ALTHEN SENSORS & CONTROLS

mm FDRF625 Series

Certified according to ISO 9001:2008

04.2017 | version 20161122 Rev 2.3.2

Contents

1. Safety precautions

- Use supply voltage and interfaces indicated in the scanner specifications.
- In connection/disconnection of cables, the scanner power must be switched off.
- Do not use scanners in locations close to powerful light sources.
- To obtain stable results, wait about 20 minutes after scanner activation to achieve uniform scanner warm-up.

2. Electromagnetic compatibility

The scanners have been developed for use in industry and meet the requirements of the following standards:

- EN 55022:2006 Information Technology Equipment. Radio disturbance characteristics. Limits and methods of measurement.
- EN 61000-6-2:2005 Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments.
- EN 61326-1:2006 Electrical Equipment for Measurement, Control, and Laboratory Use. EMC Requirements. General requirements.

3. Laser safety

The scanners correspond to the 2M or 3B safety classes according to IEC 60825-1:2007.

3.1. Class 3B scanners

The scanners make use semiconductor laser. Maximum output power is 100 mW.
The scanners belong to the 3 laser safety class. The following warning label is placed on the scanner housing:

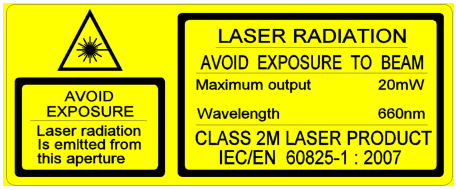
The following safety measures should be taken while operating the scanners:

- Do not target laser beam to humans;
- Avoid staring into the laser beam through optical instruments;
- Mount the scanner so that the laser beam is positioned above or below the eyes level;
- Mount the scanner so that the laser beam does not fall onto a mirror surface;
- Use protective goggles while operating the scanner;
- Avoid staring at the laser beam going out of the scanner and the beam reflected from a mirror surface;
- Do not disassemble the scanner;
- Use the laser deactivation function in emergency.

Note: Class 3B scanners are supplied only as OEM products. All responsibility for compliance with the requirements of laser safety is borne by the consumer.

3.2. Class 2M scanners

The scanners make use of an c.w. 660 nm or 405 wavelength semiconductor laser. Maximum output power is 20 mW. The sensors belong to the 2M laser safety class. The following warning label is placed on the scanner housing:



The following safety measures should be taken while operating the scanners:

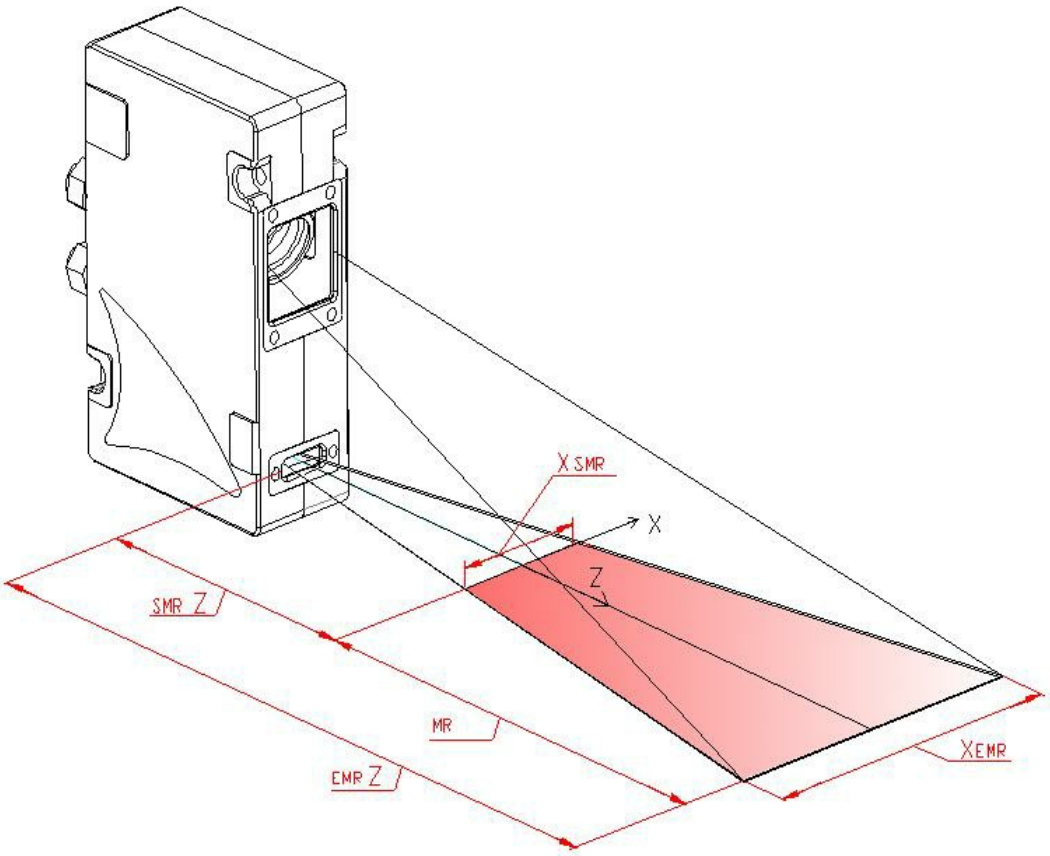
- Do not target laser beam to humans;
- Do not disassemble the scanner;
- Avoid staring into the laser beam.

4. Purpose

Laser scanners are intended for non-contact measuring and checking of surface profile, position, displacement, dimensions, sorting and sensing of technological objects, 3D scanning.

5. Structure and operating principle

Operation of the scanners is based on the principle of optical triangulation (see Figure). Radiation of a semiconductor laser is formed by a lens in a line and projected to an object. Radiation scattered from the object is collected by the lens and directed to a two-dimensional CMOS image sensor. The image of object outline thus formed is analyzed by a FPGA and signal processor, which calculates the distance to the object (Z-coordinate) for each point of the set along the laser line on the object (X-coordinate). Scanners are characterized by base distance (beginning of the range), SMR, for Z-coordinate, measuring range (MR) for Z-coordinate, measuring range for X-coordinate at the beginning of Z (Xsmr) and measuring range for X-coordinate at the end of Z (Xemr).



6. Configurations

The Series is divided into 3 groups:

- a group of scanners in a compact housing (compact line);
- a group of scanners in a standard housing (standard line);
- a special version of scanners, which consists of scanners with increased base distance, wide-range scanners and special scanners.

Overall and mounting dimensions see in p. 30.

Two modes of scanners work are possible, with sampling frequency 249 Hz and 491 Hz in the full working range. Scanners support ROI function, which lets to increase working frequency up to 1840 Hz.

Scanners are available in three versions:

- based on red laser, 660 nm;
- based on blue lasers (BLUE version), 405 or 450 nm;
- based on infrared laser (IR version), 808 nm.

Using a variety of lasers is caused by a wide range of tasks of scanning surfaces. The use of blue lasers instead of conventional red ones significantly enhances scanners capabilities, in particular, in control of shiny materials, high-temperature objects and organic materials.

The use of scanners with different laser wavelength in one measurement system avoids scanners mutual influence and greatly simplifies the system construction. Scanners with power IR laser are intended for use in conditions of large solar radiation.

Available on request is the delivery of scanners with air-blown windows and water/air cooling, inbuilt heater (see p. 27).

Also possible are customized configurations other than those listed in the User's Manual. Use a special form to make order (see p. 28.1).

Scanners are supplied with the following set of synchronization channels (all channels can be TTL or RS422):

- BASIC – one synchronization input, none synchronization output. Basic synchronization is included in the standard power cable. The synchronization input type is external. The measurement synchronization is also available.
- ENC – synchronization by the encoder signals (three synchronization inputs, none synchronization output). This requires one additional 8-pin synchronization cable for RS422, and one additional 4-pin synchronization cable for TTL. The following synchronization types are available: External, Encoder, StepDir. The measurement synchronization is also available.
- STEPDIR – two synchronization inputs, none synchronization output. This requires one additional cable. The synchronization input type is StepDir. The External and Encoder synchronization types are also available.
- INOUT – one synchronization input, one synchronization output. This requires one additional 4-pin cable. The synchronization input type is External (the measurement synchronization is also available); the synchronization output type is Additional Timer.
- FULLSYNC – three synchronization inputs and two synchronization outputs. The type of synchronization inputs and outputs is SterDir. The synchronization channels can be TTL only.

7. Main technical data

7.1. Working ranges and dimensions

Range	MR, mm	SMR, mm	EMR, mm	Xsmr, mm	Xemr, mm	Laser	Size, mm	Weight, g	Housing version
40/5-6/7	5	40	45	6	7	Class 2M	30x88x120	400	Compact
35/10-10/12	10	35	45	10	12				
55/10-10/11	10	55	65	10	11				
30/25-18/26	25	30	55	18	26				
65/25-17/23	25	65	90	17	23				
55/50-27/45	50	55	105	27	45				
90/50-23/35	50	90	140	23	35				
75/95-34/67	95	75	170	34	67				
60/35-20/30	35	60	95	20	30	Class 2M or 3B	50x98x144	500	Standard
65/65-35/55	65	65	130	35	55				
140/110-43/68	110	140	250	43	68				
125/200-60/130	200	125	325	60	130				
100/250-75/180	250	100	350	75	180				
140/250-70/155	250	140	390	70	155				
90/10-9/10	10	90	100	9	10	Class 2M	49x84x162	1000	Special
240/20-14/16	20	240	260	14	16	Class 2M	50x98x144	1000	
175/250-115/230	250	175	425	115	230	4 W, 808 nm, Class 3B	66x171x235	2000	
165/300-130/240	300	165	465	130	240	Class 2M or 3B	48x106x219	1100	
240/290-200/320	290	240	530	200	320	Class 2M or 3B	50x125x360	3000	
450/650-190/420	650	450	1100	190	420	Class 3B	50x110x300	3000	
425/990-330/960	990	425	1415	330	960	Class 3B	48x198x480	2500	
540/1400-340/980	1400	540	1940	340	980	Class 3B	48x210x415	3000	

7.2. Overall specifications

Sampling rate and accuracy	
Nominal sampling rate	248 profiles/s (standard mode), 491 profiles/s (mode of increased frequency)
Maximal sampling rate	1875 profiles/s
Linearity (measurement error), Z axis	±0.1% of the range
Linearity (measurement error), X axis	±0.2% of the range
Interface	
Digital	Ethernet IPv4
Analog	4...20 mA or 0...10 V
Synchronization inputs/outputs	RS422
Synchronization inputs	up to 3 channels
Synchronization outputs	up to 2 channels
Power supply	15...30 V

Environment resistance	
Enclosure rating	IP67
Vibration	20g/10...1000Hz, 6 hours, for each of XYZ axes
Shock	30 g/6 ms
Ambient temperature, °C	0...+40, (-20...+40 for the sensors with in-built heater), (-30...+120 for the sensors with in-built heater and water/air cooling housing). Note: At ambient temperature below -20, the scanner starts to warm up to -20 after switching on, and then starts to work.
Relative humidity	5-95% (no condensation)
Storage temperature, °C	-20...+70
Housing/windows material	aluminum/glass
Laser lifetime	
Red (660 nm)	50000 hours
Blue (405, 450 nm)	50000 hours
Infrared (808 nm)	50000 hours

8. Overall demands for mounting

The scanner is positioned so that of object under control should place in this working range. In addition, no foreign objects should be allowed to stay on the path of the incident and reflected laser radiation.

Where objects to be controlled have intricate shapes and textures, the incidence of mirror component of the reflected radiation to the receiving window should be minimized.

9. Cables

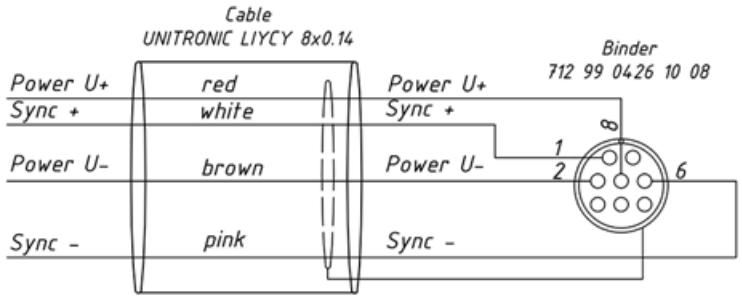
Depending on the scanner configuration, contents of delivery may include different types of cables: power cables, Ethernet cables, encoder and synchronization cables.

The basic scanner version is shipped with two cables: the power cable with lines of connecting one external synchronization channel and the Ethernet cable.

Scanners with encoder synchronization inputs or with the synchronization input/output are also shipped with the encoder and synchronization cable.

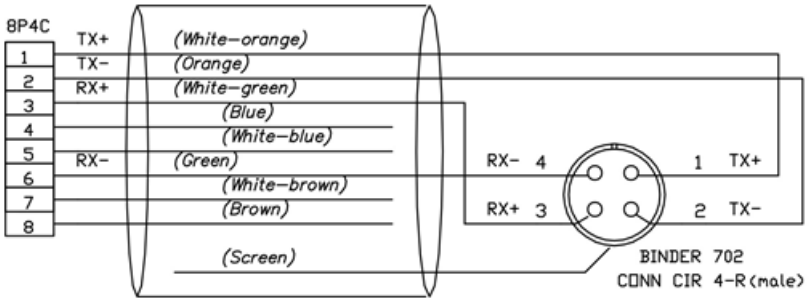
For scanners with a lot of synchronization channels and with analog outputs, the documentation on interface cables is provided before shipping.

9.1. Power cable



Binder 702 pins	Assignment	Wire color	Description
1	Sync +	White	Differential trigger input RS422
6	Sync -	Pink	
8	Power U+	Red	Power supply: 12..32V, consumption:
2	Power U-	Brown	4,8..7,7W

9.2. Ethernet cable

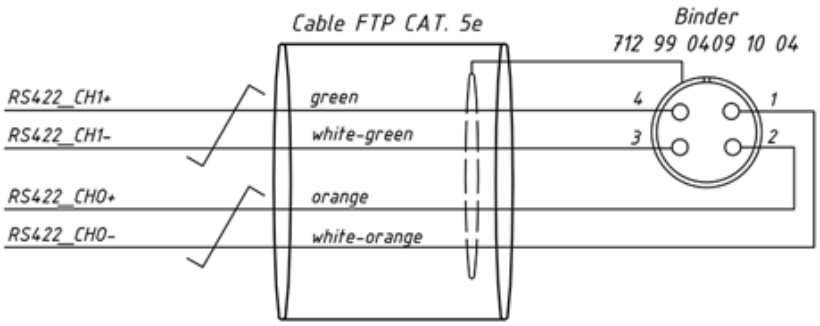


The twisted pair of cables 100Base-T4 is used to transfer data. The maximum length of a segment is 200 meters.

#	Assignment	Wire color	Description
1	TX+	White-orange	Transmit data Ethernet +
2	TX-	Orange	Transmit data Ethernet –
3	RX+	White-green	Receive data Ethernet +
4	-	Blue	
5	-	White-blue	
6	RX-	Green	Receive data Ethernet -
7	-	White-brown	
8	-	Brown	
shield			Connected to the housing

9.3. Encoder and synchronization cable

Scanners with encoder inputs have an additional socket. The cable configuration can be changed depending on the scanner configuration.



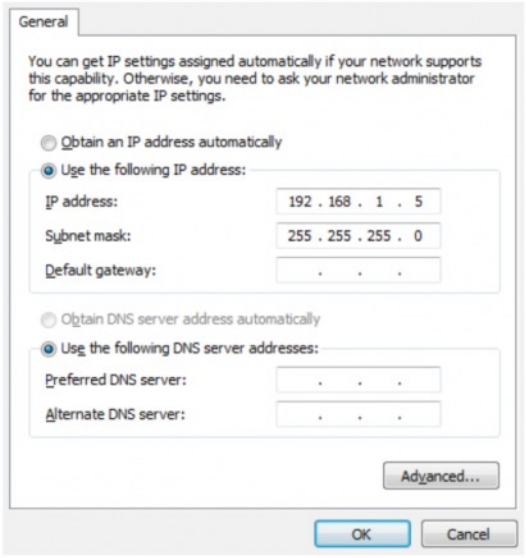
10. Network settings and the first connection

All scanners are shipped with the following default network configuration:

- IP address: 192.168.1.100
- Reserved IP address: 192.168.1.235 (set when scanner settings are reset to factory settings)
- Subnet mask: 255.255.255.0

10.1. One scanner on a network

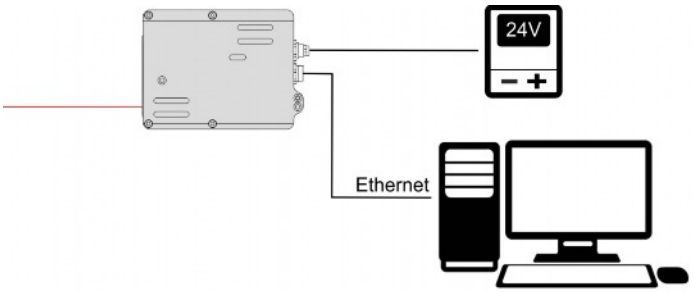
Since the initial state of the laser scanner is configured to run in the 192.168.1.* address space, configure your PC's network card, for example, as follows:



10.2. The first connection

- Perform network settings according to the preceding paragraph.
- Connect the scanner to a PC or to a network switch.
- Connect a power supply to the scanner. The network indicator of the switch port (or PC port), to which the scanner is connected, must light up.

Within 25 second after powering, scanner's firmware is booting. Two flashes of scanner's laser are an indication of booting finish.

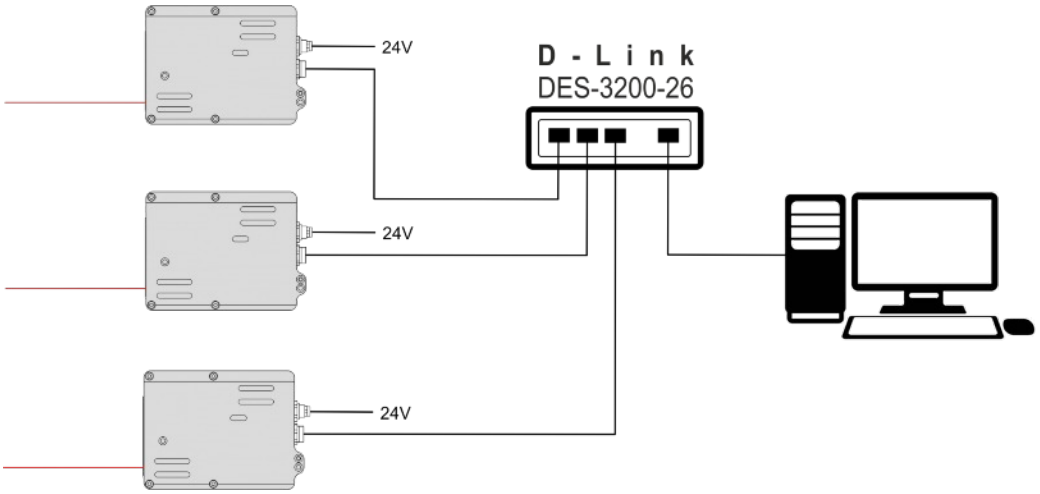


The scanner is ready to work.

10.3. Several scanners on a network

Because of a big broadcast traffic, generated by the scanner, the dedicated broadcast segment is recommended to use when planning the network topology of the scanners connection. Note: For a mutual work of several scanners in the L2 Ethernet segment, use the network switch with the function of limiting the broadcast domain. If you ignore this requirement, the scanners work will be unstable.

The following figure illustrates the possible network configurations to connect several scanners on the example of using the network switch D-Link DES-3200-26.



10.3.1. Network switch settings. Basic configuration

A basic configuration is a group of scanners connected to a Host PC (HPC):

1. HPC connects to the Company's network, using the Fast Ethernet (fe0) network interface, and gets a private address of the Company's network (in this example, 172.16.0.100/24).
2. HPC connects to the network switch with connected scanners to switch port 25 (SP25), using the Gigabit Ethernet network interface (ge1).
3. For a group of scanners, the administrator dedicates a private range of IPv4-addresses (RFC1918), which is unique within the Company's network (in this example, 192.168.0.0/28).
4. HPC assigns the IPv4-address to the interface ge1 from the range of addresses for a group of scanners.
5. Scanners connect to the switch ports 1-24 (SP1-SP24).
6. When each of the scanners is connected to the switch and to the power supply (see p. 10.2), the unique IPv4-addresses will be assigned from the dedicated range by a service program (see p. 19).
7. The switch is configured by using a command line (access is through the console port or SSH\Telnet).

```
config traffic_segmentation 1-24 forward_list 25
config traffic_segmentation 25-26 forward_list all
```

Setting is completed.

10.3.2. Network switch settings. Advanced configuration

Advanced configuration with two and more groups of scanners (in this example, GS1 and GS2) connected to two and more HPC (in this example, HPC1 and HPC2):

1. HPC1 connects to the Company's network, using the Fast Ethernet (fe0) network interface, and gets a private address of the Company's network (in this example, 172.16.0.100/24).
2. HPC2 connects to the Company's network, using the Fast Ethernet (fe0) network interface, and gets a private address of the Company's network (in this example, 172.16.0.101/24).
3. HPC1 connects to the network switch with connected scanners, using the network interface Gigabit Ethernet (ge1), to switch port 25 (SP25).
4. HPC2 connects to the network switch with connected scanners, using the network interface Gigabit Ethernet (ge2), to switch port 26 (SP26).

5. For groups of scanners (GS1 and GS2), the administrator dedicates two private ranges of IPv4-addresses (RFC1918), which are unique within the Company's network (in this example, 192.168.0.0/28 and 192.168.0.16/28).
6. IPv4 addresses are assigned for interfaces ge1 and ge2 from the range of addresses for GS1 and GS2.
7. The switch is configured by using a command line (access is through the console port or SSH\Telnet).

```
# Delete default VLAN
config vlan default delete 1-26
# Create VLAN for GS1
create vlan VLAN101 tag 101
config vlan VLAN101 add untagged 1-10,25 advertisement disable
# Create VLAN for GS2
create vlan VLAN102 tag 102
config vlan VLAN102 add untagged 11-24,26 advertisement disable
# Configure selected switch ports
config port_vlan 1-10,25 gvrp_state disable ingress_checking enable
acceptable_frame admit_all pvid 101
config port_vlan 11-24,26 gvrp_state disable ingress_checking
enable acceptable_frame admit_all pvid 102
# Set the limiting of the broadcast domain within selected VLAN
config traffic_segmentation 1-24 forward_list 25
config traffic_segmentation 25-26 forward_list all
```

8. GS1 scanners connect to the switch ports 1-10.
9. When each of the GS1 scanners is connected to the switch and to the power supply (see p. 10.2), the unique IPv4-addresses will be assigned by HPC1 from the dedicated range 192.168.0.0/28.
10. GS2 scanners connect to the switch ports 11-24.
11. When each of the GS2 scanners is connected to the switch and to the power supply (see p. 10.2), the unique IPv4-addresses will be assigned by HPC2 from the dedicated range 192.168.0.16/28.

Setting is completed.

11. Software and resources

The scanner comes with a software package, which is also available on request.
The package includes the documented software tools to implement three options of working with the scanner:

1) Via RFClearView service program.

Windows x64:
Please enquire
Windows x32:
Please enquire

2) Via software developed by the customer, using the provided SDK. FDRFSDK (Software Development Kit) includes the detailed description of all functions of the library and the examples of programs in different languages (c++, c#, Pascal), ported to various platforms (Windows, Linux, .NET), and also the examples of using the libraries in different environments (MATLAB, LABVIEW).

Download link: **Please enquire**

3) Via software developed by the customer, which implements the scanner protocols. Information about using these options of working with the scanner is

given in this User Manual. Moreover, the following tools are also available to download:

- Scanner firmware: **Please enquire**

The current version is not compatible with the scanners manufactured before January 1, 2015. You can upgrade such scanners to the latest version by using the special upgrade tool: **Please enquire**

- RF625 Emulator. This application simulates behavior of a laser scanner (FDRF625) and intended for software developing without using a real scanner. Download link: **Please enquire**

12. Ethernet interface

The scanner is supposed to function with two types of protocols, namely, UDP and TCP/IP.

12.1. UDP protocol

UDP protocol is used:

- for detection of scanner in a network;
- for transmission of result on a configurable port, by default 6003;
- for emergency control of scanner: reset current connections, reboot, laser (scanner) ON/OFF. For emergency control it is necessary to send broadcast packet with scanner S/N and command code.

Note: Transmission of UDP packets with measurement results is accompanied by periodic transmission (one time in 2 seconds) of information packet on port 6001. Besides that, if the TCP connection is active, such a packet is transmitted on reserve port 62500.

12.2. TCP protocol

TCP protocol is used:

- for configure and check the main functions of the scanner;
- for request/transmit data.

Note: When the TCP connection is active, the scanner doesn't send data over UDP.

13. Service program. RFClearView

13.1. Hardware and software requirements

The main requirements for using RFClearView:

- Operating system Windows 7 and later.
- Video card and video card drivers, which support OpenGL 2.1 and later.

13.2. Installation

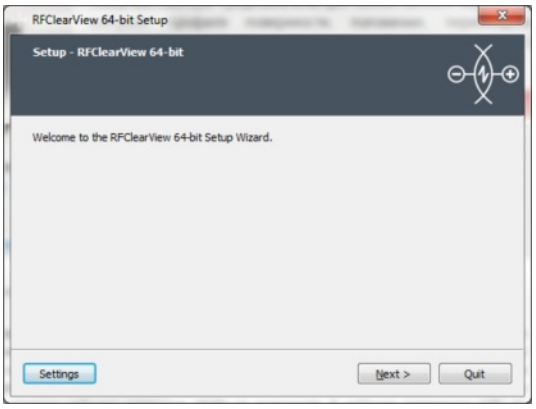
Before starting the installation, read the following information.
The RFClearView software comes in two versions – 64 and 32 bits. To determine a correct version, refer to the System Properties window or to your system administrator.
Setup files for each version exist in two implementations:

§ Standalone setup file (RFClearViewSetup_offline.exe) contains a version of RFClearView on the date of the setup file creation.

§ Setup file via the internet (RFClearViewSetup_online.exe) will download and install the latest version of RFClearView.

Download links of the latest versions:

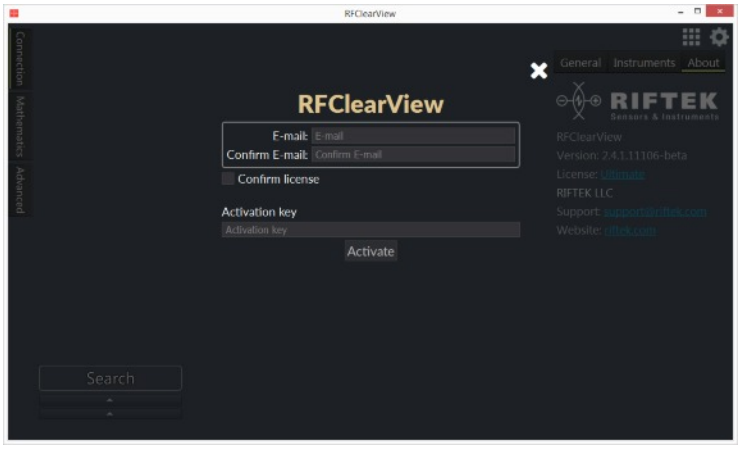
Windows x64:
Please enquire
Windows x32:
Please enquire
The installation is performed by the specially created installer.
To start the installation, you need to run the setup file RFClearViewSetup_online.exe / RFClearViewSetup_offline.exe.
When you run the setup file, Welcome Window appears:



To continue with the installation, click Next.
Follow the guidelines in dialog boxes of the installer.
When you install a free version, you will be offered to accept with a public offer that allows you to use a free version. When you switch to a paid version, the text of a paid license (without a legal force) will be offered to accept. When you buy a paid version, the text of the License Agreement is specified with the license number and customer's details. To update the program, you can use the tool that was installed with RFClearView. It can be found in the list of installed programs.

13.3. Activation

In order to activate the license, click , go to the About tab, and click the link next to the License field. The activation window appears:

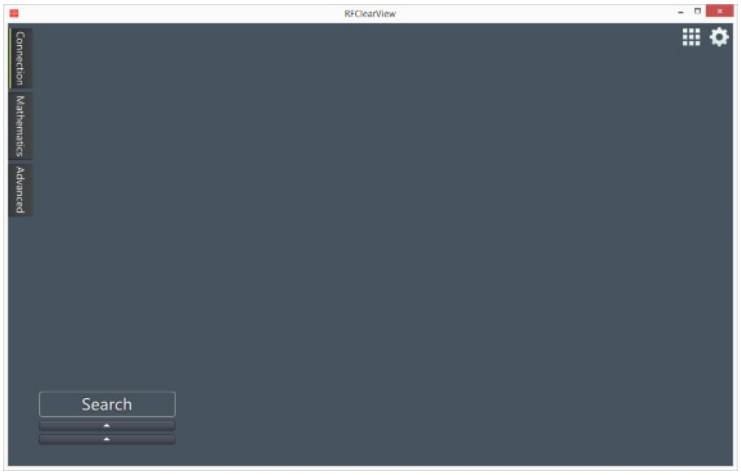


Next, enter your email, confirm it, select "Confirm license", enter the activation key, and click Activate.

Once the activation is successful, the license type on the About tab will be changed.

13.4. Main functions

The working window of the service program:



Buttons on the left border of the window are intended to activate the working panels.
Panels assignment:

Panel	Function
Connection	Search and connection (enabled by default)
Parameters	Scanner parameters setting (activated after connecting the scanner over TCP)
Mathematics	Tracking and dimensioning of the object (licensed functions)
Advanced	Working with the robot (licensed functions)

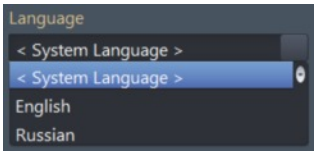
The icon ⚙ in the upper right corner of the window is intended to activate panels of additional functions:

Panel	Function
General	Language selection, log, shift of the Z axes
Instruments	Emergency requests, network ports diagnostics
About	Information panel

13.5. Special features

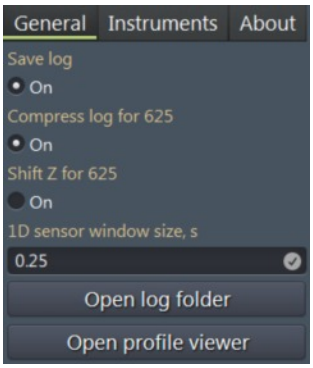
13.5.1. Language selection

The General panel ⚙:



RFClearView supports two languages: English and Russian. When you select <System Language>, the language of your operating system will be set. If the language of your operating system is different from the languages supported, then the English language will be set.
Note. After selecting the language, you must restart RFClearView for the changes to take effect.

13.5.2. Log



The General panel .

When the Save log option is selected, the log file will be automatically created when you start the measurements. To compress log files, select Compress log for 625.

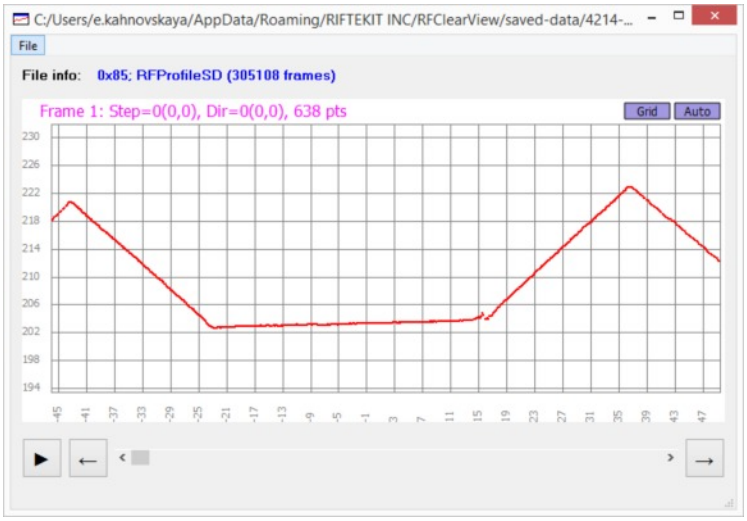
Log files are stored to the user's directory (for example, C:\Users\<User>\AppData\Roaming\RIFTEKIT INC\RFClearView\saved-data). To view the folder with log files, use the Open log folder button.

The files extension is BIN (BINZ for compressed files).

The file name consists of the serial number, device model, network parameters and time of the start of recording.

To view the log files, use the Profile Viewer program (click Open profile viewer).

In order to open the log file, click File > Open and select the file.



Log files can be converted to CSV. To do this, click File > Export to CSV in the Profile Viewer program.

13.5.3. Emergency requests

The Instruments panel .

Emergency requests can work without the active TCP connection with the scanner.

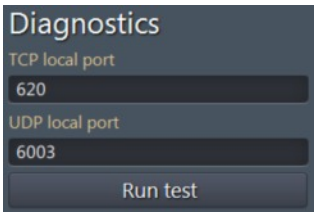
In order to send the command to the scanner, enter its serial number into the Sensor serial number field, and click the button.

The Factory reset command sets the factory values for all parameters of the scanner.

The Drop sensor connections command drops the active TCP connections.

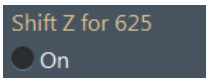
13.5.4. Network ports diagnostics

The Instruments panel .
In order to check whether the ports are available, enter ports you want to check into the corresponding fields, and click Run test. The Diagnostics shows if the ports are available to use or not. If the ports are not available, then the programs that use the ports will be shown.



13.5.5. Shift Z for 625

The General panel .
For scanners with the inverted Z coordinate, it is necessary to select Shift Z for 625 before you connect to them.



14. Use of SDK

All functions are described in the documentation of RFSDK, included in the RFSDK set.
When working with RFSDK, you need to execute the following method before you call the function for the first time or create a new device object:

RFDevice::Initialize (void)

Upon completion of the work with RFSDK, you need to execute the following method:

RFDevice::Cleanup (void)
RFDevice::GetVersionString ()

15. Search for scanner (scanners) on the network

When connected to network and powered, the scanner communicates broadcast information packet to 255.255.255.255 address, UDP:6001 with periodicity of one time in 2 seconds. The packet contains IP-address of the scanner, its serial number and other information. The Scanner Detection Protocol is described in topic 26.1.
Note: Some firewalls don't pass such packages, so you should set exceptions to detect the scanner.

15.1. Service program

To start the search for scanner (scanners) on the network, click Search button in the bottom left corner of the program window. Upon completion of the search, the program activates two panels: TCP-connection and UDP-stream (for every detected scanner).
Click the "i" icon if you want to look at the firmware version.

15.2. RFSDK

```
vector<RFDevice::RF625DDevice *> vRF625;
//Create RFLanDetector object
RFDevice::RFEthernetDetector Id;
//Execute search for device type 625 (RF625) for 3 seconds
//RF625 sends UDP information packet each 2 seconds so 3 seconds
//must be enough to catch all of them
int nRF625 = Id.Search(625, 3);
```

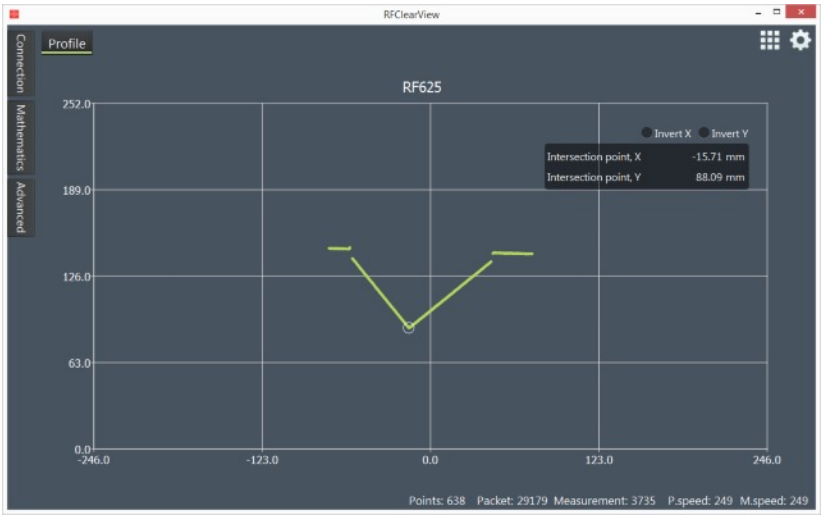
```
//Now nRF625 holds a quantity of detected RF625
//Create list of RF625Device objects for all found devices
for (i=0; i<nRF625; i++)
{
        RFDevice::RF625DDevice *p = new RFDevice::RF625DDevice(Id[i]);
        if (p)
        {
                vRF625.push_back(p);
        }
        else
        {
        // Failed to construct RF625DDevice
        }
        }
nRF625 = vRF625.size();
```

16. Scanner connection and receiving a profile

16.1. Service program. UDP-stream

Clicking of  icon on UDP-stream panel, requests UDP-stream from corresponding scanner and activates Profile panel. Obtained profile is displayed in a graphical form:

By clicking the Connection button, you can hide the panel of scanners connection and expand the Profile panel for the entire window.



By moving the object or the scanner, observe changes in the profile. Zooming is done by rotating the mouse wheel, moving image - by pressing mouse left key. The program can be run on a computer with a touch screen.

The status line in the lower part of the window shows:

Points – quantity of valid points in a profile
Packet – quantity of received packets
Measurement – quantity of received profiles
P.speed – speed of packets receiving
M.speed – speed of measurements

To disable UDP-stream, click .

16.2. Service program. TCP/IP Connection

To connect a scanner by TCP/IP protocol, click corresponding panel. Once the connection is successful, program shows the Parameters button (the button is intended for activation/deactivation parameters setting panels), scanner parameters settings panels and activates the Profile panel. To disable connection, click .

Parameters setting panels:

Panel	Function
Network	Setting parameters of the TCP/UDP connection
General	Setting the scanner parameters
Trigger	Setting the trigger parameters
Synchronization	Setting parameters of the scanners synchronization

By clicking the Connection and Parameters buttons, you can hide the corresponding panels and expand the Profile panel for the entire window.

16.3. RFSDK. Scanner connection/disconnection

RF625Device::Connect ( )

Connect to the scanner over TCP.

The RF625Device object must be created with indicating the valid parameter LPUDP_DEVINFOBLOCK_PC.

RF625Device::Connect (LPUDP_DEVINFOBLOCK_PC lpDevBlock)

Connect to the scanner over TCP.

RF625Device::UDPConnect (USHORT usUDPPort, LPCSTR szLocalIPAddress = NULL)

Connect to the scanner over UDP.

The optional parameter szLocalIPAddress is a string containing the IP address of the network interface from which the connection is performed.

RF625Device::UDPConnect (LPCSTR szLocalIPAddress = NULL)

Connect to the scanner over UDP.
The RF625Device object must be created with indicating the valid parameter LPUDP_DEVINFOBLOCK_PC.

RF625Device::UDPDisconnect ()
Disconnect the scanner (UDP).

RF625Device::Disconnect ()
Disconnect the scanner (TCP).

16.4. RFSDK and control protocol. Profile receiving

Control protocol	TCP: GetResult : 0x01
SDK	• GetResult (void * IpBuffer) Read the packet to the buffer (TCP). • GetNormalizedResult (float OUT * IpPointsBuffer, USHORT OUT * IpCount, USHORT * IpMeasureCnt = NULL, USHORT * IpPacketCnt = NULL) Read the packet that was recalculated in the float array (IpPointsBuffer). IpCount receives a quantity of profile points, and optional parameters to receive the measurement number and the packet number. • UDPGetResult (void * IpBuffer) Read the packet to the buffer (UDP). • UDPGetNormalizedResult (float OUT * IpPointsBuffer, USHORT OUT * IpCount, USHORT * IpMeasureCnt = NULL, USHORT * IpPacketCnt = NULL) Read the packet that was recalculated in the float array (IpPointsBuffer). IpCount receives a quantity of profile points, and optional parameters to receive the measurement number and the packet number.

The data packet structure is described in p. 26.

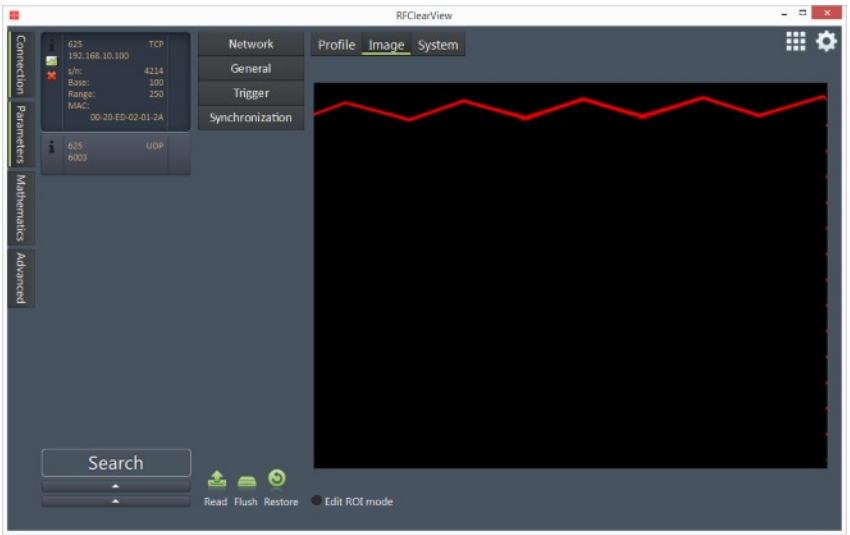
17. Image receiving

17.1. Service program

With the TCP-connection scanner can operate in the image transmission mode.
In this mode, the scanner can transmit:

- the image of laser line on the object surface, generated by CMOS-sensor, or
- the processed image after digital filtering. This image is used for profile extraction.

The image transmission rate is about 7 frames/second. This mode is used in manual tuning of the scanner.
To switch to the image observation mode, click Image button.



By moving the object or the scanner, observe changes in the image.

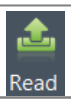
17.2. RFSDK and control protocol

Control Protocol	GetImage : 0x02 GetImageBuffer : 0x03	By the GetImage request, the scanner switches to the mode of transmitting the current image, which was formed before the request. A full frame size of the image equals to 512*640+1 byte. By the GetImageBuffer request, the scanner sends in response a part of the image with size of 32768+1 byte. Thus, in order to collect a full image, you must send the GetImageBuffer request 10 times. For each request, the Offset value is incremented by 32768 +1 (starting with zero for the first packet), the Size equals to 32768 +1 (for all requests). The first byte of the packet is the counter of the image frame part.
	GetImage (void * lpBuffer) Read a raw array containing the values of pixels.	
SDK		

18. Parameters setting procedure

18.1. Service program

Parameters of the scanner can be changed only when the scanner is connected over TCP.
In order to change parameters, activate the corresponding panel, write a new value and press the Enter key or click . All changes are made in RAM and will be lost when rebooting the scanner.
Buttons assignment:

	Read parameters from RAM.
	Save parameters to the nonvolatile memory of the scanner. Note. Only for such a case, with any subsequent activation of the scanner it will work in the configuration you have selected.
	Restore the factory (default) values of parameters.

18.2. RFSDK and control protocol

18.2.1. Reading and writing parameters

Reading parameters are performed by one request (ReadParams), in response to which the scanner sends the packet with settings of 512 bytes (see p. 26.3). All settings are available for editing and their values are described in this User's Manual.
Writing parameters to the scanner are performed by the command WriteParams. All settings, excepting the network settings, are applied immediately. Network settings are applied after rebooting the scanner.
All settings are stored in RAM and will be lost when restarting the scanner, or when power is turned off. In order to save settings to a non-volatile memory, use the command Flush (see p. 18.2.3).
The first two bytes of settings indicate on the settings version. The firmware with the older version doesn't support the functions introduced in the latest versions (see p. 26.5).

Control protocol	ReadParams (0x04) WriteParams (0x05)
Settings packet	-
SDK	- ReadParams ( ) Read user parameters. - ReadParams (void * lpBuffer) Read user parameters to the buffer. - ReadParamsToFile (const char * szFileName) Save user parameters to a file. - WriteParams ( ) Write user parameters to the RAM of the sensor. - WriteParams (void * lpBuffer) Write user parameters from the buffer to the RAM of the sensor. - WriteParamsFromFile (const char * szFileName) Write user parameters from the file to the RAM of the sensor.

18.2.2. Restoring default parameters

Control protocol	FlushParams (0x06) with additional parameter = 1
SDK	FlushParams (BOOL bDefault = TRUE)

18.2.3. Saving parameters to the non-volatile memory

Control protocol	FlushParams (0x06)
SDK	FlushParams (BOOL bDefault = FALSE)

19. Interface settings

19.1. Service program

In order to set the interface parameters, activate the Network panel.
The UDP-stream option disables/enables the UDP-packets transmission.

19.2. RFSDK and settings packet. TCP connection

19.2.1. Scanner IPv4 address

Control protocol	-
Settings packet	ucTCPAddress[4] (16-13)
SDK	- GetDeviceIPAddress ( ) Get the scanner IP address as array of 4 bytes. - SetDeviceIPAddress (BYTE ucValue[4]) Set the scanner IP address as array of 4 bytes. It is necessary to call WriteParams ( ) to apply settings. - GetHumanReadableDeviceIPAddress ( ) Get the scanner IP address as a string.

19.2.2. Subnet mask

Control protocol	-
Settings packet	ucTCPSubnetMask[4] (20-17)
SDK	- GetNetworkMask ( ) Get the network mask of the scanner as array of 4 bytes. - SetNetworkMask (BYTE ucValue[4]) Set the network mask of the scanner as array of 4 bytes. It is necessary to call WriteParams ( ) to apply settings. - GetHumanReadableNetworkMask ( ) Get the network mask of the scanner as a string.

19.2.3. TCP port

The TCP port of the scanner is set by the user. By default, port 620.

Control protocol	-
Settings packet	wTCPPort (30-29)
SDK	• GetDevicePortNumber ( ) Get the TCP port number of the scanner. • SetDevicePortNumber (WORD usPort) Set the TCP port number of the scanner. It is necessary to call FlushParams ( ) to apply settings.

19.2.4. Keeping TCP connection

This function allows to keep the TCP connection during the predetermined time (in seconds), if the communication is broken. If this time = 0, the TCP connection will be broken immediately.

Control protocol	-
Settings packet	wKeepTCPTime (45-44) ucKeepTCP (46)
SDK	• GetKeepTCPEnabled ( ) Get the state value (TRUE = enabled). • GetKeepTCPTime ( ) Get the current value of time. - SetKeepTCP (BOOL bEnable, WORD wTime = 0) Enable/disable the function and set the time. It is necessary to call WriteParams ( ) to apply settings.

19.3. RFSDK and settings packet. UDP connection

19.3.1. Host IP address

This parameter specifies the IP address of the network interface, to which the calculations data will be sent by UDP.

Control protocol	-
Settings packet	ucUDPAddress[4] (24-21)
SDK	- GetHostIPAddress ( ) Get the host IP address that receives data over UDP (it may be broadcast) as array of 4 bytes. SetHostIPAddress (BYTE ucValue[4]) Set the host IP address that receives data over UDP (it may be broadcast) as array of 4 bytes. It is necessary to call WriteParams ( ) to apply settings. - GetHumanReadableHostIPAddress ( ) Get the host IP address as a string.

19.3.2. UDP port

This parameter specifies the destination port on the data receiver.
The default port is 6003.
Tip: If there are multiple scanners on the network, use the unique port for each of them.

Control protocol	-
Settings packet	wUDPPort (26-25)
SDK	• GetHostPortNumber ( ) Get the UDP port number of the host. • SetHostPortNumber (WORD wValue) Set the UDP port number of the host that receives data over UDP. It is necessary to call WriteParams ( ) to apply settings.

19.3.3. UDP data stream

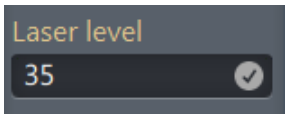
This parameter determines whether the data transmission is enabled over UDP.
Values: Enabled (1) and Disabled (0).
When the UDP stream is enabled, the scanner transmits results to the specified network address.

Control protocol	-
Settings packet	ucUDPStream (55)
SDK	- GetUDPStreamEnabled ( ) Get the state value. • SetUDPStream (BOOL bEnable) Enable/disable the UDP data stream. It is necessary to call WriteParams ( ) to apply settings.

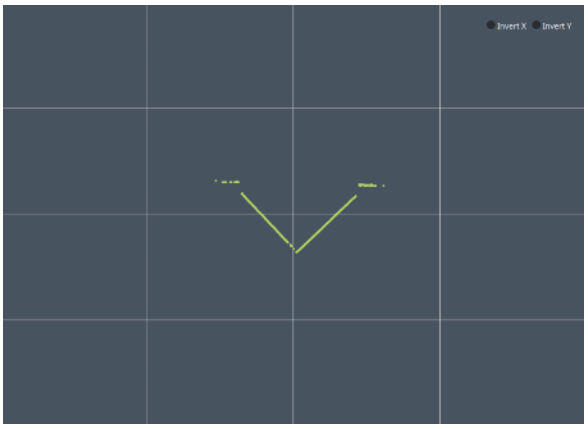
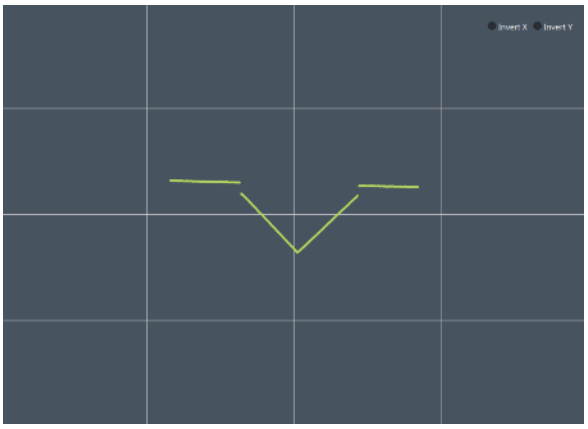
20. Image quality settings

Activate the General panel.

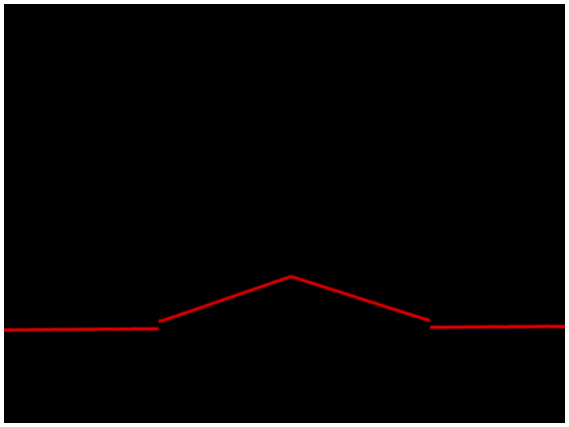
20.1. "Laser level" parameter



This parameter allows to adjust the output power of laser radiation in order to obtain optimal results in the measurement of objects with different reflectivity.
The output power is adjusted manually based on the quality of the image obtained from the image sensor in the image transmission mode, as well as based on analysis of the resulting profile quality. Possible values are in the range of 0...255 (0 – shutdown, 255 – full power). Dependence between a real power and the set power is non-linear.
Note: This parameter is not valid for scanners with power IR lasers.

Laser level is low	Laser level is optimal
	

The same profile in the Image mode:



Depending on the scanner configuration, the profile in the Image mode may be inverted by Z axis.

20.1.1. RFSDK and settings packet

Control protocol	-
Settings packet	ucLaserLevel (2) - GetLaserLevel ( ) Get the current value of the laser level.
SDK	- SetLaserLevel (BYTE ucValue) Set the laser level value into the block of user settings. It is necessary to call WriteParams ( ) to apply settings.

20.2. "Exposure time" parameter and "Auto exposure" mode

The intensity of the reflected light entering the scanner depends on the properties of the surface of the object under control. In turn, the value of electric signal generated by the CMOS image sensor of the scanner depends on the time of accumulation of radiation (integration time). Therefore, in order to obtain optimum signal, it is necessary to set optimal integration time of the image sensor.

There are two modes possible:

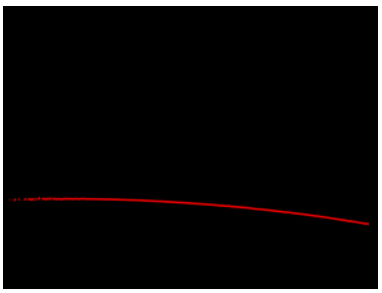
1) Exposure time is selected manually based on visual analysis of the quality of the image obtained from the image sensor in the image transmission mode, and on analysis of the quality of the resulting profile.

Note 1. The exposure time is adjusted in the range of 0...3600 us for 250 Hz scanners and 0...1912 us for 500 Hz scanners. In the ROI mode the exposure time is limited by ROI parameters (the maximum possible exposure time is getting less with reducing ROI parameters).

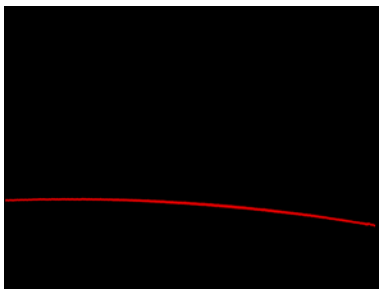
2) Auto Exposure mode is selected. In this mode, scanner automatically adjusts and sets optimal integration time at a given laser level. This mode is used primarily for homogeneous objects.

Note 2. The laser is turned on only during the exposure time in all scanners, excepting the models with the external laser control.

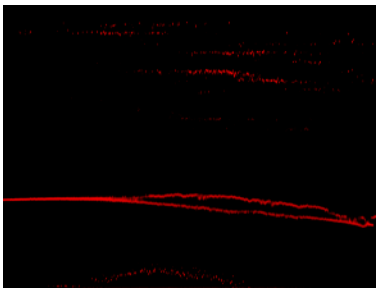
The exposure time is too low
(the profile is not completely visible)



The exposure time is optimal



The exposure time is too high:



20.2.1. RFSDK and settings packet. Exposure time

Control protocol	-
Settings packet	wExposureTime (4-3)
	- GetExposureTime ( ) Get the current value of the exposure time.
SDK	- SetExposureTime (WORD wValue) Set the exposure time value into the block of user settings. It is necessary to call WriteParams ( ) to apply settings.

20.2.2. RFSDK, control protocol, and settings packet. Auto exposure

The "Exposure time" parameter can not be applied in the enabled "Auto exposure" mode. To read the current value of the exposure time in the "Auto Exposure" mode, use the request GetAutoExposure.

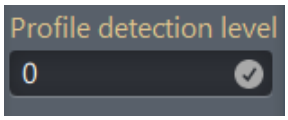
Control protocol	GetAutoExposure (0x17)
Settings packet	ucAutoExposure (31)
	- GetAutoExposure (LPWORD lpusValue) Get the current value of the exposure time, when the Auto Exposure mode is enabled.
SDK	- GetAutoExposureMode ( ) Get the state of the Auto Exposure mode (TRUE = enabled). - SetAutoExposureMode (BYTE ucMode) enabled).

21. Profile extraction quality settings

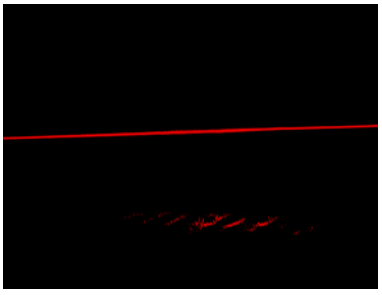
Activate the General panel.

21.1. "Profile detection level" parameter

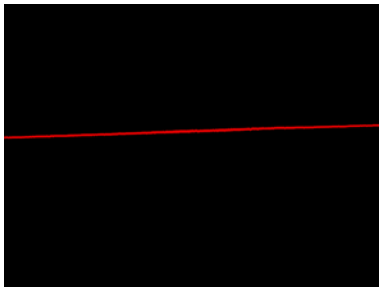
This parameter controls the level of profile detection on the image. Increasing this parameter allows to decrease the influence of image noise. By default, value is "0". The range of values: 0..255. When the value is 255, the image is not processed.



Profile detection level = 0



Profile detection level = 170

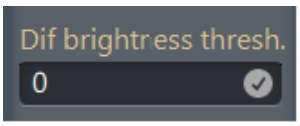


21.1.1. RFSDK and settings packet

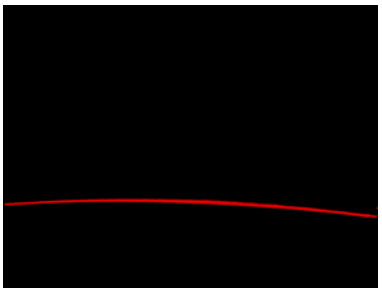
Control protocol	-
Settings packet	ucPixelBrightnessThres (32)
	• GetPixelBrightnessThreshold ( ) Get the current value of the profile detection level.
SDK	• SetPixelBrightnessThreshold (BYTE ucValue) Set the value of the profile detection level.

21.2. "Level of secondary filtering" parameter

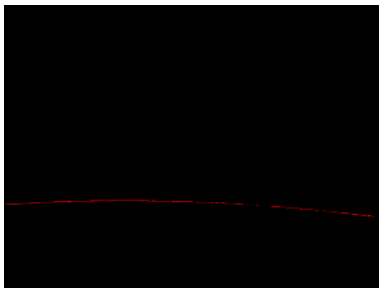
This parameter controls the image filter parameter. Increasing this parameter allows to decrease the image noise influence on the profile extraction. By default, value is "0". The range of values: 0..255.



Dif brightness thresh = 0



Dif brightness thresh = 200



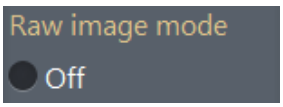
21.2.1. RFSDK and settings packet

Control protocol	-
Settings packet	ucDifBrightnessThres (33)
SDK	• GetDifBrightness ( ) Get the Dif brightness thresh value. • SetDifBrightness (BYTE ucValue) Set the Dif brightness thresh value.

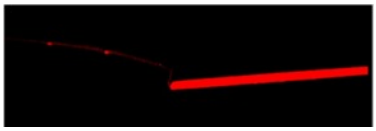
21.3. "Raw image mode" parameter

21.3.1. Service program

To select the type of image, activate the General panel. The Raw image mode option is intended to select the type of image displayed in the Image panel and used to extract the profile.



When the option is selected, the image without filtering is used. An example of the image without filtering:



In this image, a complex object has a curved section featuring low reflectivity (poorly developed image) and a straight section with a high reflectivity (a saturated image). If this image is used to extract the profile, the profile at the first section will be obtained with coordinates missing, while that of the second section with a significant error.
Note: Use unfiltered image only to configure scanner parameters.
The same image, but after filtering (Raw image mode is not selected) is shown below:

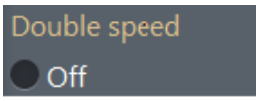
Note: Always use this mode to obtain the profile.

21.3.2. RFSDK and settings packet

Control protocol	-
Settings packet	ucRawImageMode (34)
SDK	• GetEnabledRawImageMode ( ) Get the value of the mode state (TRUE = enabled). • SetEnableRawImageMode (BOOL bEnable) Enable/disable the raw image mode.

22. Additional settings

22.1. "Double speed" parameter



This parameter switches the scanner into 500 Hz mode. In the normal mode the scanner processes all rows of the CMOS-array per 4 ms. In the DHS mode the scanner processes the CMOS-array per 2 ms that doubles the frequency of measurements with increasing the error up to 0.2% at Z.

22.1.1. RFSDK and settings packet

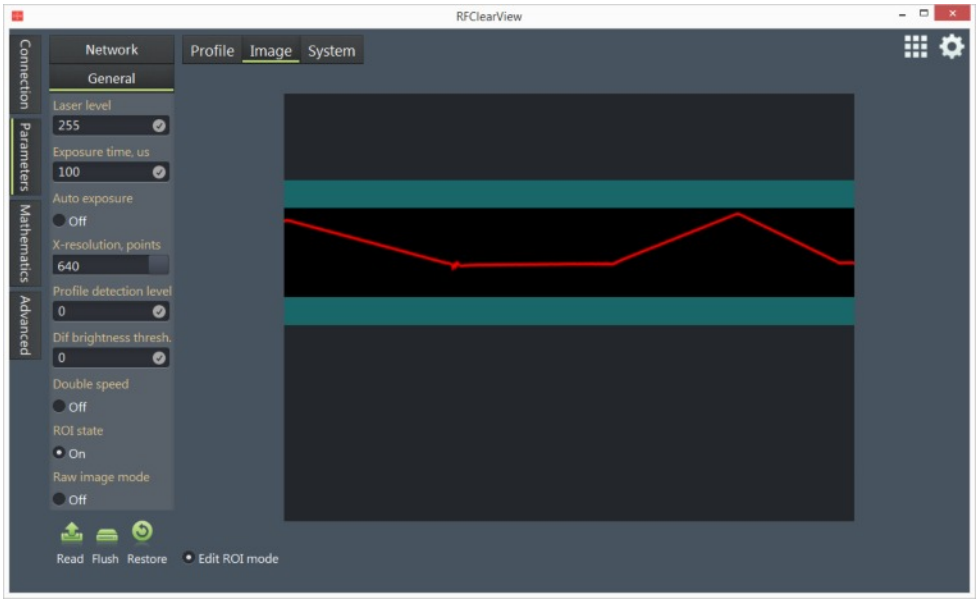
Control protocol	-
Settings packet	ucDHSEnable (36). Values: 500Hz =1; 250Hz=0
SDK	- GetEnableDHS ( ) Get the value of the mode state (TRUE = enabled). - SetEnableDHS (BOOL bEnable) Enable/disable the double speed mode. It is necessary to call WriteParams ( ) to apply settings.

22.2. "ROI" parameter

This parameter controls the active area size of CMOS-array.
By default, active area covers entire area of the sensor. Active area size decreasing allows to increase the scanner speed due to decreasing of reading time of the image.
Resizing is possible in Z-direction only and is specified in the CMOS-sensor coordinates.
ROI is defined by two parameters:

- Position – can be set in the range of 0...416 with the step of 32.
- Height – can be set in the range of 64...480 with the step of 64.

Thus, the minimum height of ROI is 64 pixels.
To change the active area size, activate the Image panel, select the Edit ROI mode (in the bottom part of the window), and move limiters by mouse. To apply settings, select the ROI state option on the General tab.



22.2.1. RFSDK

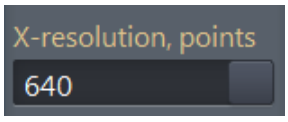
Control protocol	-
Settings packet	-
	- GetROIEnabled ( ) Get the value of the mode state (TRUE = enabled). - GetUpperBoundary ( ) Get the current value of the upper boundary of the window. - GetWindowHeight ( ) Get the current value of the window height. - SetROI (BOOL bEnable, WORD wUpperBoundary = 0, WORD wWindowHeight = 0, BYTE ucAP = 0, BYTE ucAH = 0)
SDK	bEnable – enable/disable the ROI mode. If the mode is enabled, it is necessary to set the parameters: wUpperBoundary (the upper boundary of the window), wWindowHeight (window height). Parameters ucAP and ucAH are reserved, and must be equal to 0. It is necessary to call WriteParams ( ) to apply settings. - SetUpperBoundary (WORD wValue) Set the value of the upper boundary of the window. It is necessary to call WriteParams ( ) to apply settings. - SetWindowHeight (WORD wValue) Set the value of the window height. It is necessary to call WriteParams ( ) to apply settings.

22.2.2. Active area size and scanner speed

Relationship between the scanner speed and the sensor active size is shown in Table:

Size, pixels	Speed, profiles/s	Maximal possible integration time, us
480	250	4000
416	288	3472
352	341	2932
288	416	2403
224	535	1869
160	750	1333
128	937	1066
64	1875	533

22.3. "X-resolution" parameter



This parameter sets the quantity of profile points along the X coordinate, for which the calculation of the coordinate value must be performed. Values: 80, 160, 320, 640, 1280. By default, the value is 640.

The CMOS sensor of the scanner contains 640 columns. When the resolution is 640, all columns will be processed. The resolution of 1280 points is achieved by interpolation of the image in adjacent columns. Reducing the resolution is performed by reducing the quantity of processed columns, and allows to reduce the quantity of points in the profile, and thereby to facilitate the data transfer at high frequencies of the scanner.

22.3.1. RFSDK and settings packet

Control protocol	-
Settings packet	ucInterpolation (35) • SetInterpolation (BYTE ucType) Set the value of the X-resolution. ucType: 0, 1, 2, 3, 4.
SDK	0 : 80, 1 : 160, 2 : 320, 3 : 640, 4 : 1280. It is necessary to call WriteParams ( ) to apply settings. • GetInterpolation ( ) Get the value of the X-resolution.

22.3.2. Scanner speed and resolution for X

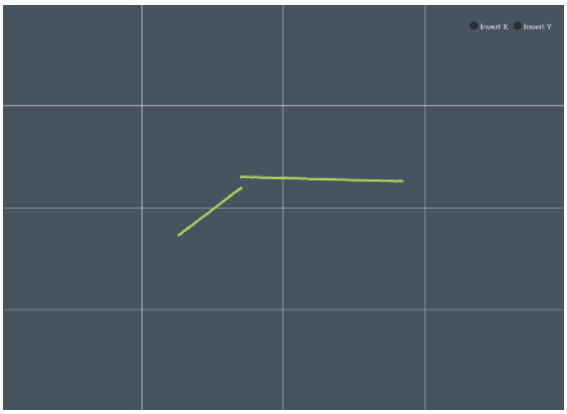
Relationship between the scanner speed and the number of points for X-coordinate is shown in Table:

Points quantity	250Hz Mode, Hz	500Hz Mode, Hz	ROI, Hz
80	250	500	1875
160	250	500	1875
320	250	500	1875
640	250	500	-
1280	250	-	-

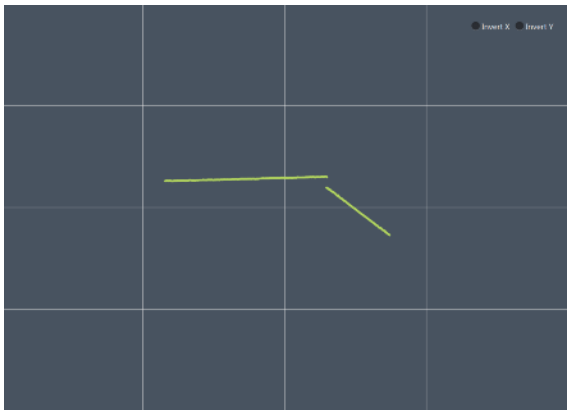
22.4. Profile inverting

This parameter allows to change the direction of coordinate axes of the scanner.

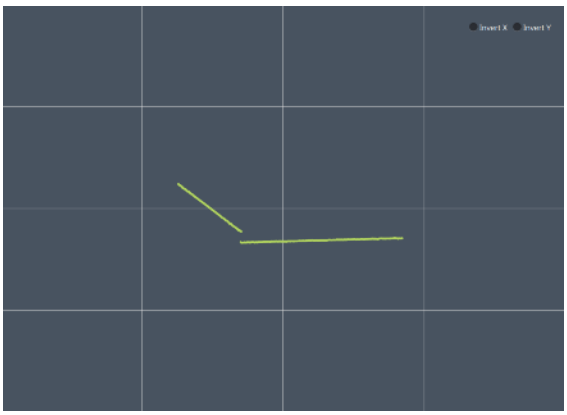
Source profile



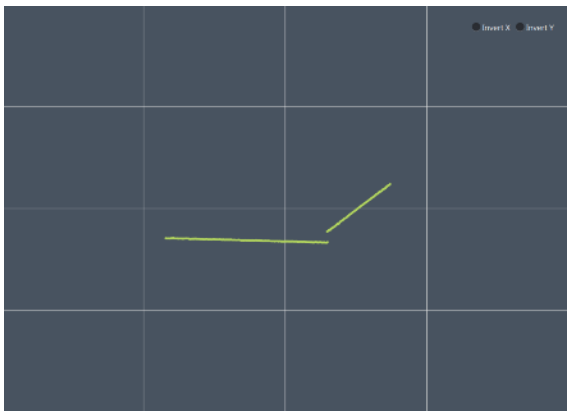
Inverted profile, X axis



Inverted profile, Z axis



Inverted profile, X and Z



22.4.1. RFSDK and settings packet

Control protocol	-
Settings packet	invertXZ (59) &0x01 – Invert X, &0x02 – Invert Z - GetXInverted ( ) Get the state of the 'Invert X' option (0 – disabled, ≠0 – enabled). - GetZInverted ( ) Get the state of the 'Invert Z' option (0 – disabled, ≠0 – enabled).
SDK	- SetXInverted (BOOL value) Enable/disable the 'Invert X' option. It is necessary to call WriteParams ( ) to apply settings. - SetZInverted (BOOL value) Enable/disable the 'Invert Z' option. It is necessary to call WriteParams ( ) to apply settings.

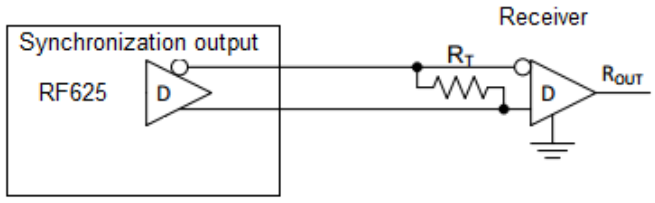
23. Trigger control parameters

Trigger is an event which induces the result transmittance from the scanner.
The result (Cartesian coordinates) is transmitted by UDP-packet or by TCP-request. There may be several sources of trigger:

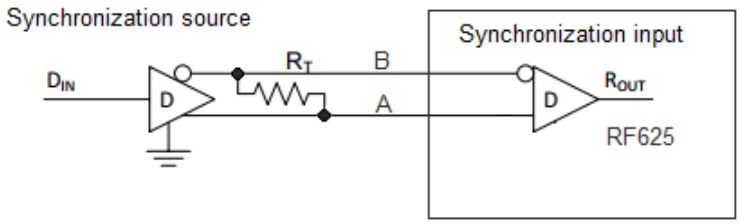
1) Base timer
2) Additional timer
3) External input
4) Encoder
5) Step/Dir
6) TCP-request
7) A combination of events listed above

23.1. External inputs/outputs

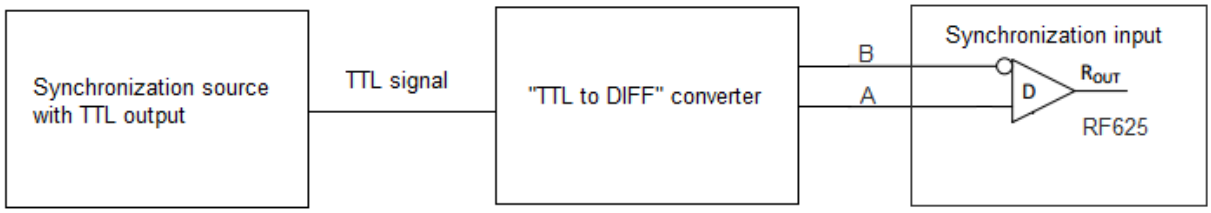
There may be available up to 8 external channels: 4 input channels (Input Channel 0...3), 4 output channels (Output Channel 0...3). Each channel is a differential line with three states, which meets the requirements of TIA/EIA-422-B and the recommendations of ITU V.11. The connection of output channels to an external receiver with a differential input (RT resistor has resistance of 80..120 ohm):



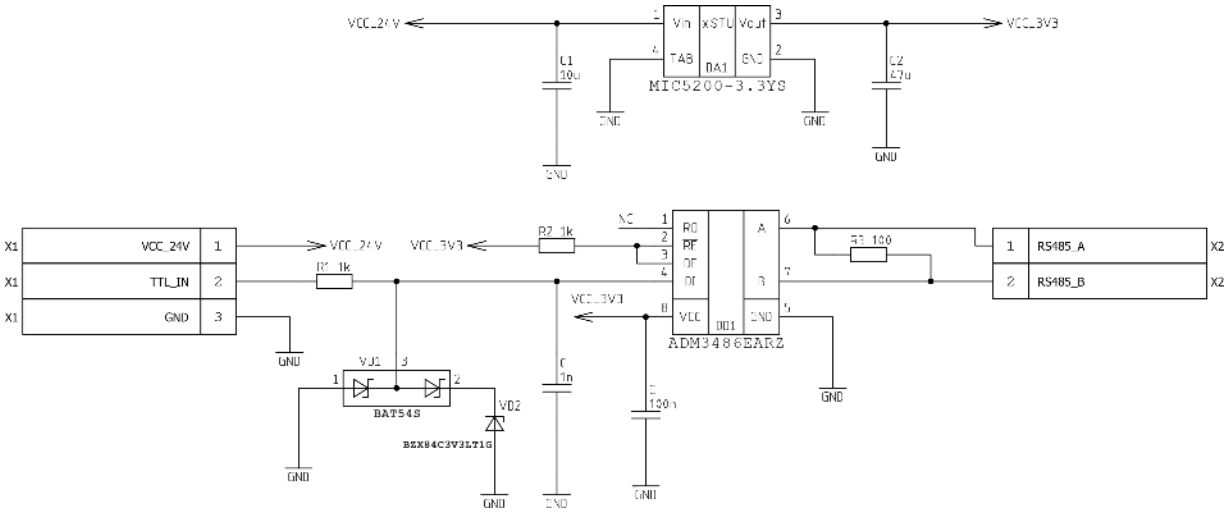
The connection of input channels to an external source with a differential output (RT resistor has resistance of 80..120 ohm):



The connection of the input channel to an external source having the TTL output:



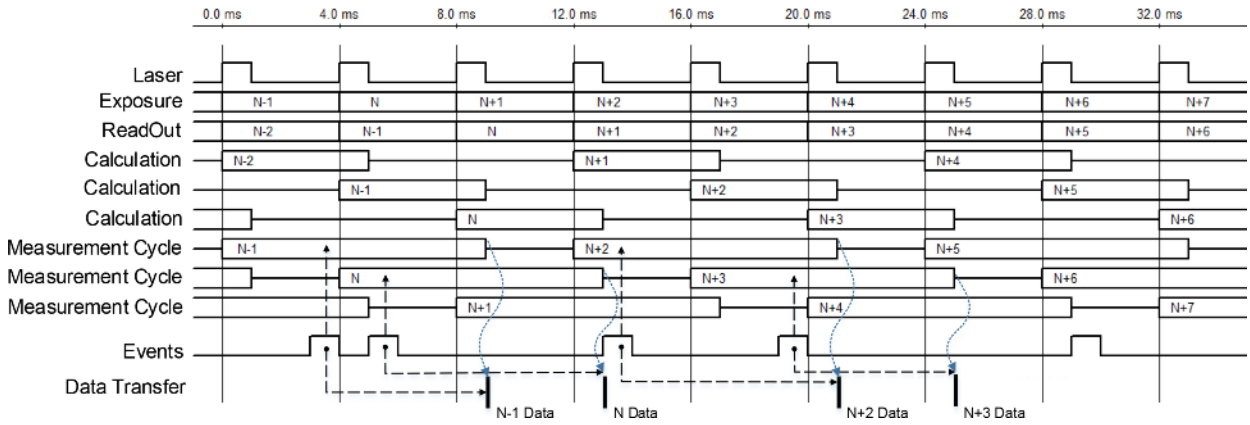
An example of the TTL-Diff converter:



23.2. Time cycles

The operation algorithm of the scanner is built in such a way that image reading and processing (profile extraction) are taken continuously in pipeline mode without stopping the CMOS image sensor. The pipeline mode is explained by diagram on which are marked:

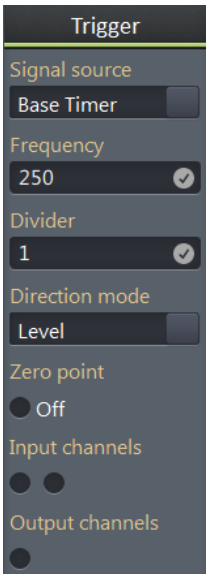
- 4 ms frame period for 250 Hz scanner (2 ms for 500 Hz scanner)
- (N-1), N… – numbers of image frames
- Laser – laser light time, which is equal to the CMOS sensor integration time
- Exposure – cycles of image sensor exposure
- ReadOut – cycles of image reading
- Calculations – cycles of calculations of corresponding frames
- MeasurementCycle – full measurement cycles
- Events – events and corresponding measurement cycles numbers
- Data transfer – the data transfer cycles and corresponding events



As seen from the chart, three measurement cycles are performed simultaneously. The transmitted result corresponds to the measurement cycle, the beginning of which is closest to the event.

23.3. "Trigger" panel

Signal sources: Base timer, Additional timer, External input, Encoder, StepDir.
The Frequency parameter controls the frequency for "Additional timer".
The Divider parameter sets the division factor for all signal sources except "Base timer". Frequency decreases according to the "Divider" parameter. The "Divider" parameter can be set in the range of 1...255. When you set 0 or 1, the division will not be applied.
Zero point is a zero point of the encoder, at which the scanner resets the counters.
Input/Output channels are the synchronization channels available to select.



23.4. Events processing

Event/ Transmittance mode	UDP-stream	TCP-request	External inputs/ outputs
Base timer Frequency of base timer is equal to frequency of image frames (248Hz, 491Hz, or ROI).	The onset of each event corresponds exactly to the beginning of the measuring cycle. Scanner automatically sends the UDP-package with results, when the event occurs. Examples: for 250 Hz scanner, packet transmittance frequency = 248 Hz; for 500 Hz scanner, packet transmittance frequency = 491 Hz. In the ROI mode the values depend on ROI parameters.	Scanner sends result by TCP-protocol for every request. The result is changed in accordance with the events frequency. If the new request arrives, but result is not changed, the zero value will be transmitted.	It is possible to program the one of output channels to transmit the timer signal.
Additional timer + Divider The value of additional timer can be set in the range of 0...2000 Hz.	Scanner automatically sends the UDP-package, when the event occurs. Examples: additional timer frequency = 100 Hz, divider = 1, packet transmittance frequency = 100 Hz; when divider = 10, packet transmittance frequency = 10 Hz.		
Trigger signal at the external input of the scanner + Divider	Scanner automatically sends the UDP-package, when the event occurs. The events frequency depends on the divider value and has to be less than scanner working frequency. The minimum frequency is not limited. The user can program the value of the event execution delay. If the sync signal at the external input is absent more than 1 second, the CMOS is stopped, and at the first input sync signal, the CMOS will be run again.		It is possible to program the one of Input channels (0..3) as the input channel.
Encoder signal + Divider	Scanner automatically sends the UDP-package, when the event occurs. Events are the voltage swings of two quadrature channels of the encoder with the set divider value. Measurements are performed at the frequency of additional timer. The reverse is processed the same as the direct step.		It is possible to program the channels, which are connected to the encoder, as the input channels.

Step/Dir signal	Events – Step. The Step counter corresponds to the measurements counter. The Dir counter is located in the extended area of data packet.

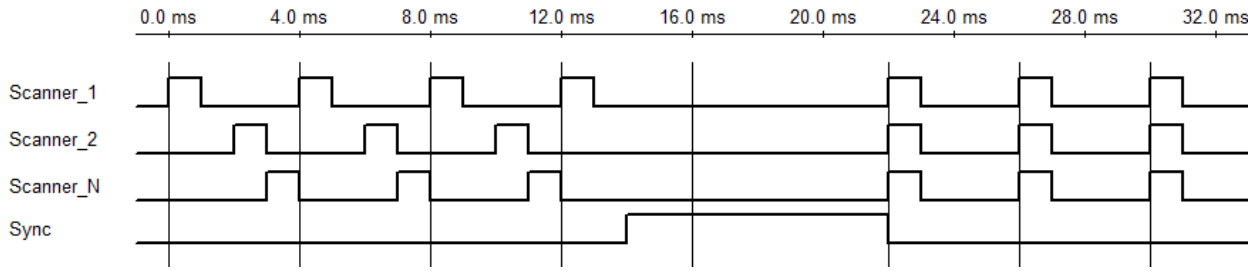
23.5. RFSDK

Control protocol	-
Settings packet	-
	- GetSyncType ( ) Get the current value of the signal source (0 – base timer, 1 – additional timer, 2 – external input, 3 – encoder, 4 – stepdir). - GetSyncChannels ( ) Get the current value of the synchronization channels. - GetSyncMeasure ( ) Get the state of the measurement synchronization mode (0 – disabled, 1 – enabled). - GetSyncFreq ( ) Get the current value of the frequency of additional timer. - GetSyncDelay ( ) Get the current delay time (milliseconds).
SDK	- GetSyncDivider ( ) Get the current value of the divider. - SetSync (WORD wType, WORD wChannels, BYTE ucMeasureSync, WORD wFreq, WORD wDelay, BYTE ucDivider) Set synchronization parameters. wType: signal source (0 – base timer, 1 – additional timer, 2 – external input, 3 – encoder, 4 – stepdir). wChannels: synchronization channel (0..3). ucMeasureSync: measurement synchronization (0 – disabled, 1 – enabled). wFreq: frequency of additional timer. wDelay: delay (milliseconds). ucDivider: divider. It is necessary to call WriteParams ( ) to apply settings.

24. Synchronization of several scanners

Where measurements are made by several scanners, it is often necessary to ensure synchronous measurement operations, in order, for example, to combine profiles obtained from different parts of the moving object into a single profile. To achieve synchronous operation of the scanners, it is necessary to:

1) ensure synchronization of the start time of Measurement cycles of scanner by feeding of synchronization impulse on synchronization inputs of the scanners. When high level occurs at the synchronization input, the scanners complete, and then stop internal cycles, and reset the frame counter. By the wave-fall of the synchronization pulse (transition to low level) all scanners simultaneously start the cycles of measurement. Duration of the synchronization pulse should not be less than the duration of the scanner time cycle.



2) eliminate or reduce asynchronous behavior of Measurement cycles of scanners during long time (long-term synchronization), which is caused by frequency instability of the internal oscillators of the scanners. The

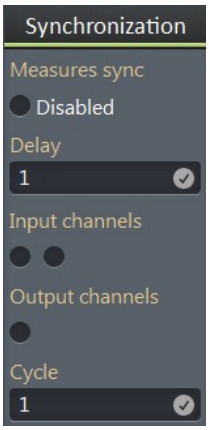
actual duration of the scanner time cycle depends on the frequency of scanner's internal oscillator, and, for example, with the oscillator instability of ± 50 ppm mistiming of frames of two scanners can reach one frame after 40 s or 10,000 frames. To support synchronous working of the scanners, it is necessary to perform the synchronization cycle start periodically according to previous point.

3) interpret correctly the frame numbers and packet numbers received from scanners (see p. 24.2.5).

To set parameters, click on the Synchronization panel.

For internal synchronization of measurements of multiple scanners, you must enable Measures sync, set the **Delay** and **Cycle** parameters, and select the output synchronization channels.

For external synchronization of measurements of multiple scanners, you must enable Measures sync, set the Delay parameter, and select the input synchronization channels.



24.1. Synchrosignal source

Possible sources of synchronization signal:

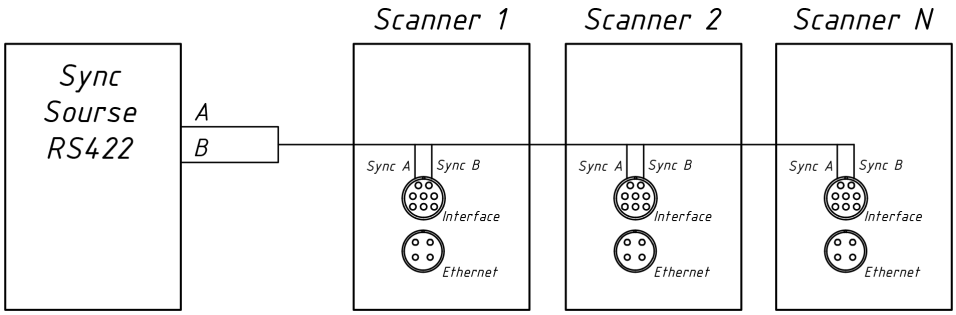
- External generator
- One scanner in the group of scanners – "master-scanner"

24.2. Connection and settings

24.2.1. External synchrosignal source

To synchronize the cycles start of several scanners, it is necessary to:

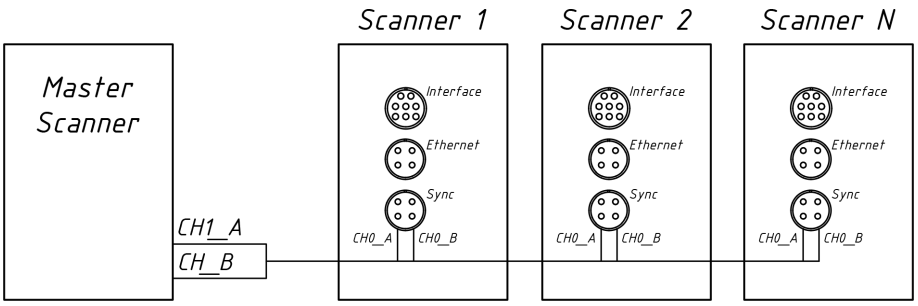
- combine synchronization inputs of all scanners;
- select the synchronization channels for every scanner;
- feed the synchronization pulse;
- restore synchronization periodically.



24.2.2. Master-scanner

To synchronize the cycles start of several scanners, it is necessary to:

- connect the synchronization output of "master-scanner" and synchronization inputs of other scanners;
- select the output synchronization channel for "master-scanner";
- set the synchronization restore period for "master-scanner" (Cycle parameter);
- select the input synchronization channel for the rest of scanners.



24.2.3. "Delay" parameter

For every scanner (besides "master scanner") you can set the delay time of reaction to the clock pulse (1 by default). The measurement cycle beginning will be delayed for this value. The delay time is set in milliseconds.

24.2.4. "Cycle" parameter

The Cycle parameter sets the duration of the working cycle for internal synchronization (in seconds), after the end of which the counters will be reset.

24.2.5. Numbers of frames and packets

Frame and packet numbers transmitted in data packets make it possible to compare profiles obtained from different scanners with synchronized cycle start, and to combine them correctly into a single profile.
The scanner data packet contains two counters: the measurement counter and the packet counter. The packet counter is incremented with the each sent packet of measurements, the measurement counter is incremented with each measurement.

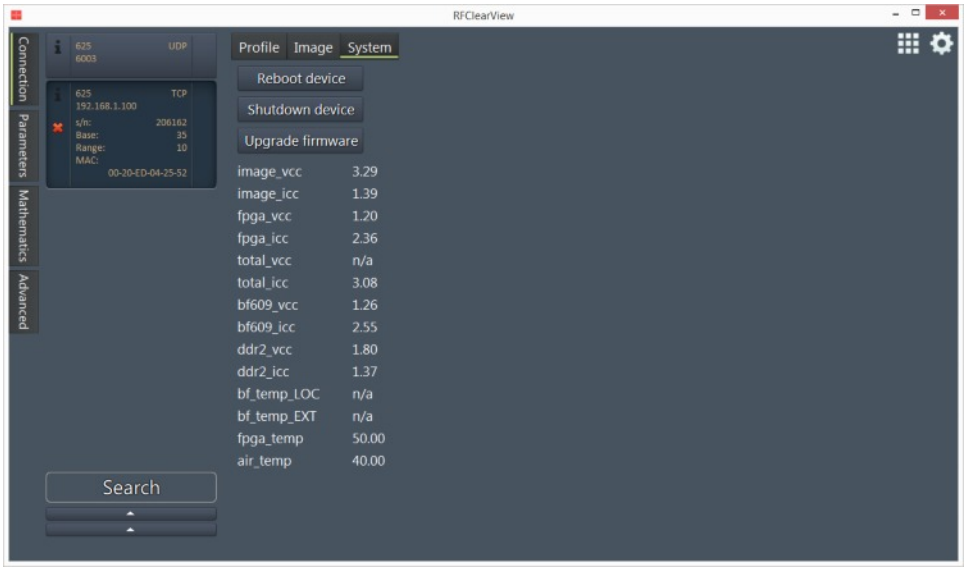
24.2.6. RFSDK and settings packet

Control protocol	-
Settings packet	ucMeasureSync (40) - GetSyncType ( ) Get the current value of the signal source (0 – base timer, 1 – additional timer, 2 – external input, 3 – encoder, 4 – stepdir). - GetSyncChannels ( ) Get the current value of the synchronization channels. - GetSyncMeasure ( ) Get the state of the measurement synchronization mode (0 – disabled, 1 – enabled). - GetSyncFreq ( ) Get the current value of the frequency of additional timer. - GetSyncDelay ( ) Get the current delay time (milliseconds).
SDK	- GetSyncDivider ( ) Get the current value of the divider. - SetSync (WORD wType, WORD wChannels, BYTE ucMeasureSync, WORD wFreq, WORD wDelay, BYTE ucDivider) Set synchronization parameters. wType: signal source (0 – base timer, 1 – additional timer, 2 – external input, 3 – encoder, 4 – stepdir). wChannels: synchronization channel (0..3). ucMeasureSync: measurement synchronization (0 – disabled, 1 – enabled). wFreq: frequency of additional timer. wDelay: delay (milliseconds). ucDivider: divider. It is necessary to call WriteParams ( ) to apply settings.

25. Diagnostics, emergency commands and firmware upgrade

In order to activate the System panel, connect the scanner over TCP, and click the System button. This panel contains the buttons for:

- emergency commands (Reboot device and Shutdown device),
- firmware upgrade (Upgrade firmware).



In addition, the System panel displays parameters of the scanner hardware condition.

25.1. Diagnostics

The diagnostics provides information about condition of the basic electric circuit nodes of the scanner. This information displays on the System panel. The scanner condition packet is described in p. 26.3.3.

25.1.1. RFSDK and control protocol

Control protocol	GetExtends (0x20)
Settings packet	-
SDK	GetExtends (void * lpBuffer) Get the current values of the scanner state into the buffer.

25.2. Emergency commands

The correct shutdown and reboot are necessary for the file system safety. When necessary, pass to the System panel, and click Reboot device to reboot the scanner, or click Shutdown device to reset the current connections.

25.2.1. RFSDK and control protocol

Control protocol	Reboot (0x14) Shutdown (0x16)
Settings packet	-
SDK	- Reboot ( ) Reboot the scanner. - PowerOff ( ) Shutdown the scanner.

25.3. Firmware upgrade

To upgrade the scanner firmware, click Upgrade firmware on the System panel, and select the file. Next, you need to reboot the scanner (click Reboot device) for the changes to take effect.

25.3.1. RFSDK and control protocol

Control protocol	UpgradeFW (0x15)
Settings packet	-
SDK	UpgradeFW (const char *szFilename) Upgrade the scanner firmware.

26. Network protocols

Network protocols are the only way of parametrization and receiving the measurements data from the scanner. All protocols are implemented on the basis of the stack IPv4.

There are 2 groups of protocols: protocols based on TCP, and protocols based on UDP. The protocol of control and parametrization, measurements data transfer protocol by request and RAW image transfer protocol from the matrix by request are the protocols based on TCP.

UDP-based protocols are intended to transmit the scan data at set frequencies, use the emergency commands to reset the scanner status and to detect the scanner on the Network.

The list of connections, used in RF625 scanners

Connection	Customizable	Port	Customizable	Work period	Description
Scanner Detection Protocol					
Dispatch to address 255.255.255.255	No	UDP:6001	No	It works always and switches off only during an active TCP connection	The packet with information about the scanner is sent every 2 seconds for the connection. See p. 26.1.
Dispatch to address 255.255.255.255	No	UDP:62500	No	It works always	
Dispatch to a broadcast address of the scanner network interface	Yes	UDP:62501	No	It works always and switches off only during an active TCP connection	
Scanner Control Protocol					
Customizable IP address of the scanner	Yes	TCP:620	Yes	It works always only in the connection standby mode	See paragraphs 26.2 and 26.3
Measurements Data Transfer Protocol					
Customizable Host IP address	Yes	UDP:6003	Yes	It works always and switches off only during an active TCP connection	See p. 26.2.
Emergency Control Protocol					
Waiting for the broadcast packet	No	UDP:62533	No	It works always	See p. 26.4.

26.1. Scanner detection protocol

When connected to the network and powered, the scanner communicates the broadcast information packet to 255.255.255.255 address, UDP:6001 with periodicity of one time in 2 seconds.

_UDPI_RFDEVICEINFOBLOCK_ :

```
typedef struct _UDPI_RFDEVICEINFOBLOCK_
{
        unsigned short      usDeviceType;
        unsigned char       ucIP[4];
        unsigned char       ucMAC[6];
        unsigned char       ucInfo[256];
} tUDPI_RFDeviceInfoBlock;
```

Description of the ucInfo structure		
Type	Size, byte	Description
Byte	0	Service information
Byte	3-1	Serial number of the device
Word	5-4	Base distance, mm
Word	7-6	Measurement range. Z axis, mm
Word	9-8	Measurement range. Xsmr, mm
Word	11-10	Measurement range. Xemr, mm
Word	13-12	Bringing the coordinates, mm
Word	15-14	Invalid values
Dword	19-16	Linux version
Byte	20	Laser color
Uint	24-21	CoreA version
Uint	28-25	CoreB version
Uint	32-29	FPGA version
Byte	199-33	Reserved
Byte	200	Valid values: 0, 1, 2, 3 = no, voltage, current, voltage and current
Byte	201	Valid values: 0, 1 = No, Yes
Byte	202	TCP connection is established
Word	221-220	User-defined UDP port
Word	223-222	Customer ID
Word	225-224	User-defined TCP port
Word	227-226	Reserved
Word	229-228	CMOS-sensor power supply
Word	231-230	CMOS-sensor current
Word	233-232	FPGA power supply
Word	235-234	FPGA current
Word	237-236	System power supply
Word	239-238	System current
Word	241-240	CPU power supply
Word	243-242	CPU current
Word	245-244	RAM power supply
Word	247-246	RAM current
Word	249-248	CPU internal temperature
Word	251-250	CPU external temperature
Word	253-252	FPGA temperature
Word	255-254	Air temperature inside the scanner

26.2. Measurements data transfer protocol

The measurements transfer without the active TCP connection is performed over UDP according to updating the data by the basic or additional timer (internal synchronization) or by external sync signal.
The measurements transfer is performed on a customizable IP address and port of the host (see p. 19).

When the TCP connection is active, the data transfer is performed by request GetResult, based on TCP (see p. 26.3).

Data packet structure		
Type	Address, byte	Description
ushort	1..0	Measurement number
ushort	3..2	Packet number
int	7..4	System time of package sending (in microseconds)
byte	8	Protocol version number
byte	9	0xFF
ushort	11..10	Quantity of points [N]
N*sizeof(short)	(12 + N*2 - 1) .. 12	Values X
N*sizeof(unsigned short)	(12 + N*2*2 — 1) .. (12 + N*2)	Values Z
short	(12 + N*4 + 1) .. (12 + N*4)	Size of additional parameters (see below). Nowadays it equals to 8.
byte	12 + N*4 + 2	Types of additional parameters: 1 - common information 2 - math calculations
3*sizeof(byte)	(12 + N*4 + 5) .. (12 + N*4 + 3)	Serial number
uint16	(12 + N*4 + 7) .. (12 + N*4 + 6)	User XEMR
uint16	(12 + N*4 + 9) .. (12 + N*4 + 8)	User ZDiap
uint16	(12 + N*4 + 11) .. (12 + N*4 + 10)	Check sum (CRC-16)

Note:

1. Measurement number: a cyclic counter of frames, taken and processed (calculated) by the scanner.
2. Packet number: a cyclic counter of the sent measurements.
3. System time of sending the packet. The time stamp is put in the moment of sending the data, the time stamps of the image capture are absent.
4. The number of points in the measurement, for which X and Z coordinates are calculated. This number is always less or equal to the size of the data buffer (80, 160, 320, 640, 1280) and sets the length of the arrays of values X and Z.
5. The values of the X and Z points, calculated per one measurement (per one frame). The arrays elements in the respective cells set the coordinate of the calculated point of the obtained measurement in coordinates of the scanner. The points values are transferred as discrete values of the scanner and recalculated into millimeters by the following formula:

PointZ(mm) = PointZ_discreete*ZDiap / DiscreeteValue;
PointX(mm) = PointX_discreete*XEMR / DiscreeteValue;

The discrete value is contained in the scanner detection packet in the variable wDiscreteValue.

26.3. Scanner control protocol

Scanner control protocol is based on TCP. The scanner is always in standby mode of the incoming connection to a customizable port. When the connection by the scanner control protocol is set, then will be stopped the transfer of UDP data and broadcast packets of detecting to ports 6001 and 62501. Scanners are controlled by the control commands (see p. 26.3.1).
The available commands are listed in the table of commands. The command RF625_GetExtends provides obtaining the data of the scanner condition in a separate packet (see p. 26.3.3). Commands ReadParams and WriteParams work with the scanner data, which are transmitted within the settings packet (see p. 26.3.4).

26.3.1. Structure of the commands packet

```
typedef struct _RF_COMMAND_PACKET {
        unsigned long                   ucCommand;
        unsigned long                   ulAttachSize;
        unsigned long                   ulOffset;
        unsigned long                   ulSize;
}   RF_COMMAND_PACKET, *LPRF_COMMAND_PACKET;
```

Command — The request code
AttachSize — The attached data
Offset — The place from which to read the transmitted attachment
Size — The size of the attachment data, which begin with Offset

26.3.2. Table of commands

Commands Note: Unless otherwise specified, AttachSize=0, Offset=0, Size=0			
Request code	Request	Description	Appropriate method in SDK
GetResult	0x01	Getting the measurement result. In response comes a packet of measurements.	RF625CMD_GetResult
GetImage	0x02	Request for the image transfer. The scanner switches into the image transfer mode and starts transfer it by the request GetImageBuffer. When the full frame of the image is transmitted, the image transfer mode is switched off.	RF625CMD_GetImage
GetImageBuffer	0x03	Receiving the image (a full frame size is 512 * 640 + 1 byte) by the request GetImageBuffer. In response, the scanner sends a part of the image having the size 32768 +1 bytes. Thus, to collect the full picture, you need to send the request Get Image Buffer 10 times. For each request, the Offset value is incremented to 32768 +1 (beginning from zero for the first packet), Size is 32768 +1 (for the all requests). The first byte of the packet is a counter of the image frame part.	RF625CMD_GetImageBuffer
ReadParams	0x04	Request for the configuration parameters of the scanner. The answer will come as the packet with the user configuration data. In answer will come the packet of 512 bytes containing the Settings packet from 0 byte (see p. 26.3.4).	RF625_ReadParams
WriteParams	0x05	Request for download the configuration parameters. By this request, configuration parameters must be transmitted into the scanner (see Settings packet). The size of settings packet is 512 bytes.	RF625_WriteParams
FlushParams	0x06	Writing the configuration parameters in a non-volatile memory (Offset = 0), the current scanner parameters that were written using Writeparams, will be saved as the default parameters; or Restoring from a non-volatile memory (Offset = 1), default parameters will be restored as a current parameters.	RF625CMD_FlushParams

Reboot	0x14	Request to reboot the scanner.	RF625CMD_Reboot
UpgradeFW	0x15	Firmware upgrade. AttachSize — the FW file size, byte.	RF625CMD_UpgradeFW
Shutdown	0x16	Request to shutdown the scanner.	RF625CMD_Shutdown
GetAutoExposure	0x17	Getting the current value of the integration time.	RF625_GetAutoExposure
Disconnect	0x19	Request for the completion of TCP-session.	RF625CMD_Disconnect
GetExtends	0x20	Request for the hardware condition. In response comes the packet with information about the hardware condition. The size is 15 * 2 bytes. If the profile transfer mode is not a current mode of the scanner, the packet will consist of 15 double-byte values 0x0FFD.	RF625_GetExtends
RF625CMD_ CreateRecovrPart	0x92	Creating a backup in a special section.	RF625CMD_CreateRecovrPart

26.3.3. Scanner condition packet

Scanner condition packet		
Size, byte	Address	Description
uint16	1-0	System time of the scanner work
uint16	3-2	CMOS-sensor power supply
uint16	5-4	CMOS-sensor current
uint16	7-6	FPGA power supply
uint16	9-8	FPGA current
uint16	11-10	System power supply
uint16	13-12	System current
uint16	15-14	CPU power supply
uint16	17-16	CPU current
uint16	19-18	RAM power supply
uint16	21-20	RAM current
uint16	23-22	CPU internal temperature
uint16	25-24	CPU external temperature
uint16	27-26	FPGA temperature
uint16	29-28	Air temperature inside the housing

26.3.4. Settings packet

Settings packet			
Type	Address	Description	Name
uint16	1-0	Configuration version	wConfigVersion
uint8	2	Laser level (0..255)	ucLaserLevel
uint16	4-3	Exposure time. The range of values: 0..3600 us	wExposureTime
uint16	6-5	The top border of the window (0..224). By default: 0	wWindowTop
uint16	8-7	Window height (31..255). By default: 255	wWindowHeight
uint16	10-9	External synchronization	wExtSyncSignal
uint16	12-11	Divider of the external sync signal (1..256)	wExtSyncDivider
uint8[4]	16-13	Device IP address. By default: 0.0.0.0	ucTCPAddress[4]
uint8[4]	20-17	Subnet mask. By default: 0.0.0.0	ucTCPSubnetMask[4]
uint8[4]	24-21	Host IP address. By default: 255.255.255.255	ucUDPAddress[4]
uint16	26-25	Host UDP port. By default: 6003	wUDPPort
uint16	28-27	UDP frequency	wUDPFrequency
uint16	30-29	TCP/IP port	wTCPPort
uint8	31	Auto exposure	ucAutoExposure
uint8	32	Pixels brightness threshold	ucPixelBrightnessThres
uint8	33	Threshold of the distance between pixels	ucDifBrightnessThres
uint8	34	Filters shutdown mode	ucRawImageMode
uint8	35	Interpolation of the profile	ucInterpolation
uint8	36	DHS	ucDHSEnable
uint8	37	Analog output	ucAnalog
uint16	39-38	Synchronization channels	wSyncChannels
uint8	40	Measurements synchronization	ucMeasureSync
uint16	42-41	Synchronization delay	wDelaySync
uint8	43	Synchronization divider	ucDivSync
uint16	45-44	Time of the TCP connection retention	wKeepTCPTime

uint8	46	TCP connection retention	ucKeepTCP
uint8	47	Filter	ucFilter
uint8	48	Smoothing	ucSmooth
uint16	50-49	Filter parameters	wFilterParam
uint16	52-51	Smoothing parameters	wSmoothParam
uint8	53	ROI auto position	ucAP
uint8	54	ROI auto height	ucAH
uint8	55	UDP-stream status	ucUDPStream
uint8	56	Averaging	ucAveraging
uint8	57	Time to reset counters at an external synchronization	ucDropCountersExt
uint8	58	Time to reset counters at an internal synchronization	ucDropCountersInt
uint8	59	Inverting the profile along the axes X and Z	invertXZ
uint8	60	Activating the information packet for the scanner network	localSAPEnabled
uint8	512-61	Reserved	ucReserved[512-61]

26.4. Emergency control protocol

This protocol is used in a case of impossibility to transmit commands over TCP.

The packet of 256 bytes is transmitted to port 62533. The first bytes of that packet is the following structure:

```
typedef struct _UDPI_RFDEVICEEMERGENCYBLOCK_ {
  uint32_t serialnumber;
  uint16_t what;
  uint32_t value;              //
  SHORT_USER_PARAMS shortParams;
} tUDPI_RFDeviceEmergencyBlock;
```

Parameter code	Value
	Valid values for **value**:
0x01	Exposure
0x02	Laser level
0x04	UDP port
0x10	TCP address
0x20	Subnet mask
0x40	UDP address
	Valid values for **what**:
0x06	Reboot the scanner
0x07	Shutdown the scanner
0x08	Switch off the scanner from the network
0x09	Set the laser level
0x0A	Set the exposure time
0x0B	Set the interpolation
0x0C	Turn on the laser
0x0D	Turn off the laser
0x0E	Save user parameters
0x10	Reset user parameters to the default values
0x11	Send the shortened user parameters on the port 62588
0x12	Send to the scanner the shortened user parameters (SHORT_USER_PARAMS) and the parameter code (value) that must be applied

The structure of SHORT_USER_PARAMS:

```
typedef struct _SHORT_USER_PARAMS_
{
  uint8_t what_todo;
  uint8_t laser_level_u8;
  uint16_t exposure_time_u16;
  uint8_t tcp_ip_address_u8[4];
  uint8_t tcp_subnet_mask_u8[4];
  uint8_t udp_ip_address_u8[4];
  uint16_t udp_port_u16;
} SHORT_USER_PARAMS;
```

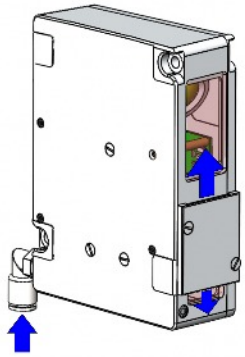
26.5. History of changes of settings packet

FF03:
+ Invert
+ Invert Z
+ Enable the local broadcast packet
FF04:
+ Step / Dir synchronization
FF05:
+ Zero mark (encoder synchronization)
FF07:
+ Added a double-byte divider of sync signals

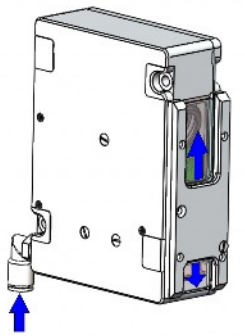
27. Additional options

Scanners come with different optional variants of the configuration:

- Robot cable. Specially to use the scanner in systems with movable parts, in one set with the scanner may be shipped a special flexible cable.
- The airflow system. The airflow system is used to remove the dust, shavings and drops of liquid from the surface of protective windows. The air pressure in the airflow system should be 1..3 atmospheres.



- Removable windows. Removable windows are used to protect the basic windows from the dust, dirt and shavings.



- The cooling system. The cooling system is used to increase the working range of temperatures. There are two types of cooling are available: the air cooling and the water cooling.
- The inbuilt heating system. The heating system of the scanner is activated when the ambient temperature is below than the working temperature of the scanner, and heats air inside the housing up to the working temperature.
- The protective housing. For using the scanner in special temperature conditions and hard industrial conditions, scanners may be equipped with special protective housings, which have additional cooling system and protective windows.

28. Support and order

28.1. Example of designation when ordering

625-(Color)-SMR/MR-XSMR/XEMR-Sync Type-Sync Signal-Sync IN (1..3)-Sync OUT(0..2)-Analog Output-Corner Connector-Cable Type-Cable Length-Heating-AK-EW-AC

Symbol	Description
Color	Red 660 – without symbol, Blue 405 nm or 450 nm – Blue, IR 808 nm – IR
MR	Measurement range for Z, mm
SMR	Start of measurement range for Z, mm
XSMR	X-range at beginning of Z, mm
XEMR	X-range at the end of Z, mm
Sync Type	Synchronization type: BASIC – synchronization by the basic internal timer of the scanner. ENC – synchronization by the encoder signals. STEPDIR – synchronization by the StepDir signals on the external inputs. INOUT – scanners with one sync input and one sync output. FULLSYNC – scanners with three sync inputs and two sync outputs.
Sync Signal	Type of input sync signal: TTL – pulse signal on the one wire referenced to ground. RS422 – differential pair in accordance with the RS422 standard.
Sync IN (1..3)	Synchronization inputs: BASIC – 1 ENC – 3 STEPDIR – 2 INOUT – 1 FULLSYNC – 3
Sync OUT (0..2)	Synchronization outputs: BASIC – 0 ENC – 0 STEPDIR – 0 INOUT – 1 FULLSYNC – 2
Analog Output	Two analog outputs: current or voltage outputs Angle cable connector
Corner Connector	90° – angle of installation Direction – connector direction
Cable Type	Cable type: STANDARD ROBOT – option, robot-cable
Cable Length	Cable length, m
Heating	Inbuilt heating
AK	Air knife option
EW	Removable protective windows option
AC	Cooling option

Example. 625-BLUE-60/35-20/30-BASIC-TTL-1-0-3M – blue laser, start of measurement range for Z - 60 mm, measurement range for Z – 35 mm, X-range at beginning of Z – 20 mm, X-range at the end of Z – 30 mm, sync type BASIC, sync signal TTL, sync in/out 1/0, cable length 3 m.

28.2. Warranty policy

Warranty assurance for the Laser Scanners FDRF625 – 24 months from the date of putting in operation; warranty shelf-life – 12 months.

Warranty repair is not provided in cases of incorrect connection and mechanical damage, including opening the housing.

28.3. Technical support

Technical assistance, related to incorrect work of scanners and to problems with Settings, is free. Requests for technical assistance should be addressed to Althen

Technical support, related to using the scanners, is paid. Technical support includes developing and researching the options of using the scanners, training to work with software tools and libraries, preliminary researches of the possibility to use scanners. Technical support of software is paid. It includes the possibility to add new features into software. To subscribe to a paid technical support, contact Althen.

29. Technical maintenance

The Laser Scanners is virtually maintenance free. As these are optical systems, they are sensitive to dust and sputter on the front windows. Cleaning is best done with a soft cloth. Do not use scratching cleaners or other aggressive media.

It is necessary to remove finger prints from the windows, because finger prints cause degradations in the scan profile.

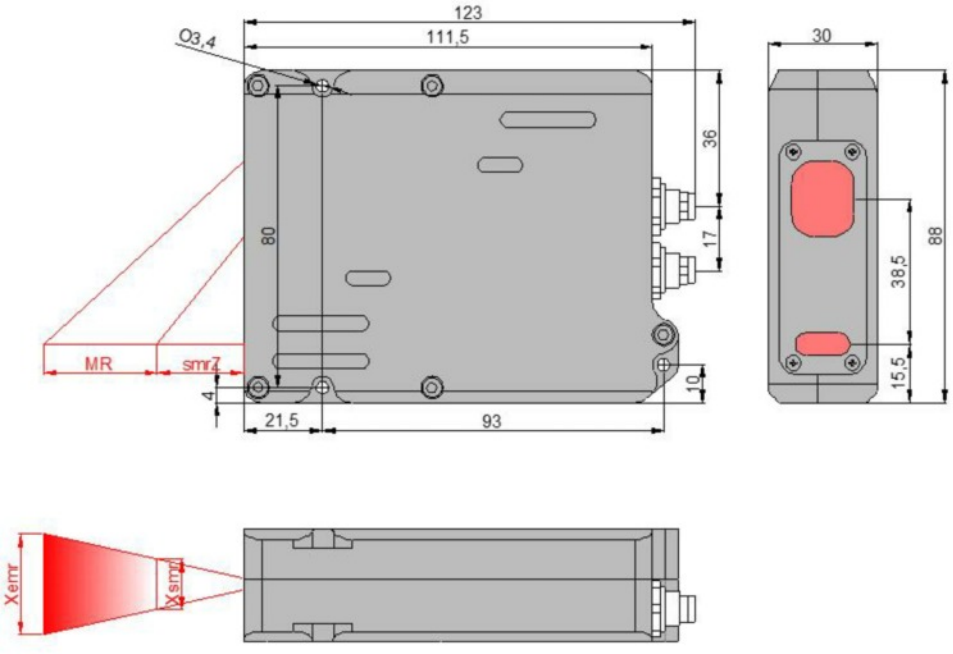
In order to remove finger prints or grease, clean the windows with 20 % alcohol and soft paper.

30. Dimensions and drawings

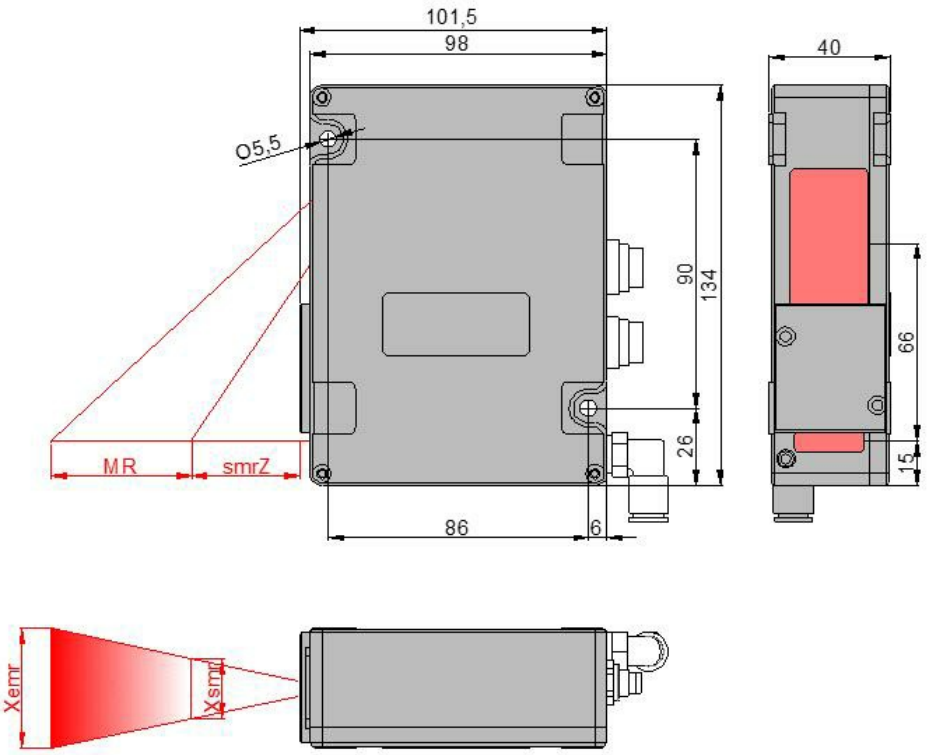
Overall and mounting dimensions of the scanners are shown in Figures below. Detailed CAD documentation (2D and 3D) is available on request.

The scanner housing is made of anodized aluminum. The front panel of the housing has two windows: one is output, the other for receiving radiation reflected from the object under control. The housing also contains mounting holes. Scanners are equipped by two connectors and can be equipped by fittings for air/water cooling system.

Compact version



Standard version



31. List of changes

Date	Version	Description
07.12.2015	2.0.0	Starting document.
06.05.2016	2.1.0	Updated the description of RFClearView. Added p. 29. 'Technical maintenance'.
31.08.2016	2.2.0	Updated the description of RFClearView. Added the description of synchronization types in p. 6.
22.09.2016	2.3.0	Updated the description of RFSDK.
02.11.2016	2.3.1	Removed p. 'Analog outputs'.
22.11.2016	2.3.2.	Updated p. 25. (backup function was removed from the service program).