

V-MD3

digital 3D radar transceiver



Features

- Easy evaluation of the radar sensor V-MD3 over a GUI
- Easy adjustment of parameters for optimization to customer applications
- Real-time streaming of all relevant radar processing data
- Data recording and playback including video using a webcam
- Firmware update over boot loader
- Saves time to market and reduces NRE costs

Applications

- Getting started with the V-MD3
- Real-time optimisation of the radar parameters for different applications
- Situation recording including video data for later analysis in the lab
- Learning about the potential of a V-MD3 sensor

Description

The V-MD3 is a high-end 3D radar transceiver with integrated signal processing and tracking algorithms. It can measure the speed, direction, distance and angle (in azimuth and elevation) of moving and static objects. The digital structure and wide power supply range make it very easy to use this sensor in any stand-alone or MCU based application.

The control panel described in this user manual allows a simple and quick evaluation of the sensor with all its parameters. All settings can be easily adjusted in the control panel and the effects can be verified in real time. The recording function also offers the option of subsequently playing back and analysing measurements.

Control Panel

Figure 1: Control panel GUI overview

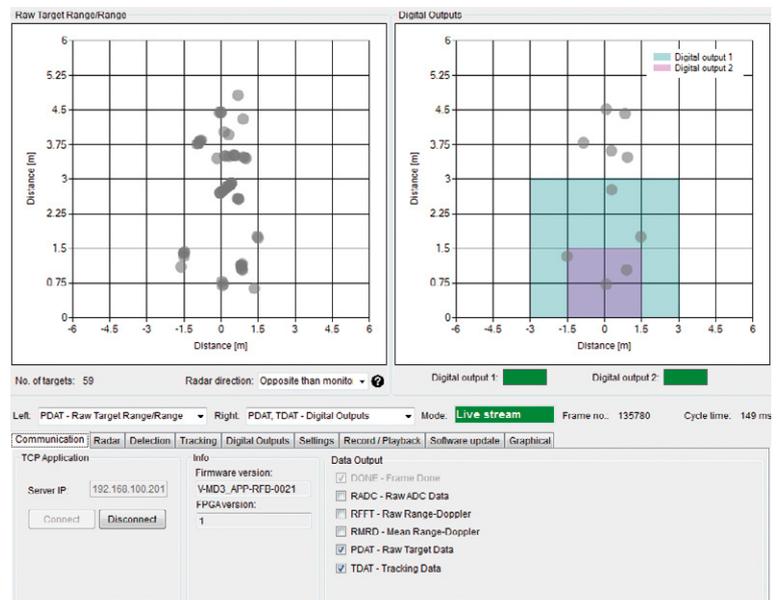


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INSTALLATION

1. Connect the delivered USB Stick to your PC or download and unzip the control panel software from www.rfbeam.ch.
2. Open the installer folder.
3. Install the V-MD3 Control Panel by double clicking the setup.exe file. If no .net framework is installed, the installer will install it automatically.



To use the integrated video function, install and test your webcam before you go to the next chapter. Please download and install necessary drivers for the webcam from the manufacturer website.

QUICK START

1. Connect the V-MD3 over Ethernet to a host PC and change the IPV4 connection settings on the host to a static setting with the following parameters:
IP-Address: 192.168.100.1
Subnet: 255.255.255.0
2. Power up the V-MD3 by applying 12 or 24V on the pin 1 and GND on the pin 3 of the M12 male A-coded connector.
3. Start the V-MD3 control panel software.

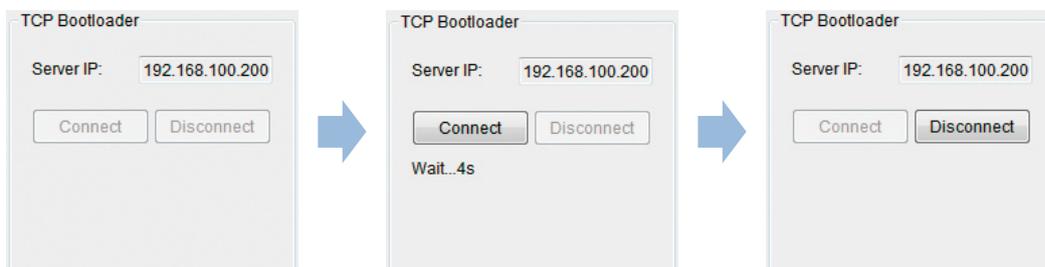


At the first start, Windows will ask whether the firewall should allow communication connections for the V-MD3 control panel. Allow it, otherwise the firewall will block the UDP packets sent from the sensor to the host.

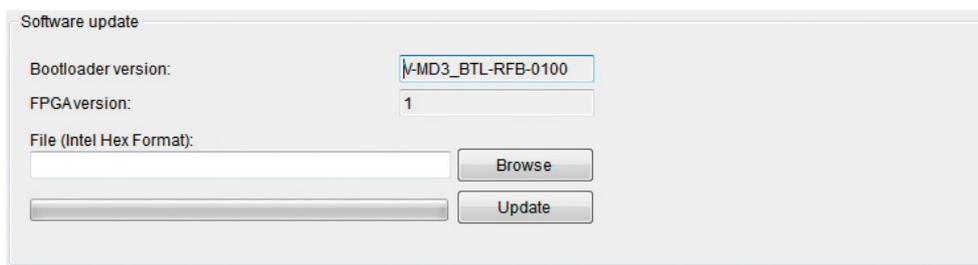
4. The control panel now tries to ping the V-MD3 on the default IP address 192.168.100.201. As soon as the sensor is ready the “Connect” button will become available.
5. Press the “Connect” button.
6. On a system with multiple webcams, a dialog will pop up. Select the webcam you want to use.
7. The mode indicator switches to Live stream and the software is ready to use.

SOFTWARE UPDATE

1. Connect the V-MD3 over Ethernet to a host PC and change the IPV4 connection settings on the host to a static setting with the following parameters:
IP-Address: 192.168.100.1
Subnet: 255.255.255.0
2. Start the Control Panel and switch to the Software update tab.
3. Power up the V-MD3 and wait until the “Connect” button becomes active. Press the “Connect” button in the next 4s to connect to the bootloader. The connection was successful if the mode display changed from Disconnected to Bootloader mode and the bootloader and FPGA version are displayed.



4. Use the “Browse” button to select the firmware update file provided by RFbeam Microwave.



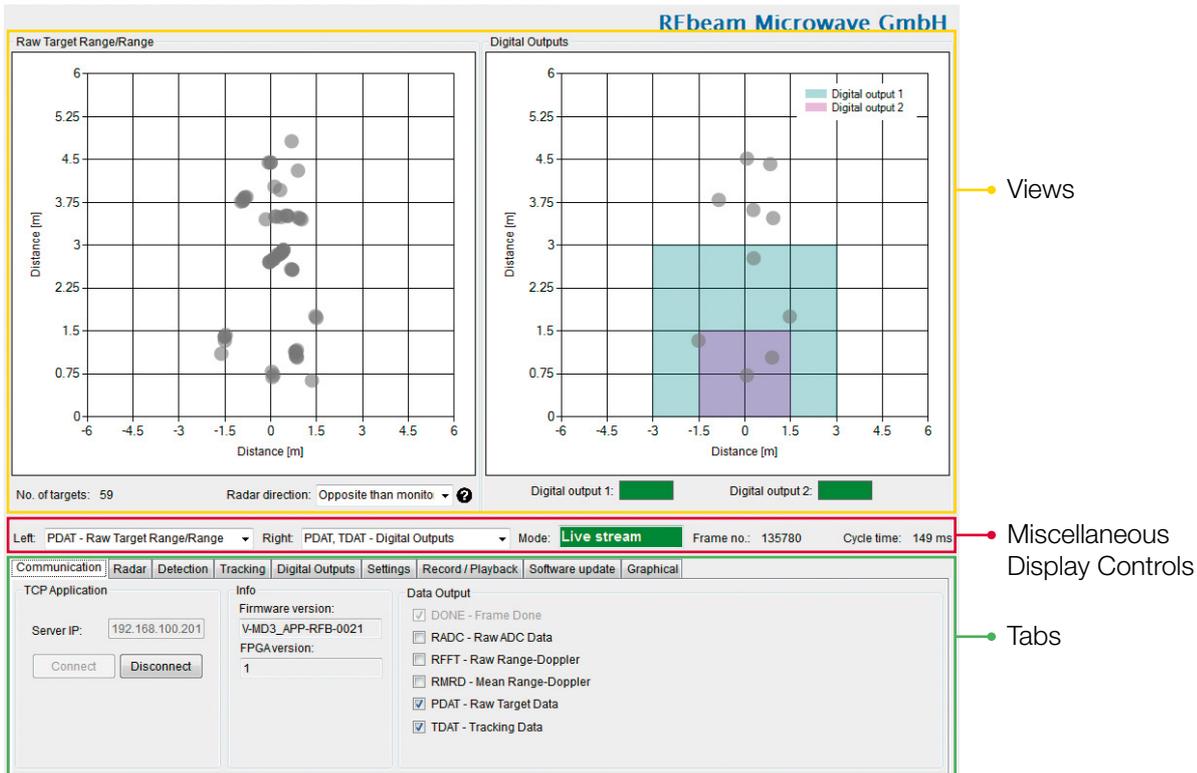
5. Press the “Update” button to start the update.
6. Wait until the process has finished. A message box indicates if the update was successful. The application starts automatically and by switching to the communication tab it is possible to directly connect to the sensor.

CONTROL PANEL

The control panel contains many configuration options. The structure of the panel views is designed to guide through the different steps of the radar processing, which is described in detail in the datasheet of the V-MD3.

The control panel consists of three different areas which are described in detail in the next chapters.

Figure 2: Overview control panel areas

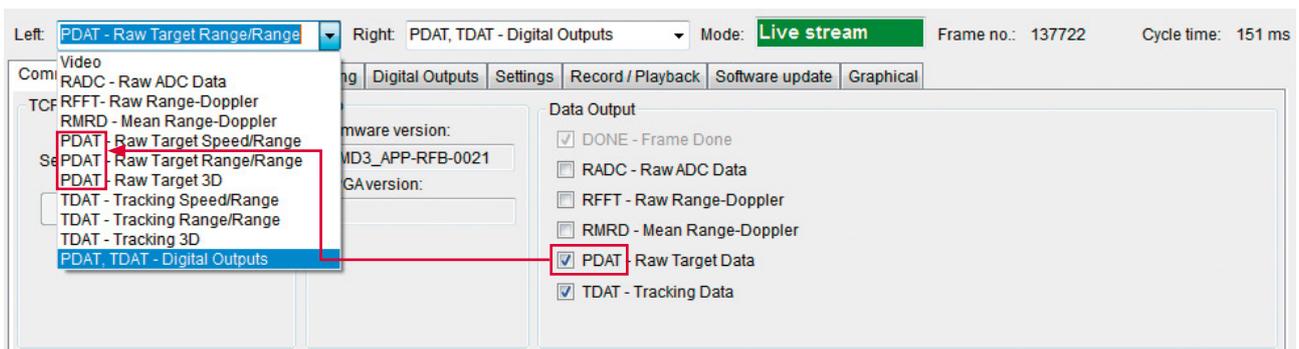


There are many views to select in the miscellaneous display controls area. All of them have a preceded shortcut based on the data output which is used in the views (RADC, RFFT, RMRD, PDAT, TDAT). To use the different views the according data output needs to be enabled.

For example, if «PDAT – RAW Target Data» is turned on in the «Data output» section, the views below will start to visualise the V-MD3 data.

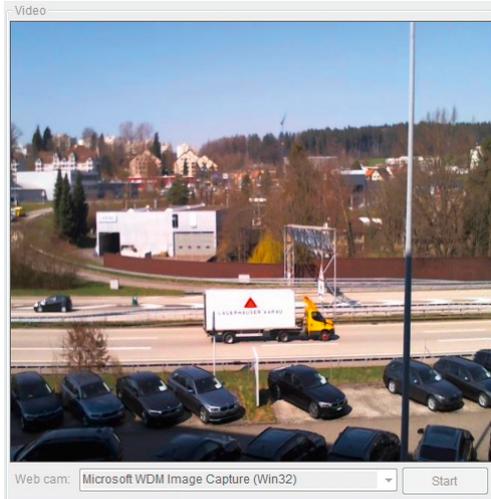
- **PDAT** – Raw Target Speed/Range
- **PDAT** – Raw Target Range/Range
- **PDAT** – Raw Target 3D

Figure 3: Data output example



Views

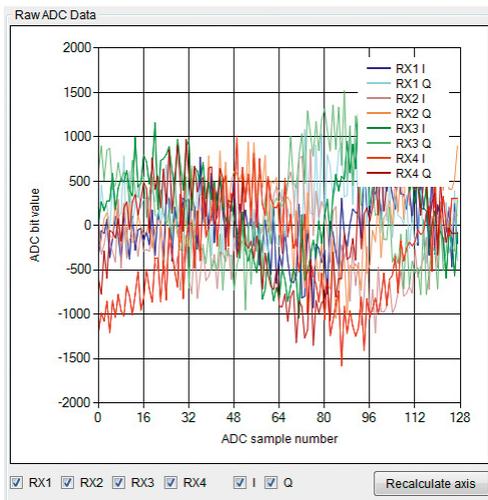
The control panel features the possibility to simultaneously show two views in parallel to visualise the sensor data in different ways. How to switch between the different views is described in the chapter Miscellaneous Display Controls



Video

If a webcam is connected to the PC it is possible to show the video picture in this view.

To start the video stream the button «Start» needs to be pressed.



RADC – Raw ADC Data

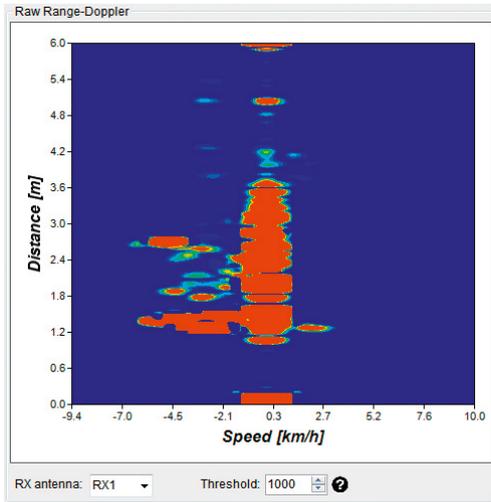
The RADC view shows all sampled ADC channels of the sensor.

Checkboxes:

It is possible to enable and disable the different groups of channels using the checkboxes.

Recalculate axis button:

Button to recalculate the Y axis of the view.

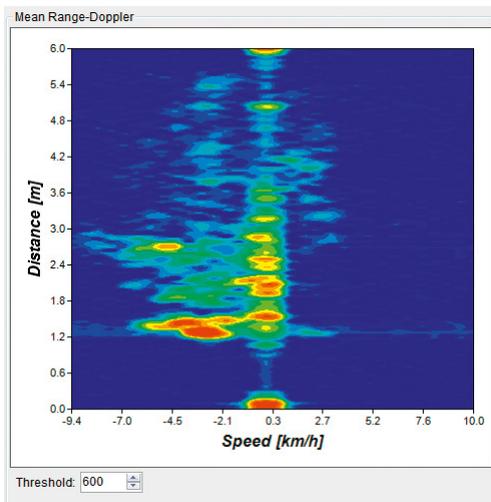


RFFT – Raw Range-Doppler

The RFFT view shows the raw range Doppler map of one receiving channel. Details about the internal processing can be found in the V-MD3 datasheet.

RX antenna:
Drop-down list for changing the receiving antenna for the displayed data.

Threshold:
Value to change the visualisation colour of the view. Does not affect the radar settings.

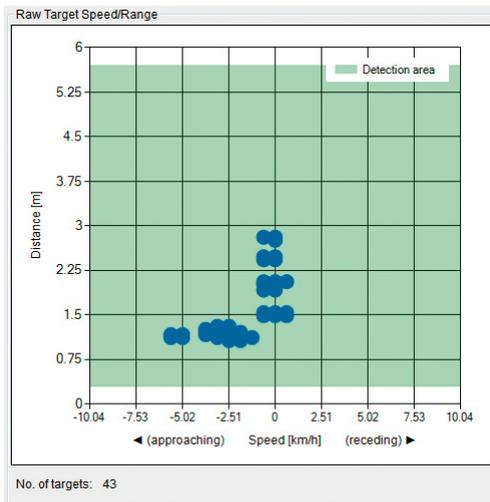


RMRD – Mean Range-Doppler

The RMRD view shows the mean range Doppler map, which is an averaged and logarithmic map of all four receiving channels. Details about the internal processing can be found in the V-MD3 datasheet.

Threshold:
Value to change the visualisation colour of the view. Does not affect the radar settings.

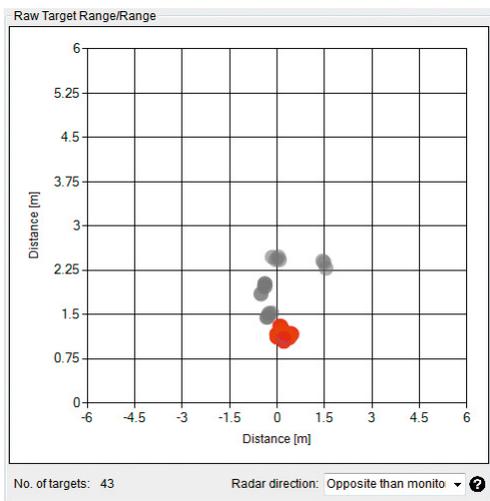
 The ADC values are complex values (I-Channel and Q-Channel). Due to hardware coupling of these channels targets in the lower half of the distance are seen mirrored in the upper half of the distance but with less magnitude.



PDAT – Raw Target Speed/Range

This view contains the raw targets found with the same axis as the mean range Doppler view. The used detection area is also visualized, which can be configured via the parameters in the detection tab. It is helpful to compare this view with the mean range Doppler when tuning the detection parameters.

No. of targets:
Count of actually reported raw targets

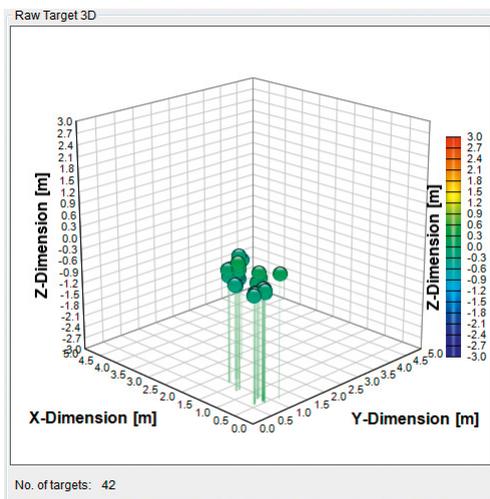


PDAT – Raw Target Speed/Range

This is one of the most interesting views as the information of the raw targets is interpreted and shown in a two-dimensional map. The targets show the radar's view of the real world. Grey targets are static targets without any speed. Green targets are moving away from the radar and red targets are moving towards the radar.

No. of targets:
Count of actually reported raw targets

Radar direction:
Defines the direction of the radar to the monitor. If «Same as monitor» is used, the webcam video has to be mirrored to correspond to the data.



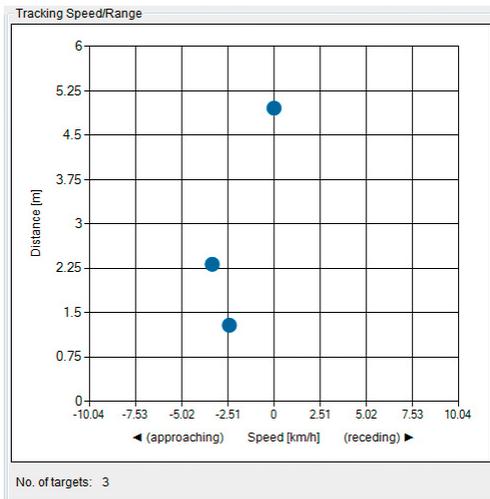
PDAT – Raw Target 3D

This view shows the raw targets in three dimensions. The information of the azimuth and elevation angles and the target distance are calculated to the location in a 3D-distance area. The targets are coloured pins and the colour suits to the Z-dimension (elevation).

No. of targets:
Count of actually reported raw targets



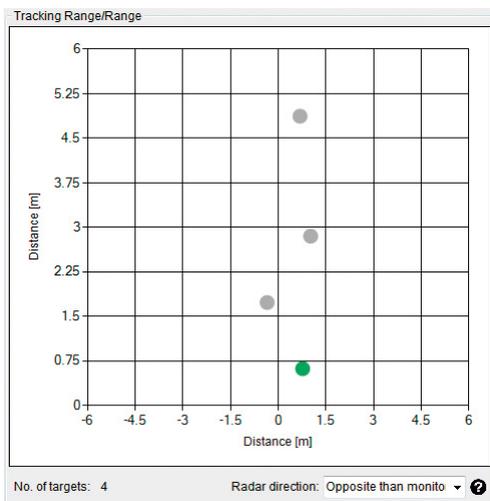
This view can only display 3D data if the radar setting uses a 3D setting. Further it can be turned around with the mouse to change the perspective.



TDAT – Tracking Speed/Range

Compare this view with the corresponding raw view to see the improvements of the tracking filter and to check the influence of the tracking settings.

No. of targets:
Count of actually tracked targets

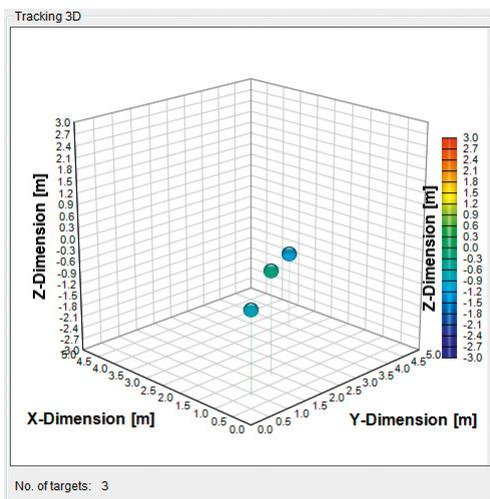


TDAT – Tracking Range/Range

Compare this view with the corresponding raw view to see the improvements of the tracking filter and to check the influence of the tracking settings.

No. of targets:
Count of actually tracked targets

Radar direction:
Defines the direction of the radar to the monitor. If «Same as monitor» is used, the webcam video has to be mirrored to correspond to the data.



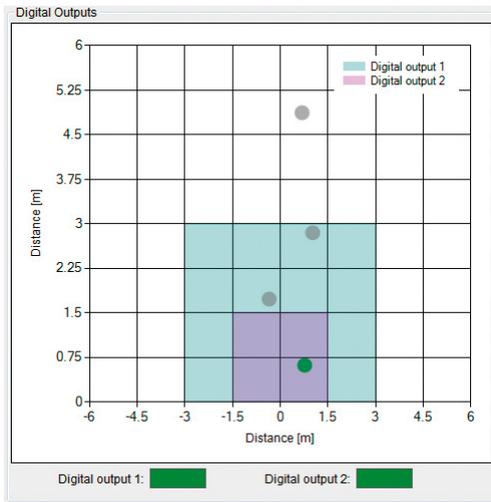
TDAT – Tracking 3D

This view shows the tracked targets in three dimensions. The information of the azimuth and elevation angles and the target distance are calculated to the location in a 3D-distance area. The targets are coloured pins and the colour suits to the Z-dimension (elevation).

No. of targets:
Count of actually tracked targets



This view can only display 3D data if the radar setting uses a 3D setting. Further it can be turned around with the mouse to change the perspective.



PDAT, TDAT – Digital Outputs

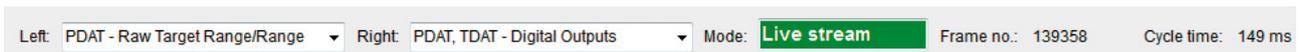
The sensor has two digital outputs that can be configured to generate a detection when an object is in a configurable area. This view shows a combination of the detection targets depending on the Digital output data setting. Below the view are two indicators that show the detection status of each digital output.

 The detection parameters for the digital outputs can be configured in the digital outputs tab.

Miscellaneous Display Controls

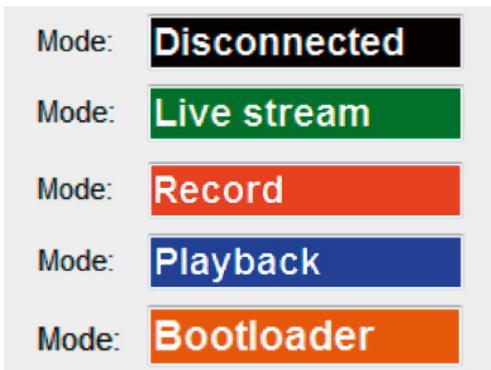
The middle of the control panel is used to control which views are visualised in the views area. It is easy to switch between the different views using the two drop down lists. Further the mode of the GUI, the actual frame number and the cycle time of the frames is displayed.

Figure 4: Miscellaneous display controls



 It is not possible to display the same view left and right at the same time.

Figure 5: Different possible modes



Modes

Table 1: Different possible modes

Mode	Description
Disconnected	No connection to the V-MD3.
Live Stream	The control panel is connected to the V-MD3 and receives data.
Record	Data will be recorded to the PC.
Playback	Recorded data will be played and visualised.
Bootloader	The control panel is connected to the boot loader of the V-MD3 and the sensor is ready for a software update.

Tabs

This chapter describes the different control tabs of the software. It is possible to control all the parameters of the V-MD3 and all the functions of the control panel over these tabs.



A more detailed parameter description of the sensor can be found in the datasheet of the V-MD3.

Communication

Figure 6: Communication tab

Section	Field / Control	Value / State
TCP Application	Server IP	192.168.100.201
	Buttons	Connect, Disconnect
Info	Firmware version	V-MD3_APP-RFB-0021
	FPGA version	1
Data Output	DONE - Frame Done	<input checked="" type="checkbox"/>
	RADC - Raw ADC Data	<input type="checkbox"/>
	RFFT - Raw Range-Doppler	<input type="checkbox"/>
	RMRD - Mean Range-Doppler	<input type="checkbox"/>
	PDAT - Raw Target Data	<input checked="" type="checkbox"/>
	TDAT - Tracking Data	<input checked="" type="checkbox"/>

TCP Application

To connect to the sensor, the correct server IP of the V-MD3 sensor must be entered. After starting the control panel, the “Connect” and “Disconnect” buttons are greyed out. The control panel tries to ping the sensor with the defined IP address in the Server IP field and activates the “Connect” button as soon as the ping to a V-MD3 under the server IP address was successful.



It may take up to 60 seconds for the “Connect” button to activate. This depends on the network environment used.

Info

If a V-MD3 is connected, this indicator shows information about the firmware and FPGA version of the sensor.

Data Output

Select which output is sent from the radar to the control panel. The according views can only show data if the corresponding data outputs are enabled.



If the sensor is in live stream mode after a successful connection and the corresponding data outputs are activated but no data is shown in the views, check the firewall settings. The control panel must have communication rights in the Windows firewall.

Radar

Figure 7: Radar tab

The Radar tab settings interface includes a dropdown menu for 'Settings' with the value '3D, 6m, 10km/h, 128/32'. Below this are four input fields: 'Rmax [m]' with value 5.9994, 'dR [cm]' with value 4.6871, 'Vmax [km/h]' with value 10.0299, and 'dV [km/h]' with value 0.6269.

This tab controls the main setting of the processing chain in the radar sensor. By changing the settings parameter it is very easy to adapt the sensor to the needs of an application and check the influences in real time. A detailed description of all settings and the influences to the processing stages can be found in the chapter Radar settings of the V-MD3 datasheet.

 Wrong settings can generate false sensor outputs. It is possible that strong targets outside the configured distance or speed range can create false reflections.

It is important to use a setting with distance and speed ranges that match with the distance and speed of the expected targets in the detection area of the sensor.

Detection

Figure 8: Detection tab

The Detection tab settings interface includes a dropdown menu for 'Sensitivity' with the value '10'. Below this are three rows of settings: 'Min./Max. distance [%]' with values 5 and 95, resulting in a range of 0.3..5.7m; 'Min./Max. speed [%]' with values 0 and 100, resulting in a range of 0..10.03km/h; and 'Detection direction' with the value 'Both'.

The detection tab controls mainly the detection filter which can be used to control the number of PDAT raw targets. It makes sense to use the RMRD – Mean Range Doppler view together with the PDAT – Raw Target Speed/Range view when you change settings in this tab because it visualises directly the used settings of the filter and the generated outputs of the PDAT structure. A detailed description of all parameters can be found in the chapter Detections Settings of the V-MD3 datasheet.

Tracking

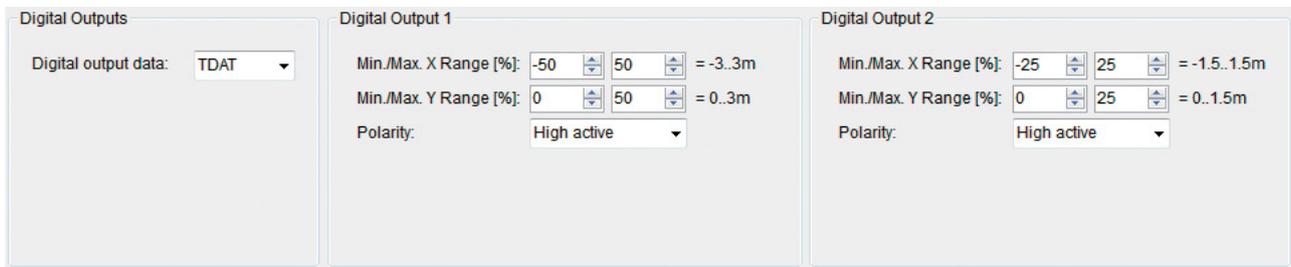
Figure 9: Tracking tab



On the Tracking tab you can control the tracking settings, which are described in the chapter Tracking settings in the V-MD3 datasheet. It makes sense to use the PDAT – Raw Target Range/Range view together with the TDAT – Tracking Range/Range view or the corresponding 3D views if a 3D radar setting is used when changing these settings.

Digital Outputs

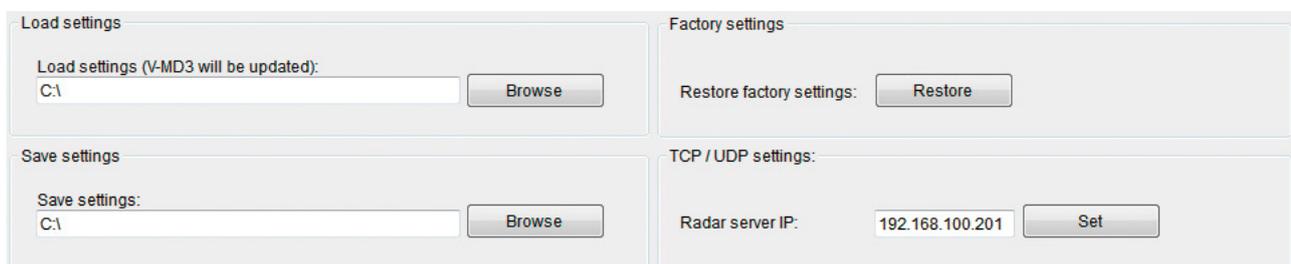
Figure 10: Digital outputs tab



On this tab you can control the digital outputs settings, which are described in the chapter Digital outputs in the V-MD3 datasheet. The use of this tab together with the PDAT, TDAT – Digital Outputs view allows for a simple and intuitive adjustment of the detection areas for the digital outputs.

Settings

Figure 11: Settings tab



On the Settings tab you can easily save and reload the complete settings of a sensor. This makes it simple to duplicate a useful data set on multiple sensors. It is also possible to restore the factory settings and change the sensor's IP address.



By changing the radar server IP, multiple sensors can be connected to the same host. The control panel dynamically processes the UDP port settings of the sensors when connecting to multiple sensors.



It is not possible to change the IP address to the fixed IP of the bootloader (192.168.100.200).

Record/Playback

Figure 12: Record/Playback tab

The screenshot shows the Record/Playback tab interface. It is divided into two main sections: 'Record data' and 'Playback data'.
Record data:
- Path to data: [Text field] [Browse]
- Store video [?]
- Bitmap (1.2MB)
- JPEG (30KB) Size: 0
- [Start] [Stop]
Playback data:
- Path to data: [Text field] [Browse]
- Cycle time [ms]: [150] [Start]
- Start frame number: [0] [Pause] [Stop]

This tab can be used to record and playback the sensor data to the hard disk. It is also possible to store the video data in parallel what can be helpful to interpret the measured data in the playback mode.

Record data

To record data, you first need to specify a path where to store the data on the PC. By selecting the Store video checkbox it is possible to also store a picture per frame from the webcam. The recording of the data can then easily be controlled over the Start and Stop button.

The software creates for every recording a new subfolder with a timestamp of the recording in the selected folder and stores there a raw binary file with all received sensor data packets and the video pictures when selected. Refer to the datasheet for detailed information about the packet structure, commands and messages in the stored binary file.



The record feature records the complete data output of the sensor specified in the communication tab under Data output. The performance of the recording may vary based on the following circumstances:

- Performance of the used PC
- Use of the video capture feature
- Enabled data output

Playback data

To playback the recorded data, the control panel must be disconnected. By selecting a folder of a recorded sequence it is possible to start, stop and pause a recording by a controlled cycle time. Even the start of the frame number in the recorded data can be chosen.

The playback feature is a very powerful tool to do an in depth analysis of the recorded data. It gives the possibility to compare the recorded data easily in all available views when the according data output was enabled for the recording.

Software update

Figure 13: Software update tab

TCP Bootloader	Software update
Server IP: 192.168.100.200	Bootloader version: V-MD3_BTL-RFB-0100
Connect Disconnect	FPGA version: 1
	File (Intel Hex Format): C:\
	Browse Update

This tab allows the update of the V-MD3 firmware over Ethernet. It can also be used to completely reset a sensor to the default values if it has an unknown programmed IP address because the IP address of the bootloader is fixed to 192.168.100.200.



A step by step instruction how to update the firmware can be found in the chapter Software update on page 4.



Use only firmware update files provided by RFbeam Microwave.

TCP Bootloader

After starting the control panel, the „Connect“ and „Disconnect“ buttons are greyed out. The control panel tries to ping the bootloader of the sensor at the fixed IP address 192.168.100.200. A connection to the bootloader is only possible after a power cycle of the sensor. If the control panel can successfully ping the bootloader, it activates the „Connect“ button for 4 seconds before the button is greyed out again because the sensor has left the bootloader and started the application software. A detailed description of how the bootloader works can be found in the chapter Bootloader in the V-MD3 datasheet.

Software update

If the control panel is connected to the bootloader, its version and the FPGA version are available in the corresponding fields. It is possible to select a hex file using the „Browse“ button and to update then the sensor firmware using the „Update“ button.

Graphical

Figure 14: Graphical tab



This tab offers the possibility to open a second window with a full screen view. Only the left view or a view with both views can be opened via the two "Full screen" buttons.

SYSTEM REQUIREMENTS

- Windows 7 or Windows 10
- .NET Framework 4 Client Profile

REVISION HISTORY

05/2020 – Revision A: Initial Version