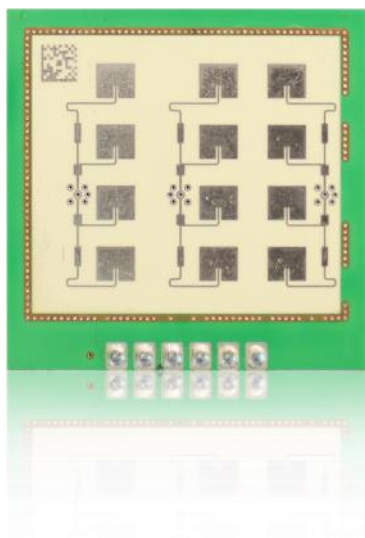


IMD-2002 User Manual

Version 1.2



www.innosent.de – Leading in radar

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CO-APPLICABLE DOCUMENTS

REFERENCE	DOCUMENT
[1]	IMD-2002 Data Sheet
[2]	IMD-2002 RadarAPI readMe
[3]	IMD-2002 Quick Start Guide
[4]	IMD-2002 Interface Protocol

REVISION HISTORY

VERSION	DATE	COMMENT
1.0	2023-09-14	Initial Release
1.1	2023-10-27	Updated filter description
1.2	2024-05-10	Added chapter 6 Frequency Information

1. SAFETY INSTRUCTIONS

- Only skilled and instructed persons shall install and connect the device.
- Proper experience in working with mains voltage, electrical and electronic devices is required.
- Do not connect the devices directly to mains voltage, instead use the voltage given in the manual.
- Do not wire any connections while power is applied to the device.
- Ground the devices carefully to prevent electrical shock.
- All connectors are pin-coded and fit in only one position.
- Mount the devices carefully to prevent them from shifting or dropping.
- The sensor shall not be opened as this will void the warranty and cause incorrect calibration of the sensor.
- Ensure adequate ventilation during operation.
- Unused connections should be covered with a sealing cap.
- Use an enclosure for the sensor to protect against environmental conditions.
- Only use fully functional equipment (ladders, aerial work platform, ...) when working above ground.
- The devices must be mounted to a stiff and solid support.
- Vibration, oscillation or any kind of movement will reduce the sensor performance.
- Make sure that your installation methods are in accordance with local safety policy and procedures and company practices. The protective conductor connection must not be used for other purposes. It must have a permanent electrical continuity and mechanical strength.

2. QUICK START

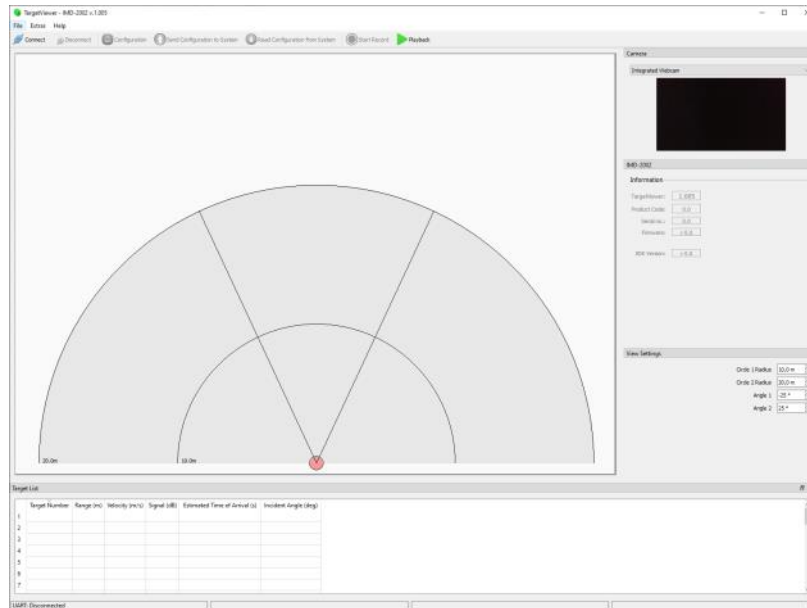
2.1 Install IMD-2002 TargetViewer

The software package can be downloaded from our website at <https://www.innosent.de/en/downloadportal/>.



Execute the TargetViewer setup file and follow the instructions of the installation on your Windows PC.

Note: Elevated administrator rights are required for the setup.



2.2 Mounting instruction

Mount the IMD-2002 in a stationary position, e.g. on a tripod. Align the sensor in the desired direction and check the correct orientation and mounting angle for your required field of view.

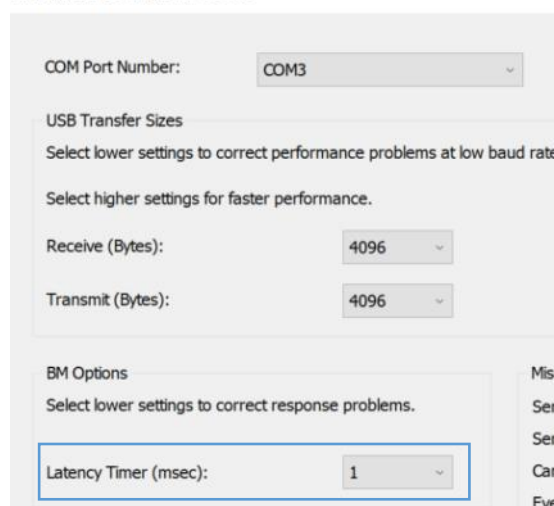
2.3 Cable connection to sensor

To connect the sensor to your PC via USB-port, use the Beefy3 breakout board and the USB to Micro-USB cable. The connector of the sensor is compatible with the pinout of the Beefy3 board. The cable and the Beefy3 are included in the evaluation kit.

- The breakout board must be connected according to the picture below. You can find information about the sensor's pinout in the data sheet.
- Configure cable latency in Windows device manager to 1ms (default 16ms).

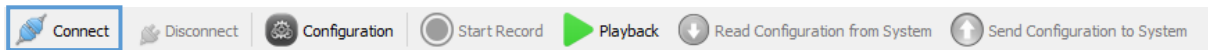


Advanced Settings for COM3

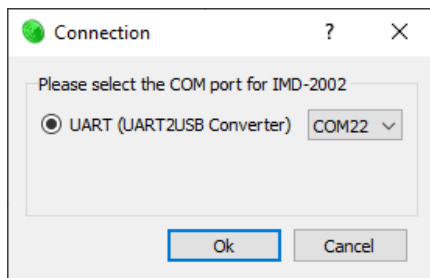


2.4 Connect the TargetViewer to the sensor

Click the 'connect' button in the top left corner.



Choose the correct COM port and click OK.



2.5 Observe moving detections

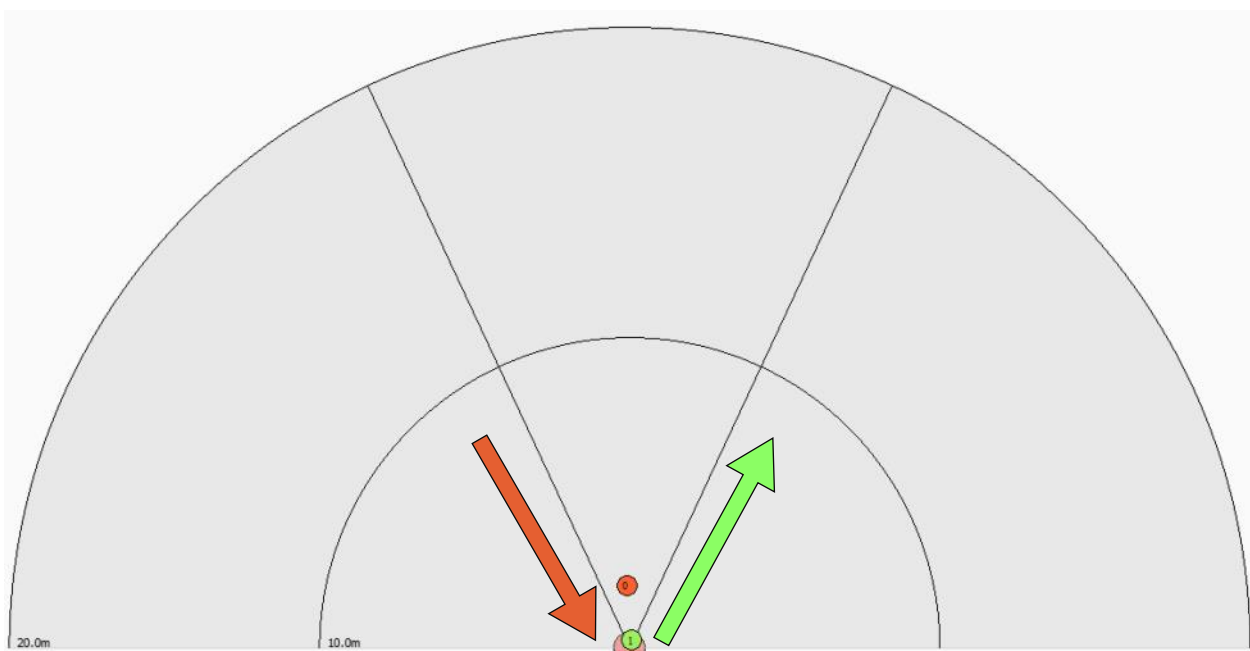
Detections are output in a target list via UART.

Detailed information about a target is displayed in the target list in the lower area of the GUI.

- Red indicates targets moving toward the sensor (approaching).
- Green indicates targets moving away from the sensor (receding).

The environment is set up properly and ready for operation.

Target Number	Range (m)	Velocity (m/s)	Signal (dB)	Estimated Time of Arrival (s)	Incident Angle (deg)
0	2,00144	0,150237	75,3303	13,3219	2
1	0,250572	-0,150237	73,0194	-1,66784	-20



3. FEATURES

3.1 Blockage Detection / Anti-Masking

Blockage Detection detects if the sensor is blocked or masked. You can find out with 'Blockage Level'. This value is sent cyclic in the target list header, see [2].

It provides a value in [%], which indicates an attenuation of the received signal.

This value can be used to calibrate to an enclosure. This will then not cause any false alarm for blockage.

Configure the parameters in [4.2] to find the sweet spot for your application.

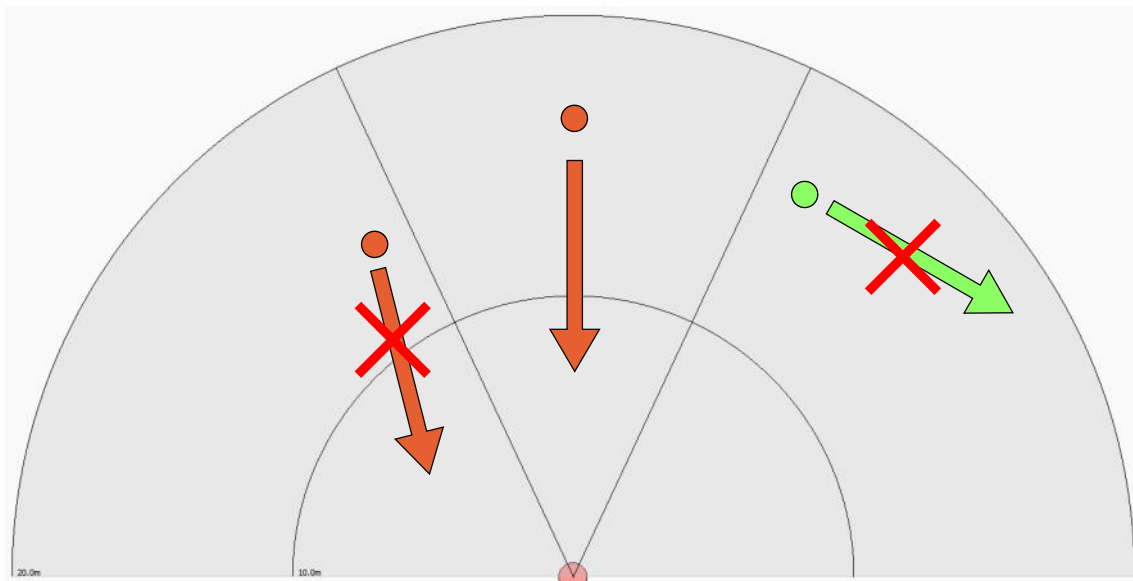
3.2 Estimated Time of Arrival - ETA

The Estimated Time of Arrival [s] is calculated in the sensor and output in the target list. Each target has this value.

The ETA is calculated with the assumption, that the target is

- approaching towards the sensor and
- in boresight

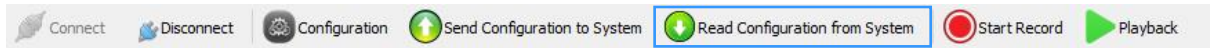
Note: If the object moves in a different direction, then the ETA is not reliable, see figure below.



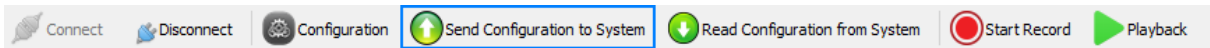
4. SENSOR CONFIGURATION

First, read settings from sensor:

Caution: If you send settings before reading from sensor, default values are applied and your customized settings are overwritten.



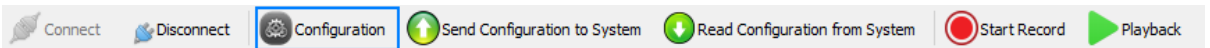
Settings are set to sensor, after button 'Send Configuration from System' has been pressed.



4.1 General Settings

Press the button 'Configuration'.

Note: The button is only active if the connection to the sensor is established properly. You can check that by reviewing the firmware field on the right side. If the version could be read, the connection was successful.



IMD-2002

Information

TargetView: 1.005

Product Code: IMD-2002

Serial no.: 1074

Firmware: v 1.018

SDK Version: v 1.006

In the configuration wizard you can set the desired configuration.

Note: These settings are set in the sensor and have direct impact on the signal processing chain.

TargetViewer Configuration

General

Filter 1

Filter 2

General

Frequency Channel 1

False Alarm Suppression ☐ Enable

Set Blockage Min Level

Get Blockage Threshold

Set Blockage Threshold 0%

Set Default Blockage Parameter

Frequency Channel: Choose a frequency channel. Prevent interference, if more than one sensor is operating nearby.

False Alarm Suppression: Enable false alarm suppression to filter out spurious detections occurring randomly. Decrease false positives.

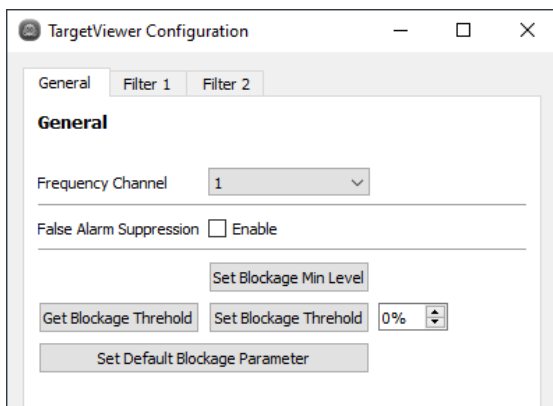
Note: This setting causes an additional latency of 250 ms.

4.2 Sensor Configuration - Blockage Detection

Blockage Detection detects if the sensor is blocked or masked. You can find out with 'Blockage Level'. This value is sent cyclic in the target list header, see [2].

Configure the following parameters to find the sweet spot for your application.

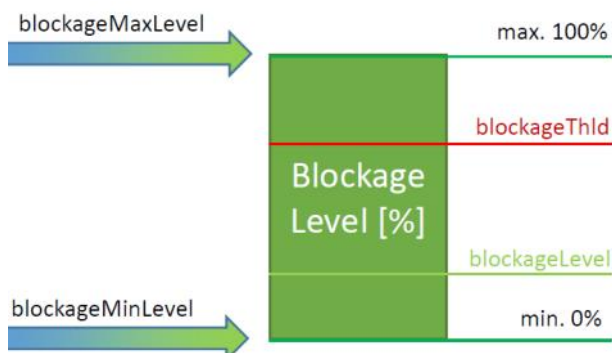
Example: If you place the sensor behind an enclosure, you set the Blockage Min Level to 0% and start evaluating a proper value for blockage detection.



Blockage Min Level: Set this value to 0%, if the sensor is used in a housing or with a radom.

Blockage Threshold: Set this threshold if the current blockage level exceeds this value, the blockage flag in the target list will be set.

Set Default Blockage Parameter: Resets the blockage min level and the blockage threshold to default values:
Blockage Min: 20%
Blockage Threshold: 0%

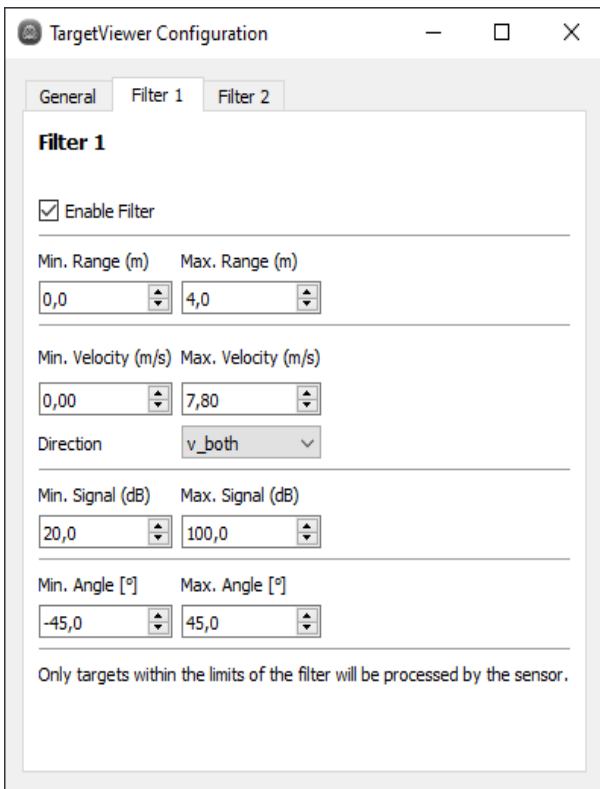


4.3 Sensor Configuration - Filter Settings

You have the possibility to set 2 filters to create different types of alarm zones. The setting options for Filter 1 and Filter 2 are the same.

Note: Each filter needs to be enabled specifically.

Caution: Filters have positive logic. This means, only targets which fit to filter settings, pass them.



Enable Filter: If checkbox is set, this filter is enabled.

Range Filter: With the range filter you can create “alarm zones” where the detection is active. Only targets in-between min and max range thresholds pass this filter.

Velocity Filter: Targets in-between min and max velocity thresholds pass this filter. The velocity filter can be set to 0 up to 7,78 m/s.

Direction: The direction selector lets you determine how the velocity filter should be applied:

- v_pos: Positive values pass the filter (receding).
- v_neg: Negative values pass the filter (approaching).
- v_both (default): Negative and positive values pass.

Example: If you set the velocity filter min to 2m/s and max to 5m/s. The negative (-2m/s to -5m/s) and positive (2m/s to 5m/s) values pass the filter.

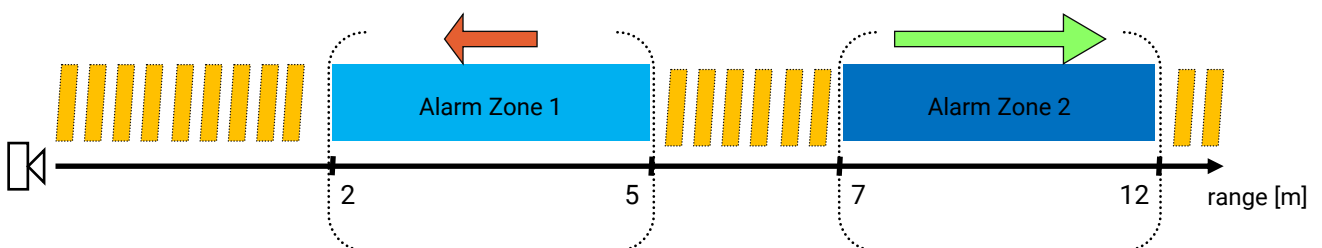
Signal Filter: Values in-between min and max signal strength pass the filter.

Note: This filter depends on RCS of targets. Signal strength is not corrected by distance

Angle Filter: Values in-between min and max angle pass the filter.

4.4 Sensor Configuration - Example for filter combination

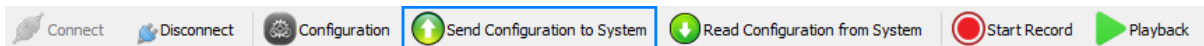
Filter 1 and Filter 2 can be combined to two alarm zones.



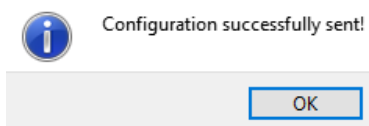
FILTER SETTING	Alarm Zone 1	Alarm Zone 2	Filtered Area
Range min/max [m]	2/5	7/10	No targets pass filter.
Velocity min/max [m/s]	1/2	4/7.8	
Direction selection	v_neg (approaching)	v_pos (receding)	
Signal min/max [dB]	0/20	20/80	

4.5 Send configuration to the system

After you have set the configuration, send the configuration to the sensor.



If the configuration has been sent successfully to the sensor, the following message appears.



Note: If an error message occurs, please check the cable connection to the sensor and reconnect.

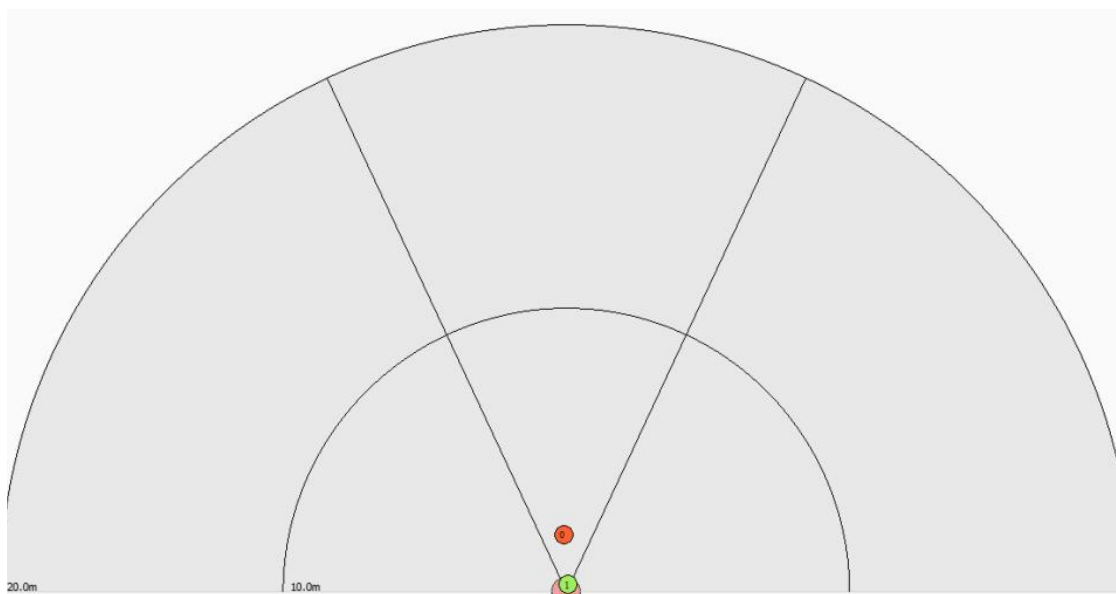
4.6 Verify your configuration

After setting the configuration, you can verify it by checking the plot.

Only targets within the chosen limits of the filters will be processed and output by the sensor. The sensor outputs a maximum of 15 targets. Targets are displayed in the plot.

Each target is displayed with an ID which represents its ID in the target list.

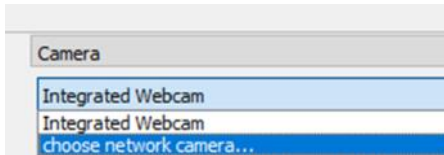
This makes it easier to determine a target in your setup and accelerates the verification workflow.



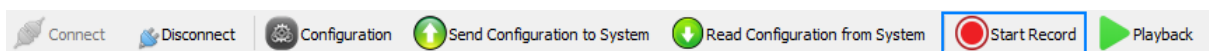
Target Number	Range (m)	Velocity (m/s)	Signal (dB)	Estimated Time of Arrival (s)	Incident Angle (deg)
0	2,00144	0,150237	75,3303	13,3219	2
1	0,250572	-0,150237	73,0194	-1,66784	-20

4.7 Record data

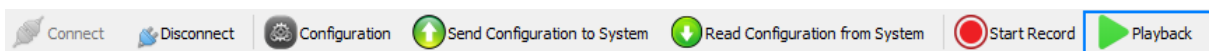
Choose a camera if you would like to record a video with the radar data.



Press 'start record' for recording the scene.



Recordings can be viewed by pressing 'playback'.

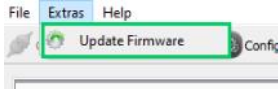


5. FIRMWARE UPDATE

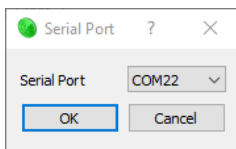
5.1 Update on PC via Target Viewer

After you have successfully connected the sensor to your PC (chap. 2), you can perform a firmware update.

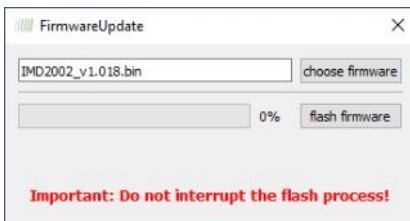
Click on 'Extras' and 'Update Firmware'.



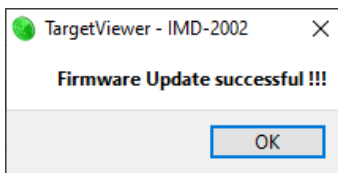
Connect update tool to the sensor.



The latest firmware is always provided with the latest software package. Choose it and click 'flash firmware'.



The update process is finished, when the following message appears.



5.2 Update on PC with firmware update tool

5.2.1 Requirements

The following software modules and files are required for flashing of firmware

- IMD2002_firmwareUpd.exe
- IMD2002_Firmware.bin and IMD2002_Firmware_Aux.bin

Note: See chap. 2 for proper connection.

5.2.2 Instruction

The flashing of "IMD2002_Firmware.bin" firmware to sensor module can be done by running "IMD2002_firmwareUpd.exe" with following arguments:

- c: for indicating Comport number
- f: for indicating the path of IMD2002_Firmware.bin.

Note: The firmware contains two files: "IMD2002_Firmware.bin" and "IMD2002_Firmware_Aux.bin". ONLY the path for "IMD2002_Firmware.bin" must be indicated, the "IMD2002_firmwareUpd.exe" will find the remain- ing file using the indicated path of "IMD2002_Firmware.bin" with an additional suffix "_Aux".

- b: set sensor to go to boot mode before flashing firmware.

Note: This flag works ONLY when the sensor module is in RUNNING mode (not by starting up).

5.2.3 Example

```

C:\Windows\System32\cmd.exe
Microsoft Windows [Version 10.0.19045.3324]
(c) Microsoft Corporation. Alle Rechte vorbehalten.

C:\temp>IMD2002_firmwareUpd.exe -c COM73 -f "C:\temp\IMD2002_v1.018.bin" -b True
Unlocking
Uploading 216 blocks at offset 2048 (0x800)
... block 1 of 216
... block 2 of 216
... block 3 of 216
... block 4 of 216
... block 5 of 216
... block 6 of 216
... block 7 of 216
... block 8 of 216
... block 9 of 216
... block 10 of 216
... block 11 of 216
... block 12 of 216
... block 13 of 216
... block 14 of 216
... block 15 of 216
... block 16 of 216
... block 17 of 216
... block 18 of 216
... block 19 of 216
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... block 206 of 216
... block 207 of 216
... block 208 of 216
... block 209 of 216
... block 210 of 216
... block 211 of 216
... block 212 of 216
... block 213 of 216
... block 214 of 216
... block 215 of 216
... block 216 of 216
Verification
... success
Unlocking
Uploading 1 blocks at offset 64512 (0xfc00)
... block 1 of 1
Verification
... success
Rebooting
Done!
C:\temp>

```

5.3 Update on target with Python firmware update tool

The Python tool is derived from the microcontroller vendor. The modified as well as the original tool are included in the IMD-2002 package.

5.3.1 Requirements

The following software modules and files are required for flashing of firmware

- IMD2002_firmwareUpd.py
- IMD2002_Firmware.bin and IMD2002_Firmware_Aux.bin
- Python 2.7
- pyserial

Note: See chap. 2 for proper connection.

5.3.2 Instruction

The flashing of "IMD2002_Firmware.bin" firmware to sensor module can be done by running "IMD2002_firmwareUpd.py" with following arguments:

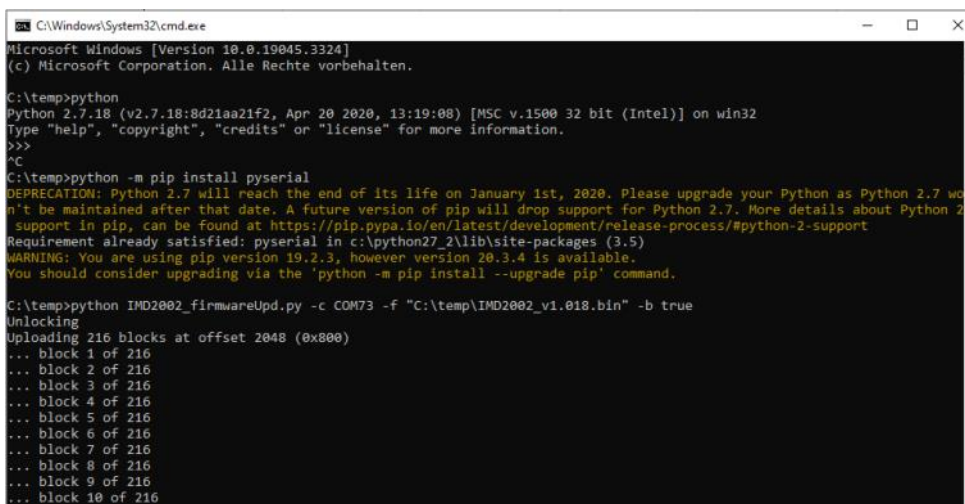
- c: for indicating Comport number
- f: for indicating the path of IMD2002_Firmware.bin.

Note: The firmware contains two files: "IMD2002_Firmware.bin" and "IMD2002_Firmware_Aux.bin". ONLY the path for "IMD2002_Firmware.bin" must be indicated, the "IMD2002_firmwareUpd.exe" will find the remaining file using the indicated path of "IMD2002_Firmware.bin" with an additional suffix "_Aux".

- b: set sensor to go to boot mode before flashing firmware.

Note: This flag works ONLY when the sensor module is in RUNNING mode (not by starting up).

5.3.3 Example



```

C:\Windows\System32\cmd.exe
Microsoft Windows [Version 10.0.19045.3324]
(c) Microsoft Corporation. Alle Rechte vorbehalten.

C:\temp>python
Python 2.7.18 (v2.7.18:8d21aa21f2, Apr 20 2020, 13:19:08) [MSC v.1500 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
>>>
C:\temp>python -m pip install pyserial
DEPRECATION: Python 2.7 will reach the end of its life on January 1st, 2020. Please upgrade your Python as Python 2.7 won't be maintained after that date. A future version of pip will drop support for Python 2.7. More details about Python 2 support in pip, can be found at https://pip.pypa.io/en/latest/development/release-process/#python-2-support
Requirement already satisfied: pyserial in c:\python27_2\lib\site-packages (3.5)
WARNING: You are using pip version 19.2.3, however version 20.3.4 is available.
You should consider upgrading via the 'python -m pip install --upgrade pip' command.

C:\temp>python IMD2002_firmwareUpd.py -c COM73 -f "C:\temp\IMD2002_v1.018.bin" -b true
Unlocking
Uploading 216 blocks at offset 2048 (0x800)
... block 1 of 216
... block 2 of 216
... block 3 of 216
... block 4 of 216
... block 5 of 216
... block 6 of 216
... block 7 of 216
... block 8 of 216
... block 9 of 216
... block 10 of 216

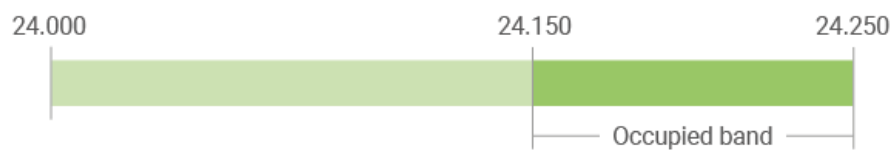
```

6. FREQUENCY INFORMATION

The information that will be given below is only a broad overview; for details please contact the regional approval agency. An overview over the frequency bands in Europe can also be found in the REC 70-03 which is available under www.cept.org.

ISM FREQUENCY BAND

In general, the IMD-2002 can be used in EU, USA, Canada and UK, as well as other regions which apply to those regulations.



6.1 CONFIGURABLE FREQUENCY BANDS

The IMD-2002 provides a configurable set of transmit frequency channels. These can be used to achieve interference mitigation.

All channels can legally be used in markets, which are regulated by RED (EU), FCC (USA) and ISED (Canada)¹.

CHANNEL #	CENTER FREQUENCY ^{2,4}	UNIT
channel f_1	24.156	GHz
channel f_2^3	24.169	GHz
channel f_3	24.181	GHz
channel f_4	24.193	GHz
channel f_5	24.205	GHz
channel f_6	24.217	GHz
channel f_7	24.229	GHz
channel f_8	24.241	GHz

¹ this list not exhaustive

² typical specifications are for general understanding and may vary

³ channel f_2 is preconfigured

⁴ frequency shift: 3 MHz

6.2 COMPLIANCES

Declarations of conformity, certificates and test reports can be provided upon request.

STANDARD	COMMENT
Conformity / Certificates	
CE	Declaration of Conformity
UKCA	
FCC Part 15.245	Tested by external TCB and applies to relevant regulatory limitations.
ISED	Tested by external TCB and applies to relevant regulatory limitations.
RF / Electrical / Other	
EN 300 440 V2.1.1	
EN 301 489-1 V2.2.3	Tested by external TCB and applies to relevant regulatory limitations.
EN 301 489-3 V2.3.2	Tested by external TCB and applies to relevant regulatory limitations.

IDS

AGENCY	ID
FCC	UXS-IMD-2002
IC	6902A-IMD2002

6.3 FCC & ISCED COMPLIANCE

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s) and complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

1. L'appareil ne doit pas produire de brouillage.
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

FCC §15.21

Changes or modifications made to this equipment not expressly approved by InnoSenT GmbH may void the FCC authorization to operate this equipment.

FCC §15.105

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

RF Exposure

This equipment complies with FCC and ISCED radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance of 20 cm between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Cet équipement est conforme aux limites d'exposition aux rayonnements ISCED établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

Ce transmetteur ne doit pas être placé au même endroit ou utilisé simultanément avec un autre transmetteur ou antenne.

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