" Serial Interface (28)

The serial interface (28, Fig. 2-2) enables the transmission of bearing data to an external display unit and also permits remote control from an external control unit.

The characters to be transferred are transmitted in ASCII code from the RTC 1100 Controller. The data bit sequence, which is assigned in each case to the characters to be transmitted, is preceded by a start bit and followed by a stop bit. Both additional bits ensure that both transmitter and receiver are time-synchronized.

The data traffic via the serial interface is in asynchronous mode. For time-synchronisation of the data transmitter and receiver the data receiver is triggered by the rising edge of the start bit at the beginning of the bit sequence of a character.

The transmission of a message begins with the header consisting of an alphanumeric character. The actual message content forms a string of (ASCII) decimal numbers. The transmission of a message is ended by the final identifier "CR" (decimal code 13).

The signal level on the data lines corresponds to the RS-232 standard, i.e. a high is defined as a voltage between +3 V and +15 V and a low as a voltage between -3 V and -15 V. The data is transmitted in negative logic.

The bearings are output as QDR values and therefore differ by 180° from the values shown in the QDM display (02).

2.2.22.1 Data Output

The data output is continuous, i.e. no control by means of a handshake signal or control characters is necessary.

Message	Header	Content
"Average" bearing (QDR value)	A	XXX 0 to 359° (QDR) Units Tens Hundreds
"Live" bearing (QDR value)	L	XXX 0 to 359° (QDR) Units Tens Hundreds
Status	S	XXX Error code, units Error code, tens 0: Bearing signal off 1: Bearing signal on 2: Deviation 3: Test 4: Ground transmitter suppression
Receiv level	P	XX 0 to 99% Units Tens
Frequency	F	XXXXXX 118.000 to 136.975 MHz kHz units kHz tens kHz hundreds MHz units MHz tens MHz hundreds

The following example shows the output of the average QDR bearing 315° as a sequence of ASCII characters :

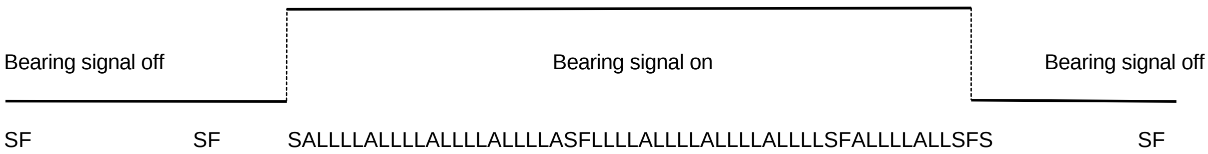
A315CR Average bearing 315° (QDR)

Final character {= decimal: 13}
Content (bearing) {= decimal: 51, 49, 53}
Header {= decimal: 65}

Time sequence

The status of the bearing signal determines the bearing data output. If no usable bearing signal is present, the RTC 1100 Controller transmits the data for status and frequency at intervals of approximately one second.

Immediately after any usable bearing signal is applied the controller transmits the status message. This is followed by the transmission of the bearing values "average" and "live". The average bearing is transmitted approximately four times per second and the live bearing approximately 18 times per second. In between, the messages "status" and "frequency" are output at intervals of approximately one second. If the bearing signal changes to the "off" state, the controller immediately transmits the status information.



S: Status
F: Frequency
A: Average bearing
L: Live bearing

2.2.22.2 Data Input

All received data are checked for correct syntax and plausibility referring to the actual unit setting. All received data are also checked for compliance with the limiting values. The data input is monitored over a time-out of 100 ms, i.e. all ASCII characters of a message must be transmitted to the bearing unit within this time.

If errors are found, the received commands are not carried out. A correct data input momentarily sets the direction finder to the required setting.

Message	Header	Content
Status	S	X └ 0: Reset 1: "Live" bearing off 2: "Live" bearing on 3: Slave display identification 1) 4: Ground transmitter suppression 9: Initate watchdog reset
Frequency	F	XXXXXX 118.000 ... 136.975 MHz kHz units kHz tens kHz hundreds MHz units MHz tens MHz hundreds

1) Changes of frequency via serial data interface will be stored. Status is approx active for 1 sec.

The following example shows the data sequence for the frequency command:

F125375CR Frequency 125.375 MHz

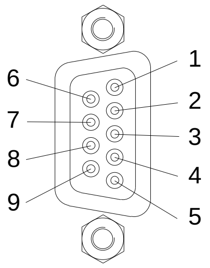
CR	Final character	{= decimal: 13}
125375	Content	{= decimal: 49, 50, 53, 51, 55, 53}
F	Header	{= decimal: 70}

After switch-on of the RTC 1100 Controller, the serial interface is in the "live bearing on" state. If transmission of the live value is not required, the instruction "live bearing off" must be transmitted each time after the controller is switched on or the supply voltage is interrupted.

2.2.22.3 Technical Data

Data format:	ASCII-8-Bit (7 data bits + 1 parity bit) (ASCII-II-character format)
Stop bit:	1
Parity:	ODD
Baud rate:	1200
Mode:	asynchronous
Level:	RS-232 High: +3 V to +15 V Low: -3 V to -15 V
Bearing output:	QDR

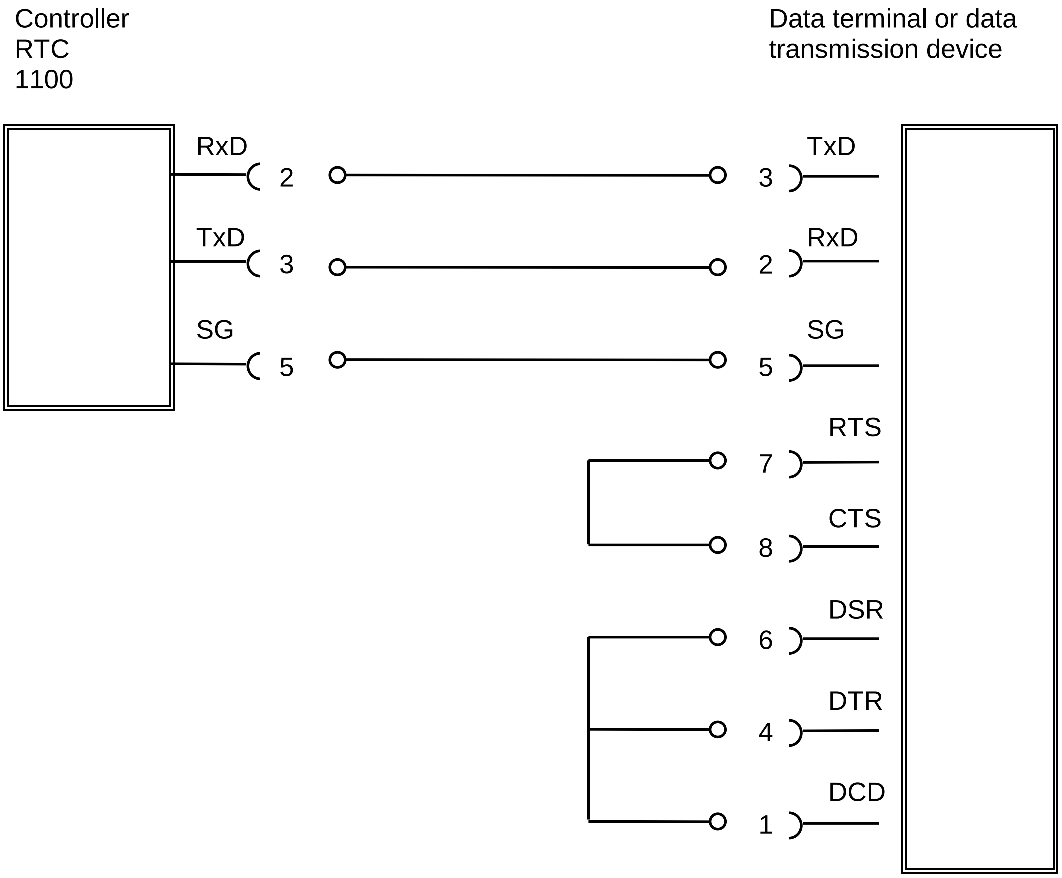
2.2.22.4 "Ser. Port" Plug Wiring (28)



Multipoint connector, 9-way
Type: D subminiature

PIN	Designation	Function	Input	Output
1	-	not wired		
2	RxD	Receive Data	X	
3	TxD	Transmit Data		X
4	-	not wired		
5	SG	Signal Ground		
6	-	not wired		
7	-	not wired		
8	-	not wired		
9	-	not wired		

2.2.22.5 Connection to a Data Terminal or Data Transmission Device



The plug wiring of the data terminal device applies for most PCs with 9-way D subminiature multipoint connectors. The terminal wiring is to be individually checked.

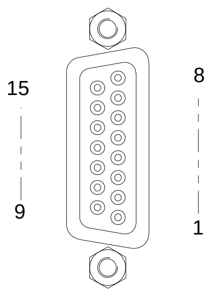
2.2.23 "Par. Port" Parallel Interface (29)

The parallel interface (29, Fig. 2-2) enables the transmission of bearing data to an external display or evaluation unit.

Data output is by means of nine data bits and a transfer signal. A signal is also available which indicates the availability of valid bearing data. In this case the determined QDR bearing (average) is output in binary form with positive 5 V logic (low = 0 V, high = 5 V). If no valid bearing is present (bearing signal off, D9-OUT is low), the D0 to D8-OUT outputs are high. The status of the data lines (D0 to D8-OUT) is valid only during the high phase of the transfer signal (STR1).

The repetition time is approximately 15 ms, i.e. approximately 66 bearings are output per second.

2.2.23.1 "Par. Port" Terminal Wiring (29)

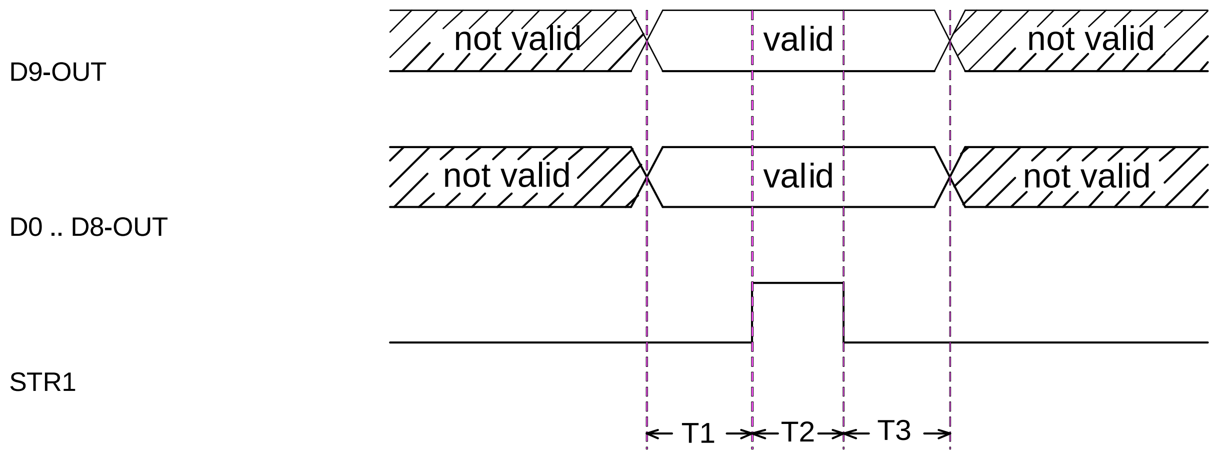


15-way female multipoint connector (29, Fig. 2-2)

Type: D subminiature

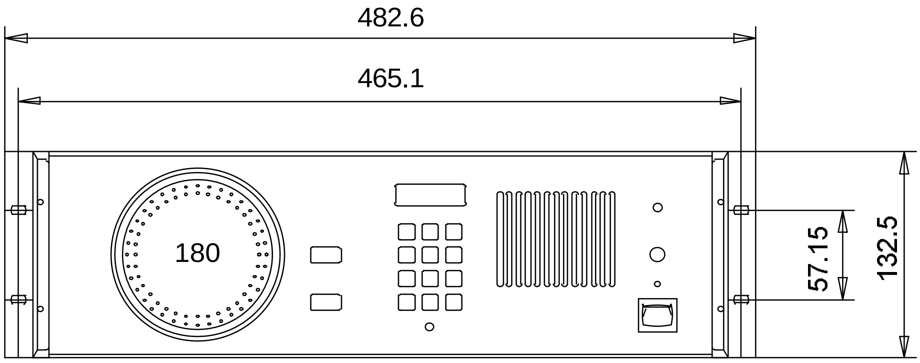
PIN	Designation	Function
1	+5V	+5-Volt supply
2	D1	Data bit 1
3	D3	Data bit 3
4	D5	Data bit 5
5	D7	Data bit 7
6	STR1	Transfer signal
7	D8-IN	No function
8	D8-OUT	Data bit 8
9	D0	Data bit 0
10	D2	Data bit 2
11	D4	Data bit 4
12	D6	Data bit 6
13	STR2	No function
14	D9-OUT	Bearing signal ON / OFF Low: OFF, High: ON
15	GND	Ground

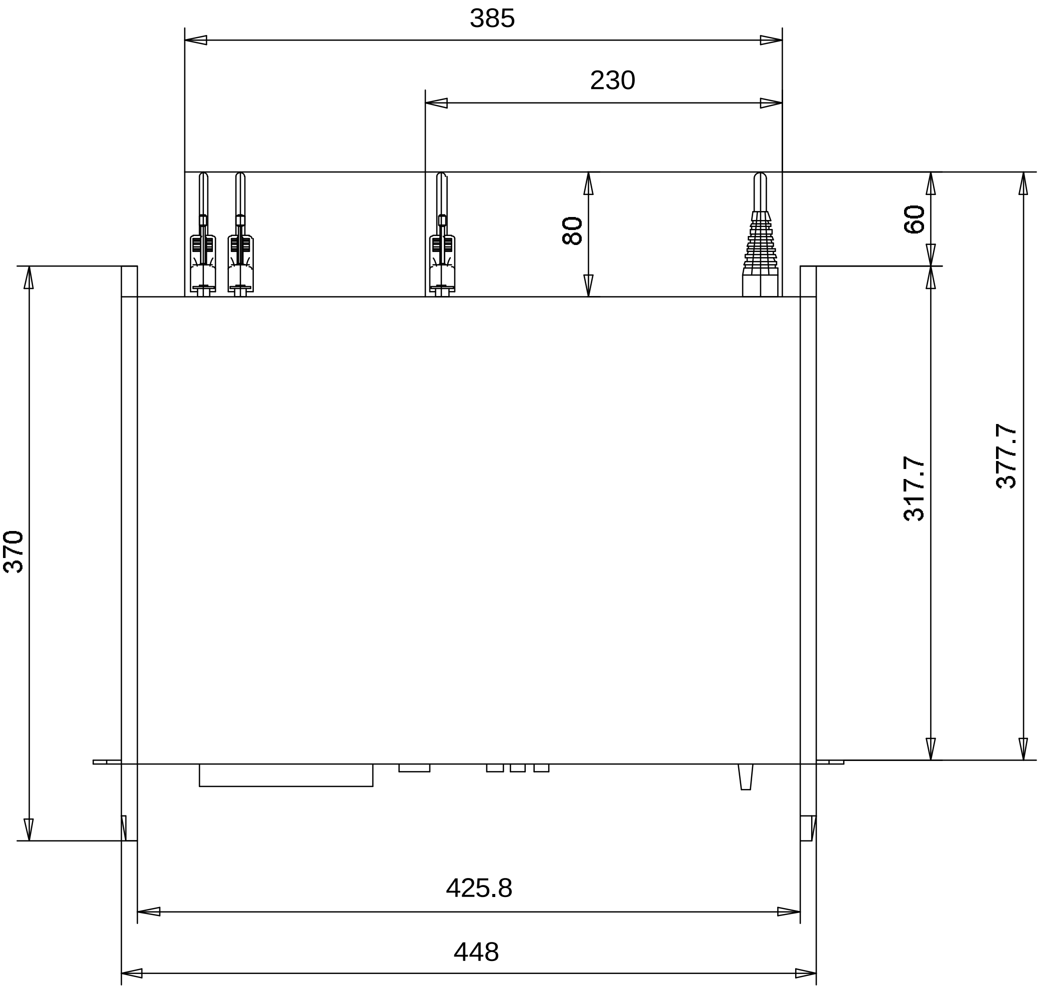
2.2.23.2 Time Sequence



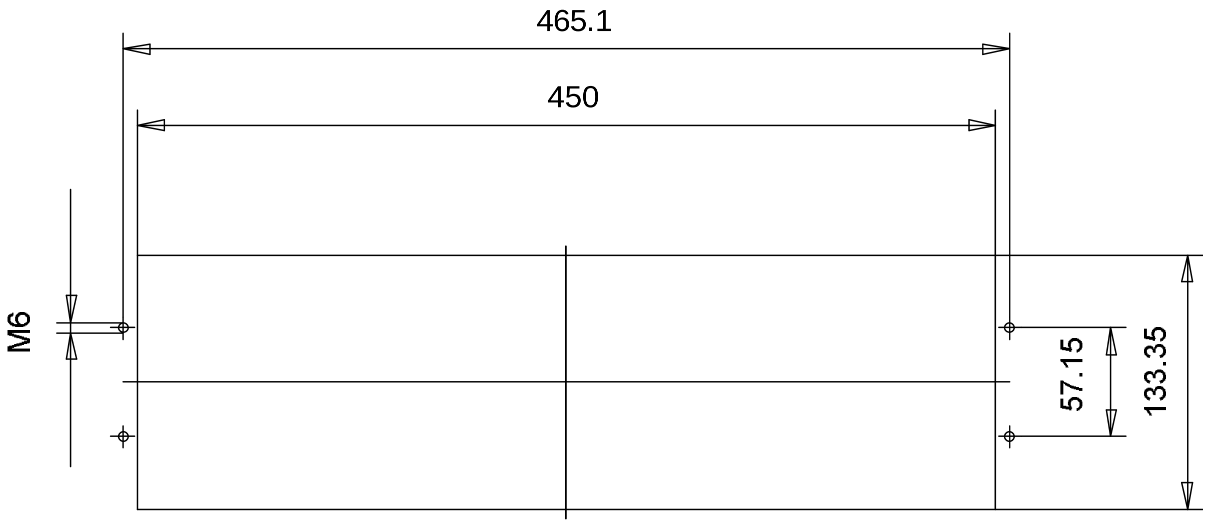
	min.	max.
T1	25 ms	---
T2	25 ms	35 ms
T3	25 ms	---

2.3 Installation Dimensions





Mounting Cutout



3 RECEIVER UNIT RTR 1200.A

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3.1 Front View of Receiver Unit

No.	Designation	Significance	see section
1	1401	Power supply module	
2	Antenna control	Plug for connection of dummy antenna	3.3.2.8
3	R/L off	Test button (R/L off)	3.3.2.7
4	1201	Antenna control module	
5	No Sync	Control lamp for error in receiver	3.3.2.6
6	F+, F-	Control lamp, frequency deviation positive, negative	3.3.2.5
7	Sql	Control lamp for receiver squelch	3.3.2.4
8	1204	Receiver module	
9	IF	Receiver test jack	
10	Power	Control lamp receiver supply voltage	3.3.2.1
11	1205	Receiver interface	
12	Frequency	Receiver display	
13	Remote/Local	Switch remote operation or manual for test purposes	3.3.2.9.1
14	↑	Button for upward frequency change in local mode	3.3.2.9.3
15	↓	Button for downward frequency change in local mode	3.3.2.9.3
16	Mode	Button without function	
17	Level/Fre-quency/Special	Switch for level or frequency indication	3.3.2.9.2
18	Sql	Slot for manual squelch adjustment	3.3.2.9.4
19	X16	BNC jack for RF antenna signal	3.2.5
20	X5	Antenna control terminal strip	
21	X15	Antenna control connection	3.2.5
22	X4	Data signals terminal strip	3.2.6
23		Data cable bushing	3.2.6
24		Data cable	3.2.6
25	X3	Power supply terminal strip	
26	F6	Fuse for DC heating (Option)	
27	F5	Fuse for 24-V power supply	3.2.4
28		Dummy cover for additional cable bushing	
29	F4	Fuse: receiver unit	3.2.2
30	F3	Fuse: receiver unit	3.2.2
31	F2	Fuse: receiver unit and AC heating	3.2.2
32	F1	Fuse: receiver unit and AC heating	3.2.2
33		Mains power cable	

No.	Designation	Significance	see section
34		Mains power cable bushing	
35	⏚	Earth connection screw	3.2.5
36	Power Select 115/230V	Mains voltage selector	3.2.1
37	OK +5V,+15V, -15V	Power supply control lamp	3.3.2.2

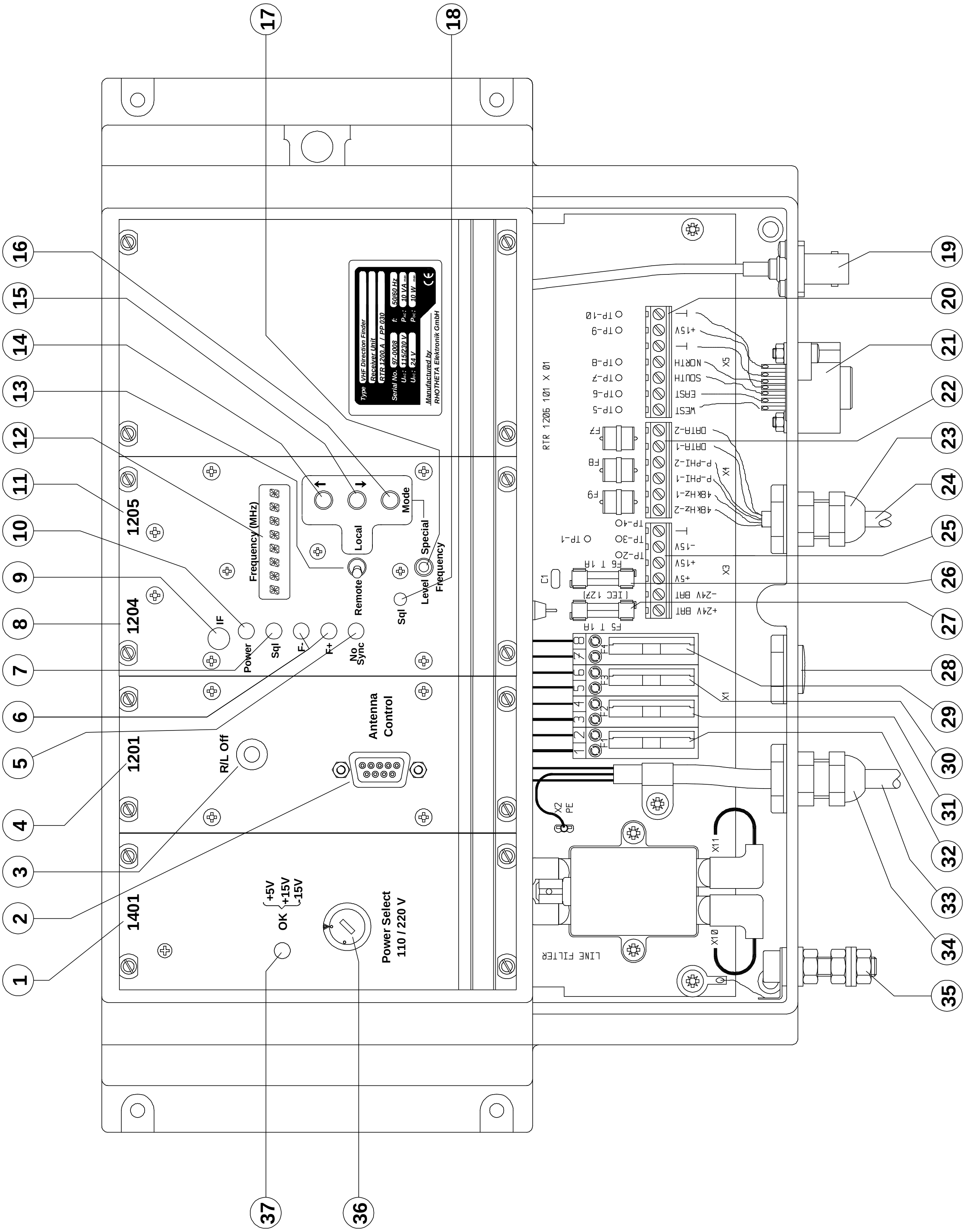


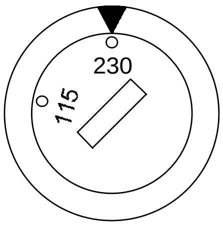
Fig 3-1 Front view of receiver unit

3.2 Preparation for Use

3.2.1 Setting the Mains Voltage

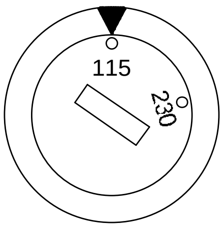
The RTR 1200 Receiver Unit can be operated on 115 V or 230 V (± 15 %) mains voltage. The unit is factory-set for a mains power supply of 230 V.

Before using the unit, check that the correct operating voltage range is set. Use a slot screw-driver to move the mains voltage selector (39, Fig. 3-1). This selector is on the front panel of the RTX 1401 (01) Power Pack module.



Selector position for 230-Volt range:

Permissible operating voltages: V_{min} = 195.5 V_{rms}
V_{max} = 264.5 V_{rms}



Selector position for 115-Volt range:

Permissible operating voltages: V_{min} = 97.75 V_{rms}
V_{max} = 132.25 V_{rms}

Bild 3-2 Mains voltage selector

In addition, make sure mains voltage fuses F2 and F3 are correct for mains voltage range selected (see section 3.2.2).

WARNING:

If the mains voltage selector is not set correctly, the unit may be damaged beyond repair.

3.2.2 Mains Fuses

Before beginning to use the unit, check that the correct fuses are fitted and are appropriate for the operating voltage range selected.

The fuses are underneath the switch box cover of the housing. Remove the cover by loosening the three fixing screws.

Designation	No.	115-V range	230-V range
F1 AC heating and receiver unit	35	IEC 127T500H/250V (500 mA, slow-blow)	IEC 127T500H/250V (500 mA, slow-blow)
F2 AC heating and receiver unit	34	IEC 127T500H/250V (500 mA, slow-blow)	IEC 127T500H/250V (500 mA, slow-blow)
F3 Receiver unit	33	IEC 127T315H/250V (315 mA, slow-blow)	IEC 127T160H/250V (160 mA, slow-blow)
F4 Receiver unit	31	IEC 127T315H/250V (315 mA, slow-blow)	IEC 127T160H/250V (160 mA, slow-blow)

3.2.3 DC Supply Connection

The RTR 1200 Receiver Unit is fitted with a DC supply connection. This allows the unit to be operated using batteries or a 24 V DC mains connection.

For DC supply, replace dummy panel (28, Fig. 3-1) by the included cable bushing. Then insert the DC supply cable through the cable bushing and screw in. To guarantee correct sealing of the cable bushing, use a 2-core round cable with an external diameter of 3 - 6.5 mm. Select appropriate conductor cross-section for 2 A continuous current.

Connect the cable to terminal strip (25), marked X3. Connect the positive voltage pole to X3.1 and the negative to X3.2.
If mains voltage is present, power supply will always be off the mains. However, if mains voltage is interrupted, the power supply module switches automatically over to DC supply. Since Receiver Unit RTR 1200 can only be switched off by separation from the supply voltages, a suitable switching device is required for the DC voltage supply facility.

Allocation of terminals:

Terminal	Designation	No.	DC voltage source
X3.1	+24V BAT	28	Positive pole: +24 VDC
X3.2	-24V BAT	28	Negative pole 0 V earth

3.2.4 DC Fuse

The DC voltage input is protected by fuse F5 (27, Fig. 3-1).

Designation	No.	Type
F5 DC voltage supply	30	IEC 127T1.0H/250V (1 A, slow-blow)

Input voltage range:

V_{min} = 21.5 V
V_{max} = 29.0 V

WARNING:

Voltages greater than 30 V may lead to the unit being damaged beyond repair.

3.2.5 Connection of RTA 1300 Direction Finder Antenna

The RTA 1300 Direction Finder Antenna is connected to the receiver unit via an RF and control cable, each.

Ensure that the antenna mast is well earthed and that there is also a low impedance and low inductivity connection between the RTR 1200 Receiver Unit earth screw (35, Fig. 3-1) and earth potential. Ensure that all applicable safety guidelines are observed.

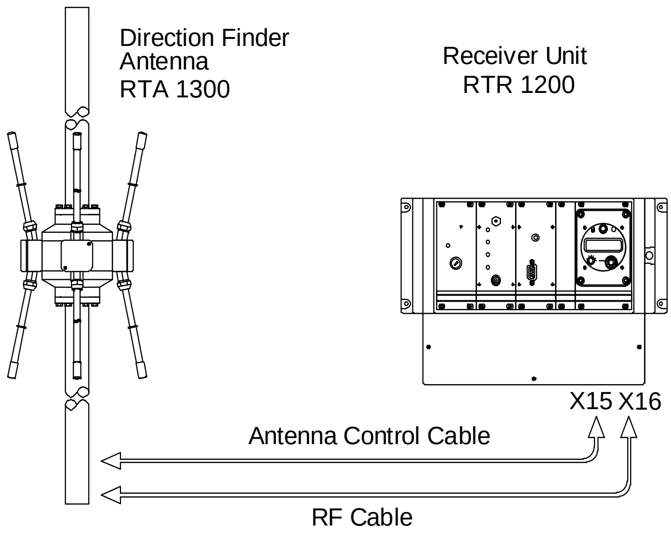


Fig. 3-3 Antenna connection

Plug	No.	Signal name	Cable
X15	24	Control signal	Control cable
X16	22	RF signal	RF cable

X15 antenna control plug (21) pin allocation:

PIN-No.	Signal
1	NORTH
2	SOUTH
3	WEST
4	EAST
5	Ground
6	+15V
PE	Screen

X15 plug (No. 21)

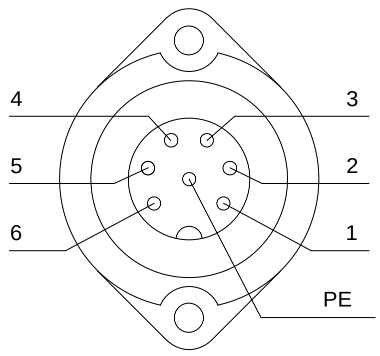


Fig. 3-4 Plug for control cable

3.2.6 Controller / Receiver Unit Data Connection

The RTR 1200 Receiver Unit is connected to the controller via a communications cable with three pairs of wires. This cable is used to transmit the bearing signal, a reference signal, the AF (speech) signal and data signals for receiver control and errors signalling.

Cable type e.g.: **A-2Y (L) 2Y ... x2 x0,6 St III Bd**

At the receiver unit end, the data cable (24. Fig. 3-1) is inserted through the housing bushing (23) and screwed in. The individual pairs of wires are connected to terminal strip X4 (22). Fit a 25-pole D-Sub plug to the controller end of the cable. Then plug the cable into the "data port" on the line interface (module RTC 1103).

Connection plan for data cable:

Terminal strip X4 (25) Receiver unit		Signal	D-Sub plug controller
Terminal	Name		Terminal No.
X 4.1	48 kHz-2	48 kHz-2	12
X 4.2	48 kHz-1	48 kHz-1	10
X 4.3	P-PHI-1	P-PHI-1	2
X 4.4	P-PHI-2	P-PHI-2	4
X 4.5	DATA-1	DATA-1	5
X 4.6	DATA-2	DATA-2	8

The matched signals DATA-1 and DATA-2, P-PHI-1 and P-PHI-2 and 48kHz-1 and 48kHz-2 are assigned to one pair of wires each in the communications cable.

If the communications cable used as the data cable is of the star-quad type (i.e. the four wires of two pairs are twisted together), the signals DATA-1,2 and 48kHz-1,2 are to be assigned to one and the same star-quad (see section 5.2).

3.2.7 Setting the Receiver

The Bearing Receiver is integrated in the Receiver Module RTR 1204/1205 (Fig. 3-1) which also contains the receiver interface. Both units are set correctly at the factory. Nevertheless, before using the direction finder for the first time, all settings should be checked once again.

Setting of receiver:

- Move Remote/Local switch (13) to Remote position.

3.3 Using the RTR 1200 Receiver Unit

Once all checks listed in section 3.2 have been carried out, the receiver unit can be used.

3.3.1 Switching on the Receiver Unit

The receiver unit is switched on by plugging the mains cable into the mains. Ensure that the socket for the mains connection is close to the receiver unit and can be reached at any time to enable the unit to be immediately disconnected from the mains if necessary.

The RTR 1200 Receiver Unit is designed for continuous operation. To preclude incorrect operation, the receiver unit is not provided with its own mains switch. If a shut-down facility is required, an external mains switch, e.g. at the controller position, is to be provided. It must be noted that at low temperatures a warm-up phase lasting up to 30 minutes may be possible after switching on the receiver unit.

3.3.2 Switch-on Reaction, Operation, Control Equipment

The receiver unit is designed for remote operation. The unit is operated by remote control using the RTC 1100 A Controller (see section 2). All relevant control functions and indications are transmitted to the controller via the data cable and evaluated in the controller. The indications and settings on the receiver unit are present only for test purposes if the unit has to be serviced and for carrying out function checks on the whole system.

3.3.2.1 Receiver Self-test

After the receiver unit has been switched on, an automatic test of the receiver display (17, Fig.3-1) is started. This involves the numerical series 188,88 flashing for approximately 4 secs. Following this, the last frequency set appears.

3.3.2.2 Power Supply OK Control Lamp

After switching on, the green control lamp (40, Fig. 3-1) of the Power Supply module RTX 1400 (01) lights up. This shows that the power supply module is functioning correctly.

3.3.2.3 CD Data Transmission Control Lamp

After switching on, the green control lamp (04, Fig. 3-1) of the demodulator module (06) lights up. The CD control lamp (04) shows that the data link between the controller and receiver unit is functioning correctly. This lamp only lights up if there is no fault in the data cable and it is connected to the controller and the controller is switched on.

3.3.2.4 Squelch Muting Control Lamp

The yellow squelch control lamp (07, Fig. 3-1) lights up as soon as a signal of sufficient strength is received. This shows that a bearing signal and speech signal is being transmitted to the controller.

3.3.2.5 f-, f+ Deviation Recognition Control Lamps

The red control lamps (02, Fig. 3-1) and (03) light up when a signal with a frequency deviation larger than ± 5 kHz is received. This shows that a signal is being received which is not suitable for direction finding purposes.

3.3.2.6 DF Signal 1 Test Plug

For test purposes, the DF signal is available at the DF-signal 1 SMB plug (05, Fig. 3-1).

3.3.2.7 IF Intermediate Frequency Jack

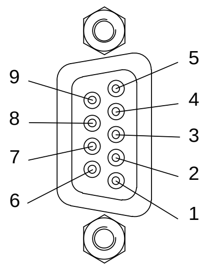
The intermediate frequency signal supplied by the receiver can be tapped at the IF BNC jack (08, Fig. 3-1).

3.3.2.8 R/L OFF Button

The R/L OFF button (10, Fig. 3-1) interrupts the right/left antenna rotation control. If this button is pressed and a received signal is present, the value 000° or 180° + north adjustment (set on the controller) appears on the QDM display of the controller.

3.3.2.9 Antenna Control Jack

The antenna control D-Sub jack (11, Fig. 3-1) is used to connect the RTM 1500 Dummy Antenna. The same signals are transmitted as at the antenna control connection (24). Additionally, the R/L signal is available.



PIN	Signal	Function
1	OST-X2	Antenna control signal, east
2	WEST-X2	Antenna control signal, west
3	GND	Ground
4	GND	Ground
5	+15V-X2	+15-V supply
6	SUED-X2	Antenna control signal, south
7	NORD-X2	Antenna control signal, north
8	R/L	Right/left rotation change-over signal
9	+15V-X2	+15-V supply

3.3.2.10 Receiver Operation

The receiver in Receiver Module RTR 1204 (14, Fig. 3-1) is controlled exclusively by the controller in normal operation (receiver setting as described in section 3.2.7). If a different operating mode is required for test purposes or if the unit has to be serviced, the receiver can also be manually adjusted.

3.3.2.10.1 ON/OFF Switch

OFF position:	Receiver is switched off.
ON position:	Receiver is switched on, receiver operates without muting (squelch) → control lamp (07) is continuously illuminated.
SQ position:	Receiver is switched on, muting (squelch) is active.

3.3.2.10.2 VOL Volume Control

The amplitude of the AF output signal (voice signal) can be altered using volume control VOL (15, Fig. 3-1).

3.3.2.10.3 Frequency Selection Switches

In normal operation, the frequency selection switches (18, Fig 3-1) and (19) are not active because each frequency adjustment is immediately corrected by the receiver interface electronic control unit. If a frequency modification is nevertheless required, the data cable to the controller must be interrupted and the receiver unit briefly switched off.

Use the frequency selection switches (18) and (19) to change the frequency in 25 kHz and 1 MHz steps.The frequency set appears on the receiver display (17).

3.3.2.10.4 Channel Selection Switch

The channel selection switch (20, Fig. 3-1) can be used to call up four receive frequencies stored in a non-volatile memory. The current frequency appears on the receiver display (17). If a stored frequency is called up by moving the channel selection switch to position 1, 2, 3 or 4, the error code "ERR 9" appears on the controller frequency display.

3.3.2.10.5 Store Button

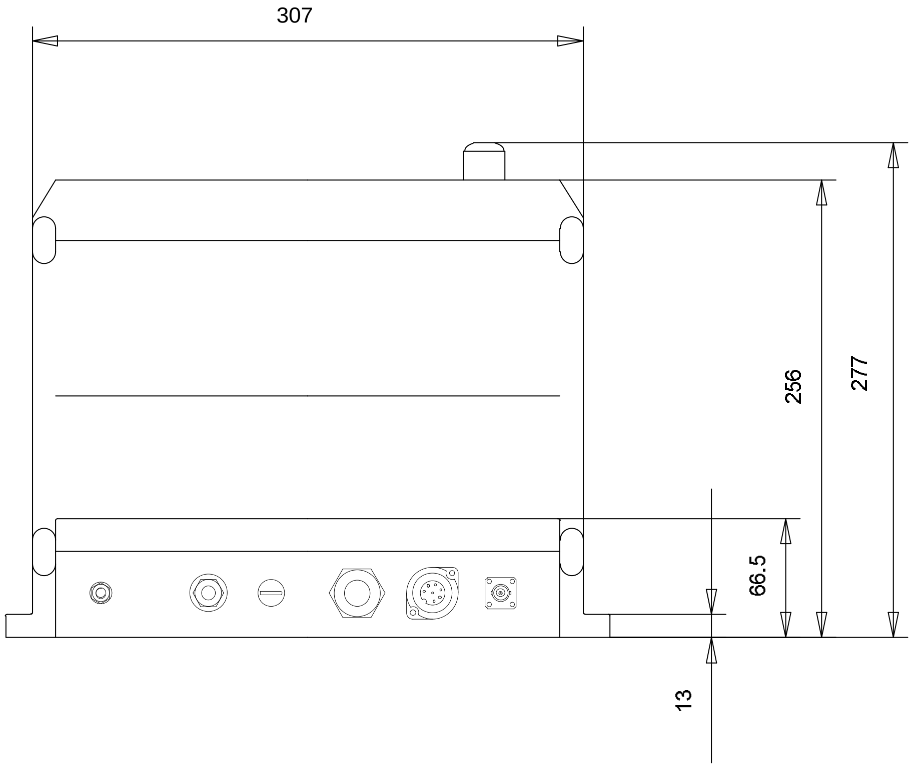
Press the Store button (16, Fig. 3-1) when the channel selection switch is in position A to store the displayed frequency on the receiver display in one of the four non-volatile channel memories.

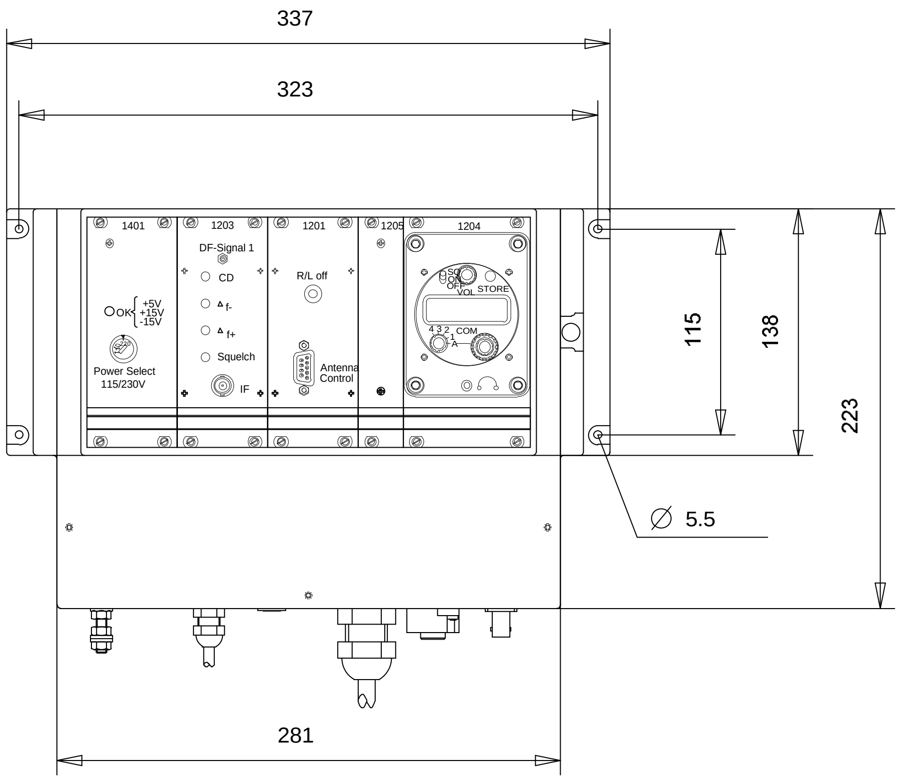
– Move channel selection switch (20) to position A.
– Set the required frequency using the controller or as described above.
– Move channel switch (20) to the channel in which the new frequency is to be stored.
– Press the Store button (16) and hold down until the frequency to be stored appears on the receiver display (17).
– The frequency is now stored.

3.3.2.11 Headphones Jack

Plug headphones or a loudspeaker into the headphones jack (21, Fig. 3-1) to listen to the voice signal.

3.4 Installation Dimensions





4 DIRECTION FINDER ANTENNA RTA 1300.A

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4.1 Set-up Notes

Normally, the major factor concerning radio reception is to transmit music, speech and pictures without distortion. How and by what route the radio waves get from the transmitter to the receiver is of little importance.

However, everyone must have realized that although when using a portable radio, medium wave reception (0.5 to 1.5 MHz = wavelength λ = 600 m to 200 m) is hardly affected by the position and environment of the receiver, but excellent VHF reception (87 to 102 MHz = $\lambda \approx$ 3 m) depends heavily on the position and direction of the rod antenna.

Moving the radio even fractions of 1 m is decisive in this case as can be heard from radio reception in a traffic jam. Such reception changes are even more noticeable with portable television sets using rod antennas to receive UHF broadcasts. In this case, the wavelengths are approx. 0.5 m.

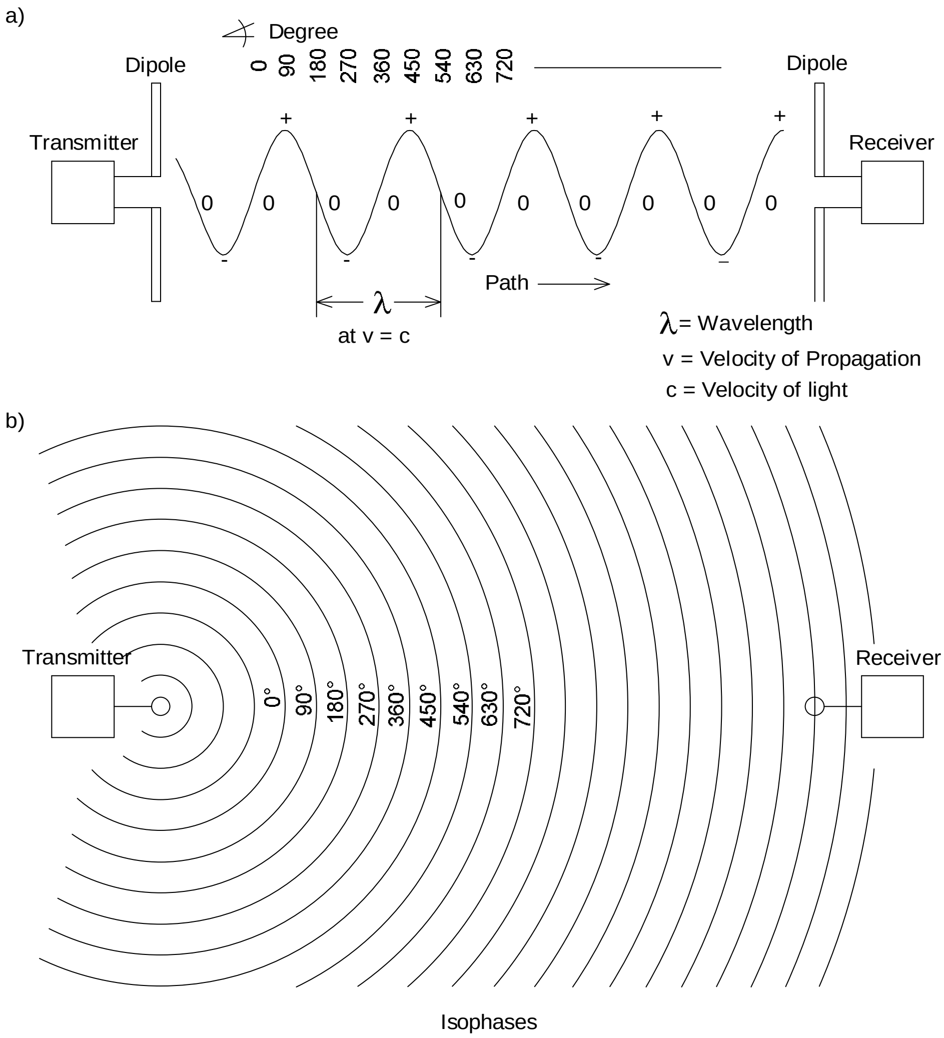


Fig. 4-1 Free-space propagation of radio waves

The cause of these effects is the propagation behaviour of electro-magnetic waves. Figure 4-1 gives an extremely simplified representation of even radio wave propagation in free space. The sine wave in Part a) corresponds to the instantaneous value of the electric field on the plane path to the receiver. Part b) is the vertical projection of Part a). The circles represent the lines of equal phase relations for even waves.

If the distance between transmitter and receiver is adequate, these are practically straight lines when they reach the receiver location. Such an idealized situation is not to be found in built-up areas, and especially not in mountainous regions. In such areas, the propagation path is obstructed by obstacles, mirror reflectors, diffuse reflectors with and without absorption characteristics, diffracting edges and resonators. Reflectors and conducting rods are effective as resonators if their size is approximately that of the wavelength to be received. Therefore, reflections increase as wavelengths become shorter, diffractions at edges however are reduced and so the effect of shadowing obstacles is more important.

Accordingly, the propagation characteristics of radio waves from approximately $\lambda < 10$ m increasingly resemble those of light. Coming back to VHF radio and UHF television reception using portable units with antenna, it is almost impossible in urban areas to find the actual direction of the transmitter by adjusting the antenna.

At a wavelength of 1 m to 3 m, wave propagation requires a direct path and if this is not available, only reflected waves are received. In urban areas, these may come from several directions simultaneously. But that is not all: the mostly horizontal or vertical plane polarized waves propagated by the transmitter are also rotated to a certain degree due to diffuse reflectors and diffracting edges. When the wave arrives at the receiver, it may be oblique, elliptically, or even circular polarized. This fact becomes apparent by the often curious antenna positions which are necessary to obtain the best reception of radio or television waves.

These points are meant to indicate that in the VHF, UHF range, direction finding of a stationary transmitter using a stationary direction finder in a built-up area or even inside a building is practically impossible.

Conditions at airports are much more favourable. These instructions are intended to allow the best positioning of the direction finder antenna.

Of course, airports are not without their reflectors, but these do not normally cause noticeable problems. All direction finders with field probes calculate the angle of signal incidence by finding out the path direction (vector), at which the largest phase modification per unit of distance is present.

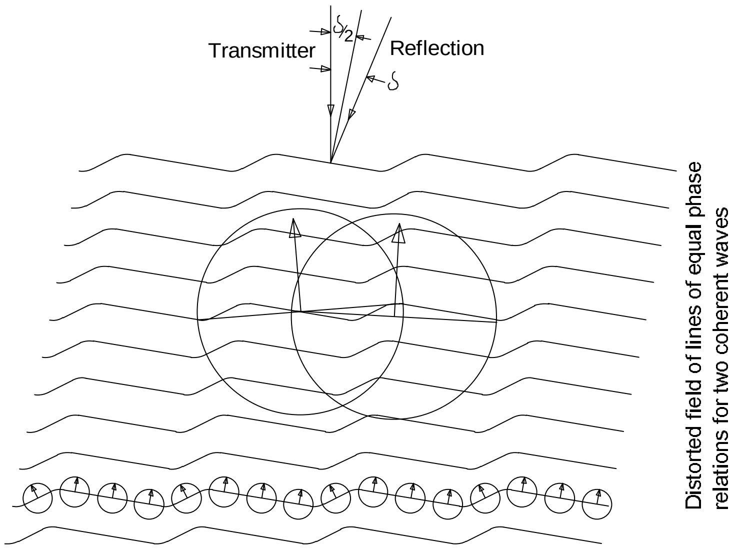
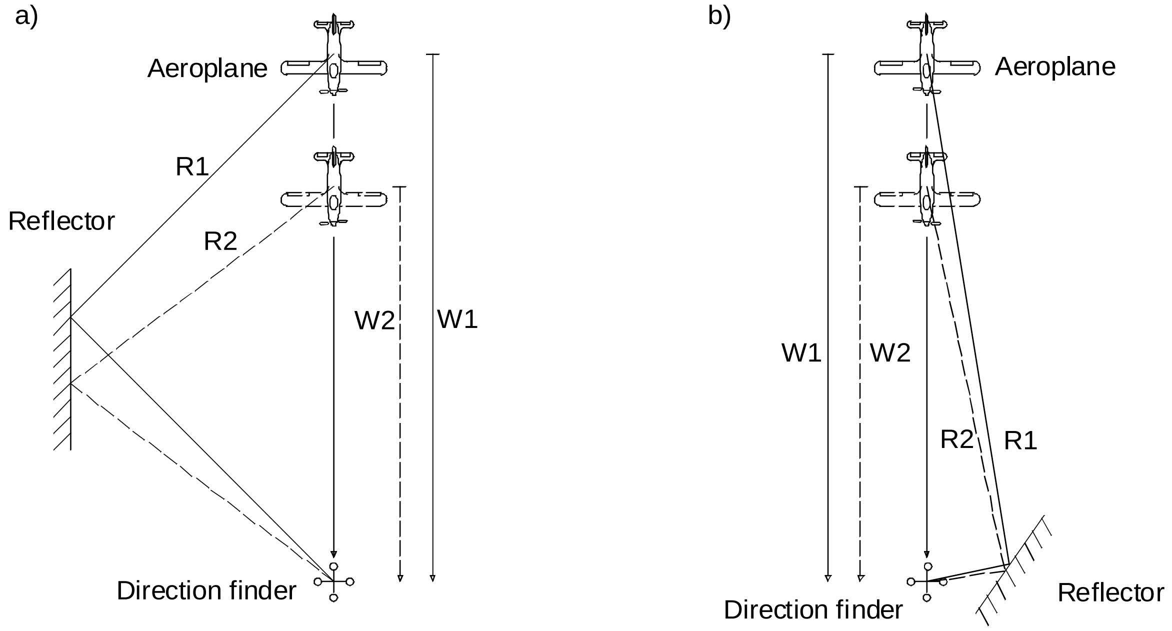


Fig. 4-2 Field of lines of equal phase relations for two coherent waves

In Figure 4-1 this vector is vertical to the lines of equal phase relations. Figure 4-2 shows the distorted field of lines of equal phase relations for two coherent waves (reflection) from different directions with different field strengths.

The advantage of wide base direction finders is most noticeable in static conditions. Static conditions indicate that the position of the transmitter and direction finder as well as the transmitter frequency does not change with time. Should one of the three named items change (e.g. transmitter in aeroplane) the direction finder antenna and the field of lines of equal phase relations begin to move in relation to one another. This movement accelerates in proportion to the relationship between the reflected path distance and the direct path distance of the radio wave (Figure 4-3).

As shown in Figure 4-2, this movement in the case of wide base direction finders causes slight azimuth oscillation. In contrast, this oscillation is larger in the case of narrow base direction finders - the series of small circles in Figure 4-2. When several values are averaged out however, both systems give the same azimuth.



favourable:

$W1/W2 \gg R1/R2$

unfavourable:

$W1/W2 \approx R1/R2$

With moving transmitter:

Rapid phase shifting between W and R signal, therefore good bearing average possible

Only very slow phase shifting between W and R signal, so no averaging possible. The displayed bearing oscillates slowly around the rated value.

Fig. 4-3 Reflected path distance and direct path distance of the radio wave

The following conclusions can be drawn:

Vertical reflector surfaces e.g. buildings, hangars, metal fences, metal masts, overhead lines as well as bushes and trees should not be within 100 m of the direction finder antenna if possible.

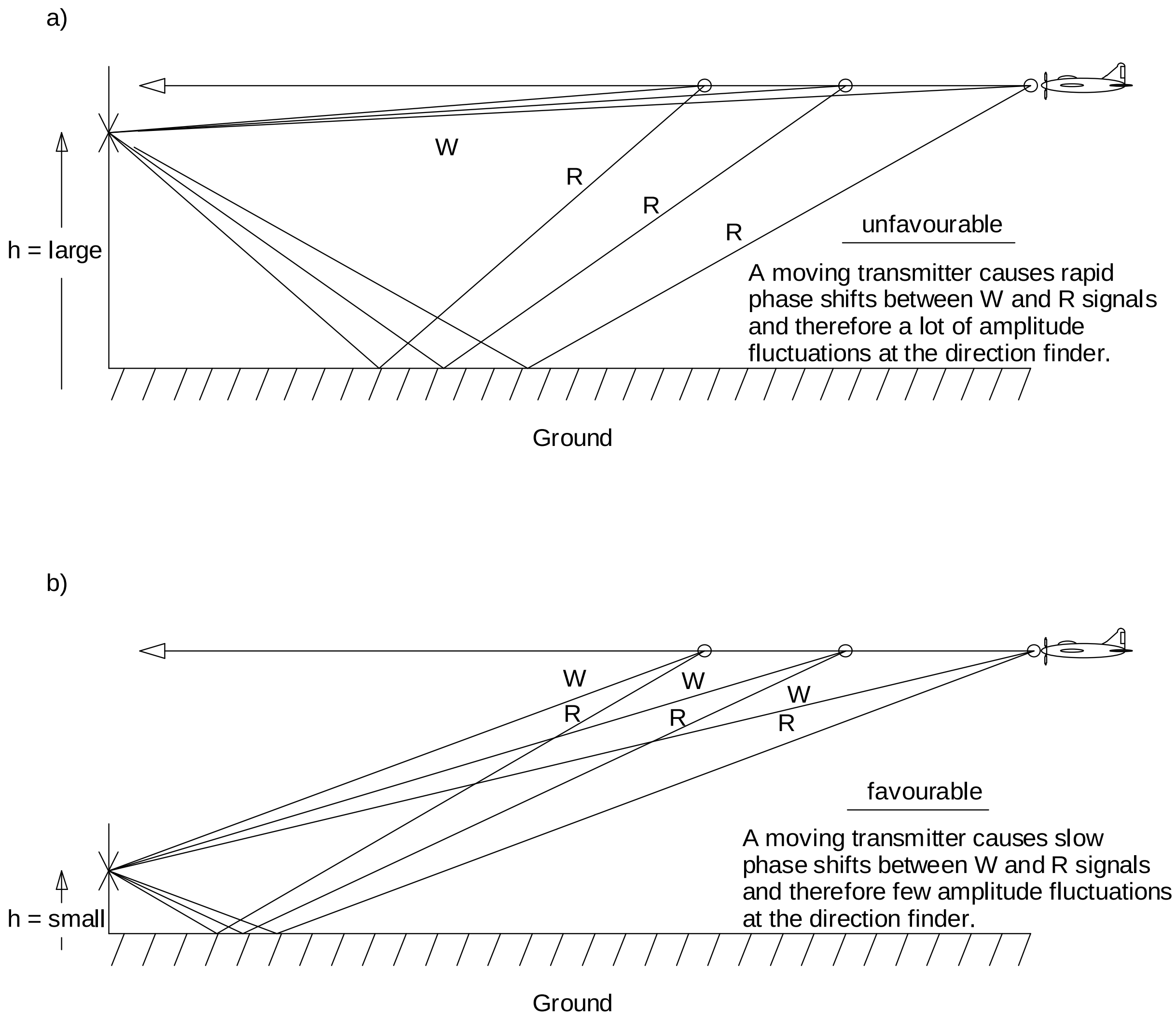


Fig. 4-4 The phases between a direct wave W and reflected wave R

Ground reflection causes a special problem. Reflections from an ideal, level ground surface around the direction finder antenna do not actually lead to errors in direction finding, but dependent on the angle of elevation, lead to field strength indentations which with ideal ground reflection may go down to zero.

It must now also be mentioned that reflections of course influence the reception level, after all this is the critical factor in VHF radio reception. Because the resulting reception field strength at the direction finder antenna is made up of the vectorial addition of direct and reflected beams, the phase relation between both signals is critical.

Figure 4-4 shows that if the transmitter is moving (e.g. aeroplane), the phases between a direct wave W and reflected wave R should shift as slowly as possible in relation to the movement of the transmitter.
This is exactly the opposite of requirements for vertical reflectors! The following conclusions can be drawn: the horizontal reflector should be as near as possible to the direction finder antenna.

In other words the antenna should be fixed close to the ground. Figure 4-5 shows the signal strength lobes plotted against angle of elevation for antenna heights 23 m and 3.5 m.

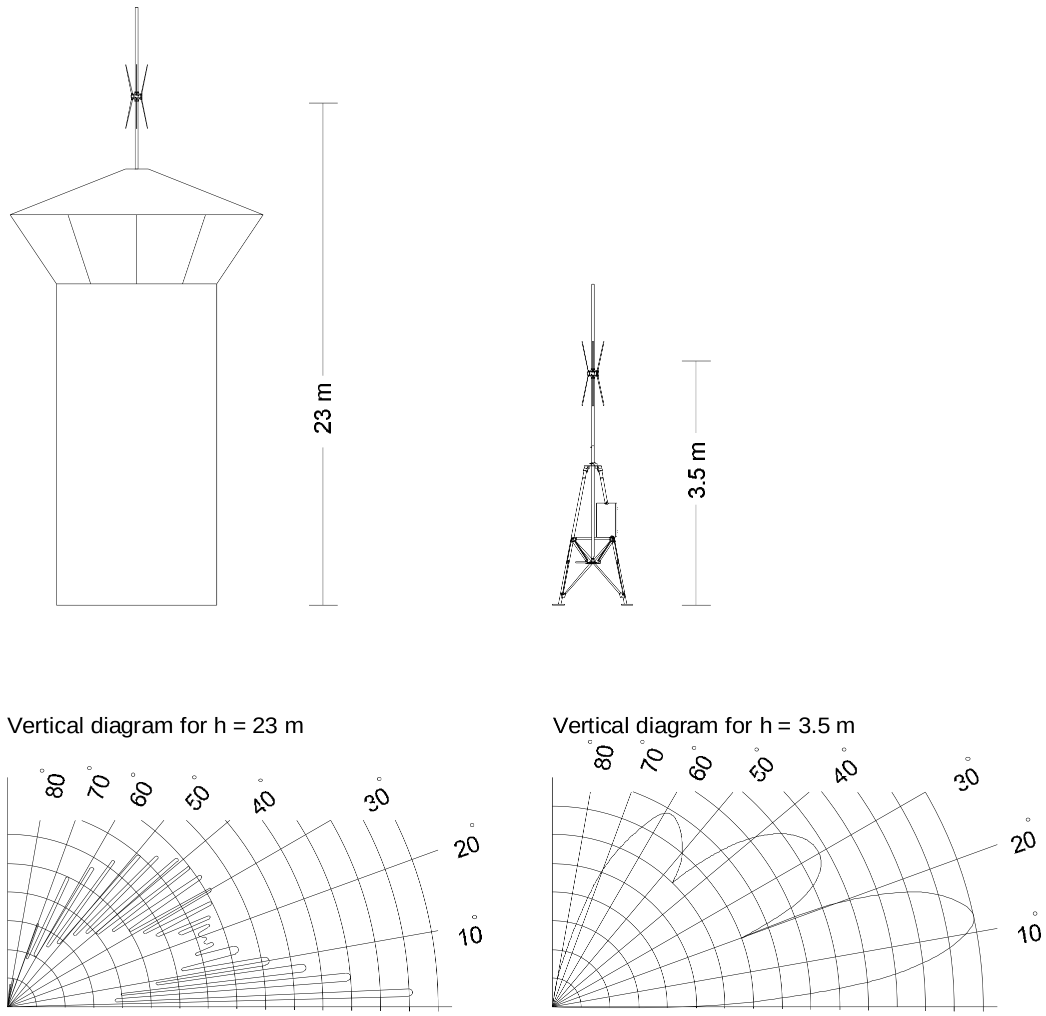


Fig. 4-5 Signal strength lobes plotted against angle of elevation

The following conclusion may be drawn:

The best position for a direction finder antenna is on a flat surface at a distance from vertical reflectors, only 3.5 to 4 m above the ground.

For reasons of cost, we often receive the request that the direction finder antenna should be put on the roof of the tower containing the direction finder equipment. Such requests must be handled on a strictly case-to-case basis.

This position on top of the tower may be successful if the surrounding area forms a very absorbent diffuse reflector, e.g. wood, grassed runways, wooden hangars covered with roof tiles, bushes. In contrast, lakes, rivers, concrete runways, flat tin roofs, a high ground-water level, i.e. all surfaces which are mirror reflectors make the tower an unsuitable set-up position.

Particular problems are caused by sloping tin roofs because their reflections are not in the azimuth and so can be expected to cause bearing errors. Wide base direction finders are more susceptible to the field strength being cancelled out (see Figure 4-5) than narrow base direction finders because the gaps in the area diagram are severely limited and so the probability that individual dipoles will be affected by this rises as the base area increases.

In order to carry out checking and acceptance, the direction finder is subjected to a "flight test" (Figure 4-6). By means of circular flights approx. 5 to 10 km away, the angular accuracy and influences due to vertical reflectors are calculated. These circular flights should be carried out in both directions in order to eliminate any possible "lag error" in the direction finder display. The aeroplane is tracked using a theodolite erected next to the direction finder antenna and angle values from this are compared with those from the direction finder display.

During the criss-cross flights, the aeroplane flies across the direction finder from various directions to find out detrimental ground reflections and the cone of silence, the area above the direction finder where no usable information can be gained from the direction finder. These over-flight measurements are especially important for testing the usefulness of a direction finder antenna set-up on the tower.

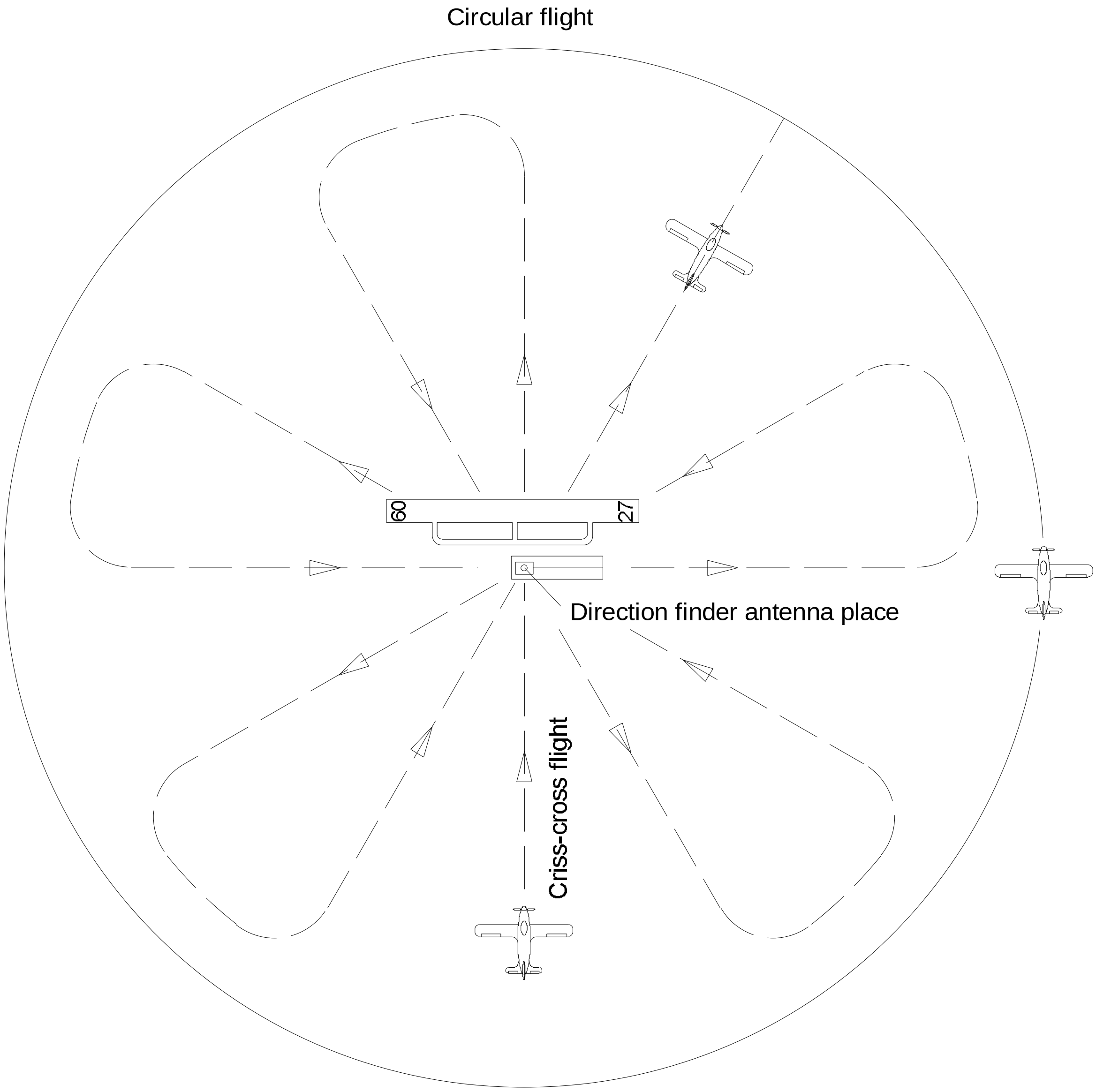


Fig. 4-6 Surveying the direction finder using criss-cross and circular flights

In conclusion: if the direction finder antenna is positioned in an open area a few metres above the ground and several 100 m away from reflecting obstacles, results will be satisfactory. If the antenna is set up on buildings more than 10 m above the ground, problems are likely and before such a position is definitively selected, it is most important to test the position by means of criss-cross over-flights.

4.2 Notes on Fig. 4-7 a/b, RTA 1300 A Direction Finder Antenna

No.	Designation	Function
1		Lightning conductor rod
2		Radiator cover
3		Radiator
4		Clamping nut
5		Radiator flange
6		Antenna head
7		North dipole label
8		Mast tube
9	X 21	Flat plug for control cable connection
10	X 13	Flat plug for control cable connection
11	X 17	Flat plug for control cable connection
12	X 15	Flat plug for control cable connection
13	X 19	Flat plug for control cable connection
14		Radiator housing
15		BNC jack for antenna cable
16		Cord grip
17	X 22	Flat plug for control cable connection
18		Radiator housing cover

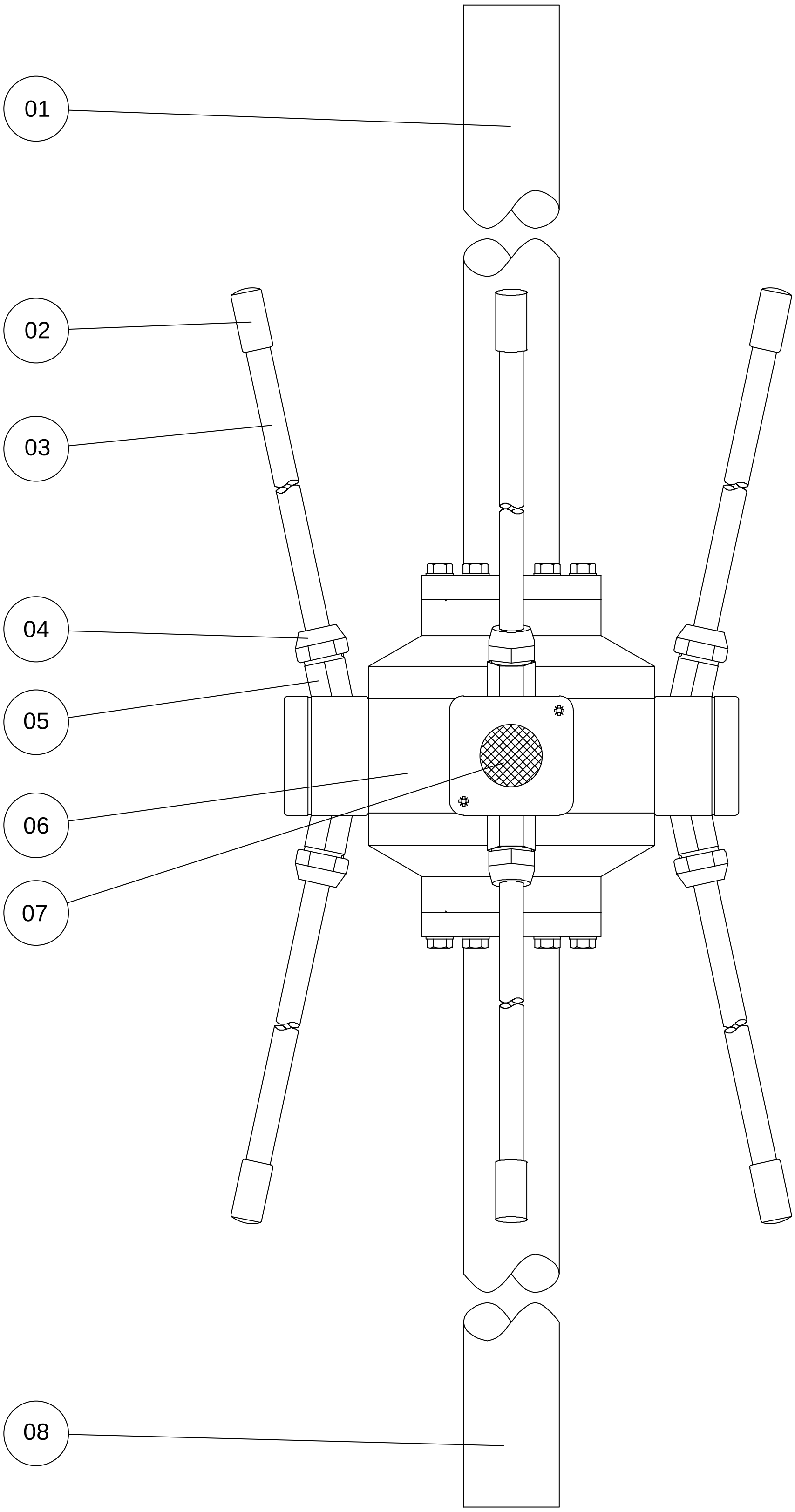


Fig. 4-7a RTA 1300.A Direction Finder Antenna

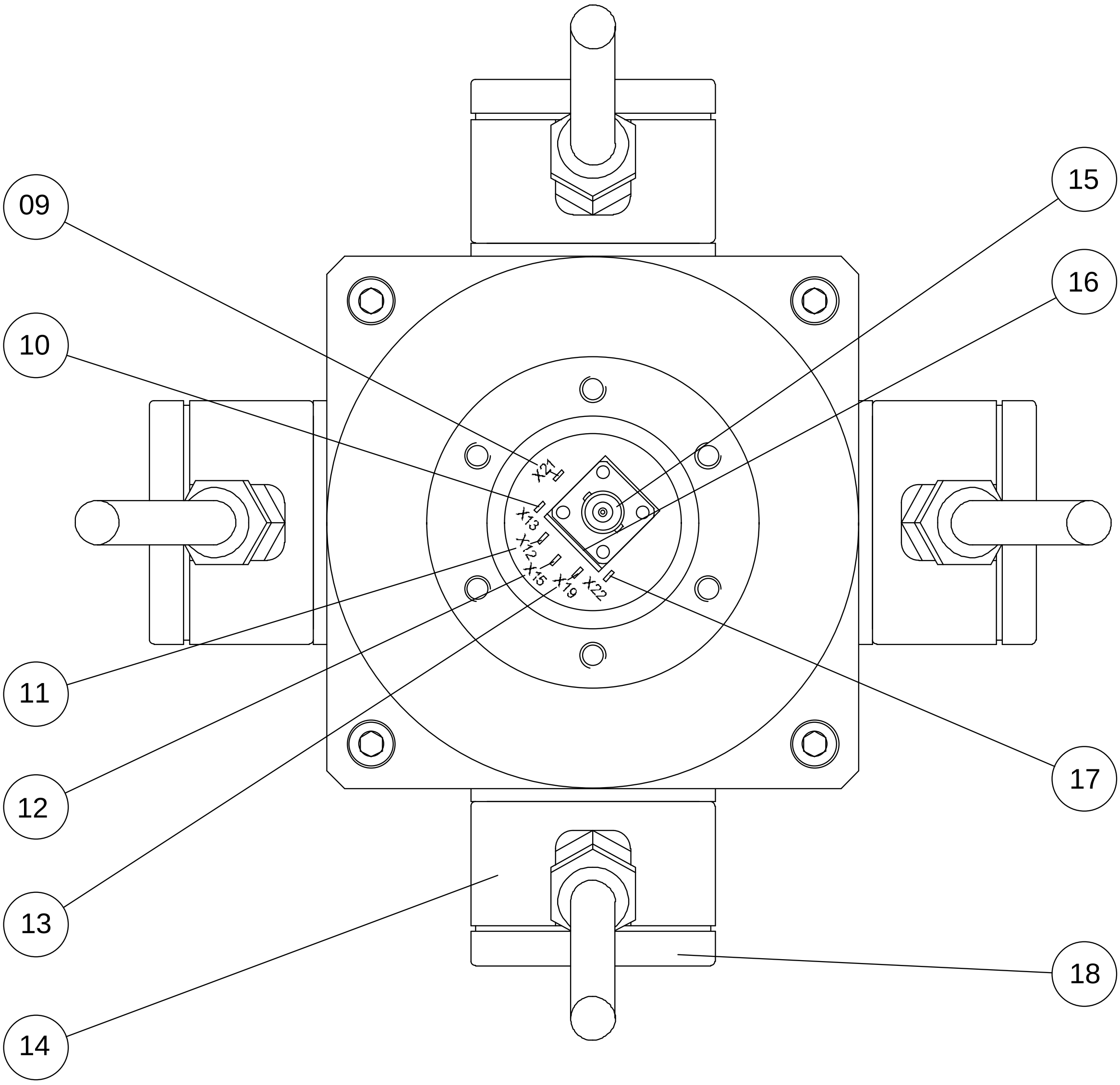


Fig. 4-7b RTA 1300.A Direction Finder Antenna (bottom view)

4.3 Assembly Instructions

1. Fit O-ring on mast tube.
   (see Figure 4-8).

2. Pull antenna cable through mast tube.

3. Connect RF cable.

4. Screw cord grip tight to clamp RF cable

5. Plug the control cable into the connection board.
   - Push back guard sockets.
   - Using pointed flat-nose pliers, grip the flat plug covers and push fully onto the flat plugs.
   - Push guard sockets back on again.

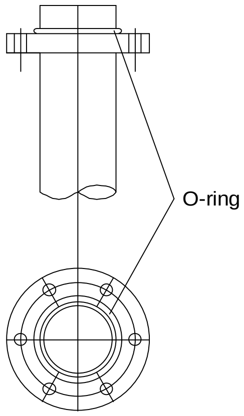


Fig. 4-8
Fitting O-ring

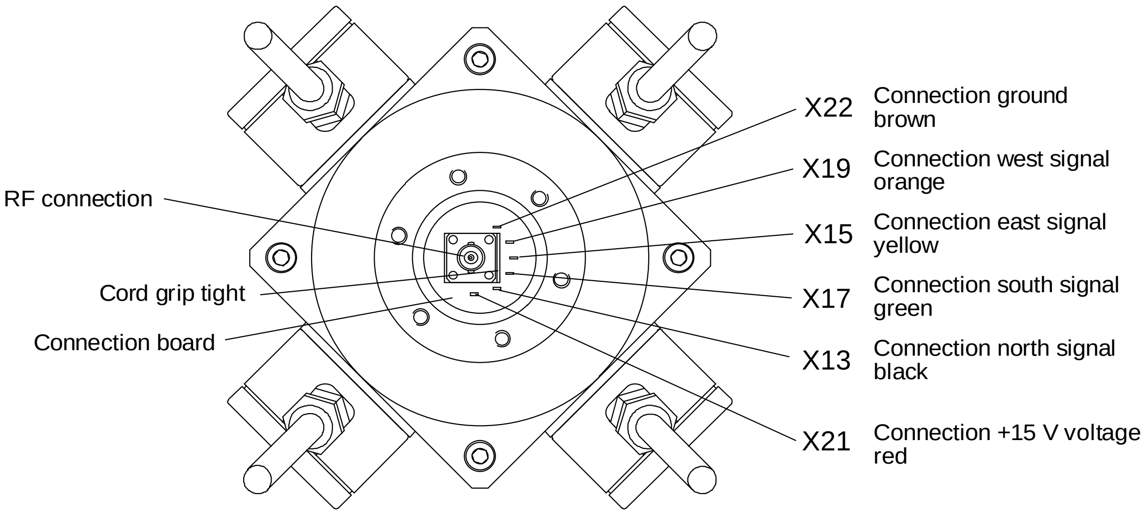


Fig. 4-9 Allocation of connections

Allocation of connections

Flat plug name,	Control cable colour	Signal
X22 (GND)	brown	Earth
X13 (NORTH)	black	North dipole control current
X17 (SOUTH)	green	South dipole control current
X15 (EAST)	yellow	East dipole control current
X19 (WEST)	orange	West dipole control current
X21 (+15 V)	red	15-V supply voltage

6. Apply a thin coat of grease to the antenna head / mast tube contact faces.

7. Screw antenna head onto mast tube.

8. Fit O-ring to lightning conductor rod (see Fig. 4-8).

9. Apply thin coat of grease to antenna head / lightning conductor rod contact faces.

10. Screw lightning conductor rod onto antenna head.

11. Fix radiators (see Fig. 4-10).
    - Push clamping nut, clamping cone, washer and rubber seal onto radiator.
    - Push radiator fully into recess for radiator.
    - Carefully tighten clamping nuts.

12. Erect mast tube (if not already done).

13. Earth mast tube.

14. Align antenna
    - Point north dipole (marked by red point on radiator housing) northwards.

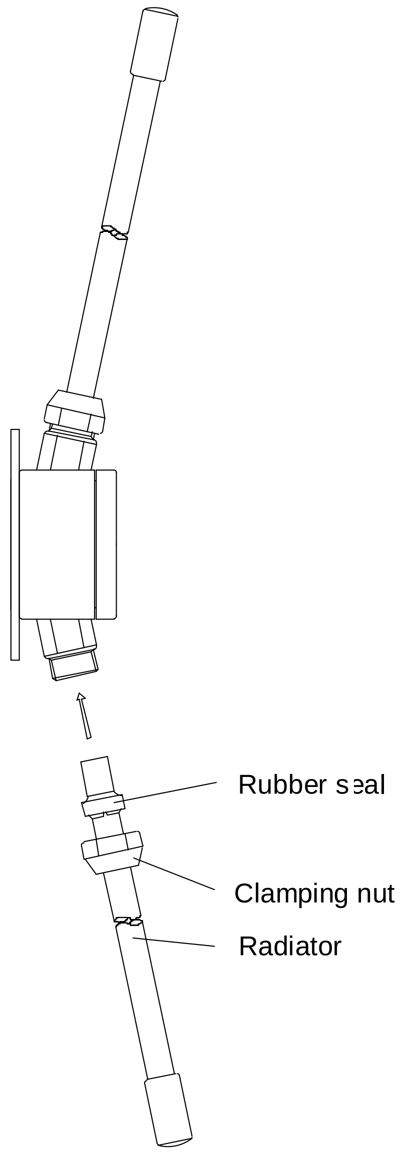


Fig. 4-10 Assembly of radiators

> **<u>WARNING</u>:**
>
> **Observe all appropriate guidelines, especially VDE regulations when conducting all building work, installation of electrical equipment and lightning protection measures.**

4.4 North Alignment of the Direction Finder Antenna and Determining the System Accuracy at the Installation Site

The north alignment is used to harmonize the angle determined by the direction finder with the actual (magnetic) north-related azimuth values.

4.4.1 North Alignment Using a Ground Transmitter (Presetting)

Presetting, which requires further correction by the north adjustment on the controller in the ± 90 range (resolution 0.5°) as described in section 2.2.10, i s achieved by the mechanical alignment of the direction finder antenna.

Nevertheless, the setting of the antenna should be carried out as accurately as possible since this makes subsequent measurements easier.

Procedure:

a) Mount the direction finder antenna on the antenna mast so that it is free to rotate. Point the marked dipole to the north. For the RTA 1306 Antenna Mast, loosen the clamping screws provided for the purpose.

b) Switch on the direction finding system. Set the north adjustment to zero. Carry out a phase adjustment (refer to section 2.2.9).

c) Set up a transmitter at an adequate distance (at least 100 m). From there, use a compass to determine the direction to the direction finder antenna.

Caution : When measuring using the compass, ensure that during the measurement there are no objects (transmitters, cars..) in the vicinity of the compass which could affect the magnetic field.

d) Activate the transmitter and transmit a continuous signal.

Caution : When transmitting with a monopole antenna (e.g. a hand held RT unit), care must be taken due to undefinable radiation conditions to ensure that the antenna is as free as possible from disturbance, i.e. vertically installed.

For hand held radio units it is advisable to hold the unit above your head. In this case the antenna points vertically upwards (refer to Fig. 4-11).

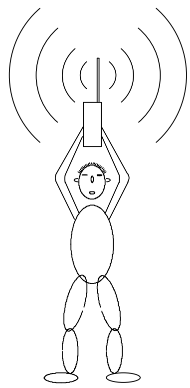


Fig. 4-11 Setting up the ground transmitter

e) Rotate the direction finder antenna in the mast mounting until the controller, which is set to the transmitter frequency, indicates the QDM value determined by the compass (set the north adjustment to zero). In this case correcting the antenna setting by rotating clockwise (viewed from above the single dipole moves in the north -- east -- south -- west direction) reduces the indicated QDM value, a counter-clockwise rotation causes an increase.

Caution : The direction finder antenna should be rotated slowly with pauses because a considerable lag error occurs in the determination in the direction finding unit. For the final adjustment, the person rotating the antenna must move away from the antenna after each correction so as not to disturb the near field of the antenna and therefore influence the direction finding.

Caution : When carrying out the above measurements there must be no objects (vehicles, parking aircraft, buildings etc) in the vicinity of the transmitter or the direction finder which could disturb the wave propagation.

4.4.2 Flight Checking for Exact North Alignment and Determining the System Accuracy at the Installation Site

For exact north alignment under operating conditions and for determining the system accuracy at the actual installation site, a flight check should be carried out.

To do this, a continuous-signal transmitter is fitted in the aircraft, which then performs circular flights about the site of the direction finder. If the communication system of the aircraft is used as a transmitter, check beforehand whether this is suitable for continuous operation.

The radius of the circle and the flight speed shall be selected such that the "lag error" effect when determining the bearing is negligibly low. It must therefore be ensured that the angular velocity does not exceed 0.3°/s.

In the case of all flight checking measurements, it must be ensured that an adequate reception field strength is present at the site of the direction finder antenna. Because of the quasi-optical wave propagation characteristic of VHF signals, there must also be a theoretical sight contact to the transmitter. If the transmitter is masked by hills, mountains, buildings or woods, the direction finder antenna cannot evaluate the directly transmitted signal, but instead assesses a signal which reaches the direction finder antenna via reflections. This normally leads to considerable bearing errors.

The instantaneous position of the aircraft can be determined by tracking with a theodolite or using a GPS receiver on the aircraft.

4.4.2.1 Determining the Position Using a Theodolite

- Set up the theodolite in the immediate vicinity of the direction finder antenna, aligned with magnetic north.
- The calibration aircraft then flies a circular flight path around the direction finder antenna and transmits a continuous signal.
- Track the aircraft using a theodolite.
- If the aircraft flies through a 10° mark, report this from the theodolite to the controller (e.g. by radio).
- Record the instantaneous bearing at the controller.

4.4.2.2 Determining the Position Using a GPS Receiver

- Store the site coordinates of the direction finder antenna in the GPS receiver.
- During the circular flight around the direction finder antenna record the QDM values determined by the GPS receiver and transmit them by radio to the direction finder where they are then compared with the bearing.

4.4.2.3 Simplified Method

If no theodolite or GPS receiver is available, a simplified measuring procedure must be used at the actual antenna installation site to precisely north align the system and determine its accuracy.

Route points:

With this method, the calibration aircraft overflies prominent landmarks (route points) the position of which has been previously determined from conformal maps (scale approximately 1 : 200000). Note that the angular values determined using the map are relative to geographical north and must therefore be corrected with the magnetic declination.

As the aircraft overflies the route point this is transmitted by RT to the direction finder. At the direction finder the instantaneous bearing is recorded and compared with the desired value from the map. To achieve a constant bearing during the overflight, the aircraft must fly radially relative to the direction finder antenna, i.e. must fly either towards the direction finder antenna or away from it.

Due to the unavoidable errors when overflying, the route points chosen should be at least 10 km from the direction finder antenna (at a distance of 10 km a lateral offset of 175 m, with regard to the direction finder, when overflying the route point produces an error of 1°).

The PTT button should be pressed and held for at least 10 seconds before and after the overflight, to enable the "before" and "after" history of the direction finding to be evaluated.

4.4.3 Evaluation

The actual values measured by the direction finder (QDM bearings) are entered in a record for comparison with the desired values (theodolite bearings, GPS bearings, route points from the map).

4.4.3.1 Evaluation of Direction Finding Signal

To assess the fitness of the antenna site as accurately as possible and therefore assess the functioning of the direction finder system, the direction finding signal (DF signal) relevant for determining the bearing should be observed on an oscilloscope during the measurements. The signal can be taken from the "DF signal 2" test output on the rear of the controller. The right / left rotation signal at the "R/L" test output is used to trigger the oscilloscope. It is taken from the "R/L" test output on the rear of the controller. The connecting cables for the test outputs are contained in the RTM 1500 Service Kit or can be ordered from your dealer.

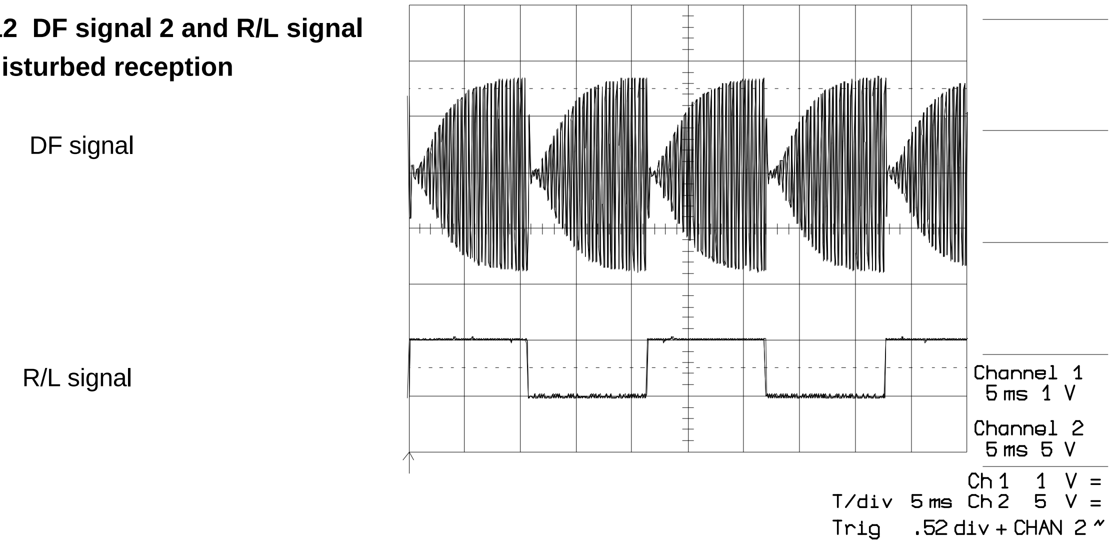
a) Where there is correct reception without reflections the bearing signal appears as shown in Figure 4-12.

- Both blocks, clockwise and counter-clockwise rotation, have the same amplitudes. The envelope curve of the oscillation increases steadily (in accordance with e function) and has no "dips".

- The blocks also experience no amplitude fluctuations over a long time period (5 seconds).

→ If the bearing signal has the above shape, it can be assumed that the bearing indicated by the controller is correct.

Fig. 4-12 DF signal 2 and R/L signal for undisturbed reception



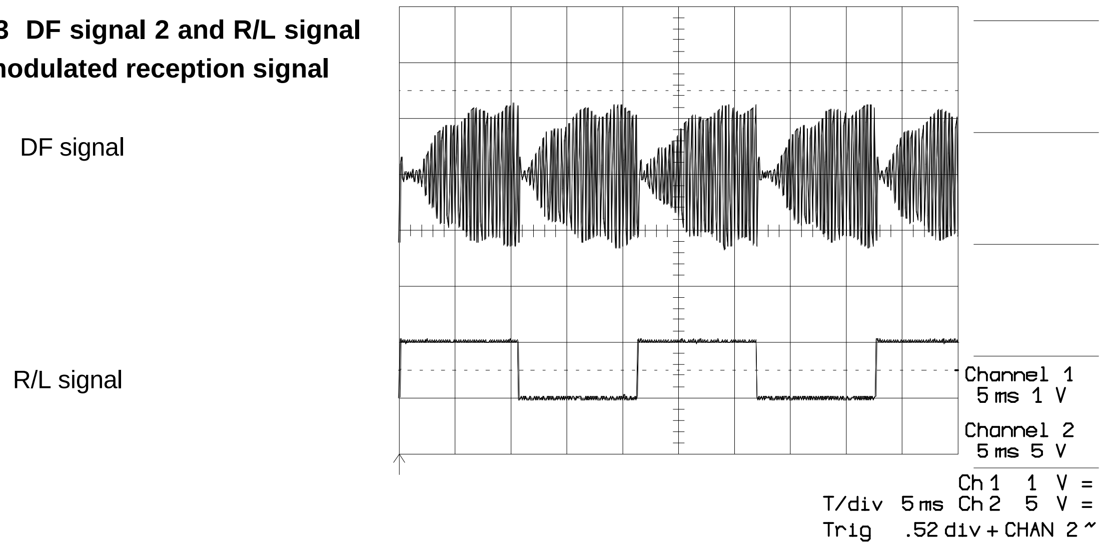
b) The amplitude of the bearing signal fluctuates within the individual blocks (refer to Fig 4-13). The fluctuation coincides with the rhythm of the audio signal.

Possible causes:

- the carrier is modulated (e.g. by speech)

→ has no influence on the bearing accuracy

Fig. 4-13 DF signal 2 and R/L signal with a modulated reception signal



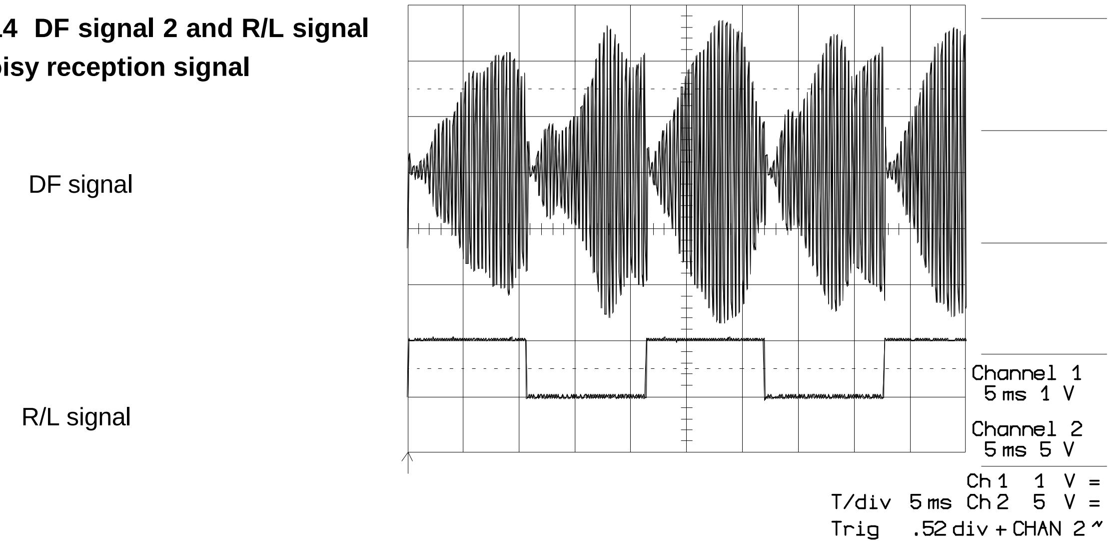
c) The direction finding signal is very noisy

Possible causes:

- The field strength of the transmission signal is too low.
- The transmitter is masked by hills, buildings, forests etc. There is no "theoretical" line of sight to the transmitter.

→ The direction finding looses accuracy or is distorted by the masking.

Fig. 4-14 DF signal 2 and R/L signal with noisy reception signal



d) - Amplitudes of clockwise rotation blocks or counter-clockwise rotation blocks "pump"

- The amplitudes of the clockwise rotation blocks and counter-clockwise rotation blocks are different

Possible causes:

- Effect of reflection

- Extreme flight manoeuvres of the calibration aircraft

- Jamming transmitter on same channel

e) Amplitude of R/L blocks is very large

- Effect of reflection

It is not possible to list all the possible disturbances and influences of direction finding signals here. As a rule it is assumed that if the direction finding signal is undisturbed the bearing shown by the controller is correct.

If the direction finding signal is observed during the complete circular flight, this provides a very good indication of the quality of the direction finding. This applies also for the azimuths at which no measuring points were recorded.

4.4.3.2 Evaluation of QDR Live Display (Green Light Dot Circle)

The QDR live display (green light dot circle) serves as a further criterium of the quality of the direction finding (including during every day operation).

During a circular flight the green light dot circle should "wander" steadily around the compass-card corresponding to the direction of movement of the aircraft. The green light dot circle display, because it is not averaged, precedes that of the red. The display jumps backwards and forwards between a maximum of two light dots.

Malfunctions which can be detected by the green light dot circle:

a) - Rapid jumping backwards and forwards (spreading out) of the light dots around the averaged value.

Possible causes:
→ Received power too low due to the long distance from the transmitter.
→ The transmitter is masked.

b) - During circular flight the light dots do not "wander" steadily around the compass-card, corresponding to the movement of the aircraft.

Possible causes:
→ Influence of reflections
→ Aircraft performs extreme flight manoeuvres
→ Jamming transmitter on same channel

c) - Light dots jump (spontaneously) backwards and forwards in large areas of the compass-card.

Possible cause:
→ Reflections

d) - Light dots jump backwards and forwards around the averaged value (red light dot) (spreading out).

Possible cause:
→ Reception signal is modulated. The spreading out area depends on the type and strength of the modulation.

4.4.3.3 Evaluation of Measuring Results

The deviations between the desired and actual values are entered in the test record compiled with the aid of the flight check. If in the case of a calibration aircraft the direction finding signal or the green light dot indication is evaluated, the observations made at the corresponding measured values are to be annotated. Bearing errors can be easily interpreted in this way. A test record of the following kind is obtained.

Example:

Test record

DESIRED	ACT	Deviation	Remarks
000°	000°	0°	
010°	011°	+1°	
020°	025°	+5°	Direction finding signal is nois y, indication fluctuates
030°	032°	+2°	
040°	041°	+1°	
050°	049°	-1°	
060°	060°	±0°	
070°	072°	+2°	
080°	083°	+3°	
090°	091°	+1°	
100°	099°	-1°	
110°	104°	-6°	Direction finding signal has amp litude fluctuations, display fluctuates by ±5°
120°	120°	±0°	
130°	131°	+1°	
140°	142°	+2°	
150°	150°	±0°	
160°	158°	-2°	
170°	170°	±0°	
180°	181°	+1°	
190°	189°	-1°	
200°	200°	±0°	
210°	217°	+7°	Direction finding signal "pumps" , green light dot circle ±20°
220°	222°	+2°	
230°	231°	+1°	
240°	240°	±0°	
250°	251°	+1°	
260°	259°	-1°	
270°	270°	±0°	
280°	280°	±0°	
290°	290°	±0°	

300°	302°	+2°
310°	311°	+1°
320°	319°	-1°
330°	330°	±0°
340°	343°	+3°
350°	351°	-1°

In the example, larger deviations occur when measuring for the 20°, 110° and 210° desired values. As can be seen by the evaluation of the direction finding signal and the green light dot circle, they are due to masking of the transmitter and reflections. The measurements are no longer taken into account in further assessment. If interference of this kind occurs, the site of the antenna is to be changed.

In the example, the deviations are in the -2° to +3 ° range. In practice, the deviations can be greater due to measuring uncertainties or reflections at the antenna site. The details of the system accuracy given in the section 1 technical data "System Accuracy" apply to reflection-free reception conditions at the antenna site but in practice such conditions are never found. Whether an antenna site is suitable must therefore be assessed in the light of the requirements of everyday operation.

4.4.4 Determining the North Correction

To determine the final north adjustment, the average value of the deviation is determined from the test record. To do this, the sum of all the different values (the signs must be taken into account) are added and divided by the number of measurements.

$$\text{average deviation} = \frac{\text{Sum of all deviations}}{\text{Number of measurements}}$$

Example:

$$+0.55^\circ = \frac{+\,18^\circ}{33}$$

In the example the direction finder has a bearing which is on average 0.55° too great. This can now be corrected with the aid of the north adjustment in steps of 0.5° (refer to section 2.2.10). The correct ion value to be set is obtained as follows:

Correction value = average deviation x (-1)

Example:

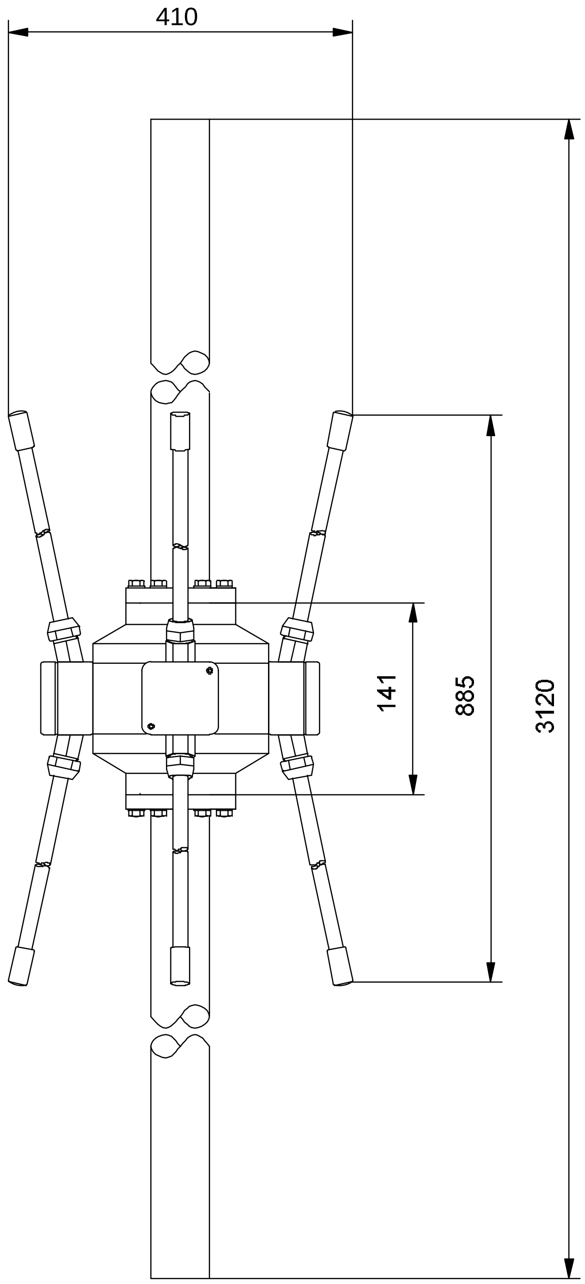
0.55 = 0.55 x (-1)

→ The value -0.5 is used as the correction value.

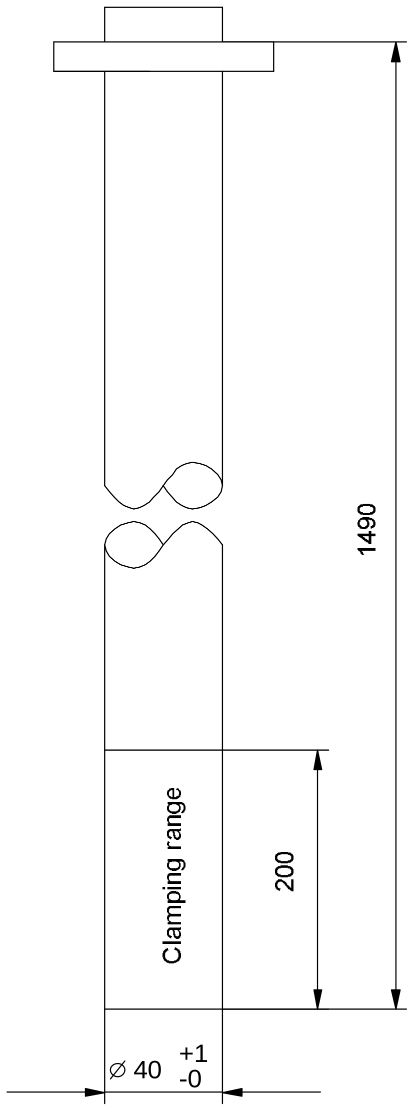
The direction finder system is now ready for operation but before the bearings can be transmitted to the aircraft approval by the relevant authorities in the respective country is necessary (refer also to section 5.1).

4.5 Installation Dimensions

RTA 1300 Direction Finding Antenna
with mast pole and lightning conductor rod



Mast pole



5 APPENDIX

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5.1 Approval of Direction Finder System

After successful installation of all components and north alignment of the direction finder antenna as described in section 4.4, the system is ready for operation. But before bearings may be transmitted to aircraft, approval from the appropriate authority must be obtained. This approval is regulated differently in every country.

5.1.1 Approval in the Federal Republic of Germany

In the Federal Republic of Germany fixed flight navigational radio stations can be registered and operated by natural or juristic persons only with the approval of the air traffic control authority responsible for the particular area (§ 81 LuftVZO).

To do this an "application for agreement and approval for the setting up, erection and operation of a fixed flight navigational radio station" is to be made to the appropriate air transport authority of the German Land. This application is to be obtained from the relevant Telecommunication Office/Superior Post Director or from the Federal Department for Post and Telecommunication.

After successful testing and acceptance by the Federal Institute for Flight Safety (BFS) (from 1993 German Flight Safety DFS), the Aviation Department issues the agreement.

The approval is issued by the Federal Department for Post and Telecommunication, Eschborn Branch Office through the local Telecommunication Office. A certificate is made out for this purpose.

(The details given refer to 1992. The right to make changes or deviations is reserved.)

CAUTION:

The direction finding system may only be brought into service after receipt of the certificate.

5.1.2 BFS Series Approval

The RT 1000 A/C Direction Finding System has the series approval of the "Federal Institute for Flight Safety" (BFS).

Series test number: B - 458/92 (for a copy of the approval certificate refer to section 5.1.6).

5.1.3 BZT Series Approval

The direction finder system is approved by the "Federal Department for Approval in Telecommunication" (BZT) :
Approval No: A102841C
Additional marking: LO
Refer to section 5.1.5 for a copy of the approval certificate.

<u>CAUTION</u>:

The series approval for the direction finding system by the BFS and by the BZT does not permit the setting up or operation of the system, but is instead a precondition for application for such approval.

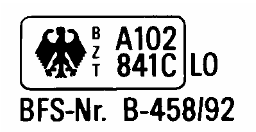
5.1.4 Approval Plate

The components of the RT 1000 A/C Direction Finder System are provided with plates which carry the approval number of the Federal Department for Approval in Telecommunication and the series test number of the Federal Institute for Flight Safety. These information plates must not be removed or covered.

They are fitted at the following positions of the system:

Controller:	on the bottom left of the front panel
Receiver unit:	on the bottom left of the clear view cover
Direction finding antenna:	on the antenna housing close to the radiator housing of the north radiator

Approval plate:



5.1.5 Approval Certificate BZT

Translation

FEDERAL OFFICE FOR LICENCES IN TELECOMMUNICATION

LICENCE

Licence No.:	A102841C
Add. Identifier:	LO
Name of Object:	RT 1000 (* = "A" or "C")
Licensee:	RHOTHETA Elektronik GmbH Unterfeldring 11 D-85256 Vierkirchen Pasenbach
Licence Type:	General Licence
Type of Object:	Stationary local VHF direction finder system

The approved object fully meets the technical regulations of Guideline FTZ 17 TR 2013, Issue June 1989.

The licence, dated 31-03-92, is no longer valid.

Saarbrücken, 21st of November 1994

Official stamp / Signature

1 item enclosed

5.1.6 Approval Certificate BFS

Translation

FEDERAL INSTITUTE FOR FLIGHT SAFETY

The VHF Small-range Doppler Direction Finder

Type RT 1000 (VAR A / C)

Frequency range 118.000 to 136.975 MHz

manufactured by Rhotheta, Schwarzfischer & Co. OHG, 8495 Roding

consists of: Antenna System RTA 1300.A, Receiver Unit RTR 1200.A,
Controller RTC 1200.A (B)

for Class of Emission: A3E, A2X (ELT modulation); bearing error ±2°

has been tested for compliance with the requirements laid down in the Technical Regulations of the Federal Institute for Flight Safety:

TV 201, Standard Specifications for automatic direction finder systems, extracts from Technical Regulations for direction finder systems used in flight communication.

The unit fully complies with the rules laid down by the Federal Institute for Flight Safety (BFS) in agreement with the Central Telecommunications Office (FTZ) of the German Federal Post, based on the Regulations for radio service of the international telecommunication treaty. The unit also meets the requirements of the Federal Ministers for Transport (BMV) and Postal and Telecommunication Affairs (BPM) as well as corresponding to the guidelines and recommendations of the International Civil Aviation Organisation (ICAO) for aeronautical telecommunications. Taking into account the conditions stated overleaf, it is therefore approved as sample for production and distribution in the Federal Republic of Germany.

The unit carries the series test No. B - 458 / 92.

Frankfurt / Main, 17th of March 1992

Signature / Official Stamp

T r a n s l a t i o n

CONDITIONS

1. Every unit carrying the FTZ series test number as well as the number on the front and designated RT 1000 (VAR A/C) must fully comply, both electrically and mechanically, with the sample tested by the Federal Institute for Flight Safety

2. Each change or addition to design or circuit of the unit deviating from the sample necessitates additional testing of this unit by the BFS.

3. Concerning the production of series units, complying with the sample, BFS reserves the right to carry out random tests of individual units.

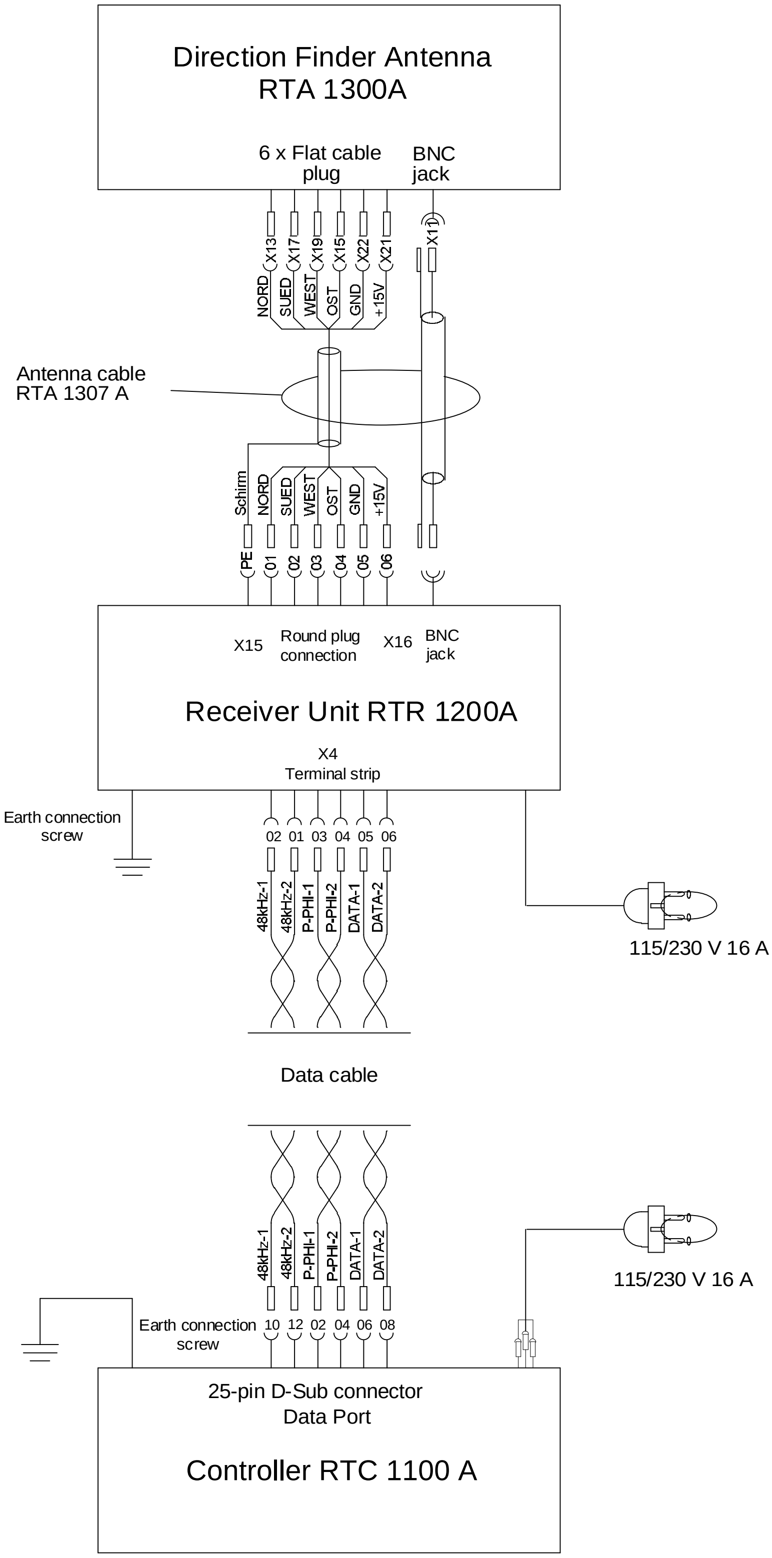
4. Permission to manufacture and distribute this unit becomes extinct after a period of five years. An extension can be granted. The extension must be applied for in writing six months prior to extinction.

5. This certificate in itself does not permit the unit to be taken into operation. Set-up and operation of radio facilities using this unit, even for demonstration purposes, depend upon a licence issued by the DBP (German Federal Post). Application is to be made to the BFS which will pass the forms on to FTZ with the request to issue the licence. The licence will be handed over to the applicant by the respective OPD (Oberpostdirektion)

6. The issued test certificate does not entitle the licensee to make any demands under patent law. It does not relieve the licensee in any way from observing the protective rights of others and does not include any protective claim as provided for under patent law.

7. The manufacturer himself is fully responsible for meeting any safety requirements, applicable to the unit, laid down in the VDE Regulations. The keeping of the VDE Regulations is not object of the sample test.

5.2 Interwiring of the Direction Finder RT 1000C



5.3 Test Record

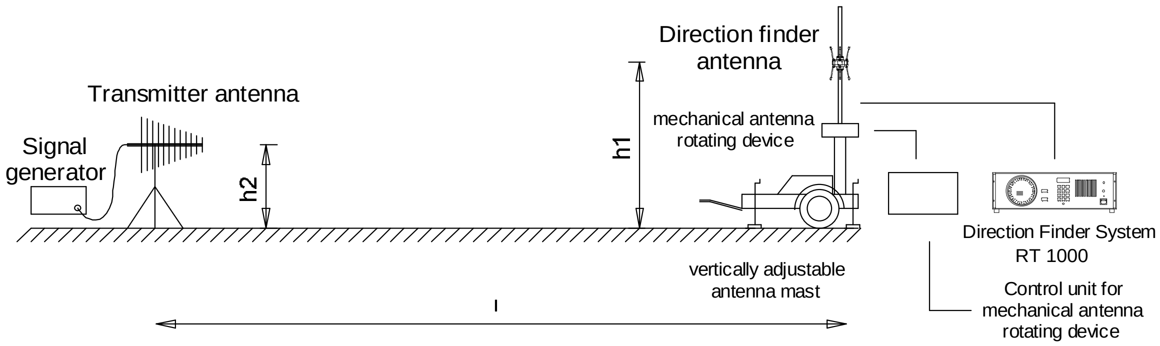
Test Record

1000.005 A 01 PP

1 Objective of test

To determine the direction finding accuracy and check the correct function of the complete system at different operating frequencies.

2 Test layout



h1 = 3.5 m, h2 = 3.5 m, l = 150 m

Signal generator	Rohde & Schwarz SMG-B2·802.0405.02
Transmitting antenna	Emco Model 3145
Antenna rotating device:	RHOTHETA
	Accuracy of setting: ± 0.3°

Direction finder

- The direction finder antenna is mounted on a height-adjustable mast which has a mechanical rotating device. With the aid of the rotating device, the direction finding antenna can be rotated about its vertical axis in 10° steps (1° steps).
- The direction finding antenna is connected to the RT 1000 Direction Finder System to be tested.
- There are no electromagnetic reflectors in the vicinity of the direction finder.

Transmitter

- The direction finding signal is radiated from a signal generator via a transmitting antenna.
- The transmitter is located at a distance l (l > 25 m) from the direction finder antenna.
- The transmitting signal is vertically polarised.
- There are no electromagnetic reflectors in the vicinity of the transmitter.

3 Preparation for test

- Reset the mechanical antenna rotating device to 0°.
- Plug the direction finder antenna into the support of the rotating device. The south dipole is aligned with the transmitting antenna.
- Switch on the transmitting signal. Select the level so that a sufficient field strength is available at the site of the direction finder antenna.
- Switch on the direction finder system and set the actual operating frequency on the controller.
- Align the direction finder antenna so that the QDM indication at the controller is 000.

4 Performance of test

1. Set the operating frequency on the transmitter and direction finder.
2. Set the mechanical antenna position (desired value).
3. After rotation of the antenna wait until the QDM indication on the controller has stabilised (lag error due to averaging).
4. Enter the QDM value in the test record.
5. Compare the QDM value (ACTUAL value) with the mechanical antenna setting (DESIRED value) and enter the difference in the test record.
6. Rotate the antenna a further 10° and repeat steps 3 to 6 until the direction finding system has been checked from 0° to 360°.