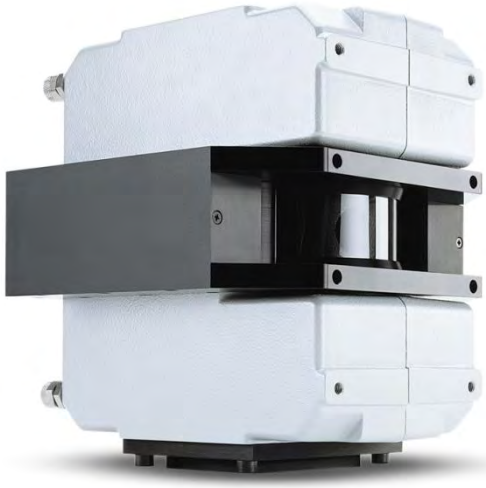
MP150
Linescanner



User Manual

Raytek®
Fluke Process Instruments

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58501

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WARRANTY

The manufacturer warrants this instrument to be free from defects in material and workmanship under normal use and service for the period of two years from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, batteries, or any product which has been subject to misuse, neglect, accident, or abnormal conditions of operation.

In the event of failure of a product covered by this warranty, the manufacturer will repair the instrument when it is returned by the purchaser, freight prepaid, to an authorized Service Facility within the applicable warranty period, provided manufacturer's examination discloses to its satisfaction that the product was defective. The manufacturer may, at its option, replace the product in lieu of repair. With regard to any covered product returned within the applicable warranty period, repairs or replacement will be made without charge and with return freight paid by the manufacturer, unless the failure was caused by misuse, neglect, accident, or abnormal conditions of operation or storage, in which case repairs will be billed at a reasonable cost. In such a case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. THE MANUFACTURER SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

SOFTWARE WARRANTY

The manufacturer does not warrant that the software described herein will function properly in every hardware and software environment. This software may not work in combination with modified or emulated versions of Windows operating environments, memory-resident software, or on computers with inadequate memory. The manufacturer warrants that the program disk is free from defects in material and workmanship, assuming normal use, for a period of one year. Except for this warranty, the manufacturer makes no warranty or representation, either expressed or implied, with respect to this software or documentation, including its quality, performance, merchantability, or fitness for a particular purpose. As a result, this software and documentation are licensed "as is," and the licensee (i.e., the User) assumes the entire risk as to its quality and performance. The liability of the manufacturer under this warranty shall be limited to the amount paid by the User. In no event shall the manufacturer be liable for any costs including but not limited to those incurred as a result of lost profits or revenue, loss of use of the computer software, loss of data, the cost of substitute software, claims by third parties, or for other similar costs. The manufacturer's software and documentation are copyrighted with all rights reserved. It is illegal to make copies for another person.

Specifications subject to change without notice.

COMPLIANCE STATEMENT

The device complies with the requirements of the European Directives:

EC –Directive 2014/30/EU – EMC

EC –Directive 2011/65/EU – RoHS II

EN 61326-1: 2013	Electrical measurement, control and laboratory devices - Electromagnetic susceptibility (EMC)
EN 50581: 2012	Technical documentation for the evaluation of electrical products with respect to restriction of hazardous substances (RoHS)

Electromagnetic Compatibility Applies to use in Korea only. Class A Equipment (Industrial Broadcasting & Communication Equipment) This product meets requirements for industrial (Class A) electromagnetic wave equipment and the seller or user should take notice of it. This equipment is intended for use in business environments and is not to be used in homes.

Content

COMPLIANCE STATEMENT **5**

CONTENT **6**

1 SAFETY INSTRUCTIONS **8**

2 TECHNICAL DATA **9**

2.1 MEASUREMENT SPECIFICATIONS 9

2.2 OPTICAL SPECIFICATIONS 10

2.2.1 Standard Focus *12*

2.2.2 Far Focus *13*

2.3 ELECTRICAL SPECIFICATIONS 14

2.4 GENERAL SPECIFICATIONS 14

2.5 DIMENSIONS 15

2.6 SCOPE OF DELIVERY 17

3 BASICS **18**

3.1 MEASUREMENT OF INFRARED TEMPERATURES 18

3.2 EMISSIVITY OF TARGET OBJECT 18

4 SYSTEM OVERVIEW **19**

5 INSTALLATION **20**

5.1 AMBIENT TEMPERATURES 20

5.2 ENVIRONMENT 20

5.3 ELECTRICAL INTERFERENCE 20

5.4 GEOMETRY 20

5.5 MOUNTING 21

5.6 INPUT AND OUTPUT CONNECTORS 22

5.7 COMMUNICATION INTERFACES 24

5.7.1 Ethernet Wiring *24*

5.7.2 Ethernet Settings *25*

5.7.3 Changing the Ethernet Settings for the PC *26*

5.7.4 Changing the Ethernet Settings for the Scanner *28*

5.8 POWER SUPPLY CABLE 29

5.9 WARM-UP TIME 29

5.10 WATER COOLING 30

5.10.1 Avoiding Condensation *30*

5.11 AIR PURGE COLLAR 32

5.12 LASER 33

6 OPERATION **34**

6.1 SCAN RATE AND TARGET VIEWING TIME 34

6.2 SECTORS 35

6.3 DATA TRANSFER MODES 36

6.4 SCANNER AS STAND-ALONE DEVICE 36

7 ACCESSORIES **37**

7.1 OVERVIEW 37

7.2 MOUNTING PLATE 38

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7.3 ADJUSTABLE MOUNTING BASE 38
7.4 TUBE FITTINGS 39
7.4.1 Installation of the Tube Fittings *39*
7.4.2 Reassembly of the Tube Fittings *39*
7.5 THERMOSTAT 40
7.6 SPARE WINDOWS 42
7.7 INDUSTRIAL POWER SUPPLY 43
7.8 RS485 INTERFACE KIT 43
7.8.1 RS485 Cable Extension *45*

8 MAINTENANCE 46
8.1 CLEANING THE WINDOW 46
8.2 REPLACING THE WINDOW 46

9 TROUBLESHOOTING 48

10 APPENDIX 51
10.1 DETERMINATION OF EMISSIVITY 51
10.2 TYPICAL EMISSIVITY VALUES 51

1 Safety Instructions

This document contains important information, which should be kept at all times with the instrument during its operational life. Other users of this instrument should be given these instructions with the instrument. Updates to this information must be added to the original document. The instrument can only be operated by trained personnel in accordance with these instructions and local safety regulations.

Acceptable Operation

This instrument is intended only for temperature measurement and is appropriate for continuous use. The instrument operates reliably in demanding conditions, such as in high environmental temperatures, as long as the documented specifications are adhered to. Compliance with the operating instructions is necessary to ensure the expected results.

Unacceptable Operation

The instrument should not be used for medical diagnosis.

Replacement Parts and Accessories

Use only original parts and accessories approved by the manufacturer. The use of other products can compromise the operational safety and functionality of the instrument.

Instrument Disposal

Do not dispose of this product as unsorted municipal waste. Go to Fluke's website for recycling information.

Operating Instructions

The following symbols are used to highlight essential safety information in the operation instructions:

Helpful information regarding the optimal use of the instrument.

Risk of danger. Important information.

Incorrect use of 110 / 230 V electrical systems can result in electrical hazards and personal injury. All instrument parts supplied with electricity must be covered to prevent physical contact and other hazards at all times.

The instrument is equipped with a Class 2 laser. Class 2 lasers shine only within the visible spectrum at an intensity of 1 mW. Looking directly into the laser beam can produce a slight, temporary blinding effect, but does not result in physical injury or damage to the eyes, even when the beam is magnified by optical aids. At any rate, closing the eye lids is encouraged when eye contact is made with the laser beam. Pay attention to possible reflections of the laser beam. The laser functions only to locate and mark surface measurement targets. Do not aim the laser at people or animals.

Conforms to relevant South Korean EMC Standards.

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2 Technical Data

2.1 Measurement Specifications

Temperature Range

LT	20 to 350°C (68 to 662°F)
MT	100 to 800°C (212 to 1472°F)
HR	100 to 650°C (212 to 1202°F)
G5	100 to 950°C (212 to 1742°F)
P3	30 to 250°C (86 to 482°F) – for P30 100 to 350°C (212 to 662°F) – for P31
2M	400 to 950°C (752 to 1742°F)
1M	600 to 1200°C (1112 to 2192°F)

Spectral Response

LT	3 to 5 µm
MT	3.9 µm
HR	3.5 to 4 µm
G5	5 µm
P3	3.43 µm
2M	1.6 µm
1M	1 µm

Detectors

LT, MT, HR, G5, P3	MCT
2M	InGaAs
1M	Si

System Accuracy[1]

LT	± 2°C (± 4°F)
MT	± 0.5% of reading or ± 3°C (6°F), whichever is greater
HR	± 0.5% of reading or ± 3°C (6°F), whichever is greater
G5	± 0.5% of reading or ± 3°C (6°F), whichever is greater
P3	± 3°C (± 6°F)
1M, 2M	± 0.5% of reading or ± 3°C (6°F), whichever is greater

Repeatability[2]

LT	± 1°C (± 2°F)
MT	± 1°C (± 2°F)
HR	± 1°C (± 2°F)
G5	± 1°C (± 2°F)
P3	± 1°C (± 2°F)
1M, 2M	± 2°C (± 4°F)

[1] at 0 - 50°C (32 - 122°F) ambient temperature

[2] at 0 - 50°C (32 - 122°F) ambient temperature

Temperature Resolution

digital interface	0.1 K
analog output	16 bit

Scan Rate

All models	150 Hz in steps of: 20 Hz, 36 Hz, 48 Hz, 76 Hz, 85 Hz, 108 Hz, 126 Hz, 150 Hz

Measured Points per Line[1]

All models	256 pixel @ 150 Hz scan rate 512 pixel @ 76 Hz scan rate 1024 pixel @ 36 Hz scan rate – model as option

Scan Angle (FOV)

All models	90°

2.2 Optical Specifications

Standard Focal Distance

All models	1.52 m / 69 in. (standard focus) special focal distances available minimal focal distance: 500 mm (20 in)
HR	∞ (far focus)

Optical Resolution D:S [2]

Measurement Resolution (90% energy)

LT, MT, HR, G5	170 : 1 (IFOV = 5.9 mrad)
P3	33 : 1 – for P30 (IFOV = 30 mrad) 75 : 1 – for P31 (IFOV = 13.3 mrad)
1M	200 : 1 (IFOV = 5 mrad)
2M	200 : 1 (IFOV = 5 mrad)

Hot Spot Detection (50% energy)

LT, MT, HR, G5	510 : 1 (IFOV = 2 mrad)
P3	100 : 1 – for P30 (IFOV = 10 mrad) 225 : 1 – for P31 (IFOV = 4.5 mrad)
1M	600 : 1 (IFOV = 1.7 mrad)
2M	600 : 1 (IFOV = 1.7 mrad)

[1] at 90° scan angle

[2] measured as slit response at 20 Hz scan rate, per pixel at focus distance

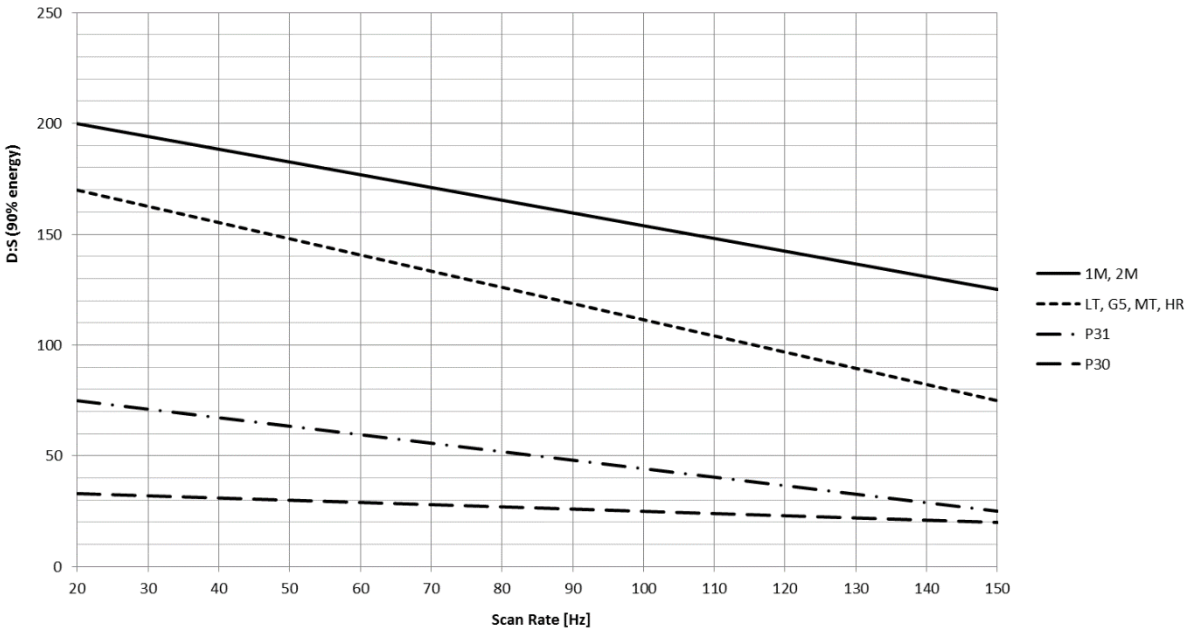


Figure 1: Optical Resolution for Measurement Resolution depending on Scan Rate

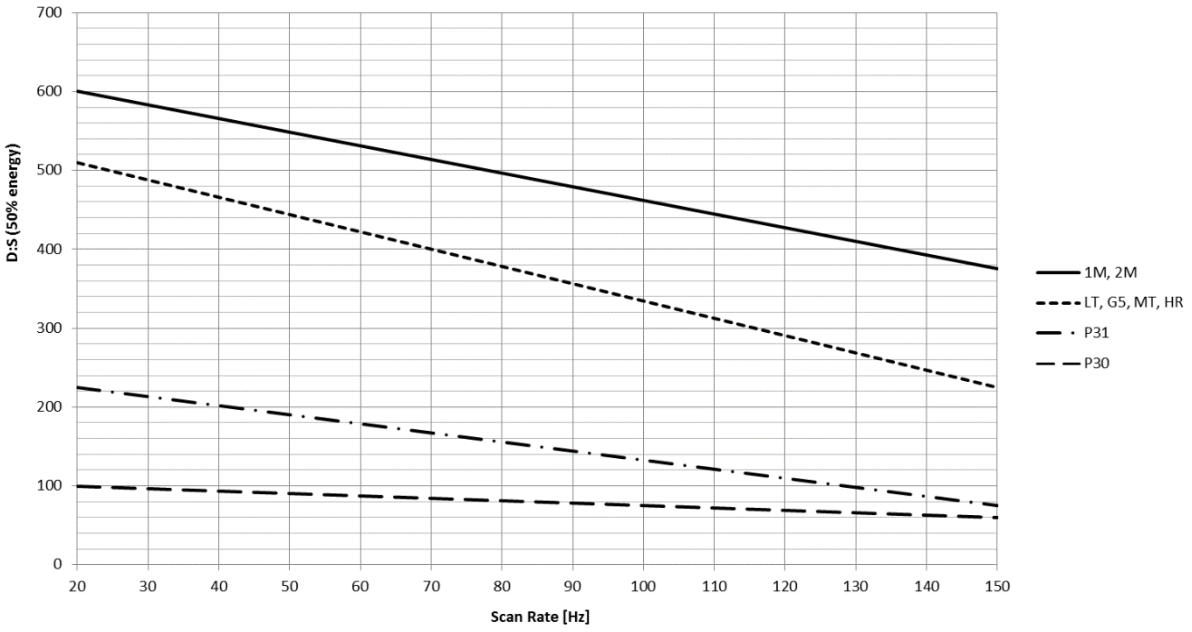


Figure 2: Optical Resolution for Hot Spot Detection depending on Scan Rate

2.2.1 Standard Focus

The focus distance is measured from the front end of the scanner!

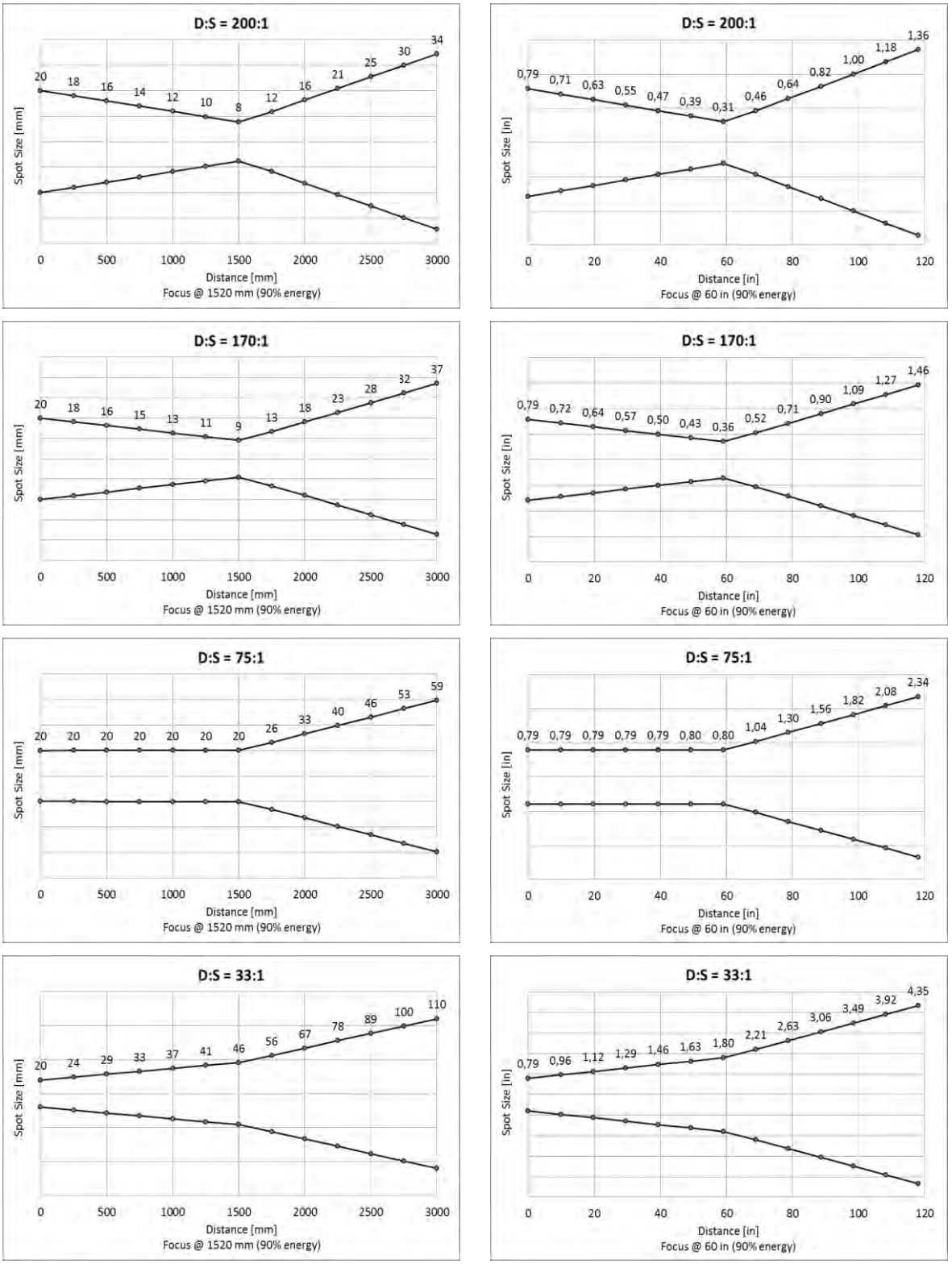


Figure 3: Optical Diagrams Standard Focus

2.2.2 Far Focus

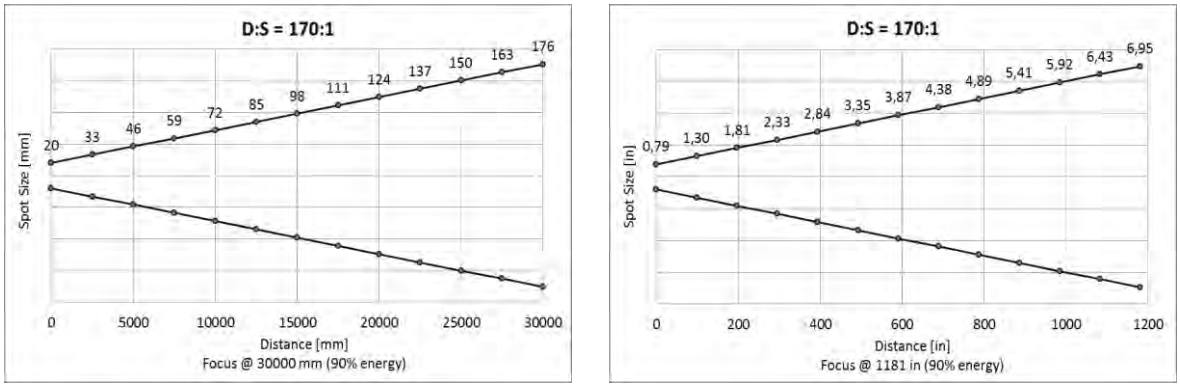


Figure 4: Optical Diagrams Far Focus

2.3 Electrical Specifications

Communications

Ethernet	TCP/IPv4 protocol 10/100 MBit/s, electrically isolated, auto-negotiation
RS485	full-duplex, not addressable 9.6, 57.6, 115.2, 230.4 kBaud

Outputs

Analog	3 active current outputs, each adjustable 0/4 ... 20 mA, maximum load: 500 Ω, minimal load: 47 Ω common ground connection for all current outputs, electrically isolated to the GND ground
Alarm	potential-free relay contacts: 30 V / 1 A normally open / normally closed
Exposure Time[1]	$\frac{1}{f_{scan}}$
Response Time[2]	20 ms + $\frac{1}{f_{scan}}$

Inputs

Trigger	+ 5 to 24 VDC pulse, high/low active
Functional Input	max. + 5 VDC function depends on the specific MP150 based system

Signal Processing

Stand-alone unit	Max, Min, Average, Peak/Valley Hold, Alarm setpoints further signal processing function through software

Power Supply 24 VDC ± 25%, 1 A

2.4 General Specifications

Mechanical Scanning System 40,000 h (about 4.5 years) meantime between failures (MTBF) for the mechanical scanning system at 48 Hz scan rate

Environment Rating IP65 (NEMA 4) in accordance to IEC 60529

Ambient Operation Temperatures[3]

All models	0 to 50°C (32 to 122°F) – without cooling max. 180°C (356°F) – with integrated water cooling (standard)
HR	down to –40°C (–40°F) with internal heating element optional for all other scanner models

Internal Operation Temperatures 0 to 60°C (32 to 140°F)

Laser automatic switch off at < 5°C (41°F) or > 50°C (122 °F)

[1] The exposure time is the minimum time during which the measured object must be present. The output value of the sensor is delayed.

[2] Time interval between the instant of an abrupt change for the object temperature and its availability on the output

[3] at still air (e.g. by using a protective housing)

Storage Temperatures	-25 to 65°C (-13 to 149°F)
Water Cooling: Pressure	max. 15 bar (218 PSI)
Water Cooling: Flow rate	typ. 1 l / min to 2 l / min (0.26 to 0.52 gallons / min)
Air Purge Collar: Pressure	max. 3 bar (43 psig)
Air Purge Collar: Flow rate	typ. 100 l/min to 200 l/min (3.53 to 7.06 cfm)
Warm-up Time	30 min.
Relative Humidity	10 to 90%, non-condensing, for operating and non-operating temperature range
Vibration	IEC 60068-2-6, 3 axes, 10 to 150 Hz, operating 2 g above 20 Hz
Shock	IEC 60068-2-27, 3 axes, operating: 5 g at 11 ms, 15 g at 6 ms
Dimensions	200 x 180 x 190 mm (7.8 x 7.02 x 7.41 in)
Weight (incl. air purge)	7 kg (15.4 lbs)

2.5 Dimensions

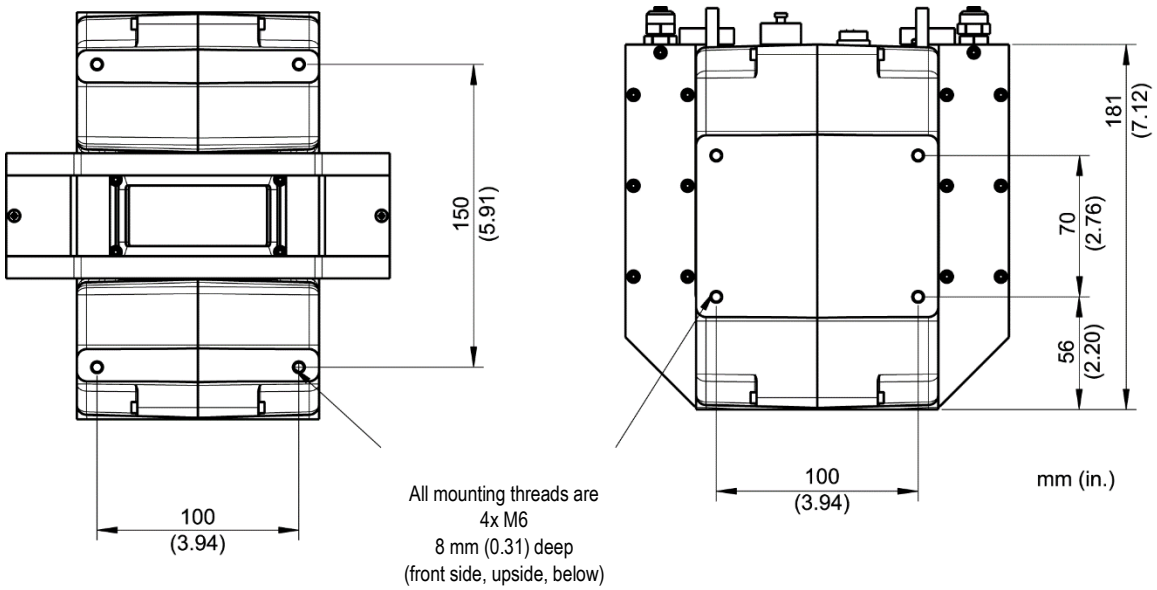
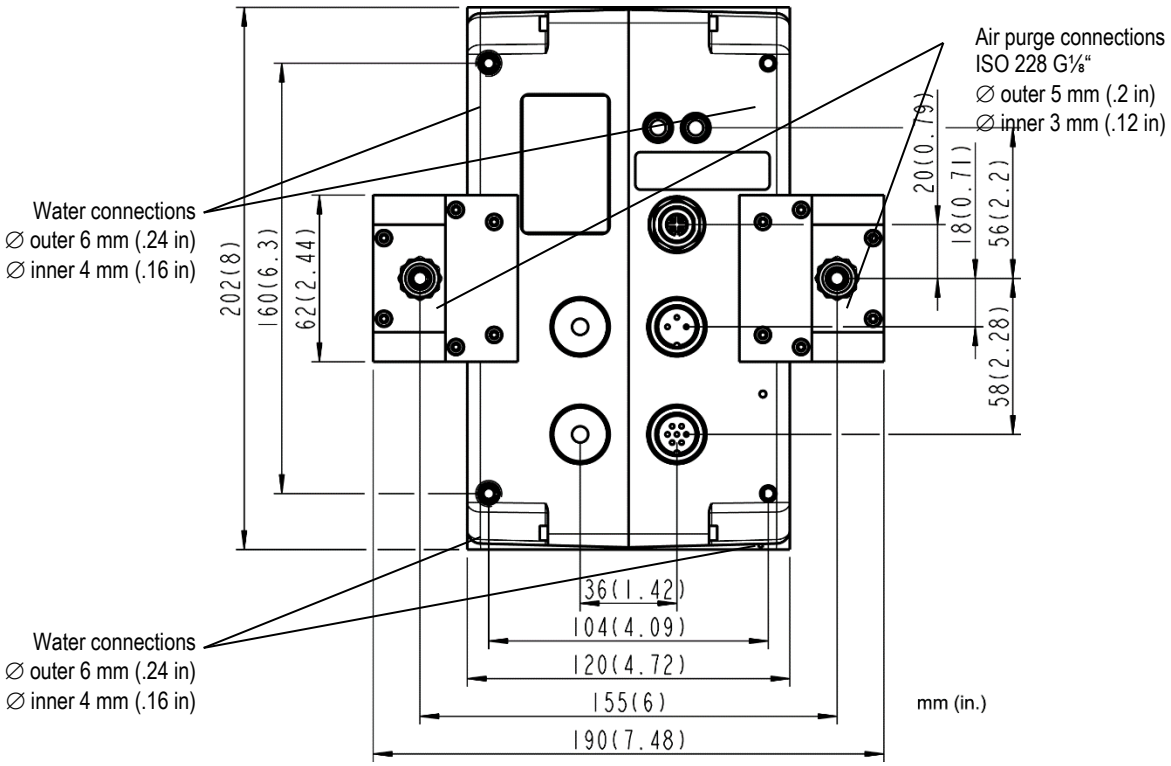


Figure 5: Linescanner mounting locations and dimensions

Note: The mounting dimensions are the same for top and bottom view!

Technical Data



2.6 Scope of Delivery

The linescanner package includes the following:

- MP150 Linescanner
- Operating Instructions (also included as PDF file on the CD-ROM)
- Software CD with DataTemp DP Software
- Protocol Manual only as PDF file on the CD-ROM
- Ethernet cable: 1x 7.5 m (24.6 ft), max. ambient temperature: 180°C (356°F)
- Power Supply cable: 1x 7.5 m (26.4 ft), max. ambient temperature: 180°C (356°F)
  (power supply XXXSYSPS should be ordered separately)
- 1x spare window for MP150
- Tools: 1x hex key wrench 2.5 mm
  1x hex key wrench 5 mm
  1x connector (female) 6-pin for inputs/outputs
  1x connector (female) 4-pin for analog current outputs

3 Basics

3.1 Measurement of Infrared Temperatures

Every object emits an amount of infrared radiation (IR) according to its surface temperature. The intensity of the infrared radiation changes with the temperature of the object. Depending on the material and surface properties, the emitted radiation lies in a wavelength spectrum of approximately 1 to 20 µm. The intensity of the infrared radiation (”heat radiation”) is dependent on the material. For many substances this material-dependent constant is known. It is referred to as “emissivity value”, see appendix 10.2 Typical Emissivity Values on page 51.

Infrared thermometers are optical-electronic sensors. These sensors are able to detect ”radiation of heat”. Infrared thermometers consist of a lens, a spectral filter, a sensor, and an electronic signal processing unit. The task of the spectral filter is to select the wavelength spectrum of interest. The sensor converts the infrared radiation into an electrical signal. The connected electronics process this signal for further analysis. The intensity of the emitted infrared radiation is thereby used to determine the temperature of the target. Since the intensity of the infrared radiation is dependent on the material, the appropriate emissivity can be selected on the sensor.

The biggest advantage of the infrared thermometer is its ability to measure temperature without the need to be in contact with the target. Consequently, surface temperatures of moving or hard to reach objects can be easily measured.

3.2 Emissivity of Target Object

For accurate temperature readings, the sensor must be set to the appropriate emissivity value for the target material. Determine the emissivity of the target object as described in appendix 10.1 Determination of Emissivity on page 51.

When measuring materials with low emissivity, the results could be effected by interfering infrared radiation from background objects (such as heating systems, flames, fireclay bricks, etc. near to or behind the target object). This type of problem can occur when measuring reflective surfaces and very thin materials such as plastic films and glass. This error can be reduced to a minimum if particular care is taken during installation, and the linescanner is shielded from reflected infrared radiation.

Contact the manufacturer for more information.

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4 System Overview

The following figure shows the principal structure of the system. It shows a solution with one scanner connected to a standard Windows PC via Ethernet communications. There is no need to open the computer.

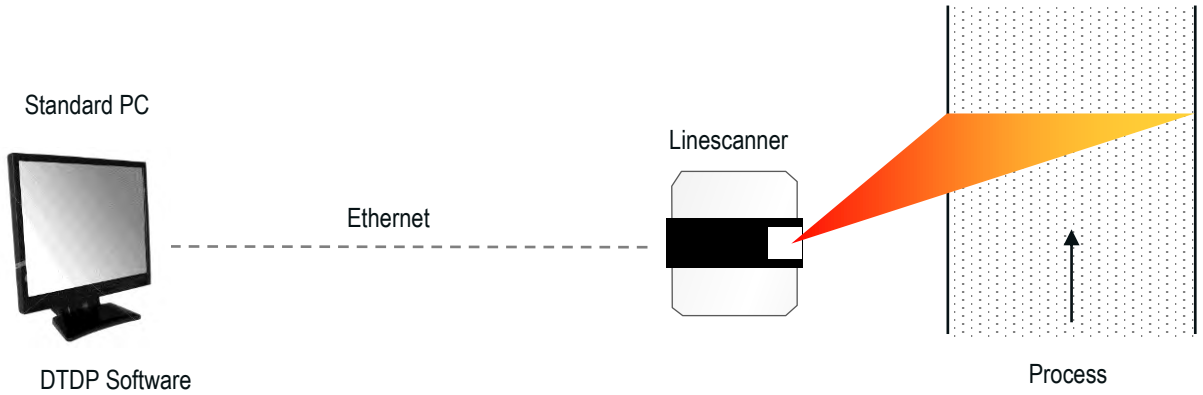

Figure 6: Principal structure of the system

The system can be expanded by adding digital or analog Output Modules running on an Ethernet network, see section see section 7.1 Overview, page 37.
Instead of outputting the temperature data by means of output modules also an OPC server capability or a serial communication port can be used for forwarding the data to other control systems, e.g. a PLC.

5 Installation

Linescanners are able to measure temperature values along a line through the use of a rotating mirror. For 25% of its revolution, the linescanner scans the field of view (FOV). This corresponds to a scan angle of 90°. The remaining 75% of its revolution is used for the internal operation of the sensor. The rotating mirror views the scene and reflects the infrared energy striking it onto a system of lenses which focuses the radiation onto a thermoelectrically cooled detector. The incoming signal is scanned, digitized, and then converted to temperature values by the internal microprocessor. For every revolution of the mirror, up to 1024 measured values will be internally collected. An air purge system keeps the scanner's window free of dust, debris, and condensation.

5.1 Ambient Temperatures

Without water cooling, the linescanner is designed for ambient operating temperatures between 0°C and 50°C (32°F and 122°F). With water cooling, it can be used in environments of up to 180°C (356°F), see section 5.10 Water Cooling, page 30. The internal temperature is the determining factor for proper operation of the linescanner. It is displayed in the DataTemp software. The difference between the external ambient temperature and the temperature inside the housing also depends on the thermal contact of the linescanner and its mounting hardware.

The temperature inside the housing must be between 0°C to 60°C (32°F to 140°F) during operation and never more then 65°C (150°F) at any time, including non-operation!

5.2 Environment

The linescanner complies with class IP65 and is therefore dust and splash resistant. The linescanner's window is made of a material that is resistant to thermal stresses and it is equipped with an integrated air purge system which protects the window against contamination. Air supply for the air purge should be oil free, clean "instrument" air.

5.3 Electrical Interference

To minimize electrical or electromagnetic interference, follow these precautions:

- Mount the sensor as far away as possible from possible sources of interference such as motorized equipment producing large step load changes!
- Ensure a fully insulated installation of the sensor (avoid ground loops!).
- Make sure the shield wire in the sensor cable is earth grounded at one location!
- To avoid potential differences use a single power circuit to power both the linescanner and the PC running the software!

5.4 Geometry

The smallest possible object which can be measured depends on two conditions:

1. The area measured must be no less than 90% (90% energy response).
2. Hot spots must be clearly detected, when in front of a cold background (50% energy response).

Remark: The measured area for 50% energy response is approximately ⅓ of the area size of the measured spot for 90% energy response.

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Refer to section 2.2 Optical Specifications, page 10, for basic versions of optical resolution values for the various models.

L = Scan line width
D = Distance to target (measured from front surface of housing)

90° FOV:
D = L/2

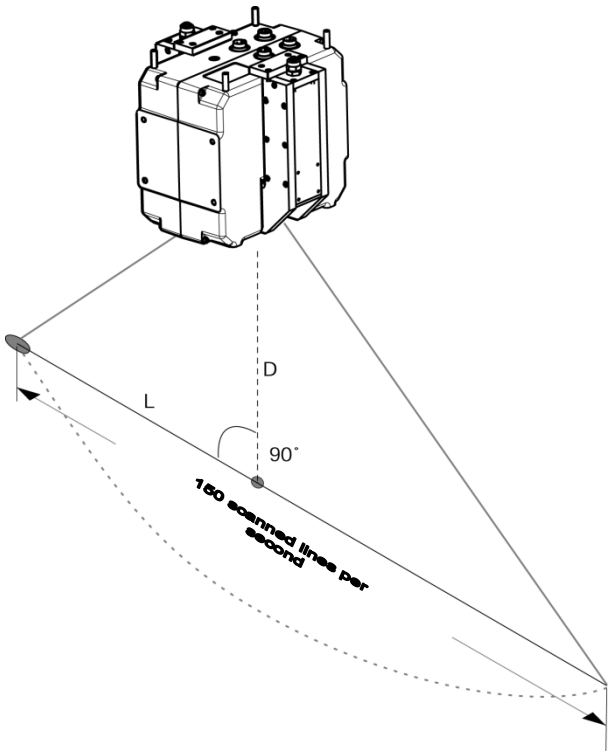


Figure 7: Relationship between scan line width and distance to target

The relationship between the scan line width (L) and the distance (D) to the front side of the linescanner housing is defined as described above. For long distances, the scan line width is about twice the measurement distance (90° FOV).

5.5 Mounting

The linescanner can be installed as follows:

- on a tripod with a standard 1/4-20 UNC (photo equipment) thread. This type of setup requires the optional tripod mounting plate (XXXTMP50ACCC) and is recommended if the linescanner is to be used only for temporary or mobile measurements.
- with the mounting holes of the linescanner housing. This type of setup is recommended for permanent installations where higher stability is desired.

Prevent all contact between heat sources and the linescanner to protect the linescanner from overheating.

5.6 Input and Output Connectors

In addition to the communication interfaces, the linescanner is also equipped with the following:

- three active analog current outputs
- an alarm output (potential-free relay contacts)
- a trigger input for synchronization

The housing of the linescanner is electrically grounded. All inputs and outputs are electrically isolated from the housing, the input voltage, and from one another. The current outputs have a joint ground connection, but are electrically isolated from any other ground connection.

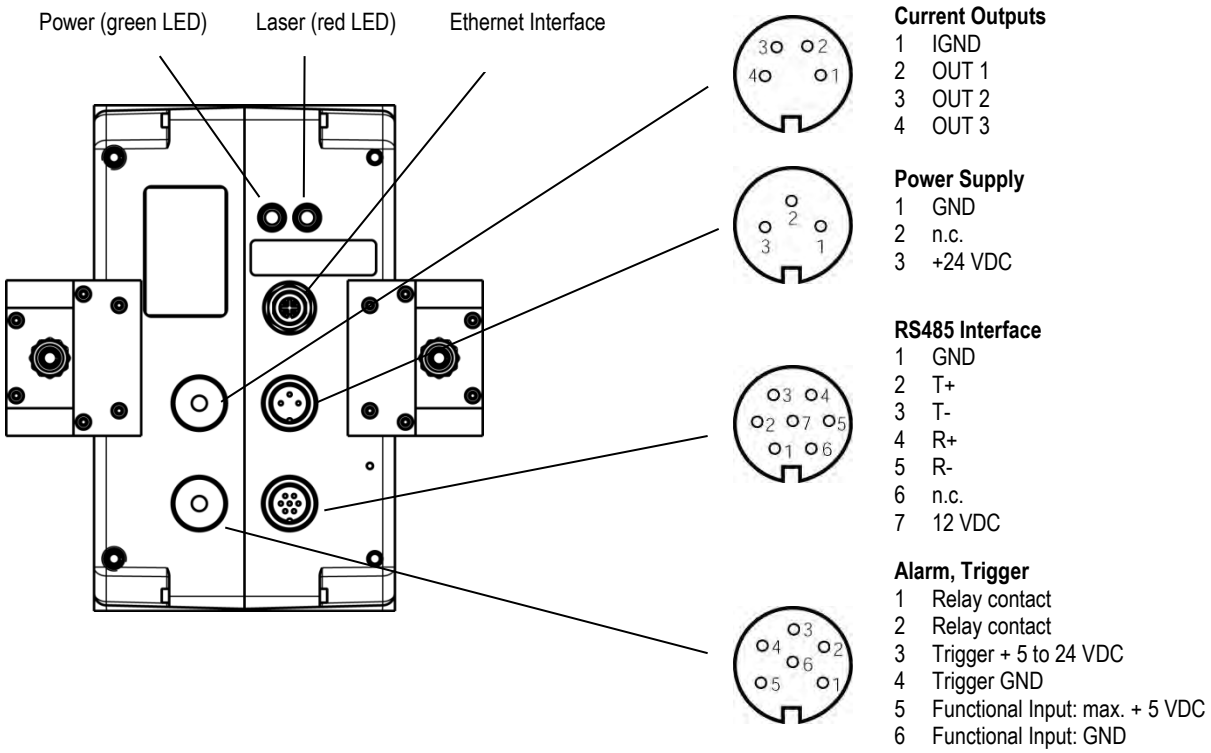


Figure 8: Input and Output Connectors (view on connectors)

Current Outputs, 4-pin

		Description	Color (6 wires)
1	IGND	common ground connection for all current outputs, electrically isolated to the GND ground	brown, pink, gray
2	OUT1	current output 1	yellow
3	OUT2	current output 2	green
4	OUT3	current output 3	white
		shield	black

Power Supply 24 V, 3-pin

		Description	Color (6 wires)
1	GND	power ground	brown
2			not connected
3	+ 24 VDC	input for + 24 VDC power supply voltage	white
		shield	black

RS485 Interface, 7-pin

		Description	Color (6 wires)
1	GND	Ground, (connected to power ground)	gray
2	T+	RS485 transmit	brown
3	T-	RS485 transmit	white
4	R+	RS485 receive	green
5	R-	RS485 receive	yellow
6	n.c.		
7	+ 12 VDC	regulated voltage for the RS232/485 converter	pink
		shield	

Alarm, Trigger, 6-pin

		Description	Color (6 wires)
1	Relay contact	Potential free relay contact, capacity max. 30 V, 1 A.	brown
2	Relay contact	Potential free relay contact, capacity max. 30 V, 1 A	white
3	Trigger +	Trigger input: + 5 to + 24 VDC	green
4	Trigger -	Trigger input GND	yellow
5	Functional input	max. + 5 VDC	pink
6	Functional input	GND	gray
		shield	black

5.7 Communication Interfaces

The MP150 can communicate via Ethernet interface or RS485. During system configuration the user selects either Ethernet or RS485. You cannot use Ethernet and RS485 communications for the data transfer at the same time!
The Ethernet connection between linescanner and the PC has a maximum speed of 100 MBit/s and permits real-time data transfer for all temperature pixels. For multi-scanner systems you can use a standard Ethernet Switch to connect to the PC network adapter.

5.7.1 Ethernet Wiring

The linescanner is shipped with an Ethernet cable specified to NEMA WC-63.1 Category 5e, UL verified to Category 5e, Ethernet/IP Compliant. This standard cable is 7.5 m (24.6 ft.) long, free from Halogen, and withstands ambient temperatures up to 180°C (356°F).
The connector on one cable end (scanner wiring) is an M12 plug-in connector, 4 pin D-coded, suited for industrial Ethernet with IP67 protection rate with a screw retention feature.
The connector on the other cable end (field/PC wiring) is an RJ45 connector.

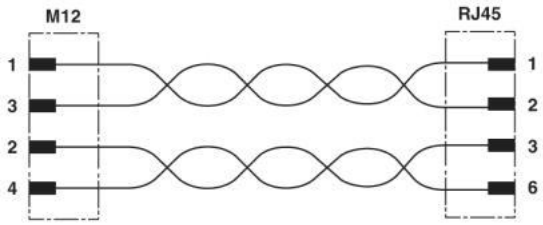
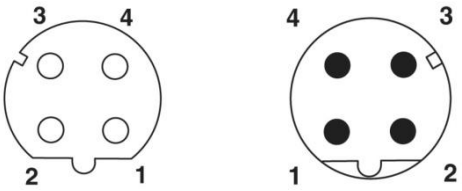


Figure 9: Ethernet Cable with M12 Plug and RJ45 Connector



M12-Pin	RJ45-Pin	
1	1	TX+
2	3	RX+
3	2	TX-
4	6	RX-

Figure 10: M12 Connector Socket at the Scanner (left) and the Corresponding Plug (right)

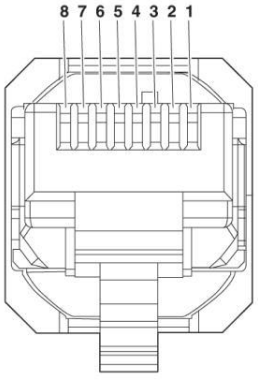


Figure 11: RJ45 Connector

5.7.2 Ethernet Settings

Scanner IP Address

The factory default IP address for the linescanner is 192.168.42.30.
The scanners address is not free of choice: It has to be unique in the network meaning that no other device in the network including the PC network adapter may run at the same IP address.

Ask your IT administrator for a free IP address to be used!

Advanced Ethernet Settings

Subnet Mask:
The Subnet Mask defines the interpretation of the IP address. The factory default setting is 255.255.255.0. The Subnet Mask can be changed using the <NM> command of the scanner.

Port:
In the case that the default scanners port (2727) should conflict with something else (it could be blocked by the firewall for example) it can be changed using the <PO> command of the scanner.

Gateway:
A gateway connects two subnets (which have a different subnet address). The IP address of this gateway is given with the route command <RO>. The default is RO0.0.0.0 - this does mean no gateway is set.

To establish the Ethernet communication, the subnet addresses for both the scanner and the PC need to match! Appropriate changes can be applied either on the scanner side or on the PC network adapter!

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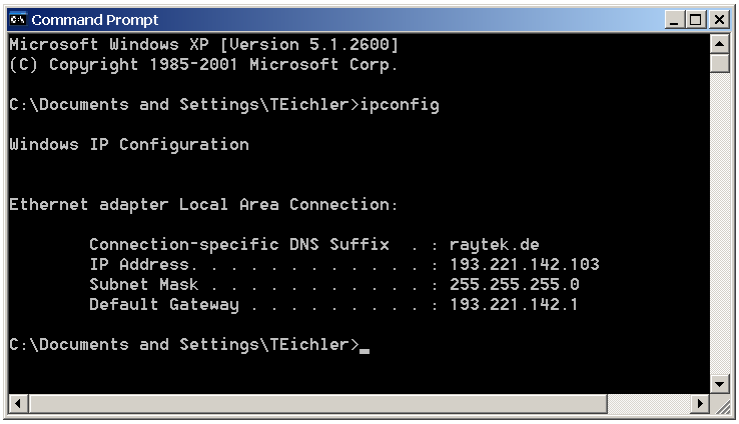
The current settings for the IP address and the netmask of the PC can be asked with the command <ipconfig> in a Command Prompt window!

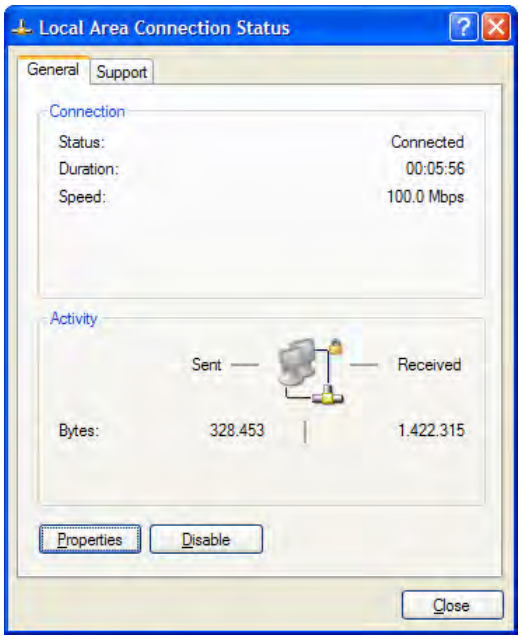


For the example above, the IP address of the PC is 193.221.142.103. The subnet address is 193.221.142, the host address is 103. The scanner's subnet address must be 193.221.142 as well. The host address of the scanner must be in the range from 1 to 254 with the exception of 103 which is already used for the PC.

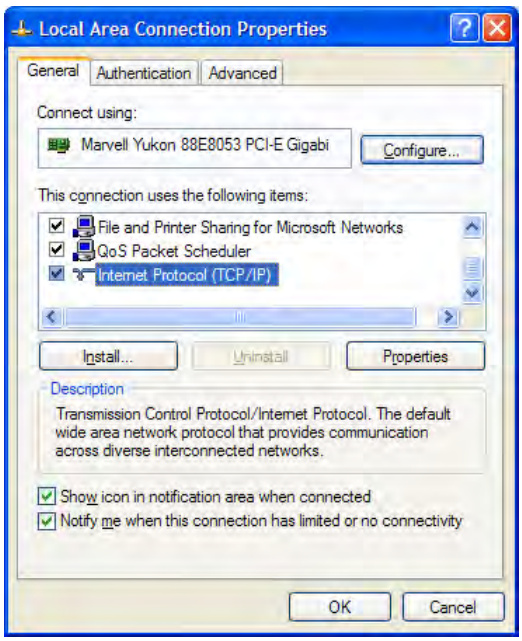
5.7.3 Changing the Ethernet Settings for the PC

The network adapter on the PC side can be configured as following:

1. Go to <Start> <Settings> <Network Connections> <Local Area Connection>
2. Click on <Properties>:

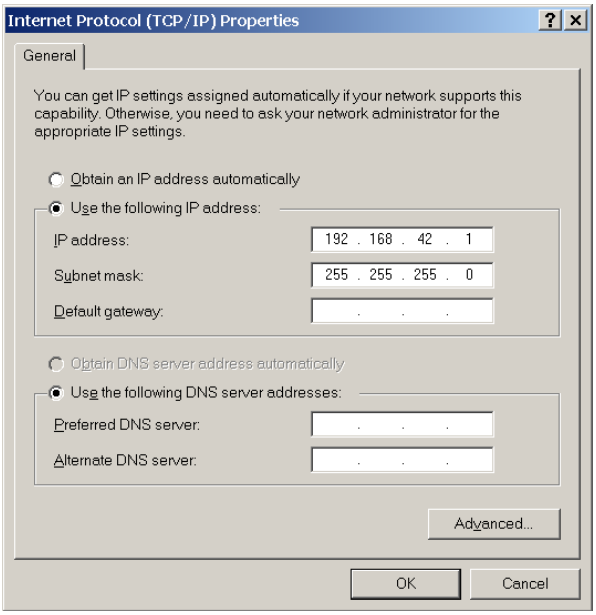


3. Under <This connection uses the following items> select <Internet Protocol (TCP/IPv4)> and click on <Properties>:



4. Activate the radio button <Use the following IP address> and make the following settings:

IP address:	192.168.42.x where x is an address between 0 and 255 except 30 which is already used by the linescanner by factory default
Subnet mask:	255.255.255.0
Default gateway:	{empty}



5. Close all dialog boxes by pressing on <OK>.

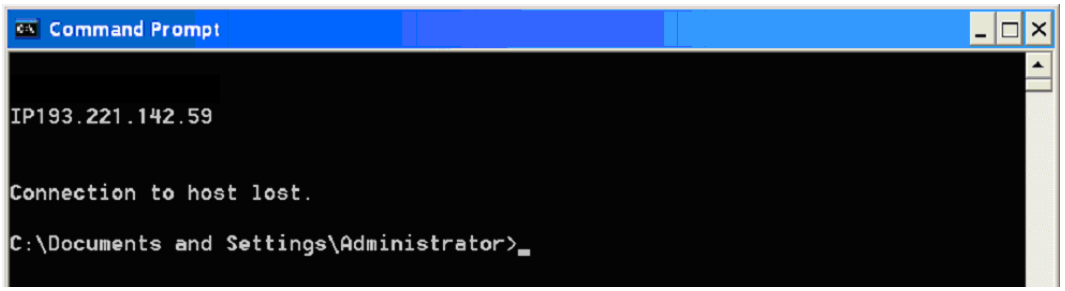
5.7.4 Changing the Ethernet Settings for the Scanner

When using the linescanner on an Ethernet network you may need to change the IP address so that the factory default address does not conflict with another device on the network. Change the IP address following the procedure described below:

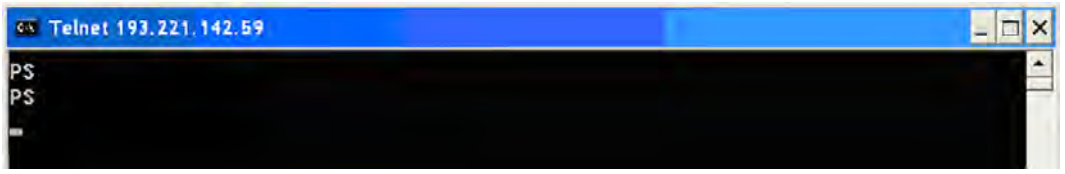
- Make sure that the PC network adapter is configured as required, see sections 5.7.2 Ethernet Settings, page 25 and 5.7.3 Changing the Ethernet Settings for the PC, page 26.
- Make sure that the scanner runtime software DTDP is stopped!
- Switch off the scanner!
- Switch on the scanner!
- Open the Command Prompt window and start a Telnet session by using the command:
  `telnet <IPAddressScanner> <Port>`

Windows 7 does not have Telnet enabled by default. Enable the Telnet Client by using the command: `pkgmgr /iu:"TelnetClient"`

- Under Telnet you have access to the scanner command level. Give the new IP address for the scanner with the command:
  `IP<NewScannerIPAddress>`



- With changing the IP address for the scanner you will immediately loose the connection, so you have to restart a further Telnet session by using the new IP address for the scanner:
  `telnet <NewScannerIPAddress> <Port>`
- Save the new IP address permanentely in the scanner with the command:
  `PS`



- Stopp the Telnet session by closing the DOS window. The Ethernet communication will be automatically closed.

5.8 Power Supply Cable

This standard cable is 7.5 m (24.6 ft.) long, free from Halogen, and withstands ambient temperatures up to 180°C (356°F).
The linescanner requires a nominal 24 VDC power supply, 18 VDC minimum. To insure that sufficient voltage is supplied to the linescanner, it is necessary to define the gage and the length of the power cable to determine the resistance and the voltage drop. The maximum current draw of the linescanner is 1 A. The following table shows typical parameters from shielded 2 wire copper cables and the maximum recommended cable length.

Cable gauge	Resistance per m (1 wire)	Voltage drop per m at 1 A (2 wire)	Max. cable length
0.5 mm²	0.040 Ω/m	0.080 V/m	75 m
0.56 mm² (AWG 20)	0.034 Ω/m	0.068 V/m	88 m
0.75 mm²	0.027 Ω/m	0.054 V/m	111 m
0.82 mm² (AWG 18)	0.023 Ω/m	0.046 V/m	130 m
1.0 mm²	0.020 Ω/m	0.040 V/m	150 m
1.31 mm² (AWG 16)	0.015 Ω/m	0.030 V/m	200 m
1.5 mm²	0.014 Ω/m	0.028 V/m	214 m
2.08 mm² (AWG 14)	0.009 Ω/m	0.018 V/m	333 m

Tab. 1: Maximum allowed cable length from a 24 VDC power supply to the linescanner

The linescanner is equipped with an electronic fuse to prevent damage from voltage spikes greater than 36 V on power or signal lines. If the fuse circuit switches the power off, disconnect the power line for several seconds and turn power on again.

5.9 Warm-Up time

For accurate temperature readings we recommend a 30 minute warm-up period after power on. During this time the internal calibration sources will be stabilized. Digital communication and the analog outputs can be started 60 seconds after power on.

5.10 Water Cooling

The linescanner is equipped with integrated stainless-steel pipes for water cooling. These pipes are embedded in the cast aluminum housing. The water cooling system enables the linescanner to be installed in ambient temperatures up to 180°C (356°F). Maximum pressure for the cooling fluid is 15 bar (218 PSI). Only filtered water should be used in order to reduce the risk of clogging at the hose couplings. In order to prevent the accumulation of water condensation on the scanner window and to protect the window, the air purge system should always be used when water cooling is used.
Threaded tube fittings to connect a water cooling system are provided as accessory, see section 7.4 Tube Fittings, page 39. The internal stainless steel tube is designed to mate to a hose with an internal diameter of 6 mm (0.24 in.).

The following table gives some examples for the efficiency of the water cooling system.

Ambient Temperature	Water Flow	Water Temperature at Inlet	Resulting Internal Temperature
180°C (356°F)	1 l / min (0.26 gallons / min)	25°C (77°F)	36°C (96.8°F)
180°C (356°F)	2 l / min (0.52 gallons / min)	15°C (59°F)	27°C (80.6°F)

Tab. 2: Efficiency of the water cooling system

5.10.1 Avoiding Condensation

If environmental conditions make water cooling necessary, it is strongly recommended to check for condensation on the interior of the scanner housing.
Water cooling also cools the air in the interior of the scanner housing thereby decreasing the capability of the air to store water. The relative humidity increases and can reach 100% very quickly. In case of additional cooling, the surplus water vapor will precipitate out as water (condensation) that will condense on the lenses and the electronics thereby causing device failure. Condensation can even occur with an IP65 sealed housing.

The presence of condensed water inside the housing will void the warranty!

There are several ways to prevent condensation:

1. Adjust the flow rate and check visually for moisture on the exterior of the housing. This method has a degree of risk if the moisture is not detected quickly.
2. Use a radiator or heat exchanger where the cooling fluid can be heated above the dew point.
3. Measure the ambient temperature and the relative humidity where the device has to be installed. Use the table below to get the **minimum** device temperature. If the temperature of the cooling fluid is much lower than the minimum device temperature, condensation can be expected. To avoid this, adjust the flow rate manually or use a thermostat to keep the device at a minimum temperature above the dew point.

The use of a thermostat is strongly recommended, see section 7.5 Thermostat, page 40!

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Relative Humidity [%]

Ambient Temperature [°C/°F]	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32
5/ 41	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	5/ 41
10/ 50	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	5/ 41	5/ 41	5/ 41	5/ 41	5/ 41	10/ 50
15/ 59	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	5/ 41	5/ 41	5/ 41	5/ 41	10/ 50	10/ 50	10/ 50	10/ 50	10/ 50	15/ 59
20/ 68	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	5/ 41	5/ 41	5/ 41	10/ 50	10/ 50	10/ 50	10/ 50	15/ 59	15/ 59	15/ 59	15/ 59	15/ 59	20/ 68
25/ 77	0/ 32	0/ 32	0/ 32	0/ 32	5/ 41	5/ 41	10/ 50	10/ 50	10/ 50	10/ 50	15/ 59	15/ 59	15/ 59	20/ 68	20/ 68	20/ 68	20/ 68	20/ 68	25/ 77
30/ 86	0/ 32	0/ 32	0/ 32	5/ 41	5/ 41	10/ 50	10/ 50	15/ 59	15/ 59	15/ 59	20/ 68	20/ 68	20/ 68	20/ 68	25/ 77	25/ 77	25/ 77	25/ 77	30/ 86
35/ 95	0/ 32	0/ 32	5/ 41	10/ 50	10/ 50	15/ 59	15/ 59	20/ 68	20/ 68	20/ 68	25/ 77	25/ 77	25/ 77	25/ 77	30/ 86	30/ 86	30/ 86	30/ 86	35/ 95
40/ 104	0/ 32	5/ 41	10/ 50	10/ 50	15/ 59	20/ 68	20/ 68	20/ 68	25/ 77	25/ 77	25/ 77	30/ 86	30/ 86	30/ 86	35/ 95	35/ 95	35/ 95	35/ 95	40/ 104
45/ 113	0/ 32	10/ 50	15/ 59	15/ 59	20/ 68	25/ 77	25/ 77	25/ 77	30/ 86	30/ 86	35/ 95	35/ 95	35/ 95	35/ 95	40/ 104	40/ 104	40/ 104	40/ 104	45/ 113
50/ 122	5/ 41	10/ 50	15/ 59	20/ 68	25/ 77	25/ 77	30/ 86	30/ 86	35/ 95	35/ 95	35/ 95	40/ 104	40/ 104	40/ 104	45/ 113	45/ 113	45/ 113	45/ 113	50/ 122
60/ 140	15/ 59	20/ 68	25/ 77	30/ 86	30/ 86	35/ 95	40/ 104	40/ 104	40/ 104	45/ 113	45/ 113	50/ 122	50/ 122	50/ 122	50/ 122	50/ 122	50/ 122	50/ 122	60/ 140
70/ 158	20/ 68	25/ 77	35/ 95	35/ 95	40/ 104	45/ 113	45/ 113	50/ 122	50/ 122	50/ 122	50/ 122	50/ 122	60/ 140	60/ 140	60/ 140	60/ 140	60/ 140	60/ 140	70/ 158
80/ 176	25/ 77	35/ 95	40/ 104	45/ 113	50/ 122	50/ 122	50/ 122	60/ 140	60/ 140	60/ 140	60/ 140	60/ 140	70/ 158	70/ 158	70/ 158	70/ 158	70/ 158	70/ 158	80/ 176
90/ 194	35/ 95	40/ 104	50/ 122	50/ 122	50/ 122	60/ 140	60/ 140	60/ 140	70/ 158	70/ 158	70/ 158	70/ 158	80/ 176	80/ 176	80/ 176	80/ 176	80/ 176	80/ 176	90/ 194
100/ 212	40/ 104	50/ 122	50/ 122	60/ 140	60/ 140	70/ 158	70/ 158	70/ 158	80/ 176	80/ 176	80/ 176	80/ 176	80/ 176	90/ 194	90/ 194	90/ 194	90/ 194	90/ 194	100/ 212

Tab. 3: Minimum device temperatures [°C/°F]

Example:

Ambient temperature = 50 °C
Relative humidity = 40 %
Minimum device temperature = 30 °C

The use of lower temperatures is at your own risk!

Temperatures higher than 55°C (131°F) are not recommended due to the temperature limitation of the device.

5.11 Air purge collar

The air purge system produces a laminar air flow that protects the linescanner window from dust, moisture, and vapor. The air flows from the couplings through the walls of the housing and through side slits near the scanner's window. The air flow should be between 100 l/min (3.53 cfm) and 200 l/min (7.06 cfm) through each side, which corresponds to a pressure between 0.5 bar (7.25 psig) and 3.0 bar (43 psig) when using the supplied metric fittings. The inside diameter for the air hose should be 4 mm (0.16 in.). The hose couplings for the air purge system are connected to the housing through ISO 228 G 1/8" stainless steel fittings.

Use only clean or "instrument grade" air (free from oil contaminants). Do not use cooled air. This could lead to condensation on the linescanners window!

5.12 Laser

The built-in laser sighting function allows fast and precise aiming at small or rapidly moving targets, or targets passing at irregular intervals. The laser is specially aligned with the scan line of the linescanner. A small, bright red laser line shows you the center of the scanned line, not the size of the spots being measured.
The laser can be turned on and off via the scanner runtime software, see menu <Scanner> <Switch Laser on/off>.

To preserve laser longevity, the laser automatically turns off after 10 minutes of constant use!

Technical Data:

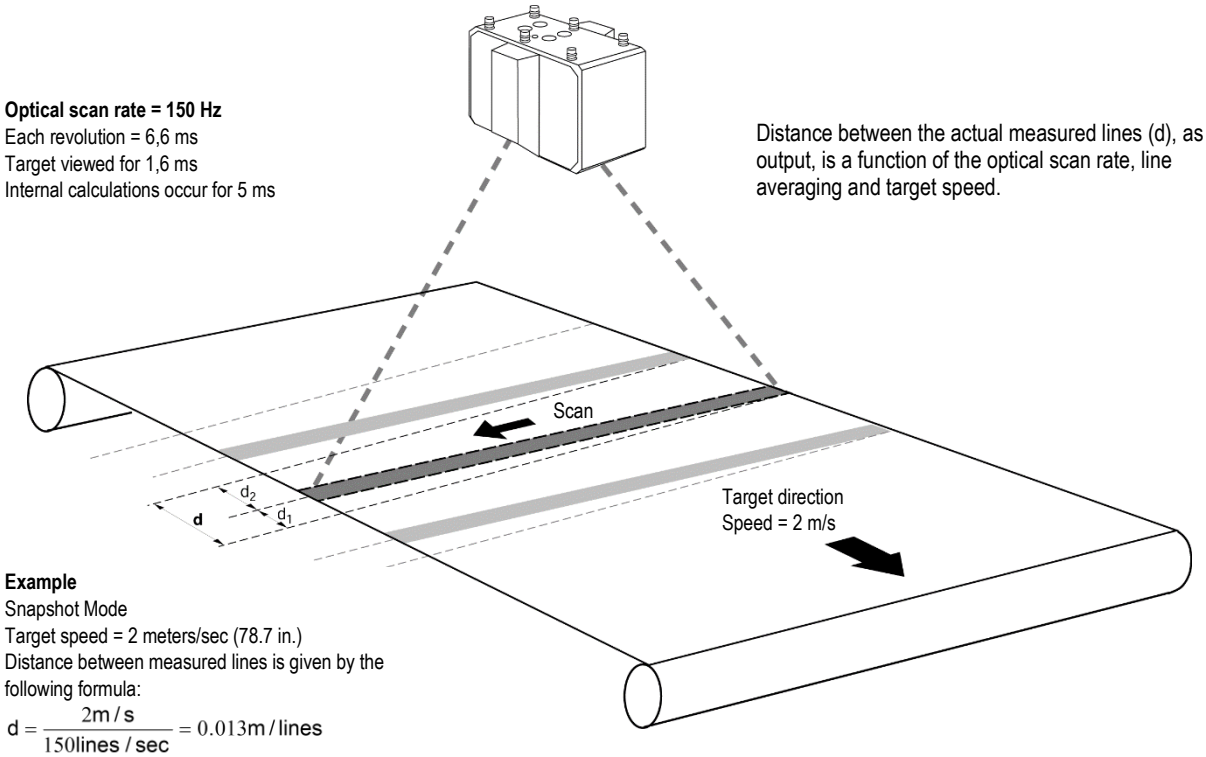
Laser type	Laser diode
Color	red
Internal temperature	automatic switch off at < 5°C (41°F) or > 50°C (122 °F)
Output power	1 mW
Laser class	2
Horizontal angle	70°, non-symmetrically

Risk of Personal Injury

Avoid exposure to laser light! Eye damage can result.
Use extreme caution when operating!
Never look direct into the laser beam!
Never point directly at another person!

6 Operation

6.1 Scan Rate and Target Viewing Time



i.e., During 100% mirror rotation, which takes 6,6 ms, target moves d = 0.013 m (0.51 in.)
During 25% mirror rotation (target viewing time), which takes 1,6 ms, target moves d_1 = 0.003 m (0.12 in.)
During 75% mirror rotation (internal calibration time), which takes 5 ms, target moves d_2 = 0.01 m (0.4 in.)

Figure 12: Linescanner applied to a moving target

6.2 Sectors

The linescanner is equipped with three analog outputs. Each output can be assigned to a ”sector” within the 90° scan angle. For each sector, the type of output (maximum, minimum, or mean value) can be selected. The output range can be configured for either 0 ... 20 mA, 4 ... 20 mA, or custom configured by user settings. The sector size and the emissivity value can be set for each sector, even if the sectors overlap. (In the case of overlapping sectors, the higher emissivity is given priority.) To use the sector function, the linescanner must run in the continuous mode.

Use the Configurator of the scanner software to configure the analog outputs!

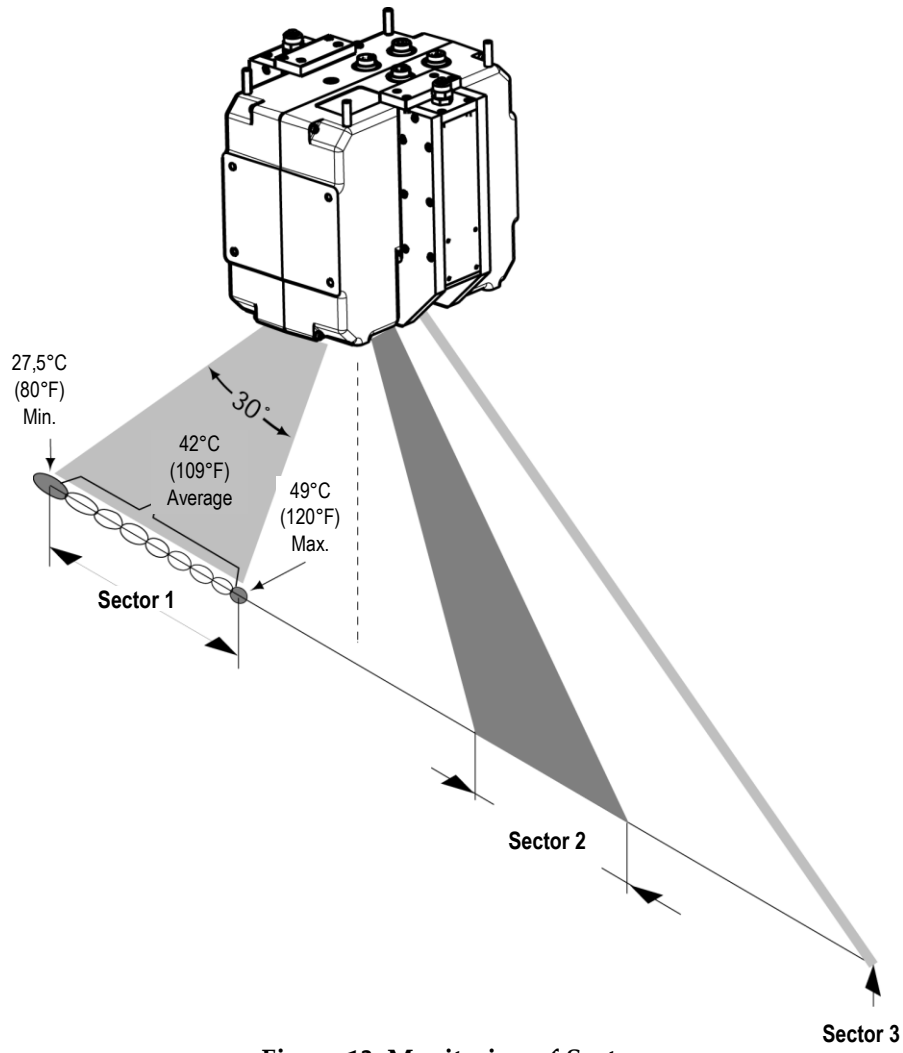


Figure 13: Monitoring of Sectors

- The maximum size of a sector is 90°.
- The corresponding analog output will remain inactive if the sector size is 0.
- Each sector can have either a maximum, minimum, or mean output value.
- Each sector is assigned to an analog interface.
- The output range can be adjusted to any value between 0-20mA.
- The analog interfaces are potential-free, but have a common ground connection

6.3 Data Transfer Modes

After each scan, the temperature values are transferred through the serial or the Ethernet interface to a computer. This computer will require either DataTemp software or custom software for data analysis. The data transfer can be achieved through one of two methods (selected by the user):

- **Snapshot mode (discontinuous mode)**: The lines are scanned at the set sampling rate and are subsequently stored in the internal memory of the linescanner (capacity: 700 lines). After completing the snapshot, all lines are transferred through the digital interface. When measuring discrete objects, it may be advantageous to use the trigger input of the linescanner to initiate the image capture. The trigger signal can be generated by a voltage/switch indicating the approach of an object from the production process into the linescanner field-of-view, see section 5.6 Input and Output Connectors on page 22 for more information.
- **Image mode (continuous mode)**: One line is scanned and transferred through the digital interface immediately. The duration of the data transfer is determined by the maximum interface speed. These factors determine whether every line is transferred.

6.4 Scanner as Stand-Alone Device

The scanner is equipped with internal sectors supporting three analog outputs and the alarm relay. To configure the scanner as stand-alone device without having a computer software running follow the steps given below:

1. Launch the DTDP Configurator.
2. Configure the scanner's standard settings like scan speed and pixel count.
3. Configure the internal sectors on the Configurator's <Device Sector> page.

   Please note, the software sectors under the <Sector> page are not supported with a scanner in the stand-alone mode.

   The DTDP software sends a <PS> command automatically to the scanner if at least one scanner internal sector is detected.
4. Launch the DTDP software one times to transfer all the parameters into the scanner. Afterwards, the DTDP software can be exit and the scanner runs as stand-alone device.

7 Accessories

7.1 Overview

A full range of accessories for various applications and industrial environments are available. Accessories include items that may be ordered at any time and added on-site. These include the following:

Mechanical:

- Mounting Plate for tripod (XXXTMP50ACMP)
- Adjustable Mounting Base (XXXTMP50ACRMB)
- Tube Fittings (with ISO threads: XXXTMP150FSISO, with NPT threads: XXXTMP150FSNPT)
- Thermostat (XXXTMP50THERM)
- Spare Windows (XXXTMP150ACSWK…)

Electrical:

- Industrial Power Supply (XXXSYSPS)
- RS485 Interface Kit
- Ethernet high temperature cable up to 180°C (356°F) (XXXTMP50SPETHCB...)
- Power supply high temperature cable up to 180°C (356°F) (XXXTMP50SPSCB...)

Fiber Optic:

- High Speed Fiber-Optic/RJ45 Converter, 1 Channel (XXXHSFIC1)
- High Speed Fiber-Optic/RJ45 Converter, 4 Channel (XXXHSFIC4)
- Fiber-Optic cable (XXXPi20FO1: 150 m / 492 ft, XXXPi20FO2: 300 m / 984 ft) multi-mode fiber, 50/125 µm, equipped with SC connectors
- Connection box for fiber optic converters (XXXSYSFICCON)

Ethernet Output Module:

- Basic Kit (XXXETHBASICKIT), contains:
  Fieldbus Coupler 750-352, Supply Module 750-602, End Module 750-600
- Digital Input Module 750-1406 (XXXETH16DI)
- Digital Output Module 750-1504 (XXXETH16DO)
- Passive Isolator 857-452 (XXXETH2AISO)
- Analog Current Output Module 750-563, preset to 0 to 20 mA (XXXETH2AOC0)
- Analog Current Output Module 750-563, preset to 4 to 20 mA (XXXETH2AOC4)
- Analog Voltage Output Module 750-562, preset to 0 – 10 V (XXETH2AOV)
- Relay Output Module 750-513 (XXXETH2R)

For more details, see the dedicated manual „I/O Module System for Infrared Linescanners“.

7.2 Mounting Plate

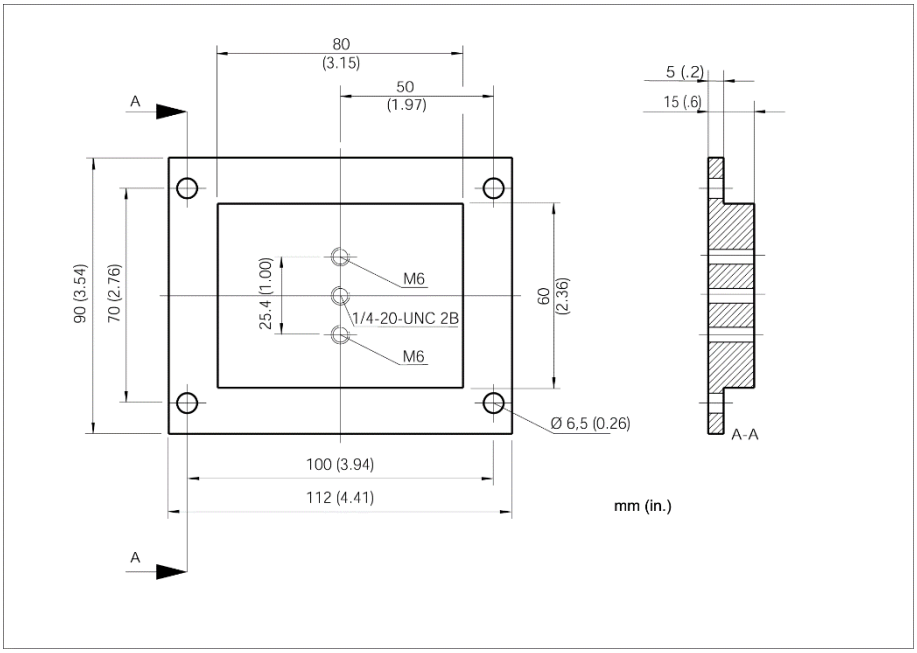


Figure 14: Mounting plate for tripod with 1/4" thread

7.3 Adjustable Mounting Base

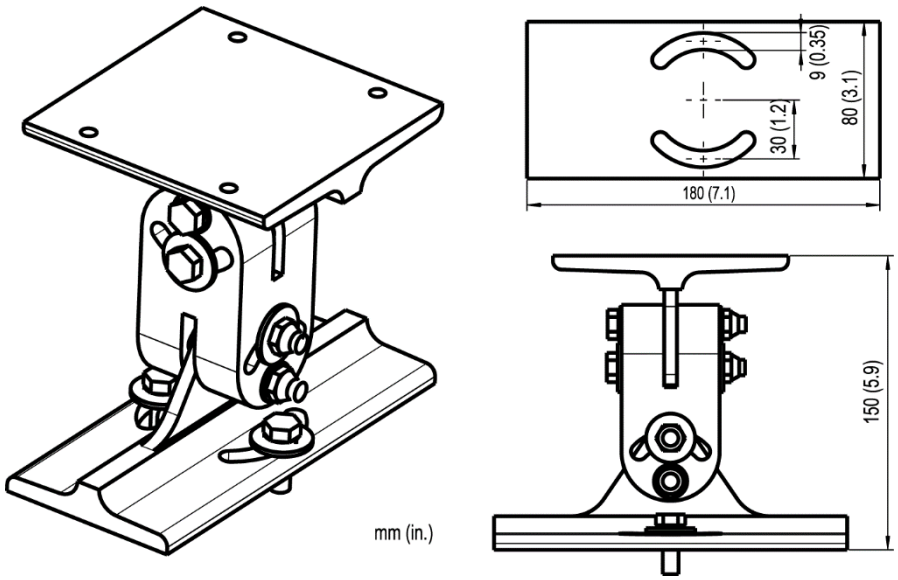


Figure 15: Adjustable Mounting Base (XXXTMP50ACRMB)

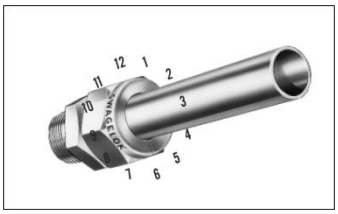
7.4 Tube Fittings

Description: 4x tube fittings - female adapter union (connects 6 mm outer diameter tube to conical thread Rc 1/8" (ISO7/1)) or 6 mm outer diameter tube to conical thread 1/8" NPT

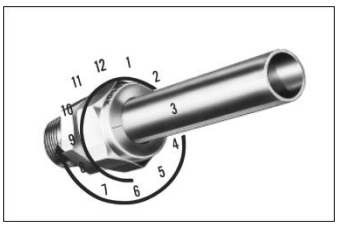
7.4.1 Installation of the Tube Fittings

The following steps explain the installation of the tube fittings to the stainless steel cooling tubes of the linescanner.[1]

- Insert tubing into the Swagelok tube fitting.
- Make sure that the tubing rests firmly on the shoulder of the tube fitting body and that the nut is finger-tight.



- Scribe the nut at the 6 o'clock position.



- While holding the fitting body steady with a back-up wrench, tighten the nut 1 ¼ turns to the 9 o'clock position.

7.4.2 Reassembly of the Tube Fittings

You may disassemble and reassemble a Swagelok tube fitting as often as required.

- Insert tubing with pre-swaged ferrules into the fitting body until the front ferrule seats.

- Rotate the nut with a wrench to the previously pulled-up position. At this point, a significant increase in resistance will be encountered.

- Tighten slightly with a wrench.

[1] Illustrations: © Swagelok

7.5 Thermostat

The thermostat is an accessory which helps keep the housing temperature over the dew point thereby avoiding damage due to condensed water in the interior of the housing. The thermostat needs no further electrical installation.

When ordering a thermostat, the shipment contains the following parts:

- thermostat, already mounted with one regulation valve, one conduit coupling ½“, two thread adapter ½“ to ⅛“, two fittings ⅛“
- external sensitive element for the thermostat
- mounting block for external sensitive element
- 2x hex screws M6x16
- 2x hex screws M3x8
- 5 m cooling hose, PA 8x1, max. pressure 12 bar (174 psi) at 70°C (158°F)

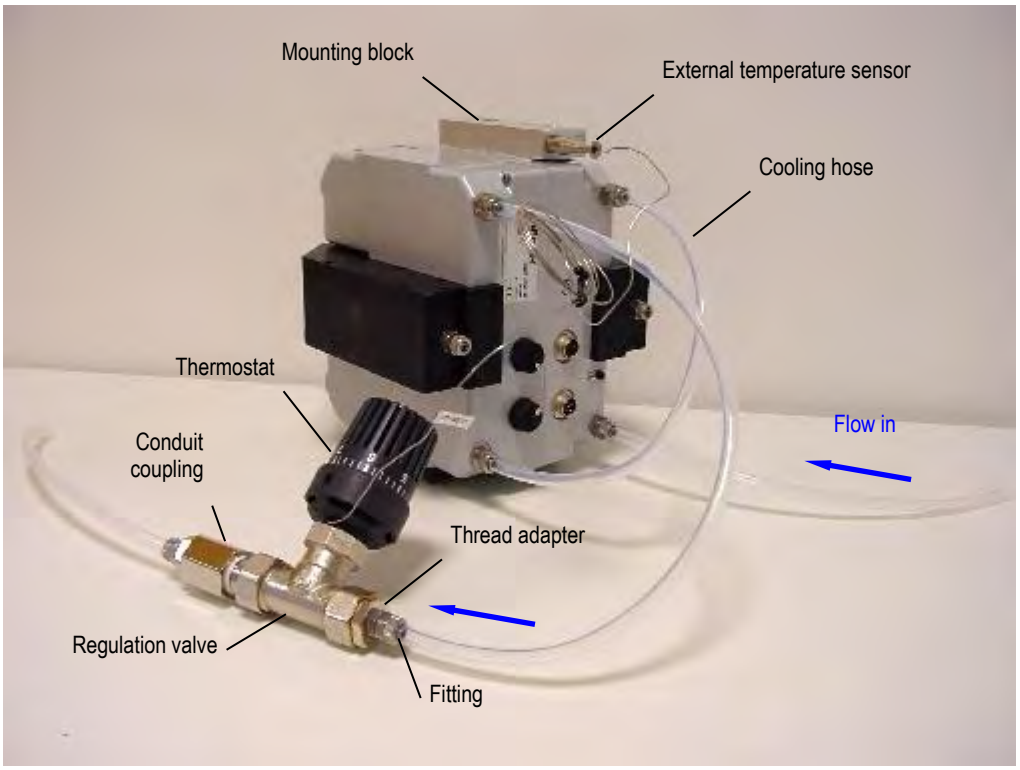


Figure 16: Installation of the Thermostat

Installation:

- Before mounting the mounting block, ensure that the mating surface is completely clean, Fix the mounting block either on the upper or on the lower side of the scanner’s housing using the supplied M6x16 hex screws.
- Mount the thermostat close to the scanner within a distance of 1.5 m.
- Cut the cooling hose to lengths according to your needs, see figure above.
- Fix the cooling hoses as shown in the figure above. Ensure that the thermostat (arrow on the housing’s side) is installed according to the flow direction.
  Note: The fittings needed to connect the inner taper thread of the linescanner tube fitting (Rc 1/8") and the cooling hose of the Thermostat are not supplied as standard components! We

recommend a Swagelok® Stainless Reducing Union (8 mm outer diameter – 6 mm inner diameter) and Swagelok Stiffener Sleeve.

- Move the external temperature sensor into the mounting block and fix it using the M3x8 hex screws Take care not to damage the sensor when tightening the screws! Do not bend the connection line between sensitive element and thermostat at a radius tighter than 5 mm!
- Adjust the thermostat according to the table below.

Relative Humidity [%]

Ambient Temperature [°C/°F]	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
0/32	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
5/41	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
10/50	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
15/59	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	0
20/68	+	+	+	+	+	+	+	+	+	+	+	+	+	0	0	0	0	0	1
25/77	+	+	+	+	+	+	+	+	+	+	0	0	0	1	1	1	1	1	2
30/86	+	+	+	+	+	+	+	0	0	0	1	1	1	1	2	2	2	2	3
35/95	+	+	+	+	+	0	0	1	1	1	2	2	2	2	3	3	3	3	4
40/104	+	+	+	+	0	1	1	1	2	2	2	3	3	3	4	4	4	4	5
45/113	+	+	0	0	1	2	2	2	3	3	4	4	4	4	5	5	5	5	6
50/122	+	+	0	1	2	2	3	3	4	4	4	5	5	5	6	6	6	6	7
60/140	0	1	2	3	3	4	5	5	5	6	6	7	7	7	7	7	7	7	–
70/158	1	2	4	4	5	6	6	7	7	7	7	7	–	–	–	–	–	–	–
80/176	2	4	5	6	7	7	7	–	–	–	–	–	–	–	–	–	–	–	–
90/194	4	5	7	7	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–
100/212	5	7	7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

+	thermostat not necessary
0	thermostat recommended
1 – 7	thermostat necessary, 1 – 7: recommended adjustment of the thermostat
–	housing temperature out of specification

Tab. 4: Thermostat Adjustment

- Check the system functionality. After a few minutes the internal housing temperature should reach the minimum device temperature as follows:

Thermostat adjustment	Minimum device temperature
0	15°C / 59°F
1	20°C / 68°F
2	25°C / 77°F
3	30°C / 86°F
4	35°C / 95°F
5	40°C / 104°F
6	45°C / 113°F
7	50°C / 122°F

7.6 Spare Windows

The available spare windows are listed in the table below. Each spare window includes a gasket. For replacing the spare window see the procedure described in section 8.2 Replacing the Window, page 46.

Spare Window	Spectral Model
XXXTMP150ACSWKLT	LT
XXXTMP150ACSWKMT	MT
XXXTMP150ACSWKG5	G5
XXXTMP150ACSWK1M	1M
XXXTMP150ACSWK2M	2M
XXXTMP150ACSWKP3	P3
XXXTMP150ACSWKHR	HR

Tab. 5: Available Spare Windows depending on the Spectral Model

Each spare window comes with a dedicated factor for the transmissivity. The transmissivity needs to be set in the scanner via the scanner system software under the menu <Scanner> <Transmissivity of the scanner window> or by using the dedicated scanner command <TAW>.

7.7 Industrial Power Supply

The DIN-rail mount industrial power supply delivers isolated dc power and provides short circuit and overload protection.

To prevent electrical shocks, the power supply must be used in protected environments (cabinets)!

Technical data:

Protection class	prepared for class II equipment
Environmental protection	IP20
Operating temperature range	-25°C to 55°C (-13°F to 131°F)
AC Input	100 – 240 VAC 44/66 Hz
DC Output	24 VDC / 1.3 A
Cross sections	input/output
	0.08 to 2.5 mm² (AWG 28 to 12)

[1]

Figure 17: Industrial Power Supply

7.8 RS485 Interface Kit

The RS232/485 interface provides a serial data transfer to the PC. However, the PC will have to be capable of communicating at a sufficiently high baud rate. Most standard PC's communicate at speeds up to 115 kBaud which is capable of communication with the linescanner at a scan speed of 36 Hz and at 256 pixel per scan data sampling rate. For faster scan frequencies or for a higher pixel count the Ethernet connection should be used.

The RS485 Interface Kit comes with 7.5 m (25 ft) long **RS485 cable** (for ambient: 180°C/356°F: XXXTMP50S485CB, for ambient: 60°C/140°F: XXXTMP150S485CBLT), RS232/485 **converter** and **RS232 adapter cable** 25 to 9-pin.

To use the RS232/485 connection, connect the linescanner to the PC with the RS485 cable. First, insert the 7-pin DIN-round plug (IP65) into the socket on the back side of the linescanner, then tighten the

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locking cap carefully. Next, connect the RS232/485 converter to the RS232 serial interface of the PC. Use the RS232 25 to 9-pin adapter cable if needed. The RS232/485 converter is powered by the linescanner, and no separate power supply is required.

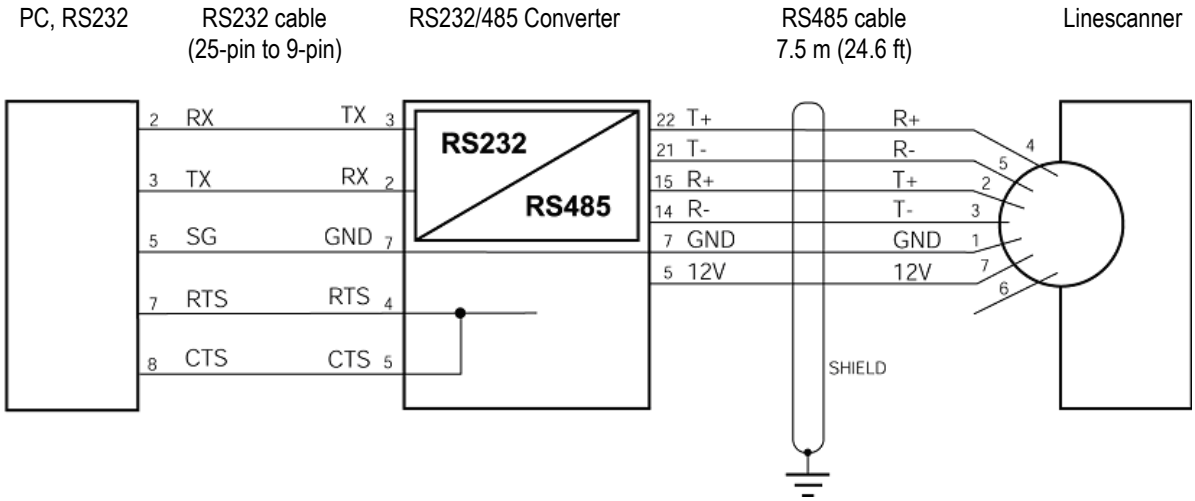


Figure 18: RS232/485 interface between linescanner and PC

RS232 Signals:

TX	transmission data
RX	received data
SG	system ground
RTS	transmission request
CTS	ready for transmission

RS485 Signals:

Twisted pairs:	T+	data transmission +
	T-	data transmission -
Twisted pairs:	R+	data reception +
	R-	data reception -

Power supply for the RS232/485 converter:

Twisted pairs:	12 V
	GND

To program the linescanner via its serial interface (see MP150 protocol manual), the serial interface settings needs to be:

8 data bits,

no parity bit,

1 stop bit,

no flow control

Allowed baud rates:

9600 Baud (linescanner factory default)

57.6 kBaud

115 kBaud

230 kBaud

7.8.1 RS485 Cable Extension

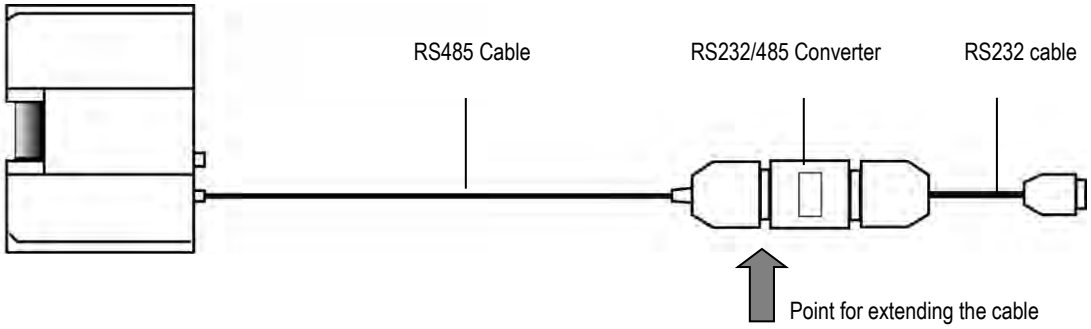


Figure 19: RS485 Cable Extension

When using an extension, separate the high-temperature communication cable only at the location indicated (see arrow in the figure above) from the RS232/485 converter. To extend the communication cable, a 6-wire cable is needed.

Be sure to use twisted pair cables as signal wires!

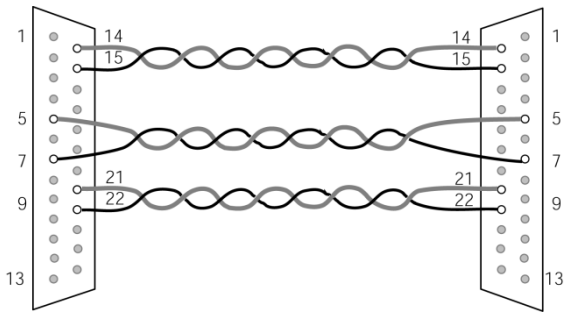


Figure 20: Extension of communication cable

8 Maintenance

If you need application assistance, calibration, repair, and solutions to specific problems our customer service representatives are always at your disposal. In many cases, problems can be solved over the telephone. If you need to return equipment to us, please contact our Service Department before doing so, please look at the address page for contact information.

8.1 Cleaning the Window

The linescanner's window must be kept as clean as possible. Any foreign matter on the window will affect the accuracy of the measurements. Take care when cleaning the window as it can easily be scratched. Please observe the following guidelines:

- Lightly blow off loose particles.
- Gently brush off remaining particles with a soft camel hair brush.
- Clean remaining dirt using a soft cotton cloth dampened in distilled water. Don't rub.
- To remove finger prints or other grease, gently wipe with a soft cloth dampened in a mild soap or distilled water (or ethanol or alcohol) solution.
- You should avoid getting any liquid in areas surrounding the window material.

8.2 Replacing the Window

1. Remove the 4 hex screws on the back side using a 2.5 mm allen wrench. Slide the collar forward to separate it from the housing!

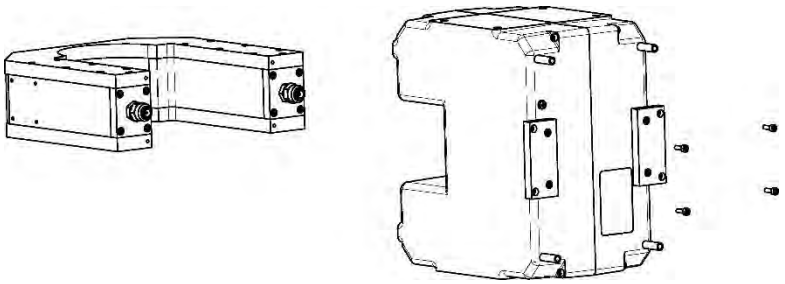


Figure 21: Removing the air purge collar

2. Remove the 4 hex screws on the front side separating the window frame from the housing. Separate the window from the frame!
3. The window assembly consists of a frame (holder), the window material (mica) and a gasket. The gasket lies close to the housing, followed by the window material. If necessary, exchange the window material. Window size: 114 x 60 mm (4.49 x 2.36 inches).

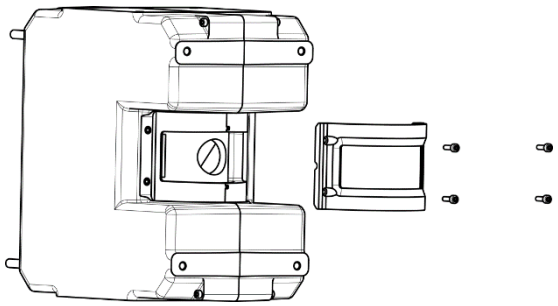
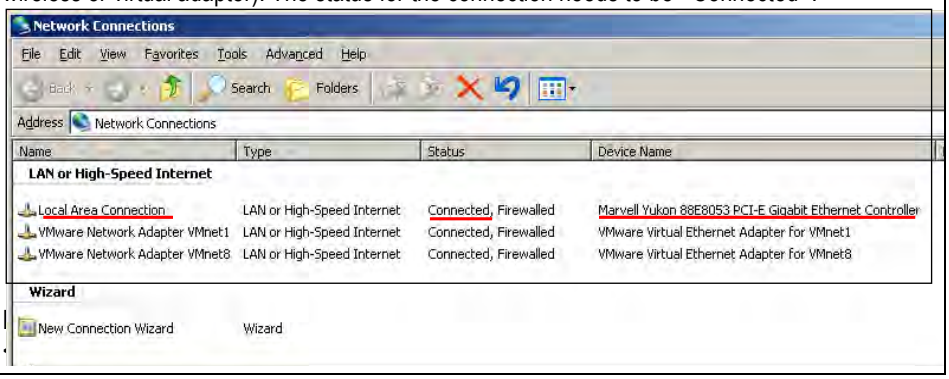


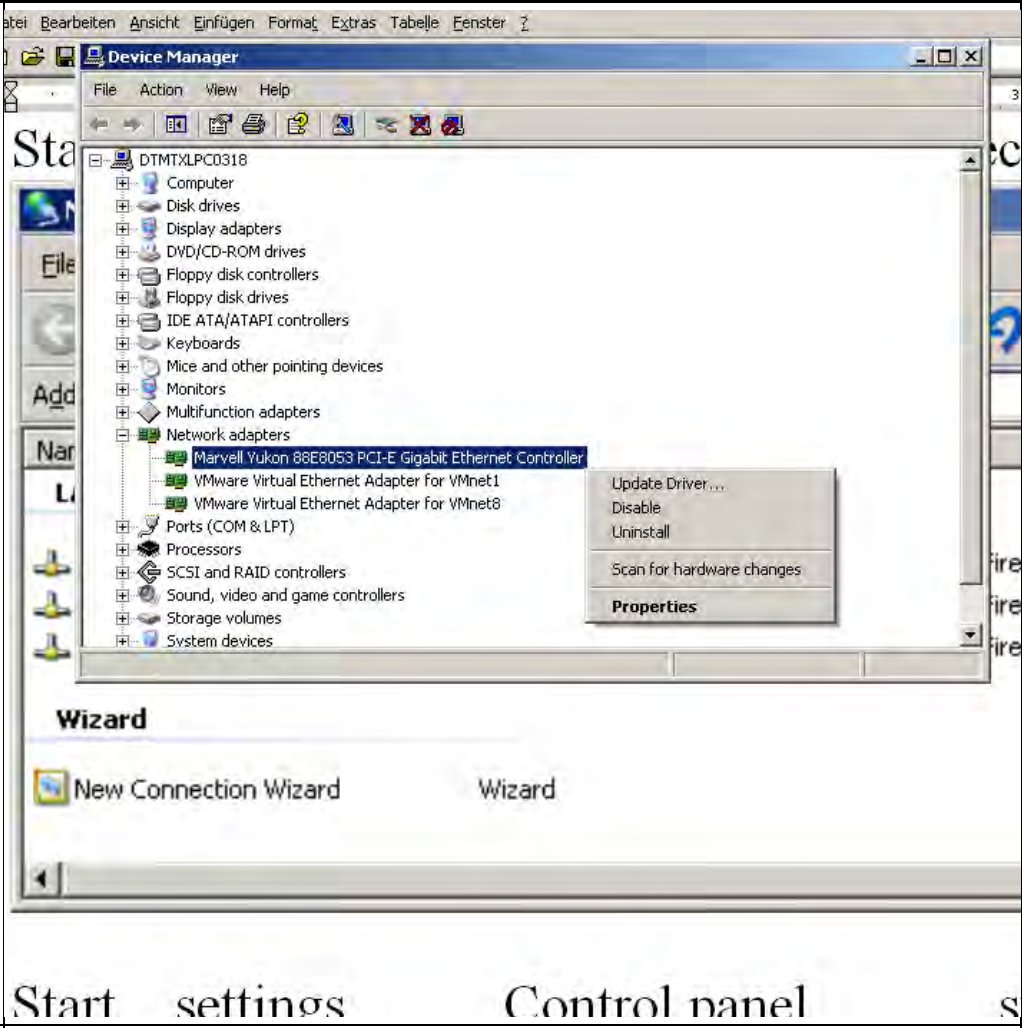
Figure 22: Separating the window

4. The four mounting screws must be placed in the holder´s corners before reassembling! Center the new film on the housing's gasket!
5. Check for even tension of the film. Remove the film and repeat the steps if there are wrinkles on the film!
6. Install the window assembly on the housing by alternating between the four screws. Do not over-tighten!
7. Install the air purge collar on the housing!

For correct temperature readings, the transmission factor for the new window must be set via the scanner runtime software, see menu <Scanner> <Transmissivity of the scanner window>!

9 Troubleshooting

Checkpoint	Possible Cause / Solution
Scanner	• Check the wiring of the whole system (correctly fitted connectors, cable damage). • Check the power for the scanner on scanner's backside LED: MP50: red LED is "on" MP150: green LED is "on" • Check the rotation of the internal scanner mirror assuming the power is on (viewing or hearing test). • The main power for scanner and PC should be provided at the same location. • Avoiding scanner overheating. Maximum internal housing temperature: 60°C (140°F). The internal housing temperature is displayed in the status bar of the scanner software. • In case of the scanner's cooling, check for condensation in the scanner's housing → condensation can cause the total outage of the unit. To avoid condensation see section 5.10.1 Avoiding Condensation, page 30. • Mount the scanner and the cables away from motors or heaters that produce strong electrical fields. • A dirty measurement window or an obstructed field of view could cause erroneous temperature values
Ethernet Communication	• Make sure that the scanner's Ethernet settings are setup correctly, see section 5.7.2 Ethernet Settings, page 25. • Make sure that the PC network adapter is setup correctly, see section 5.7.3 Changing the Ethernet Settings for the PC, page 26. • <Start> <Settings> <Network Connections> provides a list of all available network connections. The desired network connection needs to be related to your real adapter device (and no wireless or virtual adapter). The status for the connection needs to be <Connected>.  •

Checkpoint	Possible Cause / Solution
	
Serial Communication via COM port	• Verify correct COM port. If existing use another COM port on the computer. • To avoid communication problems the properties of all used COM ports must be changed as follows: <Start> <Settings> <Control Panel> <System> <Hardware> <Device Manager> <Ports (COM & LPT)> <Communications Port COMx> <Ports Settings> <Advanced> <Receive Buffer>: Low • In case of using plug-in serial cards, disable <CTS/RTS> for the Auto Flow Control. <Start> <Settings> <Control Panel> <System> <Hardware> <Device Manager> <Ports (COM & LPT)> <Communications Port COMx> <Ports Settings> <Advanced> • Avoid the use of third party USB/RS232 converters! • Ensuring the RS232/485 converter is close to the PC (and not to the scanner) • In case of communication errors, the baud rate should be reduced step by step. • Software is not to be launched during the initialization time of the scanner (about 30 s).
PC	• On some computers, the performance of the software can be increased dramatically by switching off the hardware graphic acceleration: <Start> <Settings> <Control Panel> <Display> <Settings> <Advanced> <Troubleshooting> <Hardware acceleration>: None

Troubleshooting

Checkpoint	Possible Cause / Solution
	• A too high display resolution can cause problems. Test temporarily a setting of 800x600 pixel at high color (16 bit). • For several reasons the PC can be overloaded. This can be checked by running the scanner software and pushing CTRL+ALT+DEL at the same time. In the task manager a window for the system performance can be selected. The value must be every time much below 100%. • In some cases, the graphic card of the computer can interrupt serial communications for too long a time. S3-graphic cards are known to exhibit this problem. The only solution is to exchange the S3-graphic card.

10 Appendix

10.1 Determination of Emissivity

Emissivity is a measure of an object's ability to absorb and emit infrared energy. It can have a value between 0 and 1.0. For example a mirror has an emissivity less of 0.1, while the so-called "Blackbody" reaches an emissivity value of 1.0. If a higher than actual emissivity value is set, the output will read low, provided the target temperature is above its ambient temperature. For example, if you have set 0.95 and the actual emissivity is 0.9, the temperature reading will be lower than the true temperature. An object's emissivity can be determined by one of the following methods:

1. Determine the actual temperature of the material using an RTD (PT100), a thermocouple, or any other suitable method. Next, measure the object's temperature and adjust emissivity setting until the correct temperature value is reached. This is the correct emissivity for the measured material.
2. For relatively low temperatures (up to 260°C, 500°F) place a plastic sticker on the object to be measured. This sticker should be large enough to cover the target spot. Next, measure the sticker's temperature using an emissivity setting of 0.95. Finally, measure the temperature of an adjacent area on the object and adjust the emissivity setting until the same temperature is reached. This is the correct emissivity for the measured material.
3. If possible, apply flat black paint to a portion of the surface of the object. The emissivity of the paint must be above 0.95. Next, measure the temperature of the painted area using an emissivity setting of 0.95. Finally, measure the temperature of an adjacent area on the object and adjust the emissivity until the same temperature is reached. This is the correct emissivity for the measured material.

10.2 Typical Emissivity Values

The following table provides a brief reference guide for determining emissivity and can be used when one of the above methods is not practical. Emissivity values shown in the table are only approximate, since several parameters may affect the emissivity of a material. These include the following:

1. Temperature
2. Angle of measurement
3. Geometry (plane, concave, convex)
4. Thickness
5. Surface quality (polished, rough, oxidized, sandblasted)
6. Spectral range of measurement
7. Transmissivity (e.g. thin films plastics)

Appendix

Material	Metals Emissivity			
	1 µm	1.6 µm	3.9 µm	5 µm
Aluminum				
Unoxidized	0.1-0.2	0.02-0.2	0.02-0.2	0.02-0.2
• Oxidized	0.4	0.4	0.2-0.4	0.2-0.4
Alloy A3003, Oxidized		0.4	0.4	0.4
Roughened	0.2-0.8	0.2-0.6	0.1-0.4	0.1-0.4
Polished	0.1-0.2	0.02-0.1	0.02-0.1	0.02-0.1
Brass				
Polished	0.35	0.01-0.05	0.01-0.05	0.01-0.05
Burnished	0.65		0.3	0.3
Oxidized		0.6	0.5	0.5
Chromium	0.4	0.4	0.03-0.3	0.03-0.3
Copper				
Polished	0.05	0.03	0.03	0.03
Roughened	0.05-0.2	0.05-0.2	0.05-0.15	0.05-0.15
Oxidized	0.2-0.8	0.2-0.9	0.5-0.8	0.5-0.8
Gold	0.3	0.01-0.1	0.01-0.1	0.01-0.1
Haynes				
Alloy	0.5-0.9	0.6-0.9	0.3-0.8	0.3-0.8
Inconel				
Oxidized	0.4-0.9	0.6-0.9	0.6-0.9	0.6-0.9
Sandblasted	0.3-0.4	0.3-0.6	0.3-0.6	0.3-0.6
Electropolished	0.2-0.5	0.25	0.15	0.15
Iron				
Oxidized	0.7-0.9	0.5-0.8	0.6-0.9	0.6-0.9
Unoxidized	0.35	0.1-0.3	0.05-0.25	0.05-0.25
Rusted		0.6-0.9	0.5-0.8	0.5-0.8
Molten	0.35	0.4-0.6	—	—
Iron, Cast				
Oxidized	0.9	0.7-0.9	0.65-0.95	0.65-0.95
Unoxidized	0.35	0.3	0.25	0.25
Molten	0.35	0.3-0.4	0.2-0.3	0.2-0.3
Iron, Wrought				
Dull		0.9	0.9	0.9

Tab. 6: Typical Emissivity Values

Material	Metals Emissivity			
	1 µm	1.6 µm	3.9 µm	5 µm
Lead				
Polished		0.05-0.2	0.05-0.2	0.05-0.2
• Rough		0.6	0.4	0.4
Oxidized		0.3-0.7	0.2-0.7	0.2-0.7
Magnesium	0.3-0.8	0.05-0.3	0.03-0.15	0.03-0.15
Mercury		0.05-0.15	0.05-0.15	0.05-0.15
Molybdenum				
Oxidized	0.5-0.9	0.4-0.9	0.3-0.7	0.3-0.7
Unoxidized	0.25-0.35	0.1-0.35	0.1-0.15	0.1-0.15
Monel (Ni-Cu)	0.3	0.2-0.6	0.1-0.5	0.1-0.5
Nickel				
Oxidized	0.8-0.9	0.4-0.7	0.3-0.6	0.3-0.6
Electrolytic	0.2-0.4	0.1-0.3	0.1-0.15	0.1-0.15
Platinum				
Black		0.95	0.9	0.9
Silver	0.04	0.02	0.02	0.02
Steel				
Cold-Rolled	0.8-0.9	0.8-0.9	0.8-0.9	0.8-0.9
Ground Sheet			0.5-0.7	0.5-0.7
Polished Sheet	0.35	0.25	0.1	0.1
Molten	0.35	0.25-0.4	0.1-0.2	0.1-0.2
Oxidized	0.8-0.9	0.8-0.9	0.7-0.9	0.7-0.9
Stainless	0.35	0.2-0.9	0.15-0.8	0.15-0.8
Tin (Unoxidized)	0.25	0.1-0.3	0.05	0.05
Titanium				
Polished	0.5-0.75	0.3-0.5	0.1-0.3	0.1-0.3
Oxidized		0.6-0.8	0.5-0.7	0.5-0.7
Tungsten			0.05-0.5	0.05-0.5
Polished		0.1-0.3	0.05-0.25	0.05-0.25
Zinc				
Oxidized	0.6	0.15	0.1	0.1
Polished	0.5	0.05	0.03	0.03

Tab. 7: Typical Emissivity Values

Appendix

Material	Non-Metals Emissivity		
	1 µm	1.6 µm	5 µm
Asbestos	0.9	0.8	0.9
Asphalt			0.95
Basalt			0.7
Carbon		0.9	
Unoxidized			0.8-0.9
Graphite			0.7-0.9
Carborundum			0.9
Ceramic	0.4		0.8-0.95
Clay			0.85-0.95
Concrete	0.65	0.2	0.9
Cloth		0.4-0.9	0.95
Glass			
Plate			0.98
“Gob”			0.9
Gravel		0.95	0.95
Gypsum		0.8-0.95	0.4-0.97
Ice			—
Limestone			0.4-0.98
Paint (non-al.)		0.8-0.9	—
Paper (any color)		0.8-0.9	0.95
Plastic (opaque, over 20 mils)			0.95
Rubber			0.9
Sand			0.9
Snow			—
Soil			—
Water		0.8-0.95	—
Wood, Natural			0.9-0.95

Tab. 8: Typical Emissivity Values

To optimize surface temperature measurements, consider the following guidelines:

- Determine the object emissivity using the instrument which is also to be used for the measurements.
- Avoid reflections by shielding the object from surrounding temperature sources.
- For higher temperature objects use instruments with the shortest wavelength possible.
- For translucent materials such as plastic foils or glass, assure that the background is uniform and lower in temperature than the object.
- Mount the sensor perpendicular to surface whenever emissivity is less than 0.9. In all cases, do not exceed angles more than 30 degrees from incidence.