XY-DemoRad Software Manual
v. 0.9.0 (Early Access)
for Windows OS

XY-Sensing Ltd.

Contents

1 Quick Start

Just complete a few simple steps to get your XY-DemoRad running:

1. Run the install package and follow the steps displayed on the screen.
2. Once the setup is complete, configure your network adapter according to the table below:

IP Address	192.168.10.1
Subnet Mask	255.255.255.0
Default Gateway	192.168.10.2

Table 1: Network adapter configuration for connection with a XY-DemoRad sensor.

3. Connect the sensor via wired network connection.
4. Run the XY-DemoRad application and observe real-time radar data visualization.

The detailed guide into the usage of the software is provided in sections 5 and 6. For more details about the later setup actions please refer to section 4. If you have trouble completing above instructions please look into section 7.

Please note that the radar front ends used in both versions of the XY-DemoRad allow for operation outside the proper ISM band. The user is responsible for checking and obeying applicable legal regulations, especially related to frequency allocation. The XY-Sensing Ltd. is not responsible for any violations of the legal regulations and resulting consequences caused by neglecting this considerations.

2 Software Overview

The XY-DemoRad consists of a miniaturized K-band radar sensor connected to the PC (further referred to as "host") over 1 Gb Ethernet network connection. The software is organized as follows:

1. The network communication protocol is implemented in a .NET Standard library. The protocol will be open and documented, as well as the library in the final release.
2. The library comes along with a cross-platform CLI (Command Line Interface) tool for recording raw radar data. The tool is built for .NET Core 2.2 runtime, so it may be run on Windows, Linux and Mac OS. In the final release the tool will be open-source.

3. For Windows OS the XY-DemoRad comes with a GUI (Graphical User Interface) application capable of real-time processing as well, as raw data recording.

4. Matlab/Octave GUI application. The application uses CLI tools, so it is also cross-platform.

3 System requirements

3.1 Common requirements

For the sensor connection with the host PC, 1 Gbps Ethernet wired network adapter is required.

3.2 CLI Application

The CLI tools for XY-DemoRad use .NET Core 2.2 runtime, which requires at least Windows 7 SP1, or Windows Server 2008 R2 OS installed.

3.3 GUI Application

The GUI application for XY-DemoRad uses .NET Framework 4.6.1 runtime, which requires at least Windows 7 SP1, or Windows Server 2008 R2 OS installed. Additionally the x64 architecture is required to run the software. To run the application, the minimal hardware requirements for the .NET Framework 4.6.1 should be met. However, to achieve satisfactory real-time processing experience, the recommended system configuration is provided. These are listed in Table 2.

	Minimal	Recommended
CPU	2 GHz	3 GHz
RAM	8 GB	16 GB
GPU	—	2 GB of memory
Disk space	4.5 GB	4.5 GB

Table 2: Hardware requirements for GUI application

4 Setup

If you read this paper, you have successfully installed the XY-DemoRad software on your machine. However, some steps may be required to configure your computer for using the software, or you may want to update your software.

4.1 System Configuration

To run the XY-DemoRad software you should first have your network adapter configured properly. The valid configuration is as presented below:

IP Address	192.168.10.1
Subnet Mask	255.255.255.0
Default Gateway	192.168.10.2

Table 3: Network adapter configuration for connection with a XY-DemoRad sensor.

Also, the Windows firewall should be set up to allow incoming traffic on UDP port 1034 and outgoing connections on TCP port 1033. This last step should be done automatically during the software setup. However, if for some reason ot fails, you should add the firewall rules automatically.

4.2 Software Update

To install a new version of the XY-DemoRad software on Windows just run the installer of the new version and follow the steps displayed in the installer window. When prompted, choose the "Update" option. Likely, you may need to update the firmware version on your sensor. This procedure is covered in the next section.

4.3 Firmware Update

As this is the first released version of the software, no firmware upgrades are available. However, if in one of future releases of the software any firmware update would be necessary the software will provide a proper tool.

5 Using GUI Application

To use the GUI application, just launch the executable (shortcuts will be created on desktop and in the start menu during setup) and connect the sensor using Ethernet. Make sure, that the network adapter is properly configured, as described in section 4.1. Once the sensor is connected and initialized, the dark overlay with request of connecting the sensor will disappear, and the window will look as depicted in figure 1. In the picture, number "1" marks controls responsible for controlling sensor's operation. Number "2" marks side-panel, which is selected using tabs marked with number "3".

5.1 Sensor configuration

Sensor configuration panel consists of sensor enable switch, "Defaults" and "Apply" buttons and controls for entering sensor's operation parameters such as

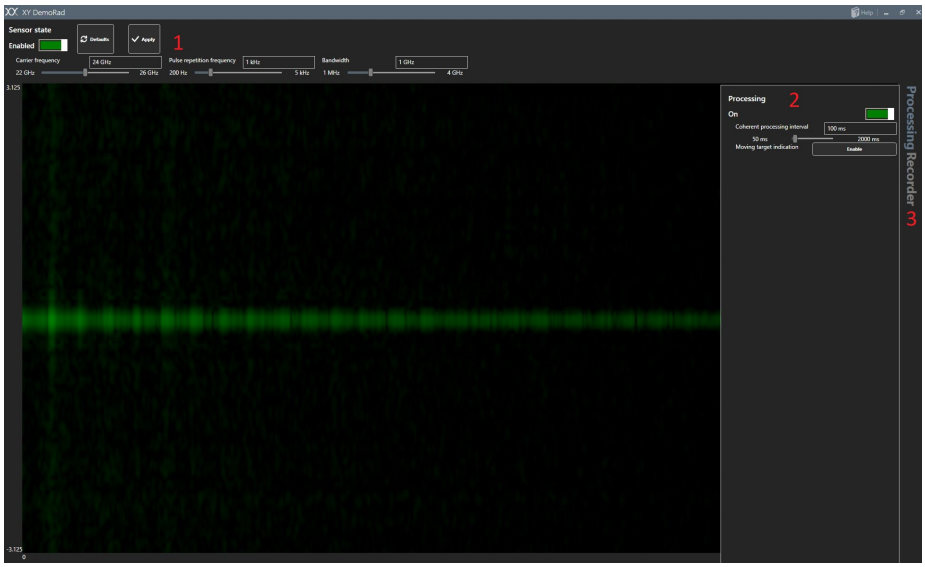

Figure 1: GUI application main window.

carrier frequency, pulse repetition frequency, bandwidth and IF chain attenuators state. Each input takes effect only after clicking "Apply" button, unless there are any validation errors, which will disable the button. This applies also to "Defaults" button, which will only reset the controls, without affecting the sensor operation until applying the new configuration.

After sensor connection, the carrier frequency defaults to the center of available band of the currently connected RF front-end. Carrier frequency is defined as the center frequency of the waveform. The bandwidth defaults to 1 GHz, unless the sensor's available band is narrower (inability to set bandwidth of 1 GHz with K-band or 122 GHz frontends probably indicates a hardware failure). Changing the center frequency affects currently available bandwidth and may current bandwidth setting if necessary to stay within hardware capabilities.

5.2 Processing

Processing parameters may be modified, when "Processing" tab is selected on the right side of the window. It is shown in figure 2. On the panel, user may find a switch for enabling and disabling the real-time processing, control for entering CPI (Coherent Processing Interval) and toggle button for enabling MTI (Moving Target Indication). The changes take effect after clicking "Apply" button on the top panel.

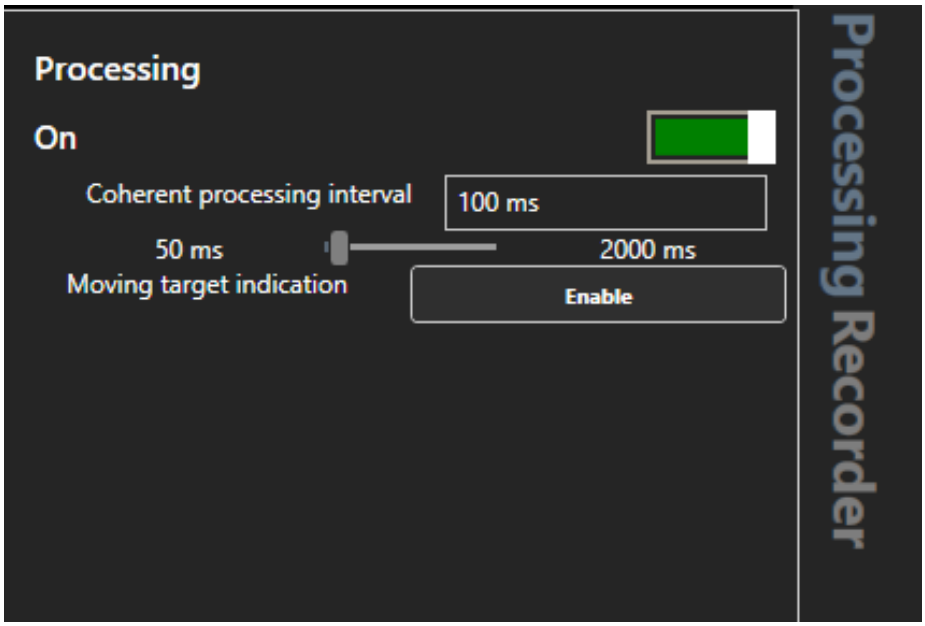

Figure 2: Processing panel of GUI application.

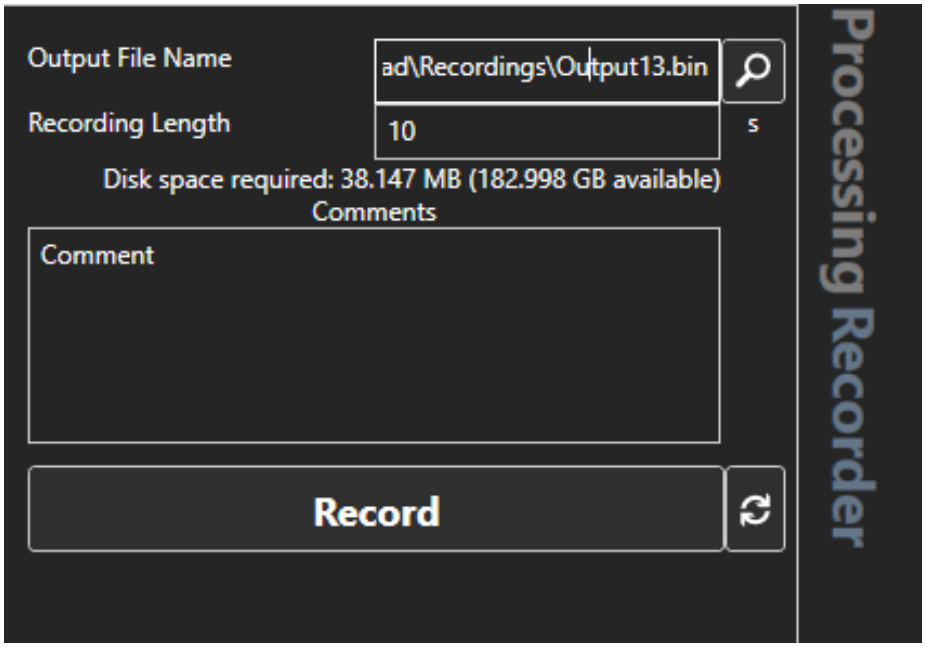

Figure 3: Recorder panel of GUI application.

5.3 Recorder

On the recording panel the user may find pick a filename for the new recording (a text box with a "Browse" button), enter desired recording length and comments that will be stored with the recording parameters alongside the recorder radar data. After clicking the "Record" button, progress bar will appear indicating status of the recording. Right of the button, there is a "Refresh" button, which may be used for restoring desired recording filename and recording length to default values.

6 Using Console Tools

The Command-Line Tools currently include the recorder. It is used to start the sensor operation with supplied parameters, record the data and disable the sensor.

Parameters may be set with one of the following ways (ordered with decreasing priority):

1. Values entered in prompts (interactive mode only)
2. Command line arguments
3. Configuration file
4. Defaults

Currently there is no information about hardware frequency limits, so it is up to user to provide realizable carrier frequency and bandwidth. Failure to meet these constrains will result in error, as the firmware on the sensor will prevent from exceeding frequency limits.

Program's usage is typical: `Recorder [options]`. Supported options are:

`-m` or `--mode` : sets the connected analog front-end. Valid values are `24G` for K-band and `120G` for 122 GHz. This option is required.

`i` or `--interactive` : sets the interactive mode. Do not use this option when executing the program in batch scripts.

`-f` or `--carrier-frequency` : sets carrier frequency defined as the center frequency of desired waveform. Enter value in Hz. May use scientific notation.

`-b` or `--bandwidth` : sets bandwidth of the waveform. Enter value in Hz. May use scientific notation.

`-p` or `--prf` : sets pulse repetition frequency. Enter value in Hz. May use scientific notation.

`-o` or `--output-file` : sets output file. This option is required.

`-c` **or** `--config-file` : sets name of the configuration file. Format of the file is provided later in the text.

`-l` **or** `--recording-length` : sets length of the recording. When this option is not used, user will need to manually start and stop recording.

`-a` **or** `--attenuators` : if this option is selected, attenuators will be enabled in the IF signal chain.

`-?, -h` **or** `--help` : shows help information.

Exemplary program invocation would be: `Recorder -m 24G -c config.json -o output.bin -a -l 10`. This command would record 10 seconds with parameters specified in file config.json to the file output.bin with attenuators enabled.

Configuration file should be provided in JSON format, as in the example below:

```
{
"carrier": 24e9,
"bandwidth": 1e9,
"prf": 1e3
}
```

Such configuration file specifies 24 GHz carrier frequency, 1 GHz of bandwidth and PRF of 1 kHz.

7 Troubleshooting

7.1 General considerations

In any case you should first ensure that:

1. The sensor is properly powered up and connected to the PC via the wired network connection
2. The host PC network adapter configuration is correct
3. The host PC firewall allows the outgoing connection on the 1033 TCP port and incoming traffic on the 1034 UDP port.
4. You tried power-cycling the sensor and restarting XY-DemoRad software.

If the problem persists, look for the possible solution in the section below.

7.2 Common issues

7.2.1 Unrepeatable frequency limits and flashes in Range-Doppler map

When this issue occurs, frequency limits after powering the sensor up several times differ significantly. Also flashes appear in the Range-Doppler maps, and the recorded signal contains large peaks every several tens or hundreds of milliseconds. Most probable reason is the switch SW1 on the top-second board in ON position. If this is the case, move it to OFF position. Another reason may be unreliably plugged-in RF front-end board. If neither is the case, unfortunately most likely a hardware failure has occurred.

7.2.2 No data from the sensor, Recorder does not progress and Range-Doppler map is black

When this issue occurs, despite the data is transferred to the host PC (can be checked using network traffic sniffer), the recording with specified length will never exit and the Range-Doppler map in the GUI application remains black, although other controls indicated successful connection and senor operation. This issue may be resolved with disabling and enabling network adapter used for the connection with the sensor, however in some cases PC reboot may be necessary.

7.2.3 Recording takes more time than expected

When this issue occurs, recording takes more time than it is supposed to. The recorder's progress bar advances slower than expected, and in some cases fails to reach the end as the recording completes before writing all requested data. Most probable cause is a slow hard drive. Ensure, that you do not record directly into devices not capable of high write speeds. Another, less likely cause may be poor quality of the network connection between the sensor and the host PC. Ensure using 1 GB/s wired LAN and prefer direct connections avoiding network switches.