User Manual

RT-1000 Multichannel DF-Channel

RHO THETA
Elektronik GmbH
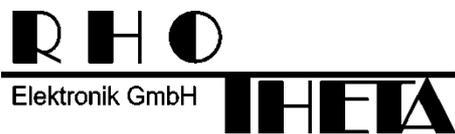
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Note

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

Content

1 Description

The DF-Channels are the central element of the bearing system. The channels include the receiver unit with the signal demodulation for AM and FM signals. Also the bearing value calculation is done in the DF-Channels.

2 Front View
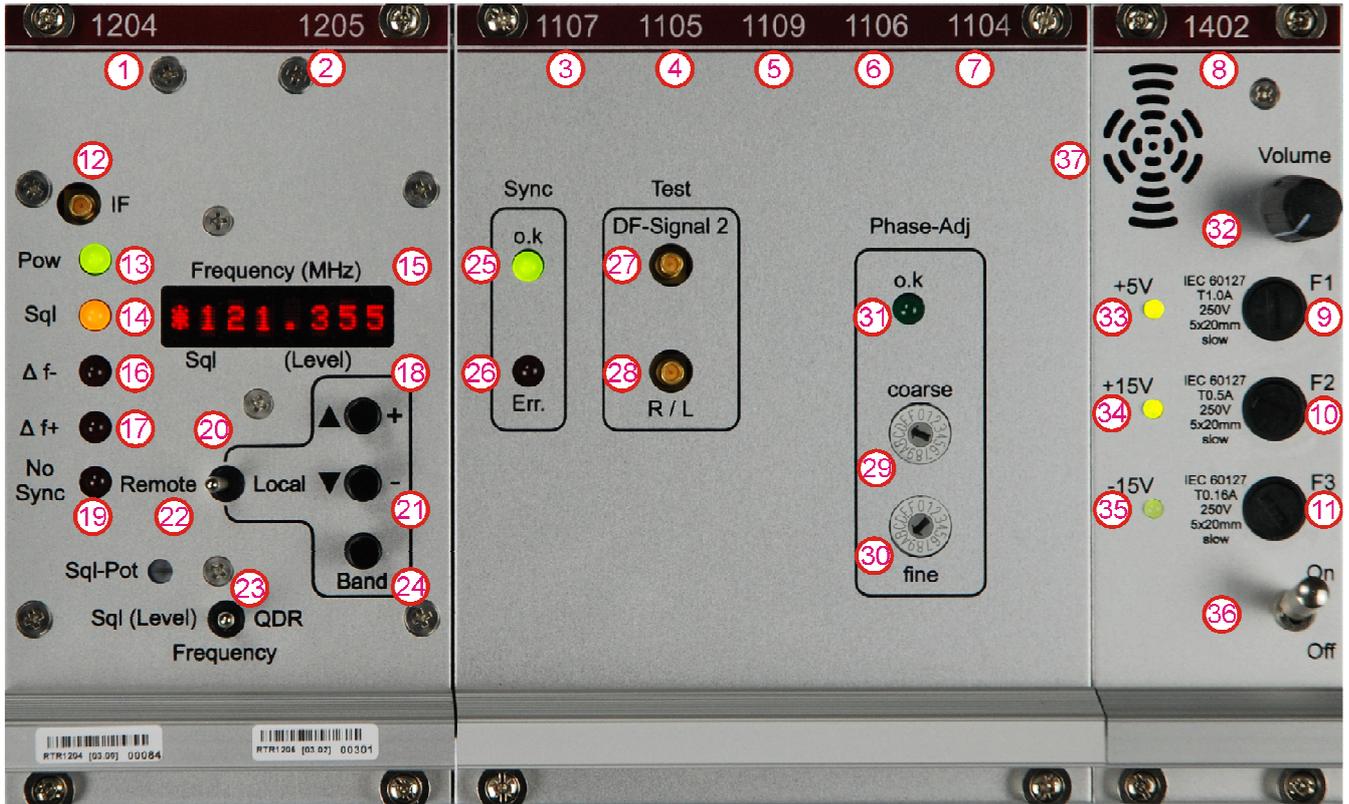
Fig. 1: DF-Channel Front View

3 Block Diagram and Component Description

DF CHANNEL

Receiver Interface	Receiver Control
RTR-1205	

Receiver Control Data

RF Input from Antenna

RF-IN

Receiver	Bearing Phase	**Bearing filter /squelch**	Bearing Phase	**Phase summator**
RTR-1204		RTR-1105	Squelch	RTC-1109

Audio AF

Reference Signals from Antenna Control

6.144 MHz

R/L-PULS

Frequency processing	Clock	Squelch / Bearing Phase	**Phase meter**
RTC-1107			RTC-1106

Audio AF

POWER

+5 V

+15 V

-15 V

Audio Power	Bearing Result	**CPU**	Receiver Control
RTX-1402		RTC-1104	Serial Interface

RS-232

DATA to DF-Control System

Audio AF

DF-Channel Components			
Pos.	Component	Number	Description
1	Receiver	RTR-1204	Receives the RF signal from the RF-Splitter. Demodulates the AM and FM signals and generates the bearing phase.
2	Receiver Interface	RTR-1205	The Receiver Interface controls the receiver unit. It is the communication interface between the receiver and the CPU.
3	Frequency Processing	RTC-1107	The Frequency Processing unit include components for filtering the audio signal. It also generates the reference clock out, which is needed for phase meter out of antenna control signals (6.144 MHz and R/L – Puls)
4	Bearing Filter	RTC-1105	The Bearing Filter unit includes the components for bearing filtering, bearing signal synchronization and a circuit to detect an evaluable bearing signal.
5	Phase Summator	RTC-1109	The Phase Summator unit is used to average the phase of the bearing phase signal before it is processed by the phase meter.
6	Phase Meter	RTC-1106	The Phase Meter unit includes the components for determining the phase position of the demodulated bearing signal relative to the reference phase. The result is the averaged bearing data and also life bearing data, which is process by the CPU.
7	CPU	RTC-1104	The CPU contains a microprocessor which controls the assemblies in the DF Channel. The CPU also serves the serial interface, which provide the bearing data and allows the remote control of the DF Channel.
8	Audio Power	RTX-1402	The Audio Power unit includes the power switch of the DF Channel, the micro fuses for the DC supplies and the speaker with a volume control.
9	F1	--	Microfuse T1.0A 250V 5x20mm, +5 V DC
10	F2	--	Microfuse T0.5A 250V 5x20mm, +15 V DC
11	F3	--	Microfuse T0.16A 250V 5x20mm, -15 V DC

4 Control Elements

Front Side Interfaces		
Pos.	**Component**	**Description**
12	IF	Receiver test jack
13	Pow	Receiver Power Control LED
14	Sql	Control LED for receiver squelch
15	Frequency(MHz) Sql/(Level)	Receiver Display
16	Δf-	Control LED for negative frequency deviation
17	Δf+	Control LED for positive frequency deviation
18	▲	Button for upward frequency change in local mode
19	No Sync	Control LED for receiver synchronisation error detection
20	Remote/Local	Switch remote operation or manual for test purpose
21	▼	Button for downward frequency change in local mode
22	Sql-Pot	Squelch adjustment potentiometer
23	Frequency Sql(Level)/QDR	Receiver display
24	Band	Button to switch between marine and air band (optional)
25	Sync o.k.	Control LED: synchronization ok, green
26	Sync Err.	Control LED: synchronization not ok, red
27	Test: DF-Signal 2	Test Plug, DF signal (filtered)
28	Test: R/L	Test Plug, R/L signal
29	Phase-Adj: coarse	Rotary switch for coarse phase adjustment
30	Phase-Adj: fine	Rotary switch for fine phase adjustment
31	Phase-Adj: o.k	Control LED for phase adjustment
32	Volume	Volume control for the Speaker (pos 31)
33	+5 V	Power control LED for the 5 V_{DC} Green: Power on Red: Fuse defect Off: No Supply Voltage/ DF Channel Off
34	+15 V	Power control LED for the +15 V_{DC} Green: Power on Red: Fuse defect Off: No Supply Voltage/ DF Channel Off
35	-15 V	Power control LED for the -15 V_{DC} Green: Power on Red: Fuse defect Off: No Supply Voltage/ DF Channel Off
36	On/Off	DF Channel Power switch. All DC supplies are switched together.
37	Speaker	Adjustable audio output for each channel

5 Rear View
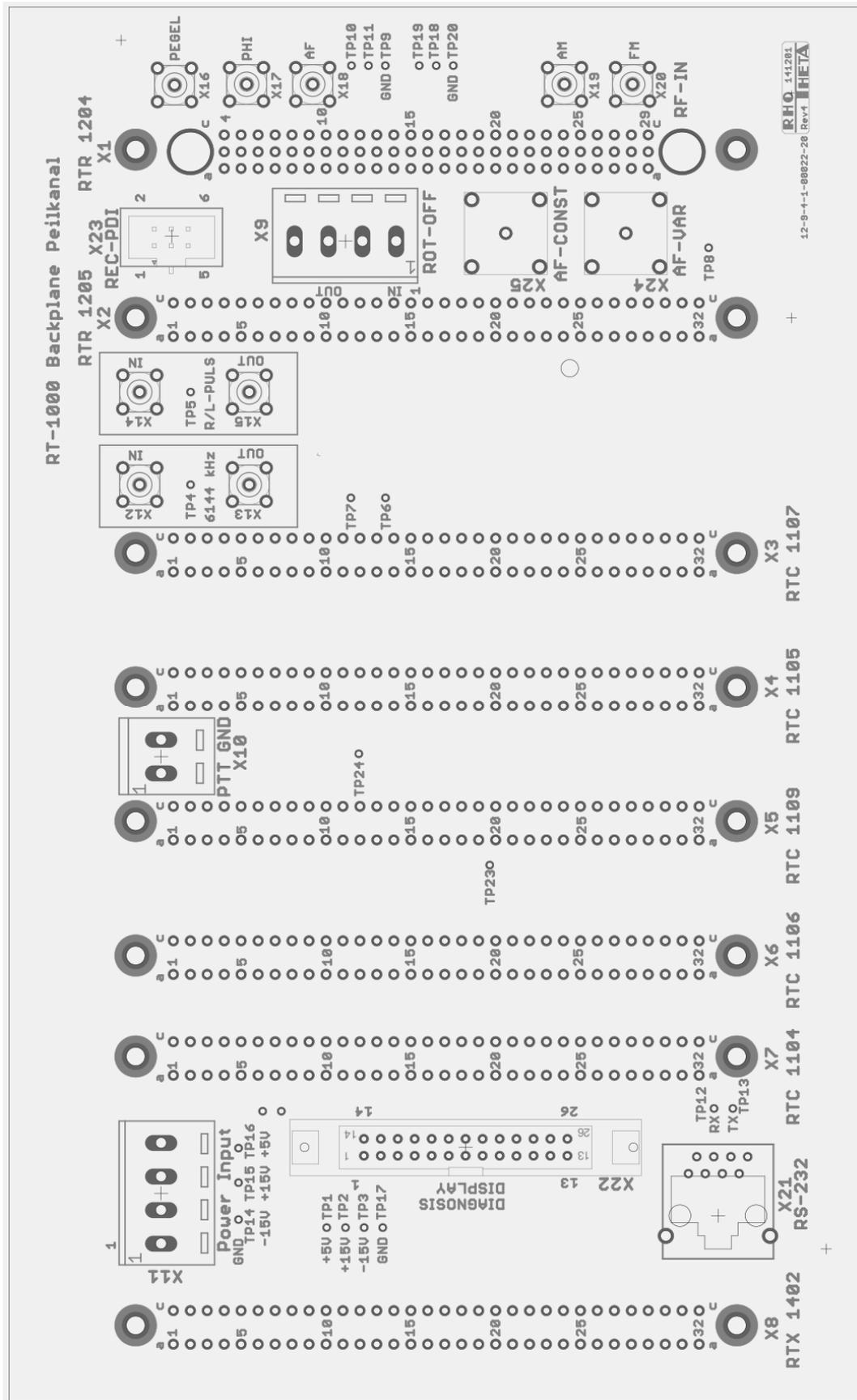
Fig. 2: DF-Channel Rear View

Rear Side Interfaces				
Pos.	Connector	Pin	Signal	Note
1	X1	1 – 4	RF-IN	RF Input from the RF-Splitter
		5 – 29	--	Internal Connector
2	X2	1 – 32	--	Internal Connector
3	X3	1 – 32	--	Internal Connector
4	X4	1 – 32	--	Internal Connector
5	X5	1 – 32	--	Internal Connector
6	X6	1 – 32	--	Internal Connector
7	X7	1 – 32	--	Internal Connector
8	X8	1 – 32	--	Internal Connector
9	X9	1	ROT-OFF IN	Input Antenna Rotation Control Signal
10		2	GND	Ground
11		3	ROT-OFF OUT	Output Antenna Rotation Control Signal
12		4	GND	Ground
13	X10	1	PTT	Push to talk input signal
14		2	GND	Ground
15	X11	1	GND	Ground Power Input
16		2	-15 V	- 15 V_{DC} Power Input
17		3	+15 V	+15 V_{DC} Power Input
18		4	+5 V	+ 5 V_{DC} Power Input
19	X12 (SMB)	--	6144kHZ IN	Input Reference Signal 6,144 MHz
20	X13 (SMB)	--	6144kHZ OUT	Output Reference Signal 6,144 MHz
21	X14 (SMB)	--	R/L-PULS IN	Input Reference Signal R/L-Pulse
22	X15 (SMB)	--	R/L-PULS OUT	Output Reference Signal R/L-Pulse
23	X16 (SMB)	--	PEGEL	Receiver Output Level Signal
24	X17 (SMB)	--	PHI	Receiver Output Bearing Phase Signal
25	X18 (SMB)	--	AF	Receiver Output Audio Signal
26	X19 (SMB)	--	AM	Receiver Output AM-demodulated Signal
27	X20 (SMB)	--	FM	Receiver Output FM-demodulated Signal
28	X21 (RJ 45)	3	GND	RS-232, Ground
29		4	RX	RS-232, Receiving Data
30		5	TX	RS-232, Transmitting Data
31	X22	1 – 26	DIAGNOSIS DISPLAY	Service Interface
32	X23 (PDI)	1 – 6	REC-PDI	Service Interface
33	X25 (BNC)	--	AF-CONST	Constant Audio Output
34	X24 (BNC)	--	AF-VAR	Adjustable Audio Output

Rear Side Test Points		
TP	**Signal**	**Note**
1	+5 V	+5 V DC Supply after the channel power switch
2	+15 V	+15 V DC Supply after the channel power switch
3	-15 V	-15 V DC Supply after the channel power switch
4	6144 kHz	Input of the Reference Signal 6.144 MHz
5	R/L-PULSE	Input of the Reference Signal R/L-Pulse
6	6144 kHz	Amplified Reference Signal 6.144 MHz
7	R/L-PULSE	Amplified Reference Signal R/L-Pulse
8	RX AFC DC	The AFC signal Level of the receiver
9	GND	Ground
10	O TXD	Internal signal, transmitted serial data
11	O RXD	
12	RXDATA	Serial Interface X21 receiving data
13	TXDATA	Serial Interface X21 transmitting data
14	-15 V	DC Power Supply -15 V Input
15	+15 V	DC Power Supply +15 V Input
16	+5 V	DC Power Supply +5 V Input
17	GND	Ground
18	RS232-RX	Internal signal, received serial data RS-232
19	RS232-TX	Internal signal, transmitted serial data RS-232
20	GND	Ground
21	CPU TXD	Internal signal, transmitted CPU data
22	CPU RXD	Internal signal, received CPU data
23	PSUM-SQU	Squelch Signal of the Phase Summator
24	PFSQL DFSIG	Bearing signal output of the bearing filter

6 Functional Descriptions

6.1 Switching on the DF-Channel

The DF-Channel is switched on by the On/Off power switch. Ensure that all components are completely inserted and the screws are in place.
The DF-Channel unit is designed for continuous operation. 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.

6.2 Switch-on Reaction, Operation, Control Equipment

The DF-Channel is designed for remote operation. The unit is operated by remote control using the RHOTHETA DF-Commander software. All relevant control functions and indications are transmitted to the remote PC via the serial interface to the DF-Control System which converts the data to LAN. The indications and settings on the DF-Channel are present only for test purposes and for carrying out function checks on the whole system.

6.3 Receiver Self-Test

After the DF-Channel has been switched on, an automatic test of the receiver display (Fig 1, Pos.15) is started. This involves the numerical series 88888888 flashing for approximately 4 s. Following this, after that the system identification "RT-1000 A" is displayed and the actual software version is shown for some seconds. When the self-test is finished the last frequency set appears.

6.4 Power Supply OK Control LED

After switching on, the green control LEDs (Fig 1, Pos. 33, 34, 35) of the Power Supply module RTX 1402 (Fig 1, Pos. 8) and (Fig 1, Pos. 13) on the receiver RTR 1204 (Fig 1, Pos. 1), lights up. This shows that the power supply module is functioning correctly.

6.5 Control Data Transmission

If the DF-Channel works in "Remote" mode (standard) the display (Fig 1, Pos. 15) shows the set frequency. It indicates that the data connection between receiver unit and controller is established. If the communication is disturbed, the error message "No Remote" is displayed.

6.6 Squelch Control LED "Sql"

The yellow squelch control LED (Fig 1, Pos. 14) lights up as soon as a signal of sufficient strength is received. This shows that a bearing signal is being transmitted to the controller.

6.7 Bearing Indication

If the system receives a signal and calculates a bearing value , the bearing indicator at the right side of the receiver display Figure 1 Pos. 15 lights up as a "*".
If no signal is received, the indicator lights up every second as a ">". If the PTT function is active, the indicator lights up as a "_".

6.8 Δf-, Δf+ Deviation Recognition Control LEDs

The red control LEDs (Fig 1, Pos. 16 & 17) light up if a signal with a large frequency deviation is received. This shows that a signal is being received which is not suitable for direction finding purposes.

For the 25 kHz frequency channel scheme the control LEDs light up for a frequency deviation > 8,0 kHz/ > 9,0 kHz typically.

For the 8,33 kHz frequency channel scheme the control LEDs light up for a frequency deviation > 1,4 kHz/ > 2,7 kHz typically.

6.9 Control LED "No Sync"

In case of a PLL lock error the red LED "No Sync" (Fig 1, Pos. 19) illuminates. It indicates a failure on the receiver unit RTR 1204.

6.10 "IF" Intermediate Frequency Jack

The intermediate frequency signal supplied by the receiver can be tapped at the IF SMB jack (Fig 1, Pos. 12).

Caution

Only for service use!

6.11 Remote / Local Switch

- "Remote" position: Standard operation mode; Receiver controlled by Controller Unit.
- "Local" position: For test purpose the working frequency can be changed locally. In this position the frequency DF Commander at the Controller side shows "ERR 9".

6.12 "Level-Frequency-QDR" Switch

Standard position of the switch is "frequency". The display (Fig 1, Pos. 15) shows the actual frequency. In position "Level" the display shows the signal level (0..99 %, not calibrated). In position "QDR" the display shows the actual bearing value.

6.13 Frequency Selection key ▲/▼

At mode "local" it is possible to increase the frequency in 25 kHz steps by pressing the key ▲ (Fig 1, Pos.18) or decreasing the frequency in 25 kHz steps by pressing the key ▼ (Fig 1, Pos. 21).

If the option 8,33 kHz is active the frequency in-/decreases combined in the 25 kHz and 8,33 kHz channel scheme.

In accordance with ICAO Annex 10 Volume V clause 4.1.2.4. table 4.1 (bis).

6.14 Squelch adjustment potentiometer

Behind the hole (Fig 1, Pos. 19) there is a potentiometer which allows a squelch adjustment. For this, a small screw driver is necessary.

If turning clockwise the squelch threshold god down, counter clockwise the squelch threshold rises.

6.15 Phase Adjustment

A special feature of the RT-1000 DF 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 Antenna Model or aligning of the labelled antenna radiator (North dipole) onto a transmitter.

6.15.1 Adjustment Using RTM 1500 Antenna Model (Option)

- Connect the antenna model instead to the TEST-IN port of the RF-Splitter (see User Manual of RTM 1501 Antenna Model).
- Feed in a VHF signal in the ATC band range with a signal level of approx. 100 mV at the antenna model RF input and adjust the receiver to the appropriate frequency. Move the antenna signal switch on the dummy antenna to the 180° position.

Note:
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 set to 0°. 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, "fine" (Fig 1, Pos. 30) and (Fig 1, Pos. 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 to find the middle of the range where the green control LED (Fig 1, Pos. 31) lights up. The QDM display should then show 180° (QDM).

6.15.2 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 the controller should be set to 0°. Phase adjustment is set.

Note:
The transmitter has to be exactly in the north of the antenna. The bearing display has to show 180° (or 000°). A deviation of more than ±1° will make it impossible to execute the phase adjustment.

6.16 Error Indication

The equipment has a wide range of self-test devices. If an error is discovered, the error code is shown flashing at 1 sec. intervals in the frequency display (Fig 1, Pos. 15).

Display: E R R 7

Error Indication	
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 of the Receiver
9	Receiver Control

Caution
If an error message appears, the DF-Channel is no longer functional.

6.17 "Sync" Synchronisation Indicators

The green indicator (Fig 1, Pos. 25) 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 (Fig 1, Pos. 26) 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

6.18 "DF Signal 2" Test Plug

The test signal for bearing determination is applied to the test connector (Fig 1, Pos. 27). The signal can be monitored using an oscilloscope. It indicates the quality of the bearing value.

Plug type: SMB

6.19 "R/L" Test Connector

The signal for changing over the fictitious antenna rotation from clockwise to counter-clockwise is applied to the test plug (Fig 1, Pos. 28). This signal is used for triggering the oscilloscope when monitoring the DF signal.

Plug type: SMB

6.20 Serial Interface

The serial interface RS-232 (Fig 2, X21) enables the transmission of bearing data to an external control unit and also permits remote control from an external unit.

The characters to be transferred are transmitted in ASCII code from the CPU RTC 1104 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) and "LF" (decimal code 10).

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.

6.21 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	X X X [CR][LF]
		         ─────>
		     ─────────>
		 ─────────────>
			0° … 359° (QDR)
			
			 Units
			 Tens
			 Hundreds

„Live" bearing, (QDR-value)	L	X X X [CR][LF]
		         ─────>
		     ─────────>
		 ─────────────>
			0° … 359° (QDR)
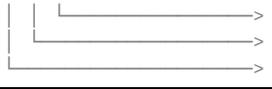			
			 Units
			 Tens
			 Hundreds

Status	S	X X X [CR][LF]
		
		         ─────>
		
		     ─────────>
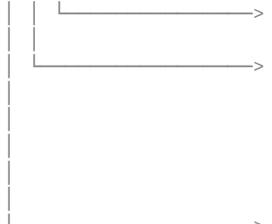		
		 ─────────────>
			Error No.: 0 = Ok / 1…9 = Error No.
			
			 actual 0 = Off
			 Scan Mode 1 = Scan Mode: DOWN
			               2 = Scan Mode: M0..9
			               3 = Scan Mode: UP
			               4 = Scan Mode: ACT/M0
			
			 Status Info: 0 = Bearing signal off
			               1 = Bearing signal on
			               2 = RF TX deviation (no bearing)
			               3 = Test
			               4 = Ground transmitter suppression
			               5 = (Reserved for testing)
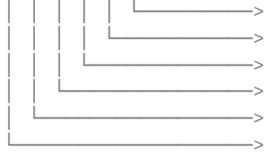
Frequency	F	X X X X X X [CR][LF]
		           ─────>
		         ─────────>
		       ─────────────>
		     ─────────────────>
		   ─────────────────────>
		 ─────────────────────────>
			118,000 … 174,000 MHz [1]
			 kHz units
			 kHz tens
			 kHz hundreds
			 MHz units
			 MHz tens
			 MHz hundreds

Receive level	P	0 X X [CR][LF]
		         ─────>
		       ─────────>
			000 … 099 %
			 Units
			 tens

Squelch Level	Q	0 X X [CR][LF]
		         ─────>
		       ─────────>
			000 … 090 %
			 Units
			 Tens
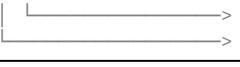
Serial No.	N	X X X X X X [CR][LF] ─────> ─────────────────────>	DF System Info Licenced options: 0…8 Serial No. 00000…65534
Power On Time	T	X X X X X X [CR][LF]	000000 … 999999 [minutes] (= max. 694 days)

1) Frequency output in the range 118.000 .. 136.975 MHz in accordance with ICAO Annex 10 Vol. V Clause 4.1.2.4 Table 4-1.
See ICAO channel-frequency-table (air band)

Timing and priority of cyclic data output

Message		
„Average" bearing	approx. every 0,25 sec	The first bearing value (after start of signal) will be transmitted immediately. Without signal, no average value will be transmitted.
„Live" bearing	approx. every 0,1 sec	With low priority. (in all available transmission breaks). Without signal, no live bearing value will be transmitted.
Status	approx. every 0,5 sec	After start of signal, „S000[CR][LF]" → „S1000[CR][LF]" will be transmitted immediately.
Frequency	approx. every 2 sec	When frequency changes, the new frequency will be transmitted immediately (also at active Scan Mode)
Receive level	approx. every 0,5 sec	
Squelch Level	approx. every 2 sec	
Serial No.	approx. every 10 sec	
Power On Time	approx. every 60 sec	

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

```
A 3 1 5 [CR][LF]
| | | |   └──┘──────>
| | | |           >
| |              >
|              >
```

	Final character	(decimal: 13 and 10)
	Content (bearing)	(decimal: 51, 49, 53)
	Header	(decimal: 65)
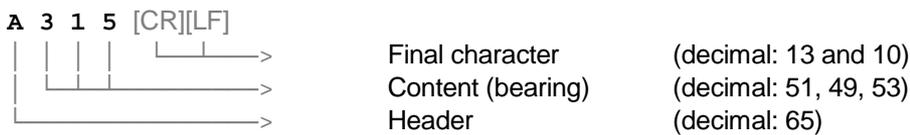
Example of 5 sec data output (with start of signal, respectively begin of bearing)

UTC Time (sec)	delta Time	Data Output (ASCII)
05:43:06.480	0.369	Q030\r\n
05:43:06.530	0.050	P017\r\n
05:43:06.620	0.089	S000\r\n
05:43:06.782	0.162	N002545\r\n
05:43:07.018	0.235	P017\r\n
05:43:07.126	0.107	S000\r\n
05:43:07.444	0.318	F121650\r\n
05:43:07.525	0.081	P017\r\n
05:43:07.633	0.107	S000\r\n
05:43:08.033	0.399	P017\r\n
05:43:08.140	0.107	S000\r\n
05:43:08.259	0.119	T001334\r\n
05:43:08.525	0.265	Q030\r\n
05:43:08.575	0.049	P017\r\n
05:43:08.648	0.072	S000\r\n

UTC Time (sec)	delta Time	Data Output (ASCII)
05:43:09.050	0.402	P017\r\n
05:43:09.158	0.107	S000\r\n
05:43:09.489	0.331	F121650\r\n
05:43:09.556	0.066	P017\r\n
05:43:09.663	0.107	S000\r\n
05:43:10.063	0.399	P017\r\n
05:43:10.171	0.107	S000\r\n
05:43:10.401	0.230	S100\r\n
05:43:10.451	0.049	A269\r\n
05:43:10.556	0.104	L265\r\n
05:43:10.606	0.049	P017\r\n
05:43:10.656	0.050	Q030\r\n
05:43:10.706	0.049	L272\r\n
05:43:10.756	0.050	A271\r\n
05:43:10.806	0.049	L276\r\n

UTC Time (sec)	delta Time	Data Output (ASCII)
05:43:10.856	0.050	L271\r\n
05:43:10.906	0.049	L271\r\n
05:43:10.956	0.049	S100\r\n
05:43:11.006	0.050	A271\r\n
05:43:11.056	0.050	L273\r\n
05:43:11.106	0.049	L262\r\n
05:43:11.156	0.049	P045\r\n
05:43:11.208	0.049	L268\r\n
05:43:11.256	0.050	A270\r\n
05:43:11.306	0.049	L268\r\n
05:43:11.356	0.049	L276\r\n
05:43:11.406	0.049	L273\r\n
05:43:11.456	0.050	L271\r\n
05:43:11.506	0.049	S100\r\n
05:43:11.556	0.050	A271\r\n

Remark:
Data logging with Wireshark via TCPIP; Timestamp as additional info; final character is displayed here as „\r\n" instead of [CR][LF]

6.22 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 [CR][LF]	0 = Clear average memory 1 = (not used) 4 = Ground transmitter suppression active 9 = Initiate System Reset 3 = Clearance for EEProm save functionality (1 sec active) 2 = Scan Mode: M0..9 start / continue 6 = Scan Mode: ACT/M0 start 7 = Scan Mode: UP start / continue 8 = Scan Mode: DOWN start / continue 5 = Scan Mode: STOP Stop (finish) active Scan Modes
Frequency	F	x x x x x x [CR][LF]	118,000 … 174,000 MHz $^{1)}$ kHz units kHz tens kHz hundreds MHz units MHz tens MHz hundreds
Squelch Level	Q	x x [CR][LF]	00 … 90 % (Standard input for digital squelch) -1 (Receiver squelch potentiometer instead of digital squelch) units tens
MEM Recall	R	x [CR][LF]	0 … 9 Recall of one frequency memory from M0…9
MEM Store	R	x x x x x x x [CR][LF]	Store of one valid frequency to the frequency memory M0…9 (used for channel scan mode M0..9) 0 … 9 (M0..9) 118,000 … 174,000 MHz $^{1)}$ (valid frequency) kHz units kHz tens kHz hundreds MHz units MHz tens MHz hundreds

1) Frequency input is possible only within the valid range. Frequency settings in the range 118.000 .. 136.975 MHz have to be in accordance with ICAO Annex 10 Vol. V Clause 4.1.2.4 Table 4-1. Other inputs will be ignored (also see ICAO channel frequency table next page).

The following example shows the data sequence for the frequency command
(set new frequency 125,375 MHz)

```
F  1  2  5  3  7  5  [CR][LF]
|  |  |  |  |  |  |     |___|___>      final character
|  |__|__|__|__|__|_____>      content (valid frequency)
|_____>      Header
```
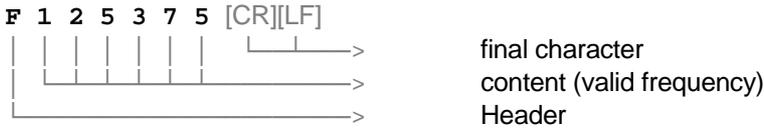
ICAO channel-frequency-table (air band):

Frequency [MHz]	Channel grid	Channel / Frequency Input FXXXXXXCRLF
118,0000	25 kHz	118000
118,0000	8,33 kHz	118005
118,0083	8,33 kHz	118010
118,0167	8,33 kHz	118015
118,0250	25 kHz	118025
118,0250	8,33 kHz	118030
118,0333	8,33 kHz	118035
118,0417	8,33 kHz	118040
118,0500	25 kHz	118050
118,0500	8,33 kHz	118055
118,0583	8,33 kHz	118060
118,0667	8,33 kHz	118065
118,0750	25 kHz	118075
118,0750	8,33 kHz	118080
118,0833	8,33 kHz	118085
118,0917	8,33 kHz	118090
118,1000	25 kHz	118100
118,1000	8,33 kHz	118105
118,1083	8,33 kHz	118110

136,9583	8,33 kHz	136960
136,9667	8,33 kHz	136965
136,9750	25 kHz	136975

Remark for frequency- and squelch input:
If a newly tuned frequency or squelch value are retained permanently in the system, even after a RT-1000 device restart, it must be stored in the EEPROM device in addition. This is done by directly transmitting a previous "S3 [CR] [LF]" commands.

Caution
Since the allowable write cycles to EEProms are limited, this option should be used only when necessary.

Example of frequency change Data In/Output:

Frequency-change to 133,400 MHz
(with 8.33 kHz ICAO grid) using a data input message.

„Fxxxxxx[CR][LF]

UTC Time (sec)	Data Output (ASCII)
08:11:41.662	P017\r\n
08:11:41.712	Q040\r\n
08:11:41.828	F118000\r\n
08:11:42.046	S000\r\n
08:11:42.170	P017\r\n
08:11:42.554	S000\r\n
08:11:42.679	P017\r\n
08:11:42.681	F133405\r\n
08:11:42.865	F133405\r\n
08:11:42.940	N002545\r\n
08:11:43.063	S000\r\n
08:11:43.084	P017\r\n
08:11:43.570	S000\r\n
08:11:43.692	P016\r\n
08:11:43.742	Q040\r\n
08:11:44.076	S000\r\n
08:11:44.199	P014\r\n
08:11:44.584	S000\r\n
08:11:44.708	P014\r\n
08:11:44.904	F133405\r\n
08:11:45.092	S000\r\n

Data Out

Data Input

Data Out

Remark:
After valid data input, the new changed frequency will be transmitted immediately …

Data logging with Wireshark via TCPIP;
Timestamp as additional info;
final character displayed as „\r\n" instead of [CR][LF]
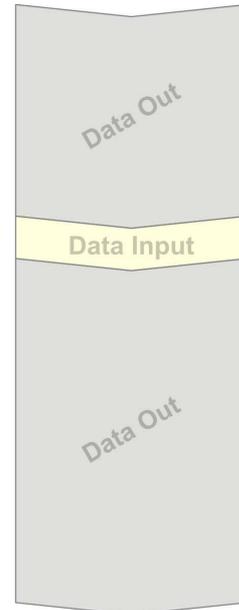
Example of storing one frequency to memory Data In/Output:
(is used as example, when configuring Scan Mode M0..9)

Frequency 156,800 MHz is stored to MEM3. and then recalled from the same memory for verifying:

(1) „S3[CR][LF]"
(Clearance for EEprom)

(2) „Rxxxxxxx[CR][LF]"
(Store to M3)

(3) „Rx[CR][LF]"
(Recall/Read from M3)

UTC Time (sec)	Data Output (ASCII)
08:54:11.917	S000\r\n
08:54:12.039	P016\r\n
08:54:12.280	F156100\r\n
08:54:12.423	S000\r\n
08:54:12.546	P016\r\n
08:54:12.673	S3\r\nR1568003\r\n
08:54:12.911	F156800\r\n
08:54:12.961	S000\r\n
08:54:13.077	P016\r\n
08:54:13.461	S000\r\n
08:54:13.463	R3\r\n
08:54:13.595	F156800\r\n
08:54:13.645	P016\r\n
08:54:13.720	N002545\r\n
08:54:13.870	Q040\r\n
08:54:13.968	S000\r\n
08:54:14.093	P016\r\n
08:54:14.478	S000\r\n
08:54:14.599	P016\r\n
08:54:14.984	S000\r\n
08:54:15.106	P016\r\n
08:54:15.491	S000\r\n
08:54:15.615	P017\r\n
08:54:15.690	F156800\r\n

Data Out

Data Input (1)+(2)

Data Out

Data Input (3)

Data Out

Remark:
After valid data input, the new changed frequency will be transmitted immediately …

Data logging with Wireshark via TCPIP;
Timestamp as additional info;
final character displayed as „\r\n" instead of [CR][LF]
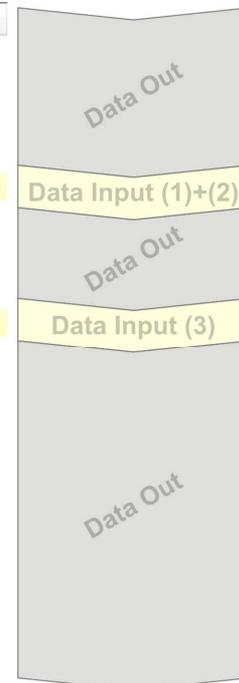
7 Electrical Parameters

7.1 Power Supply

Power Supply			
Pos.	Test Point	Value	
1	TP 1	+5,15 V_{DC} ± 0,15 V	I = 500 mA
2	TP 2	+15 V_{DC} ± 0,25 V	I = 300 mA
3	TP 3	-15 V_{DC} ± 0,25 V	I = 50 mA

7.2 DF-Signal 2 and R/L

| Reference Signals			
Pos.	Signal	Test Point	Value
1	DF-Signal 2	27 (Fig 1)	See measurement below
2	R/L	28 (Fig 1)	f = 46,875 Hz
			U_{High} ≥ 4,0 V
			U_{Low} ≤ 0,5 V
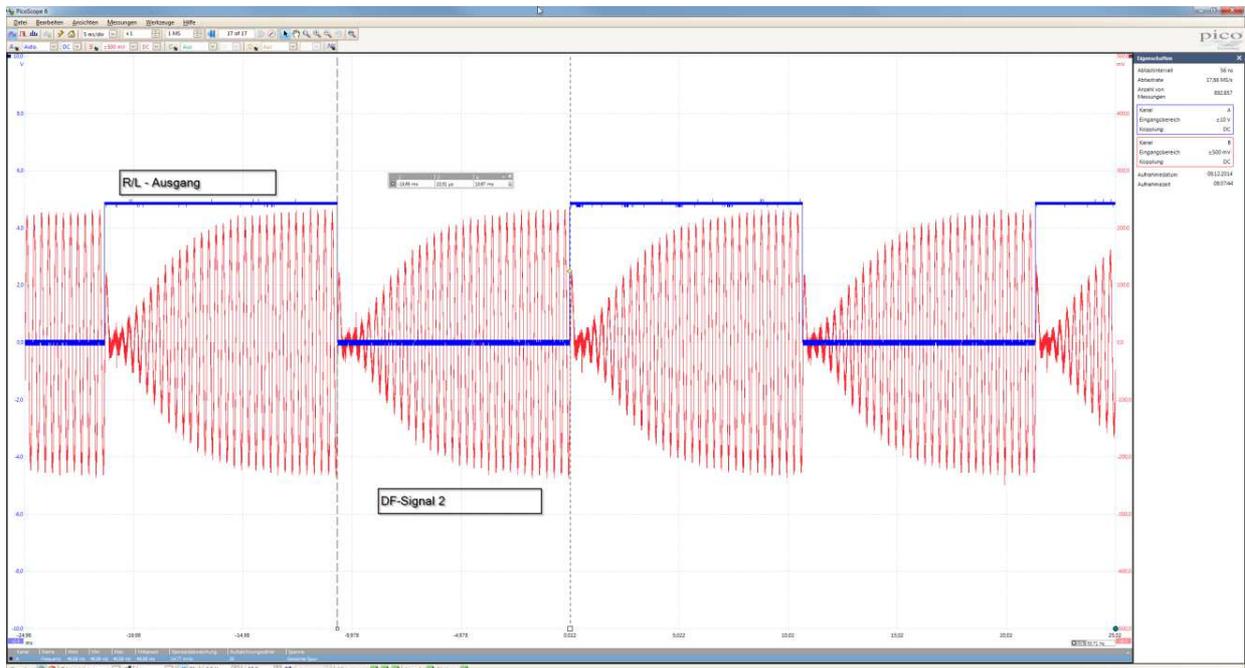
7.3 Reference Signals Input

To test the reference signals an Antenna Control unit has to be connected to the DF-Channel.

Reference Signals			
Pos.	Signal	Test Point	Value
1	6,144 MHz	TP 4	$f = 6{,}144$ MHz $\pm 0{,}03$ MHz
			$U_{High} \geq +0{,}5$ V
			$U_{Low} \leq -0{,}5$ V
2	R/L Pulse	TP 5	$t_{High} = 5{,}1$ µs $\pm 0{,}2$ µs
			$t_{Low} = 21{,}3$ ms $\pm 0{,}5$ ms
			$U_{High} \geq 1{,}0$ V
			$U_{Low} \leq 0{,}25$ V

6,144 MHz:
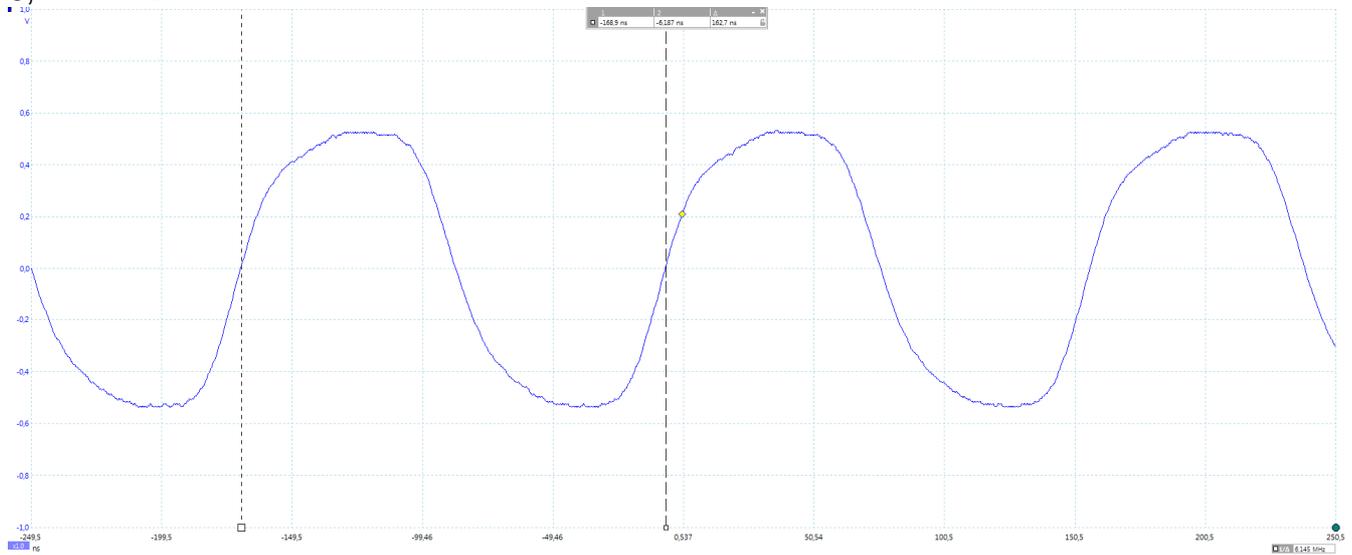
R/L Pulse
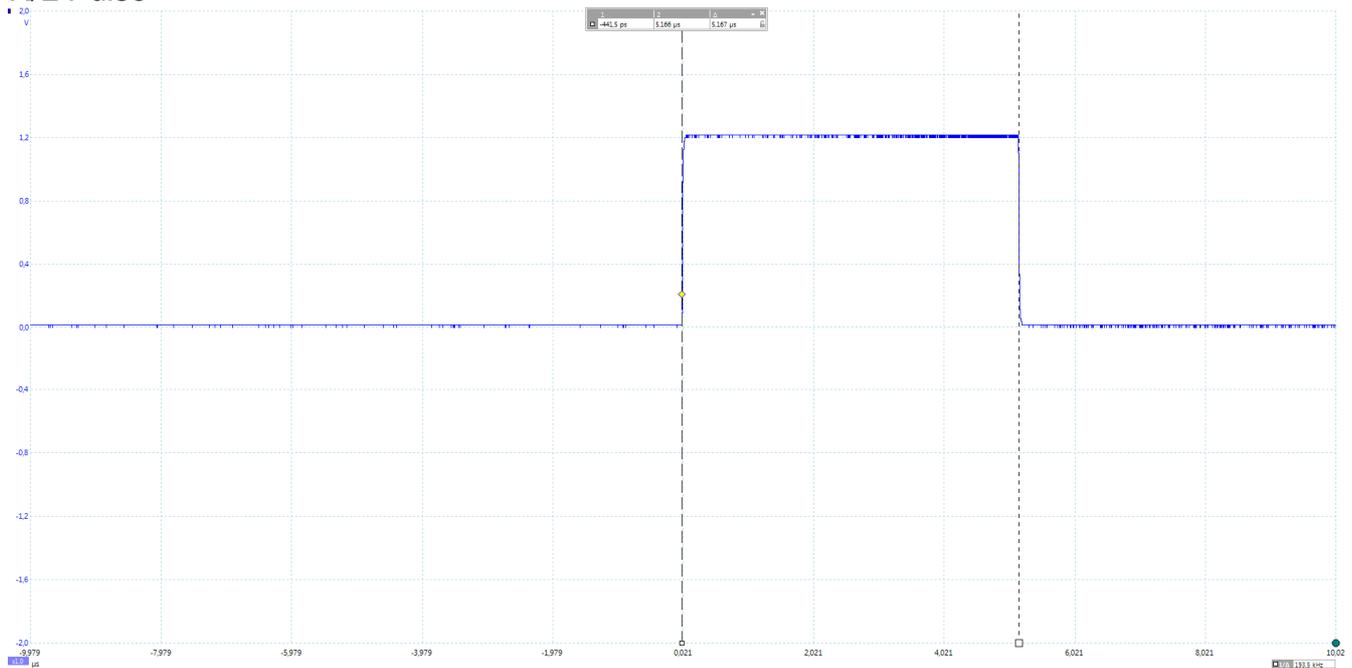
7.4 Pegel- Output

To test the level output, connect a signal generator to RF-Splitter RF-IN and measure the DC voltage with a multimeter.

Level-Output			
Connector	**Signal**	**Conditions**	**Value**
X16	Pegel	f = 127,500 MHz	
		Modulation: Off	
		P_{HF}= -120 dBm	U_{PEGEL} = 1,25 V ± 0,15 V
		P_{HF}= -100 dBm	U_{PEGEL} = 2,55 V ± 0,15 V
		P_{HF}= -80 dBm	U_{PEGEL} = 3,55 V ± 0,15 V
		P_{HF}= -60 dBm	U_{PEGEL} = 4,55 V ± 0,15 V
		P_{HF}= 0 dBm	U_{PEGEL} = 4,75 V ± 0,15 V

7.5 AM – Output

To check the AM-Output of the DF-Channel, connect signal generator to RF-Splitter RF-IN and measure the output with an analyzer (600 Ω impedance).

AM-Output				
Connector	**Signal**	**Settings**		**Value**
X 19	AM	Signal Generator		P_{out} = 0 dBm ±2 dB
		f	121,500 MHz	(U_{eff} = 775 mV ±10% @600 Ω)
		Level	-40 dBm	
		Modulation	AM	
		m	60 %	
		f_{mod}	1 kHz	
		DF-Channel		
		f	121,500 MHz	

7.6 FM – Output

To check the AM-Output of the DF-Channel, connect signal generator to RF-Splitter RF-IN and measure the output with an analyzer (600 Ω impedance).

FM-Output				
Connector	**Signal**	**Settings**		**Value**
X 19	FM	Signal Generator		P_{out} = 0 dBm ±2 dB
		f	156,800 MHz[1] (121,500 MHz)	(U_{eff} = 775 mV ±10% @600 Ω)
		Level	-80 dBm	
		Modulation	FM	
		Δf	3 kHz	
		f_{mod}	1 kHz	
		DF-Channel		
		f	156,800 MHz[1] (121,500 MHz)	

[1]*Use 121,500 MHz if the optional marineband is not included.*

7.7 PHI – Output

To check the PHI-Output of the DF-Channel, connect signal generator to the Antenna Model and the Antenna Model with the RF-Splitter TEST-IN and measure the output with an analyzer (600 Ω impedance).

PHI-Output				
Connector	**Signal**	**Settings**		**Value**
X 17	PHI	Signal Generator		f_{mod} = 3 kHz
		f	121,500 MHz	P_{out} = -7,5 dBm ±1,5 dB
		Level	-20 dBm	(U_{eff} = 330 mV @ 600 Ω)
		Modulation	OFF	
		DF-Channel		
		f	121,500 MHz	

7.8 AF – Output

To check the AF-Output of the DF-Channel, connect signal generator to the Antenna Model and the Antenna Model with the RF-Splitter TEST-IN and measure the output with an analyzer (600 Ω impedance).

AF-Output, FM Characteristic 25 kHz Raster				
Connector	**Signal**	**Settings**		**Value**
X 18	AF	Signal Generator		P_{out} = -3,5 dBm ±1,5 dB
		f	156,800 MHz[1] (121,500 MHz)	(U_{eff} = 500 mV ±10% @600 Ω)
		Level	-45 dBm	
		Modulation	FM	
		Δf	3 kHz	
		f_{mod}	1 kHz	
		DF-Channel		
		f	156,800 MHz[1] (121,500 MHz)	

[1]Use 121,500 MHz if the optional marineband is not included.

AF-Output, AM Characteristic 25 kHz Raster				
Connector	**Signal**	**Settings**		**Value**
X 18	AF	Signal Generator		P_{out} = -9,5 dBm ±1,5 dB
		f	121,650 MHz	(U_{eff} = 250 mV ±10% @600 Ω)
		Level	-45 dBm	
		Modulation	AM	
		m	30 %	
		f_{mod}	1 kHz	
		DF-Channel		
		f	121,650 MHz	

If the optional 8,33 kHz raster is included the following values are additional relevant.

AF-Output, FM Characteristic 8,33 kHz Raster				
Connector	**Signal**	**Settings**		**Value**
X 18	AF	Signal Generator		P_{out} = -10 dBm ±1,5 dB
		f	121,650 MHz	(U_{eff} = 250 mV ±10% @600 Ω)
		Level	-45 dBm	
		Modulation	FM	
		Δf	3 kHz	
		f_{mod}	1 kHz	
		DF-Channel		
		f	121,655 MHz	

AF-Output, AM Characteristic 8,33 kHz Raster				
Connector	**Signal**	**Settings**		**Value**
X 18	AF	Signal Generator		P_{out} = -10 dBm ±1,5 dB
		f	121,650 MHz	(U_{eff} = 250 mV ±10% @600 Ω)
		Level	-45 dBm	
		Modulation	AM	
		m	30 %	
		f_{mod}	1 kHz	
		DF-Channel		
		f	121,655 MHz	

8 Mechanical Parameters

Mechanical Parameters		
Parameter	**Condition**	**Data**
Dimensions	B x H x T	213,36 x 133,35 x 180 mm (42 TE, 3 U)

9 Notes