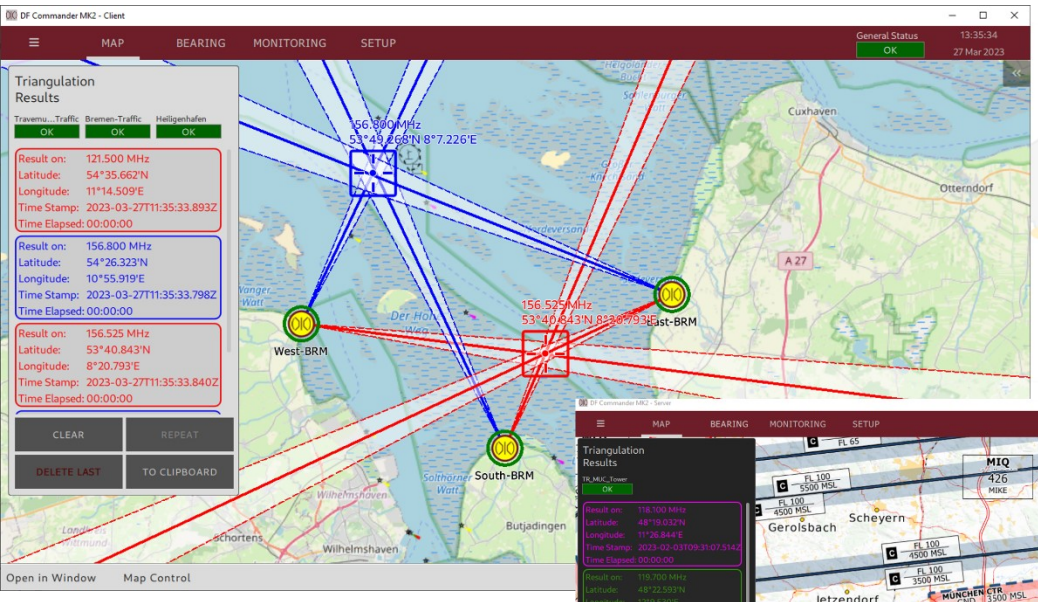
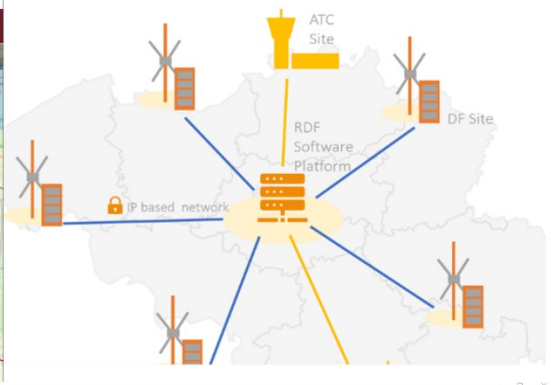
User Manual

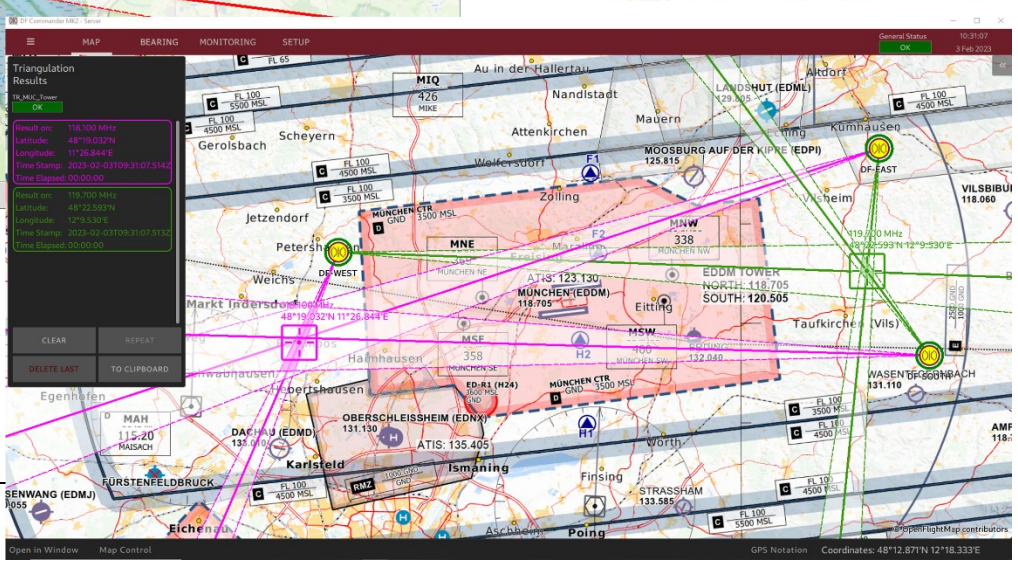
DF COMMANDER MK2

Software for the remote control, monitoring and integration of radio direction finding systems

RHO THETA Elektronik GmbH







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Note

The manufacturer reserves the right to make changes to the product described herein at any time without prior notice.

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1 Overview

The DF Commander MK2 software enables remote control and monitoring of radio direction finding systems (DF Systems). In addition to displaying the bearing results on various electronic maps, the software can calculate and display cross bearings at different frequencies.

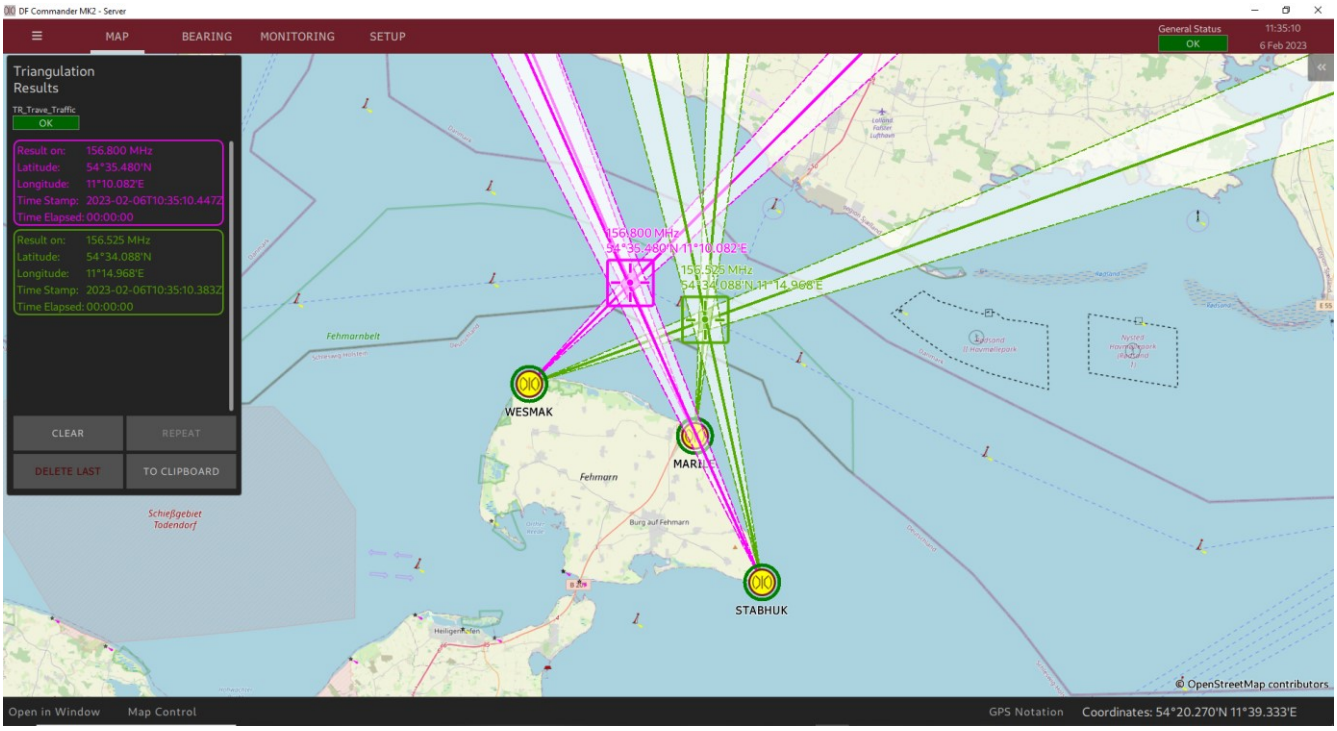


Figure 1: VTS application overview

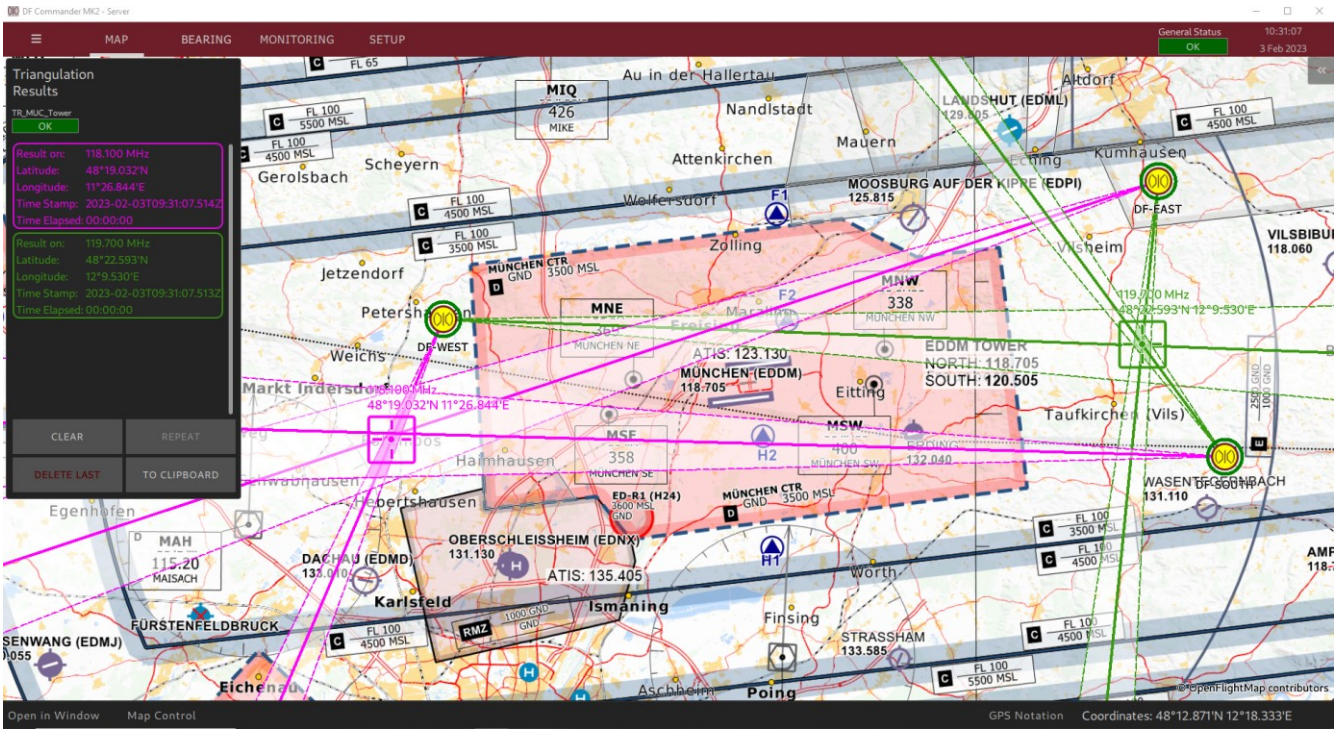


Figure 2: ATC application overview

1.1 Server Application

Bearings, cross bearing results and status information of radio direction finding systems are made available via an integrated TCP server in the “DF Commander MK2 Server” application. DF systems can also be set and controlled via the same server. Thus, the “DF Commander MK2 Server” can be understood as a service module, which enables a simple integration of radio direction finder systems into modern VTS and ATC network architectures.
By using a standardized radio direction finder protocol in JSON format, further protocol conversions can be implemented very easily.
The corresponding protocol is described in the document "Radio Direction Finder Standard JSON Protocol".

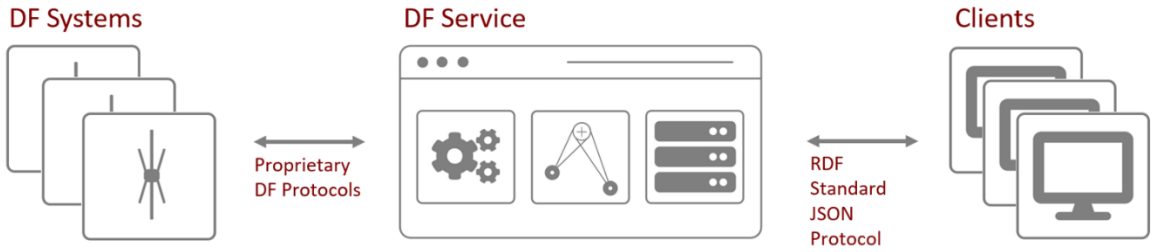


Figure 3: DF service

When starting/restarting the server application, in opposition to the client application, the settings are read from the configuration files and the corresponding systems are commanded according to the settings read.

Up to 99 clients can be connected to the DF Commander MK2 server and their IP-addresses will be shown in the “Connected Clients” list.

1.2 Client Application

In the “DF Commander MK2 Client” application, there is no local TCP/IP server available to connect to, but the same information about DF systems, bearings, cross bearing results, etc. is available, proceesed and shown via graphical user interface.
The client application is used for indication and controlling of the DF systems that are directly connected to it (local systems). In addition, the client application can process and display the data from the remote servers.
The client cannot enforce the DF systems configuration at start/restart of the application.
Besides the folding menu, that will be described below, the following pages can be selected in the upper bar of the DF Commander MK2 (server as well as client application):

1.3 Application Pages

Figure 4: "Pages"

MAP

The Map page allows the display of direction finding systems with corresponding information on the electronic map. The following can be illustrated:

- Bearing results as LOBs (lines of bearing) within the Bearing Cones
- Cross bearing results as position on the map and as text field in the triangulation window
- Module to control the map
- Module to display additional data on DF systems, triangulations, COSPAS-SARSAT lists

BEARING

The Bearing page allows displaying of DF results and signal levels of selected DF channels on a compass rose. This view is used to support the navigators and the technical system monitoring.

MONITORING

The Monitoring page allows observing of the general statuses (of systems, triangulators and servers) as well as the observing of all configured DF channels at a glance.
The configured elements are displayed in two different perspectives (tabs) as list views.

Settings cannot be made on this page. The focus of the presented views is solely on technical system monitoring.

SETUP

The Setup page is used for the entire configuration (see chapter 3).

Folding Menu

DF Commander MK2 User Manual and DF Standard JSON Protocol can be viewed and downloaded from the folding menu.
The “About” window provides license agreement information and allows entering a new license key if a new key is required (e.g., after the demo version has expired or to add new options to the software).

2 Start and End the Program

2.1 Start / Restart

After the installation, the program starts the graphical user interface (GUI) when double-clicking on the exe file.
To start the program on Linux, `start.sh` must be called up on the command line.
Using the GUI simplifies the licensing and configuration process of radio direction systems.

After the configuration of the DF systems is complete and saved (s. 3.1.1 Configuration Files, EXPORT ALL or SAVE AS DEFAULT), the application can be restarted with or without a system tray, with or without a GUI.

If some DF system settings (e.g., frequency setting in a DF channel) are currently not applicable, the corresponding message appears.

2.2 Command Line Parameters

This chapter describes the command line parameters which affect the operation mode of the application.
The following parameter can be passed to the application when calling DF Commander MK2 from the command line or using scripts.

```
-t, --show-systray
```

This parameter starts the application with the grafical user interface. Additionally the control of the application is available from the system tray.
Closing the application window just moves the application into background. The grafical user interface can be restored from the system tray.

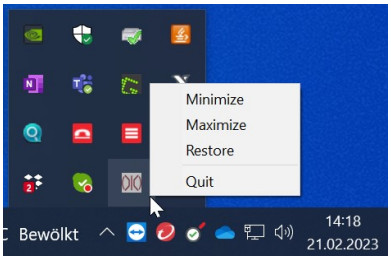


Figure 5: DF Commander MK2 with system tray

```
-g, --no-gui
```

This parameter starts the application (server application only) without graphical user interface. It can not be restored from the system tray. For quiting the application please use the task manager or commands for stopping the prozesses of your operationg system.

```
-n, --config-name <name>
```

This parameter starts the application using different configuration file location specified by <name>. This allows to run multiple instances of the application with different configurations.

Here is the exmple of starting three server with different configurations on Linux without GUI:

```
./DFCommanderMK2-Server -n "../Config1" -g
./DFCommanderMK2-Server -n "../Config2" -g
./DFCommanderMK2-Server -n "../Config3" -g
```

The recommended approach doing this includes the configuration of server using grafical interface first and then restarting the application without a GUI.

NOTE:
Other existing command line parameters are intended for internal use or trouble shooting.

2.3 Exit the Program

If the program is running with GUI, it can be simply closed by clicking on the close symbol ("x") of the window in the upper right corner.

If the program is running without a GUI, you can use the task manager or end the process in a console, command prompt (“Ctrl + C”) or terminal accordingly.

3 Configuration

This chapter describes the system configuration which can be performed in the following steps on the SETUP page:

- General settings — GENERAL
- Configuration of DF system(s) — DF SYSTEMS
- Configuration of triangulator(s) — TRIANGULATOR
- Map settings — MAP
- DF service settings (for DF Commander MK2 Server application only) — LOCAL SERVER
- Remote servers settings — REMOTE SERVERS
- Self-bearing suppression settings — SBS

As result, bearings and cross bearings are visible in the map view and accessible via the server interface.

NOTE:
Basically, all menus are structured in such a way that the current settings are displayed on the left. On the right, however, new values can be entered or selected. Press "< SET < " to apply the new settings. After setting they should appear accordingly in the left area.

3.1 General Setup

The first step is to make general settings. The individual aspects are described in sequence.

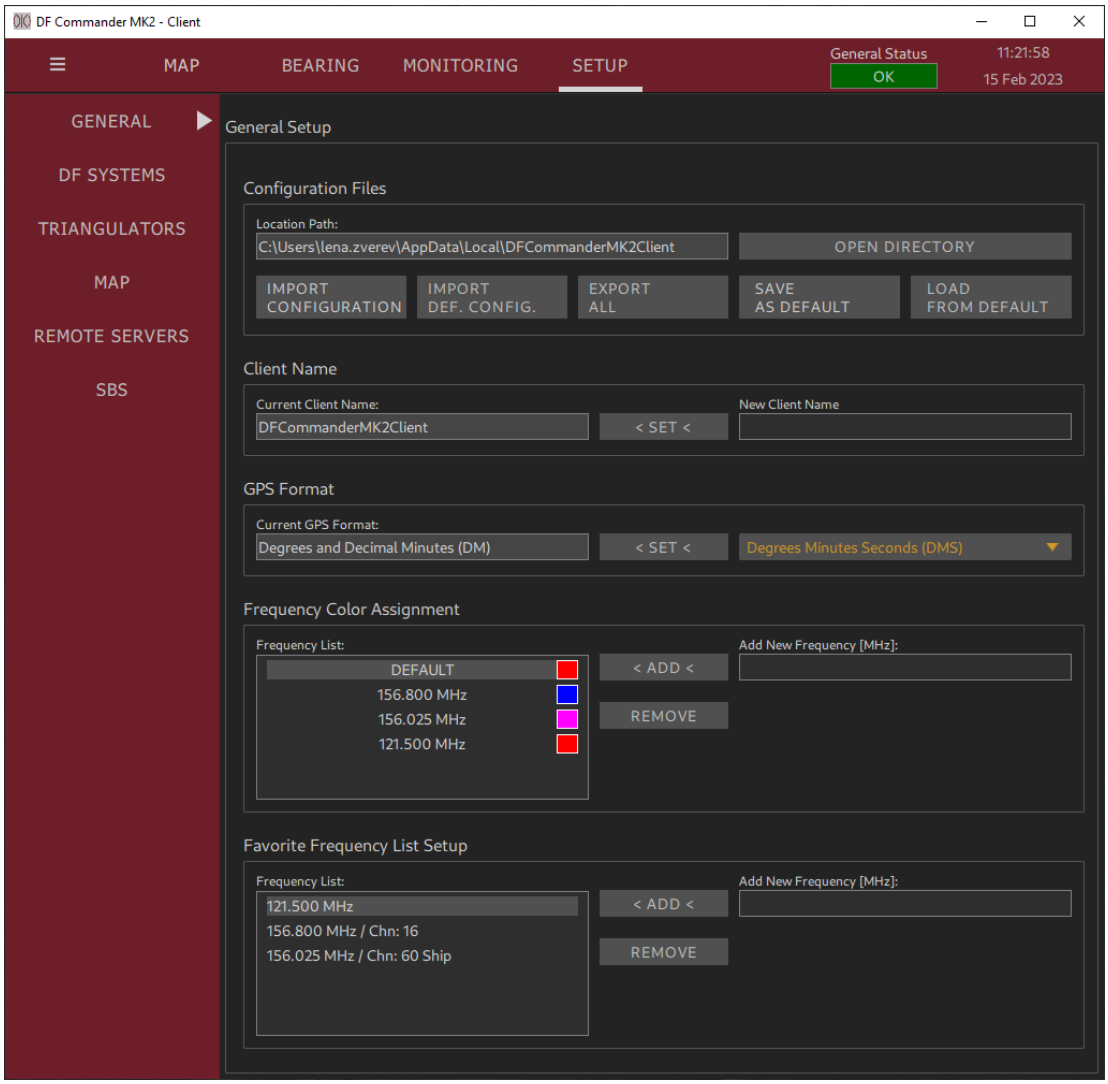
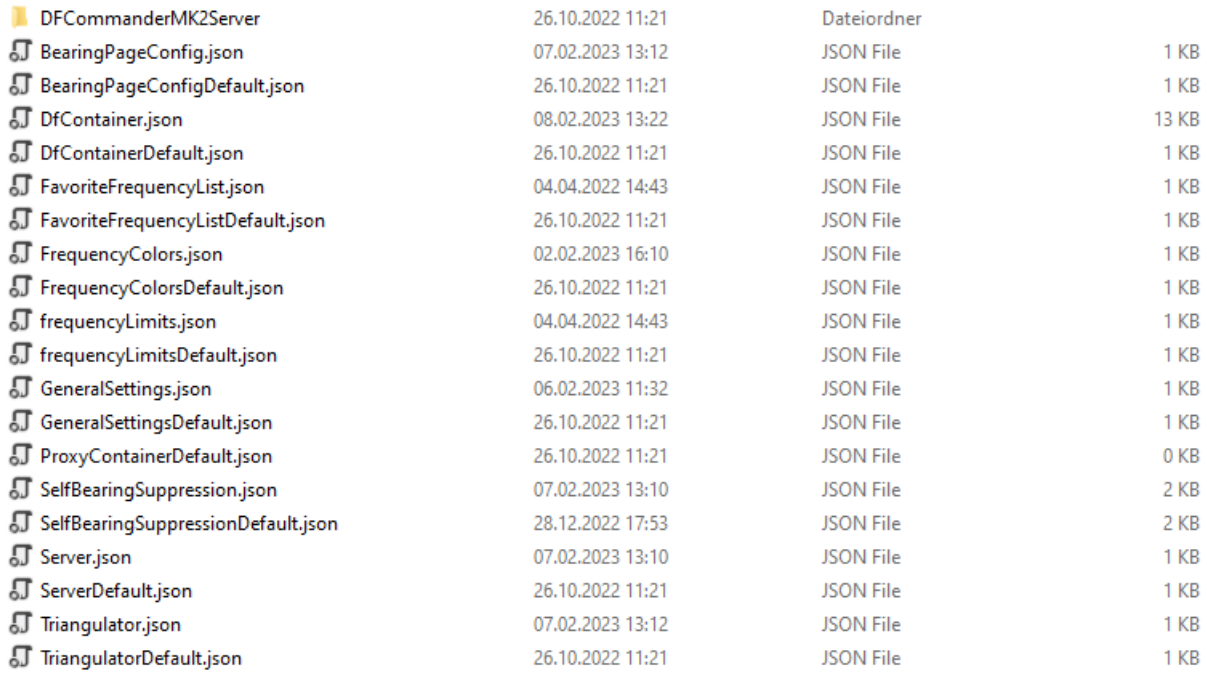


Figure 6: General setup Client Application

3.1.1 Configuration Files

The configuration files of the systems are located in the specified path and can be accessed directly by pressing the "OPEN DIRECTORY" button.



DFCommanderMK2Server	26.10.2022 11:21	Dateiordner	
BearingPageConfig.json	07.02.2023 13:12	JSON File	1 KB
BearingPageConfigDefault.json	26.10.2022 11:21	JSON File	1 KB
DfContainer.json	08.02.2023 13:22	JSON File	13 KB
DfContainerDefault.json	26.10.2022 11:21	JSON File	1 KB
FavoriteFrequencyList.json	04.04.2022 14:43	JSON File	1 KB
FavoriteFrequencyListDefault.json	26.10.2022 11:21	JSON File	1 KB
FrequencyColors.json	02.02.2023 16:10	JSON File	1 KB
FrequencyColorsDefault.json	26.10.2022 11:21	JSON File	1 KB
frequencyLimits.json	04.04.2022 14:43	JSON File	1 KB
frequencyLimitsDefault.json	26.10.2022 11:21	JSON File	1 KB
GeneralSettings.json	06.02.2023 11:32	JSON File	1 KB
GeneralSettingsDefault.json	26.10.2022 11:21	JSON File	1 KB
ProxyContainerDefault.json	26.10.2022 11:21	JSON File	0 KB
SelfBearingSuppression.json	07.02.2023 13:10	JSON File	2 KB
SelfBearingSuppressionDefault.json	28.12.2022 17:53	JSON File	2 KB
Server.json	07.02.2023 13:10	JSON File	1 KB
ServerDefault.json	26.10.2022 11:21	JSON File	1 KB
Triangulator.json	07.02.2023 13:12	JSON File	1 KB
TriangulatorDefault.json	26.10.2022 11:21	JSON File	1 KB

Figure 7: Configuration files (Server application)

The composition of the configuration files is different for the “DF Commander MK2 Server” and “DF Commander MK2 Client” applications.
If these files are deleted, they are created again by restarting the program. In this case, the settings and contents correspond to the configuration stored in the program code. DF systems and channels are not initially created.

Each functional unit has two configuration files, each in JSON format. One of them is the work file, in which the current changes are stored by the application. In the other file, however, only the basic settings are stored.

If the work files are deleted, restarting the program will recreate the work files. The settings are taken from the default configuration files.

Example:
`DfContainer.json` – Contains the current settings of the DF systems
`DfContainerDefault.json` – Contains default settings of the DF systems

1. DF systems are set as required. The settings are initially located in the work file: `DfContainer.json`.
2. Now these settings are to be defined as a fallback level. This is made possible by manually saving the file `DfContainer.json` as `DfContainerDefault.json` .
3. If it becomes necessary to load the settings of `DfContainerDefault.json` , the current working file `DfContainer.json` must be deleted and the program restarted.

The DF Commander MK2 software provides buttons on the General Setup page for easier handling of the configuration files.

IMPORT CONFIGURATION

This button allows importing the configuration files from any directory of your PC.

If the selected directory contains only one or several applicable configuration files, only these are applied for the new configuration, the rest of the settings remains unchanged.
If no configuration files are in the selected directory, or they are damaged, the software produces a corresponding warning.
A restart of the DF Commander is required to implement the new configuration.

IMPORT DEFAULT CONFIGURATION

The default configuration is replaced by the new default configuration from the imported configuration files. The default files are merely replaced and stored, but the configuration is not applied and no restart of the application is required. To apply the imported default configuration use “Load from default” button explicitly.

EXPORT ALL

Copies all configuration files from the specified DF Commander MK2 directory to any other directory. The files are simply stored in the selected directory. The restart of the application is not required.

SAVE AS DEFAULT

All working configuration performed in the application can be converted to the new default configuration. This can then be applied when there is a need to revert to the same settings instead of using the mainly empty configuration that is created when the application is first started.

LOAD FROM DEFAULT

Applies the configuration according to the data stored in the default configuration files. This requires the restart of the application.

Example of a use case “Local system functional test after repair”:

A functional test of a DF system, which requires a different configuration, is needed on site (local system) while the DF system is already being remotely controlled and monitored by a remote server (monitoring center). The operator of the remote server is informed about the test so that he does not change the settings during the execution.

1. The working configuration of the system is saved by using “SAVE AS DEFAULT”.
2. Then the new test configuration is accomplished.
3. The functional test is performed.
4. The test configuration is exported by using “EXPORT ALL” to a specified directory (e.g. „Test Setup“), if another test with the same configuration on e.g. a second system is needed.
5. After the test is finished, the previous working configuration is reloaded by using “LOAD FROM DEFAULT”.

Example of a use case “Regular tests on local system”:

If e.g., functional tests with the same test configuration are necessary time and again, the procedure could be:

1. The steps from the previous example are performed at the first test.
2. If the test setup is required again (the regular test is pending), the working configuration is first exported to another directory (e.g. "Working Configuration") with "EXPORT ALL".
3. The test setup can now be loaded from the corresponding directory („Test Setup“) with "IMPORT CONFIGURATION".
4. After the test, the working configuration is restored from the corresponding directory with "IMPORT CONFIGURATION".
5. In this way, you can switch between these two configurations at any time.

3.1.2 Server Name / Client Name

The Server Name is used to identify the present local server in the applications that use its data. Thus, this name will appear in the list of remote servers under SETUP / REMOTE SERVERS of other “DF Commander MK2 Server” or “DF Commander MK2 Client” application when they connect to the present server.
The Client Name is only visible in the “DF Commander Client” application itself, since a remote connection to the client cannot be established.

3.1.3 GPS Format

This setting allows the positions to be displayed in different formats.

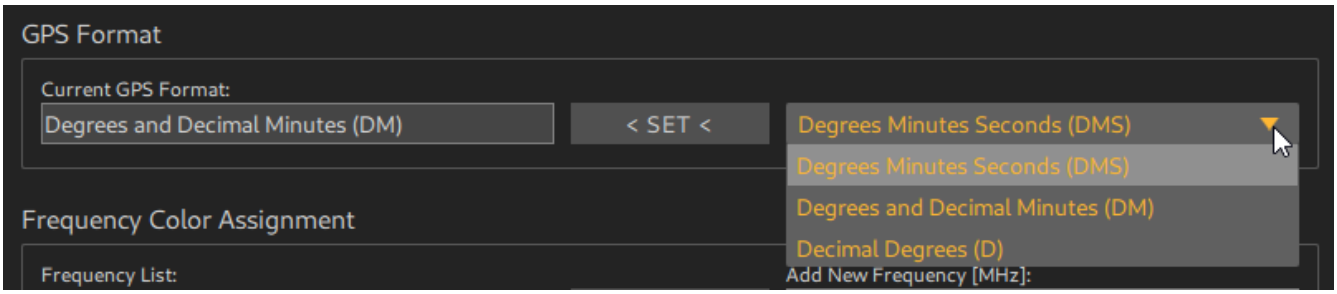


Figure 8: GPS format

Example:

Decimal Degrees (D):	54.300252°N 11.528357°E
Degrees and Decimal Minutes (DM):	54°18.842'N 11°32.125'E
Degrees Minutes Seconds (DMS):	54°16'47.79"N 11°32'16.51"E

3.1.4 Frequency Color Assignment

In this area, different colors are assigned to different frequencies. This makes it easier to distinguish bearing results from cross bearing results on the map.
The frequency in MHz is entered in the right field. Then press the "< ADD <" key.
The "REMOVE" button deletes the selected frequency from the list.

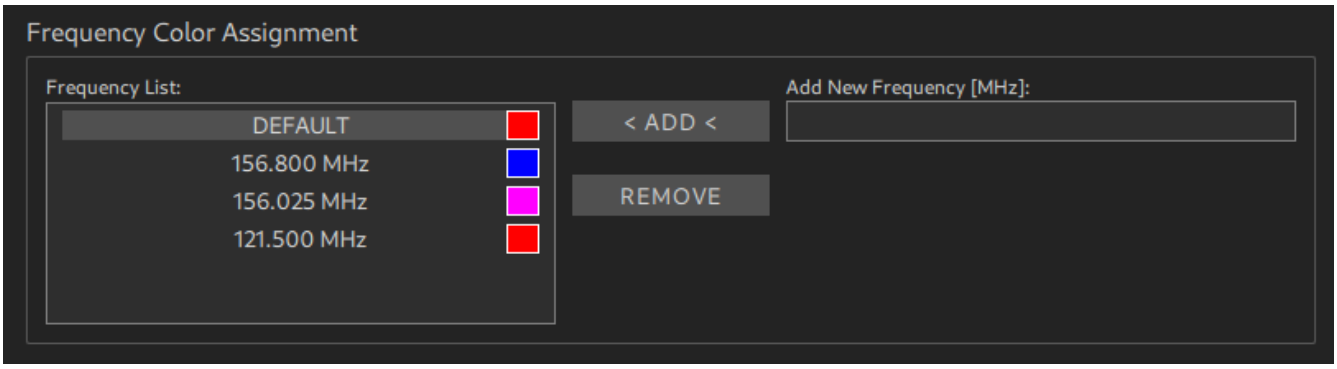


Figure 9: Frequency Color Assignment

3.1.5 Favorite Frequency List Setup

The favorite frequency list is set in this area.
The frequency in MHz is entered in the right field. Then press the "ADD" key.
The "REMOVE" button deletes the selected frequency from the list.

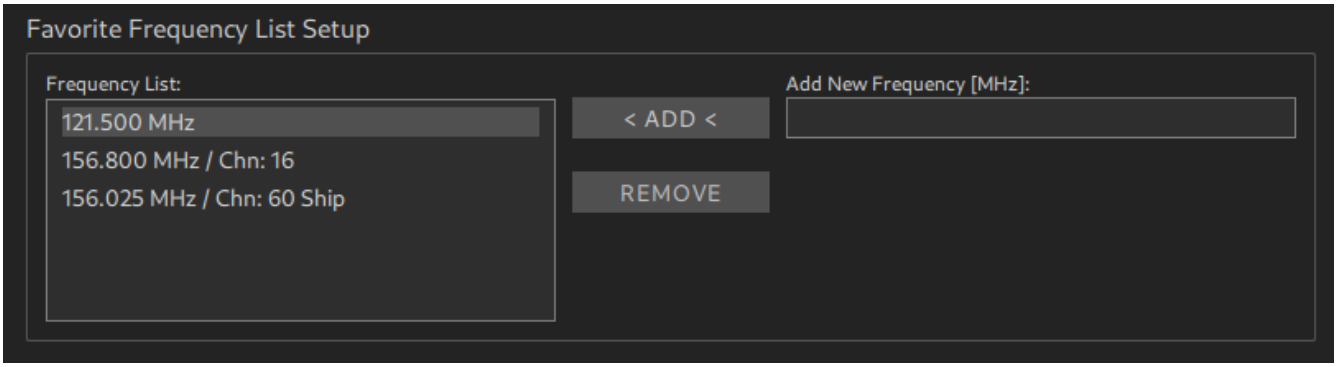


Figure 10: Favorite Frequency List setup

3.2 Map Settings

If the PC / server is connected to the Internet, the map tiles are automatically downloaded from public servers and persistently stored in the cache.

If the computer is offline, the tiles can be loaded into the cache manually. For this purpose, a special ZIP file with the desired area is prepared and provided by RHOTHETA. This file can be loaded by pressing the "INSTALL" button.

Depending on the size of the file, the selection dialog (especially with Windows) may be blocked for a while. Copying can also take some time.
A corresponding "Busy Indicator" is displayed.

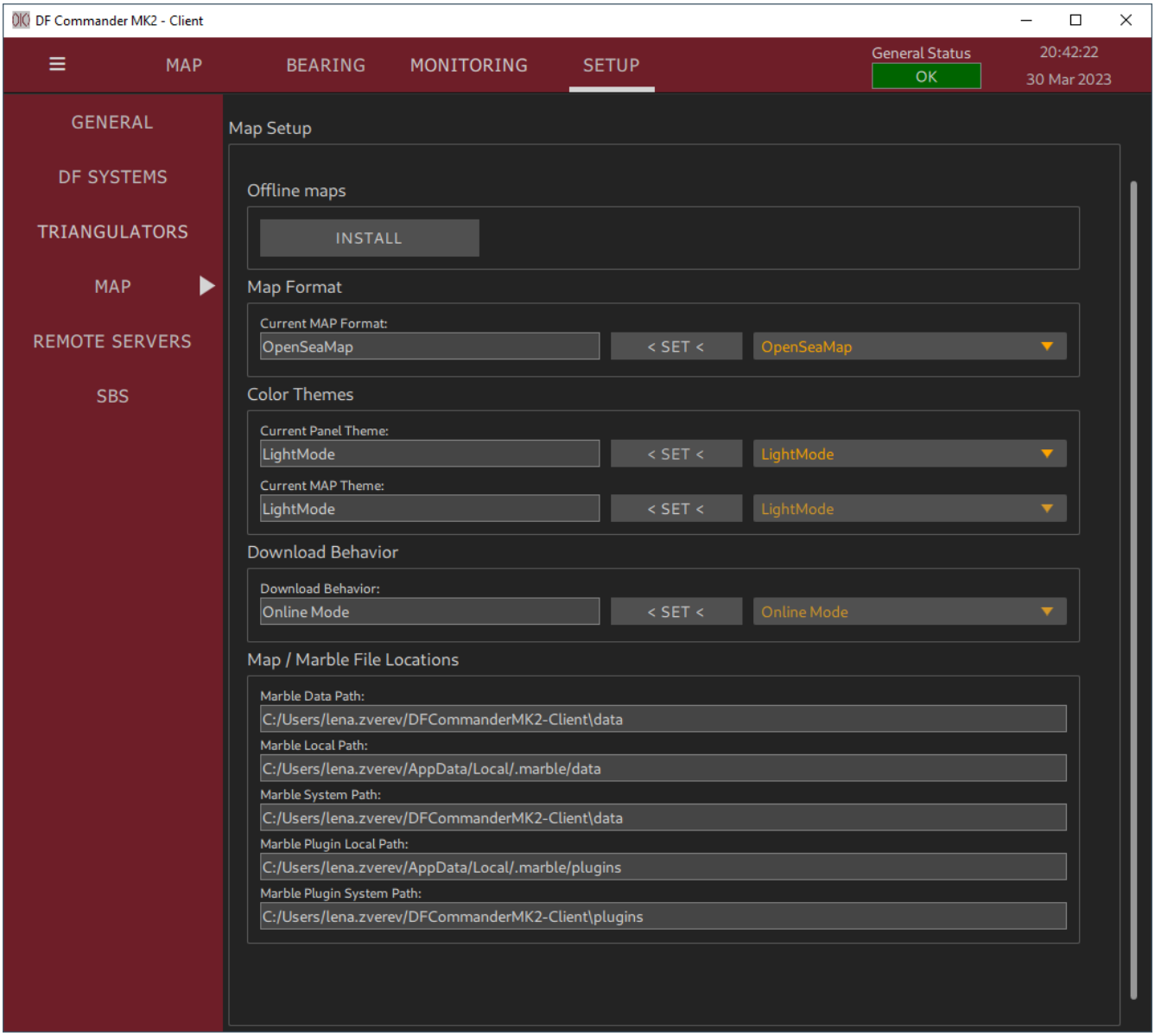


Figure 11: MAP SETUP

Furthermore, different map formats can be set. The following map formats are possible:

- OpenStreetMap Vector
- OpenStreetMap
- OpenSeaMap

- OpenFlightMap

Other formats are also possible on request.
The map theme can be set up. The “Light Mode” and “Dark Mode” are available.

Finally, the download behavior can be controlled by selecting the “Online Mode” or “Offline Mode”.

“Map / Marble File Locations” is an information field and does not require any settings. The paths to the map material and to the plugins are displayed here. This information can be relevant for possible troubleshooting.

3.3 Configuration of a DF System

This chapter shows how to set up a DF system with one direction finding channel. The configuration of several systems and channels is done in the same manner.

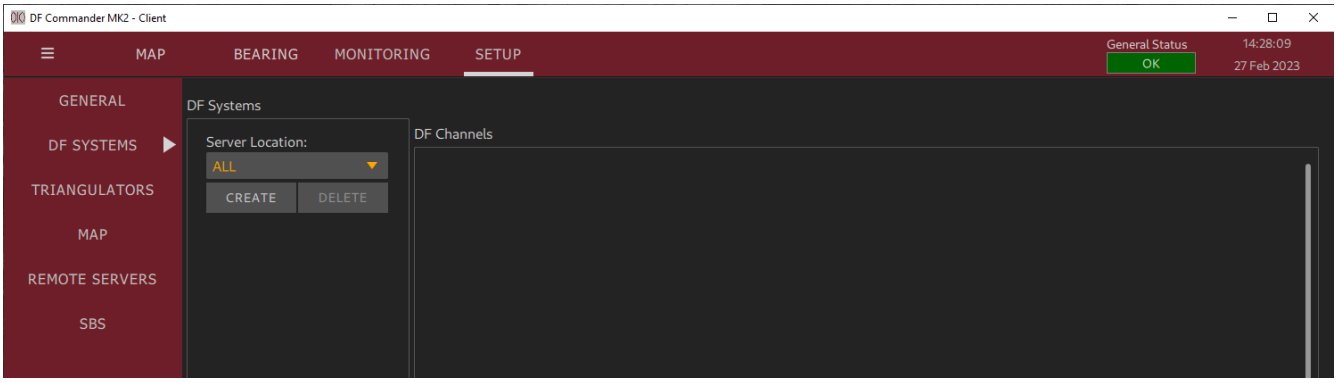


Figure 12: Empty system list

Go to the "SETUP" page, then "DF SYSTEMS" and press "CREATE".
This creates a new DF System entity. The DF system is initially not configured and therefore not able to generate bearing results. For this reason, the corresponding indicator LEDs as well as the “General Status” LED show an error.

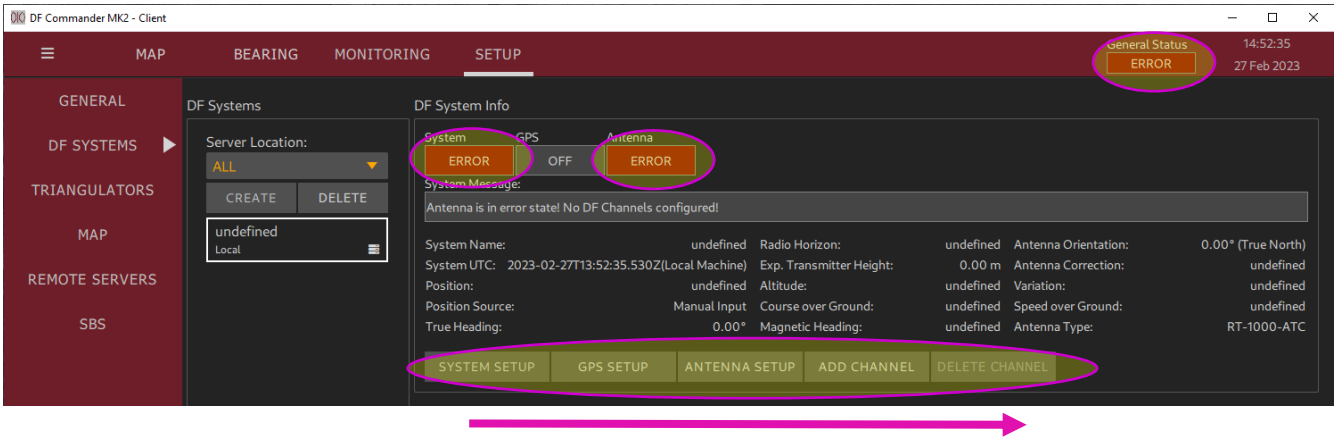


Figure 13: New DF system

In the following, the system will be configured step by step by calling up the corresponding dialogs (see buttons in the figure above) from left to right, which is described in the following chapters in the same order.

3.3.1 System Configuration

Press "SYSTEM SETUP" to open the following dialog:

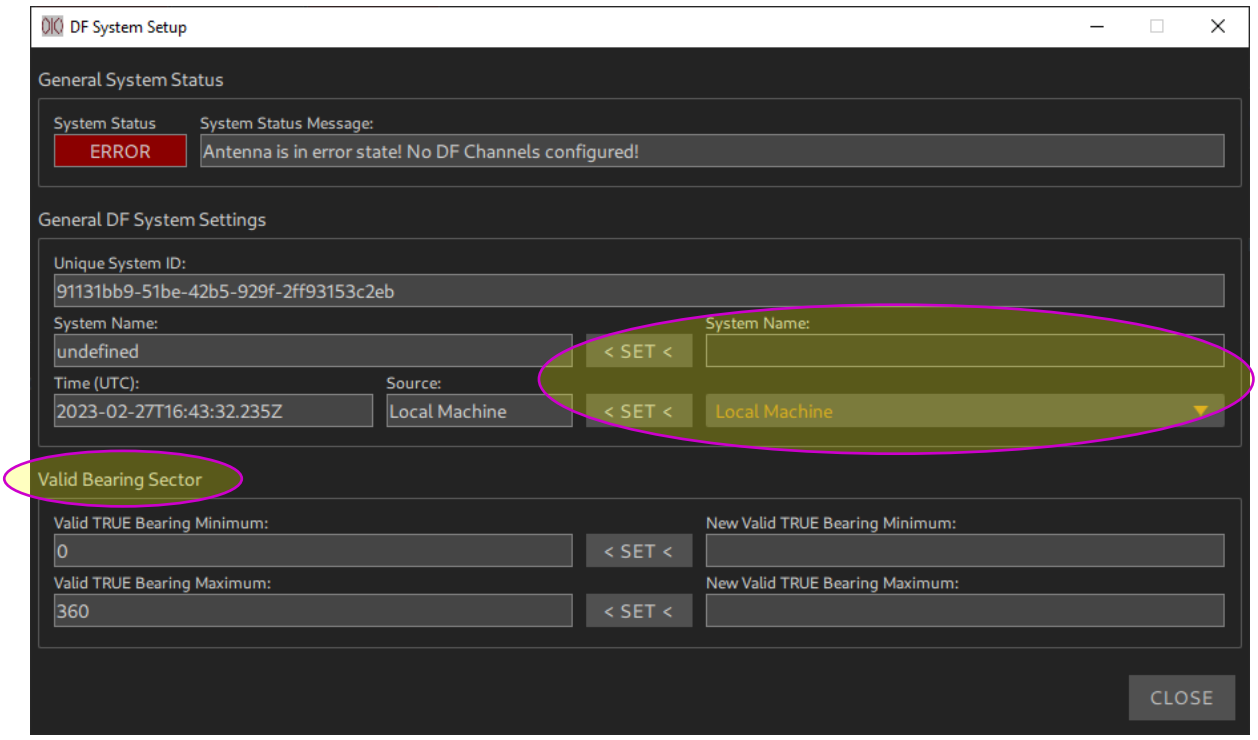


Figure 14: System Setup dialog

Enter a system name (e.g. DF STABERHUK).
The system name is used to assign the system in all displays and status data transmitted via the interface (server). Furthermore, each DF system is assigned a unique system ID.

Set the source for the reference time and press "< SET <".
The bearing values are subsequently provided with the set reference time. This time is also important for logging events (e.g. changes to the system or important error messages).

Two sources are available:

- Local Machine – the time is used by the local computer running DF Commander MK2. If necessary, the computer / server can be synchronized with an appropriate time source via the NTP protocol.
- GPS – the reference time is taken from a GPS device. For this purpose, a GPS device must be configured (see next chapter).

A valid bearing angle sector can be defined in the "Valid Bearing Sector" area in order to hide certain sectors. The DF system then only works in the defined range. The setting is made clockwise from minimum to maximum. For example, a setting from 270° to 45° means that the DF system accepts the TRUE bearing values from 270° west via 0° north to 45° as valid. The figure below shows the representation of the valid bearing sector on the map by the green circle segment.

Figure 15: Valid bearing sector

Bearing values that are outside of this range are not displayed, are not evaluated by other modules such as Triangulator and are not passed on via the protocol.

3.3.2 GPS Configuration

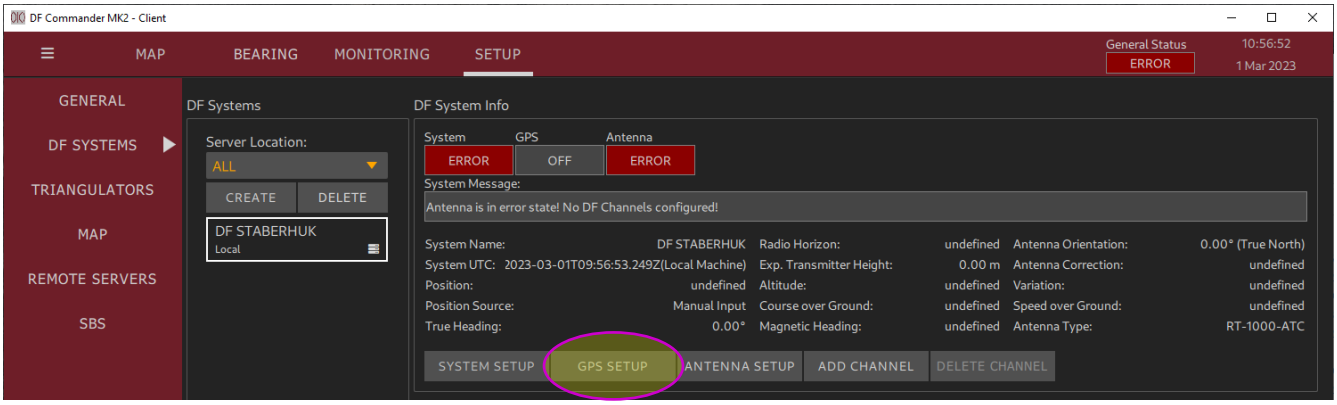


Figure 16: GPS Setup button

Press "GPS SETUP" to enter the settings of the GPS device.

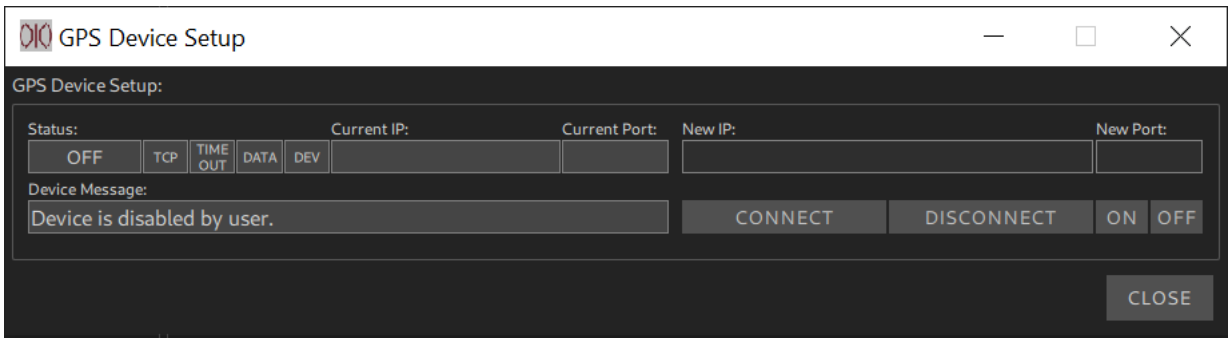


Figure 17: GPS Device setup

If the DF system used is not a mobile system, but is fixed in one place and the reference time is taken from the local machine, the GPS device can remain switched off.
Press "OFF" if the status is not shown as OFF.

The GPS device must be configured, however, if you either want to

- determine the GPS position of the antenna using a GPS device, or
- equate the orientation (heading) of the antenna to the course over ground (COG), or
- determine the reference time of the system by means of a GPS device.

The prerequisite for this is that a GPS device can send the common GPS sentences in an NMEA-0183 format via a network interface. This can be achieved by having an RS-232 / RS-422 device send its data via a serial to LAN converter (e.g. MOXA NPort device). If the prerequisite is fulfilled, only a TCP/IP connection must be established.

Press "ON", enter the IP address in the "New IP" field and the TCP port in the "New Port" field and press "CONNECT". The result must now look like this:

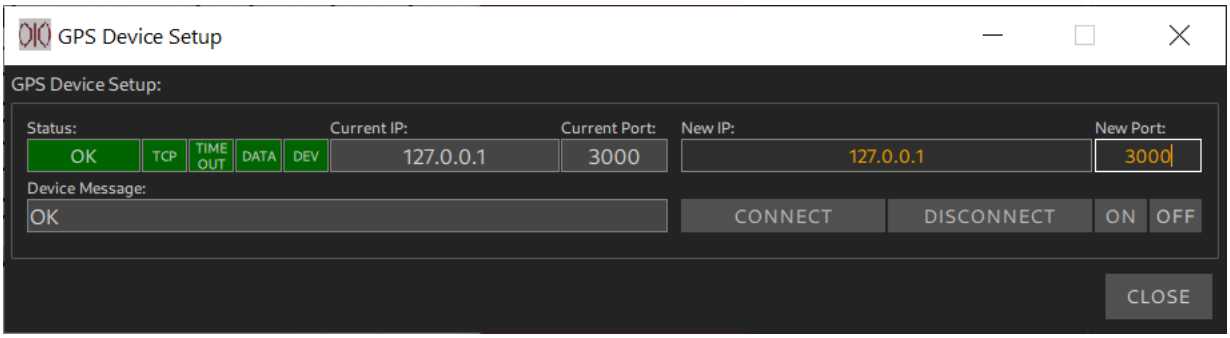


Figure 18: GPS device setup connection established

In the event of an error see Chapter 4 Status Displays.

3.3.3 Configuration of the Antenna Properties

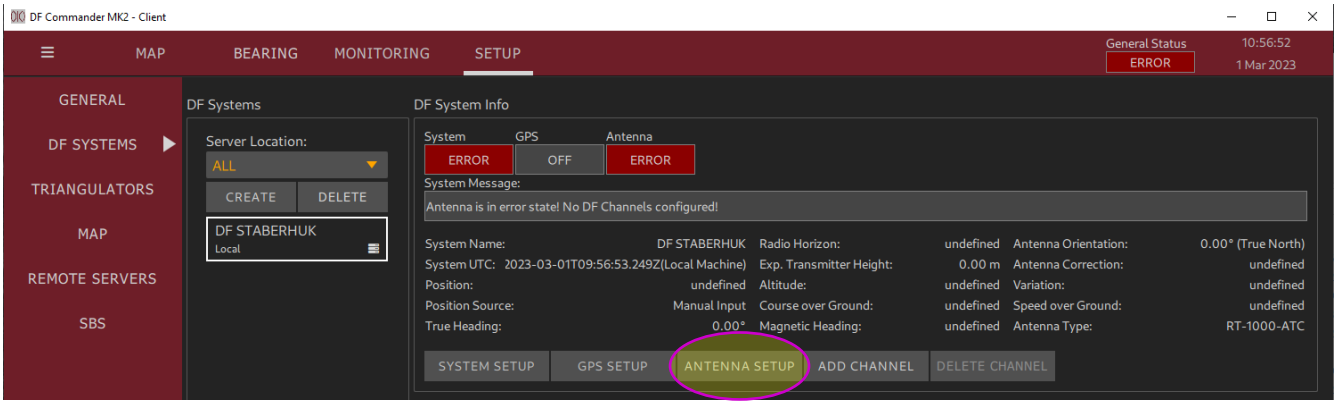


Figure 19: Antenna setup button

Press "ANTENNA SETUP". The following window opens.

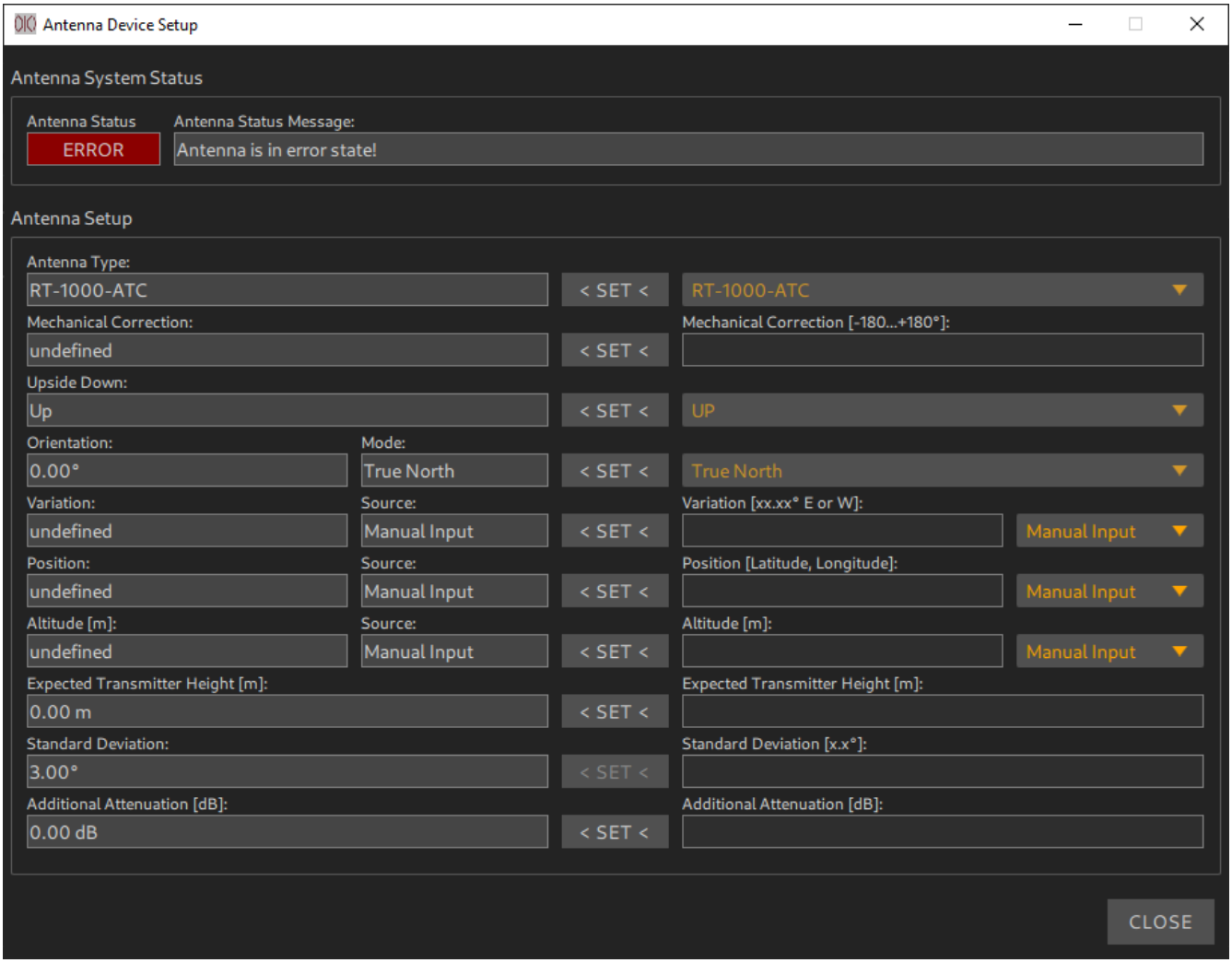


Figure 20: Antenna setup (not configured)

Initially, the antenna is in an error state because there are not enough parameters set to take bearings. For this reason, the corresponding DF system is also in the error state.

Then all parameters must be set one after the other. Finally, the antenna must display the status OK.

NOTE:
Basically, the menu is structured in such a way that the current settings are displayed on the left. On the right, however, new values can be entered or selected. Press "< SET < " to apply the new settings. After setting they should appear accordingly in the left area.

Antenna Type:
Select the type of antenna used and press “< SET <”.
With this selection, the system knows the most important antenna characteristics such as antenna gain. This allows the field strength in dBµV/m of the incoming wave fields to be determined.

Mechanical Correction
Set the correction value for the mechanical offset.
Assuming that during the measurement of the direction finding system it was determined that the antenna is mounted incorrectly by + 5.7°, the correction value must be set to -5.7° accordingly.
The mecanical correction value cannot be omitted. Even if the installation is perfect and there is no mechanical offset, the value 0° must be entered for this setting. Otherwise, the antenna status will remain in the error state.

Upside Down
Set whether the antenna is mounted vertically upright (UP) or upside down (DOWN).
This parameter is mostly relevant for mobile direction finder systems, which are e.g. mounted on the underside of the fuselage of an aircraft or on a drone. This type of mounting must be taken into account when determining the bearing. For fixed installations, the setting is usually "UP".

Orientation
Set how the antenna is oriented.

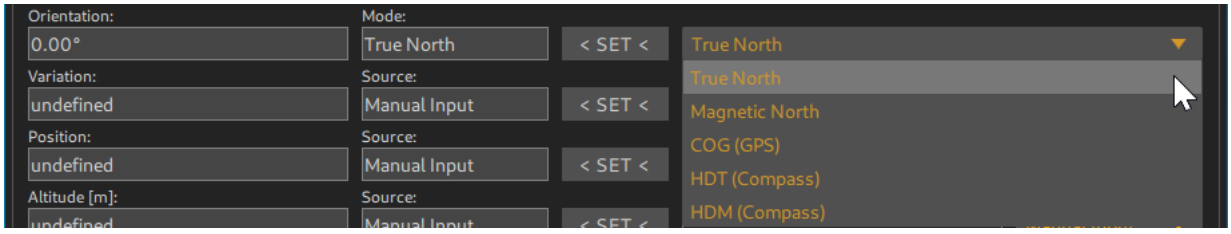
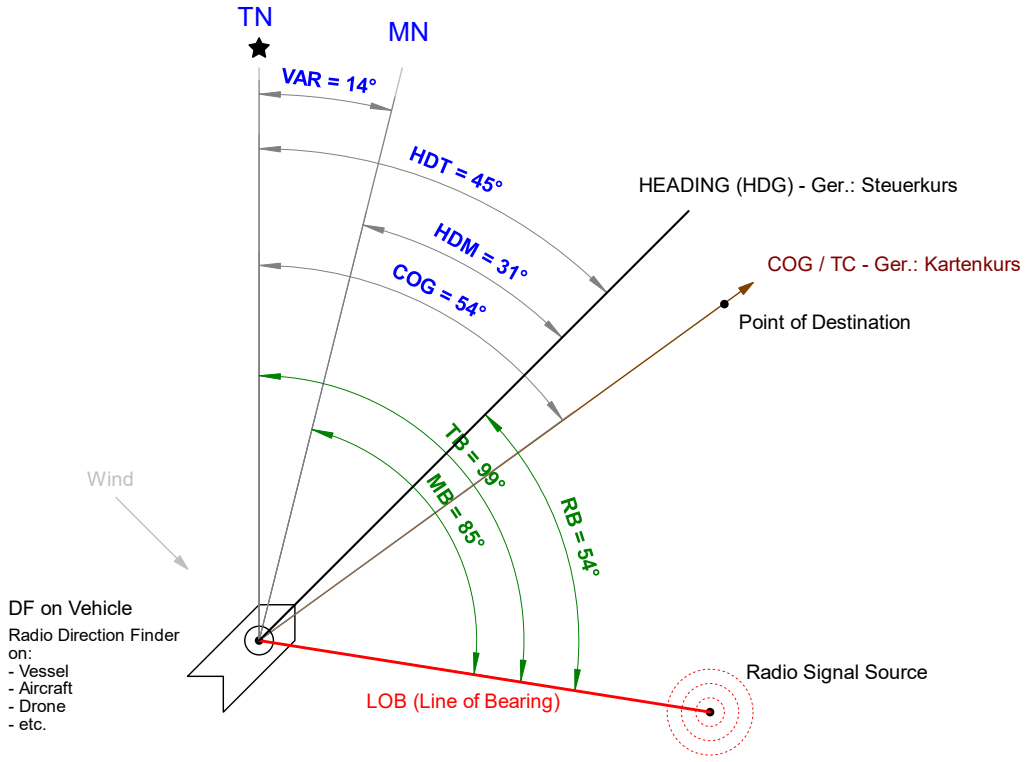


Figure 21: Setting options for antenna orientation

If the antenna is mounted on a ship or aircraft, the orientation of the antenna corresponds to the heading (HDG).
For the calculation of north-related bearing values such as TRUE BEARING or MAGNETIC BEARING, knowledge of the antenna orientation is essential. The explanation of the correlations between the bearing values and the antenna alignment is shown graphically in the following figures (Figure 22 and Figure 23).

The following settings are possible:

True North	The antenna is oriented 0° to geographic north. HDG = HDT = 0°
Magnetic North	The antenna is oriented 0° to magnetic north. HDG = HDM = 0°
COG (GPS)	For the antenna alignment or orientation the "Course Over Ground" is used by the configured GPS device. HDG = COG = HDT
HDT (Compass)	For the antenna alignment or orientation the "Course Over Ground" is used by the configured GPS device. HDG = HDT
HDM (Compass)	For the antenna alignment or orientation the "Course Over Ground" is used by the configured GPS device. HDG = HDM



TN - True North
MN - Magnetic North
VAR - Magnetic Variation = Declination (+14° = 14°E; -14° = 14°W)

HDG - Heading (Can be true or magnetic depending on sensor in use)
HDT - Heading True Aviation: TH - True Heading
HDM - Heading Magnetic Aviation: MH - Magnetic Heading

COG - Course over Ground Aviation: TC - True Course

RB - Relative Bearing

TB - True Bearing Aviation: QTE - True bearing from DF to a signal source
QUJ - True bearing from a signal source to DF

MB - Magnetic Bearing QDR - Magnetic bearing from DF to a signal source
QDM - Magnetic bearing from a signal source to DF

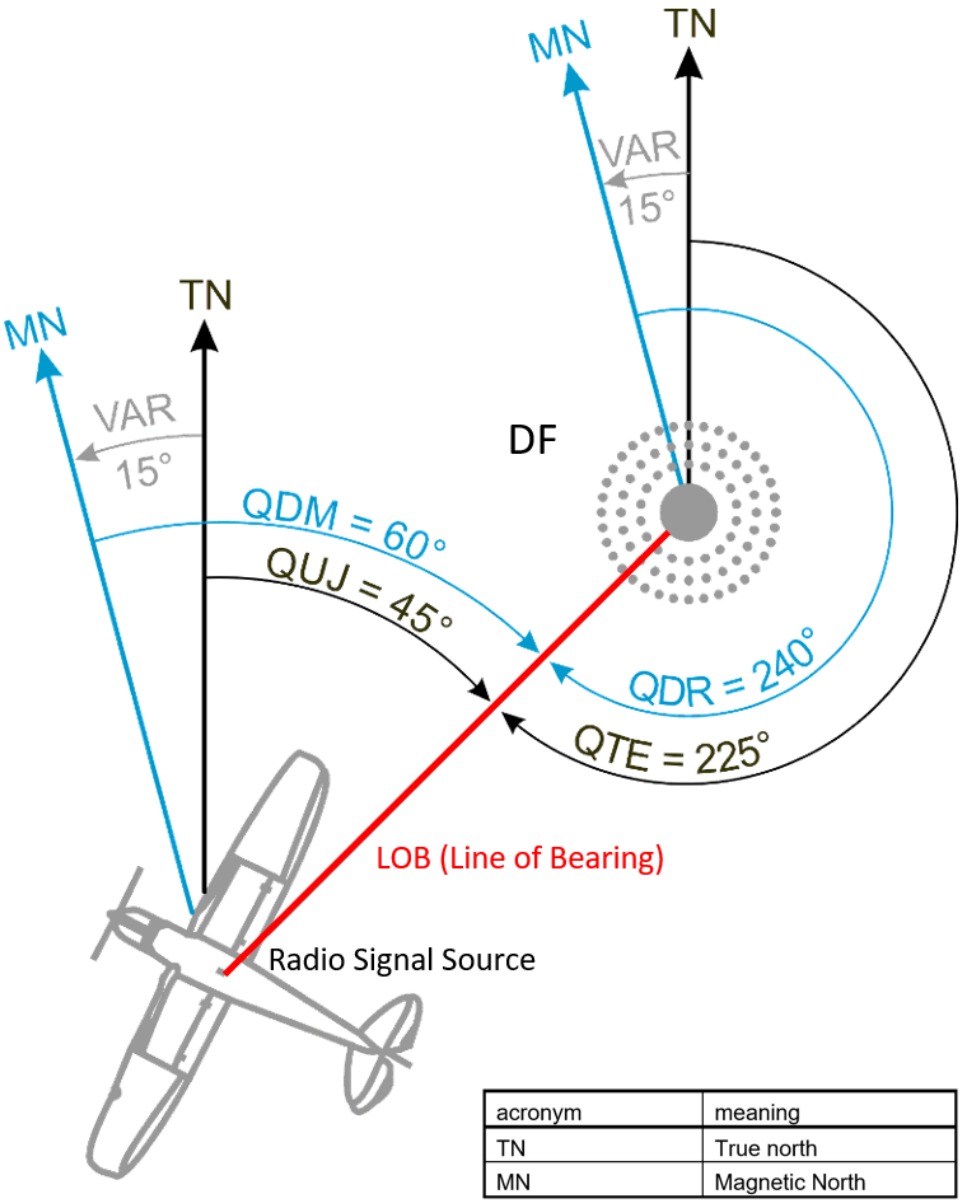
FORMULAS:

HDT = HDM + VAR
HDM = HDT - VAR

TB = RB + HDT
MB = RB + HDM

QTE = TB
QUJ = QTE + 180°
QDR = MB
QDM = QDR + 180°

Figure 22: Correlation of antenna alignment and bearing values for mobile DF systems



acronym	meaning
TN	True north
MN	Magnetic North

Switch Position / Reference Direction Display	Meaning	Reference Direction	
QDM	Magnetic bearing (course) of aircraft / vessel to the DF station	Magnetic north	QDM = QDR ± 180° QDM = QUJ - VAR
QDR	Magnetic bearing from the DF to the aircraft / vessel	Magnetic north	QDR = QDM ± 180° QDR = QTE – VAR
QTE	True bearing from the DF to the aircraft / vessel	True north	QTE = QUJ ± 180° QTE = QDR + VAR
QUJ	True bearing (track) of aircraft / vessel to the DF station	True north	QUJ = QTE ± 180° QUJ = QDM + VAR
VAR[1]	Variation		

Figure 23: Correlation of antenna alignment and bearing values for fixed bearing systems

[1] West variation values are evaluated with the sign "-" and East values with the sign "+".

Variation

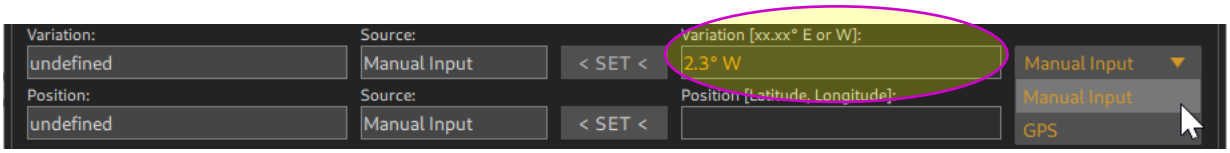


Figure 24: Setting the variation

Set the variation of the location.
If the DF antenna is mounted at a fixed position, it is recommended to select "Manual Input" and to enter the variation of the location manually. First the degrees are entered followed by the letter "E" or "W".
"W" stands for a negative, western variation. "E" on the other hand for a positive, eastern variation.
For example, 2.3° W corresponds to -2.3°.

In the case of a mobile DF system, the variation can be taken from a configured GPS device, provided that the GPS device supports the determination of the variation.
To do this, set the variation to "GPS".

Position

Figure 25: Entering the position

Set the GPS position of the direction finding antenna.

For a permanently installed antenna:
Select "Manual Input" and enter the GPS position.
The following formats are supported:

Example:

Decimal Degrees (D):	54.300252°N 11.528357°E
Degrees and Decimal Minutes (DM):	54°18.842'N 11°32.125'E
Degrees Minutes Seconds (DMS):	54°16'47.79"N 11°32'16.51"E

The position can be copied directly from the map:
- To do this, close the menu. The settings are not lost in the process.
- Go to map view.
- Navigate and zoom to the desired position with the mouse and press the right mouse button.
- Press "Copy Coordinate".
- Go back to the antenna settings and click on the field to enter the position.
- Paste the copied position in the input field (key combination CTRL + V).

For a mobile DF antenna:
Set source to GPS.
The position of the antenna is updated accordingly.

Altitude

Set the antenna altitude.

Figure 26: Setting the antenna altitude

The altitude is important for the calculation of the radio horizon, it determines the range of the direction finder, if the altitude of the emitting objects is known.

For a permanently installed antenna:
Select "Manual Input" and type in the altitude manually.

For a mobile DF antenna:
Set the source to GPS.
If the altitude of a mobile radio direction finding system does not change, it can also be entered manually.
If the bearing system is installed on a ship, it is also useful to enter the altitude manually. In the case of an aircraft installation, GPS should be set as the source.

The altitude setting cannot be omitted. If this value is not set, the antenna status remains in the error state.

Expected Transmitter Height

Figure 27: Enter Expected Transmitter Height

Set the expected height of the transmitter.

In the case of a maritime application, the "Expected Transmitter Height" could correspond to a usual or minimum height of the ship's radio antenna (e.g. 5 m).
In the case of an air traffic control scenario, the minimum flight altitude of the aircraft to be located (e.g. 300 m) can be entered here.
The radio horizon is calculated in the system from the altitude of the antenna and the expected transmitter height.

NOTE:
The radio horizon can be displayed on the map by right-clicking on the bearing system.

Standard Deviation

Figure 28: Setting the standard deviation

Set the standard deviation of the bearing system.

This setting results either from the measurement of the bearing accuracy at the location or can be taken from the data sheet of a corresponding radio direction finder. The standard deviation is also transmitted to the connected clients as a system parameter. It can be used for display inaccuracy or used for other calculations.

Additional Attenuation

Figure 29: Setting the additional attenuation

If an additional RF cable is used between the antenna and the DF system, its attenuation should be entered in the useful frequency band. This attenuation is used in the calculation of the field strength in dBµV/m.

Result

After all parameters have been entered, the "Antenna Device Setup" window should look like this, for example:

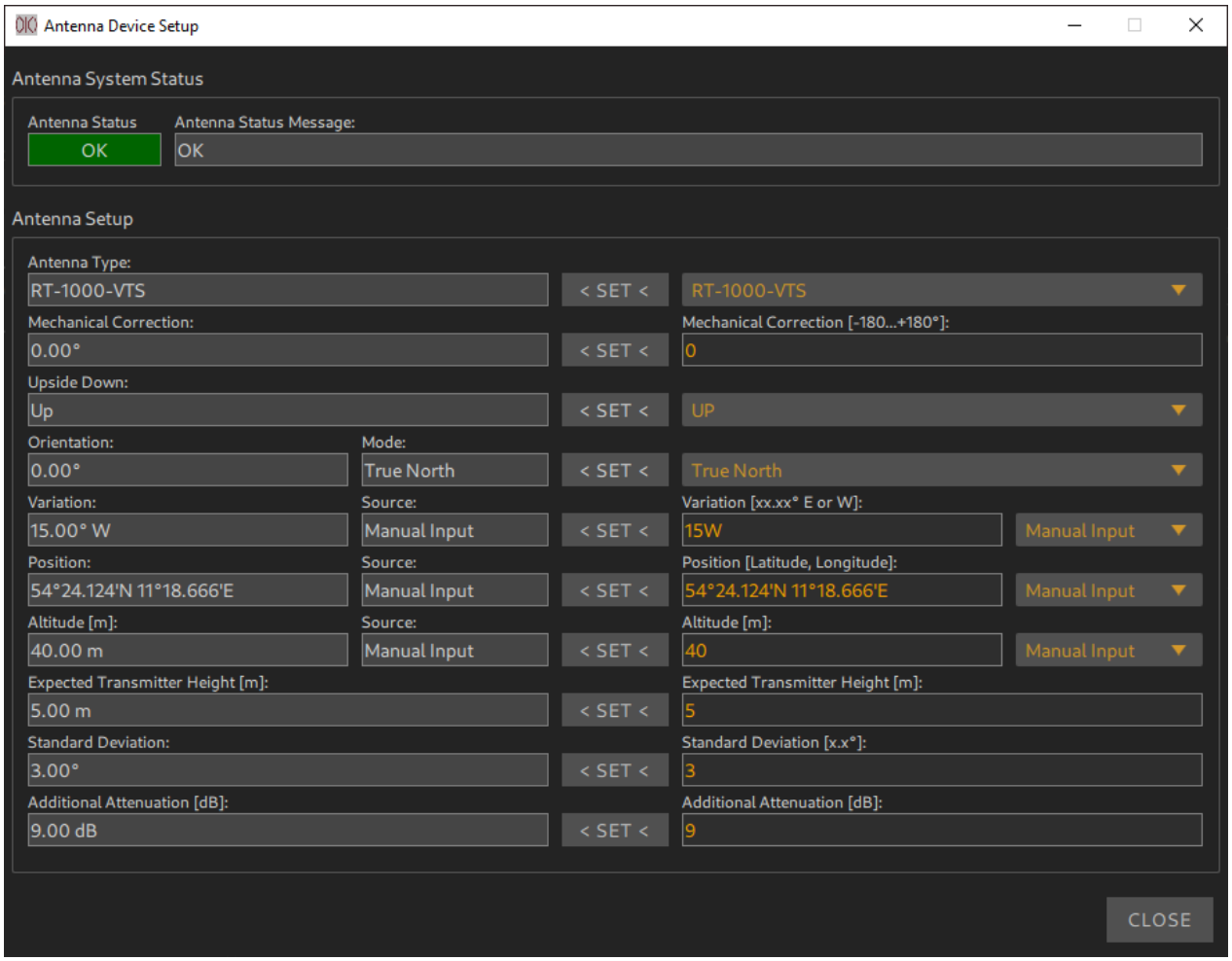


Figure 30: Antenna setup (configured)

3.3.4 Channel Configuration

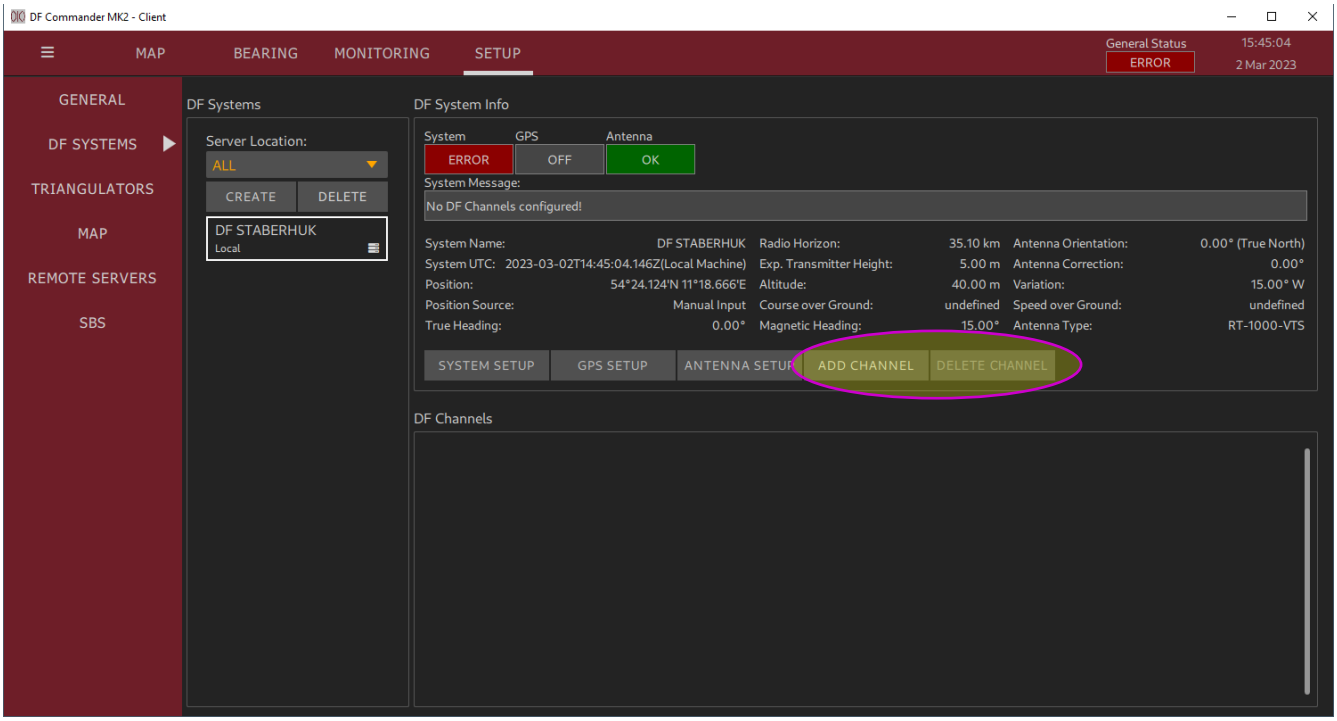


Figure 31: Antenna is configured in DF SETUP

Channels can be added or removed from a DF system.
To do this, use the "ADD CHANNEL" or "DELETE CHANNEL" buttons. The channel to be deleted must be selected explicitly.

From the list of systems, select the system to which you want to add a new channel. Then press "ADD CHANNEL" to create a new bearing channel for the selected system.

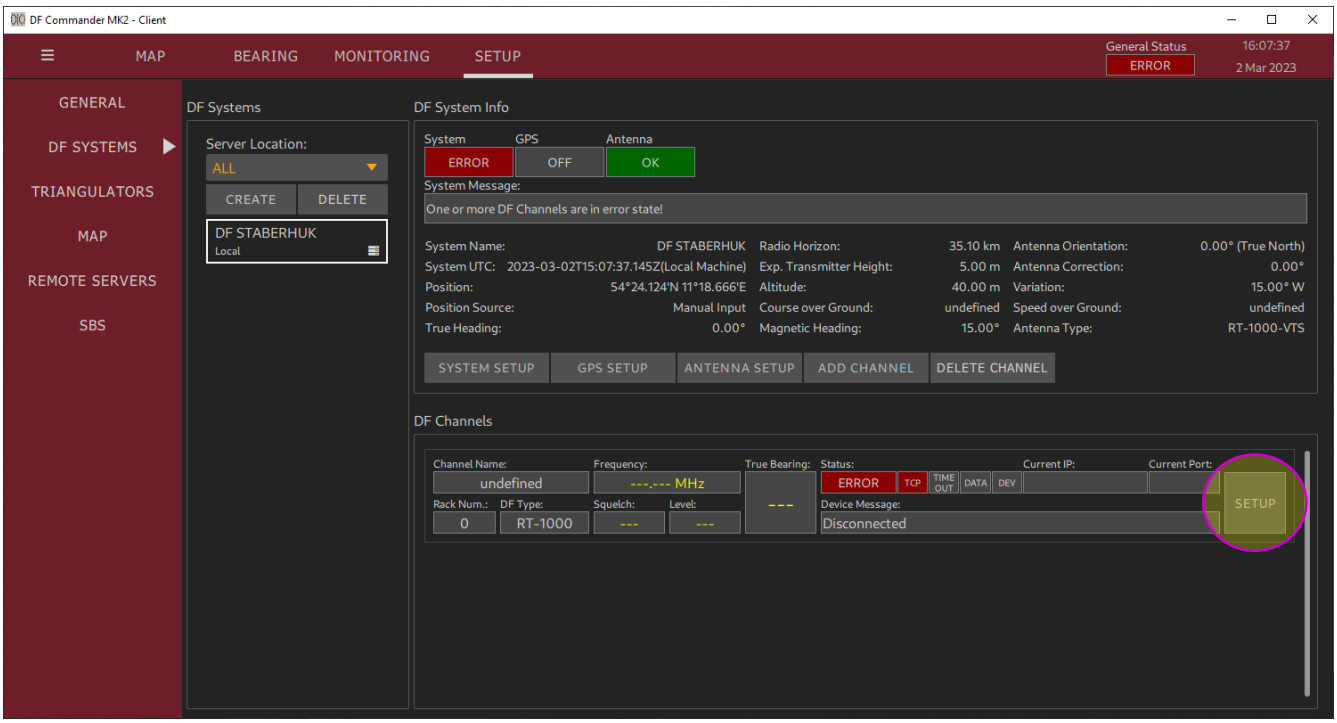


Figure 32: New bearing channel has been added

Press "SETUP" to configure the channel.

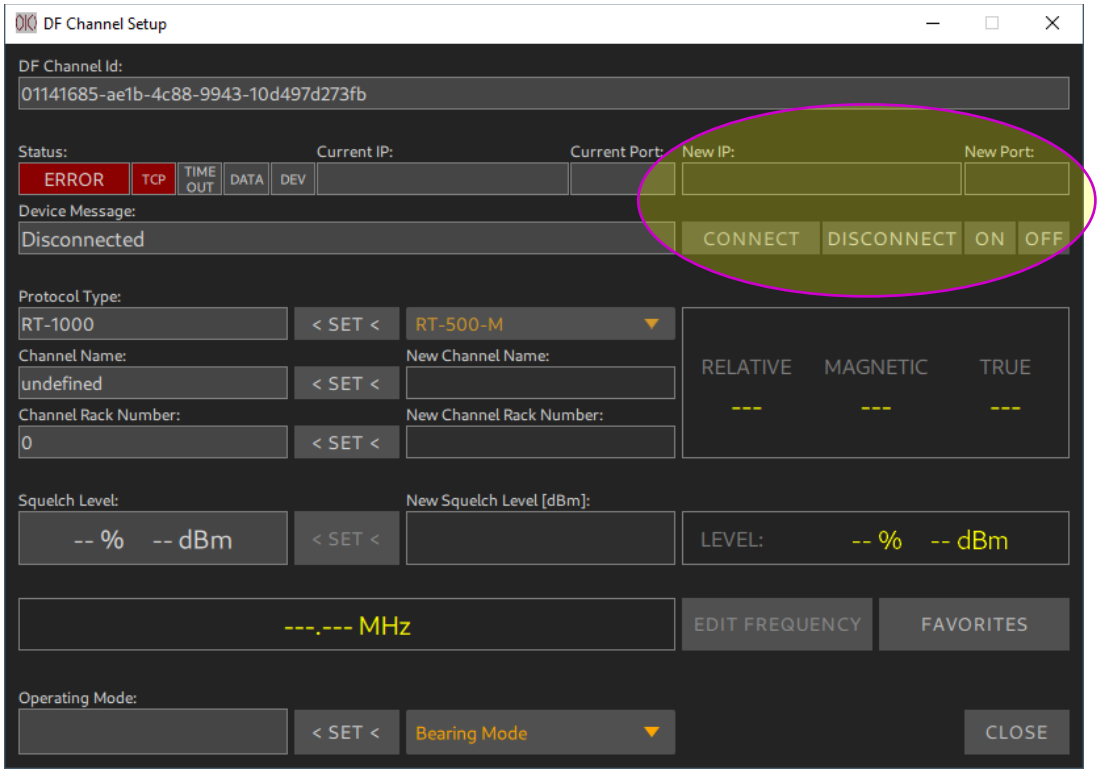


Figure 33: Configuration of a DF channel

Create a TCP/IP connection to the corresponding DF channel by entering the IP address and port in the "New IP" and "New Port" fields and pressing "CONNECT". See Chapter 4 "Status Displays" in case of problems with the connection.

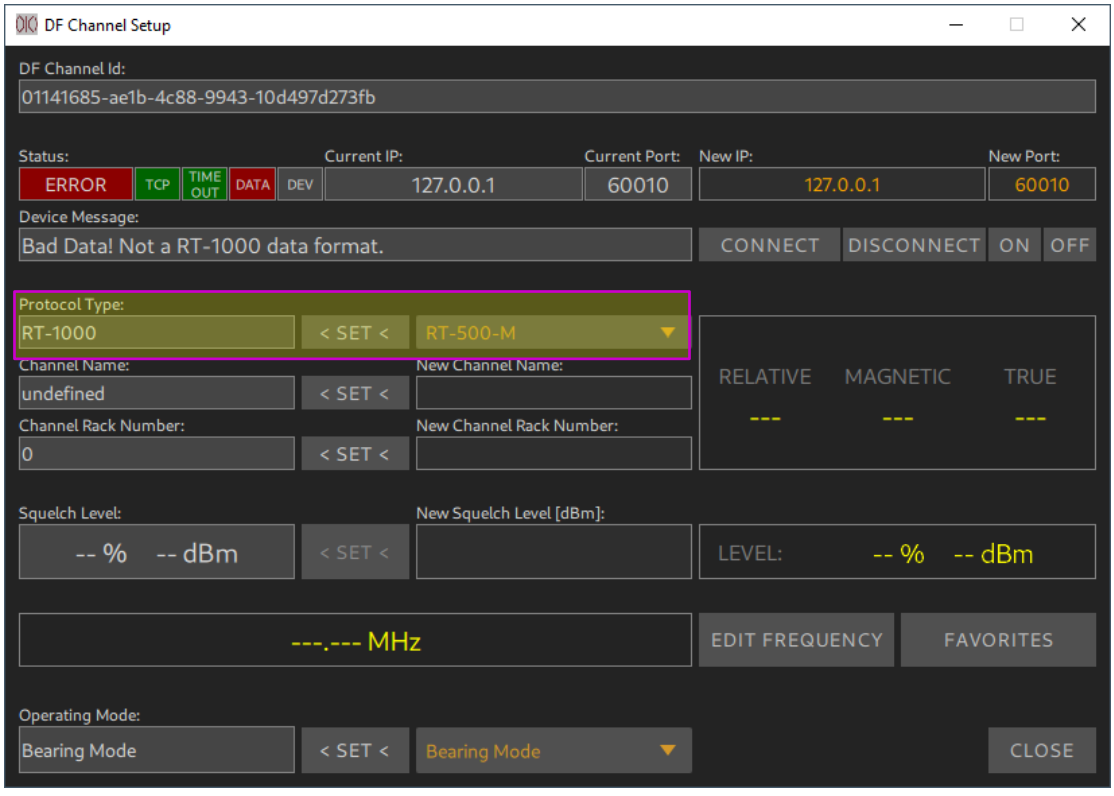


Figure 34: Establishing the connection to the DF channel

In this case, the connection to the RT-500-M system was successfully established. The green "TIMEOUT LED" indicates that the device is sending out its data cyclically. However, the protocol type is set for the RT-1000 system. This means that the data from the RT-500-M system cannot be evaluated.

Protocol Type
Set the protocol of the bearing system used.
In the example shown above, the protocol must be set to RT-500-M because the RT-500-M bearing data are received (RT-500-M simulator is used).

Channel Name
Assign a name to the bearing channel: Type it in the "New Channel Name" field and press "< SET <".

Channel Rack Number
In the case of a radio direction finder with several direction finding channels, a corresponding number can also be assigned in the rack.

After successfully entering the parameters, the window should look like the following figure.

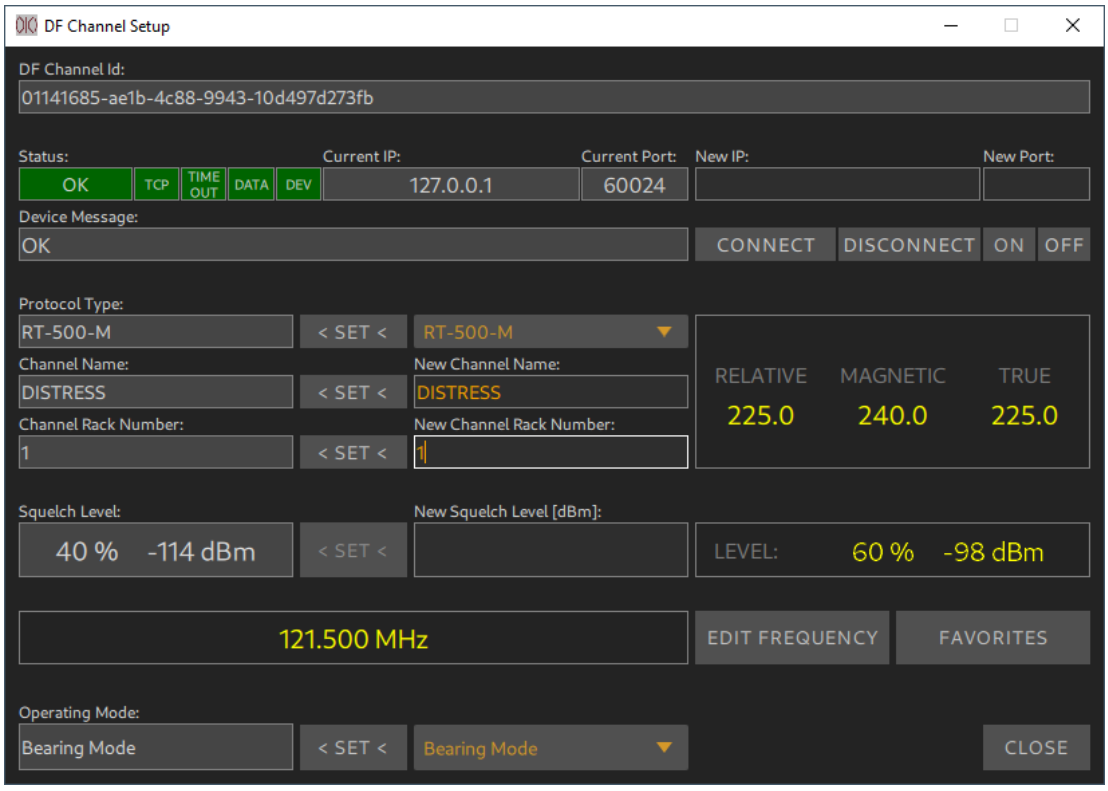


Figure 35: Successful channel setting

In this example, the DF channel receives a signal on 121.500 MHz with a level of 60% which corresponds to -98 dBm at the receiver input. The squelch level is set to -114 dBm (40%). Since the receive level is 16 dB higher than the set squelch level, the bearing is set accordingly.
For example, the bearing channel determines a relative bearing of 225°. Since the antenna has been aligned to "True North" and a mechanical correction of 0° has been set, the "True Bearing" corresponds to the relative bearing value of 225°. The variation of the location was

set to 15° W in the antenna settings, i.e. -15°. This results in a value of 240° for the "Magnetic Bearing".
The values correspond to the example from Figure 23: Correlation of antenna alignment and bearing values for fixed bearing systems.

Setting the Squelch Level

Figure 36: Squelch setting

Enter the squelch level value in dBm in the "New Squelch Level [dBm]" field and press "< SET <".
Depending on the network connection, the setting may take some time. After the successful setting the new "Squelch Level" must appear in the left area.

Setting the frequency

Figure 37: Frequency setting

A new frequency can be set either directly or from the favorites list.
Press "EDIT FREQUENCY" to enter the frequency directly.

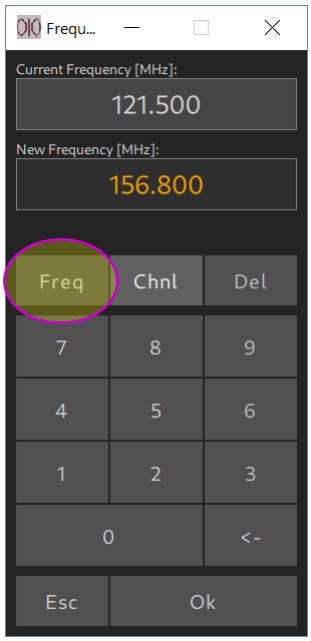


Figure 38: Input in MHz

Enter the new frequency in MHz and press “OK”.

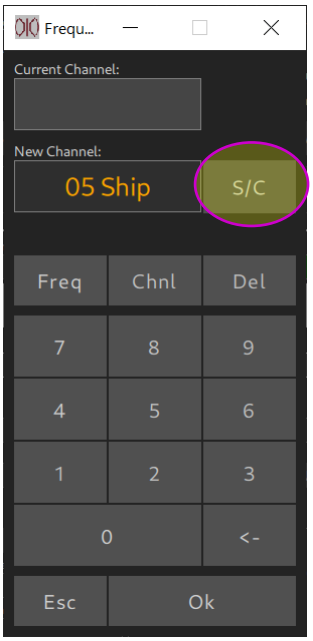


Figure 39: Input as VHF channel

Enter the maritime VHF channel number. If the VHF channel is a duplex channel, Ship or Coast must be selected accordingly. To do this, press "S/C". Then press “OK”.

If no entry is made, the dialog closes automatically after approx. 10 seconds.
Press "FAVORITES" to enter the frequency from the favorites list.

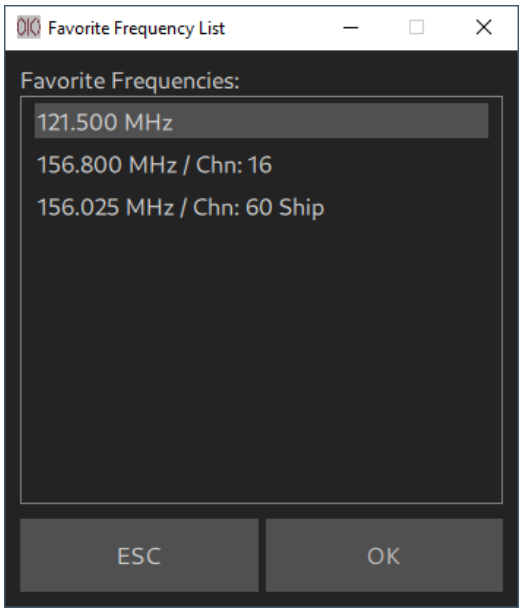


Figure 40: Entry from the favorites list

Select the desired frequency and press “OK”.

Depending on the network connection, setting the frequency may take some time. After successful setting, the newly set frequency is displayed.

If no new frequency appears after approx. 8 seconds, the frequency could not be set. An error message is displayed.

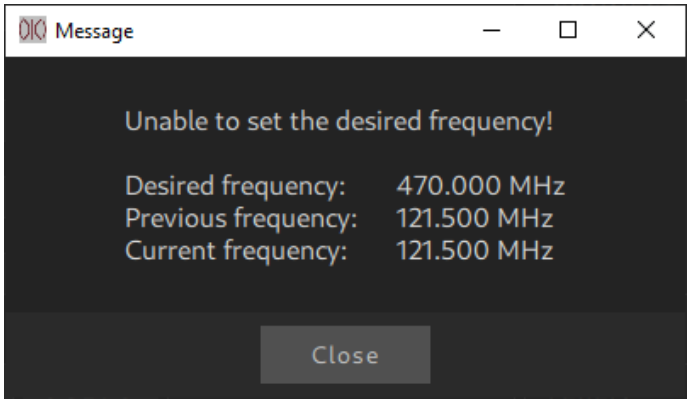


Figure 41: Frequency error message

Possible causes are either that the network transmission took more than 8 seconds or that the bearing channel does not support the desired frequency.

3.3.5 Checking the Configuration

A DF system with one DF channel was set. Now the settings are to be checked.

Checking on the SETUP page

The setup menu should look like the following picture. None of the control LEDs should light up red. The system is configured locally, which is shown additionally.

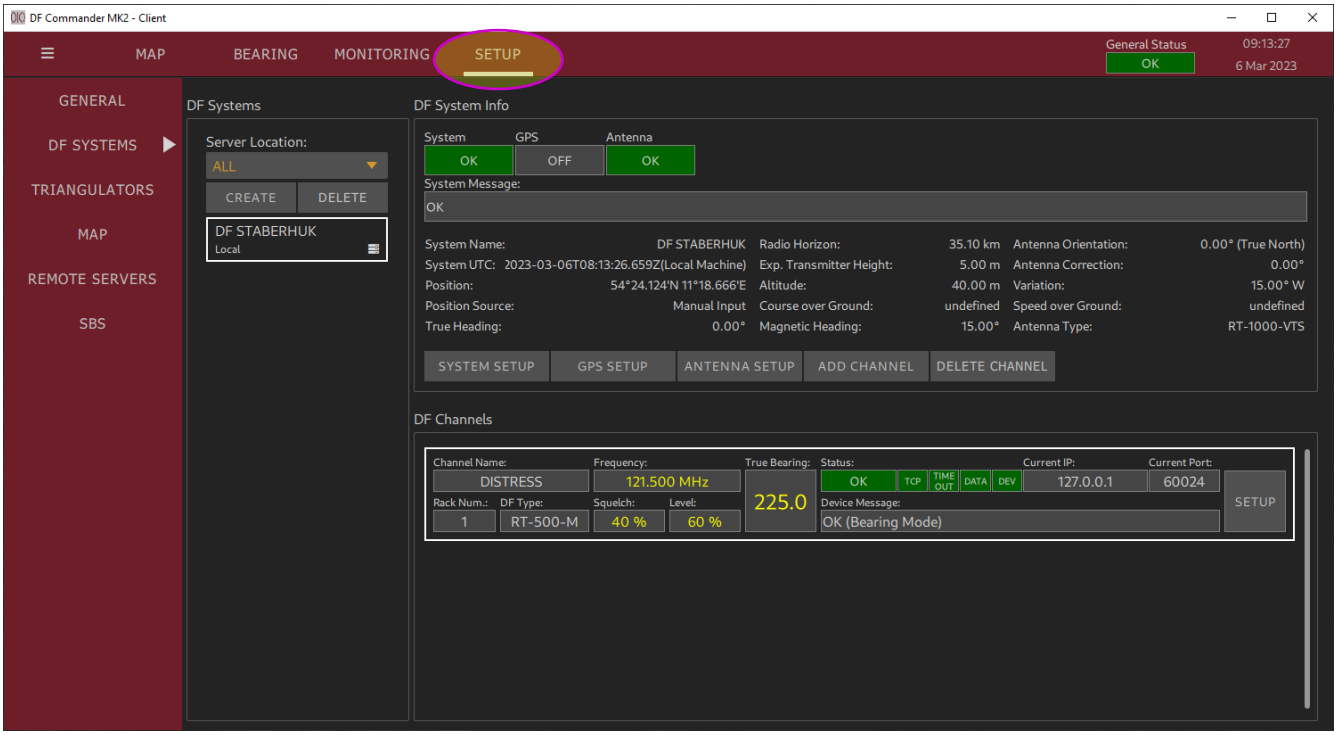


Figure 42: Checking in the SETUP menu

Checking on the MONITORING page

Switch to the "Monitoring page" / “General Status Monitoring” by pressing the "MONITORING" button. None of the control LEDs should light up red.

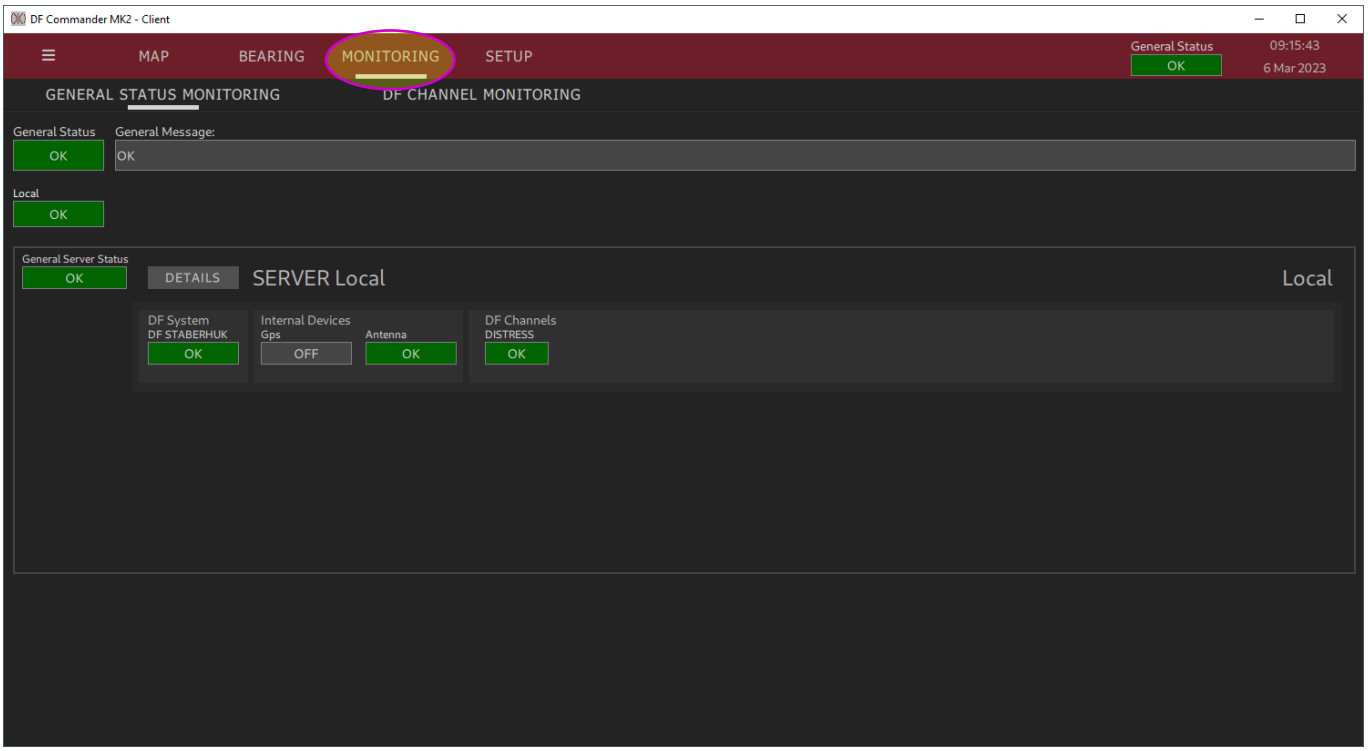


Figure 43: Checking on the MONITORING page / General Status Monitoring

Checking on the MAP page

To do this, switch to the map view and navigate to the set position of the DF antenna.
The DF system must appear on the map view.
Press the right mouse button on the bearing system to display the radio horizon.

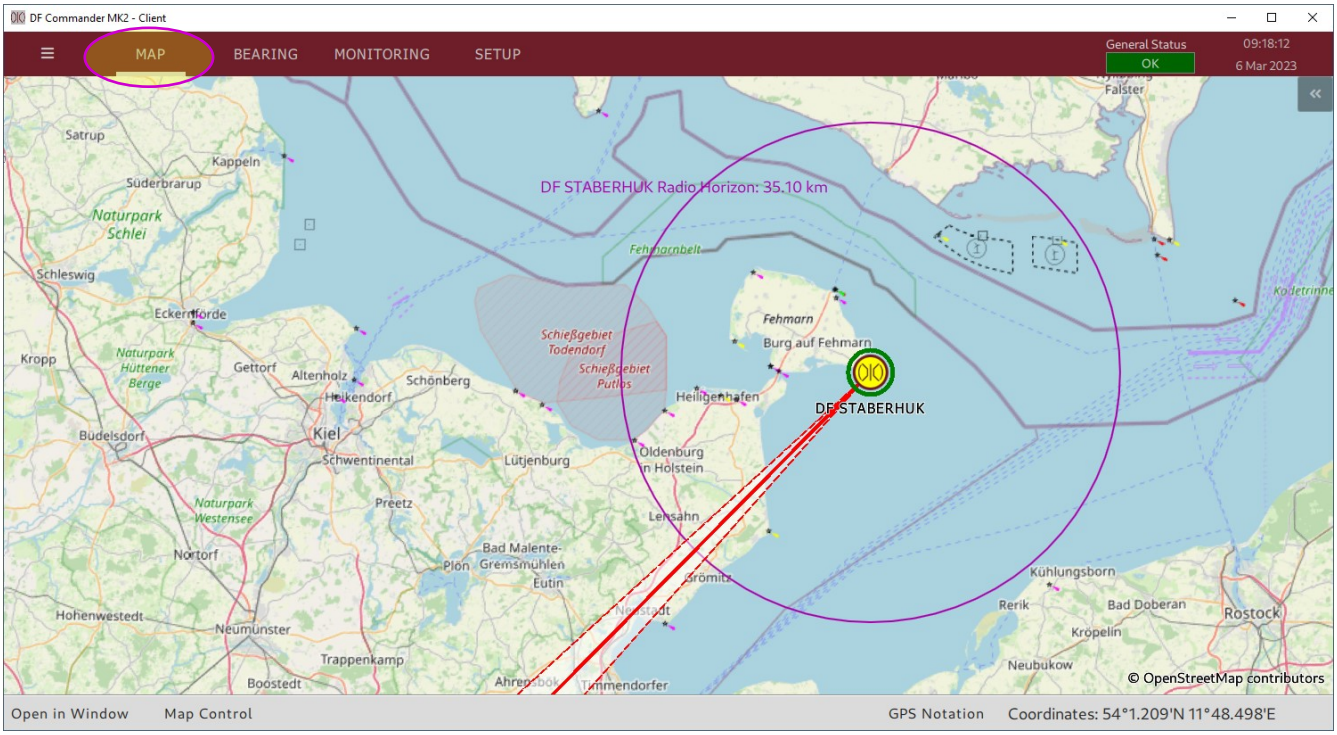


Figure 44: Checking on the MAP page

This completes the configuration of a DF system with one DF channel. Configuration of further systems and channels follows the same principle.

3.4 Triangulator

To be able to determine cross bearing results, also called triangulation results, the triangulator must be configured. However, this requires a successful configuration of at least two radio direction finding systems, each with at least one channel.

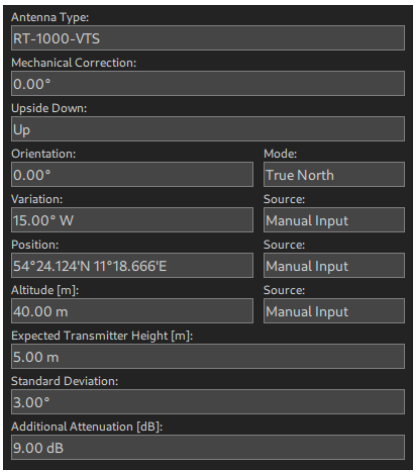
3.4.1 Configuration

In the following example, the triangulator is set up so that cross bearing results on two different frequencies from three independent radio direction finding systems can be calculated and displayed simultaneously.

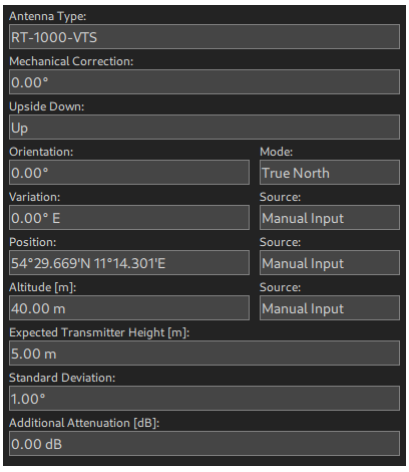
Example of the sysems configuration
The radio direction finding systems must be configured before the configuration of the triangulator can be started.

Three radio direction finding antennas are configured as follows.
For other relevant system settings see the chapter 3.3 Configuration of a DF System (GPS does not need to be configured).

STABERHUK:



MARIENLEUCHTE:



WESTERMARKELSDORF:

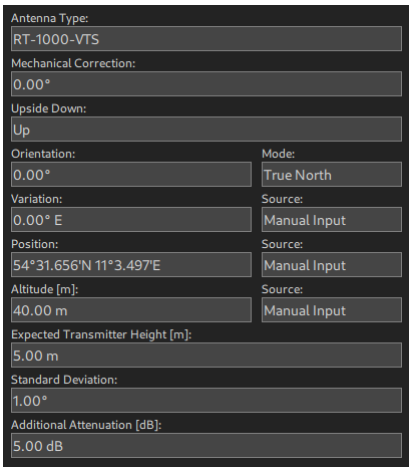


Figure 45: Configuration of radio direction finding antennas

To make the setting eye-catching, each channel's bearing in this example is made using a DF simulator.
See the "MONITORING -> DF CHANNEL MONITORING".

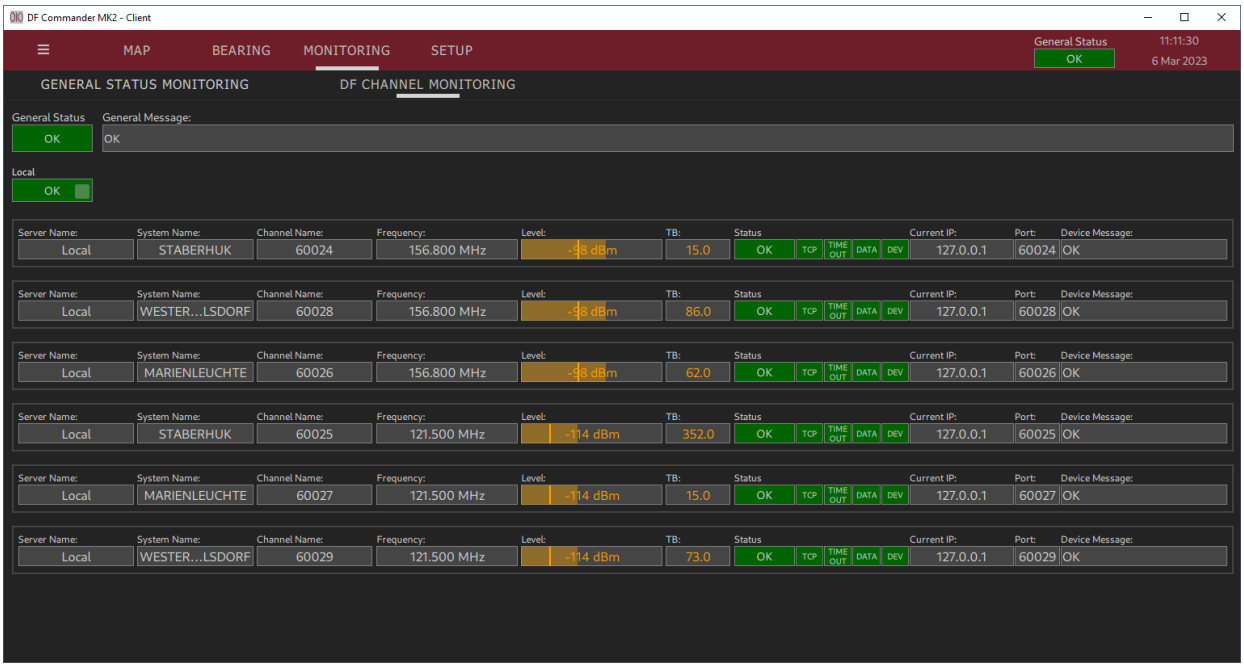


Figure 46: Direction finding channels on monitoring page / DF Channel Monitoring

Task definition for triangulator configuration

The radio direction finding systems
- STABERHUK
- MARIENLEUCHTE
- WESTERMARKELSDORF

are to be used for the determination of the cross bearing.

Cross bearings should be able to be performed on the
- 121.500 MHz
- 156.800 MHz

frequencies.

Configuration of Triangulator

Go to “SETUP -> TRIANGULATORS” and press “CREATE” to generate a new triangulator. The general status LED shows the ERROR state as long as the created triangulator is not set up correctly.

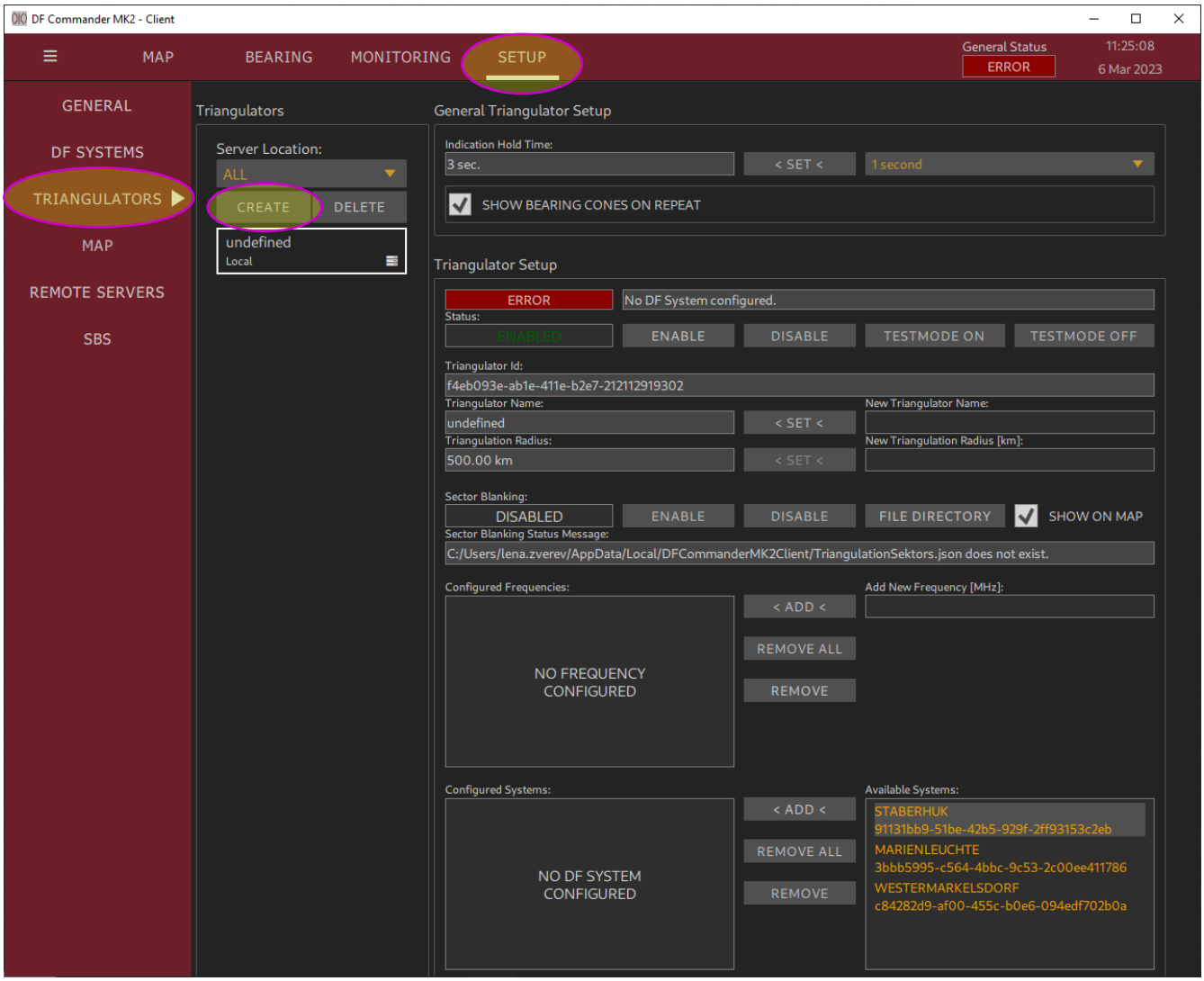


Figure 47: Creating the new triangulator

The triangulator is initially in the error state as well. Only when the triangulator is able to calculate results does its state change to OK.

For this purpose, the following requirements must be met:

- Target frequencies are set in the triangulator.
- At least two radio direction finding systems are set in the triangulator.
- The direction finding channels of the radio direction finding systems used must be set to the target frequencies.
- Radio direction finding systems used must not be in error status.

In the "Add New Frequency" field, enter the frequency in MHz and press "< ADD <".
The frequencies selected for triangulation then appear in the list "Configured Frequencies" on the left side.
Repeat the procedure for all desired frequencies.

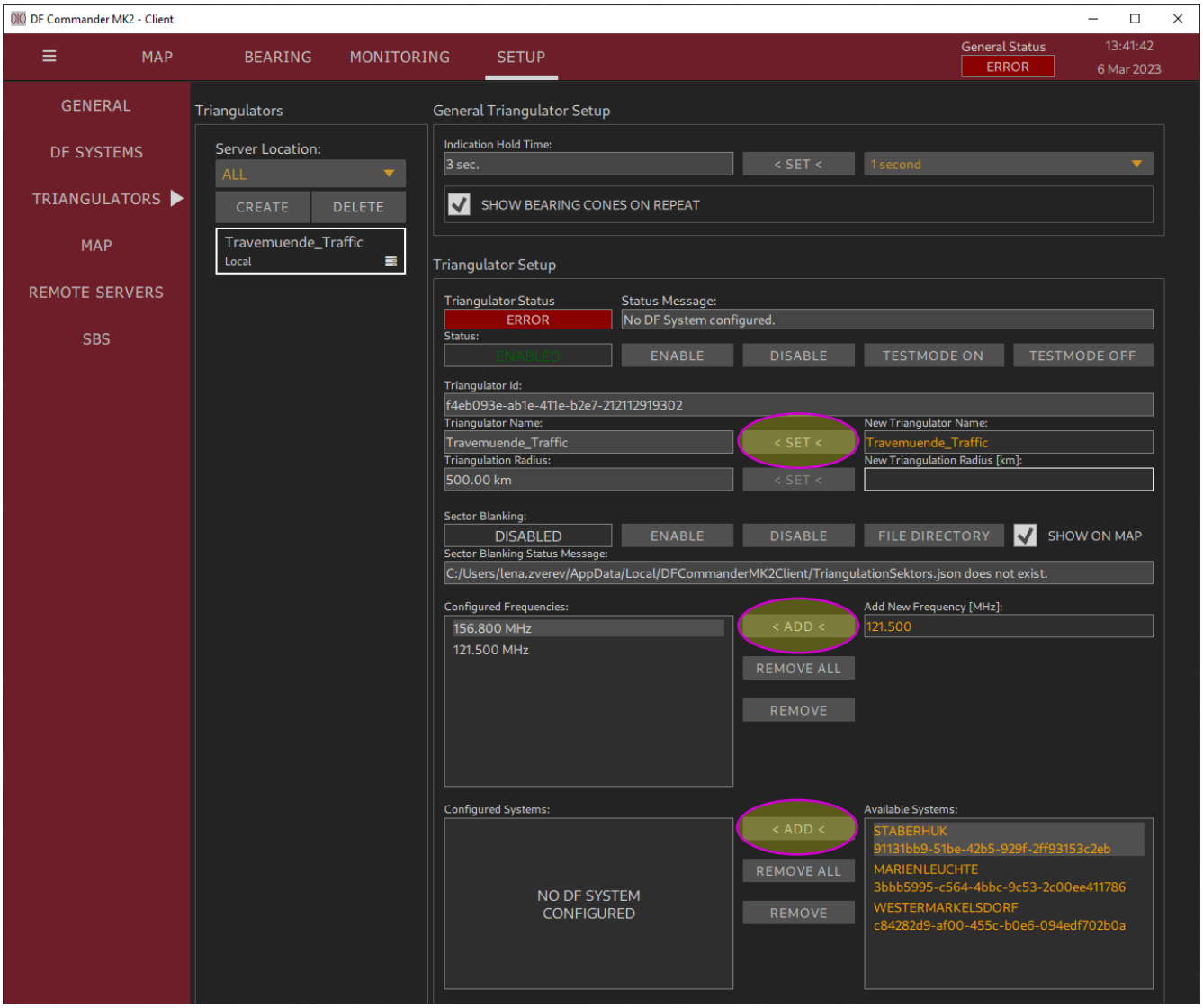


Figure 48: Triangulator frequency setting

The triangulator reports that the systems must be set. See "Status Message" - "No DF System configured".

Give the triangulator an appropriate name and press on "<ADD<".

Select the systems in the right field "Available Systems" and press "< ADD <". The systems then appear in the" Configured Systems" view.

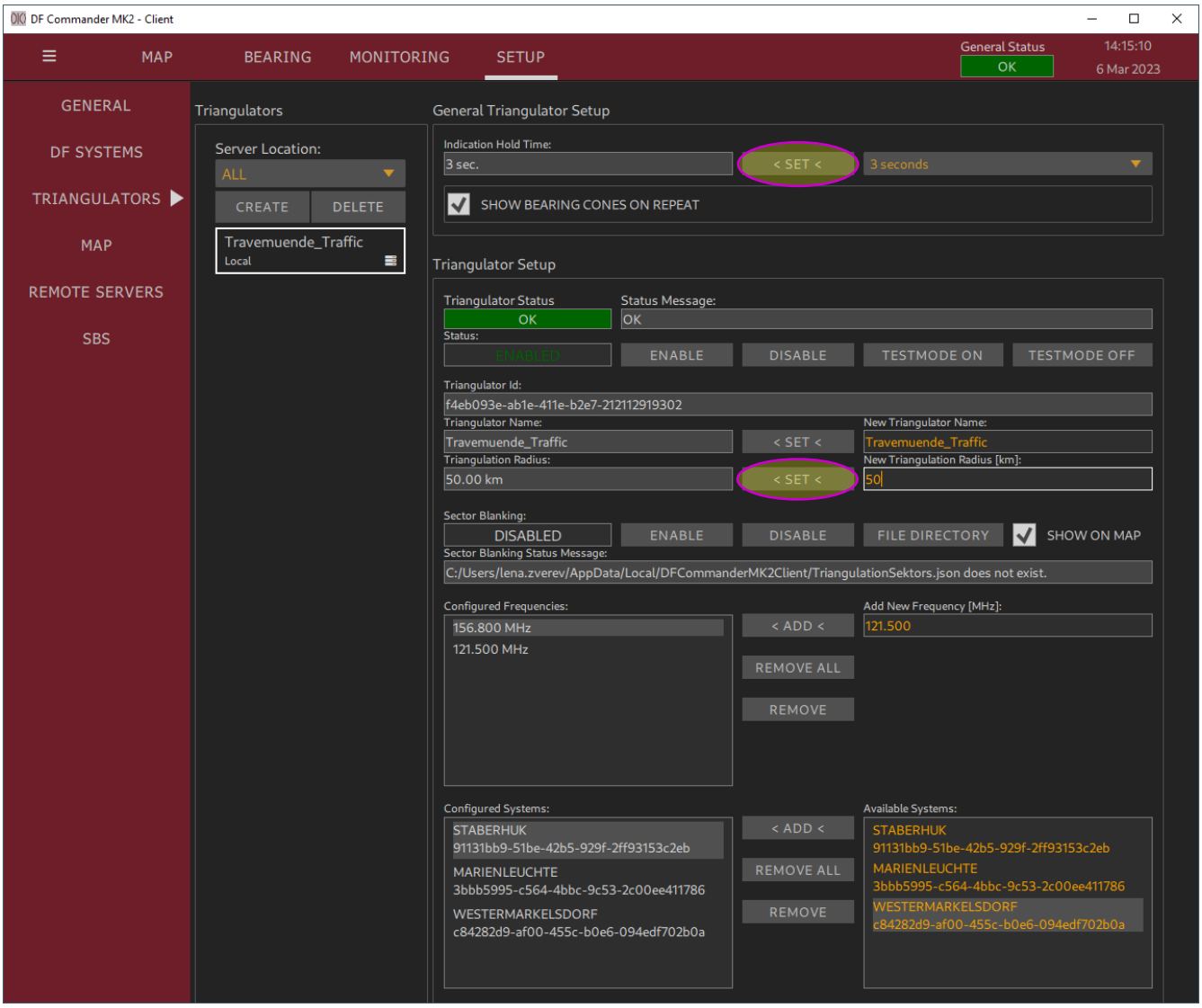


Figure 49: Triangulator successfully set

The triangulator is now able to perform calculations. Its status is OK.

Further parameters can be set:

Triangulation Radius
Triangulation radius limits the display and forwarding of the triangulation results if they were determined too far from the bearing station and are not reasonable due to physical conditions. A triangulation result is valid if the determined position is within the set radius around all radio direction finding systems.

Indication Hold Time:
The "Indication Hold Time" determines how long the cross bearing results are to be displayed on the map after the radio has stopped transmitting and the bearing disappeared.
For this duration, the triangulation results are displayed in grey on the map.
The setting "Infinite" means that the result does not disappear until a new valid result at the set frequency is calculated.

The checkbox “Show bearing cones on repeat” defines, how the calculated triangulation results appear on map.

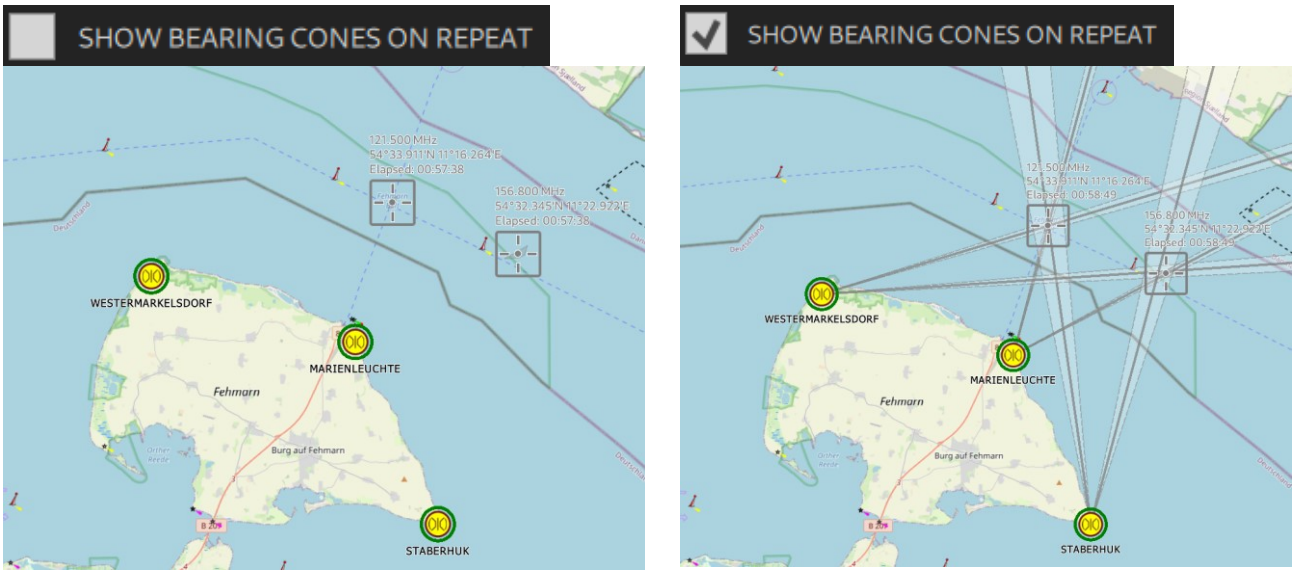


Figure 50: Display of triangulation results with/whithout bearing cones

Sector Blanking

See Chapter 3.4.3 Sector Blanking.

3.4.2 Display on the Map

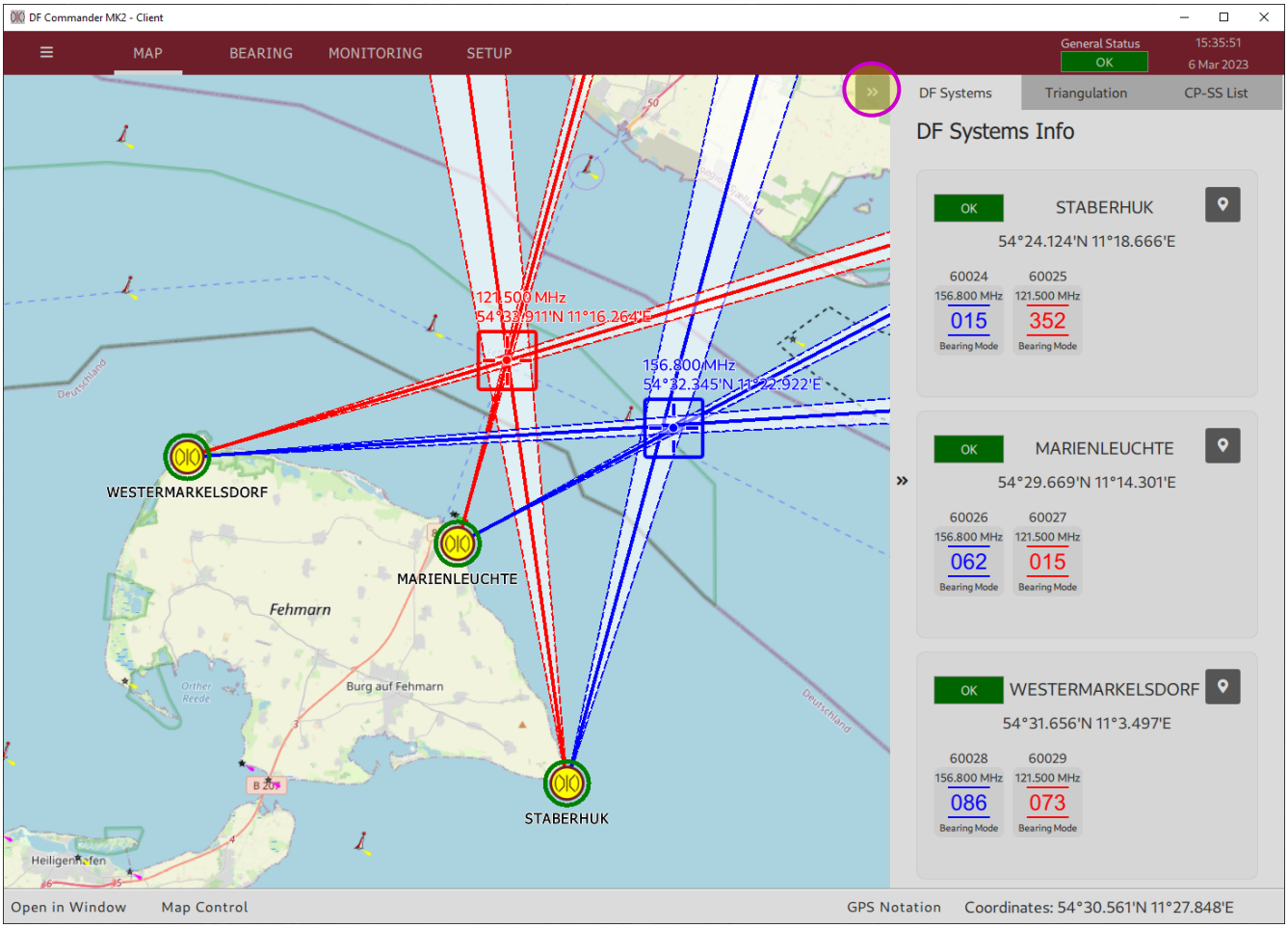


Figure 51: Triangulation results on the map

In the map view there are several options for displaying the triangulation result. Besides the graphical cross-bearing result (bearing cones with cross-polygons and resulting values), the numeric display in the right sidebar or as separate window are possible.
Open the right sidebar and select "Triangulation". The numeric triangulation result information is presented here.

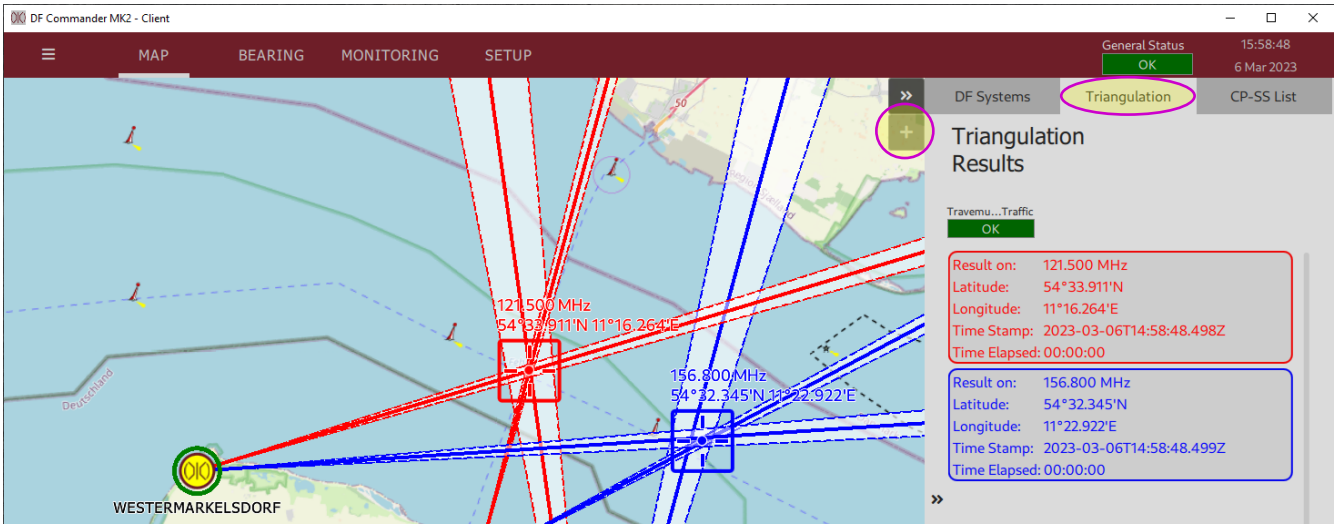


Figure 52: Numeric triangulation results in the sidebar

Click on “+” in order to open triangulation results in a separate window.
The "Triangulation Results" window appears. Click on the "eye icon" to turn on the transparency of the window.

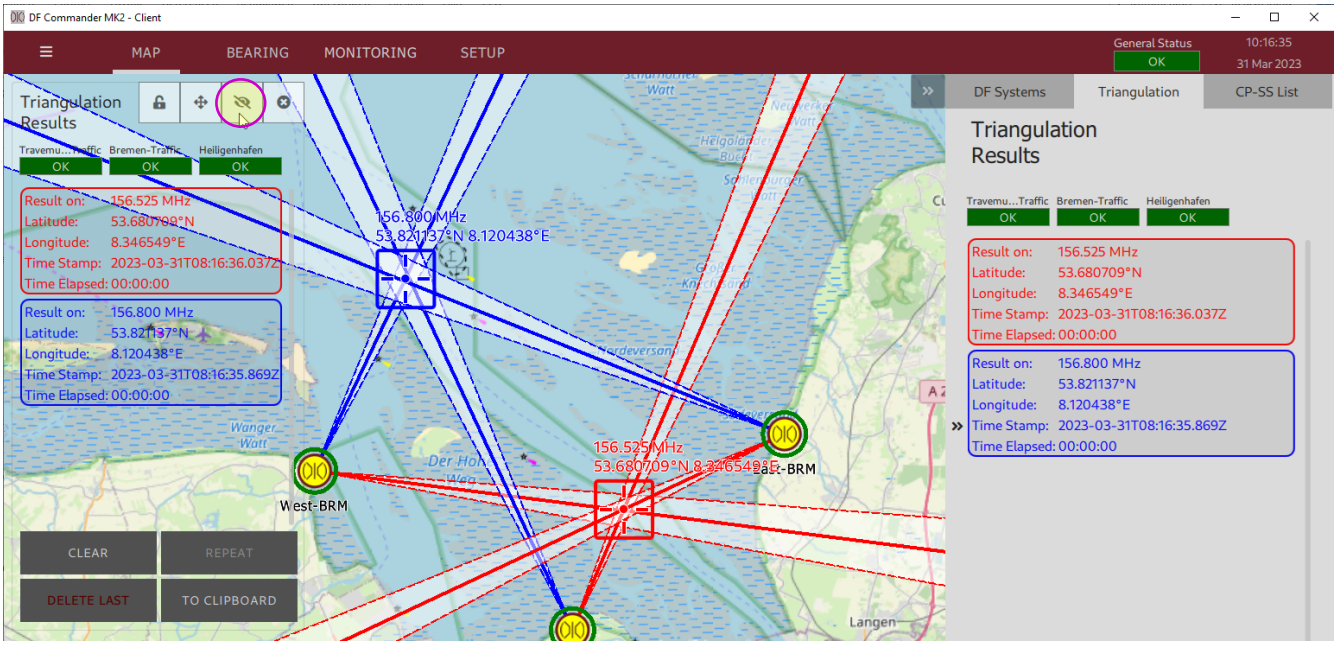


Figure 53: Numeric triangulation results in the separate window

The Triangulation Results window displays the current status of the triangulator and corresponding triangulation results in a list view. By clicking on a result, the map is centered on it.

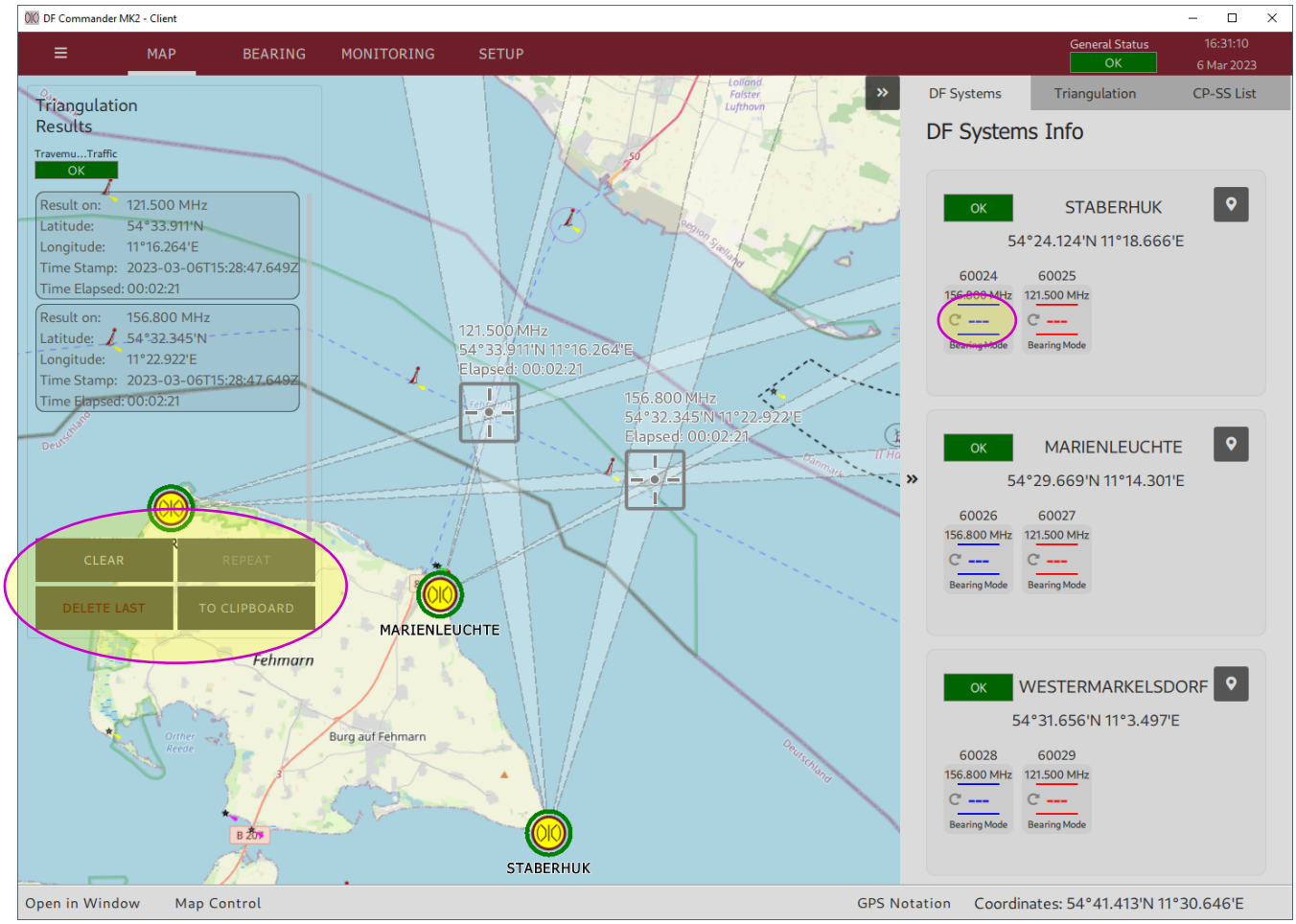


Figure 54: REPEAT and CLEAR

Press "TO CLIPBOARD" to copy the results to the clipboard. Now these results can be pasted anywhere, e.g., in a text editor, using the key combination CTRL + V.

If the radio signal is no longer transmitted on the corresponding frequencies, the cross bearing results are held for a selected time (“Indication Hold Time”) and then no longer displayed:

- Press "REPEAT" to display the results again.
  Even now the results can be copied to the clipboard.
- Press "CLEAR" to remove the results from the map and from the list.
- Pressing "REPEAT" will cause the results to reappear until the next valid cross bearings are determined.
- Press "DELETE LAST" to permanently delete the last results. They will not appear again by pressing "REPEAT".

It is also possible to display/highlight the individual bearings in repeat mode if you click on the empty bearing values ("---") of the individual channel in the “DF Systems Info” slider.

3.4.3 Sector Blanking

In the area “Sector Blanking”, the triangulator can be configured in a way that the triangulation results are only valid in certain areas. Only valid triangulation results are displayed on the map and transferred via integrated server.

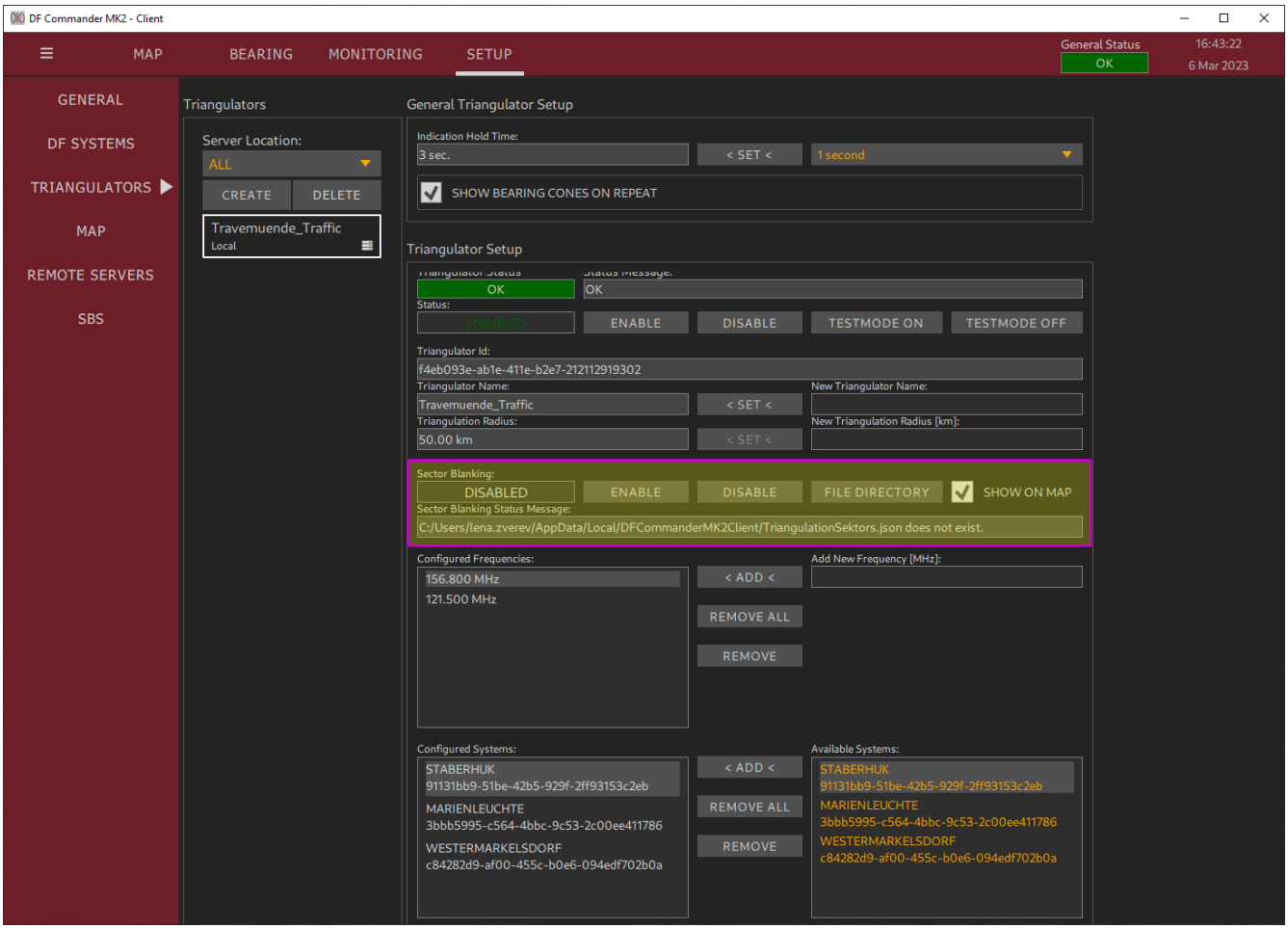


Figure 55: Sector Blanking

Definition of valid sectors / polygons

Please define the polygons in GeoJSON format (see also the specification in RFC 7946) and save the polygons in the file `TriangulationSektors.json`.

The file `TriangulationSektors.json` must exist in the same location, where all other configuration files a stored. Click on “FILE DIRECTORY” in order to open the file path.

Create the file `TriangulationSektors.json` with any text editor of your choise.
The polygons can be eather defined as “Multipolygon” type or as “FeatureCollection” type.
See examples below.

Example Multipolygon:

```
{
    "type": "MultiPolygon",
    "coordinates": [
        [
            [
                [180.0, 40.0], [180.0, 50.0], [170.0, 50.0],
                [170.0, 40.0], [180.0, 40.0]
            ]
        ],
        [
            [
                [-170.0, 40.0], [-170.0, 50.0], [-180.0, 50.0],
                [-180.0, 40.0], [-170.0, 40.0]
            ]
        ]
    ]
}
```

Polygon 1

Polygon 2

Longitude

Latitude

Example FeatureCollection:

```
{
    "type": "FeatureCollection",
    "features": [
        {
            "type": "Feature",
            "properties": {},
            "geometry": {
                "type": "Polygon",
                "coordinates": [
                    [
                        [
                            11.044006347656248,
                            54.559322587438636
                        ],
                        [
                            11.225280761718748,
                            54.54339315407258
                        ],
                        [
                            11.2664794921875,
                            54.62615829892253
                        ],
                        [
                            11.060485839843748,
                            54.61025498157912
                        ],
                        [
```

Polygon 1

Longitude

Latitude

```
                        11.044006347656248,
                        54.559322587438636
                    ]
                ]
            ]
        }
    },
    {
        "type": "Feature",
        "properties": {},
        "geometry": {
            "type": "Polygon",
            "coordinates": [
                [
                    [
                        11.285705566406248,
                        54.51789312005292
                    ],
                    [
                        11.370849609375,
                        54.463652645044796
                    ],
                    [
                        11.42852783203125,
                        54.554544410585585
                    ],
                    [
                        11.285705566406248,
                        54.51789312005292
                    ]
                ]
            ]
        }
    }
]
}
```

Polygon 2

NOTE:
Using the following web page, the polygons can also be created very easily: www.geojson.io

Please go to www.geojson.io:

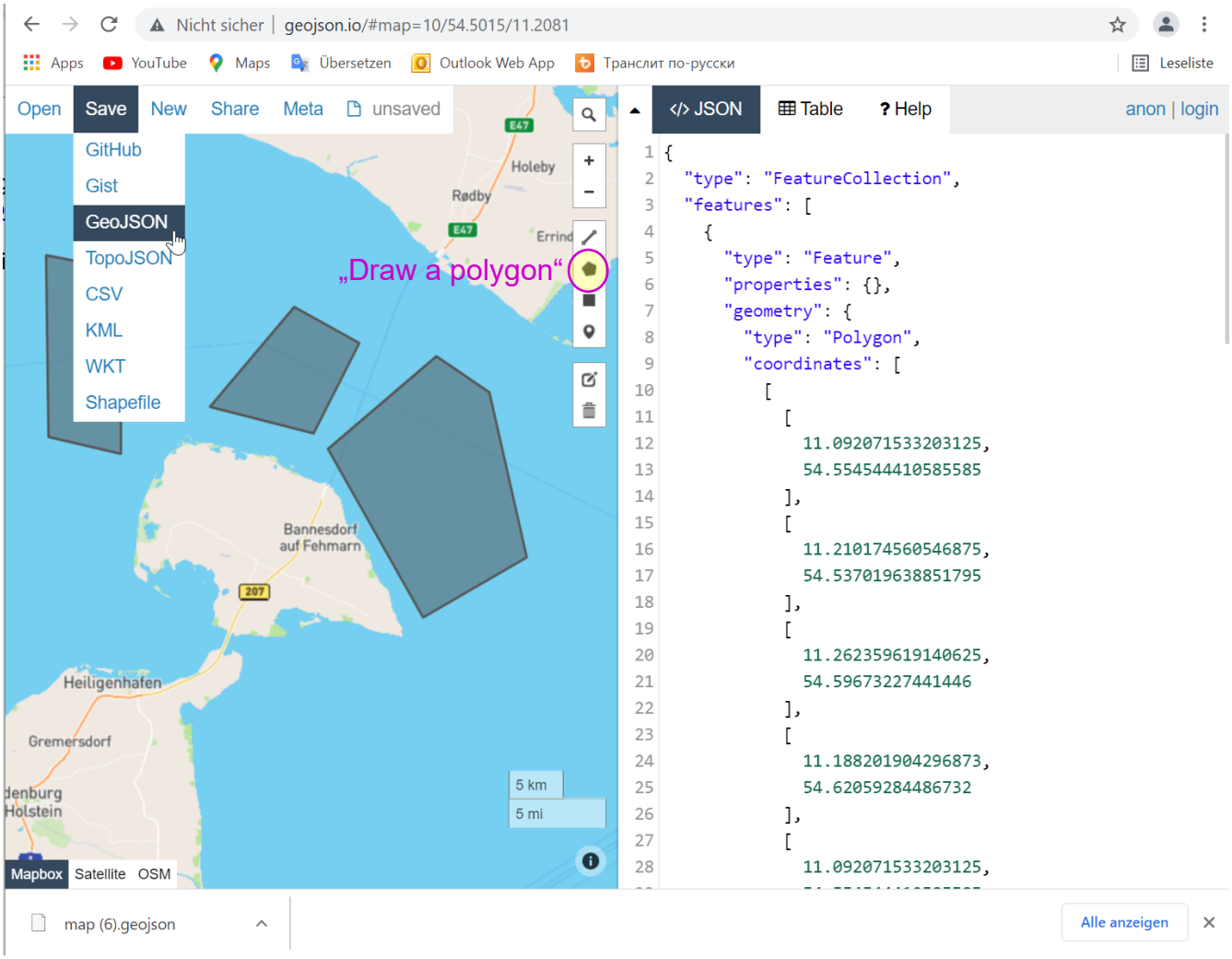


Figure 56: www.geojson.io

Draw a polygon using the tool “Draw a polygon”.

Go to “Save” and to “GeoJSON. The file will be downloaded into the download folder of your browser.

Open this file and save it to `TriangulationSektors.json` in the folder with other configuration files (directory specified under “Sector Blanking Status Message”).

Reading in the `TriangulationSektors.json`

Click on “ENABLE” to read in the polygons from the file and activate sector blanking.

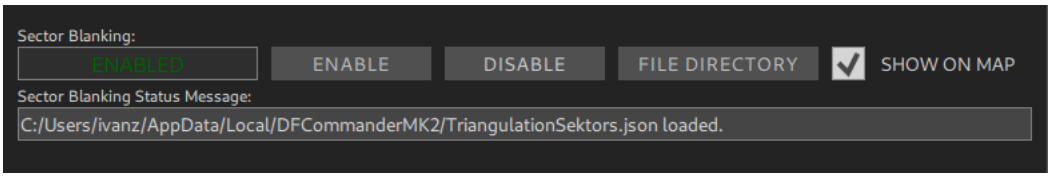


Figure 57: Activate Sector Blanking

If the file exists and conforms to the appropriate format, sector blanking is activated. In the "Sector Blanking Status Message" area, you will receive a message that the file has been loaded. In the event of an error, a message with the corresponding error information also appears.

Activate the checkmark "SHOW ON MAP" to display the polygons on the map.

On the map you can now see that triangulation results are only valid within the defined polygons (cross bearing at 156.800 MHz in blue color). The cross bearing at 121,500 MHz (red cones), however, lies outside the polygons - it is not counted as a valid triangulation result.

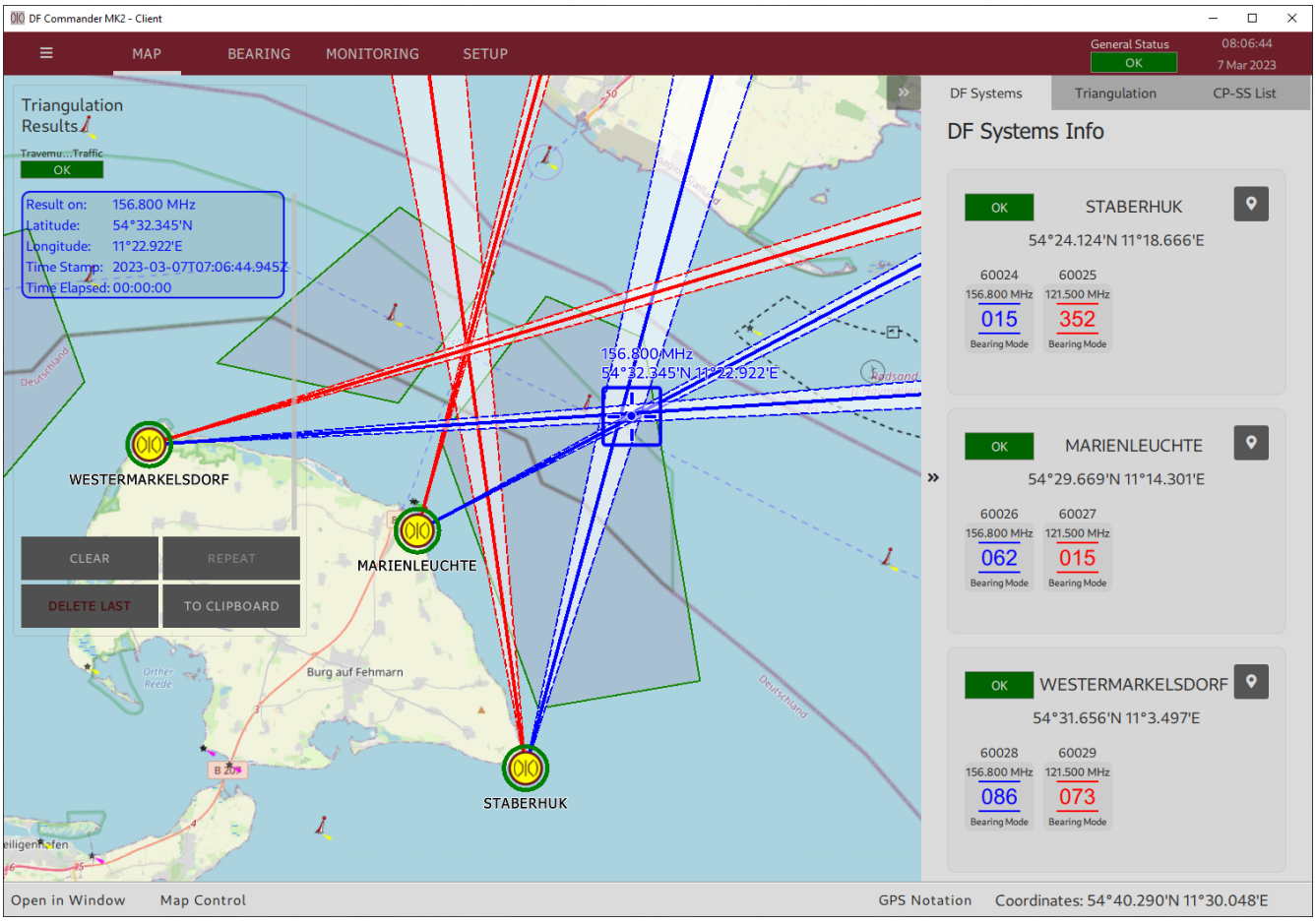


Figure 58: Triangulation results valid only inside the polygons

3.5 Server Setup (only for “DF Commander MK2 Server” Application)

The status of all DF systems and their channels, triangulator status, bearing results and finally the triangulation results are available via the DF service. All connected clients receive this data and can also configure the system via the DF service. The client application itself (“DF Commander MK2 Client”) does not include the local server functionality (“LOCAL SERVER”), only the server application (“DF Commander MK2 Server”) does.
The corresponding protocol is described in the document "Radio Direction Finder Standard JSON Protocol".

WARNING:
The server is a simple TCP server with no special protection against common attacks such as Denial of Service Attack. It is designed to work in a trusted, secured network with appropriate safeguards.

The following describes how to configure the server.

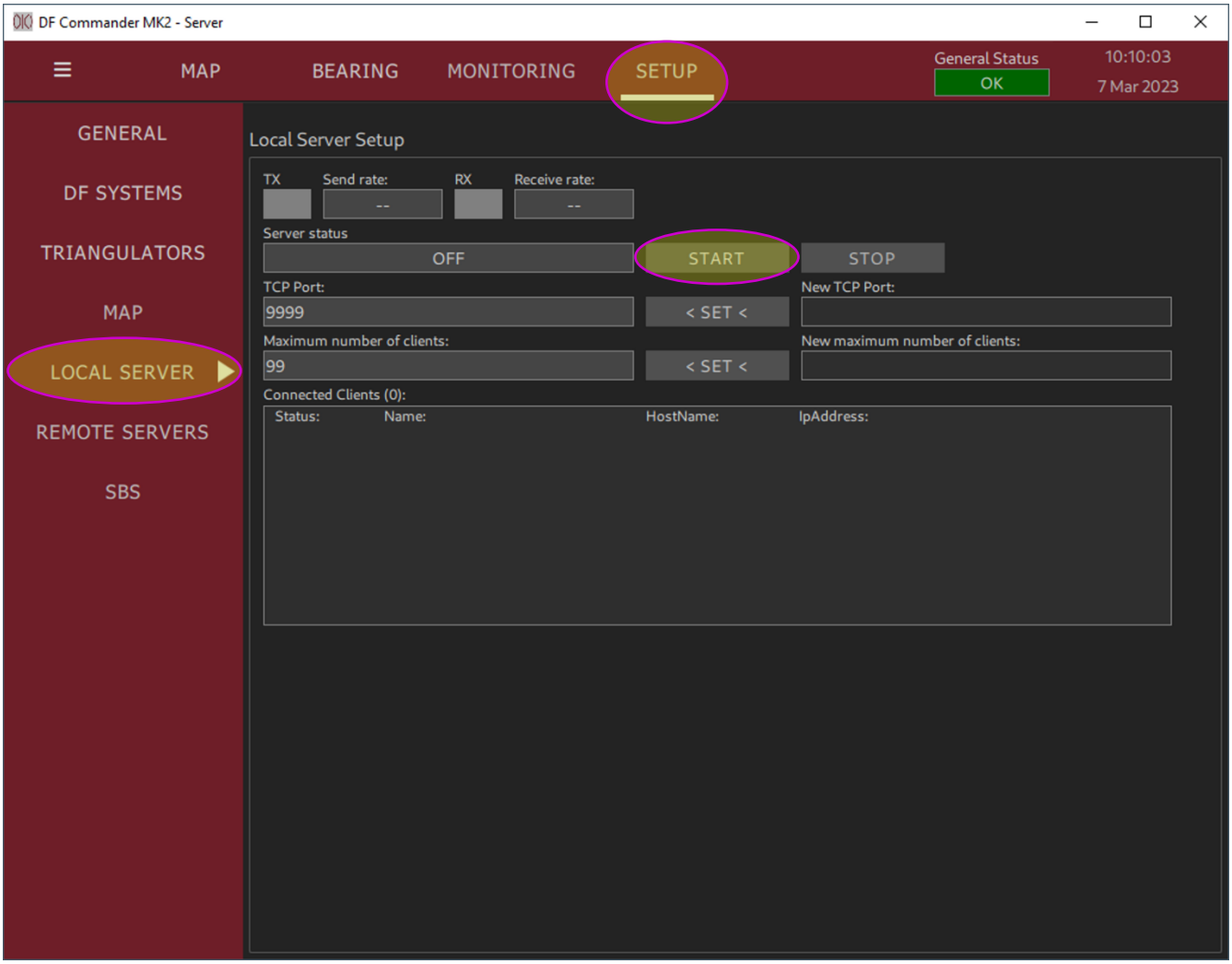


Figure 59: Server configuration (server is disabled)

Switch to “SETUP” and then press "LOCAL SERVER".
Press "START" to start the server. If necessary, allow the firewall to start.

If necessary, set the desired TCP port in the "New TCP Port" field and press "< SET <".

The server starts automatically on the new port.
The server can be reached via the IP address of the DF Commander MK2 computer and the configured TCP port.

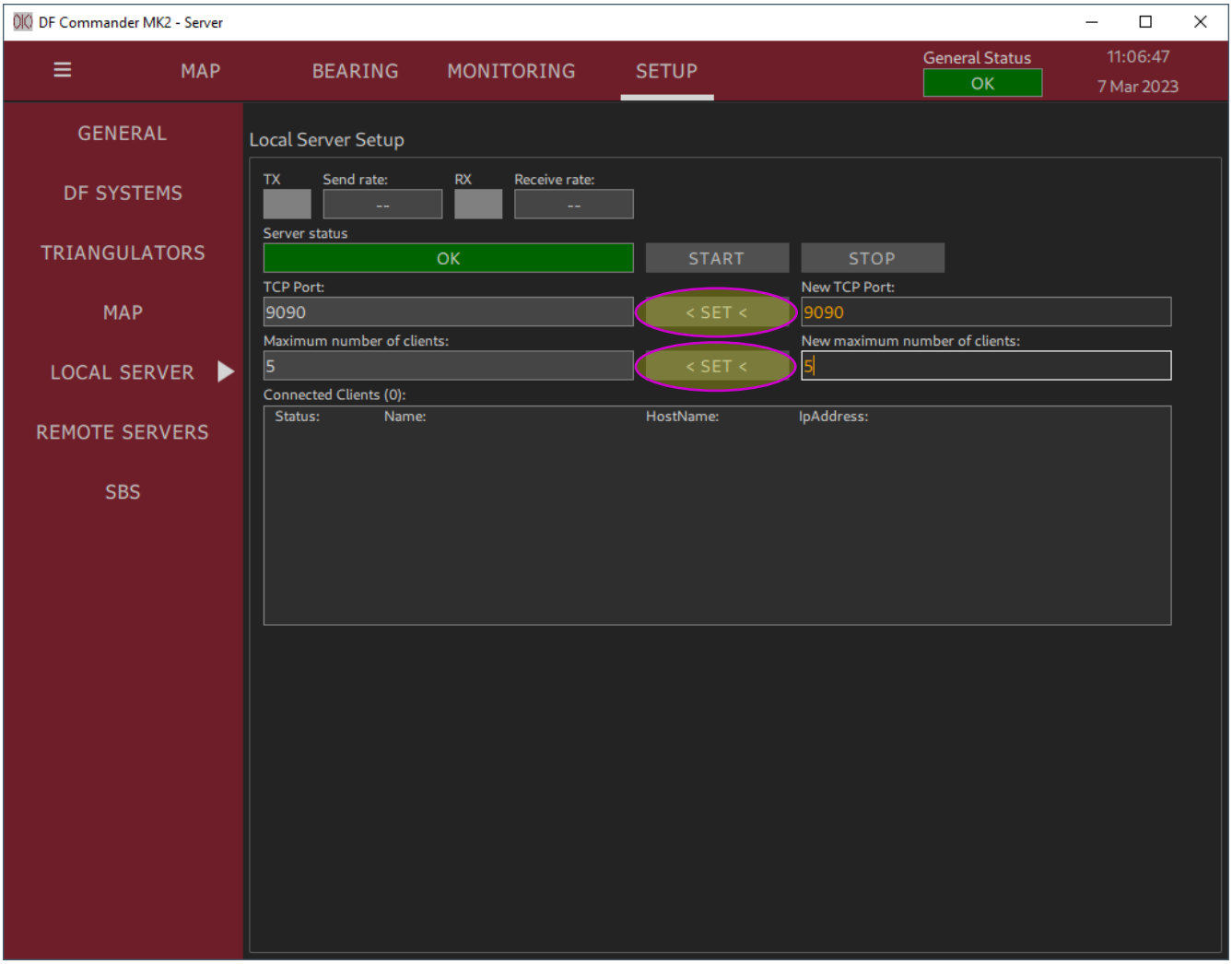


Figure 60: Server configuration (server is activated)

If necessary, set the maximum number of clients to be served by typing the number in the "New maximum number of clients" field and then pressing "< SET <".

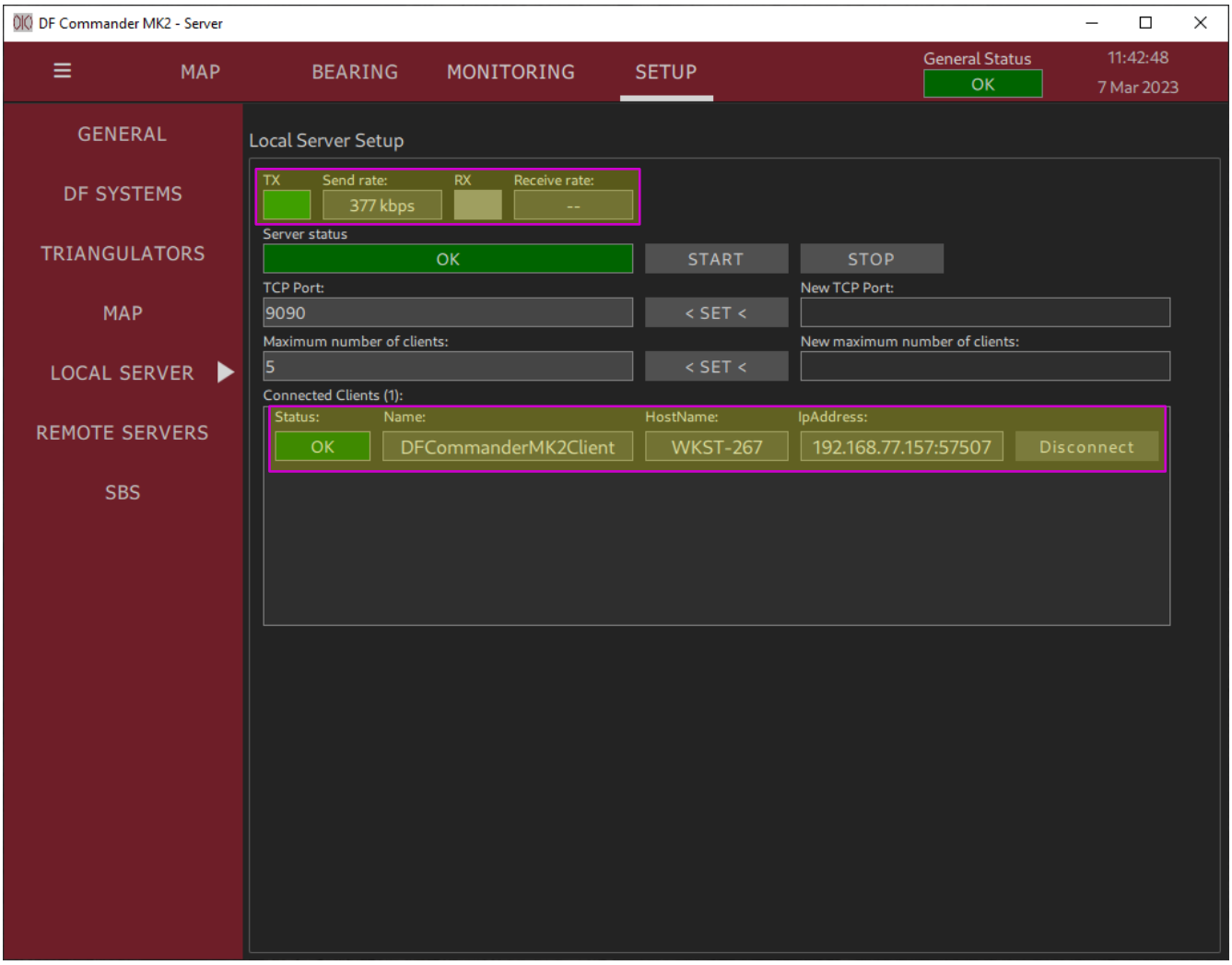


Figure 61: Server configuration (1 client connected)

The top line shows the transmission rate in kByte per second at which the server sends the data to the connected clients.

The server shows the connected clients in the “Connected Clients” list.
The relevant data of the clients such as the respective status, name, hostname and IP address / used port, are displayed.

3.6 Remote Servers Setup

The “DF Commander MK2 Server” as well as the “Client” application can connect to a remote server (one or more) in order to include and process its data e.g. for monitoring purposes. The description of the corresponding protocol can be found in the document "Radio Direction Finder Standard JSON Protocol".

3.6.1 Configuration of Remote Server

The following explains how to configure a remote server using the "DF Commander Client" application as an example.

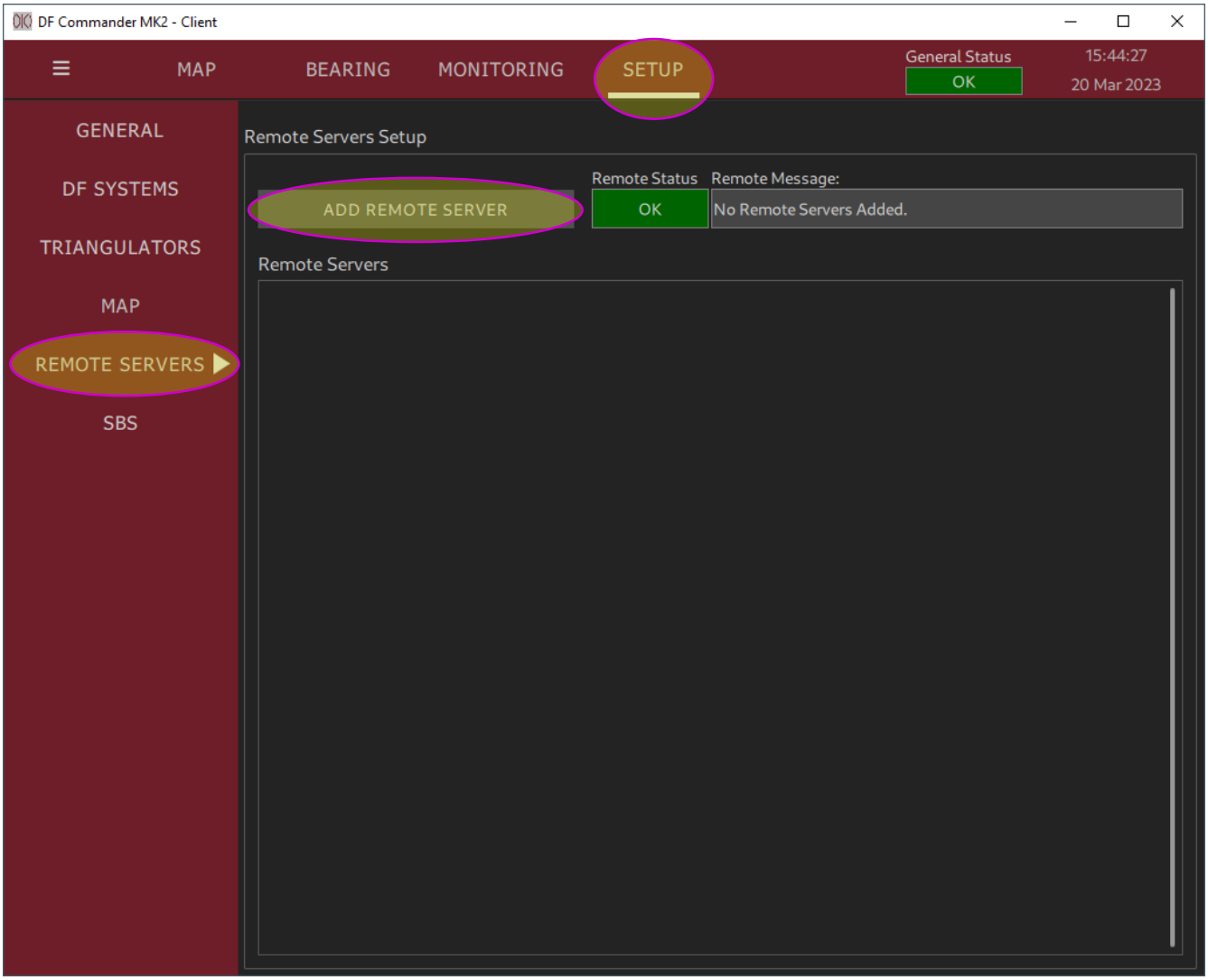


Figure 62: Remote server configuration (no remote servers connected)

Go to “SETUP” and then press "REMOTE SERVERS".
Press "ADD REMOTE SERVER".

The remote server can be reached via the IP address of the “DF Commander MK2” computer and the configured TCP port.

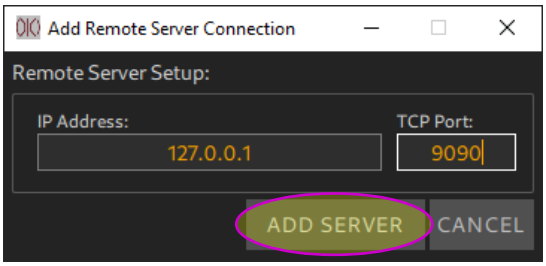


Figure 63: Remote server configuration (entering the IP address and port)

Other remote servers can be added in the same manner.
After the TCP/IP link is established, all connections are represented in a list of remote servers.

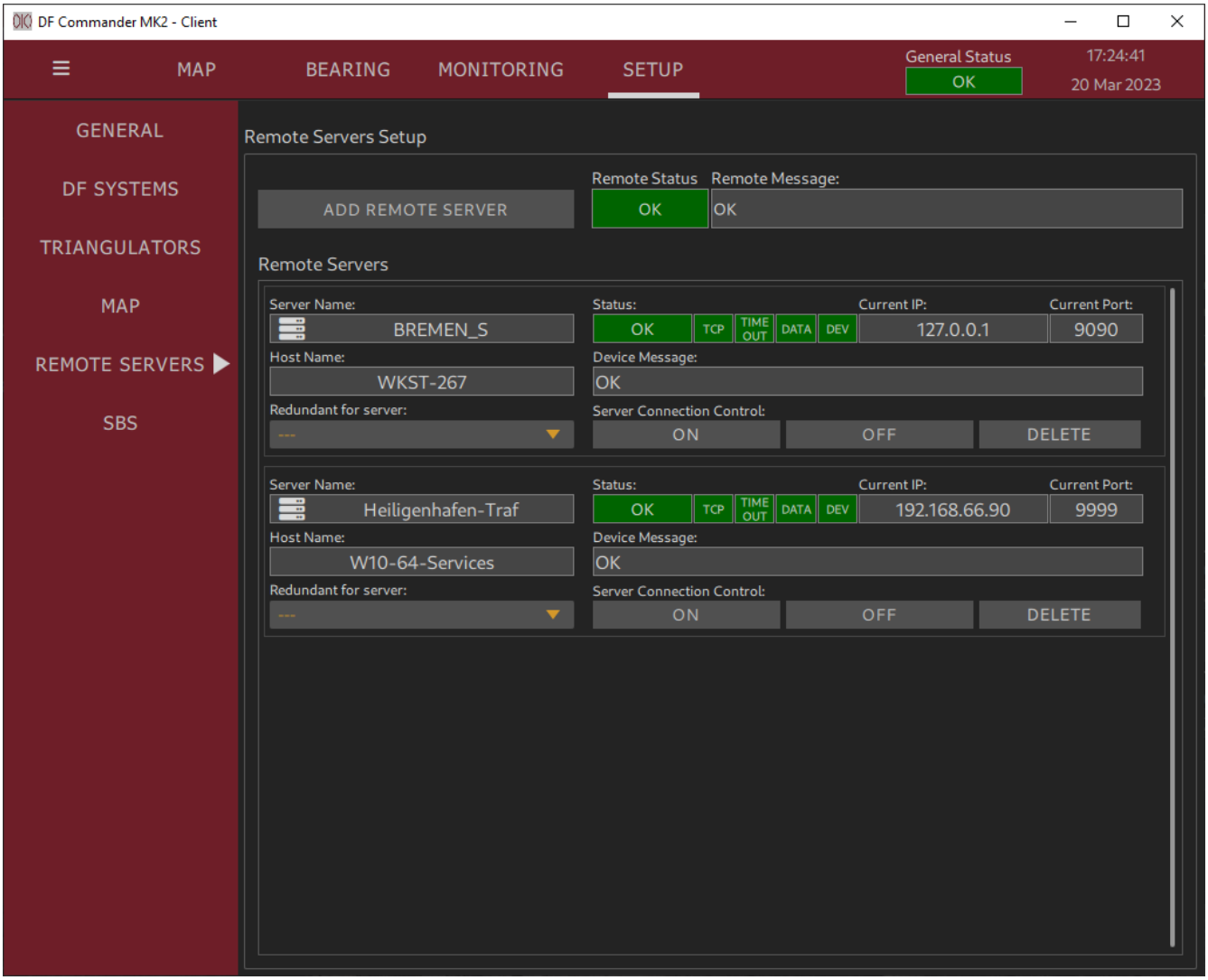


Figure 64: Remote server configuration (two remote servers connected)

3.6.2 Checking the Configuration

Two remote servers are added. The resulting display of the (local and) remote servers on other pages can be checked.

Checking on the SETUP page

Go to the SETUP page and select the DF SYSTEMS tab.
The DF systems setup menu should look like in the following picture. None of the control LEDs should light up red.
The locally or remotely configured systems are additionally labeled with appropriate graphic symbols (and in words for local systems).

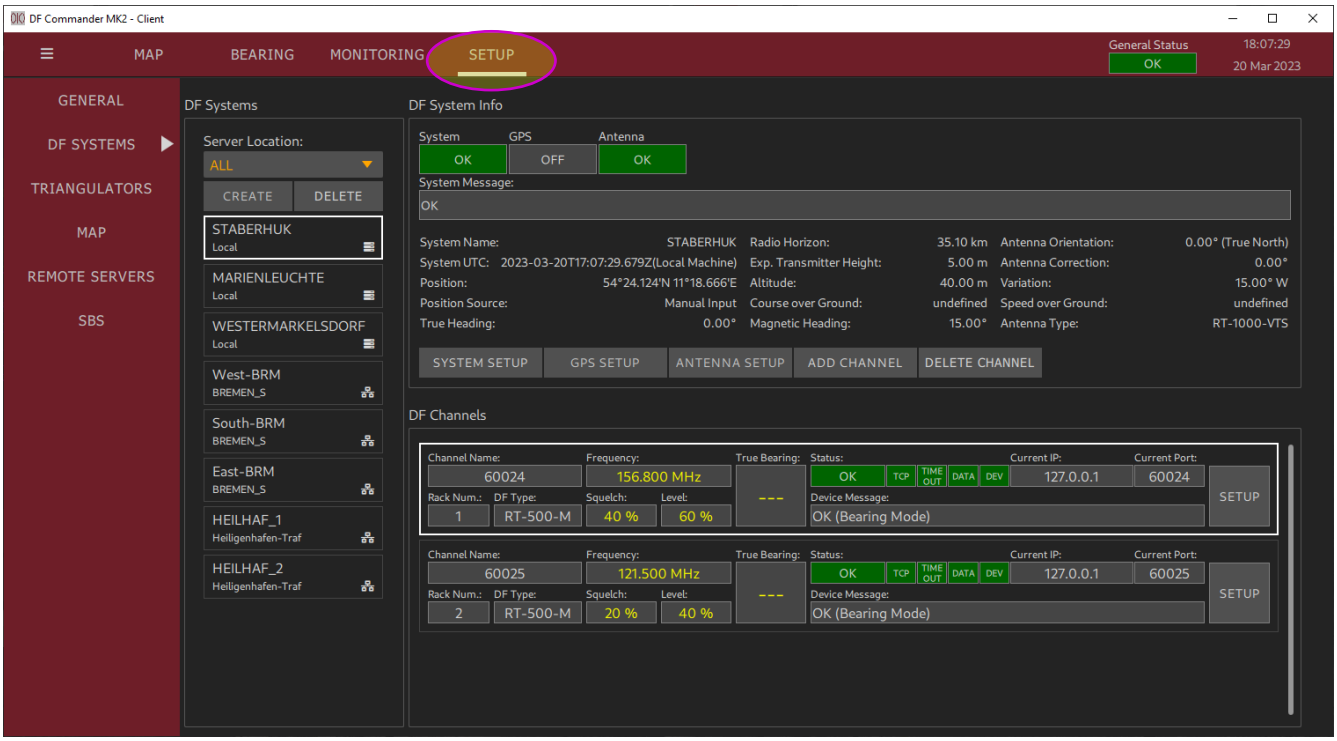


Figure 65: Remote servers on DF SYSTEMS setup page

Checking on the MONITORING page

Switch to the monitoring page by pressing the "MONITORING" button.
The local and remote systems are sorted one below the other in a scrolling view.
None of the control LEDs should light up red.

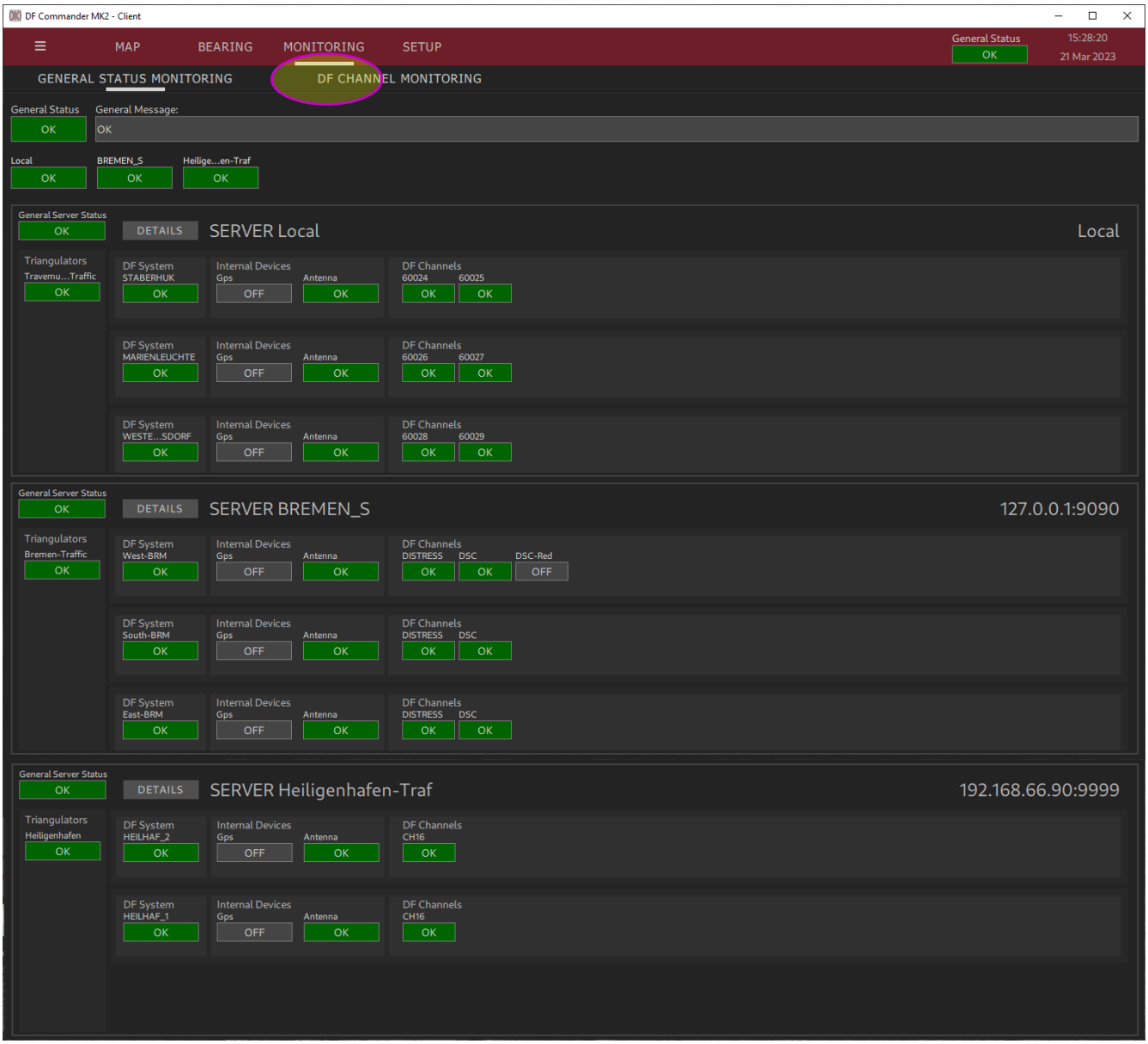


Figure 66: Remote (and local) servers on the monitoring page

Checking on the MAP page

To do this, switch to the MAP and navigate to the positions of the (local and remote) DF systems. The bearings and triangulation results (if applicable) must appear on the map view. Only the local server's triangulation results show the intersection polygons (cross-section of the bearing cones) centered on the triangulation result. The triangulation display from the remote servers only shows the results without the intersection polygons.

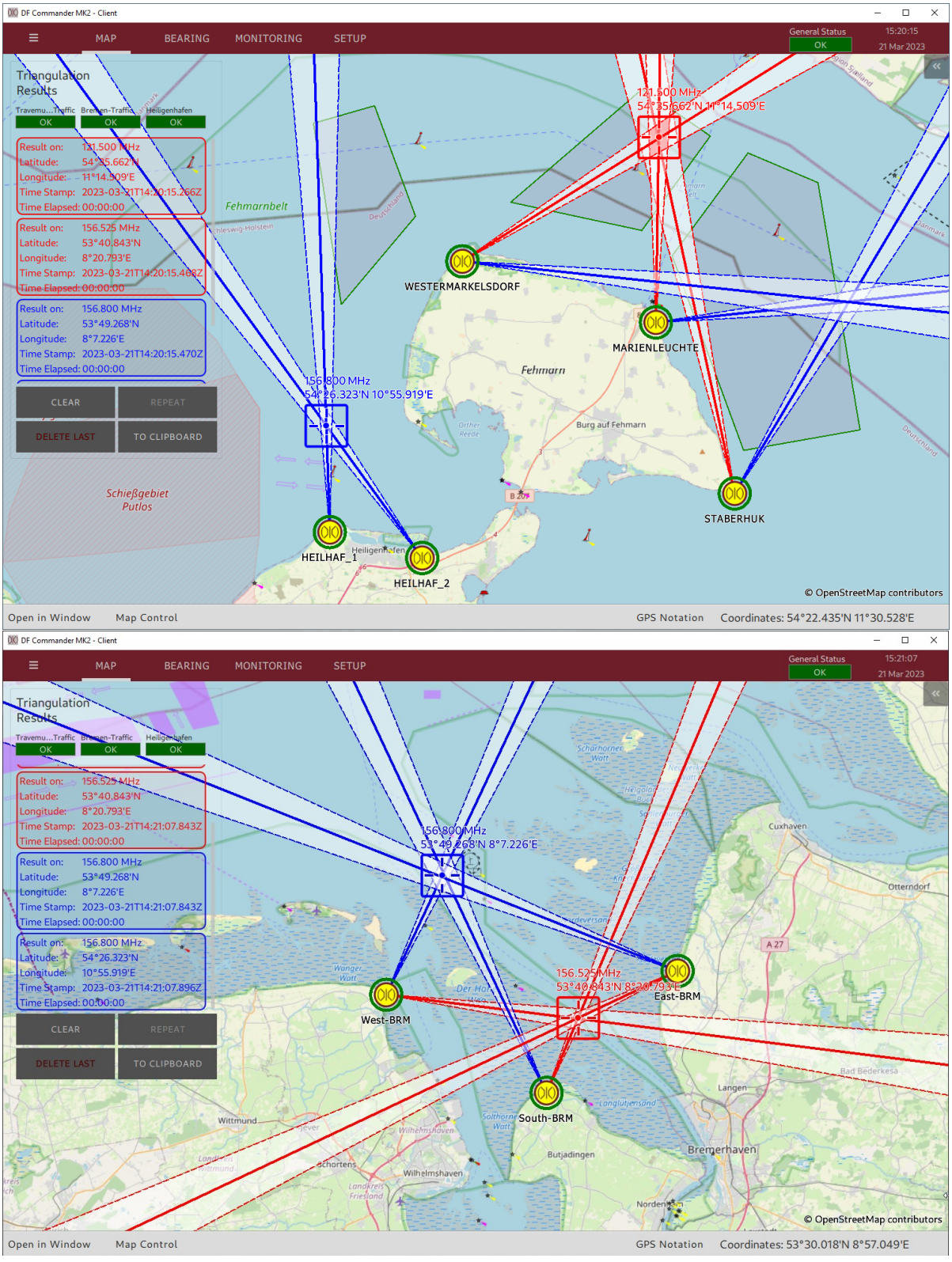


Figure 67: Remote servers on the map

As a reminder, the triangulation results that are outside the sector blanking polygons (configurable in SETUP -> TRIANGULATORS) are not calculated and displayed as is the case in the upper image for triangulation on the local server at 156.800 MHz (in blue color).

3.6.3 Redundant Servers

The software offers a possibility to define one server as redundant for the other.
This is often necessary for installations on critical locations to avoid system failures during monitoring. Or if the main server must be shut down for maintenance, a redundant server can step in at any time.
A prerequisite for the correct functioning of the redundant server in the event of the failure of the primary server is that the configuration of both servers is completely identical. Only the names of the systems/channels may differ for better visibility.

1. Set up the hardware for the redundant server and install a "DF Commander MK2 Server" application on a separate PC.
2. Adopt the settings of the systems and their channels in the software exactly as it is set up on the primary server (for which it is currently being set up).
3. Add the redundant server as a remote server in the DF Commander MK2 application of the surveillance PC.

After the connection of the server, it should look like in the following picture: all LEDs are green.

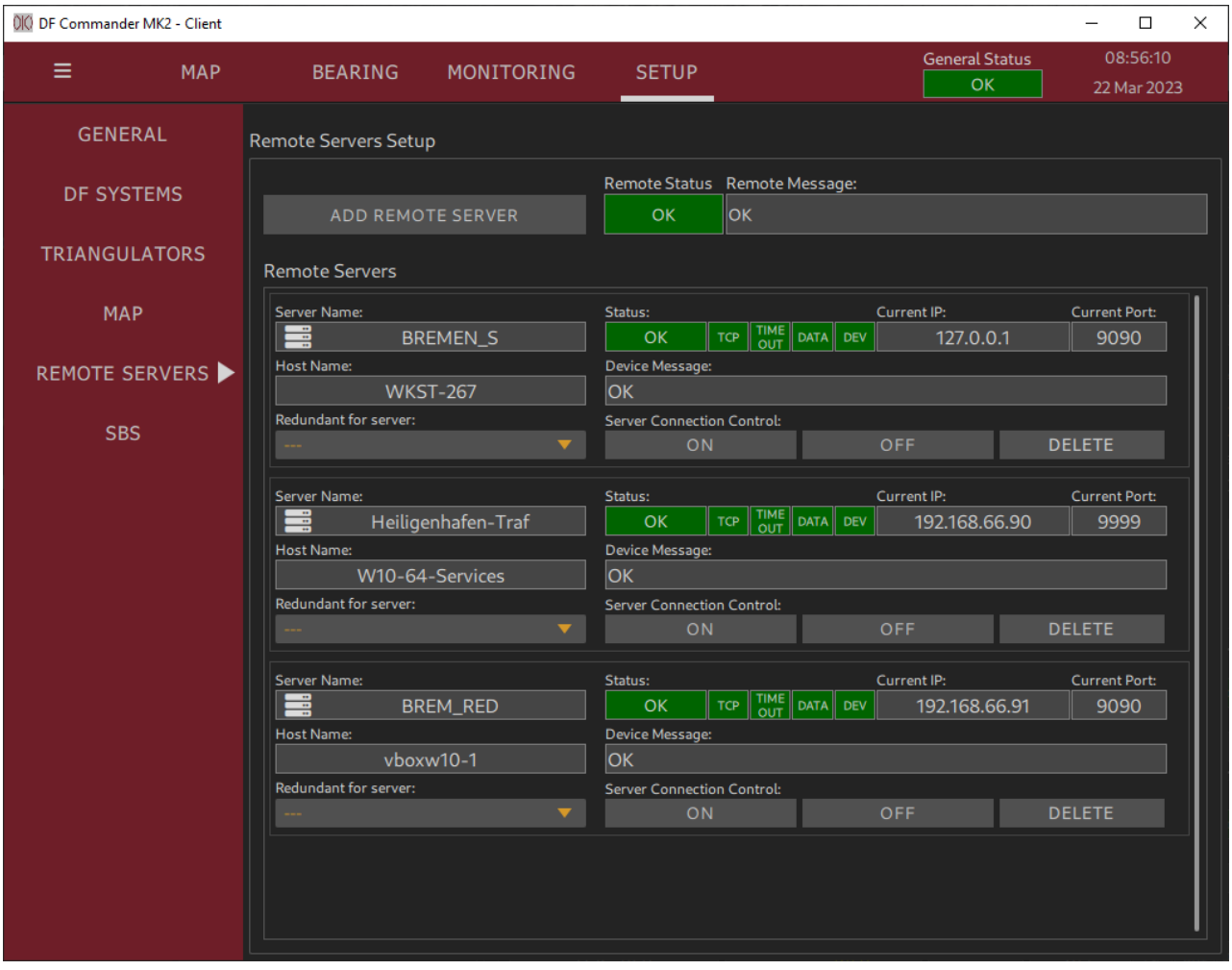


Figure 68: Adding the redundant server to remote servers list

4. The newly added remote server must now be defined as a redundant server.
   In the "Redundant for server" drop-down menu, select the primary server that is to be replaced in the event of a failure.

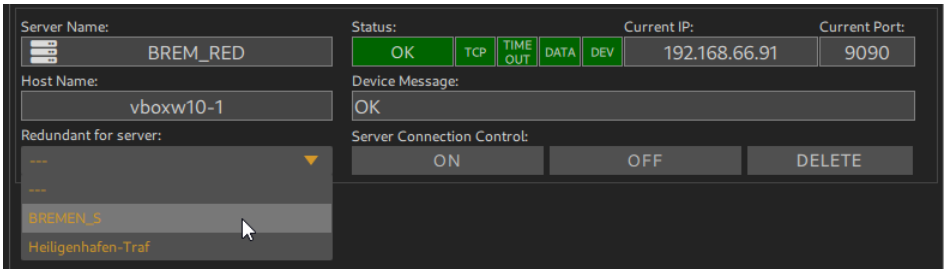


Figure 69: Define the redundant and primary servers

5. The redundant server is graphically marked as such and is now "online" in the waiting state, i.e. its data will be ignored until a failure occurs, which is additionally explained by the device message.

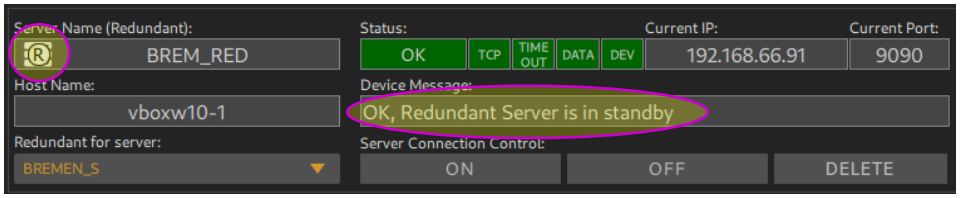


Figure 70: The redundant server is arranged

On the MONITORING page the redundant server is shown empty, only its status data is displayed.

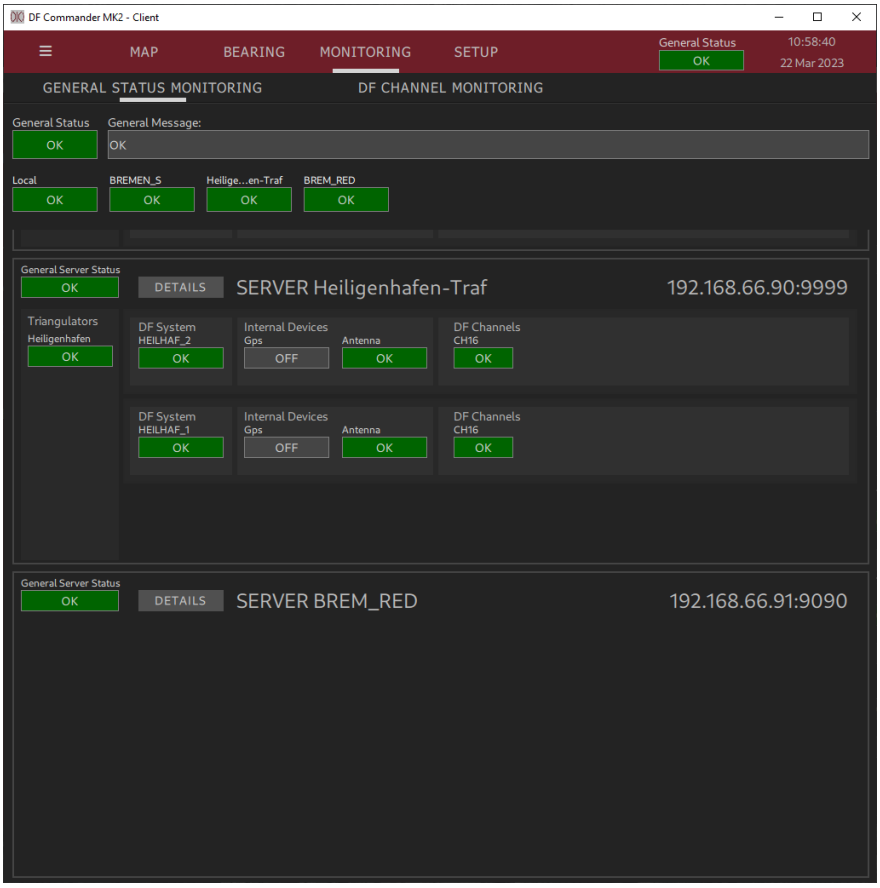


Figure 71: Indication of the redundant server on monitoring page

The following generally applies to the server redundancy concept in DF Commander MK2:

- Any server inside the remote servers list can be defined as a redundant server.
- More than one servers can be defined as redundant for the same primary server.
- If the primary server changes to ERROR state, the next free redundant server takes over the operation instead of the defective server.
- The remote status changes the current state to WARNING.

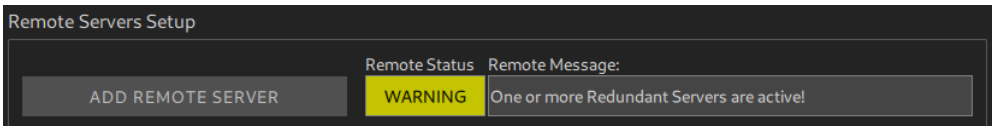


Figure 72: The remote status is in warning state

- If the redundant server is out of function, the second redundant server takes over the operation.
- If the redundant server malfunctions (while the primary server is functioning properly), its status changes to ERROR. The remote status changes to WARNING.
- If a defective server can not be replaced by a redundant server, then the remote status goes to ERROR.
- If the defective server works again, its settings are taken from the corresponding redundant server. The remote status returns to OK.

3.7 Self Bearing Suppression

The Self Bearing Suppression (SBS) function is used to suppress the bearing indication while the RF signal is being transmitted from the ground transmitter station, e.g., while a tower controller is speaking to an aircraft. This function is also called Ground Transmitter Suppression (GTS).

To ensure this function, the hardware must be set up first.
The so-called PTT module is used to connect the push-to-talk button of the ground transmitter to the PC with installed DF Commander MK2 software (please refer to “User Manual PTT Module”).

Then the appropriate software setup is required to connect the PTT module to the direction finder and ensure the SBS function with the desired parameters.
To configure the software for self-bearing suppression the following steps are required.

1. Go to the "SETUP" page and select "SBS".

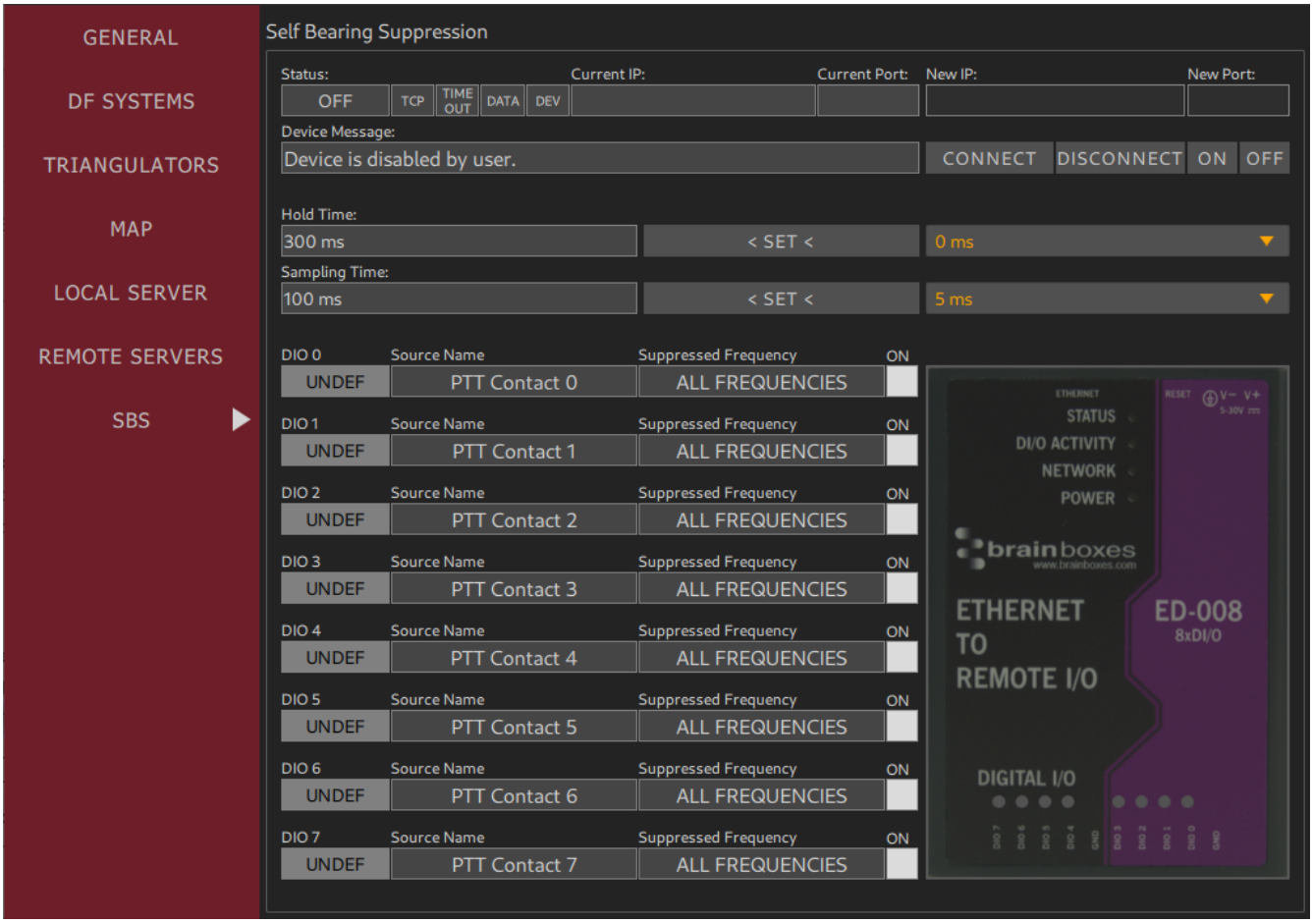


Figure 73: Self Bearing Suppression Setup

2. Connect the DF Commander to the PTT module:
   Press "ON", if status is “OFF”, enter the IP address of the PTT module in the "New IP" field and the TCP port in the "New Port" field and press "CONNECT".
   The result should look like this:

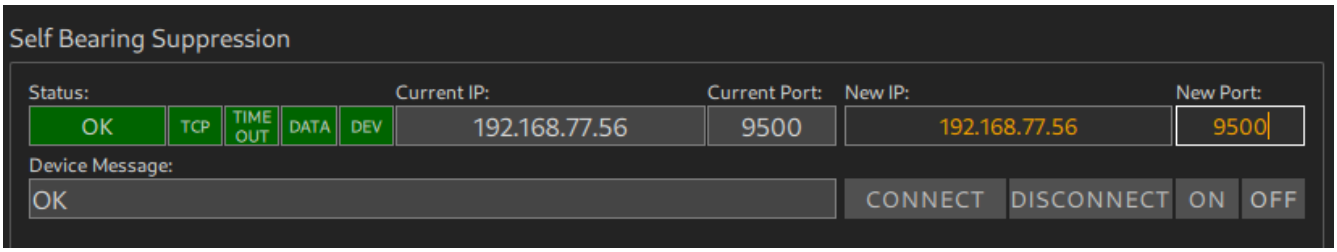


Figure 74: SBS setup connection established

In the event of an error see Chapter 4 Status Displays.

3. Set the SBS hold time.

Figure 75: SBS Hold Time setting

In practice, ground transmitters continue to transmit the RF signal for a certain time after the push-to-talk button is released (switch-off delay).
This setting is used to avoid an unwanted bearing indication to the ground transmitter during this “switch-off delay” time.
When the push-to-talk button is released (so that the DIO contact is no longer in the “low” state/connected to ground), the bearing suppression of the corresponding frequency remains active for a delay defined by the "Hold Time".
Hold time is set to 300 ms per default.
To change this setting, select the desired value in the drop-down menu and press “< SET <”.

4. Set the sampling time.

Figure 76: SBS Sampling Time setting

The sampling time defines the periodicity in which DF Commander MK2 requests the status information of the inputs of the PTT module (status of the push-to-talk buttons).
This setting has a direct impact on the reaction to pressing of the push-to-talk button. If sampling time is set to e.g., 500 ms, in the worst case the bearing indication is only suppressed after 500 ms, i.e. the direction finder shows the bearing to the ground transmitter station for 500 ms. This looks like a brief deflection of the bearing arrow (signal-beam) from the aircraft/ship to the ground station.
If the tower controller wants then to check the last bearing, which should be the bearing to an aircraft/ship, by pressing the "Repeat" button, this is not possible because the last bearing is overwritten with the bearing to the ground transmitter.
Sampling time is set to 50 ms per default.
To change this setting, select the desired value in the drop-down menu and press “<SET<”.

5. Configure the appropriate DIO(s) of the PTT module.

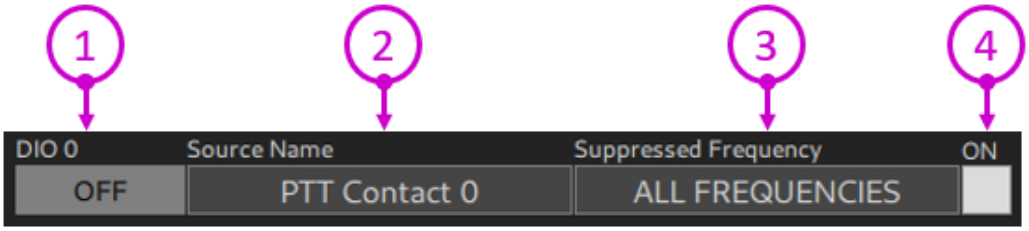
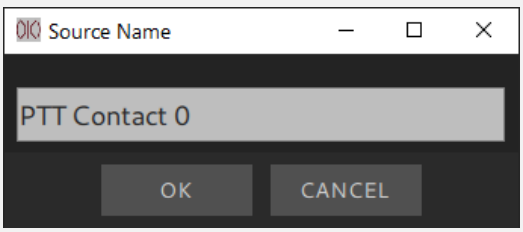
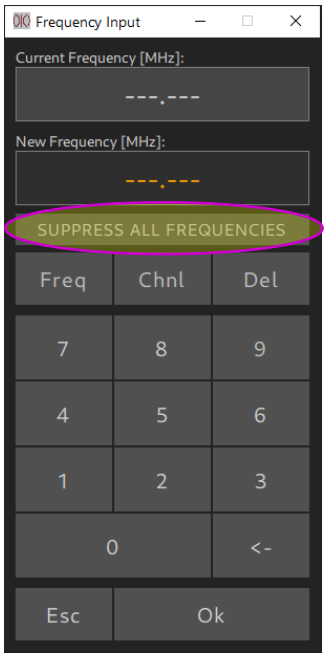
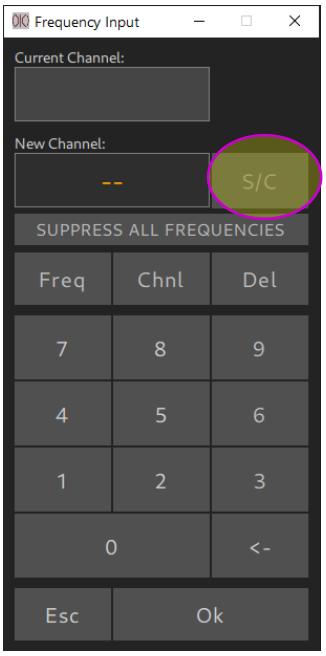


Figure 77: DIO setup

The push-to-talk button is connected to a certain DIO (digital input/output) of the PTT module. In this step, each DIO, that has a connection should be set up to enable proper SBS function.

1	**DIO State LED**	**Shows the state of the correspondent DIO. The LED can take the following states:** OFF: The OFF state indicates that the actual input/output of the PTT module is in the "high" state (not connected to ground). If the push-to talk button is connected properly, this state means that the button is currently not pressed. The physical connection to the device is still maintained, even if the SBS function is not activated. This can be used to check the correctness of the hardware setup. ACTIVE: The ACTIVE state indicates that the actual input/output of the PTT module is in the "low" state. If the hardware setup is correct, this means that push-to-talk button is currently pressed. UNDEF: The UNDEF state indicates that the actual input/output state of the PTT module is unknown. This is the case, when the TCP/IP connection is interrupted or the device is disabled by user.
2	**Source Name**	This text input field allows the assignment of specific name to the DIO source. The default name indicates the number of the physical push-to-talk contact (DIO number of the PTT module). To change the name, click into the text field. Following dialog shows up:  Enter the new name by overwriting the current source name and press "OK".
3	**Suppressed Frequency**	This input field allows the assignment of a specific frequency (or maritime channel), which must be suppressed when the connected push-to-talk button is

		pressed. It is also possible to activate the ground transmitter suppression on all frequencies. The default value of “Suppressed Frequency” is “ALL FREQUENCIES”. To change this value, click into the input field. The frequency input dialog appears:  Enter the new frequency in MHz, or activate all frequencies by clicking the button “SUPPRESS ALL FREQUENCIES”, and press “OK”.  Enter the maritime VHF channel number. If the VHF channel is a duplex channel, Ship or Coast must be selected accordingly. To do this, press "S/C". Then press “OK”.
4	**Checkbox “ON”**	This checkbox activates the Self Bearing Suppression at the corresponding DIO. This means that if the PTT module detects a low voltage level on the corresponding DIO, the DF Commander MK2 immediately (depending on the “Sampling Time” setting) receives the information on which input of the PTT module it occurred and suppresses the bearing indication of all channels operating on the suppressed frequency that is assigned to this DIO. If this checkbox is not checked, the SBS function for this DIO with the corresponding suppressed frequency is not activated. The physical connection to the device is still maintained. This can be used to check the correctness of the hardware setup (s. DIO State LED).

Short explanation of an example:

In this example the push-to-talk button is connected to DIO 2 of the PTT module. The ground transmitter has the name “Ground Control 1” with the frequency of 121.975 MHz. The SBS function is activated.

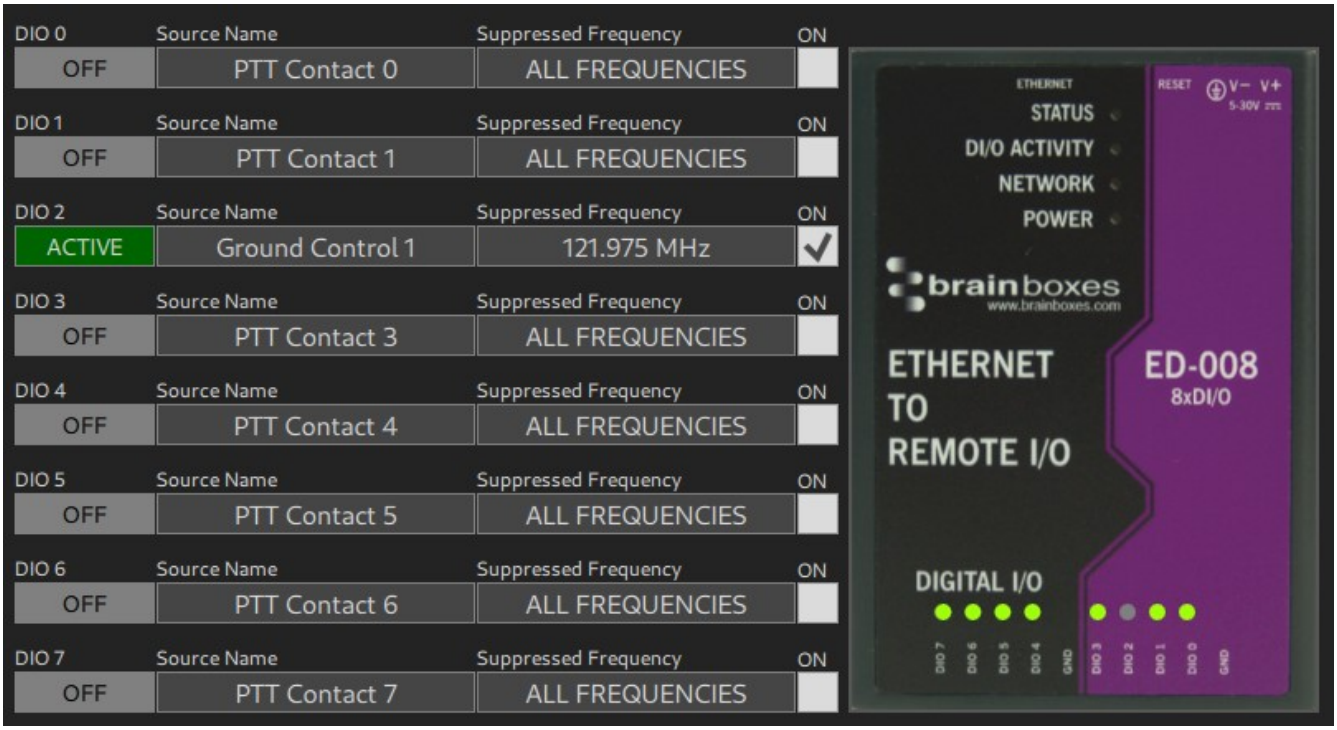


Figure 78: SBS Example

The DIO state LED is “ACTIVE”, which means that the tower control operator is currently speaking, the push-to-talk button of the ground transmitter is pressed.
The picture of the PTT module is displayed on the right side. This image represents the actual DIOs state of the hardware when it’s properly set up. The “DIGITAL I/O” LEDs of the PTT module are shining green if the PTT buttons are not pressed. When a button is pressed, the corresponding pin LED turns off.
Consequently, the DIO 2 of the PTT module is in the “low” state and DF Commander suppresses the bearing indication on all channels with the frequency of 121.975 MHz.

4 Status Displays

All modules that require a network connection have a detailed status display. In the following, the display elements are described in detail on the basis of a bearing channel.

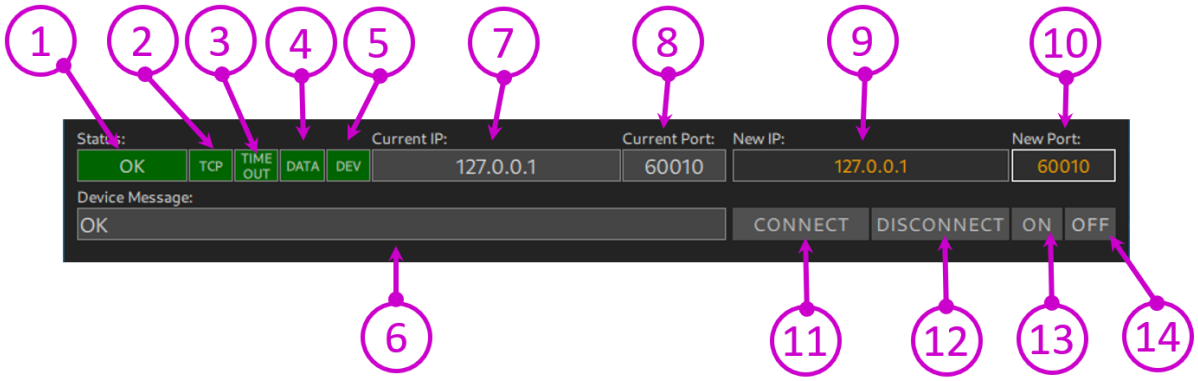
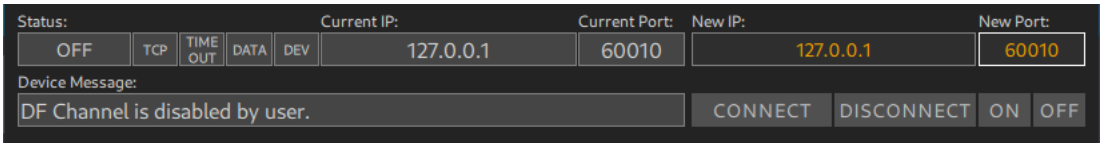


Figure 79: Status displays

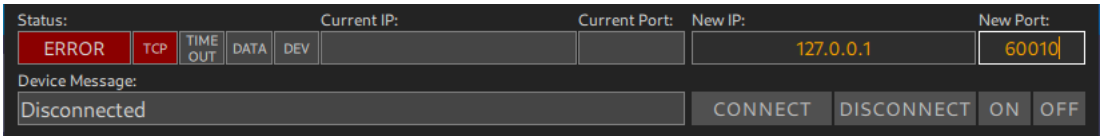
1	**General Status LED / General State LED**	**Shows the general status of a network device (e.g. bearing channel or GPS receiver).** **The LED can take the following states:** OFF: The data of the device are not utilized. Errors are ignored and not forwarded. The module can be deactivated by pressing the "OFF" button. The connection to the device can still be maintained. Disabling a device can be beneficial during a device repair or replacement. For example, no overall system error of a bearing system is generated while a bearing channel is exchanged. ERROR: The device is in error state. It cannot serve its purpose. For example, a bearing channel cannot determine bearing values. WARNING: The device can still do its job, but with limitations. Warning is also issued when a device is not operating within its specified conditions. For example, an operating temperature has been exceeded or the operating voltage has fallen dangerously below the specified value. OK: The device works perfectly.
2	TCP LED	Indicates whether a TCP/IP connection to the device exists. Lights up red when there is no connection. Flashes yellow / red when trying to establish a connection. Green - the connection is established.

3	TIMEOUT LED	The TIMEOUT LED lights up red when no data is being sent cyclically by the device. Green - data arrives cyclically.
4	DATA LED	The DATA LED indicates whether the data coming from the device is valid.
5	DEV LED	The DEV LED indicates whether the device itself issues an error or warning. Lights up red when the device issues an error message. Lights up yellow when the device issues a warning. Green – no errors.
6	Device Message	The bar displays the error status in plain text.
7	Current IP address	No input possible
8	Current TCP port	No input possible
9	New IP address	The new IP address is to be entered here.
10	New TCP port	The new TCP port is to be entered here.
11	CONNECT	Button for establishing the connection with the device
12	DISCONNECT	Button for closing the connection with the device
13	ON	Activating the device Data and status from the device are to be evaluated.
14	OFF	"Software" - Deactivating the device Data and status from the device should not be evaluated.

Examples based on a DF channel in a DF system:

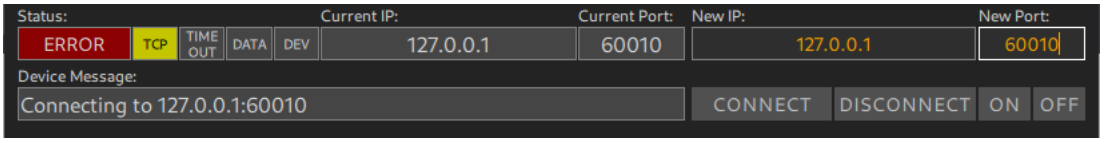


The bearing channel is deactivated. It may be that the TCP/IP connection is established, but the actual error status is unclear.



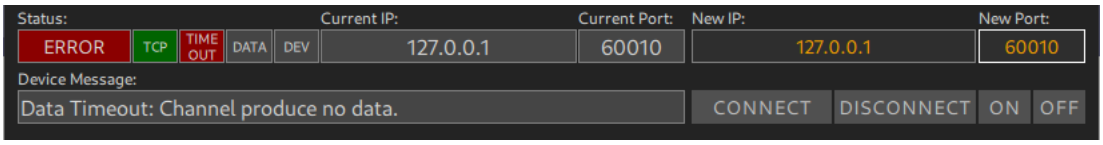
There is no connection to the DF channel.
Possible cause of error:

- CONNECT has not been pressed.



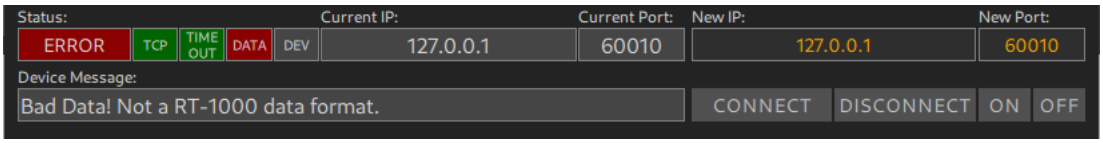
An attempt is made to establish a connection to the IP address 127.0.0.1 and port 60010, but without success.
Possible cause of error:

- The TCP/IP server of the device does not work.
- There is no LAN connection to the device.



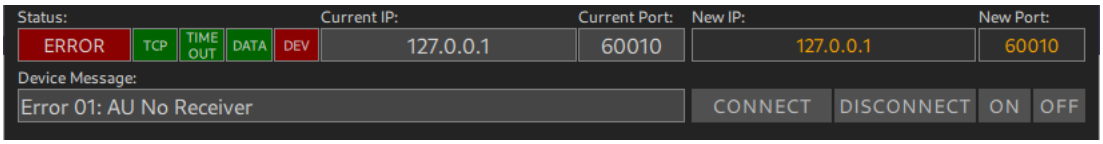
The TCP/IP connection is established, but the device is not producing any data.
Such behavior can occur when a DF channel consists of two components. For example, a RT-1000 DF channel generates a RS-232 data stream that is fed to a serial to LAN converter. The converter assumes the role of a server to which a connection is established.
Possible cause of error for devices using serial to LAN converters:

- The source of the serial data is switched off (DF channel is off, but not the serial to LAN converter).
- The serial line between the device and the serial to LAN converter is interrupted (no physical connection).
- The baud rate in the device is set incorrectly.
- The serial port settings in the serial to LAN converter are incorrect.

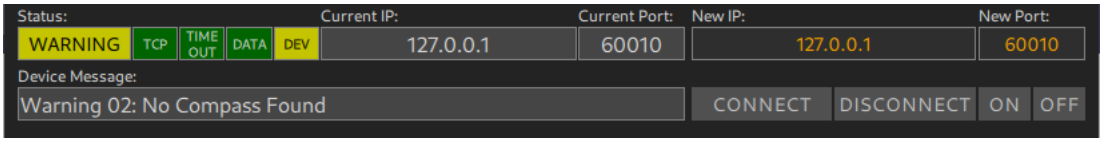


A TCP/IP connection is established.
The device sends data cyclically.
However, the data is not intended for the set device. In this case, data from an RT-1000 bearing channel is expected according to the RT-1000 data protocol. The incoming data cannot be evaluated.
Possible causes of error:

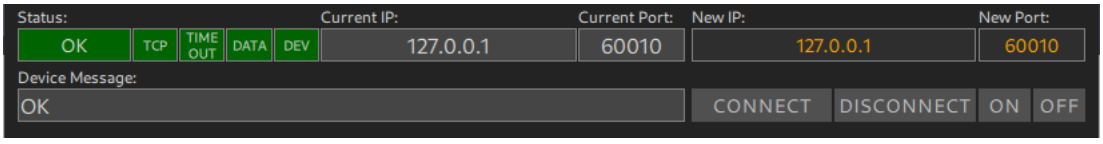
- The connection was established to an incorrect device (e.g. to a GPS device or to another DF system).
- The protocol setting of the bearing channel is wrong (e.g. RT-1000 protocol was set, although RT-500-M protocol is desired).



A TCP/IP connection is established.
The device sends data cyclically.
The data is valid.
However, the device itself produces an error. To find the cause of the error, the documentation of the respective system must be consulted.
In this example, a connection was established with an RT-500-M device. It reports an error: "Error 01: AU No Receiver". According to the RT-500-M system documentation, the receiver in the Antenna Unit has failed.



A TCP/IP connection is established.
The device sends data cyclically.
The data is valid.
However, the device itself produces a warning. To find the cause of the warning, the documentation of the respective system must be consulted.
In this example, a connection is established with an RT-500-M device. It reports a warning: "Warning 02: No Compass Found". Without a compass connection, the bearing system can only determine relative bearing values – no north-related bearing values. Accordingly, it works with limitations.



In this case, the TCP/IP connection, as well as the cyclic data are valid and correct.
The system is expected to function properly.

5 Monitoring Page

The Monitoring page is used for the technical monitoring of all configured DF systems and their channels. Configuration is not possible here.
According to requirements, it can be chosen between two views of the monitoring page.

5.1 General Status Monitoring

“General Status Monitoring” offers the status data of all servers (local and remote), their systems and triangulators, defined by LEDs.
If general status LED is in ERROR or WARNING state, this page is the quickest way to find the cause of the problem, as all statuses are visible at a glance.

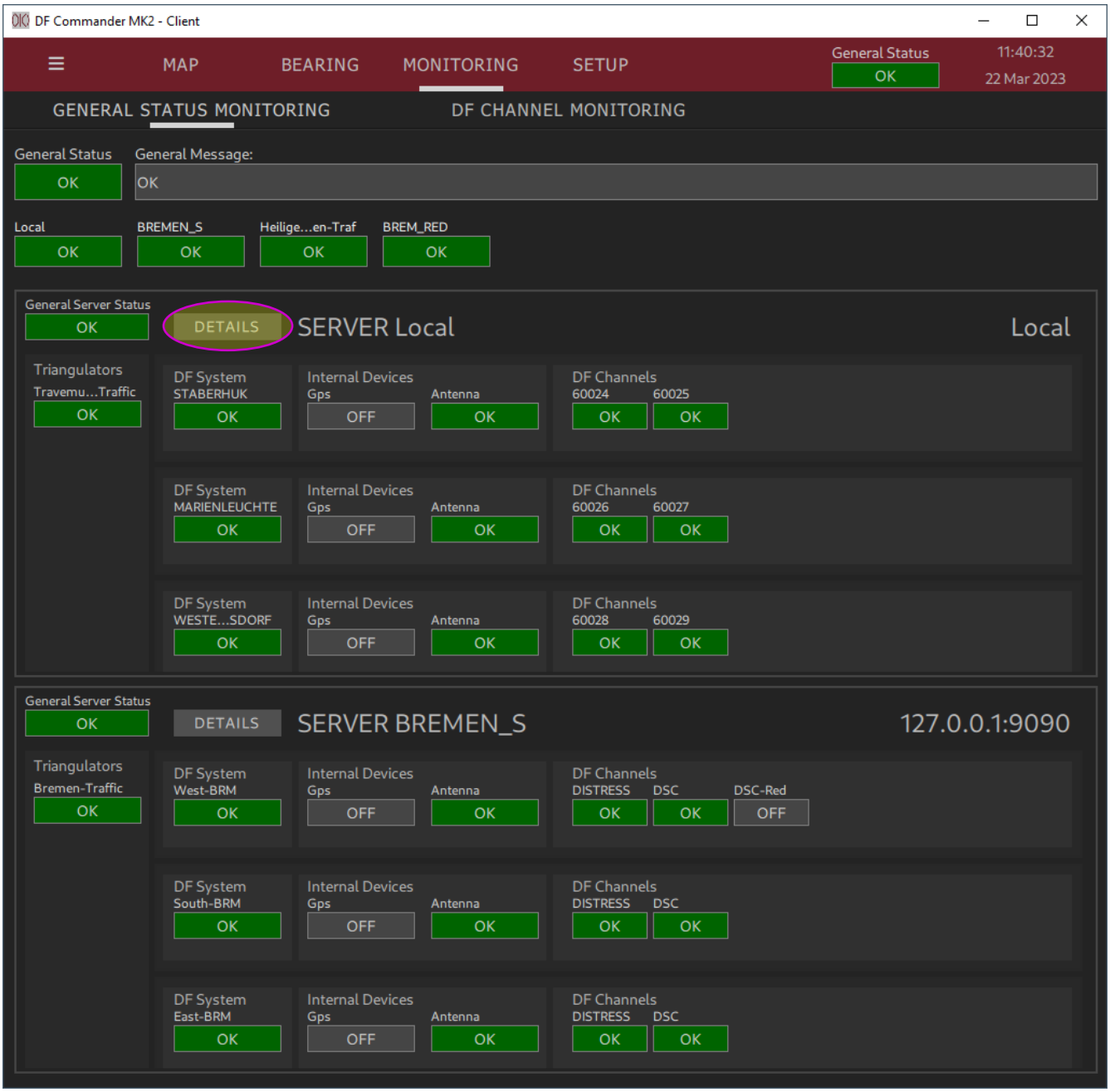


Figure 80: Monitoring page / general status monitoring

5.2 System Details

If more information about specific servers is needed on the General Status Monitoring page, there is also a possibility to view more detailed information.
To do this, click the "DETAILS" button next to the server name.

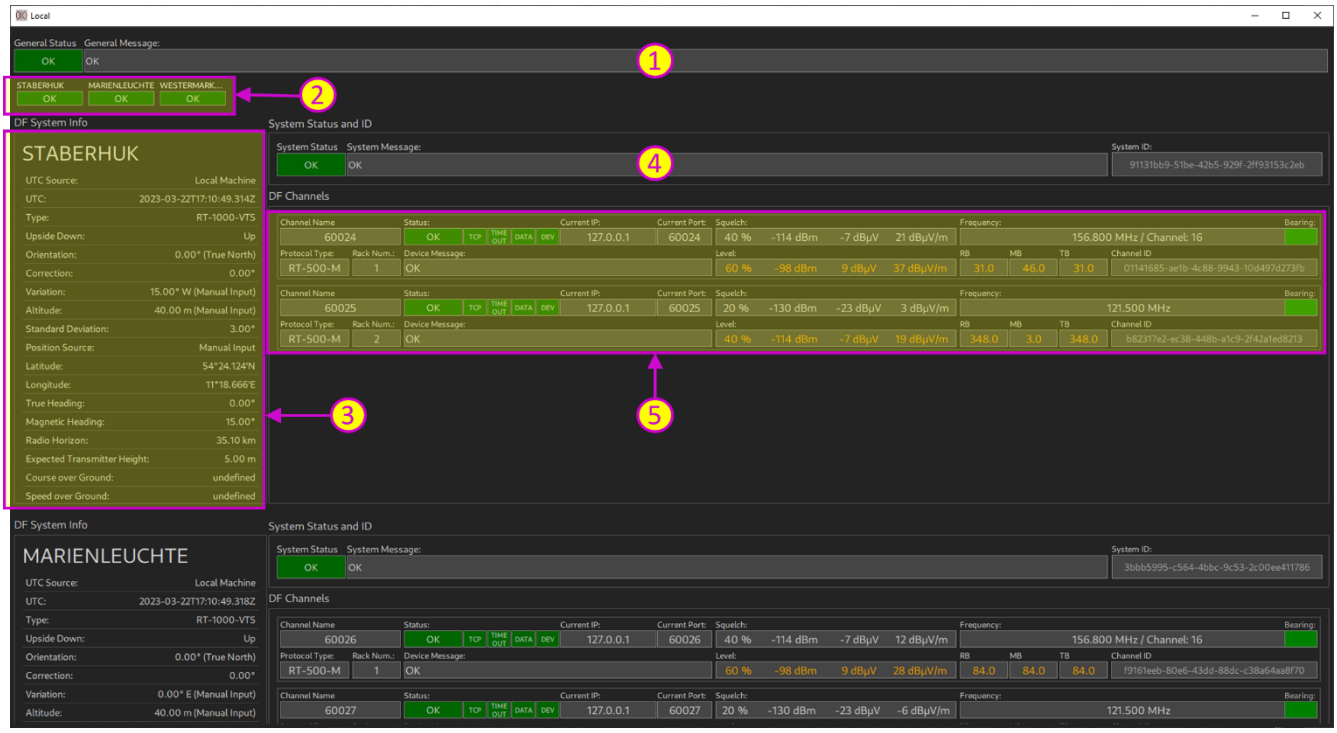


Figure 81: Monitoring page / setup details of a specific server

1	General Status LED and General Message Displays the combined status of all DF systems. As soon as a bearing system or a bearing channel reports an error, the state of the LED also changes to error. A plain text message is displayed accordingly.
2	System status LED bar Contains the status LEDs of individual bearing systems in one bar. Since the bars are always displayed at the top, it is possible to see at a glance which system has a fault. Click on an LED to go to the corresponding system.
3	System data display Displays all current data of the respective bearing system.
4	Status LED of the system with the corresponding plain text message In the event of an error, the plain text message can assist in troubleshooting.
5	DF channel list Displays all configured bearing channels of the respective system. All relevant information is displayed for each channel. The status display is particularly important for troubleshooting. See Chapter 4 "Status Displays" for details.

5.3 DF Channel Monitoring

The DF Channel Monitoring is a good tool to monitor all configured channels simultaneously. The status information and some main settings are displayed on this page.

The receiving situation can be monitored particularly well, since it is immediately apparent on which channel, at which frequency a bearing (degrees and signal level) is currently being received.

All channels are displayed in a scrollable list view.

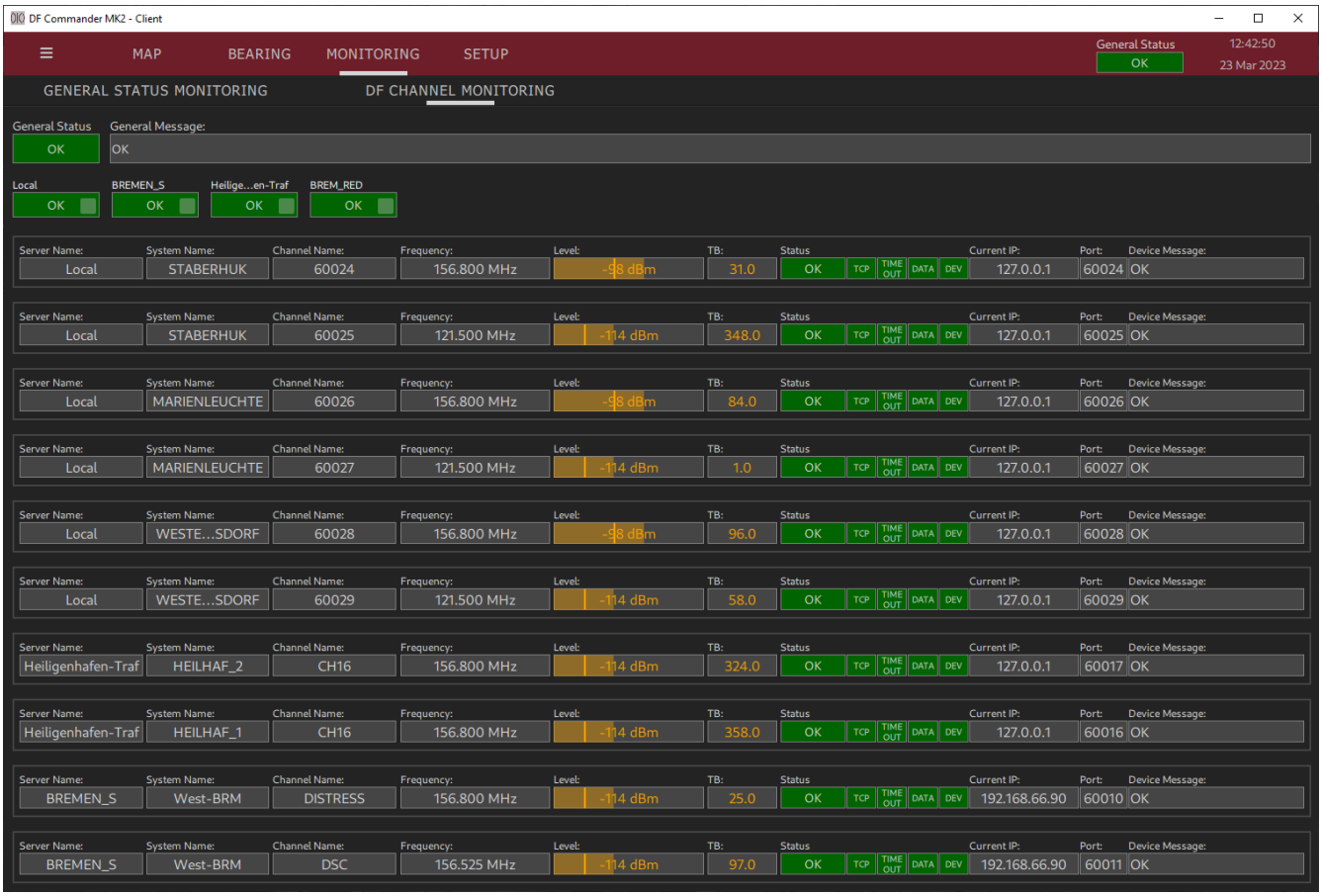


Figure 82: Monitoring page / DF channel monitoring

The page provides a way to select a single server (or multiple specific servers) to view. Within the server status LED is a checkbox that can be activated to choose only the channels of this particular server to display. The channels of the unselected servers are hidden in this case.

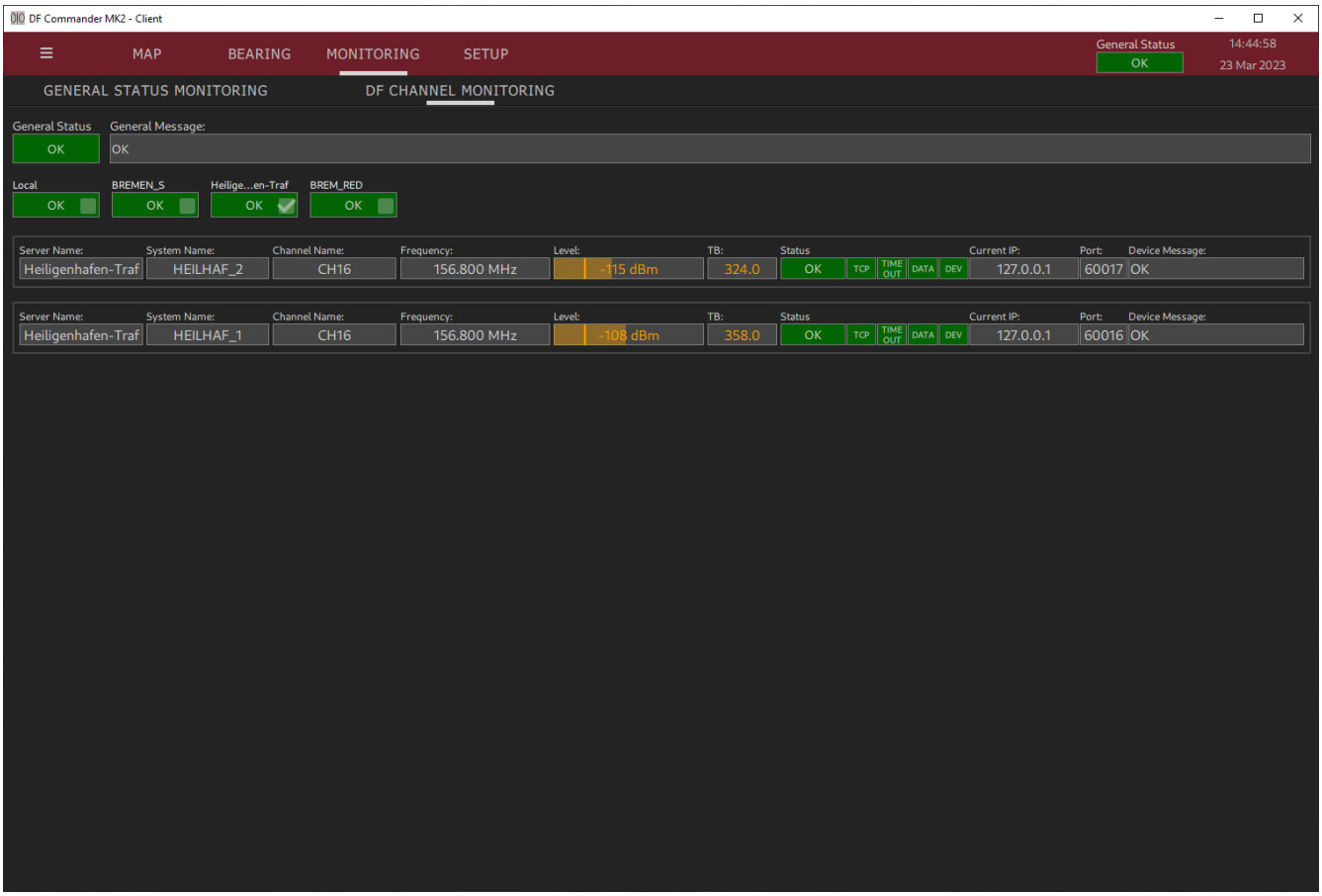


Figure 83: Monitoring page / DF channel monitoring of one server

6 Bearing Page

The Bearing page allows the display of bearing results and signal levels of selected bearing channels on a compass rose. This view is used to support the navigators and the technical system monitoring.

The Bearing page can be opened on a separate monitor in an independent window. This makes it possible, for example, to have the monitoring page open on one screen and several bearing pages open on another screen in order to monitor certain bearing channels from a nautical/navigator or air traffic controller/pilot's point of view.

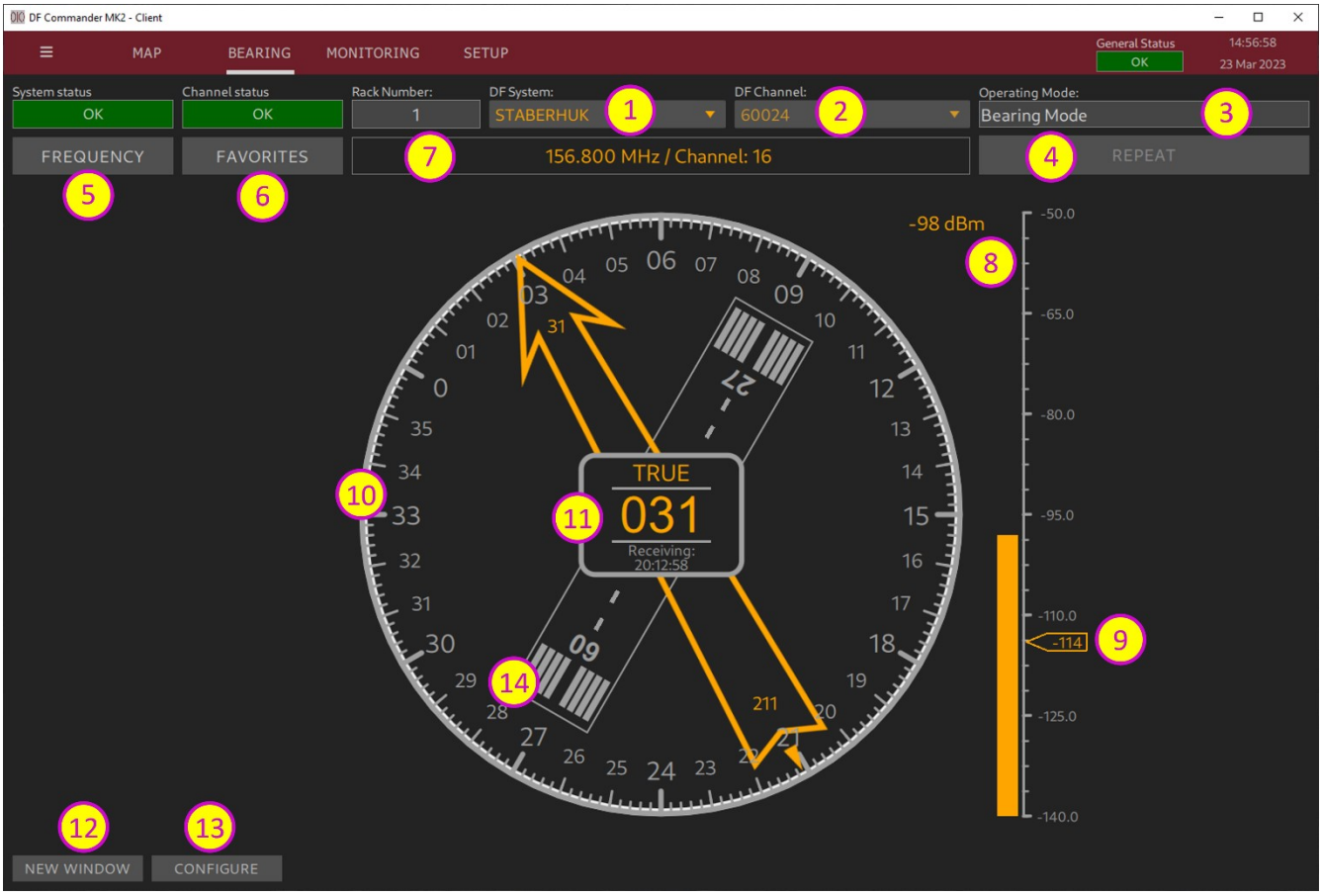


Figure 84: Bearing page

1	Selection of the system
2	Selection of the bearing channel
3	Operating mode indication The operating mode can be set under SETUP/DF SYSTEMS, channel setup.
4	"REPEAT" button Pressing the REPEAT button displays the last bearing as long as the button is held. A current bearing naturally takes precedence over the repeat display.
5	Frequency setting in MHz See Figure 38: Input in MHz and Figure 39: Input as VHF channel

6	Frequency setting via the favorites list See Figure 40: Entry from the favorites list.
7	Display of the current frequency In the case of a marine band frequency, a corresponding VHF channel is displayed with Ship or Coast identification, if applicable.
8	Level display The scale of the level display can be reconfigured. Thus level displays in %, dBm, dBµV and dBµV/m are possible.
9	Squelch setting Use the mouse to move the control element to the desired value and release. The squelch is set to the desired value. The squelch setting is limited to reasonable values.
10	Bearing rose The numbers of the bearing rose refer to the central bearing display (point 11). If "TRUE" is set in the central display, the numbers also correspond to TRUE bearing. The bearing rose can be rotated (see point 13). If the Bearing page is used by an ATC or VTS navigator, the bearing rose can be rotated so that the upper number corresponds to the window viewing direction. This allows the operator to visually follow the displayed arrow and potentially see a vessel or aircraft directly.
11	Central bearing display A bearing value is displayed here in the corresponding reference. In the current display, the reference is set to "TRUE". This means that the numerical value corresponds to the "True bearing". Press the reference to set another reference. The following references are possible: RELATIVE, MAGNETIC, TRUE, QDM, QDR, QTE, QUJ.
12	"NEW WINDOW" button Opens the Bearing page in a separate window.
13	"CONFIGURE" button Opens the configuration window for the Bearing page. The configuration refers to all open bearing windows.
14	Runway display A runway can also be displayed on the bearing rose to give the tower controller better orientation (see point 13).

Press "CONFIGURE" to open the configuration window.

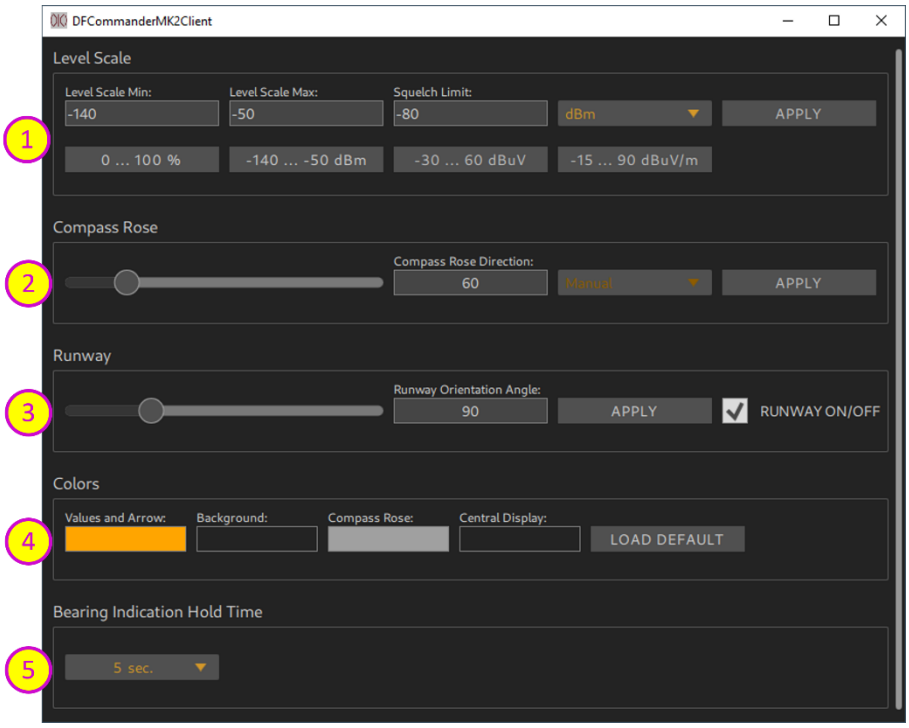


Figure 85: Bearing page configuration window

1	<u>Level display settings</u> In the upper line the level display can be adjusted flexibly. Define the minimum, maximum and limit for the squelch setting. Select the unit. The following units are possible: %, dBm, dBµV, dBµV/m. Press “APPLY” to accept the level display configuration. In the second line "scale hotkeys" are available. They allow a quick adjustment of the level display scale with already preset conceivable values.
2	<u>Rotation of the bearing rose</u> Move the slider or enter the value of the alignment of the bearing rose directly and press "APPLY".
3	<u>Runway setting</u> Define a runway orientation angle in degrees, and switch on the indication by checking the “RUNWAY ON/OFF” box.
4	<u>Color setting</u> In this menu you can set colors for the values and the arrow, for the background, for the compass rose and the background of the central bearing display. Press the corresponding rectangle and select the color. The color is applied immediately. Press "LOAD DEFAULT" to return to the default color settings.
5	<u>Bearing Indication Hold Time / afterglow time of the arrow and the values</u> When the radio signal is no longer received, the bearing is still displayed in light grey. After this afterglow time the display disappears. The value "Infinite" means that the values are displayed until a new bearing is determined.

7 MAP Page

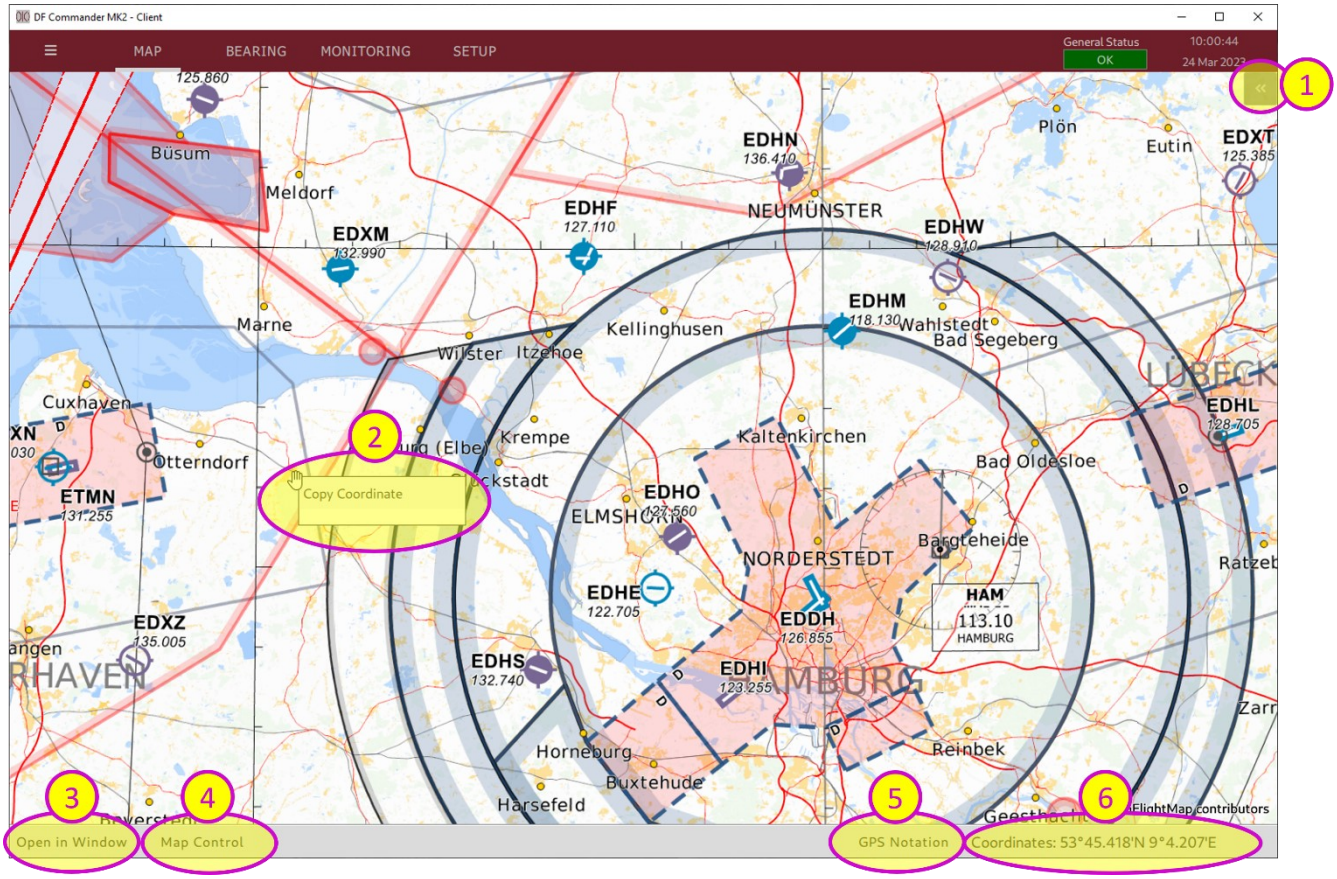


Figure 86: Map display

1	<u>Sidebar control element</u> Press the control element to open the sidebar which contains relevant data regarding the indication on map. The relevant information can be opened in corresponding windows, that are bound to the map and are only visible in the map.
2	<u>Right mouse button</u> Press the right mouse button and "Copy Coordinate". This copies the current coordinates of the mouse to the clipboard. They can be inserted anywhere, e.g. in a text editor.
3	<u>Open in Window</u> Press this button to open the map view in a separate window. Only one window is possible.
4	<u>Map Control</u> Press this button to open the map control element.
5	<u>GPS Notation</u> Press “GPS Notation” to set the GPS format. This function has exactly the same effect as the setting in General setup. See Chapter 3.1.3 "GPS Format".
6	<u>Coordinates</u> Shows the GPS coordinates of the current mouse position on map.

8 COSPAS-SARSAT Scan & Decode / Marine Scan

The DF Commander MK2 supports COSPAS-SARSAT scan as well as the graphic display of COSPAS-SARSAT signals.
The actual COSPAS-SATSAT scan, detection and decoding is done by the direction finding system. DF Commander MK2 application only represents the data.

8.1 COSPAS-SARSAT Scan / Marine Scan

To use the COSPAS-SARSAT or Marine scan function, first set the COSPAS-SARSAT or Marine scan mode on the direction finding system and then in the DF Commander software. The scan modes are set under channel setup menu, with the “Operating Mode” setting (SETUP / DF SYSTEMS / DF Channel SETUP).

NOTE:
For the exact scan / decode behavior please refer to the user manual of the DF system in use.

8.2 COSPAS-SARSAT Decode

To use the COSPAS-SARSAT decode function, first set the COSPAS-SARSAT decode mode on the direction finding system. Then go to SETUP / DF SYSTEMS / DF Channel SETUP and select the “Cpss Decode Mode” on the corresponding DF channel.

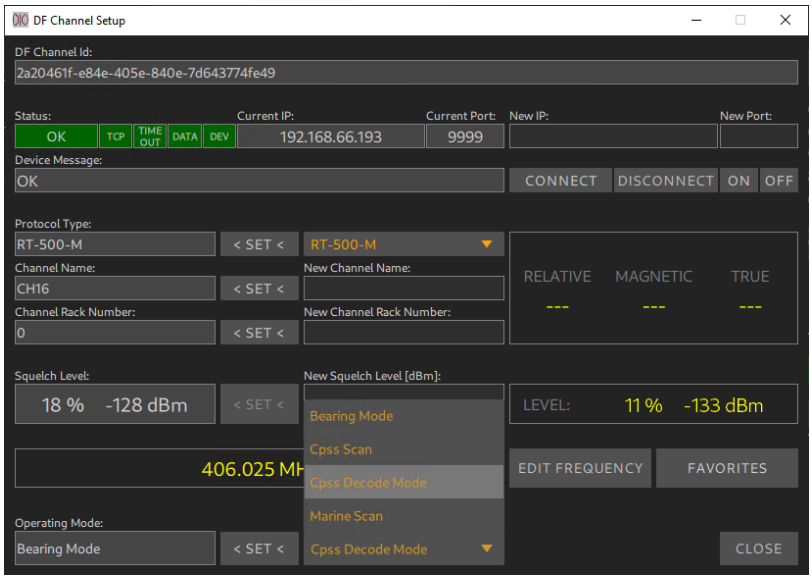


Figure 87: Switching to COSPAS-SARSAT Decode Mode in DF channel

When a COSPAS-SARSAT beacon is detected, it is shown on the map at the decoded position with the corresponding beacon ID.

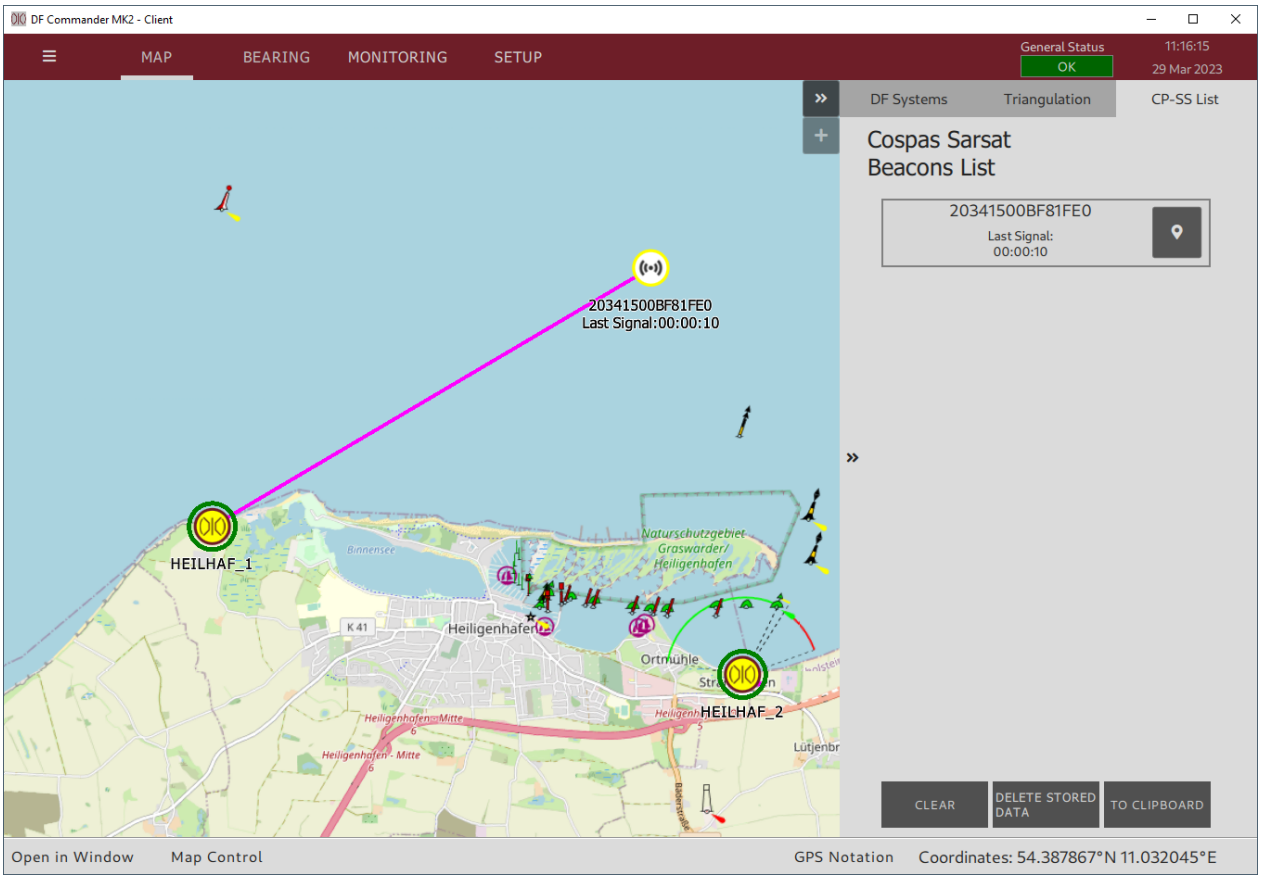


Figure 88: Decoding DF system with the bearing line to the CP-SS beacon

The DF system, which detects and decodes the COSPAS-SARSAT data, shows this on map by blinking “CPSS RECEIVED” and drawing bearing line(s) to the beacon position(s), if the position data is contained in the COSPAS-SARSAT message.
If the position data is not contained, the beacon ID appears in the list of the COSPAS-SARSAT beacons, but the bearing line to the beacon is then not available.
The list of detected beacons can be viewed in the sidebar of the map.
To show the details to the specific beacon, click on it in the beacons list.

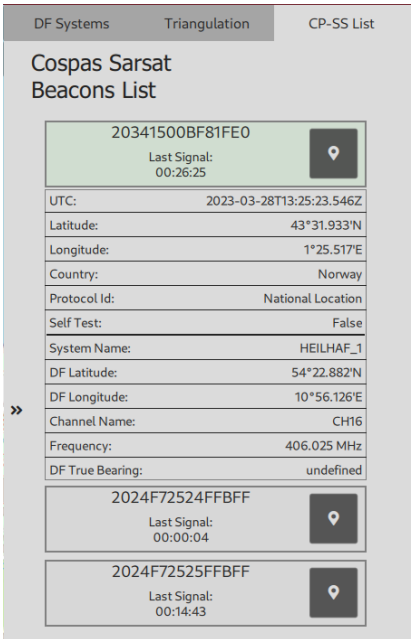


Figure 89: Cospas-Sarsat beacons list with opened details of a specific beacon

8.3 COSPAS-SARSAT Files

The COSPAS-SARSAT files are located in a separate folder, in the configuration files directory, which is opened in SETUP / GENERAL by clicking on the "OPEN DIRECTORY" button.

The files of the individual decoded beacons are sorted in the separate folders.

NOTE:
The files of the COSPAS-SARSAT beacons are never deleted, even if the "CLEAR" button is operated.
Should it be desired to delete these files, it must be done manually in the files directory.

9 Limitations

Some additional limitations must be paid attention to.

RT-500-M Antenna Unit RT-600 Antenna Unit RT-600 Antenna Unit	Only one DF Channel can be connected to the Antenna Unit at a time.
RT-500-M DCU	Only one DF Channel can be connected to the RT-500-M DCU at a time when using COSPAS-SARSAT Decode Mode, if revision of RT-500-M DCU is [Rev 3.06] or less.
Local Server TCP Port	Limited to ports available on the used machine. If chosen TCP port is already in use, TCP Server cannot be started.
COSPAS-SARSAT	Storage of COSPAS-SARSAT messages is limited to 5000 messages per beacon. If more messages are received, the oldest ones are deleted.
MAP page	“Open in Window” button is limited to opening only 1 new window.

Table 1: General Limitations

10 Installation

NOTE:
Please make sure your personal firewall or virus & malware protection is configured not to block the installation of the “DF Commander MK2” software.

NOTE:
If the user changes or replaces the dynamic link libraries, RHOTHETA Elektronik GmbH no longer accepts liability for the functionality of the entire software. This voids the warranty.

10.1 Minimum PC and Network Requirements

NOTE:
If the text is not visible in the dialogs of the DF Commander MK2, the font “Cantarell” must be configured on your PC.

Minimum PC and network requirements		
Operating systems:	*Windows 10 or higher (64 Bit)* *Linux RHEL 8.4 (64 Bit)*	
Processor:	*Intel Core i5 (5th Gen) or AMD Ryzen 5*	
Hard Disk:	*500 GB*	
Memory:	*16 GB RAM*	
Interfaces:	*1 x RJ45 (LAN), interfaces for mouse and keyboard*	
Monitor resolution:	*Minimum:* *Recommended:*	*1024 x 768* *1280 x 1024*

<table>
<tr>
<td>Minimum required network bandwidth for integrated server:</td>
<td>
Protocol: RHOTHETA DF Standard JSON Protocol

Data content:
- Active bearing on all channels (bearing update every 250 ms)
- Active trinagulation on all different frequencies if possible

Network Layer: TCP

Data rates for <u>one client</u> connected to integrated server:

<table>
<tr><th>Total number of DF Channels</th><th>Average*</th><th>Max. Peak**</th></tr>
<tr><td>1</td><td>25 kBit / s</td><td>150 kBit / s</td></tr>
<tr><td>3</td><td>75 kBit / s</td><td>500 kBit / s</td></tr>
<tr><td>6</td><td>150 kBit / s</td><td>800 kBit / s</td></tr>
<tr><td>12</td><td>300 kBit / s</td><td>1500 kBit / s</td></tr>
<tr><td>18</td><td>450 kBit / s</td><td>2500 kBit / s</td></tr>
<tr><td>24</td><td>600 kBit / s</td><td>5500 kBit / s</td></tr>
</table>
*Average is the minimum data rate which must be provided by network (This data rate was measured in a period of 60 seconds)

** Max. Peak is the data rate measured with the max. hold method whithin 100 ms time slot over a period of 5 minutes.
</td>
</tr>
<tr>
<td>Preinstalled Software</td>
<td>Adobe Acrobat Reader (Not older than 2016)</td>
</tr>
</table>

Table 2: Minimum PC requirements

10.2 Installation in Windows

Double click on the delivered installer:

- `DFCommanderMK2-Server-X.XX-xxx-xxxxxxxxxx-Installer.exe` or
- `DFCommanderMK2-Client-X.XX-xxx-xxxxxxxxxx-Installer.exe`

and follow the subsequent instructions.

It is recommended to install the software into the user home directory: e.g.:
`C:\Users\max.mustermann\DFCommanderMK2-Server`

The executable file is:

- `DFCommanderMK2-Client.exe` or
- `DFCommanderMK2-Server.exe`

To remove the program, run `maintenancetool.exe`, which is located in the same folder.

10.3 Installation in Linux

Unpack the delivered tarball, e.g.:
`DFCommanderMK2-Server-X.XX.tar.gz`

into the user home directory:
`tar xzf DFCommanderMK2-Server--X.XX.tar.gz`

To run the program, `start.sh` must be called up on the command line:
`cd DFCommanderMK2`

```
./start.sh
```

10.4 Licensing

After starting the software, you will be prompted to enter the credentials. Fill out the form, if necessary, select a network interface from the list, read and confirm the agreements.
At the end of the process the license key must be entered. To get a license key, copy the data from the last window (or save it in a file) and send it to RHOTHETA.
Depending on the ordered options, RHOTHETA will generate a specific license key.

If you already own a DF Commander MK2 application and only want to expand it with additional options, please contact RHOTHETA.

A new license key can be entered via folding menu in the left upper corner by selecting “About”, and using the same procedure as described above.

11 Abbreviations

Term:	Definition:
ATC	Air Traffic Control
VTS	Vessel Traffic Service
DF	Direction Finder, Direction Finding System
HMI	Human Machine Interface
ID	Identification
IP	Internet Protocol
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
SAR	Search And Rescue
System	In the context of the DF Commander a “system” is an antenna with at least one direction finder.
PTT GTS SBS	Push-To-Talk Ground Transmitter Suppression Self Bearing Suppression
VTS	Vessel Traffic Service

Table 3: Terms and Abbreviations

12 Notes