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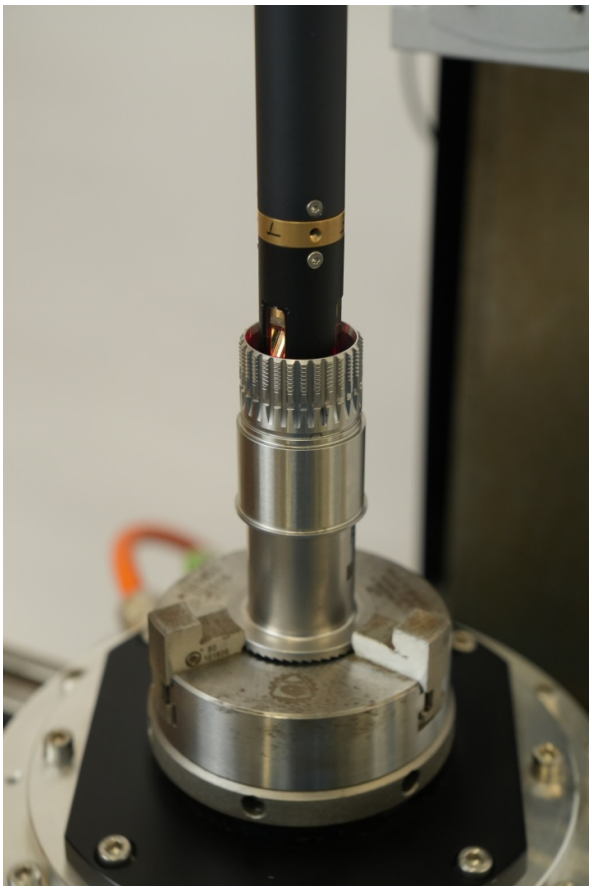

MULTISENSOR INNER DIAMETER MEASUREMENT SYSTEM

RF040-3-20/27 Series

User's manual

www.riftek.com
info@riftek.com

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1. Safety precautions

- Use supply voltage and interfaces indicated in the system specifications.
- In connection/disconnection of cables, the system power must be switched off.
- Do not use the system in locations close to powerful light sources.
- The system must be grounded.

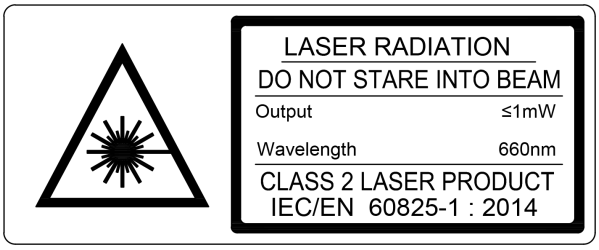
2. CE compliance

The system has been developed for use in industry and meets the requirements of the following Directives:

- EU directive 2014/30/EU. Electromagnetic compatibility (EMC).
- EU directive 2011/65/EU, "RoHS" category 9.

3. Laser safety

The sensors make use of c.w. 660 nm wavelength semiconductor lasers. Maximum output power is 1 mW. The system belongs to the 2 laser safety class according to IEC/EN 60825-1:2014. The following warning label is placed on the system body:



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

- Do not target a laser beam to humans.
- Avoid staring into a laser beam.
- Do not disassemble the system.

4. General information

The system is designed for non-contact measuring of inner diameter of the bushing hole. The system is used on the production line as the quality control tool.

5. Basic technical data

Parameter		Value
Diameter measurement range, mm		20...27
Measurement accuracy, um		±2
Measurement rate, internal diameters per second		2000
Light source		red semiconductor laser, 660 nm wavelength
Output power, mW		<1
Laser safety class		2 (IEC60825-1)
Output interface		RS485
Power supply, V		9…36
Power consumption, W		3
Environmental resistance	Enclosure rating	IP67
	Vibration	20 g / 10…1000 Hz, 6 hours for each of XYZ axes
	Shock	30 g / 6 ms
	Permissible ambient light, lx	3000
	Relative humidity, %	5-95 (no condensation)
	Operating ambient temperature, °C	0…+45
	Storage temperature, °C	-20…+70
Housing material		aluminum, brass
Weight (without cable), gram		250

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

6. Example of item designation when ordering

RF040-3-Dmin/Dmax-L

Symbol	Description
Dmin	Minimum measurement diameter, mm
Dmax	Maximum measurement diameter, mm
L	The laser head length

Example: RF040-3-20/27-450 – Multisensor Inner Diameter Measurement System RF040-3, measurement range - 20...27 mm, length = 450 mm.

7. Structure and operating principle

Operation of the system is based on the hole surface coordinates measurement by point laser triangulation sensors.

The system contains laser head with three sensors RF609 Series (https://riftek.com/upload/iblock/dcd/l3sf08x62c0sbr0jmv6f27u8qcenpah5/Laser_Probes_RF609_and_RF609Rt_Series_eng.pdf) located around the circumference in one housing at an angle of 120 degrees to each other (see Figure 1).

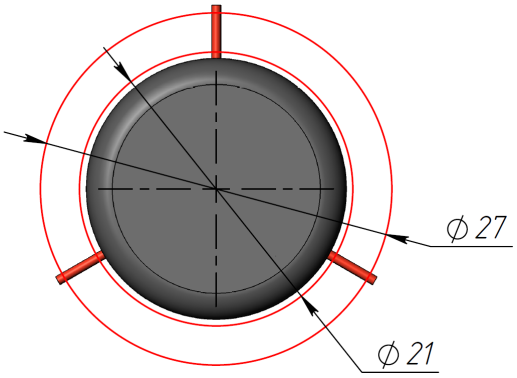


Figure 1. The laser head with three triangulation sensors

Overall and mounting dimensions of the laser head are shown in Figure 2.

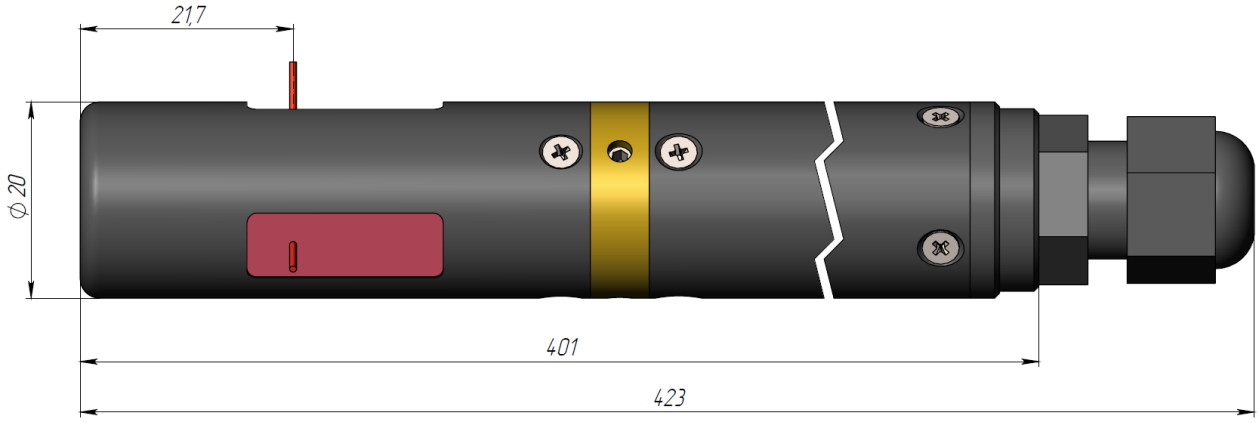


Figure 2. Overall and mounting dimensions of the laser head

Overall and mounting dimensions of the communication module are shown in Figure 3.

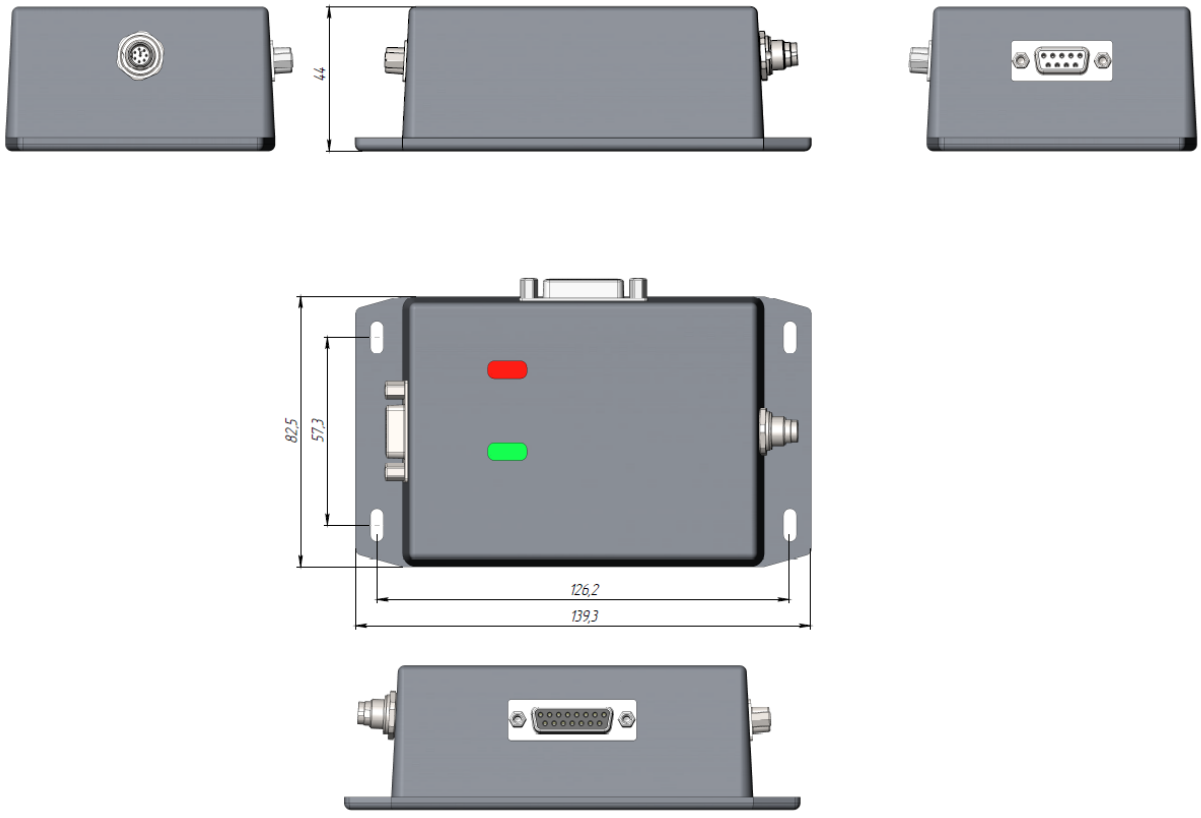


Figure 3. Overall and mounting dimensions of the communication module

The system operates as follows.
The laser head connects to the computer via a communication module.
The controlled shaft is set in rotation.
The laser head is inserted into the hole and moved by translation module to the definite position inside the hole.
Laser sensors measure distances to the hole inner surface synchronously with the shaft angle of rotation.
Data from the laser head is transmitted to the computer via a communication module
The program calculates inner diameter of the hole.

8. Overall demands for mounting

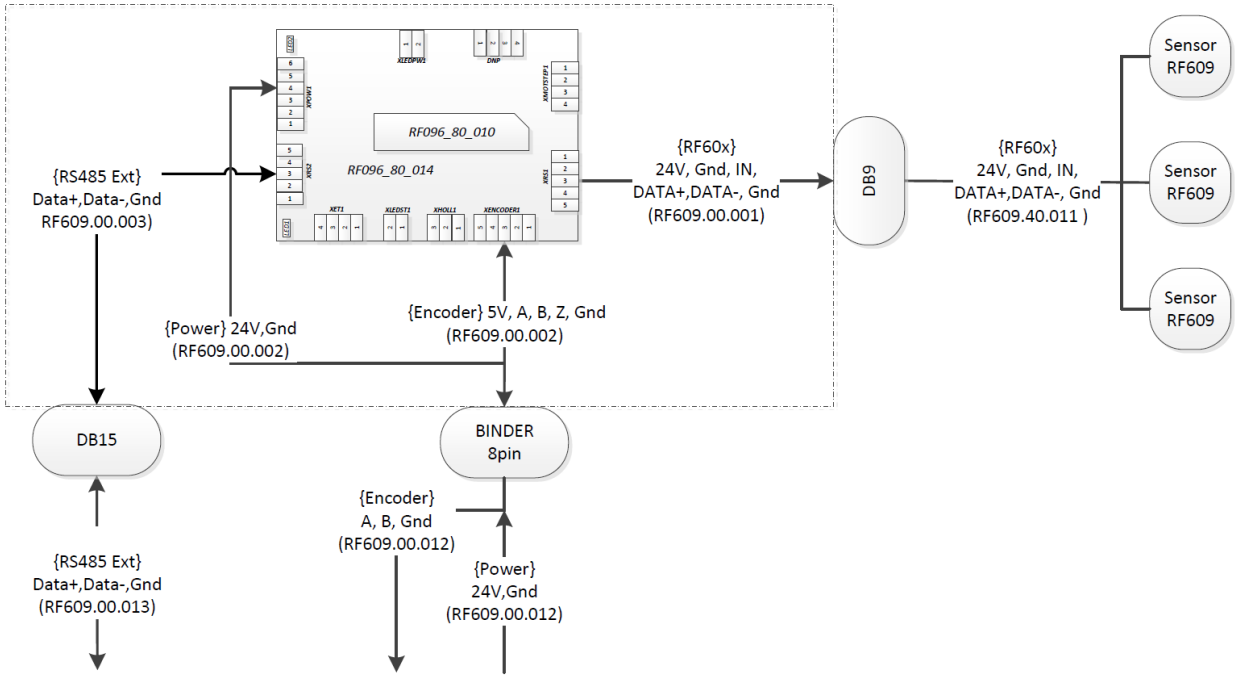
The system is positioned so that the object under control has to be placed within the working range of the system.

ATTENTION!
The system must be grounded – static electricity may cause the failure of electronic components.

9. System connection

9.1. Structural diagram

The structural diagram of the system is shown in the figure below



Communication module contains three connectors:
1. DB9 for connection with laser head.
2. DB15 for connection with computer.
3. Binder for connection of encoder of the shaft rotation table and supply voltage.

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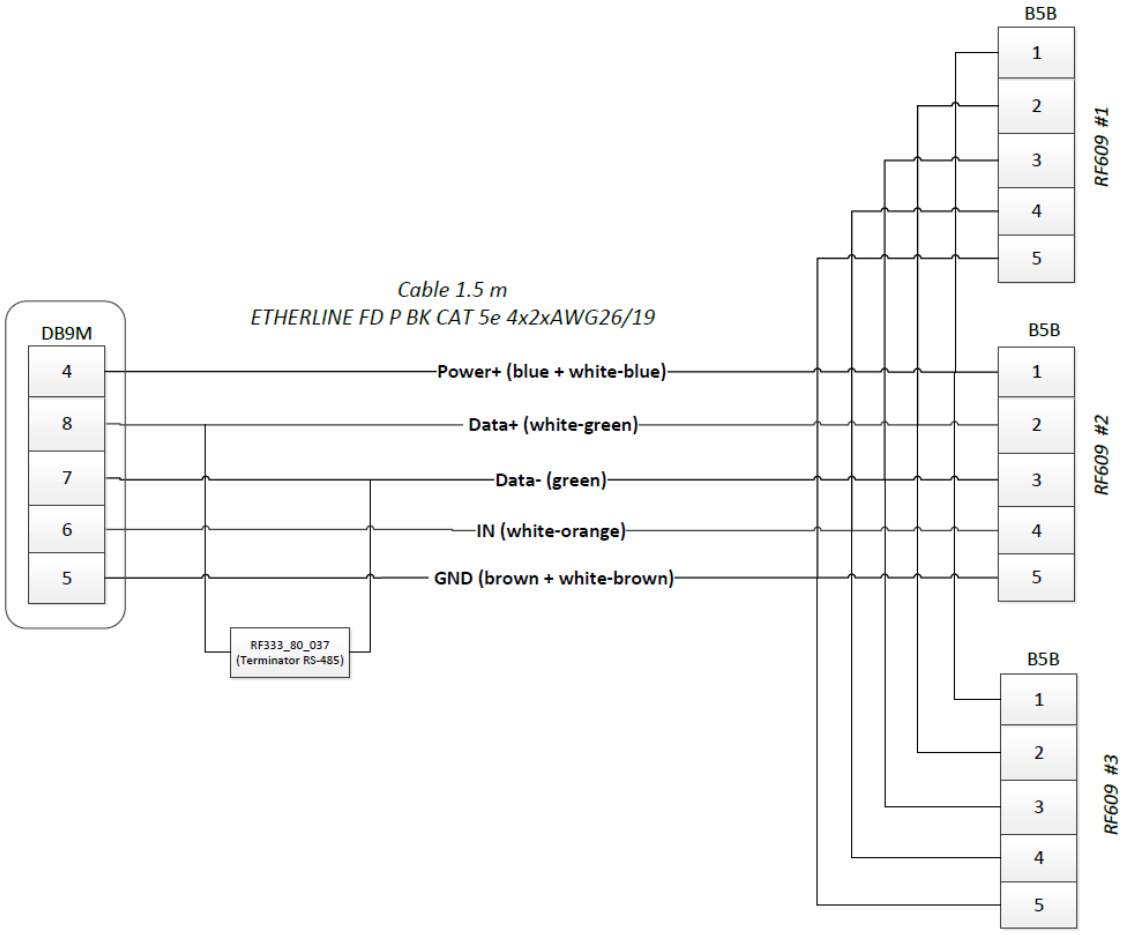
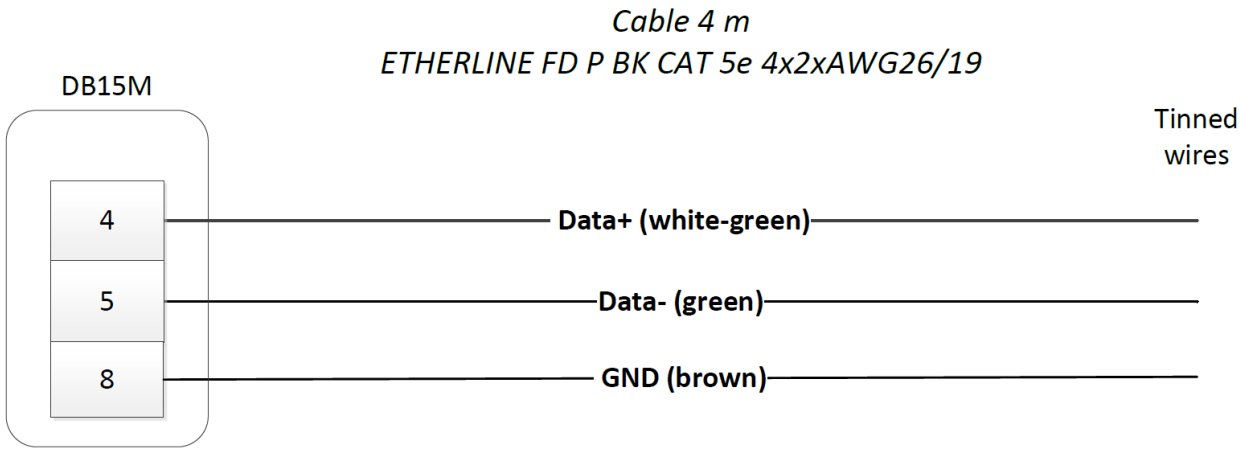
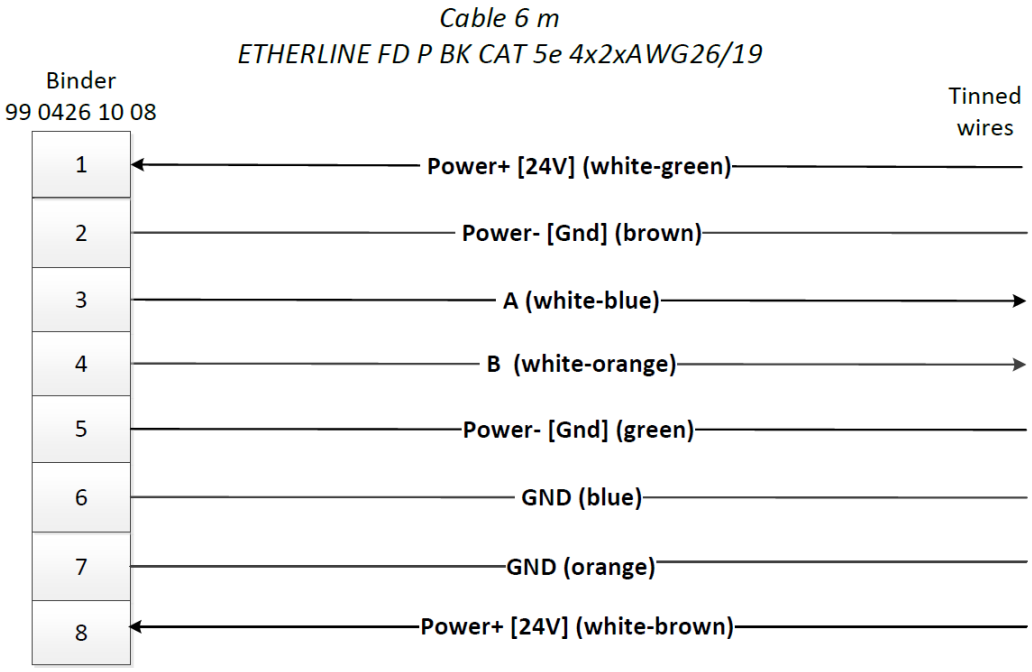
9.2. Laser head cable



9.3. Computer cable



9.4. Encoder cable



10. Intended use

10.1. Preparation for use

The preparation involves the following steps:

- Visual inspection.
- Installation and connection.
- Switching the system.
- Calibration.

10.1.1. Visual inspection

- Check the system for completeness and absence of damage.
- Check the cables and ground wire.
- Check the condition of output windows and, if necessary, wipe them with a soft cloth.

10.1.2. Installation and connection

- Install the system on a robot or linear translation module.
- Make all required electrical connections.

10.1.3. Switching the system

Feed power to the system – 24 V.

10.1.4. Calibration

System calibration is performed before the start of measurements and, if necessary, during measurements at intervals determined by the technological process. The calibration procedure is described below.

10.2. Operating the system

The measurement process is fully automated and operation of the system is reduced to the work with the software.

11. Control software

11.1. General information

The control program is intended for:

1. Sensor control during measurement and calibration.
2. Reading raw data from the sensor and processing it.
3. Interacting with user software via the TCP protocol.

To launch, you need to unzip the archive named "rf609.zip" with the program to your computer's hard drive and run the executable file "rf609.exe".

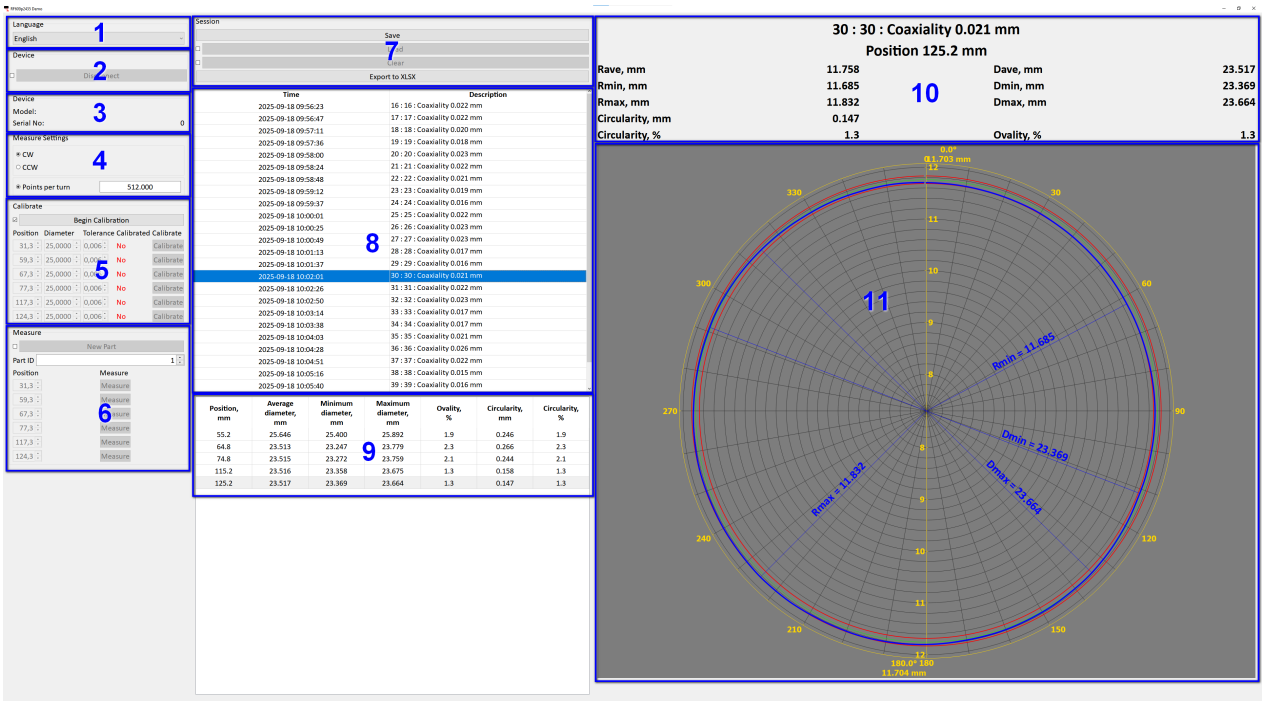
NOTE. Upon request, a service program can be developed that takes into account the specific requirements of the customer.

11.2. System requirements

- A desktop or laptop running MS Windows 10 or later.

11.3. Main program window

The main program window is shown below.



1. **Language.** This section is used to select the GUI language.
2. **Device.** This section is used to connect to the sensor.
3. **Device.** This section shows the connected sensor properties.
4. **Measure settings.** This section is used to set the direction of rotation and the number of points per revolution
5. **Calibrate.** This section is used to define the positions for device calibration, the nominal diameter of the calibration part and tolerance.

The calibration process is performed as follows:

- Click the **Begin calibration** button to start.

- The device will then move to each defined position.
- At each position, click the **Calibrate** button.
- The calibration result is displayed as a "Yes" or "No" status.
- After all positions are calibrated, click the **Finalize calibration** button to complete the process.

6. **Measure.** This section is used to define the part ID, and positions to scan.

The measure process is performed as follows:

- Click the **New part** button to start.
- The device will then move to each defined position.
- At each position, click the **Measure** button.
- The measure result is added to the tables and chart on the left.

7. **Session.** This group contains elements allowing to save, load or clear measurements.
8. **Navigation panel**. This panel contains a table of parts measured in the current session, in which the user can select individual part for viewing details. The comment for a part contains its coaxiality value.
9. **Part panel.** This panel contains a table of measured characteristics of the selected part at each position, such as Inner Diameter, Circularity, etc.
10. **Text panel.** This panel displays the measured parameters of the selected part at the selected position in an enlarged view.
11. **Graphical panel.** This panel displays the scanned profile of the selected part at the selected position as a graph.

11.4. Data exchange protocol

This protocol defines the exchange of commands and replies between the control software (server) and the user's software (client) over TCP. The client sends commands to the server, and the server responds with a corresponding reply.

Commands and replies are null-terminated strings.

Each command has a fixed syntax and expected reply. Replies always indicate whether the command succeeded (DONE) or failed (FAILED). In some cases, replies also contain measurement values or status information.

1. Connection management:

Command	Reply
CONNECT port_name baudrate address *example: CONNECT COM1 921600 1*	CONNECT DONE CONNECT FAILED

2. Calibration:

Command	Reply
BEGIN_CALIBRATION	BEGIN_CALIBRATION DONE BEGIN_CALIBRATION FAILED
CALIBRATE_AT pos_index pos reference_diameter tolerance *example: CALIBRATE_AT 1 10.1 23.502 0.006*	CALIBRATE_AT DONE CALIBRATE_AT FAILED
FINALIZE_CALIBRATION	FINALIZE_CALIBRATION DONE FINALIZE_CALIBRATION FAILED

3. Measurement process:

Command	Reply
NEW_PART part_id *example: NEW_PART 5*	NEW_PART DONE NEW_PART FAILED
MEASURE_AT pos_index pos *example: MEASURE_AT 1 10.1*	MEASURE_AT DONE diam *example: MEASURE_AT DONE 23.508* MEASURE_AT FAILED

Command	Reply
FINALIZE_PART	**The first reply:** COAXIALITY DONE value COAXIALITY FAILED **The second reply:** FINALIZE_PART DONE FINALIZE_PART FAILED

4. Status and device control:

Command	Reply
GET_STATUS	STATUS NOT_CONNECTED STATUS READY STATUS BUSY **Note:** READY means you can call BEGIN_CALIBRATION or NEW_PART. BUSY means the device is on some process.
SWITCH_LASER ON/OFF	SWITCH_LASER ON/OFF DONE SWITCH_LASER ON/OFF FAILED
GET_LASER_STATUS	LASER_STATUS ON LASER_STATUS OFF LASER_STATUS FAILED
CLEAR_MEASURES	CLEAR_MEASURES DONE CLEAR_MEASURES FAILED

Below is the sequence of interactions between the client and the server during operation.

1. Preparation.
   a. Connect all electrical connections.
   b. Switch on the sensor power supply.
   c. Launch the service program on the PC.
   d. Establish a TCP connection between the user software and the control software. By default, the control software uses port 27015. If necessary, the port number can be changed in the file settings.dat, located in the program folder.
2. Main exchange.
   a. Start working with the sensor as follows:
      i. Connect to the device using the CONNECT command.
      ii. Verify that the device is ready for operation with the GET_STATUS command.
      iii. Switch on the sensor lasers with the SWITCH_LASER ON command.
      iv. Verify that the lasers are on with the GET_LASER_STATUS command.
   b. Install the reference part and calibrate the sensor in the following sequence:
      i. Start the calibration process with the BEGIN_CALIBRATION command.
      ii. Perform calibration in each required section using the CALIBRATE_AT command.
      iii. Finalize the calibration process with the FINALIZE_CALIBRATION command.
   c. Sequentially measure each part as follows:
      i. Install the part.
      ii. Start the measurement process with the NEW_PART command.
      iii. Measure the part in each required section using the MEASURE_AT command.
      iv. Finalize the part measurement with the FINALIZE_PART command.

d. After all required parts have been measured, finish working with the sensor as follows:
   i. Switch off the sensor lasers with the SWITCH_LASER OFF command.
   ii. Verify that the lasers are off with the GET_LASER_STATUS command.
3. Shutdown.
   a. Exit the control software.
   b. Switch off the sensor power supply.

12. Warranty policy

Warranty assurance for the Multisensor Inner Diameter Measurement System RF040-3-20/27 Series – 24 months from the date of putting in operation; warranty shelf-life – 12 months.

13. Revisions

Date	Revision	Description
25.09.2025	1.0.0	Starting document.
29.04.2026	1.1.0	In Section 7, Figures 1 and 2 have been updated. The image on the title page has been changed.

14. Distributors

AUSTRALIA

Applied Measurement Australia Pty Ltd
RAILWAY INSTRUMENTS ONLY
Thornton Plaza, Unit 5,
27 Thornton Crescent, Mitcham
VIC 3132, Australia
Tel: +61 39874 5777
Fax: +61 39874 5888
sales@appliedmeasurement.com.au
www.appliedmeasurement.com.au

BELGIUM

Althen Sensors & Controls BV
Verrijn Stuartlaan 40, 2288 EL,
Rijswijk, Leidschendam
The Netherlands
Tel: +31 0 70 392 4421
Tel: +31 0 61 396 7830
Tel: +31 0 64 323 8393
sales@althen.nl
info@althen.nl
www.althensensors.com

BOSNIA AND HERZEGOVINA

ASCO RAIL sp. z o.o.
EXCLUSIVE REPRESENTATIVE FOR RAILWAY EQUIPMENT
ul. Wielowiejska 53, 44-120
Pyskowice, Poland
Tel: +48 32 230 45 70
Fax: + 48 32 233 21 34
biuro@ascorail.pl
export@ascorail.pl
www.ascorail.pl

BRAZIL

CAPI Controle e Automação Ltda
Rua Itororó, 121, CEP 13466-240
Americana-SP, Brazil
Tel: +55 19 36047068
Fax: +55 19 34681791
capi@capicontrole.com.br
www.capicontrole.com.br

BULGARIA

ASCO RAIL sp. z o.o.
EXCLUSIVE REPRESENTATIVE FOR RAILWAY EQUIPMENT
ul. Wielowiejska 53, 44-120
Pyskowice, Poland
Tel: +48 32 230 45 70
Fax: + 48 32 233 21 34
biuro@ascorail.pl
export@ascorail.pl
www.ascorail.pl

CHILE

MOL INGENIERIA LTDA
EXCLUSIVE REPRESENTATIVE FOR RAILWAY EQUIPMENT
República de Honduras 11936
Las Condes, Santiago de Chile
Tel: +56 9 59200362
hconcha@molingenieria.com
www.molingenieria.com

CHILE

Verne SpA
Apoquindo 2818, oficina 31
Las Condes, Santiago, Chile
Tel: +56 2 228858633
info@verne.cl
jsaavedra@verne.cl
www.verne.cl

CHINA

Beijing Haiwei Lutong Technology Co., Ltd
Yard 1, Tianxing Street, Fangshan
District, Beijing, China
Tel: +86 10 8366 1866
Fax: +86 10 8366 1866
info@haiwlt.com
www.haiwlt.com

CHINA

Chongqing Wolf Industrial Technology Co., Ltd
Room 2307 / 2308, Light of City
international business building,
No. 19 Jiangnan Avenue, Nan'an
District, Chongqing, China
Tel: 023 62832618
Fax: 023 62832113
info@wolf-hk.com
www.wolf-hk.com

CHINA

Beijing Gemston Mechanical & Electrical Equipment Co., Ltd
RAILWAY INSTRUMENTS ONLY
Room 613, Anfu Mansion, Fengtai District, Beijing, China
Tel: +86 10 6765 0516
Fax: +86 10 6765 6966
Mobile: +86 137 1755 1423
dh0526@163.com
www.baoft.cn

CHINA

Xi'an Win-Success Automation Technology Co.,Ltd
Room 3-1-1039, Iduhui Building, No.11 Tangyan South Road High-Tech Zone, Xi'an Shaanxi PRC, China
Tel: +86 29 81106280
Fax: +86 29 81106285
Mob: +86 133 19271405
info@maxsenor.com
www.maxsensor.com

CHINA

Micron-Metrology co., Ltd
No.2, Kecheng Rd., Industrial Park District, Suzhou,
Jiangsu Province., China
Tel: 0512 65589760
Mob: +86 189 1806 9807
sales@micron-metrology.cn
www.micron-metrology.cn

CHINA

Zhenshangyou Technologies Co., Ltd
Rm 2205-2210, Zhongyou Hotel 1110 Nanshan Road, Nanshan District 518054 Shenzhen, China
Tel: +86 755-26528100/8011/8012
Fax: +86 755-26528210/26435640
info@51sensors.com
www.51sensors.com

CROATIA

ASCO RAIL sp. z o.o.
EXCLUSIVE REPRESENTATIVE FOR RAILWAY EQUIPMENT
ul. Wielowiejska 53, 44-120
Pyskowice, Poland
Tel: +48 32 230 45 70
Fax: + 48 32 233 21 34
biuro@ascorail.pl
export@ascorail.pl
www.ascorail.pl

CZECH REPUBLIC

ASCO RAIL sp. z o.o.
EXCLUSIVE REPRESENTATIVE FOR RAILWAY EQUIPMENT
ul. Wielowiejska 53, 44-120
Pyskowice, Poland
Tel: +48 32 230 45 70
Fax: + 48 32 233 21 34
biuro@ascorail.pl
export@ascorail.pl
www.ascorail.pl

DENMARK

BLConsult
Ryssbält 294
95 291 Kalix, Sweden
Tel: +46 70 663 19 25
info@blconsult.se
www.blconsult.se

ESTONIA

FoodLab OÜ
Haabersti linnaosa, Astangu tn 52
13519 Eesti, Tallinn, Estonia
Tel: +372 56 363110
foodlab.ee@gmail.com

FINLAND

Kvalitest Industrial AB
EXCEPT FOR RAILWAY INSTRUMENTS
Ekbacksvägen 28,
16869 Bromma, Sweden
Tel: +46 0 76 525 5000
sales@kvalitest.com
www.kvalitest.com
www.kvalitest.se

FINLAND

TERÄSPYÖRÄ-STEELWHEEL OY
RAILWAY INSTRUMENTS ONLY
Juvan teollisuuskatu 28
FI-02920 ESPOO, Finland
Tel: +358 400 422 900
Fax: +358 9 2511 5510
steelwheel@steelwheel.fi
www.teraspyora.fi

FRANCE

BLET Measurement Group S.A.S.
1 avenue du Président Georges Pompidou, 92500 Rueil Malmaison, France
Tel: + 33 0 1 80 88 57 85
Fax: +33 0 1 80 88 57 93
technique@blet-mesure.fr
www.blet-mesure.fr

GERMANY

Disynet GmbH
Breyeller Str. 2, 41379
Brueggen, Germany
Tel: +49 2157 8799 0
Fax: +49 2157 8799 22
disynet@sensoren.de
www.sensoren.de

GERMANY

Finger GmbH & Co. KG
OPTICAL MICROMETERS ONLY
Sapelloh 172, 31606
Warmsen, Germany
Tel: +49 5767 96020
Fax: +49 5767 93004
finger@finger-kg.de
www.finger-kg.de

GERMANY

ALTHEN GmbH Meß- und Sensortechnik
Dieselstrasse 2, 65779
Kelkheim, Germany
Tel: +49 0 6195 7 00 60
info@althen.de
www.althensensors.com/de/

HUNGARY

ASCO RAIL sp. z o.o.
EXCLUSIVE REPRESENTATIVE FOR RAILWAY EQUIPMENT
ul. Wielowiejska 53, 44-120
Pyskowice, Poland
Tel: +48 32 230 45 70
Fax: + 48 32 233 21 34
biuro@ascorail.pl
export@ascorail.pl
www.ascorail.pl

INDIA

Influx Big Data Solutions Pvt Ltd
No:2, Krishvi, Ground Floor,
Old Airport Road, Domlur,
Bangalore - 560071, India
Tel: +91 73 37748490
Tel: +91 94 48492380
milan@influxtechnology.com
support_india@influxtechnology.com
www.influxtechnology.com

INDIA

Paragon Instrumentation Engineers Pvt. Ltd.
RAILWAY INSTRUMENTS ONLY
200, Station Road,
Roorkee, 247 667, India
Tel: +91 1332 272394
tanuj@paragoninstruments.com
www.paragoninstruments.com

INDONESIA

PT. DHAYA BASWARA SANIYASA
Botanic Junction Blok H-9 NO. 7
Mega Kebon Jeruk, Joglo
Jakarta,11640, Indonesia
Tel: +62 21 2932 5859
management@ptdbs.co.id

ISRAEL

Nisso Dekalo Import Export LTD
1 David Hamelech Street
Herzlia 46661 Israel
Tel: +972 99577888
Fax: +972 99568860
nissodekaloltd@outlook.com
www.fly-supply.net
www.aircraft-partsupply.com

ITALY

FAE s.r.l.
Via Tertulliano, 41
20137 Milano, Italy
Tel: +39 02 55187133
Fax: +39 02 55187399
fae@fae.it
www.fae.it

JAPAN

Tokyo Instruments, Inc.
6-18-14 Nishikasai, Edogawa-ku,
Tokyo, 134-0088 Japan
Tel: +81 3 3686 4711
Fax: +81 3 3686 0831
f_kuribayashi@tokyoinst.co.jp
www.tokyoinst.co.jp

LATVIA

FoodLab OÜ
Haabersti linnaosa, Astangu tn 52
13519 Eesti, Tallinn, Estonia
Tel: +372 56363110
foodlab.ee@gmail.com

LUXEMBOURG

Althen Sensors & Controls BV
Verrijn Stuartlaan 40, 2288 EL,
Rijswijk, Leidschendam
The Netherlands
Tel: +31 0 70 392 4421
Tel: +31 0 61 396 7830
Tel: +31 0 64 323 8393
sales@althen.nl
info@althen.nl
www.althensensors.com

MALAYSIA

OptoCom InstruVentures
H-49-2, Jalan 5, Cosmoplex
Industrial Park, Bandar Baru
Salak Tinggi, Sepang, Malaysia
Tel: 603 8706 6806
Fax: 603 8706 6809
optocom@tm.net.my
www.optocom.com.my

MONTENEGRO

ASCO RAIL sp. z o.o.
EXCLUSIVE REPRESENTATIVE FOR RAILWAY EQUIPMENT
ul. Wielowiejska 53, 44-120
Pyskowice, Poland
Tel: +48 32 230 45 70
Fax: + 48 32 233 21 34
biuro@ascorail.pl
export@ascorail.pl
www.ascorail.pl

NETHERLANDS

Althen Sensors & Controls BV
Verrijn Stuartlaan 40, 2288 EL,
Rijswijk, Leidschendam
The Netherlands
Tel: +31 0 70 392 4421
Tel: +31 0 61 396 7830
Tel: +31 0 64 323 8393
sales@althen.nl
info@althen.nl
www.althensensors.com

NORWAY

BLConsult
Ryssbält 294,
95 291 Kalix, Sweden
Tel: +46 70 663 19 25
info@blconsult.se
www.blconsult.se

NORWAY

Salitec AS
PB 468, N-1327
Lysaker, Norway
Tel: +47 23 891015
Fax: +47 92101005
mail@salitec.no
www.salitec.no

PERU

Verne Perú S.A.C.
Las Codornices 104,
Surquillo, Lima, Peru
Tel/fax: +51 992436734
info@verne.cl
www.verne.cl

POLAND

ASCO RAIL sp. z o.o.
EXCLUSIVE REPRESENTATIVE FOR RAILWAY EQUIPMENT
ul. Wielowiejska 53, 44-120
Pyskowice, Poland
Tel: +48 32 230 45 70
Fax: + 48 32 233 21 34
biuro@ascorail.pl
export@ascorail.pl
www.ascorail.pl

POLAND

RIFTEK EUROPE sp. z o.o.
ul. Domaniewska 17/19, 02-672
Warsaw, Poland
info@riftek.com
www.riftek.com

PORTUGAL

Campal Inovacoes Ferroviarias Lda.
Lagoas Park, Edifício 7, 1° Piso
Sul, 2740-244 Porto Salvo, Oeiras,
Portugal
Tel: +351 21 584 4348
campal@campal.pt
www.campal.pt

SERBIA

ASCO RAIL sp. z o.o.
EXCLUSIVE REPRESENTATIVE FOR RAILWAY EQUIPMENT
ul. Wielowiejska 53, 44-120
Pyskowice, Poland
Tel: +48 32 230 45 70
Fax: + 48 32 233 21 34
biuro@ascorail.pl
export@ascorail.pl
www.ascorail.pl

SLOVAKIA

ASCO RAIL sp. z o.o.
EXCLUSIVE REPRESENTATIVE FOR RAILWAY EQUIPMENT
ul. Wielowiejska 53, 44-120
Pyskowice, Poland
Tel: +48 32 230 45 70
Fax: + 48 32 233 21 34
biuro@ascorail.pl
export@ascorail.pl
www.ascorail.pl

SLOVENIA

ASCO RAIL sp. z o.o.
EXCLUSIVE REPRESENTATIVE FOR RAILWAY EQUIPMENT
ul. Wielowiejska 53, 44-120
Pyskowice, Poland
Tel: +48 32 230 45 70
Fax: + 48 32 233 21 34
biuro@ascorail.pl
export@ascorail.pl
www.ascorail.pl

SOUTH KOREA

BS Holdings
B-201,Wonpogongwon 1ro,
59 Danwon-gu, Ansan-si,
Gyeonggi-do 15455, Republic of
Korea
Tel: +82 31 411 5011
Fax: +82 31 411 5015
bsh5011@hanmail.net
www.lasersolution.co.kr

SOUTH KOREA

PROSEN. CO., LTD
M-1001, Songdo techno park IT
center, 32, Songdogwahak-ro,
Yeonsu-gu, Incheon, 21984,
Republic of Korea
Tel: +82 32 811 3457
Fax: +82 32 232 7458
trade@prosen.co.kr
www.prosen.co.kr

SPAIN

IBERFLUID Instruments S.A.
C/ Botanica, 122, 08908
L'Hospitalet de Llobregat
Barcelona
Tel: +34 93 447 10 65
Fax: +34 93 334 05 24
myct@iberfluid.com
www.iberfluid.com

SWEDEN

BLConsult
Ryssbält 294,
95 291 Kalix, Sweden
Tel: +46 70 663 19 25
info@blconsult.se
www.blconsult.se

SWEDEN

Kvalitest Industrial AB
EXCEPT FOR RAILWAY INSTRUMENTS
Ekbacksvägen 28,
16869 Bromma, Sweden
Tel: +46 0 76 525 5000
sales@kvalitest.com
www.kvalitest.com
www.kvalitest.se

SWITZERLAND

ID&T GmbH
Gewerbestrasse 12/a
8132 Egg (Zurich), Switzerland
Tel: + 41 44 994 92 32
Fax: + 41 44 994 92 34
info@idtlaser.com
www.idtlaser.com

THAILAND

Advantech Solution Co., Ltd.
20/170 Motorway Rd.,
Kwang Pravet, Khet Pravet,
Bangkok, Thailand 10250
Tel: +662 1848705
Fax: +662 1848708
sales@advantechsolution.com
www.advantechsolution.com

TURKEY

MAK Elektronik Malzeme Analiz ve Kalite Kontrol Cihazlari Dis Tic. Ltd. Sti.
Cenap Sahabettin Sokak, No:39,
34718 Kosuyolu - Kadikoy /
Istanbul - TURKEY
Tel: +90 216 402 10 34
Fax: +90 216 402 10 35
ulastac@metalografi.net
www.makelektronik.com.tr

TURKEY

TEKMA Mühendislik A.S.
Cevizli Mh. M. Kemal Cd.,
Hukukçular Towers,
A-Blok, No: 66-A/39
Kartal - Istanbul
Tel: +90 216 970 1318
Tel: +90 850 840 2334
info@tekma.eu
www.tekma.eu

UKRAINE

KODA
Frunze st. 22, 61002,
Harkov, Ukraine
Tel/Fax: +38 057 714 26 54
mail@koda.com.ua
www.koda.com.ua

UNITED KINGDOM, IRELAND

Althen UK
Northamptonshire
United Kingdom
Tel: +44 0 7823 921427
t.stoyles@althen.co.uk
www.althensensors.com
www.althencontrols.com

USA, CANADA, MEXICO

International Electronic Machines Corporation
RAILWAY INSTRUMENTS ONLY
850 River Street, Troy,
New York, USA
Tel: +1 518 268-1636
Fax: +1 518 268-1639
marketing@iem.net
www.iem.net

USA

Althen Sensors & Controls
2531 Bradley St., Oceanside, CA,
92056, USA
Tel: 858 633 3572
r.ream@althensensors.com

USA, CANADA, MEXICO

Acuity Products of Schmitt Industries, Inc.
2765 NW Nicolai Street
Portland, OR, 97210, USA
Tel: +1 503 227 7908
Fax: +1 503 223 1258
sales@acuitylaser.com
www.acuitylaser.com