FLUKE
Process Instruments

CS400 System

Kiln Shell Temperature Monitoring

Hardware Manual

PN 5259635, English, Rev. 1.0, Sep 2021

Warranty

The manufacturer warrants this instrument to be free from defects in material and workmanship under normal use and service for the period of four 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.

Every change of the standard system design must be acknowledged from the manufacturer; otherwise, the warranty of the complete system will be lost!

This manual is available in different languages. In case of differences between the language versions, the English manual is binding.

Table of Contents

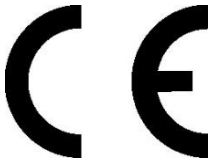
List of Tables

Table **Page**

List of Figures

Figure **Page**

Compliance Statement



The device complies with the requirements of the European Directives:

EC – Directive 2014/30/EU – EMC

EC – Directive 2014/35/EU – low voltage

EC – Directive 2011/65/EU – RoHS Compliance
amended by Directive (EU) 2015/863 (RoHS III)

EN 61326-1: 2013	Electrical measurement, control, and laboratory devices - Electromagnetic susceptibility (EMC)
EN 61558-1: 2006	Safety Requirements for power transformers, power supplies, reactors, and similar products (low voltage)
EN 61558-2-6: 2010	Safety Requirements for power transformers, power supplies, reactors, and similar products for use up to 1.1 kV (low voltage)
EN 50581: 2012	Technical documentation for the evaluation of electrical products with respect to restriction of hazardous substances (RoHS)

Safety Information

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. Eventual 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 the measurement of temperature. The instrument is appropriate for continuous use. The instrument operates reliably in demanding conditions, such as in high environmental temperatures, as long as the documented technical specifications for all instrument components 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 operation safety and functionality of the instrument.

Safety Symbol	Description
	Read all safety information before in the handbook
	Hazardous voltage. Risk of electrical shock.
	Warning. Risk of danger. Important information. See manual.
	Laser warning
	Earth (ground) terminal
	Protective conductor terminal
	Switch or relay contact
	DC power supply
	Conforms to European Union directive.
	Disposal of old instruments should be handled according to professional and environmental regulations as electronic waste.
IP65	International Ingress Protection Marking

To prevent possible electrical shock, fire, or personal injury follow these guidelines:

- Read all safety information before you use the product.
- Use the product only as specified, or the protection supplied by the product can be compromised.
- Do not use the product around explosive gases, vapor, or in damp or wet environments.
- Carefully read all instructions.
- Do not use and disable the product if it is damaged.
- Do not use the product if it operates incorrectly.
- Do not apply more than the rated voltage between the terminals or each terminal and earth ground.
- Do not look directly into the laser with optical tools (for example, binoculars, telescopes, microscopes). Optical tools can focus the laser and be dangerous to the eye.
- Do not look into the laser. Do not point laser directly at persons or animals or indirectly off reflective surfaces.
- Do not use laser viewing glasses as laser protection glasses. Laser viewing glasses are used only for better visibility of the laser in bright light.
- Use the product only as specified or hazardous laser radiation exposure can occur.
- Incorrect wiring can damage the sensor and void the warranty. Before applying power, make sure all connections are correct and secure!
- To prevent possible electrical shock, fire, or personal injury make sure that the sensor is grounded before use.
- Have an approved technician repair the product.
- The metallic enclosure of the sensor is not necessarily earthed by installation. At least one of the following safety measures must be met to minimize the danger of electrostatic charges:
  - Earth grounding of the cable shield
  - Installing the unit’s metallic enclosure on an earth grounded mounting bracket or on any other grounded bases
  - Protect the operator from electrostatic discharge

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1 Description

The CS400 system is a comprehensive temperature measurement system for the monitoring, control, and analysis of rotating kiln shells used in cement and lime production, mineral processing, hazardous waste incineration and other processes. This system is a unique combination of hardware centered on the industry-leading MP linescanner and a powerful, industrial software package. The system allows accurate monitoring of the kiln shell and early detection of hot spots indicating damaged or missing refractory bricks, preventing costly kiln damage and extending production runs.

Figure 1-1: Linescanner

The key component of the CS400 system is the infrared linescanner. The linescanner collects infrared energy, emitted from the kiln surface allowing the system to measure the temperature along the length of the kiln.

The CS400 system provides many features, which include full-color thermograms of the kiln surface, user defined alarms, I/O module support, and extensive historical data analysis capability. The CS400 system also adds OPC server functionality and full integration of all available accessories. Most notably, additional point sensors can be installed and configured to monitor portions of the kiln “shadowed” from the main sensor by physical obstructions and the results displayed as one homogenous thermogram. Similarly, a separate sensor is available to monitor the burning zone of the kiln and again the data will be seamlessly incorporated into one common display in the control room.

Using an optical fiber cable from the scanner in the field to the PC Ethernet interface in the control room is a reliable way for connecting. Using fiber optics, you can prevent electrical interference from corrupting the CS400 system. The optical fiber cable supports high speeds and long-distance transmissions (up to 2 km / 1.2 mi). One fiber optic communication line only from the field to the control room minimizes the installation efforts on-site.
For a complete system overview see section 8.2 System Installation – with Accessories, page 48.

2 Technical Data

2.1 Measurement Specification

Temperature range	100 to 650°C (212 to 1202°F)
Spectral response	3.5 to 4 µm
Detector	HgCdTe
Accuracy	± 0.5% of reading or ± 3°C (± 6°F) whichever is greater, at 0 to 50°C (32 to 122°F) ambient temperature for the scanner
Repeatability	± 1°C (± 2°F) at 0 to 50°C (32 to 122°F) ambient temperature for the scanner
Temperature resolution	0.1 K (digital interface)
Sampling rate	1024 pixel per scan line

2.2 Optical Specifications

Scan angle (FOV)	90°
Measurement resolution	170:1 (IFOV = 5.9 mrad)[1], 90% energy
Spot detection	510:1 (IFOV = 2.0 mrad)[2], 50% energy
Focus	infinity

2.3 Electrical Specifications

System power	100 to 240 VAC (for the system connection box)
Ethernet	TCP/IPv4 protocol 10/100 MBit/s, electrically isolated, auto-negotiation IP address: 192.168.42.30 – default for the first scanner 192.168.42.31 – default for the second scanner +1 for each further scanner
Alarm output	potential-free relay contacts: max. 30 V / 1 A, normally open / normally closed

2.4 Environmental Specifications

Ingress protection	IP65 (IEC529) – for the linescanner
Ambient temperature	-40 to 50°C (-40 to 122°F), – for scanner with housing, without cooling, no direct sunlight
Warm-up time	20 min.
Lifetime	40,000 h MTBF (mean-time between failure), for the scanning system

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

2.5 Weights and Dimensions

Linescanner	Length	180 mm (7.09 in)
	Width	120 mm (4.72 in)
	Height	200 mm (7.87 in)
	Weight	7 kg (15.4 lbs)
Protective housing	Length	300 mm (11.81 in)
	Width	300 mm (11.81 in)
	Height	300 mm (11.81 in)
	Weight	8 kg (17.6 lbs)
Protective housing	Length	452 mm (17.79 in)
	Width	496 mm (19.53 in)
	Height	450 mm (17.72 in)
	Weight	13 kg (28.6 lbs)
	with mounting bracket and protective sighting channel	
Position indicator		
Sensor head	Length	50 mm (1.97 in)
	Diameter	50 mm (M50 x 1,5) (1.97 in)
	Weight	0.3 kg (0.66 lbs)
Junction box	Length	84 mm (3.31 in)
	Length	110 mm (4.33 in) with electronic tube
	Width	79 mm (3.11 in)
	Height	67 mm (2.64 in)
	Weight	0.7 kg (1.5 lbs)
System connection box	Width	380 mm (15 in)
	Height	380 mm (15 in)
	Deep	210 mm (8.3 in)
	Weight	9.8 kg (22 lb) - netto
Packaging	about 40 kg (88 lb) – for one scanner system	
	about 80 kg (176 lb) – for two scanner system	

2.6 Scope of Delivery

The scope of delivery for a CS400 system includes the following:

CS400 Kit	Linescanner (RAYTMP150HRR1) 7.5 m (24.6 ft) Ethernet cable 7.5 m (24.6 ft) power cable 7.5 m (24.6 ft) alarm/trigger cable Spare window for linescanner (reorder: S-MP-WK-HR) Protective Housing (A-MP-ENC) stainless steel box protective window (reorder: S-MP-WK-ENC) grommet kit adjustable mounting bracket System connection box in the field (A-CS-CONBOX) Fiber optic / RJ45 Ethernet converter: 4x Ethernet, 2x fiber optic channels Power Supply 100/240 VAC to 24 VDC, 2.5 A Fiber optic patch cable with SC connector, 2 m (6.6 ft) - 2 pieces
Basic Hardware Kit	Position indicator with junction box (A-CS-SYSECPI) Fiber Optic Converter Box in the control room Fiber optic / RJ45 Ethernet Converter: 4x Ethernet, 2x fiber optic channels Power Supply 110/230 VAC to 24 VDC, 1.25 A Ethernet patch cable, 2 m (6.6 ft) Fiber optic patch cable with SC connector, 2 m (6.6 ft) - 2 pieces
Tool Kit	Hex key wrench 2.5 mm Hex key wrench 4 mm Hex key wrench 5 mm Wrench 7x8 and 10x13 Key for locking/unlocking enclosure doors
Documentation	CS400 hardware and software manual MP linescanner operating instructions, MP protocol manual (on data carrier only)

3 Pre-Installation

The customer is responsible for preparation of the sensor stand, installation of the position indicator with the trigger bar and the complete field wiring as indicated in the appendix.

3.1 Environment

Please take note of the following:

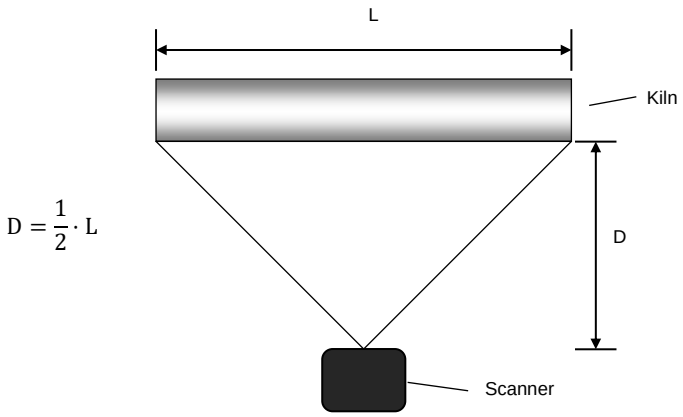
- The maximum ambient temperature for the scanner within the protective housing is 50°C (122°F). If necessary, add an additional shaded roof to protect the protective housing from direct sunlight or provide water direct to the scanner.
- For details on grounding the sensor stand, please refer to the local building codes for lightning protection.
- The housing of the linescanner and the system connection box must have the same potential – check for good electrical contact at grounding wire connection.

3.2 Scanner Distance to Kiln

The CS system with one-scanner is suited for small to medium length kilns up to 60 m (200 ft) in length. For longer kilns a system with two or more scanner will be required.

The linescanner has a 90° scan angle. The distance D between the scanner and the kiln required for complete coverage of the kiln length L can be calculated as follows:

Figure 3-1: Distance D and Kiln Length L

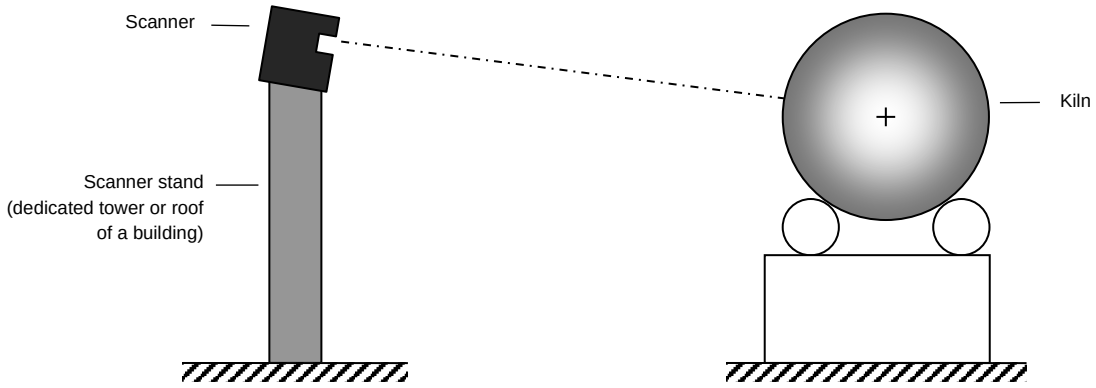


$$D = \frac{1}{2} \cdot L$$

3.3 Scanner Alignment

The optimal scanner alignment is shown in the figure below.

Figure 3-2: Scanner Alignment

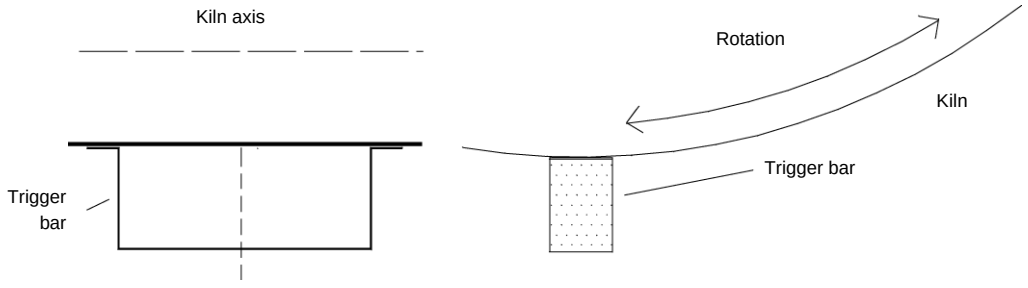


3.4 Trigger Bar

A position indicator is mounted on the colder end of the kiln and generates a trigger pulse once per revolution to supply the CS400 system with data on the rotational speed of the kiln. The installer must mount a trigger bar onto the kiln shell as shown in the figure below.

The maximum ambient temperature for the position indicator is 230°C (446°F). For installing the position indicator see section 4.4 Position Indicator, page 26.

Figure 3-3: Welding the Trigger Bar on the Kiln



3.5 Cable Requirements

The following cables are necessary for standard installations, see also system drawings given in section 8.2 System Installation – with Accessories, page 48.

- **W1** power supply cable for scanner (preinstalled with system connection box)
- **W3** trigger/alarm cable for linescanner (preinstalled with system connection box)
- **W8** from the junction box of the position indicator to the system connection box (standard installation) or to TSM remote control box (when used with accessory Tire Slip Monitoring).
- **W9** from the TSM remote control box to the system connection box. This cable is used for data communication, power supply, and trigger pulse.
- **W14** from the MI connection box to the system connection box and between MI connection boxes when more than one shadow sensor is installed. This cable is used for data communication and power supply to the pyrometer.
- **W15** from the Endurance connection box to the system connection box. This cable is used for data communication and power supply to the pyrometer.
- **W16** MI sensing head cable.
- **W17** Endurance sensing head cable.
- **W18** Ethernet communication cable for scanner (preinstalled with system connection box)
- **W20** Fiber optic cable from system connection box to the control room and to the second scanner (if used). Fiber optic cable to be provided by customer.
- **W22** Ethernet cable from fiber optic converter (control room) to the PC.
- **W23** from the position indicator head to the TSM junction box.
- **W24** Power supply cable 100 to 240 VAC.
- **W25** Fiber optic cable from the first scanner to the second scanner (if used). Fiber optic cable to be provided by customer.

Note

All copper cables must be shielded! The wires from W9, W14, and W15 must be a twisted pair! Local building codes should be observed when selecting cables!

Table 3-1: Required Cables

Cable	Distance	Cable features	Supplied from …	Example / Remarks
W1, W3	7.5 m (25 ft.)	preinstalled	Manufacturer	
W8	350 m (380 yd)	3 x 0.25 mm², 24 AWG, 3 conductors, shielded	Customer	(N)YLHCY-J 3 × 0.25 mm² Manhattan/CDT, P/N M13233
W9	350 m (380 yd)	2 x 2 x 0.25 mm², 24 AWG, 3x twisted pair, shielded	Customer	LifYCY 2 × 2 × 0.25 mm²
W14	350 m (380 yd)	2 x 2 x 0.5 mm², 20 AWG, 2 x twisted pair, shielded	Customer	max. 5 pyrometers
	350 m (380 yd)	2 x 2 x 1.5 mm², 16 AWG, 2 x twisted pair, shielded	Customer	max. 14 pyrometers
W15	350 m (380 yd)	2 x 2 x 1.5 mm², 16 AWG, 2x twisted pair, shielded	Customer	
W16	8 m (26 ft)	preinstalled	Manufacturer	
W17	15 m (49 ft.)	preinstalled	Manufacturer	

W18	7.5 m (25 ft.)		Manufacturer	
W20	< 2 km (1.2 mi)	Fiber optic cable (outdoor), 2 fibres, multi-mode, 62.5/125 µm or 50/125 µm, equipped with SC connectors	Customer	Standard cable designation: A-DQ(ZN)B2Y…
W22	2 m (6.5 ft.)	Ethernet patch cable (CAT5, RJ-45)	Manufacturer	
W23	5 m (15 ft.)		Manufacturer	
W24		Power supply cable 100 to 240 VAC, 50 / 60 Hz, min. 3 x 1.5 mm² (16 AWG)	Customer	NYY
W25	< 2 km (1.2 mi)	Fiber optic cable (outdoor), 2 fibres, multi-mode, 62.5/125 µm or 50/125 µm, equipped with SC connectors	Customer	Standard cable designation: A-DQ(ZN)B2Y…

Note

The cable length causes a certain voltage drop on the power cable. In case of using multiple sensors (shadow pyrometers via W14), longer cable lengths, or less gauges it must always be ensured, that the sensor will be supplied with the minimal voltage power!

Voltage requirements:

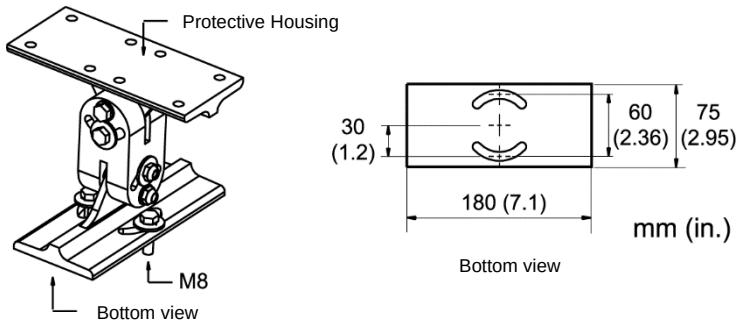
- Linescanner: min. 18 VDC
- Burning zone pyrometer: min. 20 VDC
- Shadow pyrometer: min. 12 VDC

4 Installation

4.1 Mounting

The linescanner protective housing requires a solid vibration-free mounting stand. The protective housing comes with a mounting bracket, adjustable 90° in all 3 axes. To mount the protective housing onto the sensor stand, e.g. on a tower, make a mounting plate with two 8.5 mm (0.31 in.) diameter mounting holes, as shown below. The mounting bracket is 150 mm (5.9 in) high.

Figure 4-1: 3-Axis Mounting Bracket for Protective Housing



Preparing the protective housing to be mounted on the sensor stand

Open the protective housing from the back to access to the internal components. On the bottom of the box, there is a rail/carrier system on which the linescanner will be mounted. Open the latches on both sides of the rail, loosen the bolt on top of the carrier and take off the carrier. Mount the linescanner onto the carrier using the 4 M6 x 12 screws provided. Connect the earth ground to the top of the linescanner. To install the ground on the left mounting thread, use a M6 x 12 hex head screw with washer and lock washer.

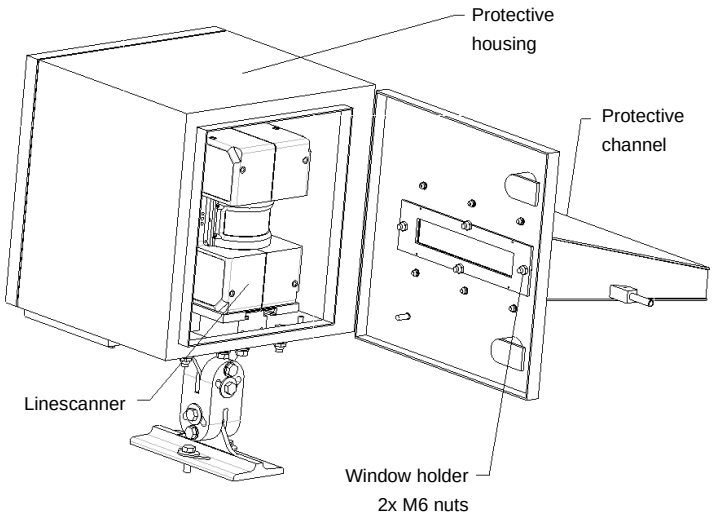
Mounting the protective channel and the window

Open the front door of the protective housing. Mount the protective field-of-view channel on the front side by using 6 M4 x 12 bolts. The slotted side of the protection channel faces downwards. The bolts must be inserted from inside the box (i.e. the nuts are outside).

Note

Make sure that the drain hole for rain water in the protective channel faces downwards!

Figure 4-2: Protective Housing with Protective Channel



Installing the linescanner

Open the back door. Insert the linescanner (with the mounted carrier) into the rail/carrier system. Lock in the linescanner in place with the latches and screw.

Electrical Installation

For best performance, the electrical installation of the CS400 System should correspond to one of the recommended installation configurations illustrated in section 8.2 System Installation – with Accessories, page 48.

Connecting the cables

The cables W1, W3, and W18 (located between the linescanner and the system connection box) are factory preinstalled and supplied along with the system connection box.

For running the cables through the protective housing: open one grommet plate (on the bottom of the protective housing) by loosening the three Allen-bolts. Use an appropriate grommet by considering the different cable outer diameters:

- Cable W1 (power supply): Ø 5 mm (0.2 in)
- Cable W18 (Ethernet): Ø 6 mm (0.24 in)
- Cable W3 (Alarm/Trigger): Ø 7 mm (0.28 in)

Feed the cable through the grommets so that grommet is approximately 400 mm (15.7 in) away from the linescanner connectors (round plugs). Place the grommet plate over the grommets as shown in the figure below. Be careful to have the cable identification plates pointed toward the system connection box (longer end of the cables). Close unused holes with the blind grommets then close the grommet plate.

Figure 4-3: Cable Installation

Using the 4 M5x25 screws, mount the grommet plate on the outside of the protective housing. Plug the cable connectors into the linescanner. Connect the socket and the plug for earth ground.

Note

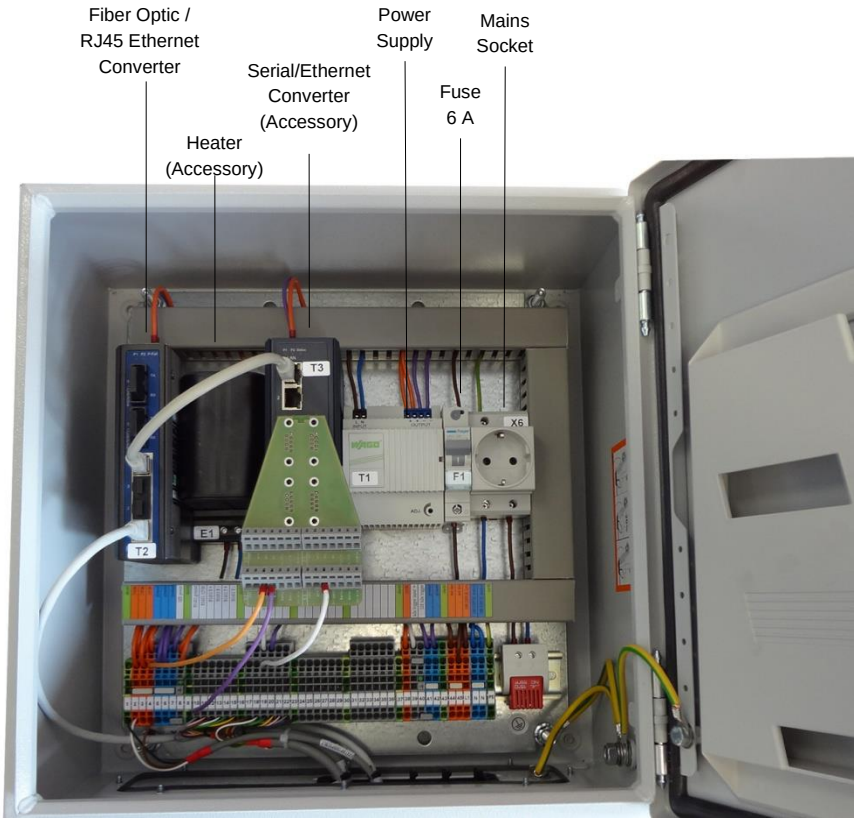
If installing the system in a warm environment, water-cooling may be necessary. The tubes used for water may be run through the second grommet plate!

4.2 System Connection Box

The system connection box connects all device field cables with the customer supplied optical fiber cable. The system connection box includes the Fiber Optic / RJ45 Ethernet Converter, the 24 VDC power supply and the Serial/Ethernet converter for supporting the accessories (if used).

The box is supplied with quick installation line-up terminals. For more technical data, see section 9.2 Connection Box, page 61.

Figure 4-4: Opened System Connection Box



Installation

The system connection box can be mounted up to 7 meters (23 ft) away from the scanner. However, to simplify aiming the scanner at the kiln it is the best that the connection box is mounted as close to the scanner as possible. The cables between the linescanner and the connection box needs to be protected from mechanical damage.

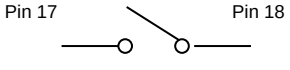
Mount the connection box in a convenient location. The cables W1, W3, and W18 are factory preinstalled. Insert the cable W20 using the grommet plate taking care to select the correct grommet size for the cable diameter.

Connect the cables for the accessories with the connectors of the line-up terminal as described in section 8.4 System Connection Box – Wiring, page 50.

After double-checking all connections, switch the power on. The 24V-LED indicates the ON/OFF status (see terminal pin 8 in the system connection box). Check the trigger signal coming from the position indicator (see terminal pin 40 in the system connection box).

Pins 17 and 18 of the terminal in the system connection box connect to the internal alarm relay of the scanner. The contacts are potential free, the maximum load is 30 V / 1 A. The configuration of the alarm relay is supported by the CS400 system software.

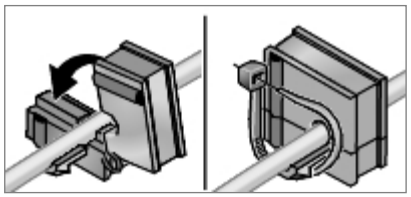
Figure 4-5: Connection to the Internal Alarm Relay of the Scanner



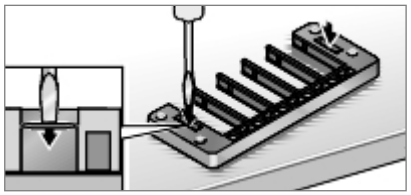
4.2.1 Cable Entry System

The cable entry system is a split system that allows pre-assembled cables to be routed into the system connection box without disassembling the connectors.

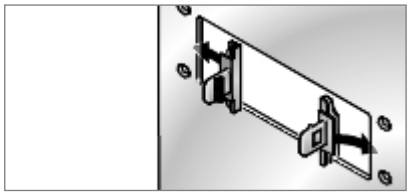
Snap-on mounting[3]



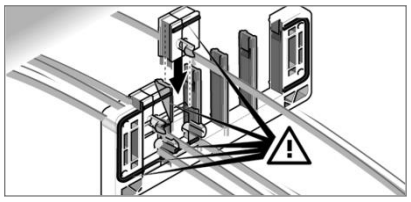
Lay cable into appropriate grommet and provide strain relief where necessary using cable ties.



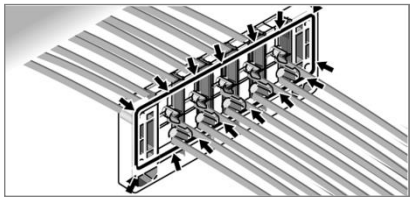
Use appropriate tool to punch through cover on base frame.



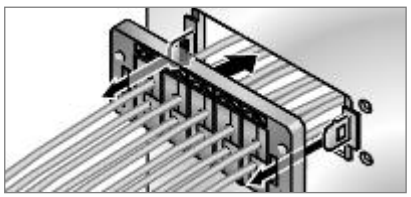
Set catch hooks into the sides of the cut-out.



Insert rail completely.

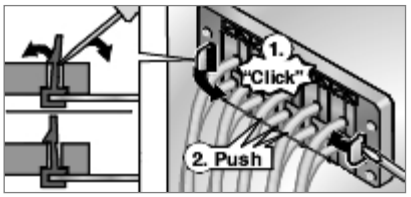


The grommet must produce a continuous seal on the back side.



Set the rail onto the catch hooks and press on.

[3] Illustrations: © Murrplastik



Lock the catch hooks with the rail. Press gently on grommet one more time.

4.3 Fiber Optic / RJ45 Ethernet Converter

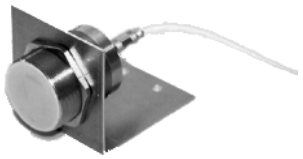
The Fiber Optic / RJ45 Ethernet Converter assures high reliability and stability in harsh environments, making it a robust bridge between enterprise fiber-optic backbones and Ethernet devices like the linescanner. Using fiber optics, you prevent electrical interference from corrupting the CS400 system. The Fiber Optic / RJ45 Ethernet Converter supports fast speed and high distance transmissions. Copper based Ethernet communication is very limited in length without using a repeater.

The Fiber Optic / RJ45 Ethernet Converter in the system connection box is converting up to 4 Ethernet channels to support one or two scanners and the CS400 accessories. The Fiber Optic / RJ45 Ethernet Converter in the control room is converting the glass fiber signals back to TCP/IP Ethernet again. For further technical details see appendix 9.3 Fiber Optic / RJ45 Ethernet Converter, page 62.

4.4 Position Indicator

The position indicator is a temperature resistant inductive proximity switch used to synchronize the scanning system with the kiln rotation.

Figure 4-6: Position Indicator



The position indicator consists of two parts, a high temperature sensor head, and a junction box. Since the maximum ambient temperature allowed is 230°C (446°F), the sensor may be mounted near the kiln's surface. For the junction box a maximum ambient temperature of 70°C (158°F) is allowed. For further technical details see appendix 9.5 Position Indicator, page 65.

Both components, sensor and junction box, are connected via a high temperature cable (length: 5 m / 15 ft). Protecting the cable against mechanical stress is recommended. Since the position indicator is necessary to generate a trigger pulse for the CS400 system, a trigger bar must be welded onto the colder end of the kiln and if possible close to the drive ring (see the figure below).

The distance between the trigger bar and the position indicator is a very important parameter for correct operation. If the distance is too small, the trigger bar can destroy the sensor head. On the other hand, if the distance is too big, the position indicator will be unable to detect the trigger bar. Thus, it will not be able to generate the trigger pulse for the system.

Note

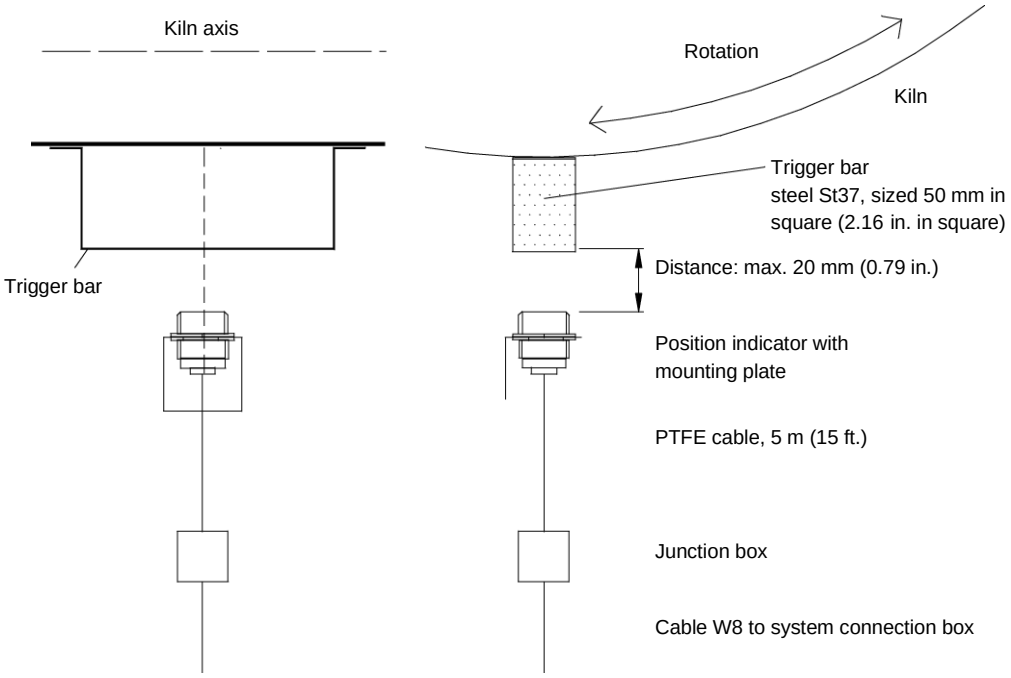
In the case of a non-existing trigger signal, the system switches to the non-synchronized mode. The non-synchronized mode is indicated in the software, thermograms are not recorded!

Note

In multi-scanner systems, the trigger signal may be associated with any scanner!

Note
The trigger signal is only required if the accessory Tire Slip Monitoring is not used!

Figure 4-7: Mounting the Position Indicator



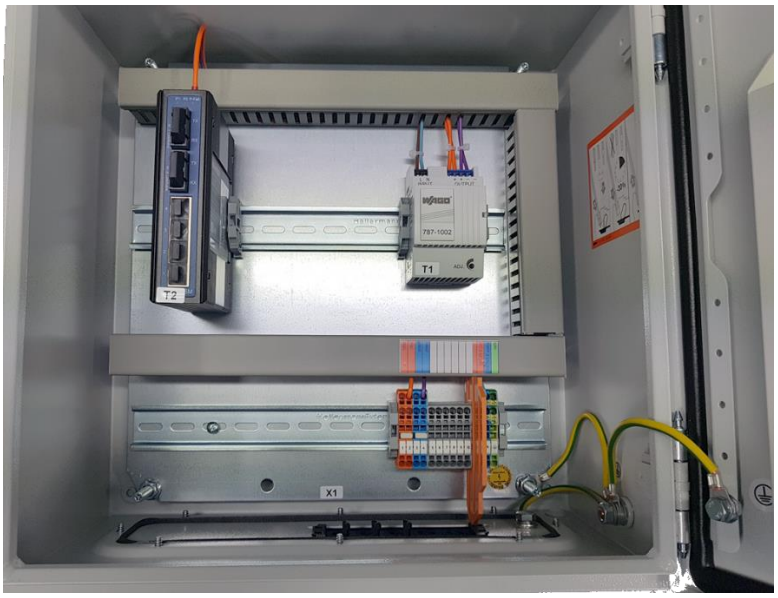
Adjustment of the position indicator:

1. Mount the trigger bar.
2. Mount the position indicator mounting plate.
3. Check the distance between position indicator and trigger bar.
4. Lock the position indicator in place and monitor its' operation. With each revolution of the kiln you should obtain a trigger pulse indicated by an LED in the junction box (field).

4.5 Fiber Optic Converter Box

The Fiber Optic Converter Box is in the control room and connects the fiber optic cable from the field to the Ethernet interface of the computer. For more technical data, see section 9.2 Connection Box, page 61.

Figure 4-8: Fiber Optic Converter Box



5 Options

5.1 Start-up-Service

The start-up service includes the installation of the scanners into the protective housing boxes, checking all wiring, communications, and services from the scanners to the location of the computer. The scanner alignment will be checked and corrected as necessary. Software will be installed, and all users will be trained on the full operation of the system, including routine maintenance procedures. The entire system will be operational before the final acceptance and sign-off by the customer. The manufacturer does not provide construction, erection, mechanical, electrical, or building services. Prior to the start-up service the scanner housings should be installed in the designated locations per our recommendations. All wiring should be in place and the associated electronics positioned in the control room. The manufacturer will check the final connections and power the system. The scanner heads should not be put into the protective housings until this start-up service begins.

Note
The startup service option is not included in the CS standard package, it must be ordered as a separate line item!

6 Accessories

Accessories include items that may be ordered at any time and added on-site.

- Serial RS485 / RJ45 Ethernet Converter (A-CS-CONV-ETH485)
- I/O Modules
- Tire Slip Monitoring – TSM (A-CS-TSM-KIT-485)
- Shadow Monitoring (A-CS-SM-KIT-485)
- Burning Zone Monitoring (A-CS-BZ-EN-KIT-485)
- Internal Heater (A-CS-CAB-HEAT)

6.1 Serial RS485 / RJ45 Ethernet Converter (A-CS-CONV-ETH485)

The serial RS485 / RJ45 Ethernet Converter is a dedicated device server for connecting to four RS485 devices to a TCP/IP network.
The serial RS485 / RJ45 Ethernet Converter must be installed in case of having either one or all accessories such as Burning Zone Monitoring, Shadow Monitoring, or Tire Slip Monitoring. The converter must be mounted in the system connection box in the field.

6.1.1 Technical Data

Ethernet Communications

Speed	100 Mbit/s
Ports	2x
Port connector	RJ45
Protection	built-in 1.5 kV magnetic isolation
IP-address	192.168.42.10 (default)

RS485 Communications

Ports	4x
Port connector	DB9 male
Protection	built-in 15 kV ESD for all signals

Software

Driver support	Windows 10, 32-bit / 64-bit
Utility software	Device Configuration Utility (on the Support DVD) for installing virtual COM ports

Mechanics

Dimensions (W x H x D)	48.6 x 140 x 95 mm (1.91 x 5.51 x 3.74 in)
Mounting	DIN-rail

Power

Power input	12 to 48 VDC, redundant dual inputs
Power connector	terminal block
Power consumption	6.3 W

Environment

Operating temperature	-10 to 60°C (14 to 140°F)
Storage temperature	-40 to 85°C (-40 to 185°F)
Operating humidity	5 to 95% RH

6.1.2 LED Indicators

There are LEDs display the power status, network status, and serial communication status located on the front panel of the Serial RS485 / RJ45 Ethernet Converter, each of them has its own specific meaning as shown in the table below.

Table 6-1: LED Indicators

LED	Color	Description
P1	Green Off	Power 1 is on. Power 1 is off, or power error condition exits.
P2	Green Off	Power 2 is on. Power 2 is off, or power error condition exits.
Status	Orange Off	Blinking: System is ready. Steady on: the device has been located by utility's location function. System is not working.
Ethernet	Orange Green	Blinking: Ethernet port is transmitting or receiving data. Steady on: Ethernet has the good link for 10 Mbps or 100 Mbps operations. On: 100 Mbps Ethernet connection Off: 10 Mbps Ethernet connection
Serial	Orange Green Off	Serial port is transmitting data. Serial port is receiving data. No data is transmitted or received through the serial port.

6.1.3 Driver Installation

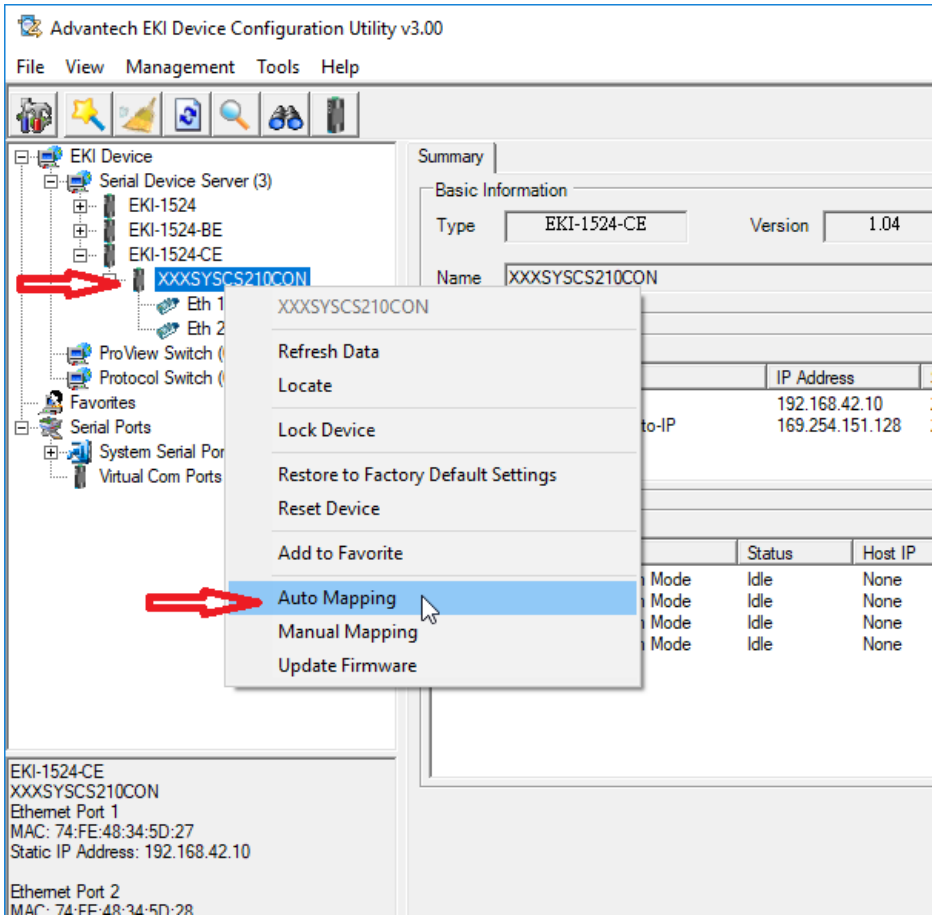
The following procedure describes the way to install a virtual COM port on the CS computer by using the Configuration Utility Software. The virtual COM ports work like standard Windows COM ports, so the CS software sees no difference between both.

Note

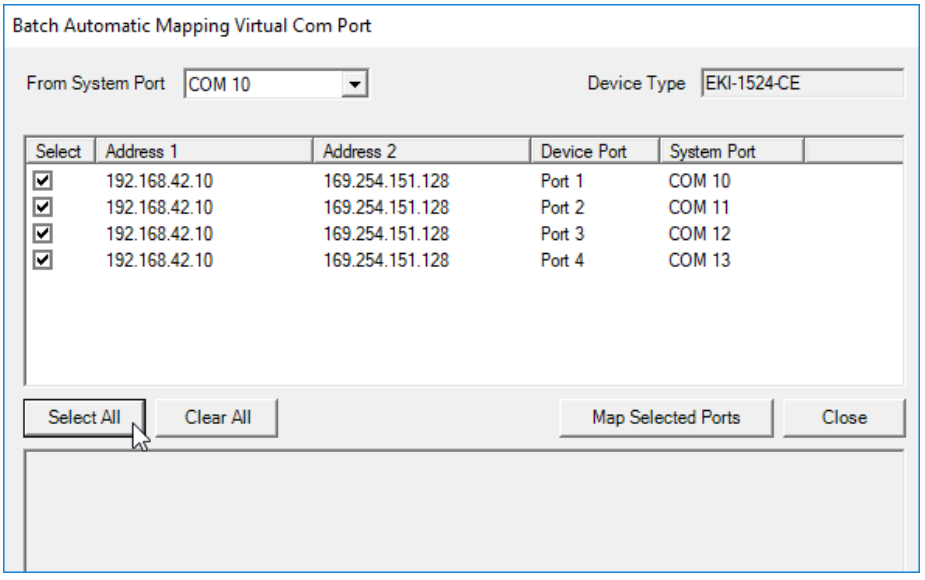
Please reserve TCP/UDP port 5048 and 5058 in your Ethernet network, Configuration Utility Software will use these ports to communicate with the Serial RS485 / RJ45 Ethernet Converter! Make sure that a possible firewall does not block these ports!

Installation procedure

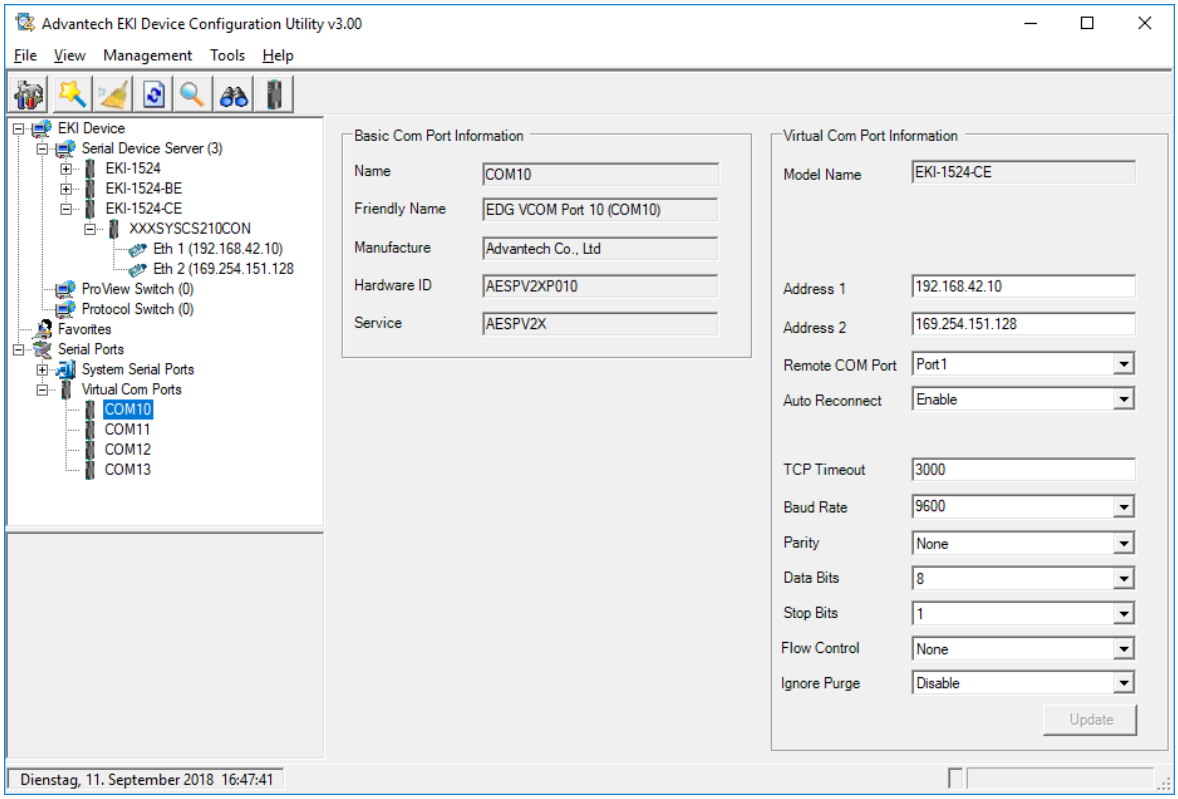
1. Power on the Serial RS485 / RJ45 Ethernet Converter!
2. Insert the Advantech driver utility DVD for the Serial RS485 / RJ45 Ethernet Converter into the DVD drive (e.g. E:\) on the host PC.
3. Use the Windows explorer to execute the setup program, the path for the setup program on the DVD should be:
   E:\Utility& Driver\SerialDeviceServerConfigurationUtility\Serial_Device_Server_Configuration_Utility_[Version]_Release_[date].exe
4. After the installation is finished, open the Serial Device Server Configuration Utility from the Windows Start Menu by clicking <Start> <All Programs> <Advantech eAutomation> <Serial Device Server Configuration Utility>. The Serial Device Server <XXXSYSCS210CON> will appear in the sub-tree of Device Server List area as shown below (may take several seconds).



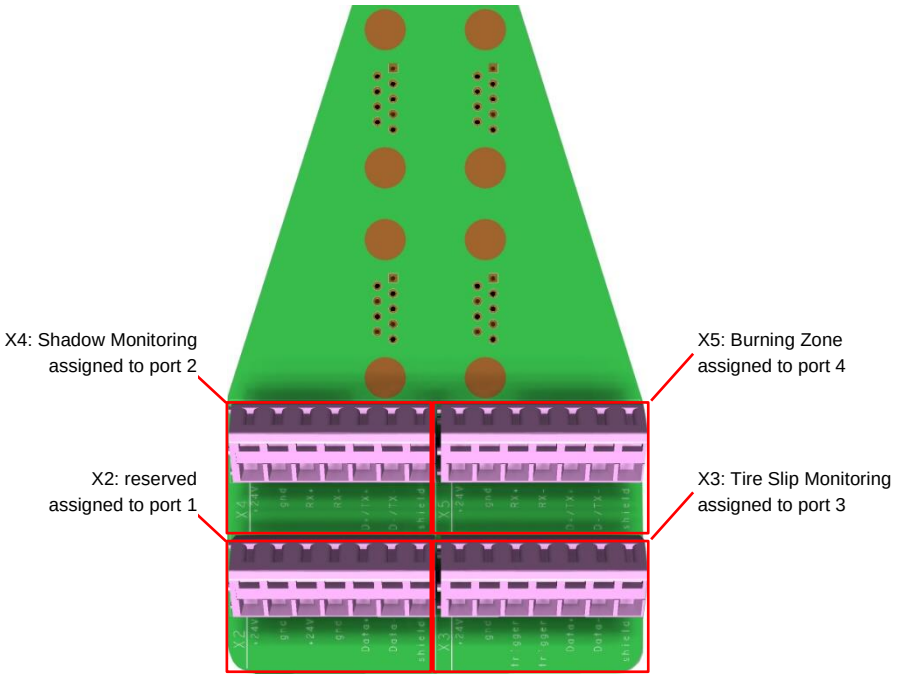
5. Right click the serial device <XXXSYSCS210CON> and select the “Auto Mapping” function.
6. The serial ports that can be assigned to virtual COM will be shown in the following window. Click the <Select All> button and press <Map Selected Ports> button. All selected serial ports will be mapped to virtual COM ports in sequential order.



7. The COM ports in the <Virtual Com Ports> listing are now available for use by Windows applications.



8. The configuration for the four ports of the serial device <XXXSYSCS210CON> are preset in accordance with the available CS accessories, e.g. port 2 is configured as RS485 type for communicating with the shadow monitoring to be wired at connector X4 in the system connection box. In the example above port 2 is assigned to the virtual COM port 11 to be used in the CS software configuration.



Note
It is not recommended to change the pre-set configuration for the four ports of the serial device <XXXSYSCS210CON>*!*

6.2 I/O Modules

The CS400 system supports a flexible approach to implement Ethernet based I/O modules with the following individual components:

- Basic Kit (A-IO-BASICKIT), contains:
  Fieldbus Coupler 750-352, Supply Module 750-602, End Module 750-600
- Digital Input Module 750-1406, 16 channels (A-IO-16DI)
- Digital Output Module 750-1504, 16 channels (A-IO-16DO)
- Passive Isolator 857-452 (A-IO-2A-ISO)
- Analog Current Output Module 750-563, preset to 0 - 20 mA, 2 channels (A-IO-2AOC-0)
- Analog Current Output Module 750-563, preset to 4 - 20 mA, 2 channels (A-IO-2AOC-4)
- Analog Voltage Output Module 750-562, preset to 0 - 10 V, 2 channels (A-IO-2AOV)
- Relay Output Module 750-513, normally open, 2 channels (A-IO-2R-NO)
- Relay Output Module750-517, changeover, 2 channels (A-IO-2R-CO)

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

6.3 Tire Slip Monitoring – TSM (A-CS-TSM-KIT-485)

To avoid kiln deformation that can damage refractory kiln torsion must be kept within certain limits. Kiln shell torsion is greatly affected by the degree of clearance between the tires and the kiln shell. The simplest and most accurate procedure is to measure the kiln shell's rotational speed as compared to the rotational speed of the tires. The result is termed as tire slip. The Tire Slip Monitoring System is an automatic measurement and registration system designed to monitor tire slip and alert the user when the system exceeds user-defined limits.

For an overview of a CS400 system with TSM, see section 8.2 System Installation – with Accessories, page 48.

6.3.1 Delivery

The scope of delivery for the TSM accessory:

- Position indicator with junction box, 3 position indicators delivered for monitoring of 3 tires
  (each further tire requires an additional position indicator (A-CS-PI-KIT), up to 6 tires can be monitored with the TSM system)
- TSM Remote Control

6.3.2 Functionality

The TSM system monitors tire slip by measuring the rotational speed of the kiln shell and of each tire. The rotation time differences between the shell and each tire are converted to a radial slip.
The electronics in the TSM remote control box captures the trigger signals from the different rings and send <ring number> and <time stamp> to the PC via digital communication.

6.3.3 TSM Remote Control

The TSM remote control box contains a micro-PLC and an RS485 communication port, all in a protective housing. The measured values for the kiln and for each of the tires are then sent to the computer through the RS485 port.

Figure 6-1: TSM Remote Control Box

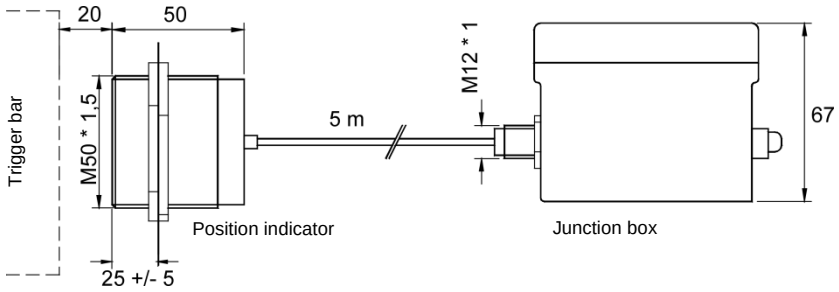
For more technical data, see section 8.7 TSM – Wiring, page 54.

6.3.4 Position Indicator

Temperature resistant inductive proximity switches are used to trigger the PLC counter rotation time. The trigger bar for the position indicator is welded directly onto the tire.

Figure 6-2: Position Indicator

Figure 6-3: Position Indicator and Trigger Bar



6.3.5 Installation

Figure 6-4: Mounting the Position Indicator

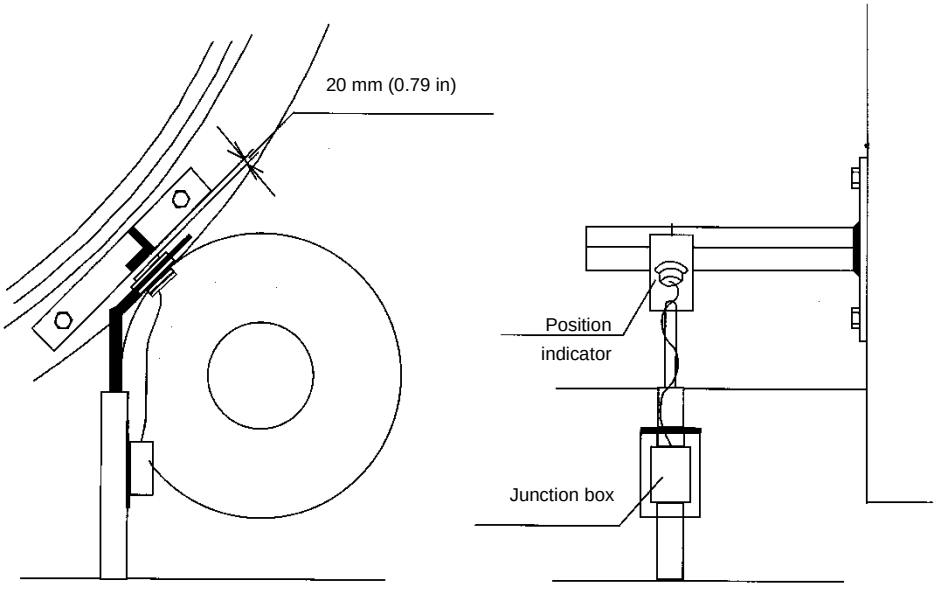
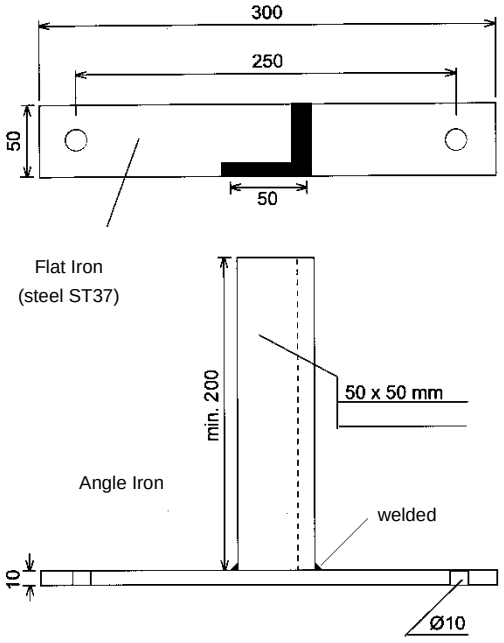
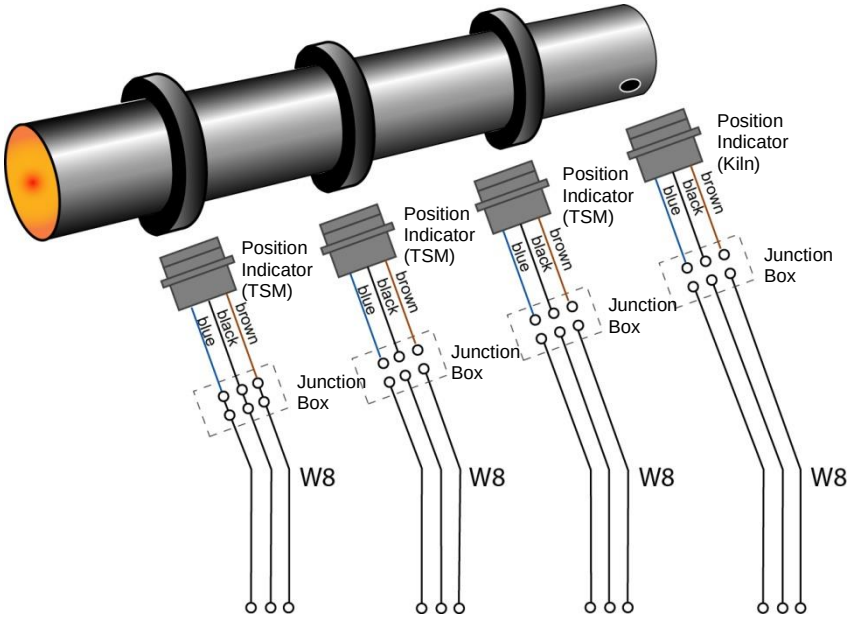


Figure 6-5: Trigger Bar – details –



6.3.6 Wiring

Figure 6-6: Wiring of TSM



For the detailed wiring of the TSM see section 8.7 TSM – Wiring, page 54.

For recommended cables see section 3.5 Cable Requirements, page 19.

Note

The position indicator for the kiln (master) must be wired to the <kiln trigger> labeled input on the terminal line of the TSM remote control box! All subsequent TSM position indicators must be wired to the inputs <Ring 1>, <Ring 2> and so.

6.4 Shadow Monitoring (A-CS-SM-KIT-485)

The linescanners can be hindered from monitoring the complete kiln by physical obstructions and by shadows from the tires. With the shadow monitoring kit additional pyrometers can be installed and configured to monitor these “shadowed” portions. The temperature values from these pyrometers are integrated in the scanned data from the linescanners and the results are displayed as one homogenous thermogram.

For an overview of a system configured with Shadow Monitoring, see section 8.2 System Installation – with Accessories, page 48.

6.4.1 Technical Data

Temperature range	-40 to 600°C (-40 to 1112°F)
Spectral response	8 to 14 µm
Accuracy	± (1% of reading or 1°C) whichever is greater
Optical resolution	10 : 1 (90% energy)
Head ambient temperature	0 to 180°C (32 to 356°F)
Head cable length	8 m (26 ft.)
Protection rate (head)	IP65 (NEMA-4)
Digital interface	RS485

For other technical data see MI3 operators manual.

6.4.2 Delivery

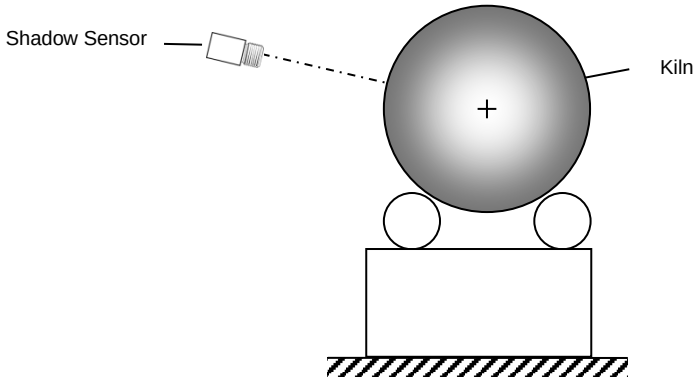
The scope of delivery for the Shadow Monitoring accessory:

- MI310LTH sensor and MI3 Communication Box (metal) with RS485 communications
- Air purge jacket, stainless steel
- Adjustable mounting bracket
- Connection box

6.4.3 Mounting

The recommended sensor mounting is shown in the figure below. The angular alignment of the sensor head reduces the risk of possible contaminations on the optics.

Figure 6-7: Recommended Alignment of Shadow Sensor



It is important that the sensor is mounted at a distance from the target, sufficient to be able to "see" the entire area of interest. For this reason, the manufacturer provides a field of view calculating software called "Spot Size Calculator", which allows the calculation of the resulting spot size for a given sensor model and based on a specific mounting distance, see https://www.flukeprocessinstruments.com/SpotSizeCalculator/index.htm

Note

Make sure that the resulting spot size for the shadow sensor covers the size of the shadowed area!

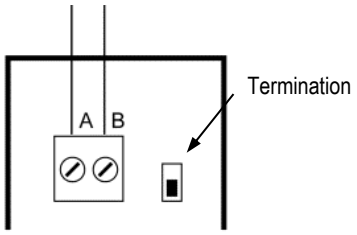
Example:

Optical resolution for the MI3 sensor:	10:1
Distance to the kiln	5000 mm (200 in.)
Resulting spot size:	500 mm (20 in.)

6.4.4 Wiring

For an installation of two or more shadow sensors in a network, each MI3 communication box is wired parallel to the others. You may connect up to 32 units. Make sure to deactivate the preset shunt resistor for all units except for the last one in the chain. The switch for activating the shunt is found on the circuit board in the communication box as shown in the figure below. To switch the shunt you must first open the box lid.

Figure 6-8: MI3 Circuit Board with Termination for Activating the Shunt



For detailed wiring of Shadow Monitoring see section 6.4.4 Wiring, page 42.

For recommended cables see section 3.5 Cable Requirements, page 19.

6.5 Burning Zone Monitoring (A-CS-BZ-EN-KIT-485)

With Burning Zone Monitoring a two-color point sensor (Endurance ratio pyrometer) can be installed looking into the burn zone of the kiln to monitor the temperatures in this very important area. The two-color unit will essentially “see” through the smoke and other by-products of combustion and the temperature reading will be displayed on the main screen.

For an overview of a CS400 system with Burning Zone Monitoring, see section 8.2 System Installation – with Accessories, page 48.

6.5.1 Technical Data

Temperature range	600 to 1800°C (1112 to 3372°F)
Spectral response	1 µm nominal
Accuracy	± (0.5% $T_{measured}$ + 2°C), $T_{measured}$ in °C
Optical resolution	100 : 1 (95% energy)
Protection rate (sensor)	IP65 (NEMA-4)
Ambient temperature	
without cooling	0 to 65°C (32 to 149°F)
with ThermoJacket	up to 315°C (600°F)
Cable length	15 m (49 ft.)
Digital interface	RS485

For other technical data see Endurance operator’s manual and the ThermoJacket operators manual.

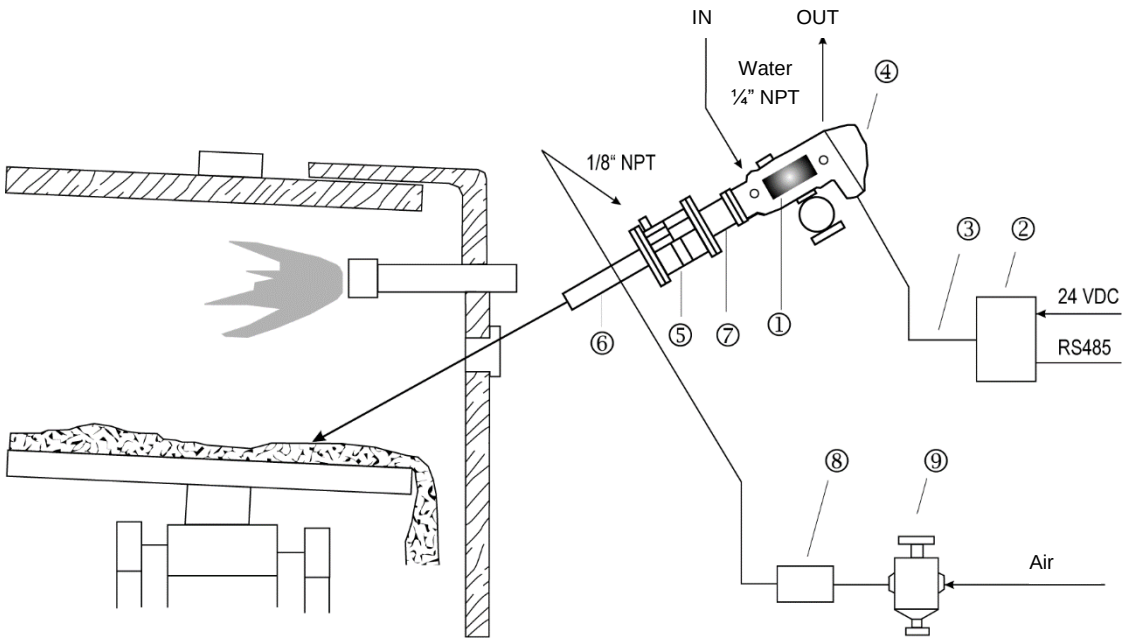
6.5.2 Delivery

The scope of delivery for the Burning Zone Monitoring accessory:

① Endurance ratio pyrometer, type: E1RL
② Endurance connection box
③ High temperature cable, 15 m (49.2 ft)
④ ThermoJacket for Endurance pyrometer, with adjustable mounting bracket
⑤ Blast gate assembly with quartz window
⑥ Sighting tube, 30 cm (11.8 in) length, stainless steel
⑦ Adjustable pipe adapter assembly
⑧ Air flow regulator
⑨ Air pressure regulator

6.5.3 Installation

Figure 6-9: Installing the Burning Zone Pyrometer



6.5.4 Wiring

For detailed wiring of Burning Zone Monitoring see section 8.9 Burning Zone – Wiring, page 58.

For recommended cables see section 3.5 Cable Requirements, page 19.

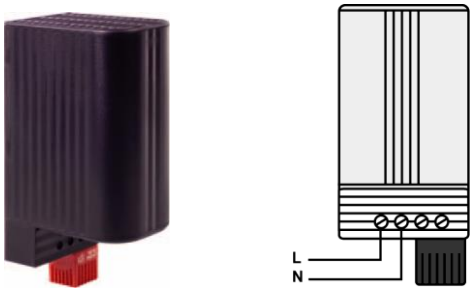
6.6 Internal Heater (A-CS-CAB-HEAT)

The internal heater is for the use in the system connection box for ambient temperatures below 0°C (32°F). The surface temperatures on the accessible side surfaces of the housing are kept down as a result of the heater design. The heater comes with plug-in thermostat and is designed for permanent operation.

6.6.1 Technical Data

Voltage	100 to 240 VAC
Heating capacity	max. 50 W (170 BTU/hour)
Wiring	cable diameter max. 2.5 mm² (AWG 14)
Mounting	DIN rail
Fitting position	vertical
Operating temperature	-20 to 70°C (-4 to 158°F)
Storage temperature	-45 to 70°C (-49 to 158°F)

Figure 6-10: Internal Heater



For more detailed information see section 8.4 System Connection Box – Wiring, page 50.

7 Maintenance

You can find a troubleshooting guide for common system problems in the Linescanner manual.

System specific problems you can find listed below.

7.1 Troubleshooting

Table 7-1: Troubleshooting

Checkpoint	Possible Cause / Solution
Kiln Trigger	The system has lost synchronization due to missing signals from the position indicator: • Check alignment and distance between trigger bar and position indicator. • Increase the metal mass of the trigger bar for a reliable signal generation. • Check the wiring. Note: The trigger signal can be verified by a blinking LED on the junction box located close to the position indicator!
Ethernet Communication via Fiber Optic	If there is no communication after installation and powering of all components required - please check the 'cross-over' of the two fibers between the glass fiber converter in the field and the control room (TX is in all cases to be connected to RX of the other converter)!
TSM	Use only position indicators supplied from the manufacturer!

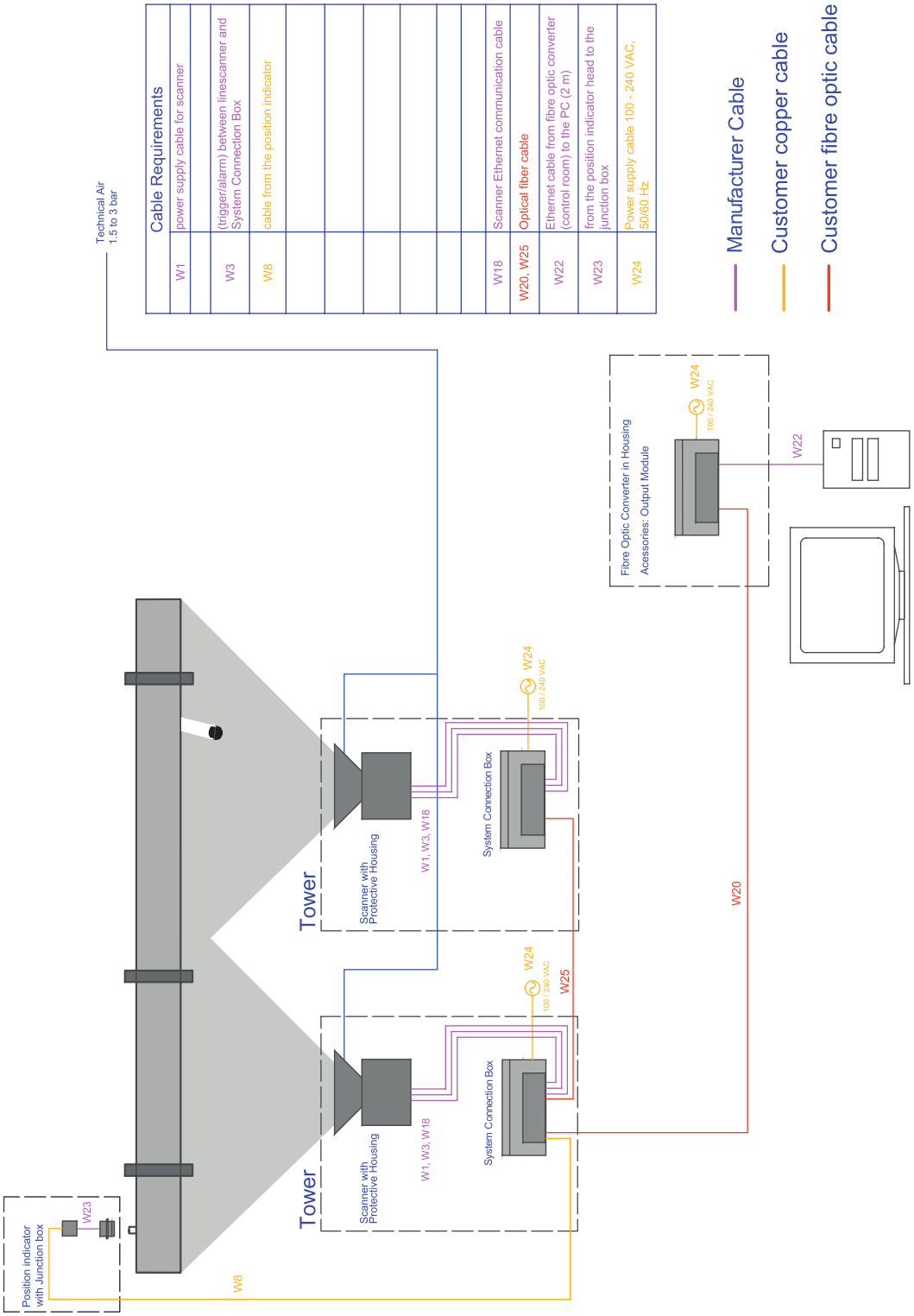
Note

To get quick help send a detailed error report to the TechSupport Team of the manufacturer including the current configuration files!

8 Drawings

8.1 System Installation – without Accessories

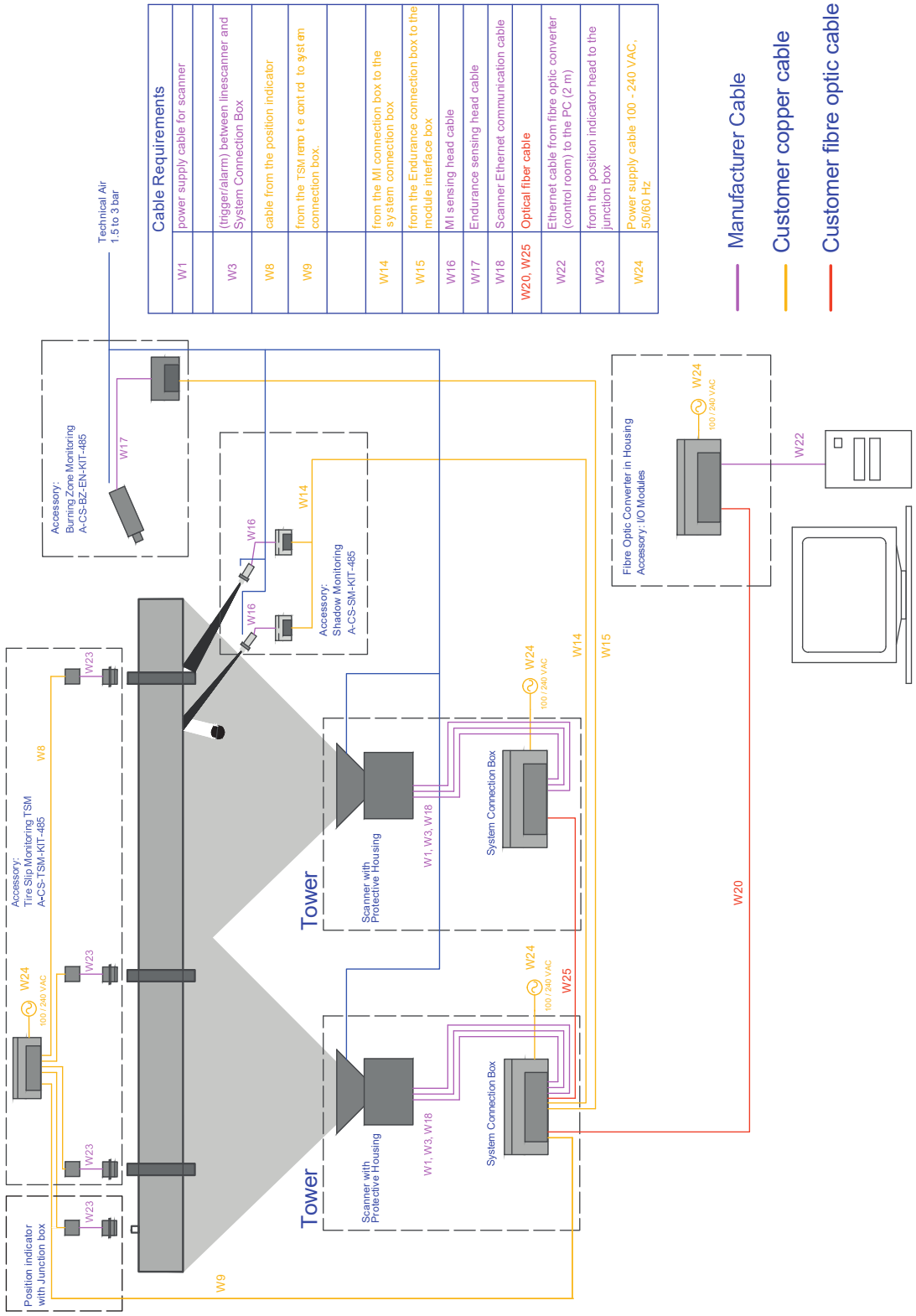
Figure 8-1: System Installation – without Accessories



For more detailed information see section 3.5 Cable Requirements, page 19.

8.2 System Installation – with Accessories

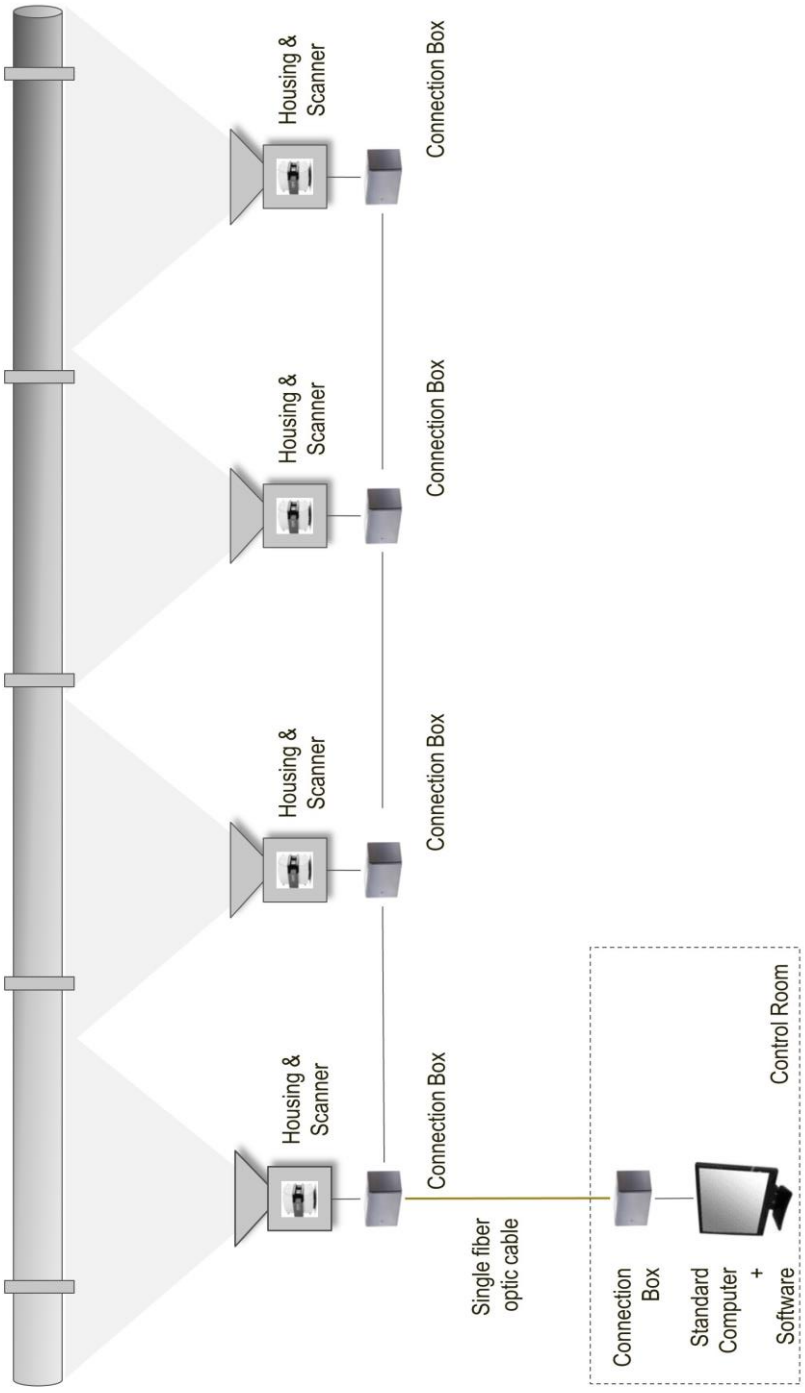
Figure 8-2: System Installation – with Accessories



For more detailed information see section 3.5 Cable Requirements, page 19.

8.3 System Installation – Multiple Scanners

Figure 8-3: System Installation – Multiple Scanners



The drawing above shows the principal design of a system with 4 scanners. The detailed wiring is the same for all scanners. The position indicator for the kiln can be connected to any of the connection boxes.

8.4 System Connection Box – Wiring

Figure 8-4: System Connection Box – Wiring

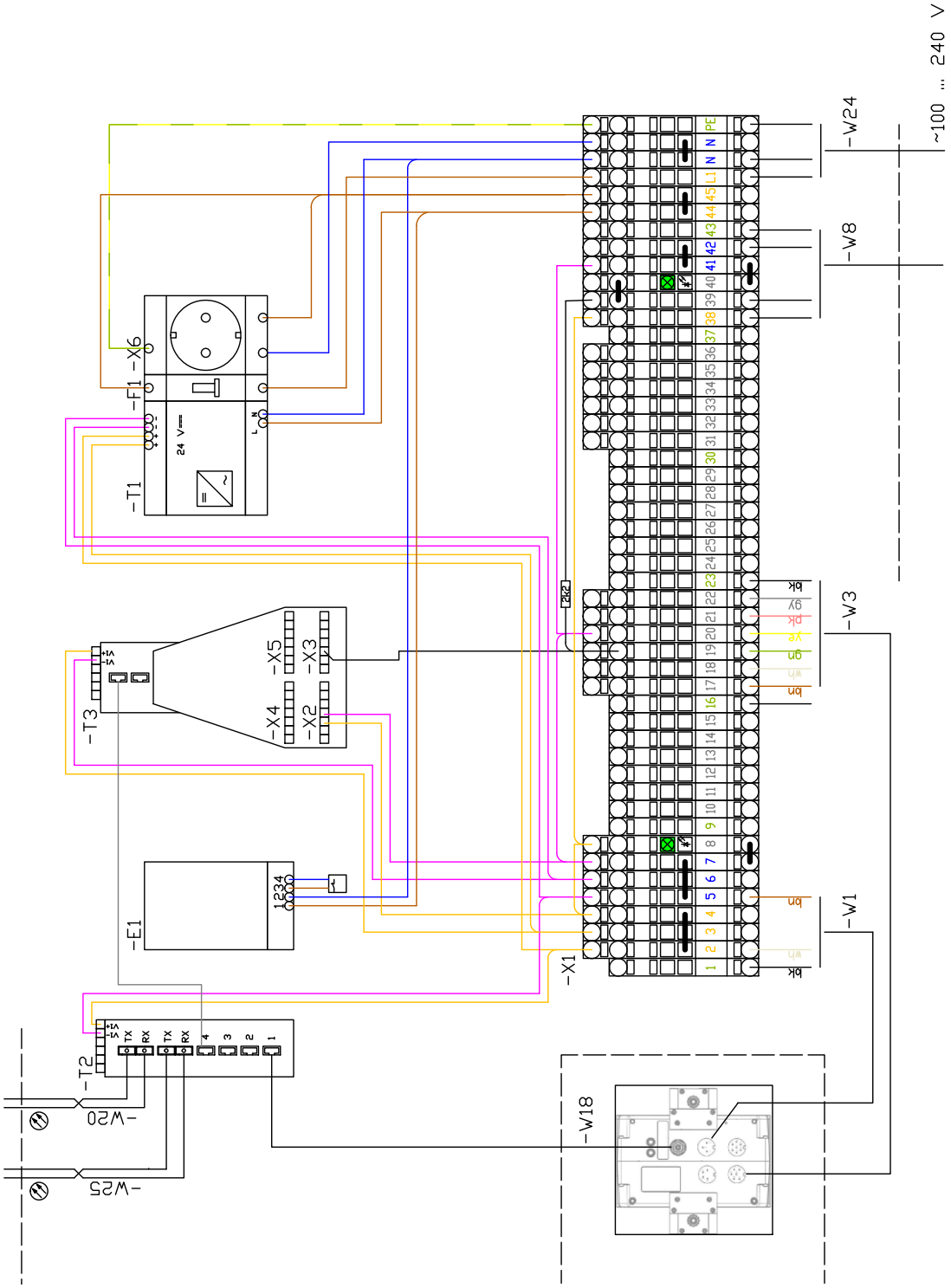


Table 8-1: W1 – Power Supply 24 V, 3-pin

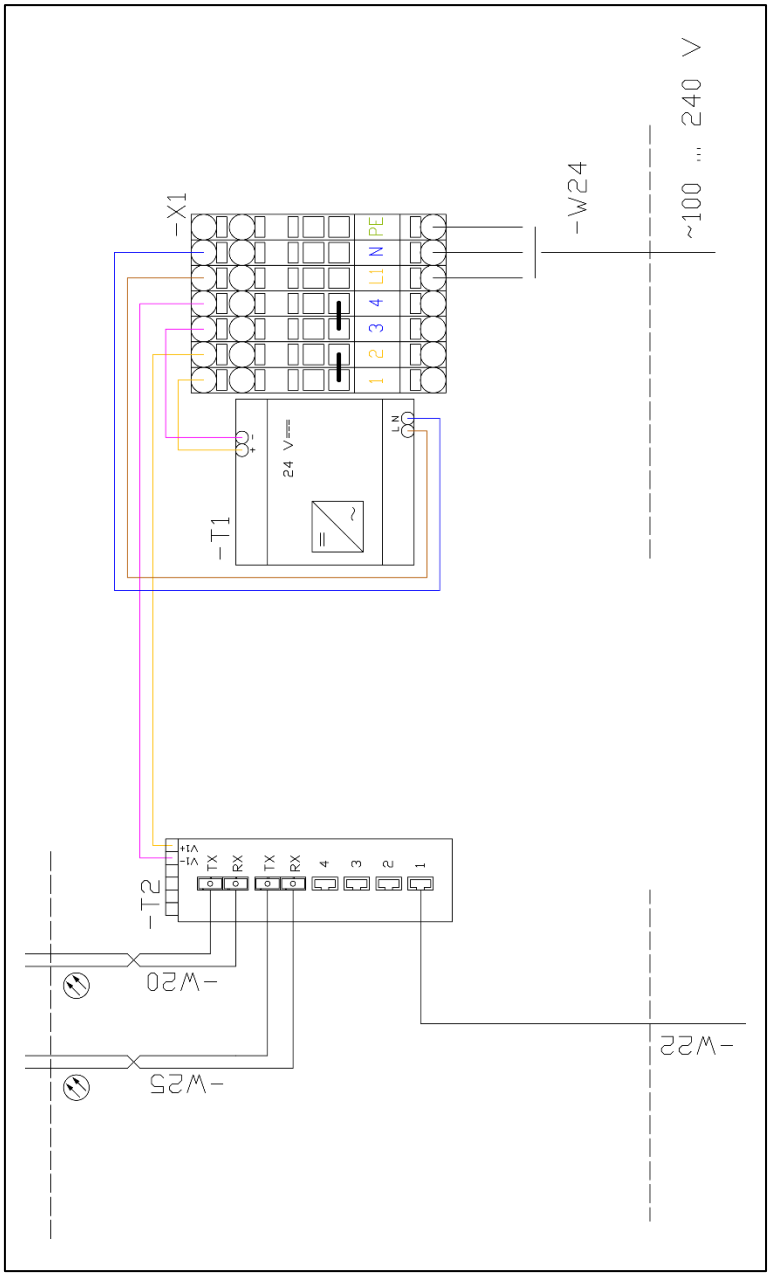
		Description	Color (6 wires)
1	GND	power ground	brown
2			not connected
3	+ 24 VDC	input for + 24 VDC power supply voltage	white
		shield	black

Table 8-2: W3 – 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	Not used	pink
6	Functional input	Not used	gray
		shield	black

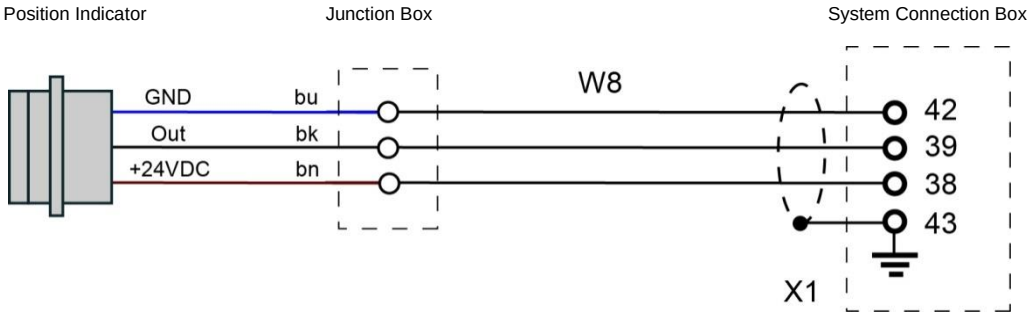
8.5 Fiber Optic Converter Box – Wiring

Figure 8-5: Fiber Optic Converter Box – Wiring



8.6 Position Indicator – Wiring

Figure 8-6: Position Indicator – Wiring

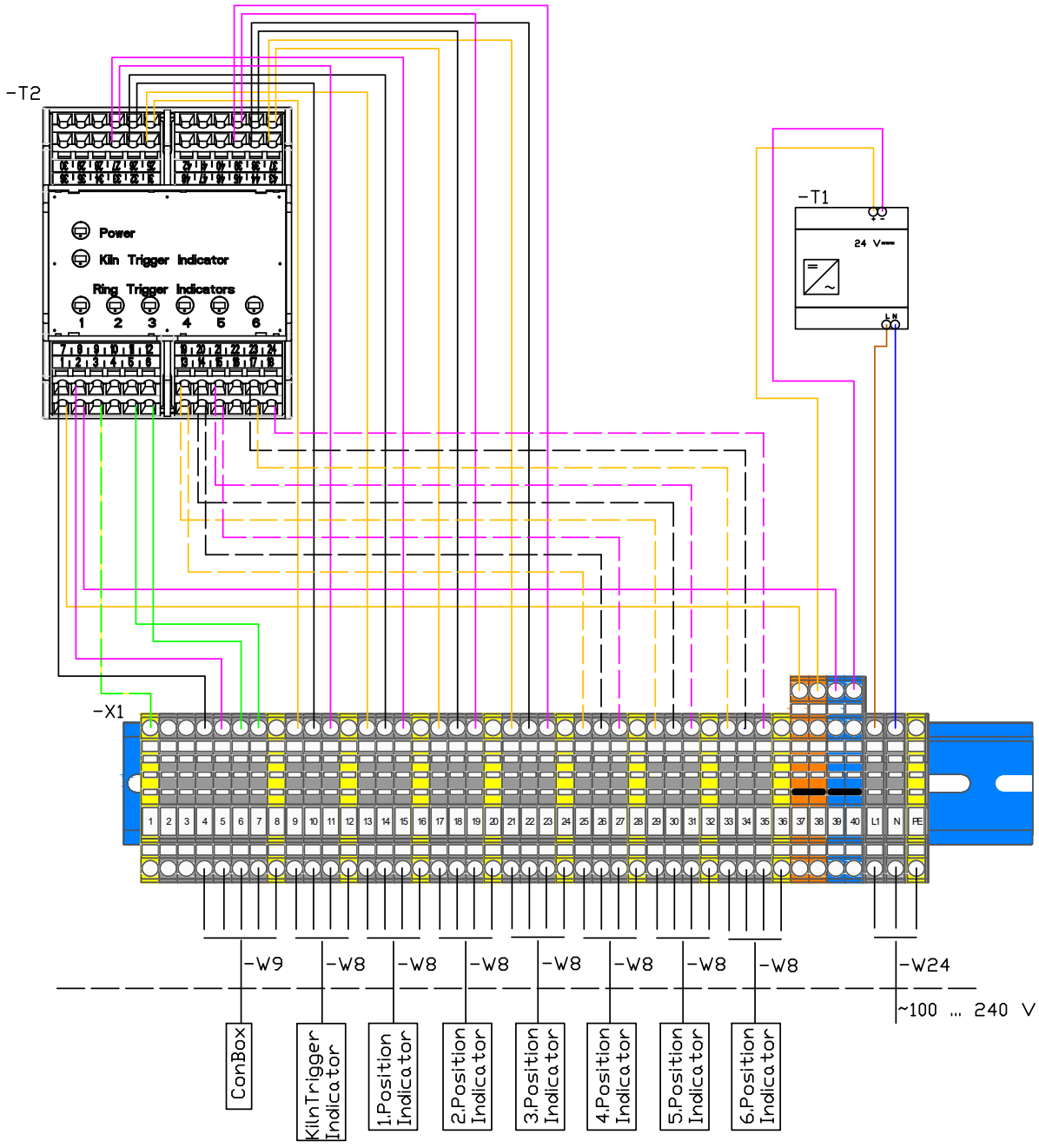


Note

The W8 cable for the position indicator is only to be wired to the system connection box like shown above for the cement system! In case of using the TSM accessory the position indicator is connected to the TSM connection box in the field directly!

8.7 TSM – Wiring

Figure 8-7: Wiring Scheme for TSM Remote Control Box



Note

The internal wiring for the position indicators 4, 5, 6 – the dotted lines – does not come as factory default.

8.7.1 Terminal – W8 Wiring

Figure 8-8: Terminal Wiring for the Position Indicator (Kiln Trigger)

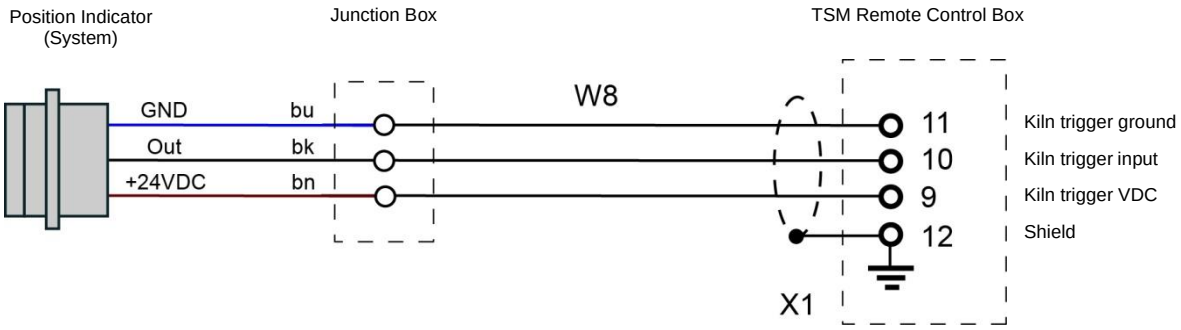


Figure 8-9: Terminal Wiring for the Position Indicator (Ring 1)

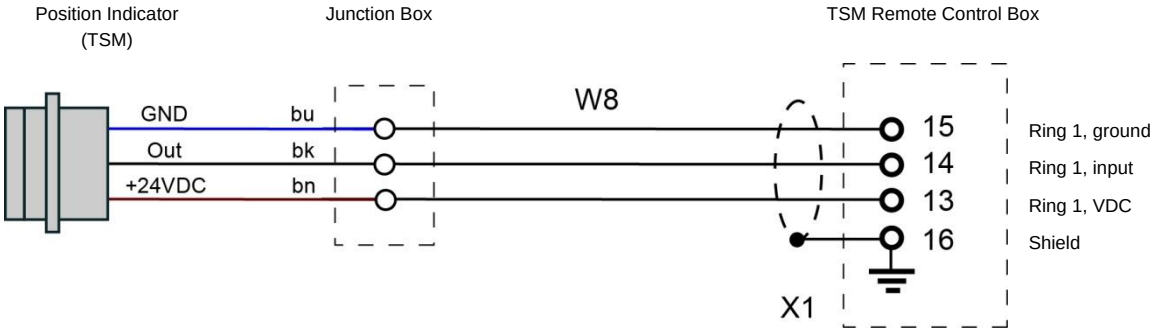
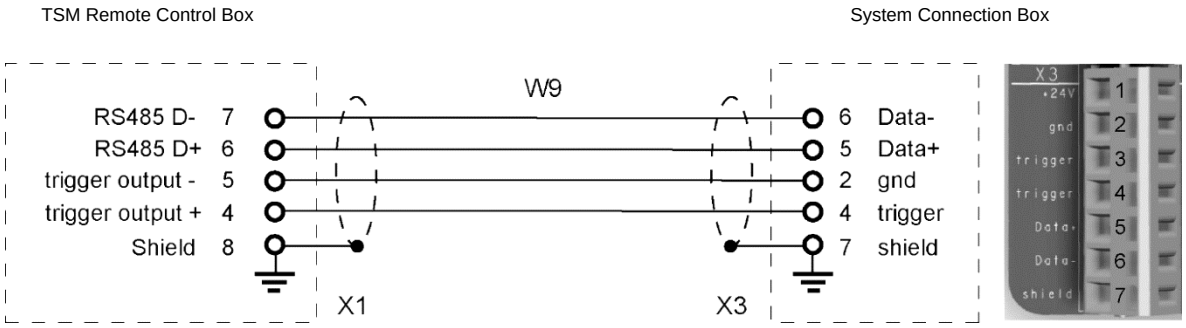


Table 8-3: W8 – Complete Terminal Wiring for all Position Indicators

Position Indicator	Ring 1 Pin	Ring 2 Pin	Ring 3 Pin	Ring 4 Pin	Ring 5 Pin	Ring 6 Pin
Shield	16	20	24	28	32	36
+ 24 VDC	13	17	21	25	29	33
Out	14	18	22	26	30	34
GND	15	19	23	27	31	35

8.7.2 Terminal – W9 Wiring

Figure 8-10: Wiring of W9 between TSM Remote Control Box and System Connection Box



8.7.3 Internal Wiring for the Position Indicators 4, 5, 6

The internal wiring for the position indicators 4, 5, 6 does not come as factory default. If you want to run your system with these additional position indicators then you have to implement the internal wiring by your own. The complete wiring for the TSM Remote Control Box is given below.

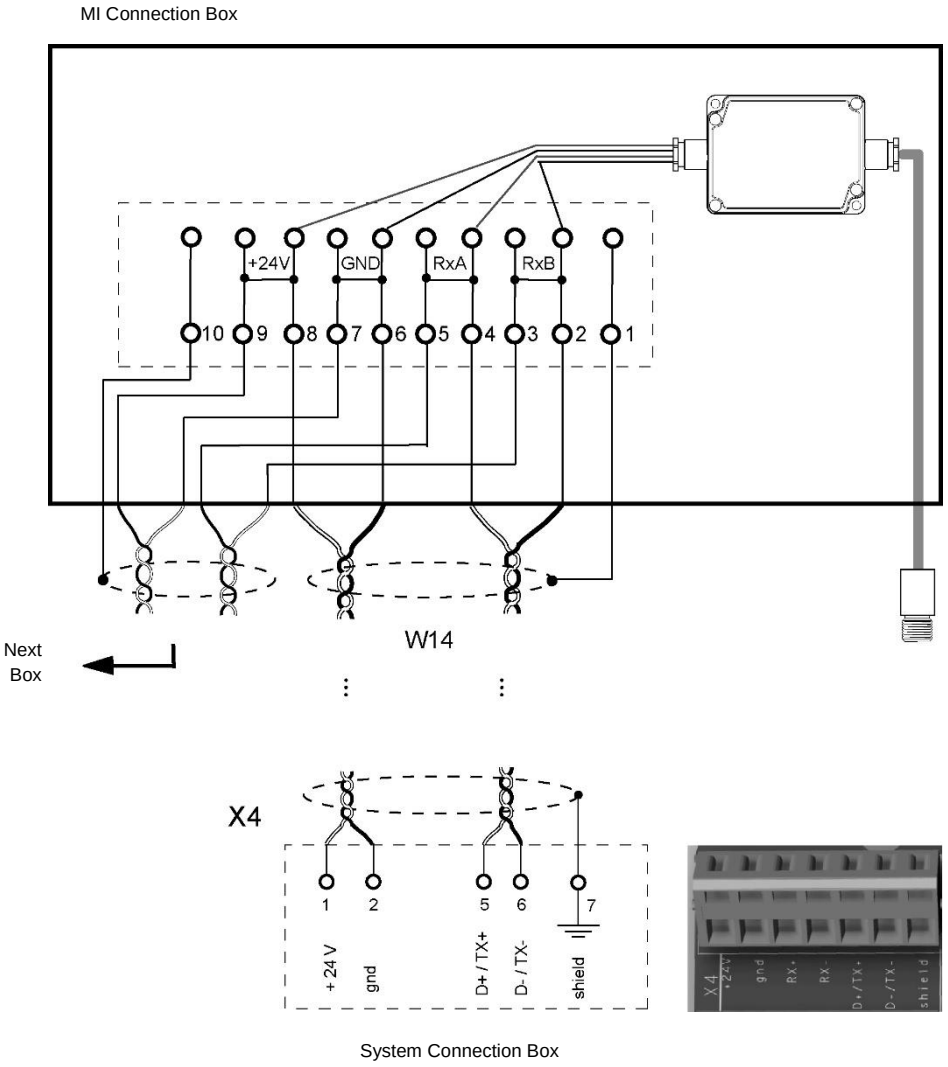
Figure 8-11: Wiring for the Position Indicators 4, 5, 6

30	**29**	**28**	**27**	**26**	**25**	top	**42**	**41**	**40**	**39**	**38**	**37**
		shield	gnd	Kiln Trigger	+24 Vdc out				shield	gnd	Ring 2	+24 Vdc out
36	**35**	**34**	**33**	**32**	**31**	bottom	**48**	**47**	**46**	**45**	**44**	**43**
		shield	gnd	Ring 1	+24 Vdc out				shield	gnd	Ring 3	+24 Vdc out

7	**8**	**9**	**10**	**11**	**12**	top	**19**	**20**	**21**	**22**	**23**	**24**
Trigger Scanner	gnd	shield					+24 Vdc out	Ring 5	gnd	shield	Ring 6	shield
1	**2**	**3**	**4**	**5**	**6**	bottom	**13**	**14**	**15**	**16**	**17**	**18**
+24 Vdc out	gnd	shield		TxB	TxA		+24 Vdc out	Ring 4	gnd	shield	+24 Vdc out	gnd

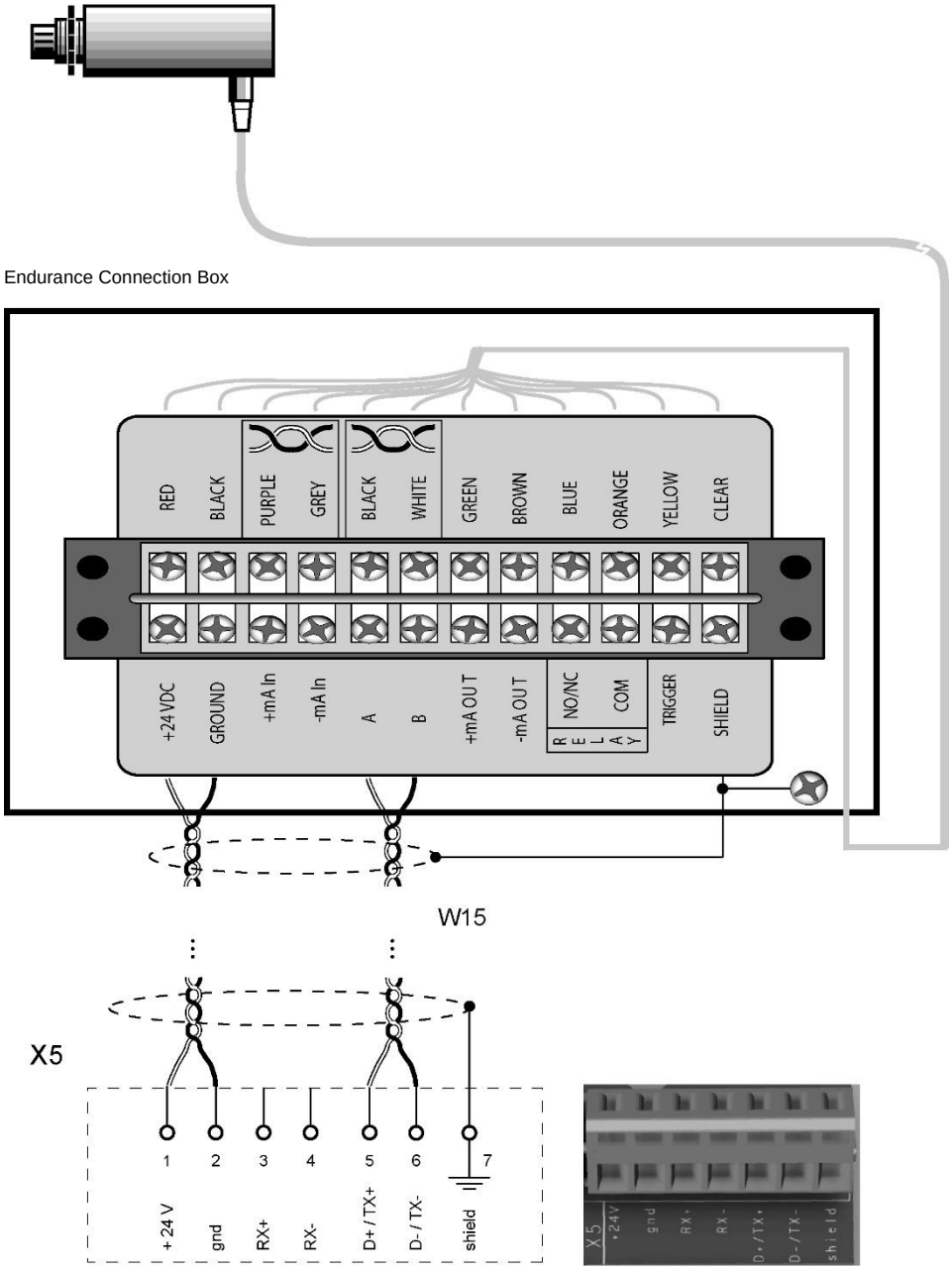
8.8 Shadow Monitoring – Wiring

Figure 8-12: Shadow Monitoring – Wiring



8.9 Burning Zone – Wiring

Figure 8-13: Burning Zone – Wiring



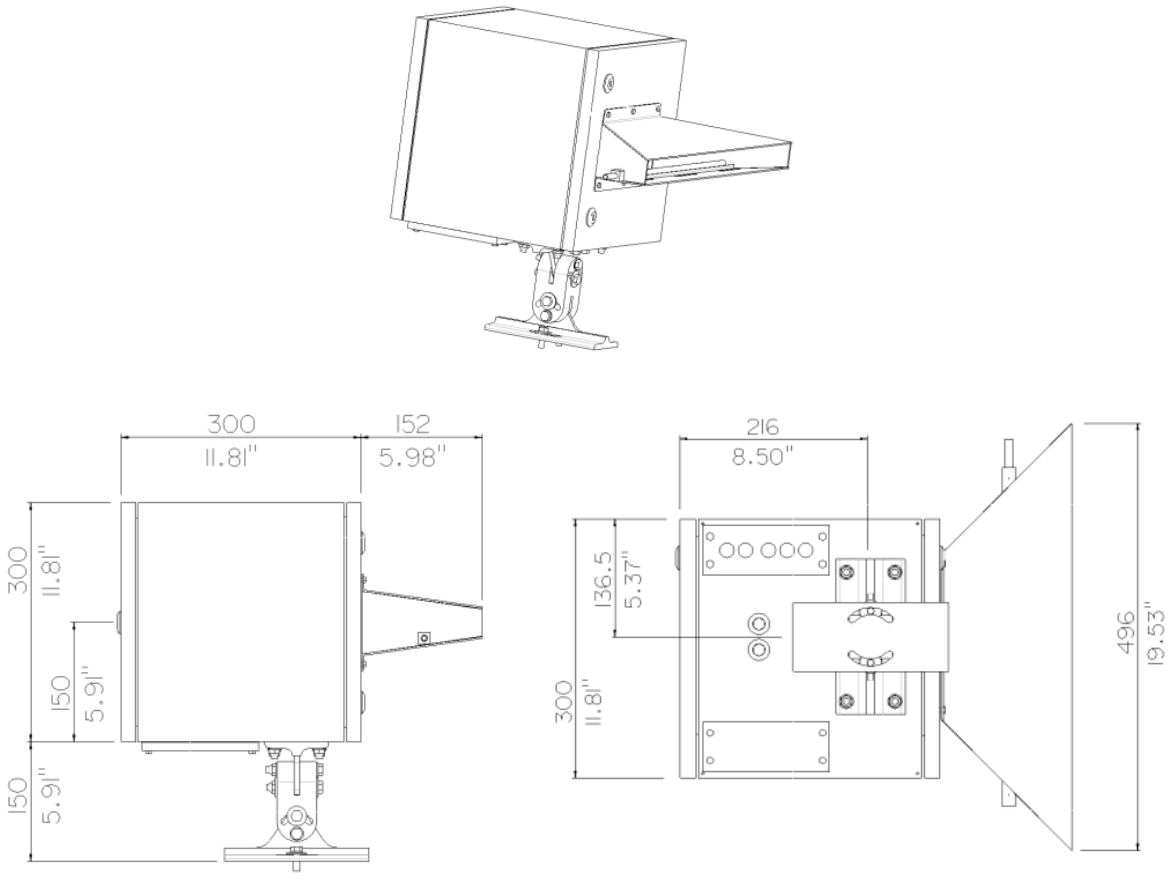
System Connection Box

9 Appendix – Technical Data

9.1 Protective Housing (A-MP-ENC)

To protect the linescanner from the high temperatures and poor air quality near the kiln, the scanner is enclosed in a rugged stainless-steel protective housing. Air purging and/or water-cooling is available, if required. Multiple scanner systems contain one protective housing per scanner.

Figure 9-1: Protective Housing



9.1.1 Technical Data

Material

Box	Stainless Steel 1.4301
Seal	EPDM, CR
Mounting bracket	galvanized steel
Dimensions (h x w x d)	300 x 300 x 300 mm (11.81 x 11.81 x 11.81 in.)
- with mounting frame	height is about 450 mm (17.72 in.)
Weight	about 20 kg (44 lb), linescanner included
Protection rate	IP54
Window transmission	0.9

Air purge

Connector	outer diameter 8 mm (0.315 in.)
Pressure	1.5 to 3 bar (air must be cleaned)

9.1.2 Scope of Delivery

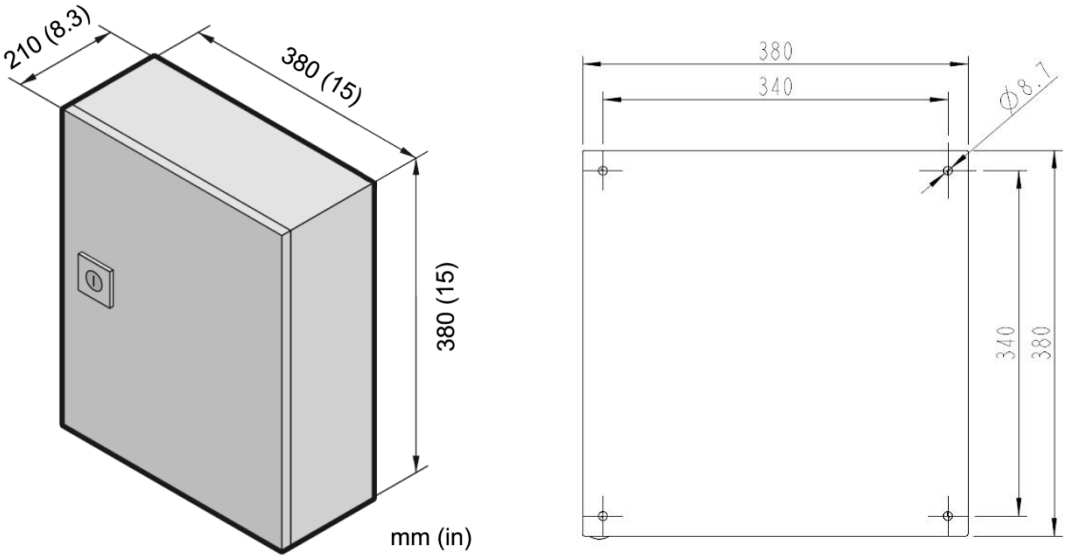
- stainless steel box with air purge and all mounting parts
- adjustable mounting bracket allowing aiming along any axis
- grommets and grommet plate
- spare removable window

9.2 Connection Box

The connection box is used for the following items:

- System connection box in the field
- Fiber Optic Converter Box in the control room
- TSM – Tire Slip Monitoring (A-CS-TSM-KIT-485)

Figure 9-2: Connection Box



9.2.1 Technical Data

Box	sheet steel, powder-coated
Temperature range	0 to 50°C (32 to 122°F) -30°C (-22°F) with internal heater A-CS-CAB-HEAT for the system connection box
Dimensions (W x H x D)	380 x 380 x 210 mm (15 x 15 x 8.3 in)
Net weight	approx. 12 kg (26 lb)
Protection rate:	IP66 (NEMA 4)
Power supply	100 to 240 VAC, 50/60 Hz
Wiring	cable diameter max. 2.5 mm² (AWG 14)
Power input	max. 110 W (for the system connection box) max. 30 W (for the fiber optic converter box)
Fuse	6 A (fuse only with system connection box)

9.3 Fiber Optic / RJ45 Ethernet Converter

9.3.1 Technical Data

Ethernet Communications

Ports	4x
Port connector	RJ45
Distance	max. 90 m (295 ft)

Fiber Optic Communications

Ports	2x
Port connector	SC type
Fiber	multi-mode, 62.5/125 µm or 50/125 µm
Distance	max. 2 km (1.24 mi)

Mechanics

Dimensions (W x H x D)	37 x 140 x 95 mm (1.45 x 5.5 x 3.7 in)
Mounting	DIN-rail

Power

Power input	12 to 48 VDC, redundant dual inputs
Power connector	removable screw terminal
Power consumption	6.5 W

Environment

Operating temperature	-10 to 60°C (14 to 140°F)
Storage temperature	-40 to 85°C (-40 to 185°F)
Operating humidity	5 to 95% RH
Protection	4.000 V_{DC} ESD (Ethernet), 3.000 V_{DC} Surge (EFT for power)

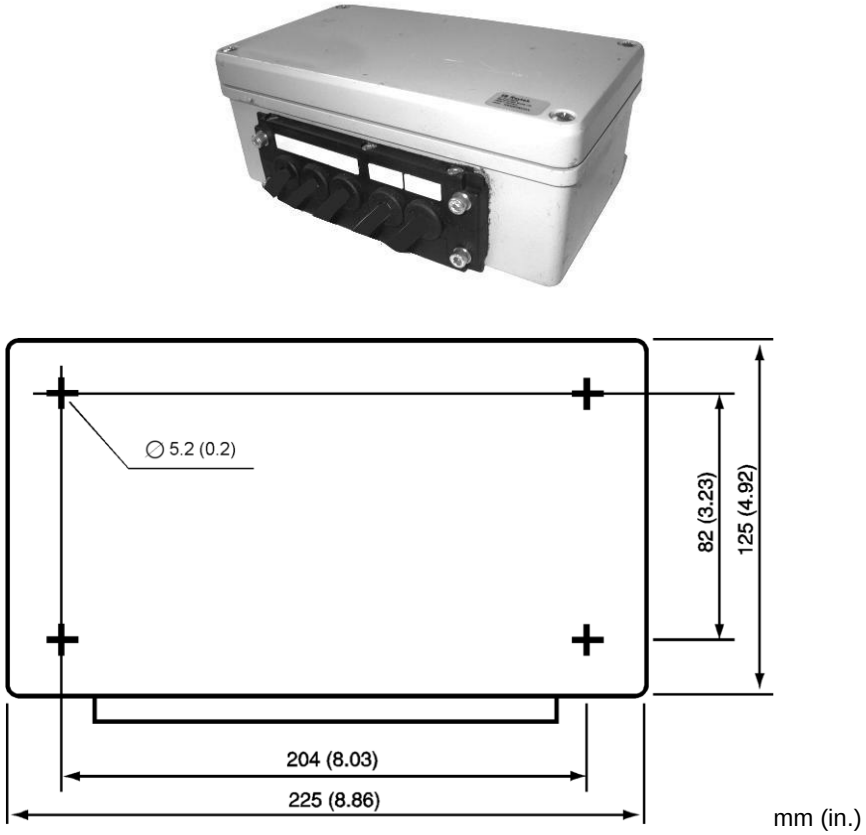
9.4 Connection Box for Accessories

The connection box connects the cables of a field device (shadow pyrometer, burning zone pyrometer) with the customer cables in the field.

All connection boxes come with the same housing but have different internal electrical wiring. The connection box is used for the following items:

- Endurance connection box (for Burning Zone Monitoring)
- MI connection box (for Shadow Monitoring)

Figure 9-3: Connection Box for Accessories



9.4.1 Technical Data

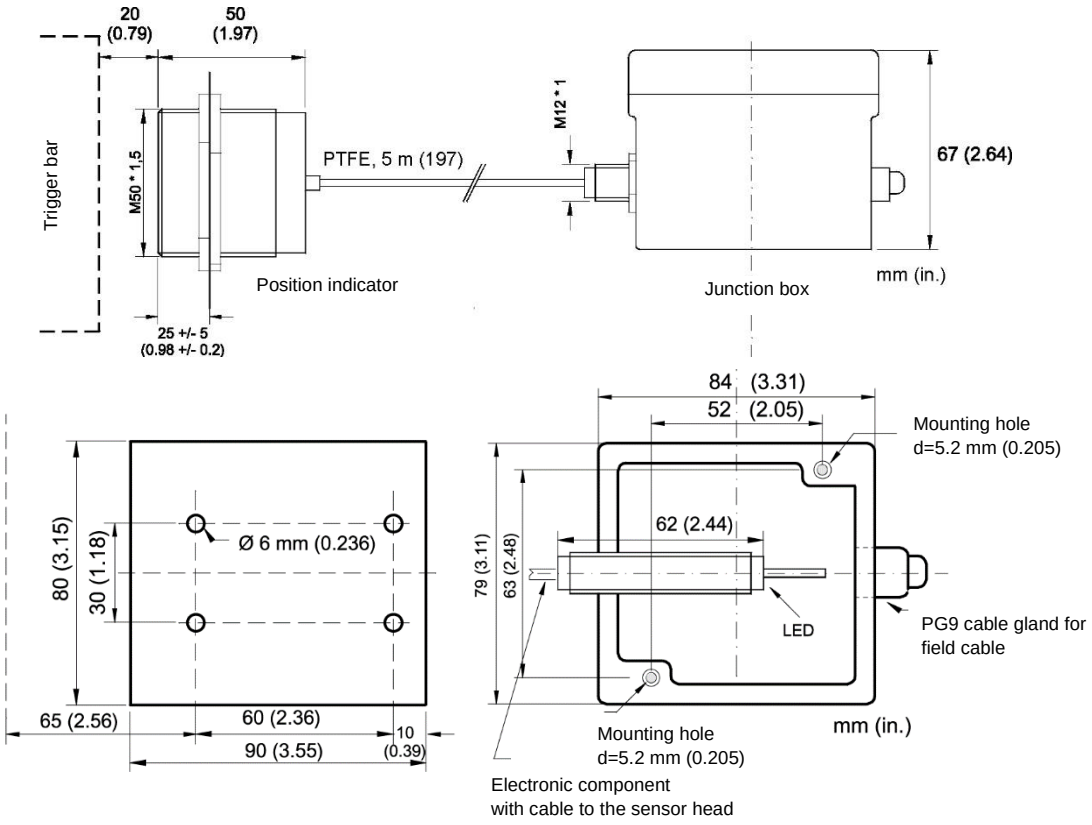
Box	Aluminum die cast
Cable grommet plate	Polyamide, halogen free and thermoplastic rubber
Temperature range	-40 to +80°C (-40°F to 168°F)
Dimensions (h x w x d)	90 x 225 x 130 mm (3.54 x 8.85 x 5.11 in.)
Weight	1.8 kg (3.96 lb)
Protection rate:	IP65 (NEMA 4)

9.4.2 Delivery

- Connection box
- Cable grommet plate
- Set of grommets for different cable sizes

9.5 Position Indicator (A-CS-SYSECPI)

Figure 9-4: Dimensions of Position Indicator and Junction Box



9.5.1 Technical Data

Switching distance	max. 20 mm (0.79 in.) positioned to steel St37, sized 50 mm in square (2.16 in. in square)
Temperature range	position indicator: -25 to 230°C (-13 to 446°F) junction box: -25 to 70°C (-13 to 158°F)
Length of cable	5 m (15 ft)
Protection rate:	IP67
Output	No. 2: active 24 V / 300 mA max. short circuit protected
Junction Box	Pin 2 (brown cable): + 24 VDC (7 to 40 VDC), ripple max. 15 % Pin 3 (black cable): output active Pin 1 (blue cable): 0 V