RIFTEK
Sensors & Instruments

3D LASER MEASUREMENT MACHINE

RF1010SL Series

User's manual

Contents

1. Safety precautions

- Use supply voltage and interfaces indicated in the machine specifications.
- In connection/disconnection of cables, the machine power must be switched off.
- Do not use machine in locations close to powerful light sources.
- To obtain stable results, wait about 20 minutes after machine activation to achieve uniform scanner warm-up.
- Avoid metal chips getting into the machine body.
- Do not allow foreign objects to get between moving and stationary parts of the measuring machine after turning it on.
- Do not obstruct the movement of moving parts of the machine.
- Friction parts of the ball screw assembly should be kept clean and be lubricated.
- The machine should be grounded and connected to ground line via a separate lateral line.

2. Electromagnetic compatibility

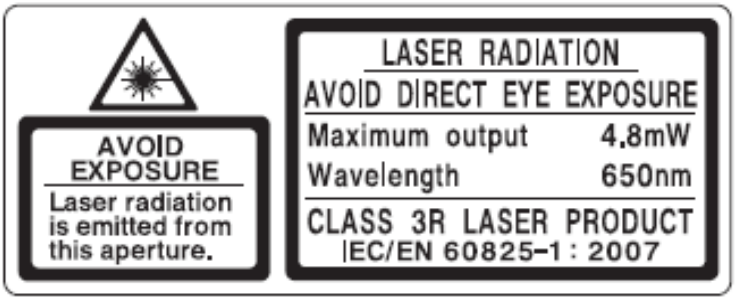
The machine has been developed for use in industry and meets the requirements of the following standards:

- 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 machine makes use of laser scanner. Laser scanner belongs to the 2M laser safety class according to IEC 60825-1:2007.

The scanner makes use of an c.w. 660 nm wavelength semiconductor laser. Maximum output power is 8 mW. The following warning label is placed on the laser body:



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;
- Do not disassemble the laser scanner;
- Do not place any objects that can cause reflection on the path of the laser radiation.

4. General information

The measuring machine is designed for non-contact measurement of geometrical parameters of objects, specifically suspension arms, and is a standalone software/ hardware system.

Technical characteristics of the machine can be changed for a specific task.

5. Structure and operating principle

The work of the machine is based on the principle of 3D laser scanning of object/ objects with subsequent construction of a 3D computer model and determination of geometrical parameters from the model.

The machine structural design is illustrated in Figure 1 (machine with cover removed).

The machine comprises two columns 1,2, closed with the guide 3. The carriage 4, carrying the laser scanner 5, is mounted on the guide 3. Mounted on the column 1 the stepping motor 6 is connected to the ball screw (not shown) that drives the carriage 4. In the extreme positions of the carriage 4 limit switches (not shown) are mounted. There are a signal block 7 and a power supply 8 on the column 2.

Laser scanner 5 radiation is formed in a line and is projected onto the controlled object 9. The resulting image of the contour (cross-sectional profile) 10 of the object is analyzed by a signal processor of the scanner which calculates the distance to the object (Z coordinate of points) for each of a plurality of points along the laser line on the object (X coordinate of points).

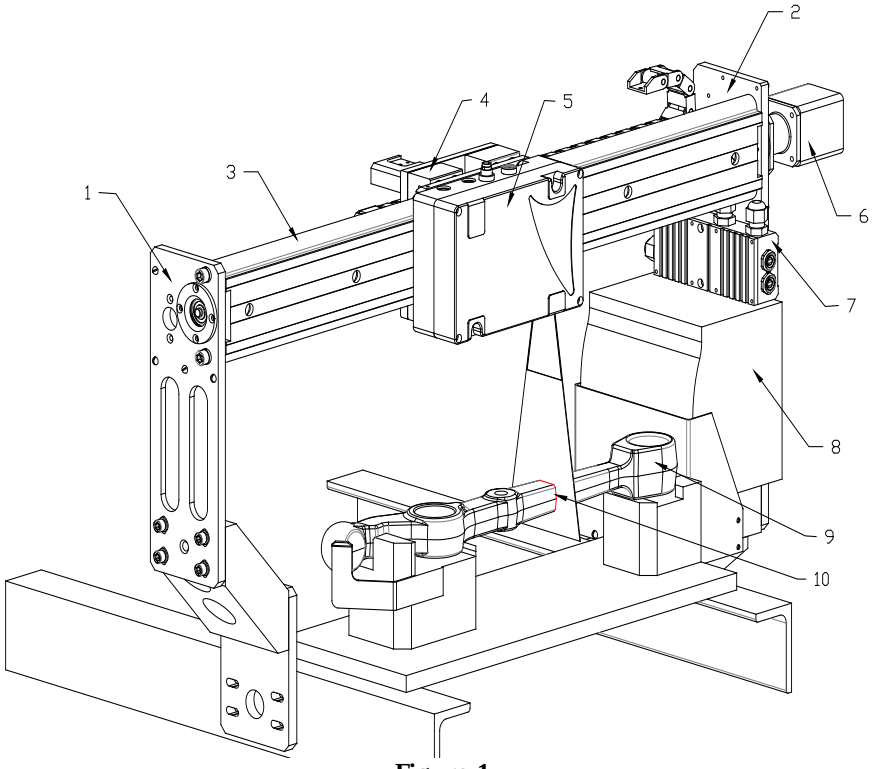


Figure 1

The machine operates as follows.

The laser scanner mounted on the carriage moves along the object, the direction of the movement being the coordinate Y. The laser scanner determines the coordinates of the object profile points (X, Z) at fixed regular linear intervals along the Y coordinate defined by the stepper motor drive, fig. 2.

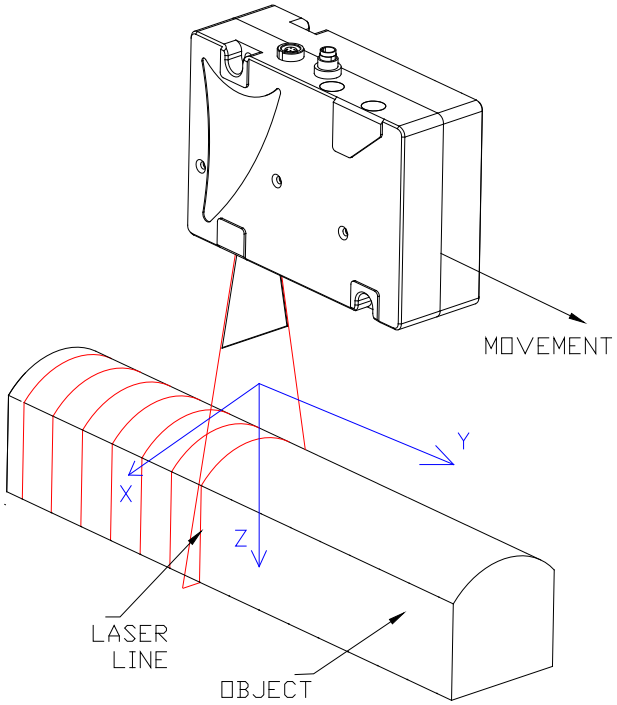


Figure 2

The result is a 3D computer model of the object in the form of Point Cloud with established profile coordinates (X,Y,Z). An example of the model is shown in Figure 3. The required geometrical parameters are calculated from the resulting object model.

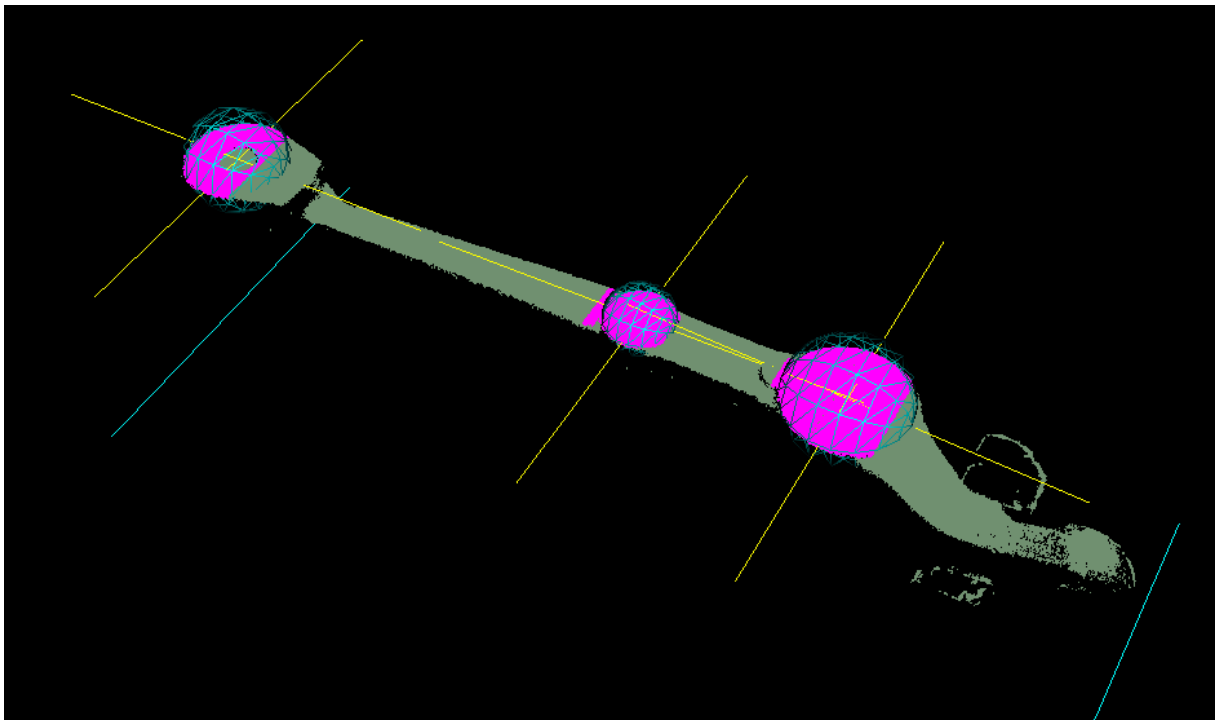


Figure 3

6. Basic technical data

Parameter	Value
Scanning range Y-axis, mm	370
Scanning range, Z-axis, mm	135
Scanning range X (start of measurement, Z-axis), mm	45
Scanning range X (end of measurement Z-axis), mm	70

Measurement accuracy, X,Z axes, um	±50
Measurement accuracy, Y axis, um	±20
Sampling rate, profiles/s	250
Speed, mm/s	
Parameters under control	see point 10.1.2.
Dimension, mm	730x415x180
Weight, kg	40
Power supply	alternating-current mains with sampling rate (50 ± 1) Hz, nominal power 220 with allowable stress ±10 %.
Power consumption, W	300
Environment conditions	Environment temperature: +1..+35°C Relative humidity 25-65%

7. Dimensions

The dimensions of the machine are shown in the figure 4.

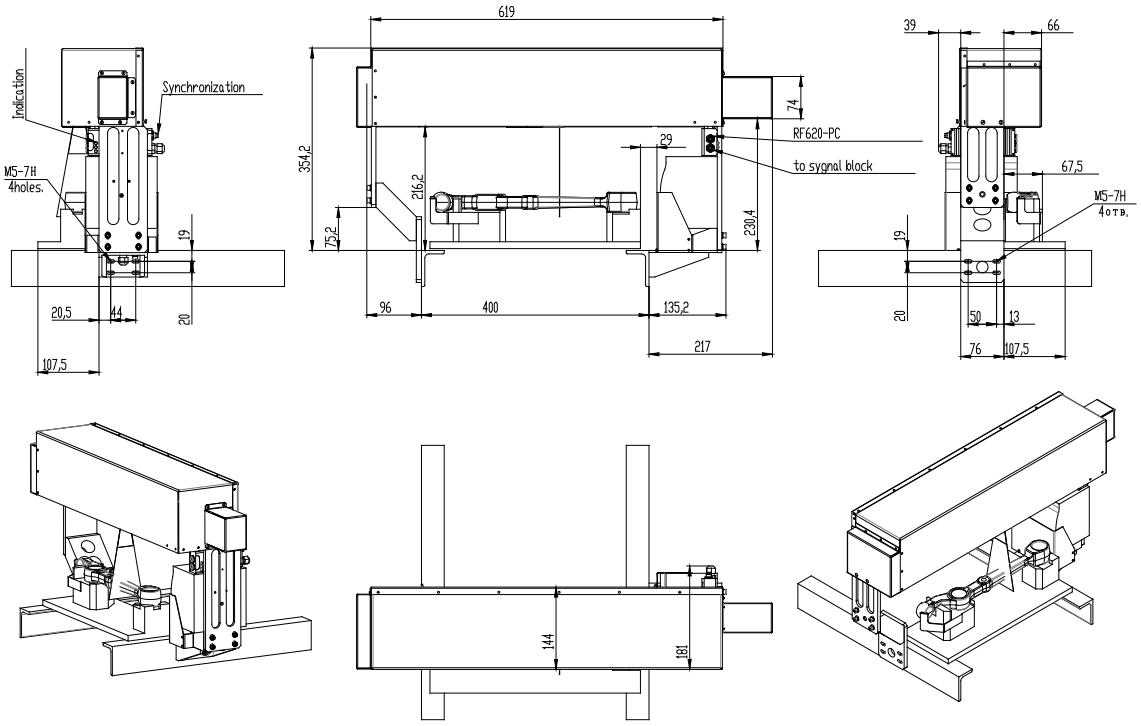


Figure 4

8. Mounting and setup

To reduce the volume of adjustment work measuring machine is delivered fully assembled.

Installation of the machine on a conveyer belt is made as follows.

In the conveyer frame screw holes (M5-7H) are made as per the scheme. Marking the holes is made from pallets, located in the measurement area, according to the figures 5 and 6.

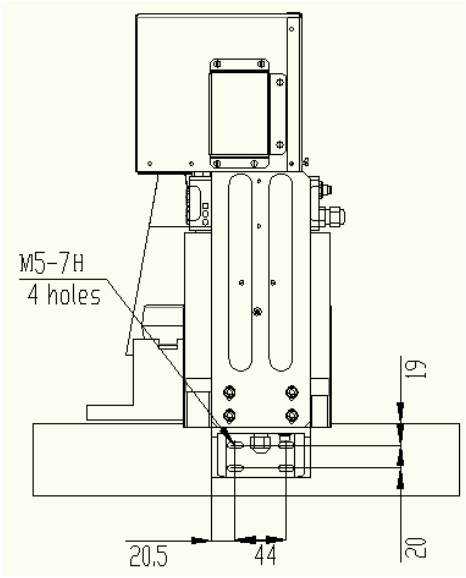


Figure 5

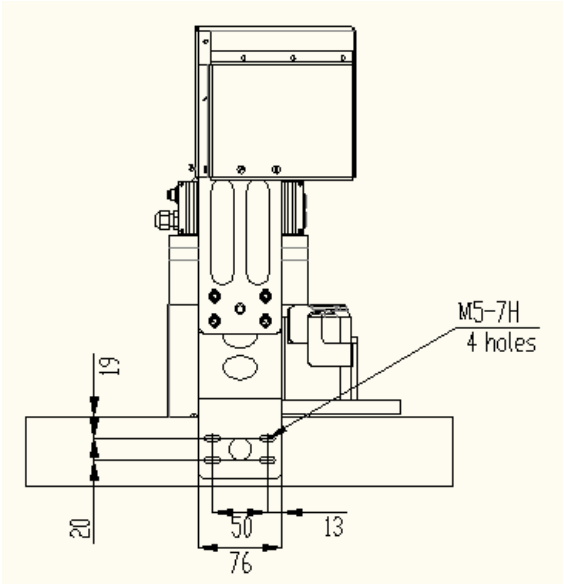


Figure 6

At the measuring station mounting screws are loosened, providing horizontal motions of the support bracket, fig. 7,9.

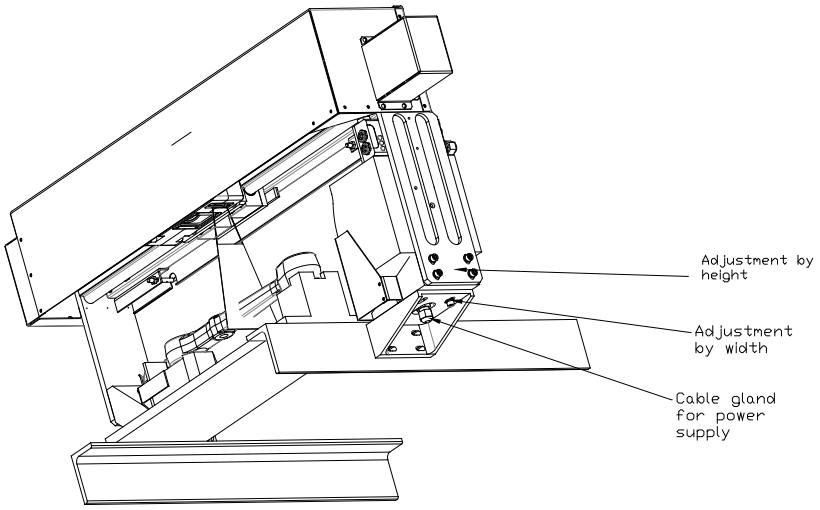


Figure 7

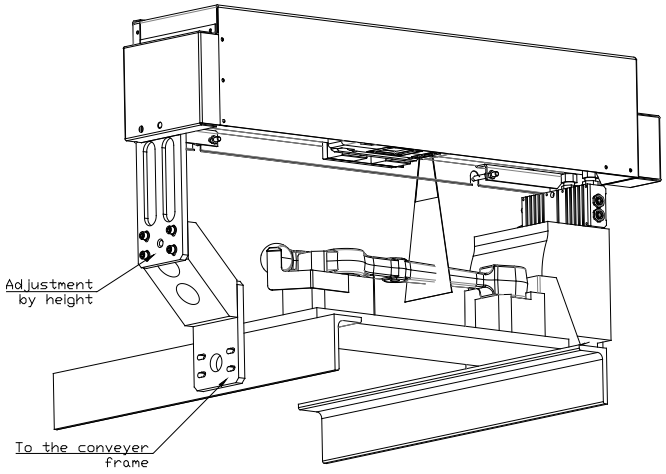


Figure 8

Next is the station installation on the conveyer frame using M5 screws. After the station is installed it should be located at the distance from the conveyer according the installation dimensions, figure 4.

9. Connection diagram

Connection diagram is shown in Fig. 9.

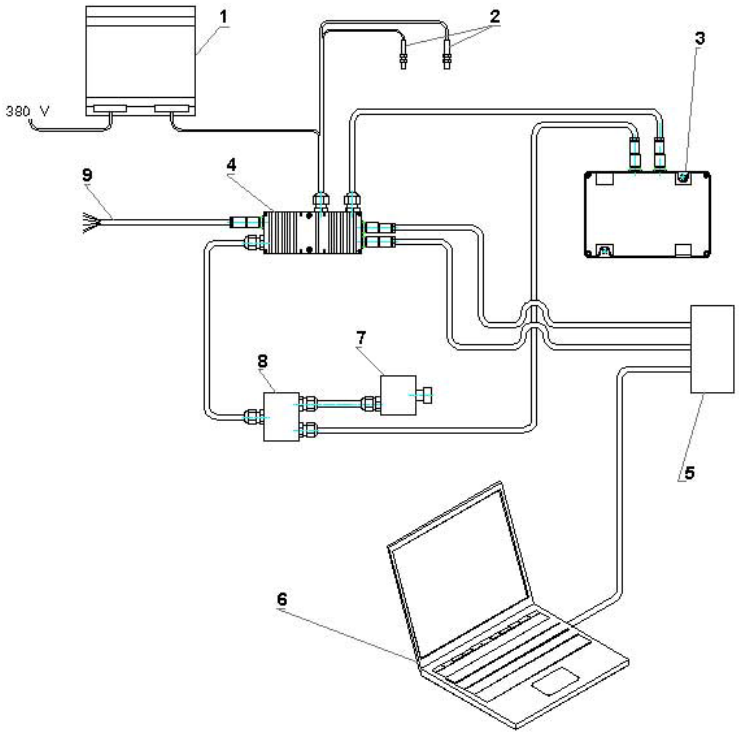


Figure 9

Where 1 – power supply; 2 – limit switches; 3 – laser scanner; 4 – signal block; 5 – network router; 6 - terminal (PC); 7 – stepper motor; 8 – switching unit; 9 – synchronization and signaling machine condition cable.

9.1. Signal block

All interface connections to the machine are implemented via the signal block. 3 LEDs duplicating digital output status are located on the panel of signal block.

9.1.1. Connection diagram.

Connection to signal block is shown in Figure 10.

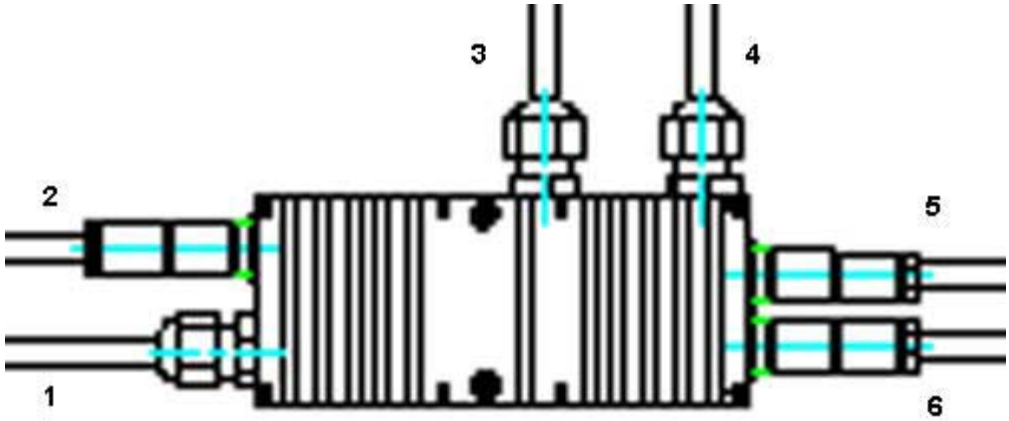


Figure 10

Where 1 – stepper motor to laser scanner connection (cable entry); 2 - synchronization and machine condition digital outputs connection; 3 – power and limit switches connection (cable gland); 4 – network interface of the laser scanner connection (cable gland); 5 - network interface to the router scanner connection (connector); 6 – signal block network interface to the router connection (connector).

9.1.2. LED indication

LED indicators, located on the signal block characterize the current state of the measuring machine and the result of measurement:

Machine condition	Indication
System is ready	Green
Measurement process	Yellow
Failure	Red
Valid detail	Flashing green
Rework	Flashing yellow
Waste	Flashing red

9.1.3. Interface cables

System signals cable 9 is shown in the Figure 11.

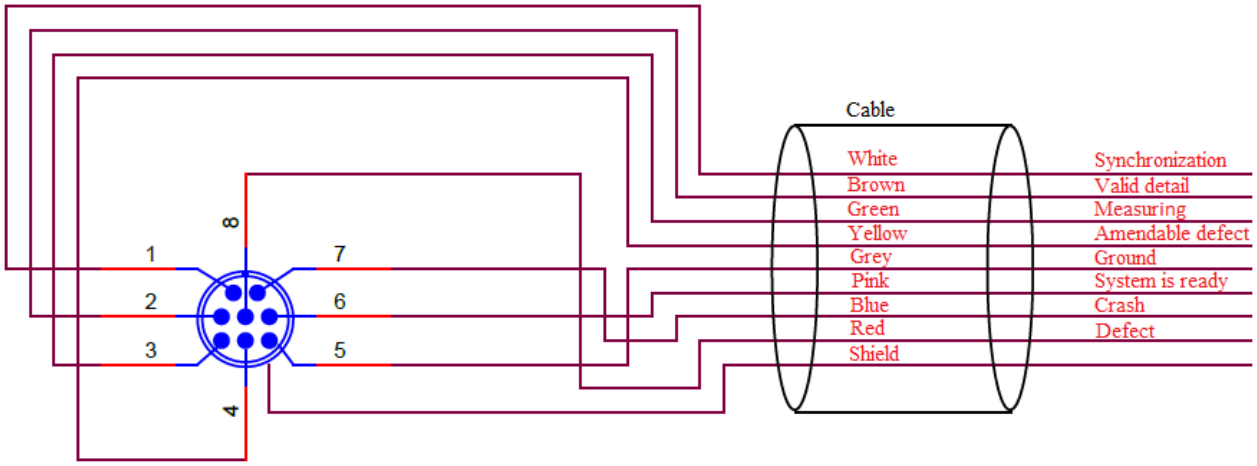


Figure 11

Laser scanner connection cable is shown in the Figure 12.

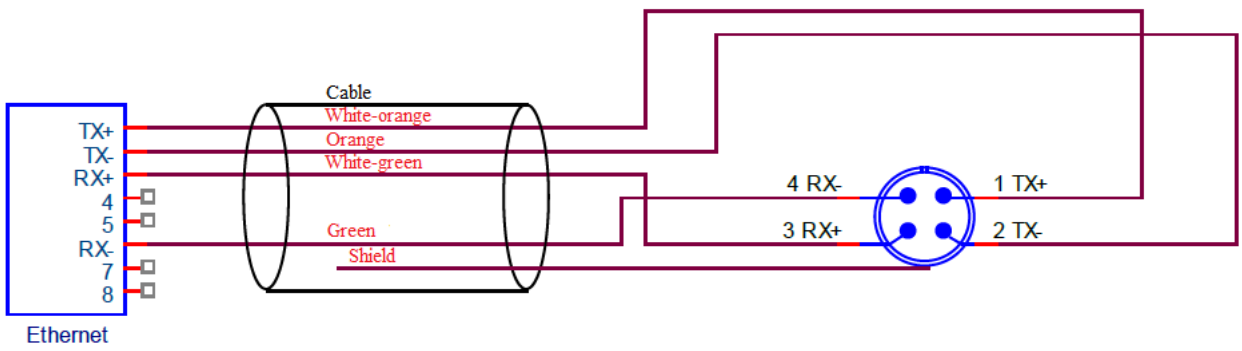


Figure 12

9.1.4. Input-output circuitry

Trigger input stage is shown in Figure 13. Synchronization input is designed to alarm of object on the measuring position.

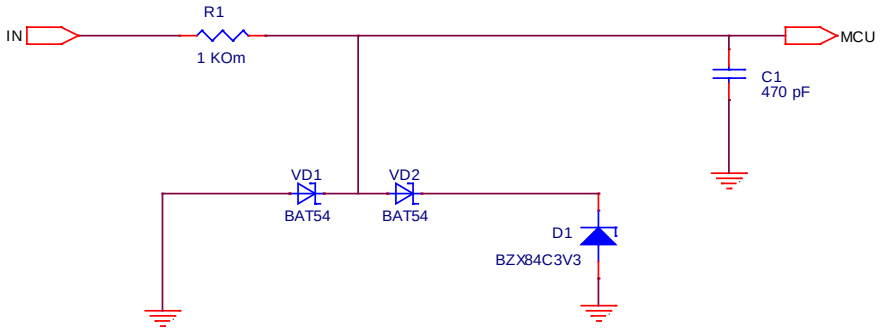


Figure 13

The output stage of the machine condition output is shown in the Figure 14. The outputs are used to connect external alarm and actuators.

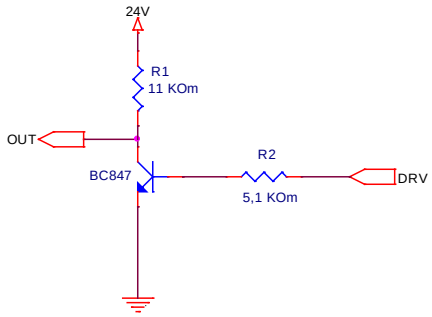


Figure 14

10. Software

The software is implemented to run on the operating system Windows XP, Vista, 7. Qt-library version 4.8.0 Microsoft redistributable package 2010 is used in the software.

Software consists of 4 components:

- Scan control RFScanDetail.exe,
- Statistics details viewer RFStatViewer.exe
- Signal block testing TestSignalBlock.exe
- Scanner setup and test rf620et-sp.exe

Additional applications that may be needed to set up and debug the scanner:

- Wireshark network analyzer
- DHCP server

10.1. Scanning Control

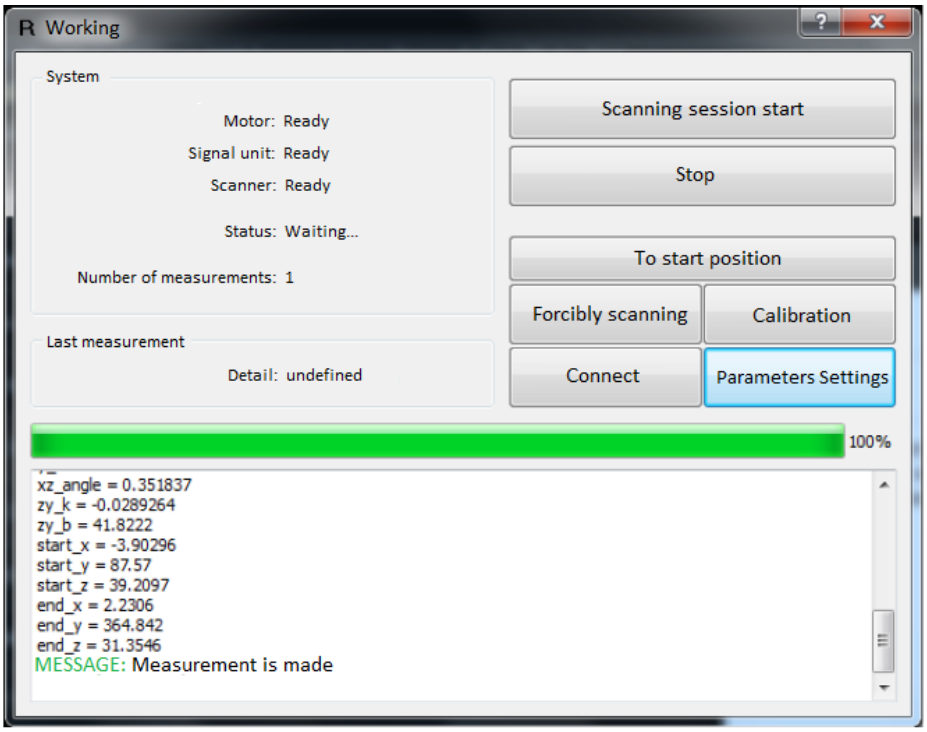
The scanning control application provides:

- control of the machine in working process and debug modes
- receiving data from scanner and three-dimensional detail model construction
- detail model mathematical calculation
- input tolerances and setting calculation parameters
- assessment of detail state and comparison with tolerances
- logging events and results
- machine status control
- signal block management
- calibration of the machine

10.1.1. Machine Control

Operating window of the application is shown in the figure below. Control buttons are located in the right part of the window.

Being started the application automatically searches for the devices of the measuring machine in the network and connects to them. If the devices aren't connected to the network when the application is started, the process can be started forcedly by pressing the **Connect** button.



If all the devices are found, the scanning session starts automatically. Scanning session can be stopped via pressing the **Stop** button.

The machine state is displayed in the title bar of the application: **Working** - scanning session is started, **Stopped** - scanning session is stopped. If the session is stopped the measuring process can only be started forcibly from the app via the **Forcibly scanning** button.

The scanning session can be started again via the **Scanning session start** button.

When the scanning session is disabled the system calibration can be performed via the **Calibration** button.

Measurement parameters can be configured at any time while the application is working via the **Parameters Settings** button. But the changes will take effect only after restarting the application.

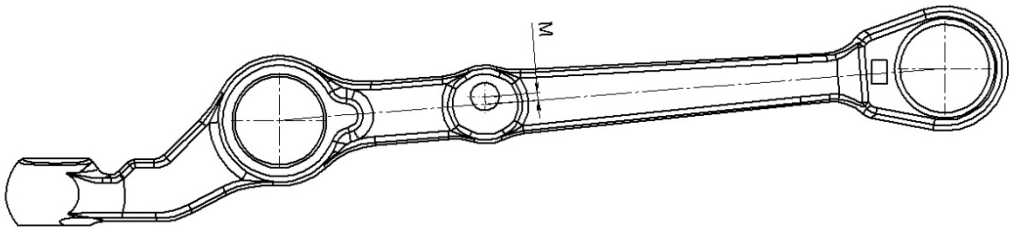
The basic devices (namely, scanner movement drive, signal block, laser scanner and counter of measured items) status is displayed in the central part of the window.

In the bottom part of the window the calculation results of the last scanned detail and validity evaluation (namely, valid, spoilage and rework) are displayed.

10.1.2. Calculations

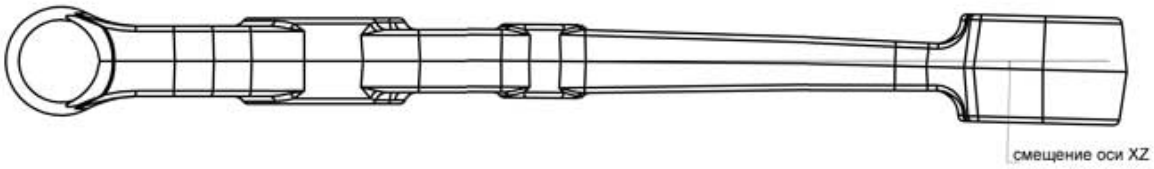
The scanning control application performs the next set of calculations:

- Calculation of the axis displacement in the XY-plane as



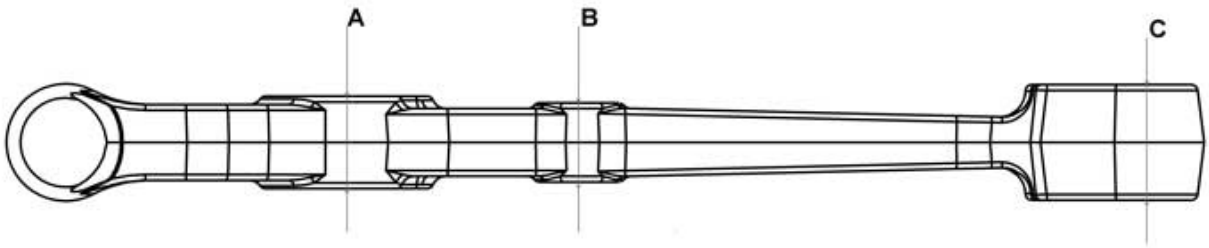
deviation of the central elbow axis position from the axis connecting centers of the two extreme elbows, mm.

- Calculation of the axis displacement in the XZ-plane as



maximum angle (in degrees) between the lines that run along the upper landing of the three elbows,. That is, the angle difference is calculated pairwise between the three lines taken. Displacement of the axis is the maximum difference of the angles.

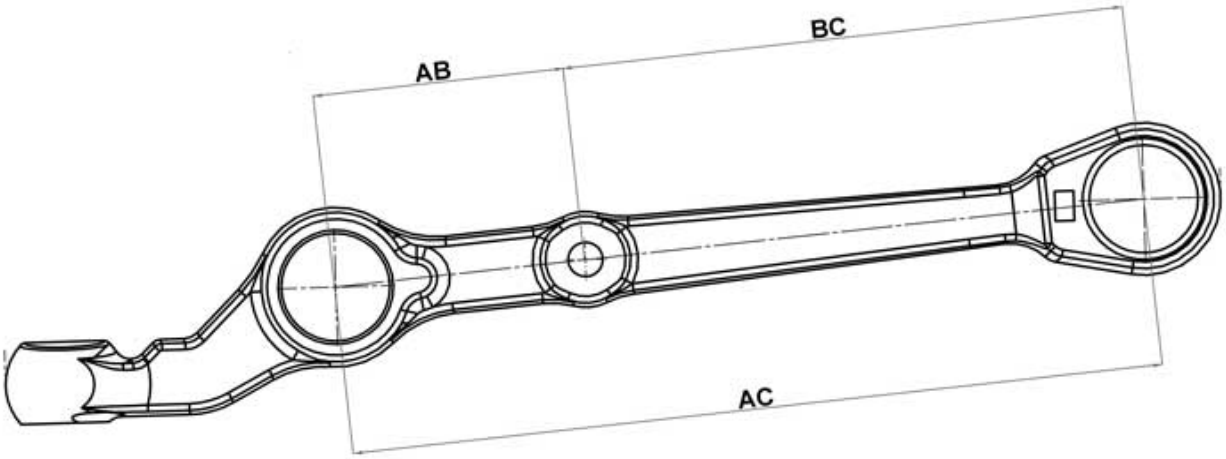
- Detail width calculation in A,B and C positions



Detail width in A and C positions is calculated according to the calibration data. The calculation is based on the line passing through the center of the visible part of the calibration block. The height of the A and C elbows is compared with the height of the calibration block at A and C points. Then from the nominal value of the calibration standard height the difference between the elbow height and the calibration standard height is subtracted. The obtained result is the elbow height.

The elbow width in B position is calculated on the basis of the widths of the elbow A and C. The central axis of the detail is reproduced on the basis of the A and C widths. The width of the elbow B is calculated from the central axis and the height of the elbow B.

- Distances AB, BC and AC calculation



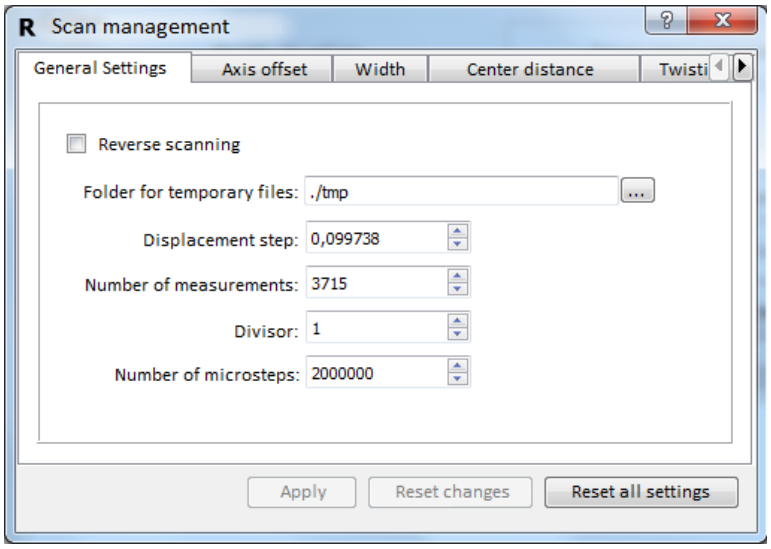
The distances between the axes A, B and C in XY-plane are calculated.

- Detail twisting calculation

The maximum angle between the lines running along the upper landing of three elbows perpendicular to the detail axis is calculated, degrees. That is, the difference between the angles of these three lines is calculated pairwise. Detail twisting is the maximum difference of the angles.

10.1.3. Input tolerances and setting calculation parameters

To enter the setup mode press the **Parameter Setting** button in the main window of the application. The settings window contains several tabs.

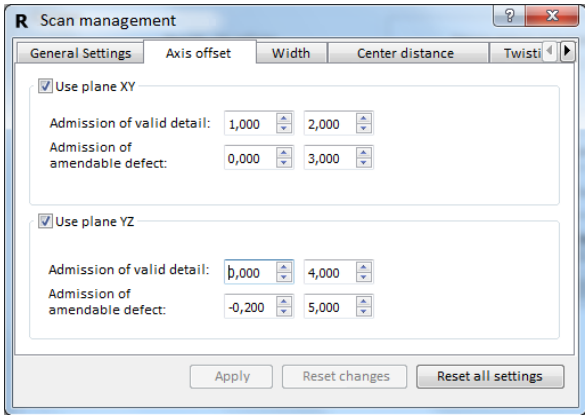


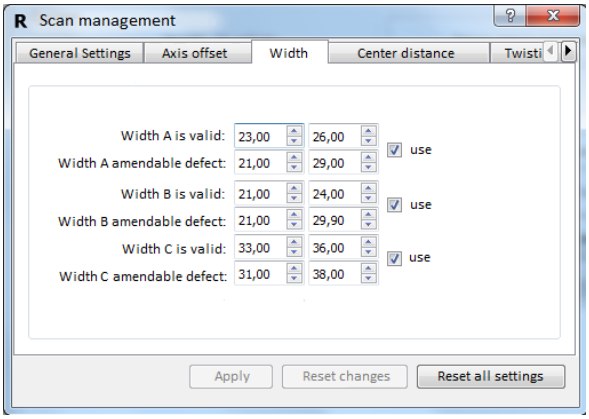
Tab **General Settings.**

- turn on the reverse scanning when scanner movement direction need to be reversed
- folder for temporary files – set the pass to store temporary files if necessary
- displacement step, number of measurements, divisor, number of microsteps – factory defaults are shown

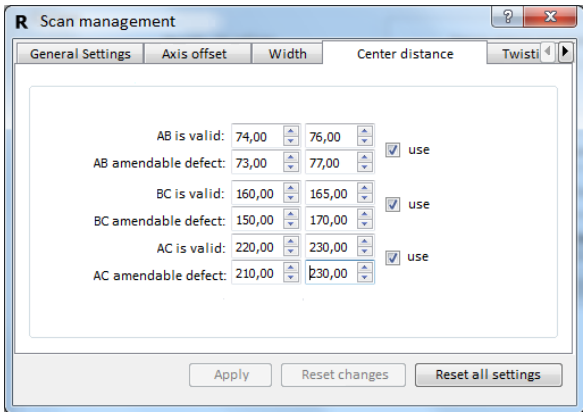
The other tabs are designed for the input of tolerances. The logic of the signaling LEDs and the logic output of the synchronization unit will comply with the established tolerances.

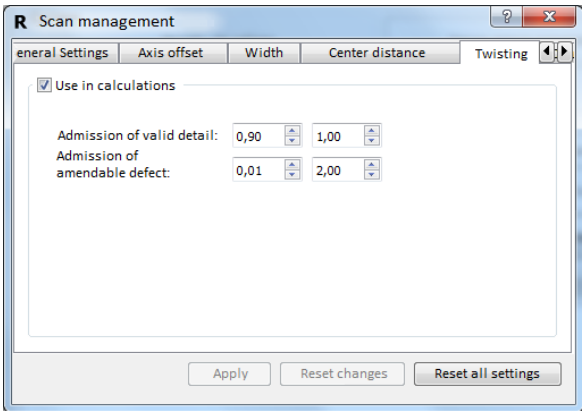
Tabs **Axis offset** and **Width**





Tabs **Center distance** and **Twisting**





10.1.4. Logging events and results

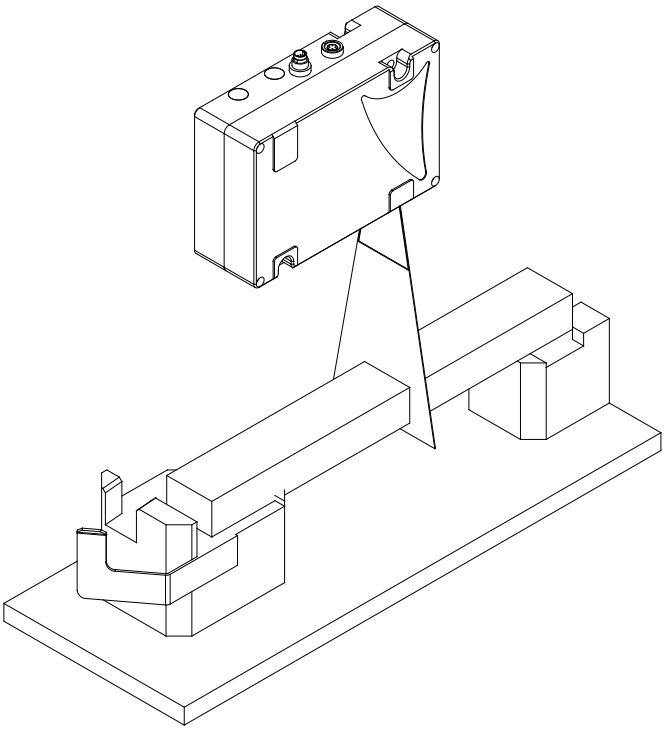
During operation of the machine the scanning control application conducts event logging to the files **system[index]** in the **/Log/** folder. The file title contains an index, when exceeding the current file size a new log file with the index for 1 bigger than the previous is created.

The results of processing the model of the detail as well as the accidents are logged to the database. The database is implemented on the basis of **splite**. Database files are stored in **[month].sqlite** files, where **month** is the number of the current month. That means all entries in a month are stored in a single file. All database files are stored in the folders form **/[year]/**, where **year** is the number of current year. All the data belonging to the particular year measurements are in the same appropriately named folder. According to these data the statistics viewer builds statistical reports. All data can be transferred for analysis to another computer preserving the folder structure.

When the application is working the initial scanning data three-dimensional models in the ***bin** format are recorded in the temporary directory **/tmp/**. The address of the temporary folder is specified in the program settings. The files formed in this folder can be used for detailed analysis of the calculation faults, development of the new and correction of the existing calculations.

10.1.5. Calibrating the machine.

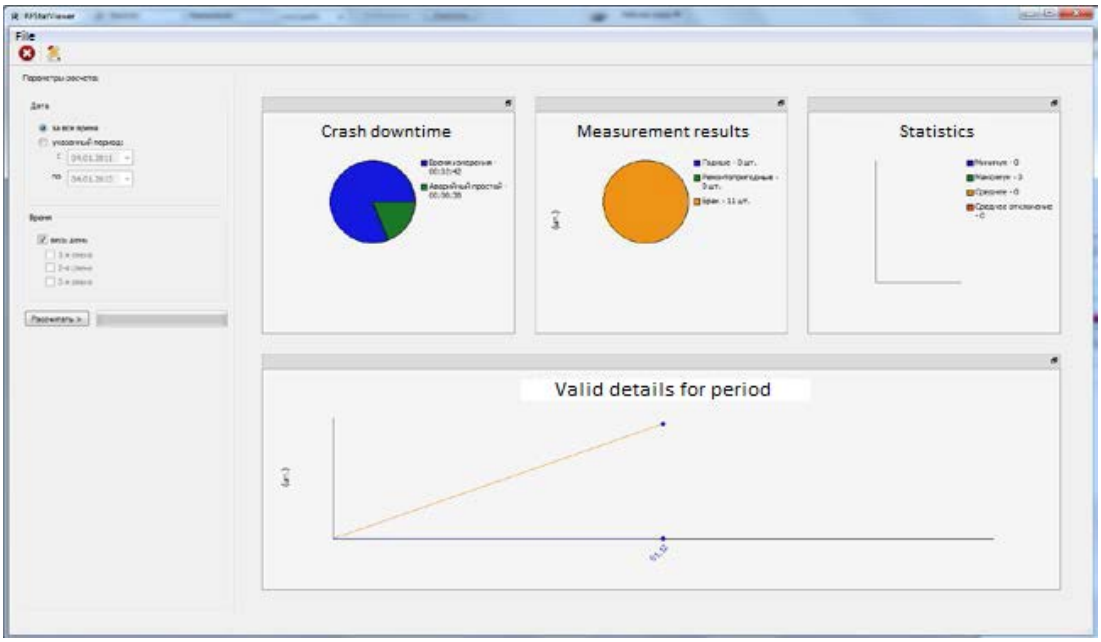
To calibrate the machine install the calibration block (supplied rectangular specified sizes block) in the control position, see the Figure below.



In the main window of the application click **Calibrate**. After the block is scanned the machine is ready for operation.

10.2. Detail statistics viewer

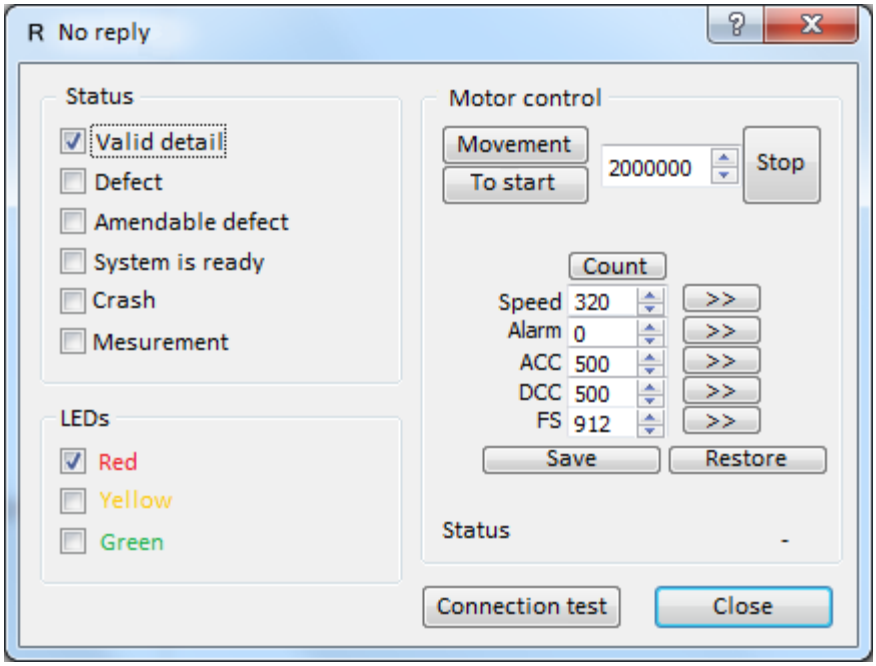
To view the statistics of measurements run **RFStatViewer.exe.** The main window of the application is shown in the Figure below.



The application allows to generate statistical reports for a given period of time.

10.3. Signal block testing application

To test the signal block run **TestSignalBlock.exe.** The main window of the application is shown in the Figure below.



Condition Group enables to test the logic outputs, **LEDs** Group tests LED performance. To test the movement system set the number of steps and click **Move**. To return the carriage in the initial position click **Ini Position**. The other parameters are shown informative.

11. Intended use

11.1. Preparation for use

Preparation the machine includes:

- external inspection;
- set up on a conveyer;
- switching the machine;
- calibrating the machine;
- checking the machine.

11.1.1. External inspection

Before operating it is needed to ensure of the serviceability of the equipment, check the cables, ground wires. Check the condition of output windows of the scanner and, if necessary, wipe them with a soft cloth.

11.1.2. Set up on a conveyer

Install the machine on a conveyer according to the Paragraph 8 of this manual. Make the electrical connections in accordance with the Paragraph 9.

11.1.3. Switching the machine

11.1.4. Calibrating the machine

Calibrate the machine according to the Paragraph 10.1.5. Setting calibration should be held on a daily basis before the work shifts.

11.1.5. Checking the machine

To check the functionality of the machine conduct a full cycle control of the geometrical parameters of the control sample detail. It is recommended to conduct at list one functional test of the machine at the beginning or during the shift.

11.2. Operating the machine

The geometric parameters measurement cycle is fully automated and operation of the machine is reduced to the work with the program.

- run the machine control application
- add/control the tolerances according to the Paragraph 10.1.3
- when getting the synchronization signal the machine performs the scanning of the detail, calculation of the geometrical parameters and grading
- after the scanning the carriage automatically returns to the starting position and the machine waits for the next synchronization signal

12. Maintenance

12.1. General instructions

Maintenance of the machine is carried out to ensure constant-ready status and continued availability of its work and to prevent premature failure. Maintenance includes preventive measures aimed at identification and elimination of defects and to ensure the normal operation while installation and working. It is recommended to conduct the daily, weekly and annual maintenance work.

12.2. Safety precautions

During the installation maintenance security measures outlined in the Paragraph 1 should be observed.

12.3. Maintenance procedure

12.3.1. Daily maintenance work

Daily maintenance includes:

- visual inspection of the machine,
- checking of completeness,
- inspection of the units and elements that make up the machine,
- checking for any damage of the structural elements, power and instrument cables, indicators and connectors,
- weakening of screw connections and insulation failures,
- before starting work, it is necessary to wipe the input and output laser scanner windows with a soft dry cloth.

12.3.2. Weekly maintenance work

Weekly maintenance includes:

- cleaning of laser scanner windows with a dry soft lint-free cloth from contamination of dirt;
- checking of free movement of the carriage.

12.3.3. Yearly maintenance work

Authenticated calibration of the laser scanner should be made once a year

12.4. Operability test

It is recommended to conduct the functional test at least once at the beginning or during the shift, for what it is necessary to complete full cycle control of the geometrical parameters of the control sample (not supplied).

13. Routine repairs

Possible troubles and trouble-shooting instructions are given in the following table.

Troubles	Possible cause	Corrective actions
Incorrect measurements	The influence of an external illumination source	Remove the external source or protect the controlled item from its influence.
	Wet surface of the detail with the drops of coolant and water	Remove the drops of coolant and water
	Laser scanner window pollution	Clean the scanner window
	Malfunctions of the software	Reboot the computer
	The detail is unsuitable for the control	Remove any external objects or coatings from the surface of the detail
	Scanner displacement	Calibrate the machine
Other		Contact the manufacturer

14. Warranty policy

Warranty assurance for the 3D Laser measurement machine RF1010SL – 24 months from the date of putting in operation; warranty shelf-life - 12 months.