Product Data Sheet

1DC 96 – 1DC 960

Roll-2-Roll® Sensor

Roll-2-Roll
Technologies

Product Overview:

Product Name: 1DC 96 – 1DC 960
Product Type: Roll-2-Roll® Sensor

Product Description:

1DC series of Roll-2-Roll® Sensor is a groundbreaking all-in-one sensor that combines our CMOS line scan technology with integrated processing power, eliminating the need for external controllers. The 1DC series harnesses our patented light scattering and spatial filtering technology. From paper to metal, clear film to composite, this intelligent sensor delivers unmatched precision across multiple applications. For customers who demand versatility without compromise, the 1DC is the premium solution you've been waiting for.

Applications:

Web Guiding
Edge Position Measurement
Multiple Edge Position Measurement
Center Position Measurement
Contrast Guiding
Line/Contrast Position Measurement
Width Measurement
Coating Width Measurement
Multiple Strip Width Measurement
Thread/String Counting
Flag Detection
Splice Detection
Tear Detection
Simple Inspection

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1 Introduction

1.1 Product Overview

The 1DC series represents the next generation of Roll-2-Roll® Sensors for industrial automation applications. This groundbreaking integrated sensor combines our proven CMOS line scan technology with embedded processing power in a single compact housing, eliminating the need for external controllers and interconnecting cables. The 1DC integrates the functionality of our ODC sensor (camera, optics, and light source) with the processing power of the powerful SCU6x controller, offering a streamlined solution that reduces installation complexity while maintaining all the capabilities of our separate component systems.

Designed for demanding industrial environments, the 1DC delivers high-precision measurement and detection capabilities across a wide range of materials and applications. The all-in-one design significantly reduces setup time, minimizes potential points of failure, and provides a more compact installation footprint compared to traditional multi-component systems.

1.2 Working Principle

The 1DC sensor operates on Roll-2-Roll Technologies' patented light scattering and spatial filtering technology. Unlike conventional sensors that rely on blocking or transmitting signals, our technology utilizes the principle that all materials—whether opaque, transparent, porous, or non-porous—scatter light when illuminated.

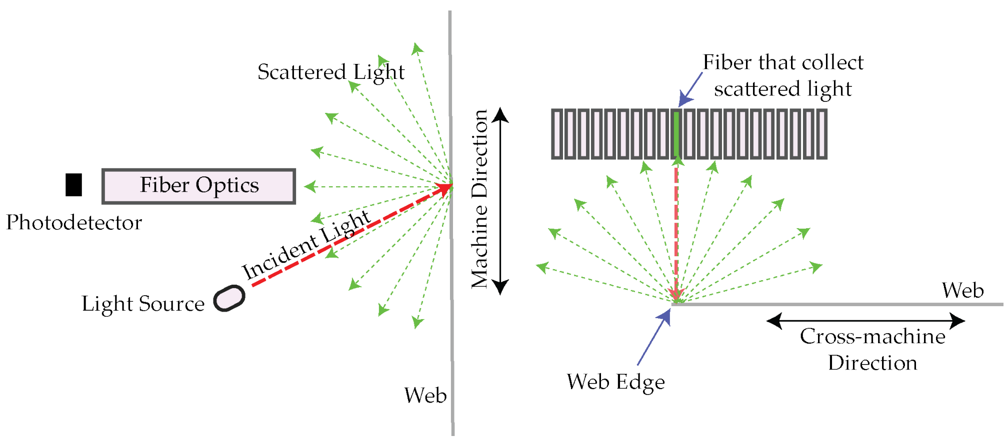


Figure 1: Scattering and Spatial Filtering Technology

The working principle can be broken down into three key stages (see Figure 1):

1. **Illumination**: An integrated LED light source (available in infrared, white light, or ultraviolet options) illuminates the target material.
2. **Light Scattering and Spatial Filtering**: As light falls on the material, it scatters in all directions. The patented fiber optic array acts as a spatial filter, collecting only the scattered light that falls within specific angles, providing directional sensitivity. The fiber optics also function as a linear lens array with 1:1 magnification, eliminating the distortion common in traditional lens systems.
3. **Image Capture and Processing**: The spatially filtered light is projected onto a high-resolution one-dimensional CMOS line scan camera. The captured image is then processed by the integrated controller using advanced digital signal processing algorithms to precisely determine the position, edges, or contrasting features of the material.

1.3 Advantage Over Conventional Sensors

Traditional fork/U-shaped or opposing beam sensors fundamentally operate on a principle of light blockage or transmission. These sensors have a transmitter on one arm and a receiver on the opposite arm, with the web material passing between them. Their measurement is based on how much of the transmitted signal is blocked by the material.

This approach creates several significant limitations:

- **Material Dependency**: Materials that partially transmit the sensing signal (light, sound, or air) produce inconsistent results. Transparent materials, porous webs, or materials with variable opacity can cause measurement errors that require complex calibration procedures (see Figure 2).
- **Environmental Sensitivity**: Conventional sensors are often affected by environmental factors such as dust accumulation, temperature changes, or ambient light conditions. These factors can introduce measurement drift or unpredictable behavior.
- **Installation Constraints**: The two-sided design requires precise alignment between the transmitter and receiver arms. This creates mounting challenges in space-constrained areas and increases installation complexity.
- **Limited Information**: Traditional sensors typically provide only basic positional data, lacking the detailed spatial information needed for complex applications like contrast detection or multi-edge measurements.
- **Calibration Requirements**: When transitioning between materials with different properties, these sensors often require recalibration, increasing downtime and setup complexity.

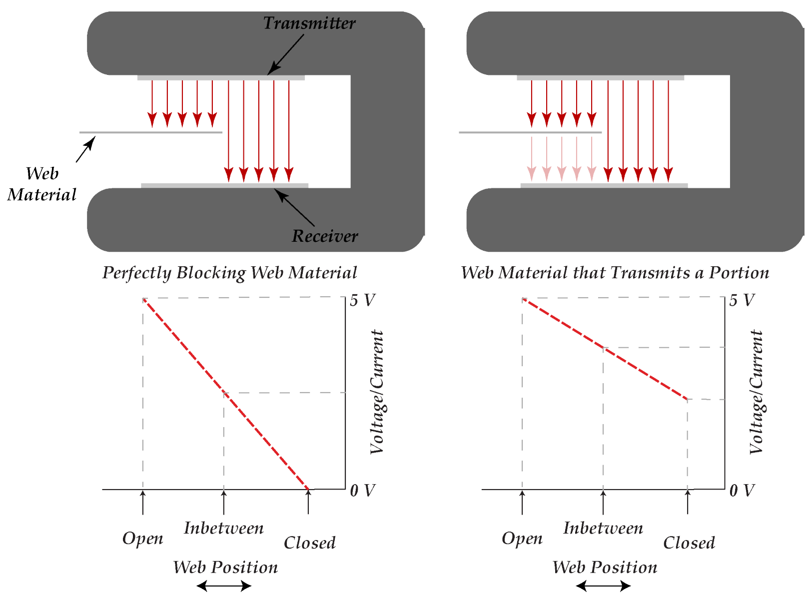


Figure 2: Material Dependence of Conventional Sensors

The Light Scattering Advantage

The 1DC sensor uses the principle of light scattering, setting it apart from traditional sensing methods. When light from the built-in LED source (whether infrared, white light, or ultraviolet) strikes the target material, it harnesses this phenomenon: **all materials scatter light**. This principle applies regardless of whether the material is opaque, transparent, porous, or has varying surface traits.

In contrast to other sensor technologies that depend on obstructing or allowing light to pass through, the 1DC sensor exploits the consistent scattering of light. The scattered light provides crucial spatial information regarding the material's edge position, distinguishing features, or other relevant surface properties. This method removes the necessity for recalibration when transitioning between various materials, which is a considerable benefit in manufacturing settings with frequently changing material properties.

1.4 Advantage Over Traditional Machine Vision

Traditional machine vision systems typically rely on circular lens optics that introduce significant distortion, aberration, and focal inconsistencies across their field of view. As the field of view widens, edge distortion becomes increasingly problematic, compromising measurement accuracy. To mitigate these optical limitations, expensive telecentric lenses are often required for precision measurement applications, substantially increasing system costs.

Conventional vision systems also demand complex external lighting arrangements that require careful design and precise positioning. These lighting systems not only increase the total installation footprint but also introduce additional points of failure. As working distance increases, vision systems suffer from resolution degradation, forcing difficult trade-offs between measurement field of view and precision. The required mounting gantries and support structures for cameras and lighting add further complexity, cost, and space requirements to the installation (see Figure 3).

Perhaps most challenging is the environmental sensitivity of traditional vision systems. Changes in ambient lighting conditions can significantly impact measurement reliability, often necessitating extensive shielding or enclosures. The combination of separate cameras, lighting, and processing components results in complex integration challenges and multiple potential failure points throughout the system.

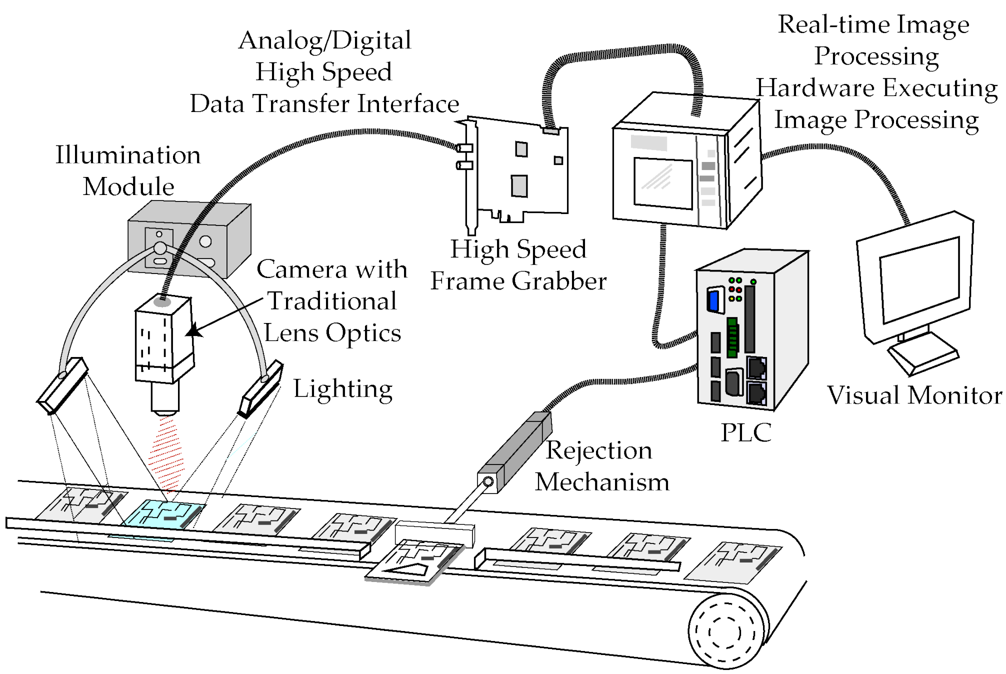


Figure 3: Complexities of Traditional Machine Vision Systems

Linear Optics with 1:1 Magnification

The 1DC's patented fiber optic array fundamentally transforms the sensing paradigm by utilizing a linear optical system with 1:1 magnification across the entire field of view. This innovative design effectively functions as an integrated telecentric lens system without introducing barrel distortion, vignetting, or field curvature common in traditional lens systems. The result is exceptionally precise measurements with consistent pixel-to-real-world correlation across the entire sensing width.

The fiber optic array also provides inherent directional sensitivity, acting as a spatial filter that only collects scattered light falling within specific angles. This natural filtering capability eliminates ambient light interference without requiring complex image correction algorithms or specialized optical components. The precision linear path creates a distortion-free image transfer that maintains measurement accuracy regardless of a material's position within the field of view.

Integrated Light Source Advantages

The 1DC's integrated illumination system eliminates the need for external lighting components entirely. By building optimized LED illumination directly into the sensor housing, the system achieves consistent lighting conditions across the entire measurement field. This integration removes the complexity of designing, installing, and maintaining separate lighting systems while dramatically reducing the overall installation footprint.

The purpose-designed illumination is aligned and optimized to the optical path, ensuring efficient lighting geometry that maximizes contrast for reliable edge detection. This fixed geometric relationship between the light source, subject, and optical path eliminates the variability and alignment issues common with separate lighting components. The integrated design also provides superior protection against contamination and physical damage compared to exposed external lighting systems.

Optimized Illumination Control

With the light source positioned at an optimal distance from the measured material, the 1DC achieves exceptional control over the illumination conditions. This close proximity allows for highly efficient light utilization, reducing power requirements while maintaining excellent signal-to-noise ratios in the captured image. The system dynamically adjusts illumination intensity to accommodate varying material properties, automatically compensating for changes in reflectivity or translucency.

This precise illumination control creates consistent imaging conditions regardless of material type or environmental factors, enabling the sensor to reliably detect edges and features across an extensive range of industrial materials without recalibration. The optimization of the light-to-subject relationship eliminates shadows, hotspots, and uneven illumination that typically plague conventional vision systems, further enhancing measurement reliability even in challenging industrial environments.

1.5 Key Features and Benefits

One-Sided Compact Design

- **Installation Flexibility**: Mounts on one side of the web, eliminating access requirements to both sides
- **Scalability:** With a one sided design it is easy to scale the measurement range by stacking multiple sensors side-by-side on one side providing full web width coverage

- **Simplified Web Path**: Allows direct web routing without special accommodations for opposing sensors
- **Vibration Immunity**: Unified design maintains internal alignment in high-vibration environments
- **Retrofit-Friendly**: Easily integrates into existing equipment with minimal mechanical modifications

All-in-One Integration

- **Complete Solution**: Combines light source, optics, camera, and processing in a single compact unit
- **Machine Vision Alternative**: Eliminates need for expensive external lighting, mounting gantries, and dedicated computers
- **Cable Reduction**: Simplified wiring with only power and communication connections
- **Space Optimization**: Compact footprint ideal for installations with limited mounting area
- **Rapid Deployment**: Plug-and-play functionality without complex system integration

Advanced Sensing Technology

- **Superior Optical Design**: Linear fiber optic array eliminates distortion common in traditional circular lens systems
- **Material Versatility**: Measures any material—from clear films to metals, nonwovens to composites—without recalibration
- **High Resolution**: Precision of 0.0635 mm (0.0025") across the entire sensing width
- **Consistent Accuracy**: Maintains measurement precision across the full field of view without edge distortion
- **Adaptable Illumination**: Integrated LED lighting (IR, white light, or UV options) for optimal material detection

Intelligent Processing

- **Self-Calibrating Algorithm**: Automatically adapts to changing material properties
- **Multiple Detection Modes**: Edge detection, contrast sensing, line guiding, width measurement, and more
- **High Processing Speed**: Rapid response time for high-speed applications
- **Digital Filtering**: Advanced noise reduction for stable measurements in challenging environments
- **Parameterized Operation**: Sophisticated detection without programming or vision system expertise

Industrial Connectivity

- **Comprehensive Protocol Support**: Support all major industrial Ethernet protocols
- **Real-time Communication**: Continuous data streaming for process monitoring and control
- **Configurable Registers**: Flexible parameter settings to customize functionality

Business Benefits

- **Reduced Total Cost of Ownership**: Lower installation costs, less maintenance, and higher reliability

- **Increased Uptime**: Quick product changeovers without sensor repositioning or recalibration
- **Improved Product Quality**: Precise measurement and control for consistent manufacturing
- **Part Number Simplification**: One sensor for multiple applications
- **Inventory Reduction**: One sensor for multiple applications

The 1DC represents a groundbreaking hybrid between conventional sensors and sophisticated machine vision systems. It delivers the simplicity of a sensor—easy to install, operate, and maintain—while providing the advanced measurement capabilities traditionally reserved for complex vision systems. This unique combination eliminates the traditional tradeoff between simplicity and functionality, offering industrial users sophisticated vision-based measurement without the complexity, cost, or expertise requirements of traditional machine vision implementations.

The 1DC combines the best of both worlds:
Simple installation and operation like a sensor
with the advanced measurement capabilities of machine vision

	Simple Sensors	1DC Sensor	Machine Vision Systems
Ease of Installation	Basic	Simple	Complex
Material Versatility	Low	Excellent	Good
Calibration Needs	Frequent	None	Complex
Expertise Required	Low	Low	High
Measurement Capability	Basic	Advanced	Advanced
Total System Cost	Low	Medium	High
Mounting Requirements	Two-sided	One-sided	Complex

Feature	Conventional Sensors	1DC Technology	Machine Vision Systems
Form Factor	Two-sided U-shaped or fork	One-sided compact integrated unit	Multiple components (camera, lighting, computer)
Ease of Installation	Simple but requires alignment	Simple plug-and-play	Complex, requires expert setup
Material Versatility	Limited by material properties	Works with all materials	Good for visible properties
Calibration Requirements	Needed for each material change	None - self-calibrating	Complex and frequent
Measurement Capability	Basic position only	Multiple modes (edge, contrast, width)	Comprehensive with custom programming
Resolution	Low to moderate	High (0.0635mm)	Dependent on optics and setup
Distortion	N/A	None (linear optical system)	Present with standard lenses
Processing	Simple	Integrated advanced algorithms	Requires separate computer
Configuration	Simple adjustment	Parameter-based setup	Complex programming
Expertise Required	Minimal	Minimal	Extensive vision knowledge
Space Requirements	Both sides of web	One side only	Substantial (camera, lights, compute)
Cost	$$	$$$	$$$$
Maintenance	Regular calibration	Minimal	Software updates, hardware maintenance, alignment
Speed	Fast	Fast	Depends on processing setup
Optical System	N/A	Linear fiber optic array	Circular lens with distortion
Working Distance	Fixed	Optimized (10-25mm)	Variable but typically larger
Connectivity	Limited	Comprehensive industrial	Complex but flexible

2 Technical Specifications

2.1 General Specifications

Parameter	Value
Sensing Principle	Light scattering with spatial filtering technology
Sensor Type	Integrated line scan camera with fiber optic array
Controller	Integrated SCU6x-based processing system
Functional Principle	Diffuse-reflective/Scattering
Sensor Measurement Range	96 mm – 960 mm (3.78" to 37.8")
Optimal Working Distance	6-25 mm (0.25" to 1")
Maximum Working Distance[a]	80 mm (3.15")
Resolution	0.0635 mm (0.0025")
Repeatability	±0.0635 mm (±0.0025")
Linearity	Better than 99.9%
Minimum Detectable Object	0.1 mm (0.004")
Minimum Distance Between Edges	2 mm (0.08")

[a] Depends on the material scattering properties.

2.2 Optical Specifications

Parameter	Value
Light Source	LED
Light Source Options	Infrared (850 nm), White light (warm white), Ultraviolet (385 nm)
Lens Type	Linear fiber optic array with 1:1 magnification (distortion-free)
Camera Type	CMOS Line Camera
Camera Capture Rate	25 Hz – 1000 Hz (with special firmware)
Camera Pixel Count	1536 to 15360 pixels
Camera Pixel Resolution	0.0635 mm (0.0025")
Number of Cameras	1 – 10
Filter Window	Acrylic (Polycarbonate)

2.3 Electrical Specifications

Parameter	Value
Supply Voltage	20 - 30 VDC
Input Connection Type	M8 4-pin A-Coded Male Connector
Power Consumption	5W to 36W (depending on camera size)
Current Consumption	250 mA typical, 1500 mA maximum (at 24 VDC)
Input Protection	Under/Over Voltage, Reverse Polarity, Reverse Current, ESD Protection
Communication Interface	Industrial Ethernet port (M8 4-pin A-Coded Female Connector)
Ethernet Protocols	EtherNet/IP, PROFINET, Modbus/TCP, EtherCAT, CC-Link IE Filed Basic

2.4 Mechanical Specifications

Parameter	*Value*
Housing Material	*Aluminum with powder coating*
Sensor Dimensions	*(W × H × D) Model dependent:* *– 1DC-96: 81 × 192 × 51 mm (see Figure 5)* *– 1DC-192: 81 × 289 × 51 mm (see Figure 7)* *– 1DC-384: 81 × 481 × 51 mm (see Figure 9)* *– 1DC-480: 81 × 577 × 51 mm (see Figure 11)* *– 1DC-768: 81 × 866 × 51 mm (see Figure 13)* *– 1DC-960: 81 × 1059 × 51 mm (see Figure 15)*
Mounting	*Mounting holes for M4, 6-32 or 8-32 screws*
Enclosure Rating	*IP67*
Filter Window	*Acrylic (Polycarbonate)*
Anti-Static Coating	*Available on Request*

2.5 Controller Specifications

Parameter	*Value*
Processing Functions	*Edge Position Measurement,* *Multiple Edge Position Measurement,* *Center Position Measurement,* *Line/Contrast Position Measurement,* *Width Measurement,* *Coating Width Measurement,* *Multiple Strip Width Measurement,* *Thread/String Counting,* *Flag Detection,* *Splice Detection,* *Tear Detection*
Processing Speed	*5 ms to 4 ms (application dependent)*
Control Algorithm	*Intelligent self-adjusting with automatic brightness control*
Number of Detectable Edges	*Up to 128 edges simultaneously*
Edge Quality Factor	*0–256 scale (reported via industrial communication)*
Software Features	*Dynamic thresholding,* *sub-pixel approximation,* *automatic brightness control,* *slope and alignment compensation,* *windowing/region of interest framing,* *flutter detection,* *pattern matching,* *contrast pattern tracking,*

2.6 Environmental Specifications

Parameter	*Value*
Operating Temperature	*-10°C to +65°C (+14°F to +150°F)*
Storage Temperature	*-40°C to +70°C (-40°F to +158°F)*
Relative Humidity	*5% to 95%, non-condensing*
Cooling	*Passive, no fans*
Installation Location	*Indoor use only*
Chemical Resistance	*Resistant to most industrial oils and lubricants*
Dust/Water Protection	*IP67 (when properly connected)*
Vacuum Compatibility:	*YES*

Note

Specifications are subject to change without notice. For the most current specifications, please consult the latest product documentation.

2.7 Dimensions

1DC 96-xx

The 1DC 96-xx is the smallest sensor of the 1DC series of Roll-2-Roll® Sensor. Application Examples for this sensor include:

- Edge Guiding
- Woven Seal-belt width measurement
- Extrusion width measurement
- Conveyor belt position measurement

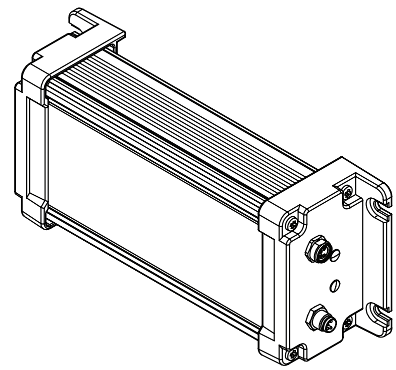


Figure 4: 1DC 96-xx Sensor

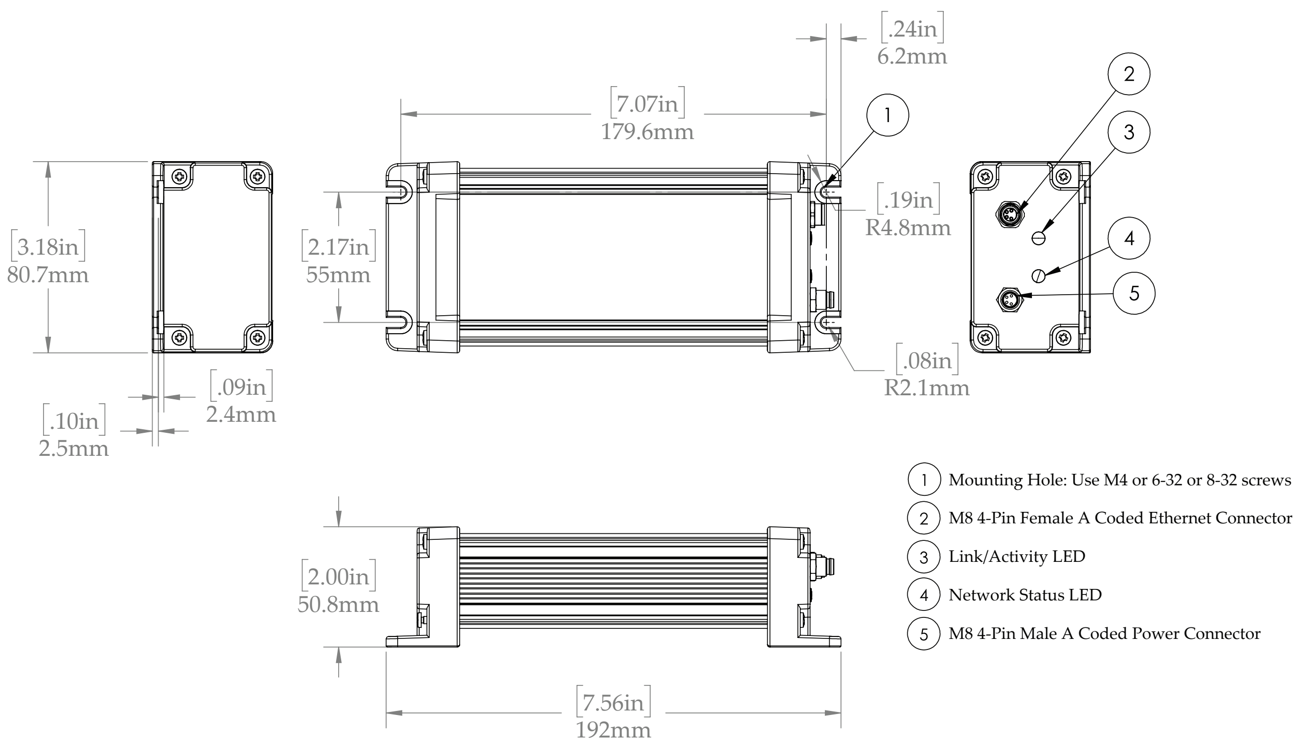


Figure 5: 1DC 96-xx Physical Dimensions

1DC 192-xx

The 1DC 192-xx is a mid range sensor for a wide variety of applications including:

- Edge Guiding
- Woven Seal-belt width measurement
- IV Bag width measurement
- Extrusion width measurement
- Shrink sleeve width measurement

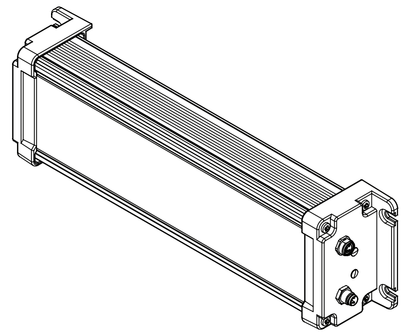


Figure 6: 1DC 192-xx Sensor

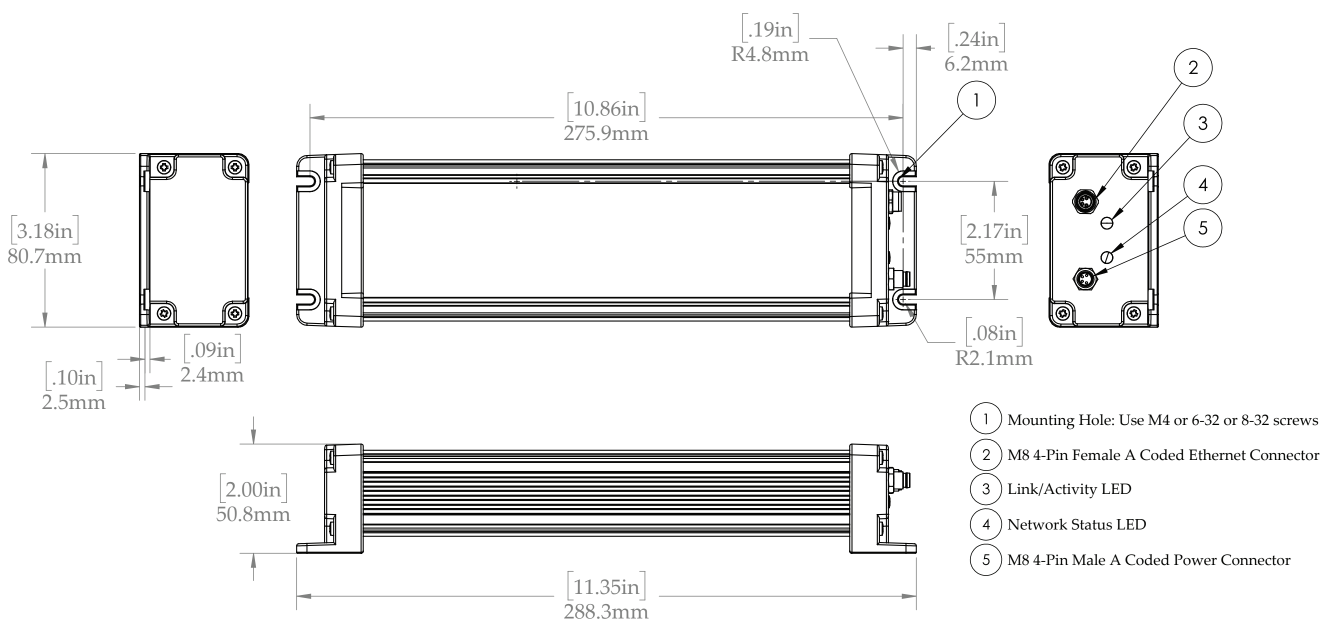


Figure 7: 1DC 192-xx Physical Dimensions

1DC 384-xx

The 1DC 384-xx is a mid range sensor for a wide variety of applications including:

- Edge Guiding
- Blown Film Width Measurement
- Extrusion width measurement
- Shrink sleeve width measurement

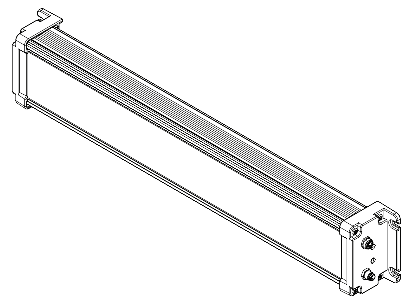


Figure 8: 1DC 384-xx Sensor

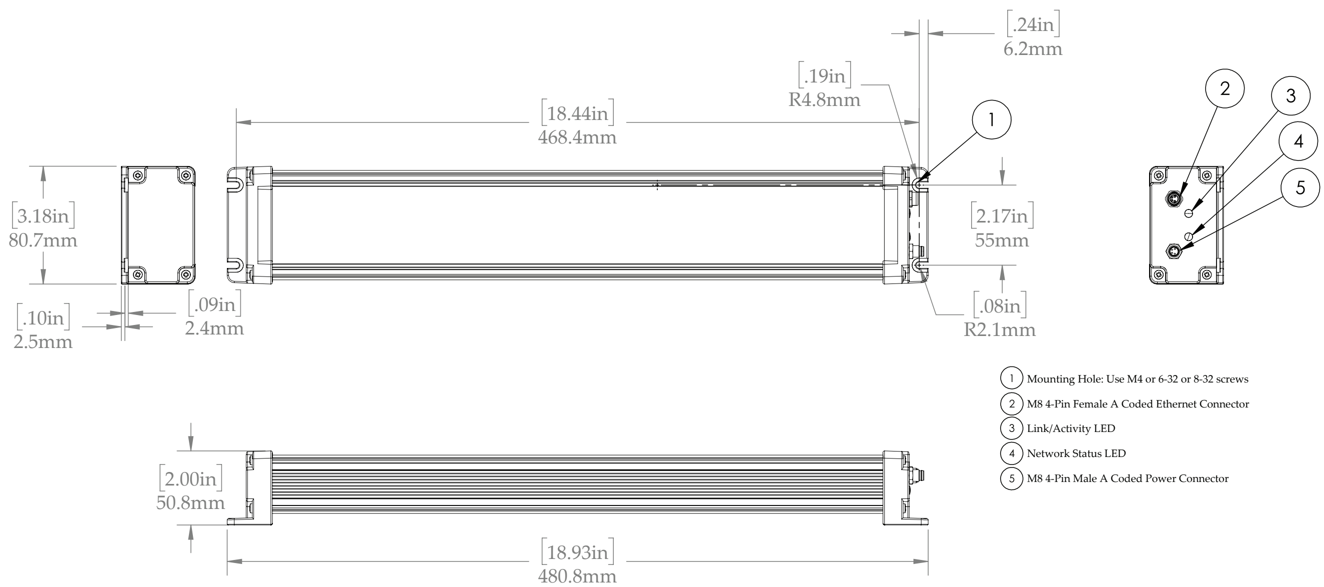


Figure 9: 1DC 384-xx Physical Dimensions

1DC 480-xx

The 1DC 480-xx mid range sensor, with dimensions that are most widely used in the ODC family. The sensor can be used in a wide variety of applications including:

- Edge Guiding in commercial printing presses
- Blown film web width measurement
- Thread counting in diaper manufacturing machines
- Extrusion width measurement
- Shrink sleeve width measurement

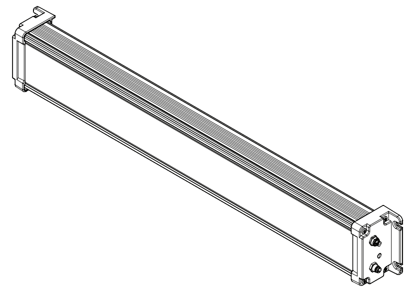


Figure 10: 1DC 480-xx Sensor

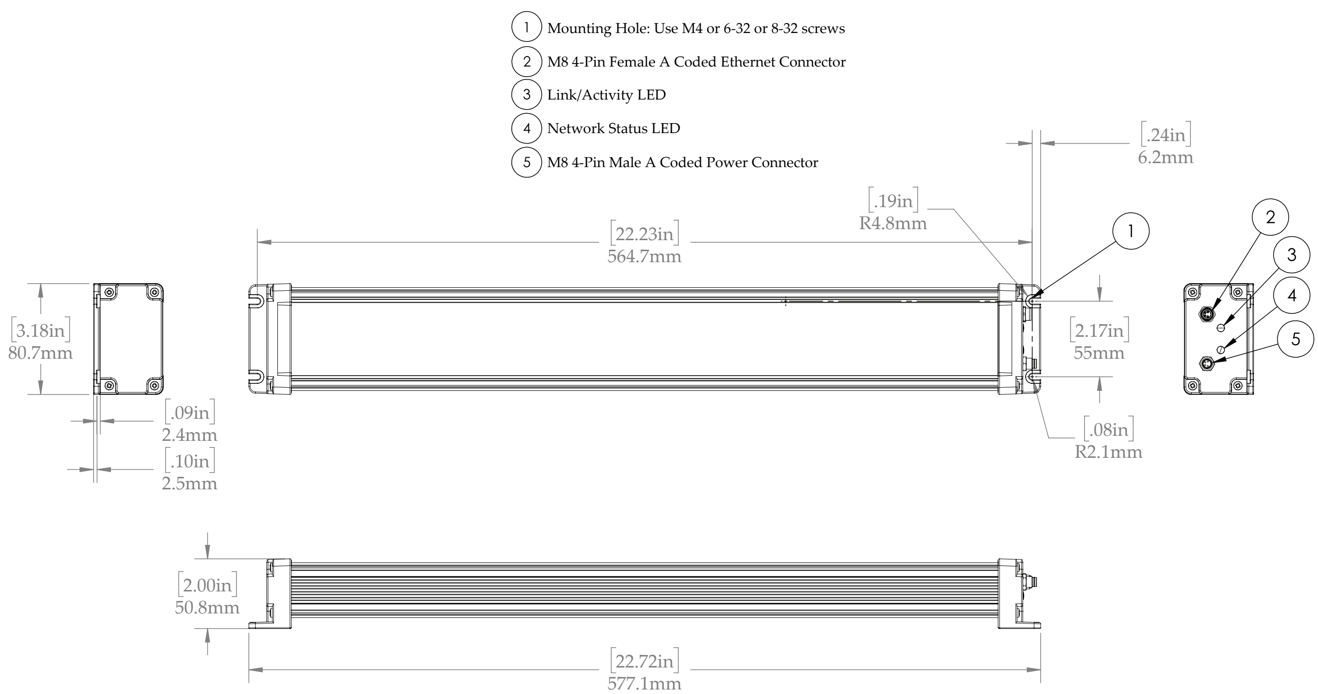


Figure 11: 1DC 480-xx Physical Dimensions

1DC 768-xx

The 1DC 768-xx is wide sensor of the 1DC series of Roll-2-Roll® Sensor. This sensor can be used in a wide variety of applications including:

- Edge Guiding (wide format web guiding)
- Corrugated web position measurement
- Multiple slit width measurement
- Web position and width measurement in metals industry
- Li-Ion Battery width measurement (coating and edge width)

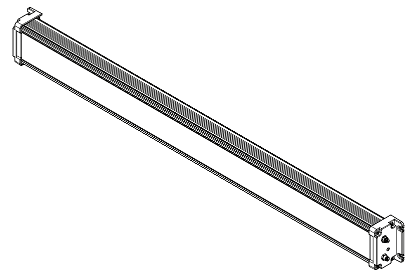


Figure 12: 1DC 768-xx Sensor

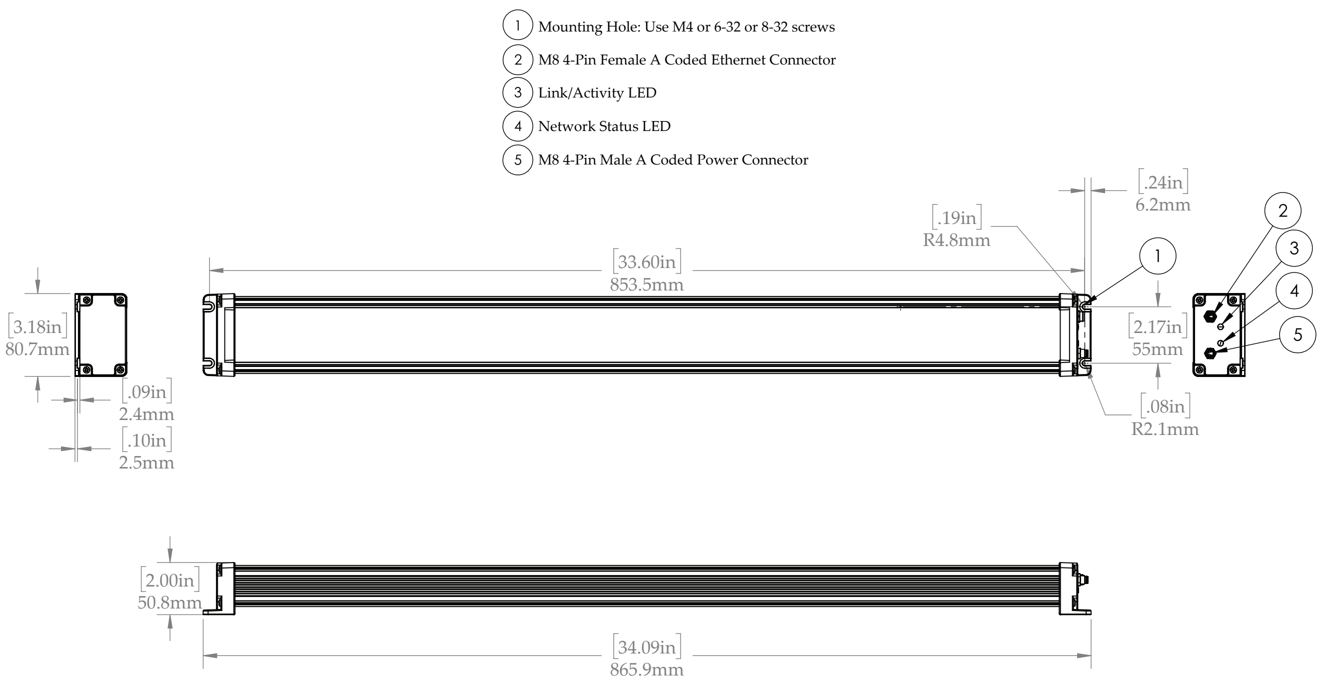


Figure 13: 1DC 768-xx Physical Dimensions

1DC 960-xx

The 1DC 960-xx is widest sensor of the 1DC series of Roll-2-Roll® Sensor which is used in a wide variety of applications including:

- Edge Guiding (wide format web guiding)
- Corrugated web position measurement
- Multiple slit width measurement
- Web position and width measurement in metals industry
- Li-Ion Battery width measurement (coating and edge width)

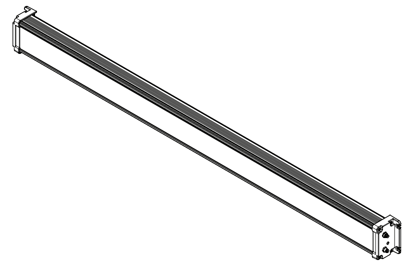


Figure 14: 1DC 960-xx Sensor

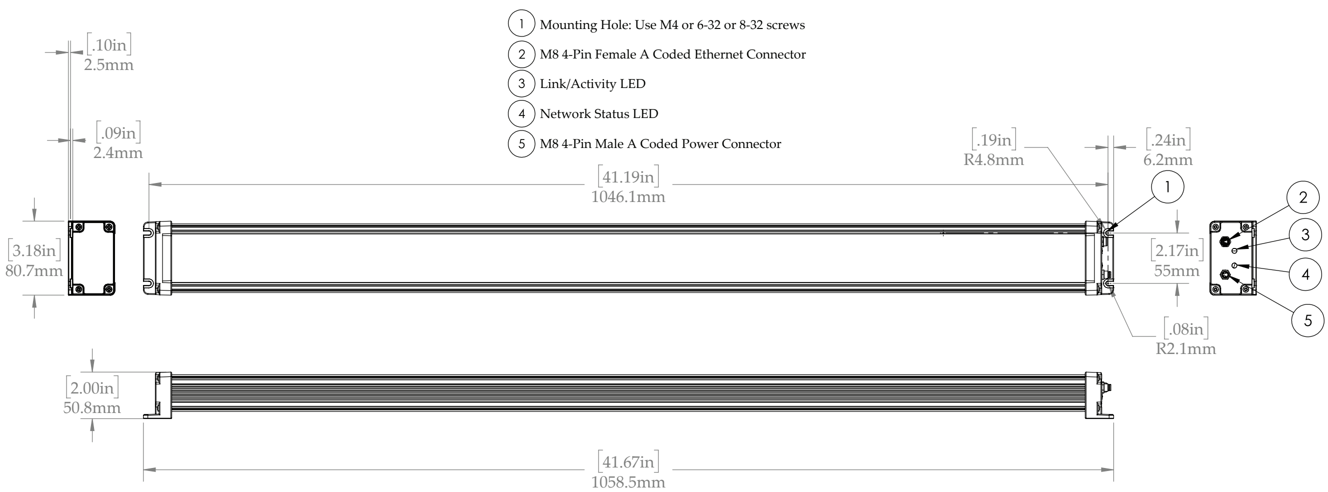


Figure 15: 1DC 960-xx Physical Dimensions

3 Mounting and Installation

3.1 Mechanical Mounting Options

Proper mechanical mounting is essential for optimal sensor performance. The mounting holes on the sensors can be used to directly mount the sensor on the machine frame to provide stable installations that minimize vibration and movement.

For convenience and ease of installation, 1" or 1.5" mounting brackets are available to securely attach the sensors to the machine using aluminum extrusion profiles (see Figures 16 and 17).

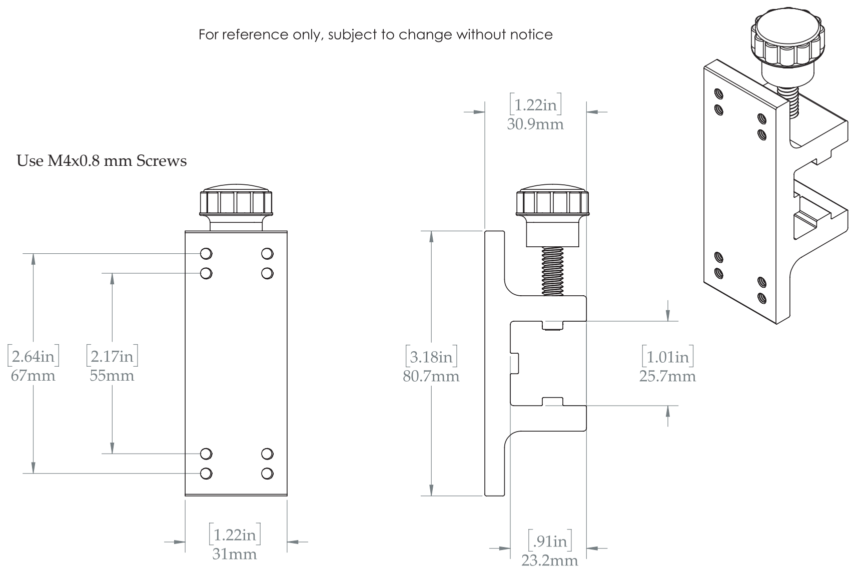


Figure 16: 1" Sensor Mounting Bracket for use with 1" extrusion or 25 mm extrusion

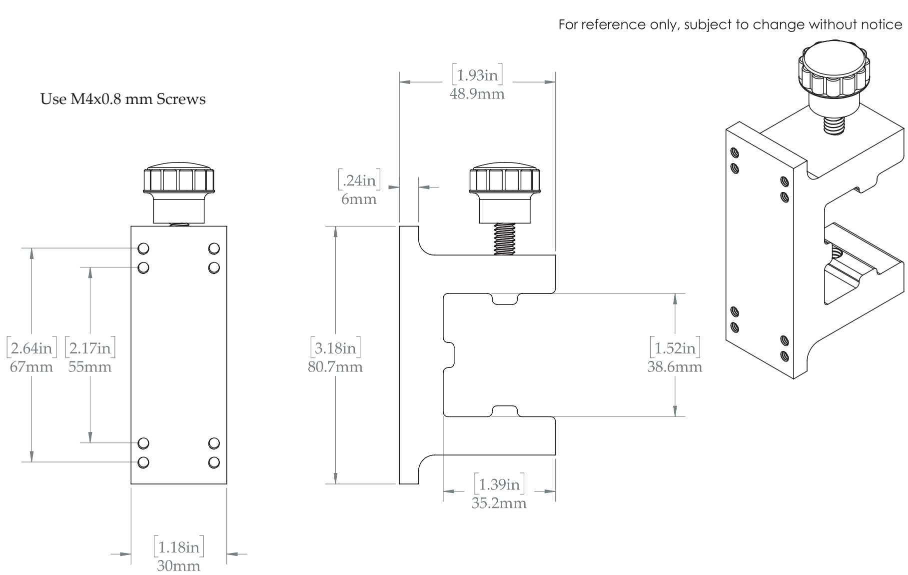


Figure 17: 1.5" Sensor Mounting Bracket for use with 1.5" extrusion

3.2 Installation Guidelines

All Roll-2-Roll® Sensors, including the 1DC series, are camera-based systems that work on the principle of light scattering. Hence, the sensor performance is improved with proper installation that can increase light scattering, improve image contrast, reduce background noise to create a good image.

Working Distance

Working distance refers to the distance from the sensor face to the web material, with the optimal range typically between 6 mm to 25 mm. Due to the inverse square law governing light propagation, the closer the sensor is to the web material, the greater the intensity of scattered light received by the sensor. For materials with strong light-scattering properties such as paper and nonwovens, the working distance can extend beyond the optimal range up to 80 mm while still maintaining reliable measurements.

- For contrast sensing applications, position sensors approximately 10 mm from the web
- For reflective webs (metallic, shiny), maintain 10 - 20 mm working distance
- Ensure the entire face of the sensor is at a constant distance from the web along the entire length

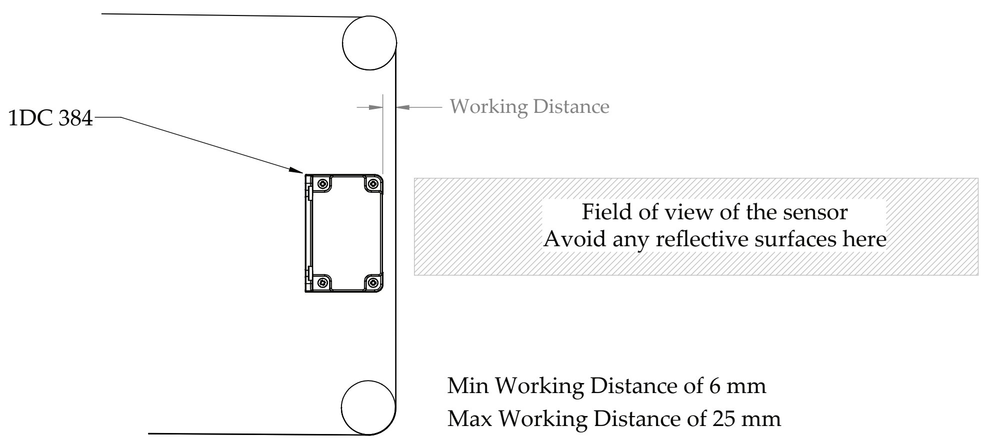


Figure 18: Working Distance and background Recommendations

Background Requirements

The camera-based nature of the sensor system means that objects behind the web in the sensor's field of view can be detected and potentially interfere with accurate web detection. Since the sensor captures an image of the area within its field of view, maintaining appropriate background clearance is essential for optimal performance. The system includes background suppression algorithms that automatically adjust LED brightness while maximizing image contrast, but proper physical installation remains important for reliable operation.

- Maintain minimum 150 mm clearance between sensor and any background object or web path
- Ensure no objects are within the sensor's field of view behind the web
- Position sensors to meet background free space conditions when installed close to idle rollers
- Consider material opacity when determining background requirements

> ✍ **Note**
> ***Alternative Background Solution:*** *For tight installations where the clearance requirement cannot be met, a black matte artificial background can effectively overcome the clear space requirements. This material works by absorbing light from the sensor and preventing reflection back, enhancing the detection capabilities. It is critical that the material is truly matte and black in color to ensure 100% absorption of light from the sensor. Non-reflective backgrounds also serve to enhance edge contrast for detection applications. In addition, a black roller can be used as a background, allowing the sensor to be installed close to the roller while maintaining proper detection performance.*

Position and Orientation

Sensors can be installed on either side of the web, with the choice depending on the accessibility of the threading and the available space constraints in the machine design. Regardless of the specific configuration, all sensor installations should position sensors to minimize the effects of mechanical vibration on measurement accuracy, as vibrations can introduce noise into the sensing system and reduce the quality of edge detection or contrast measurements.

It is also essential that the plane of the web remains parallel to the sensor's length dimension, as depicted in Figure 19. This alignment guarantees that the cameras positioned inside the sensor maintain a uniform distance from various sections of the web, preventing any false contrast variations caused by distance misalignment.

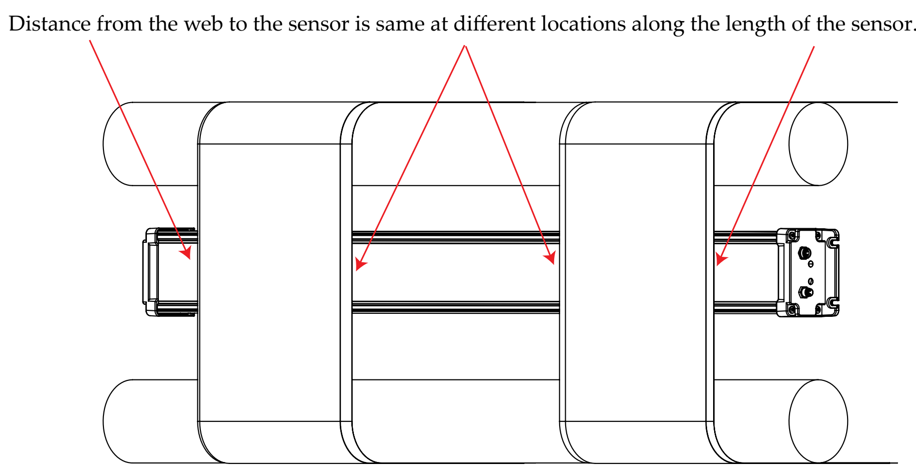


Figure 19: The sensor working distance along the length of the sensor

The performance of camera-based web sensing systems depends significantly on how light interacts with the monitored material. Different materials interact with light in unique ways, requiring specific sensor orientations to achieve optimal sensing results. The principle of light scattering is fundamental to sensor operation, and adjusting the sensor angle can dramatically enhance detection accuracy across various material types.

Most standard materials scatter light due to their surface texture, as shown in the left side of Figure 20. For these materials, the sensor can be installed parallel to the web. However, with materials like metallic, shiny, glossy, or clear webs, light tends to reflect rather than scatter. These reflective surfaces direct most incident light away from the sensor, returning only a minimal fraction. Since the angle of incidence equals the angle of reflection for these materials, proper angular orientation becomes critical for successful detection. The 1DC sensors have LED arrays positioned at an angle from the normal, enabling effective detection of reflective webs when the sensor is rotated approximately 11° from normal, as illustrated on the right side of Figure 20.

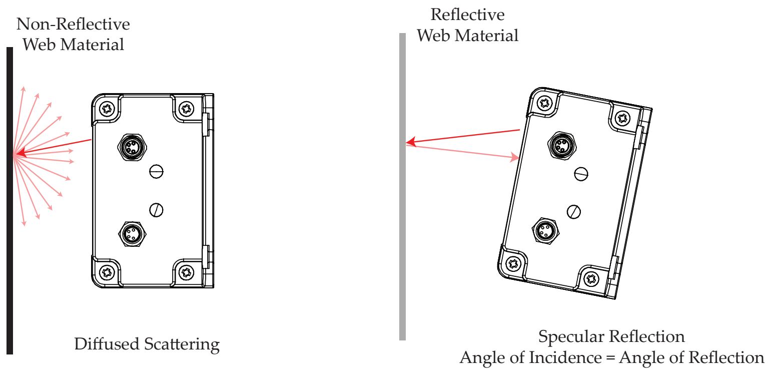


Figure 20: Diffused scattering with non-reflective webs and specular scattering of reflective webs may require different sensor rotation.

Web Stability Considerations

Inspection applications require sensors to be mounted in a free space between two rollers (as shown in Figure 21) where the web is stable and without flutter or out-of-plane motion that could affect measurement accuracy. To further enhance stability, positioning sensors closer to one of the rollers (as shown in Figure 22 helps reduce out-of-plane motion of the web. The mounting surface should always be structurally sound to minimize vibrations that could interfere with the accuracy of the detection.

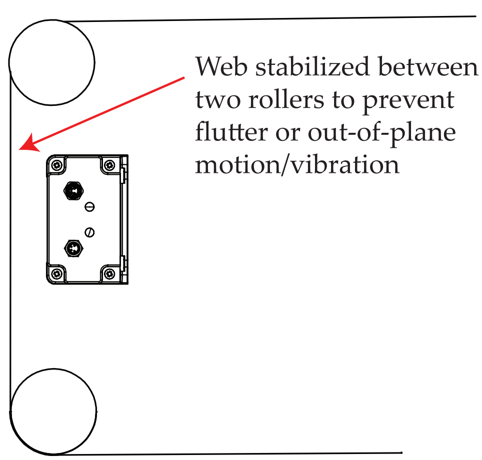


Figure 21: Sensor installed between two fixed roller for inspection applications

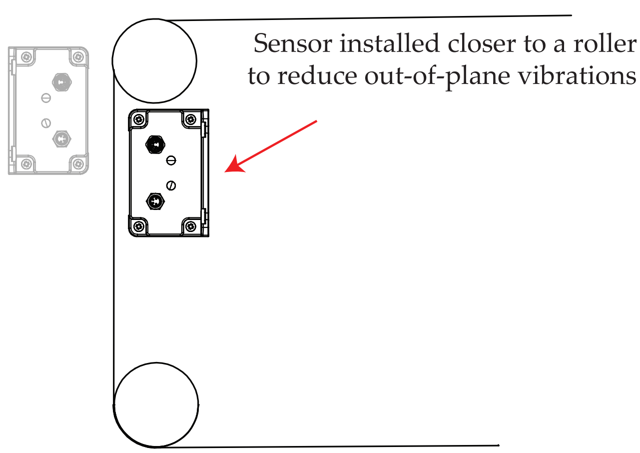


Figure 22: Sensor installed closer to roller to minimize web instabilty

Minimizing and Maximizing Light Scattering

For materials with high reflectivity, like metallized films or foils, and for transparent materials, such as glass or clear films, tilting the sensor by 11° from vertical redirects reflected light back into the sensor. This adjustment greatly enhances edge detection.

For applications such as lithium-ion battery inspection, it is beneficial to reduce scattering to improve the contrast between coated and uncoated sections of the web. This is achieved by rotating the sensor counter-clockwise (as seen from the connector end), which purposefully limits the amount of scattered light captured, thus enhancing the visual contrast between the different surfaces to aid in the detection of coating edges.

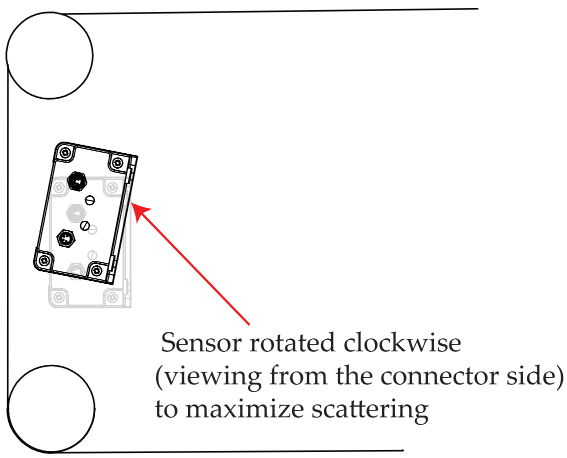


Figure 23: Sensor oriented to maximize scattering

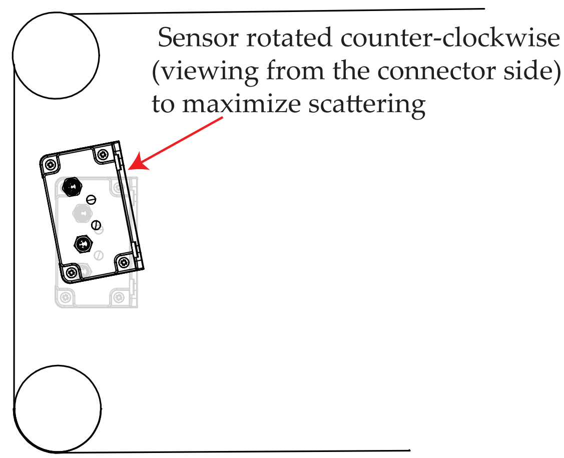


Figure 24: Sensor oriented to minimize scattering

The specialized angled mounting brackets designed for this purpose is available for use with standard aluminum extrusion profiles (see Figures 25 and 26).

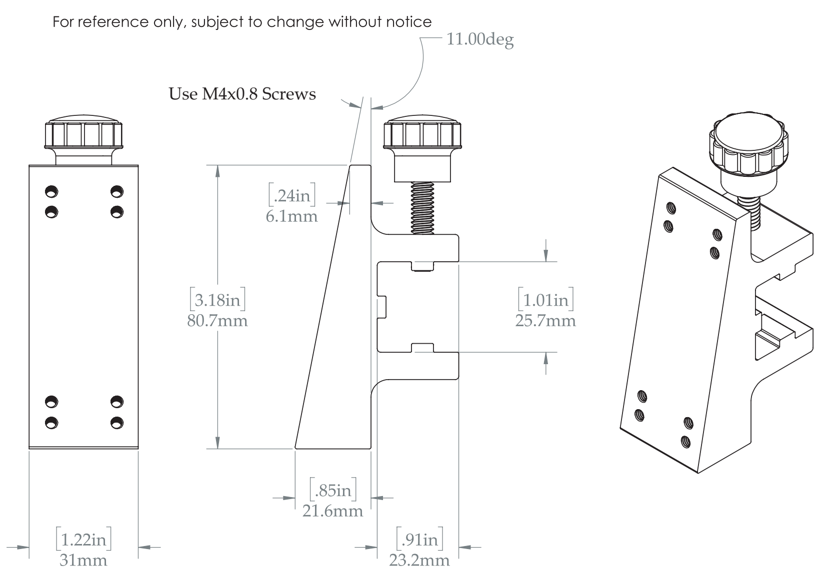


Figure 25: Angled 1" Sensor Mounting Bracket for use with 1" extrusion or 25 mm extrusion

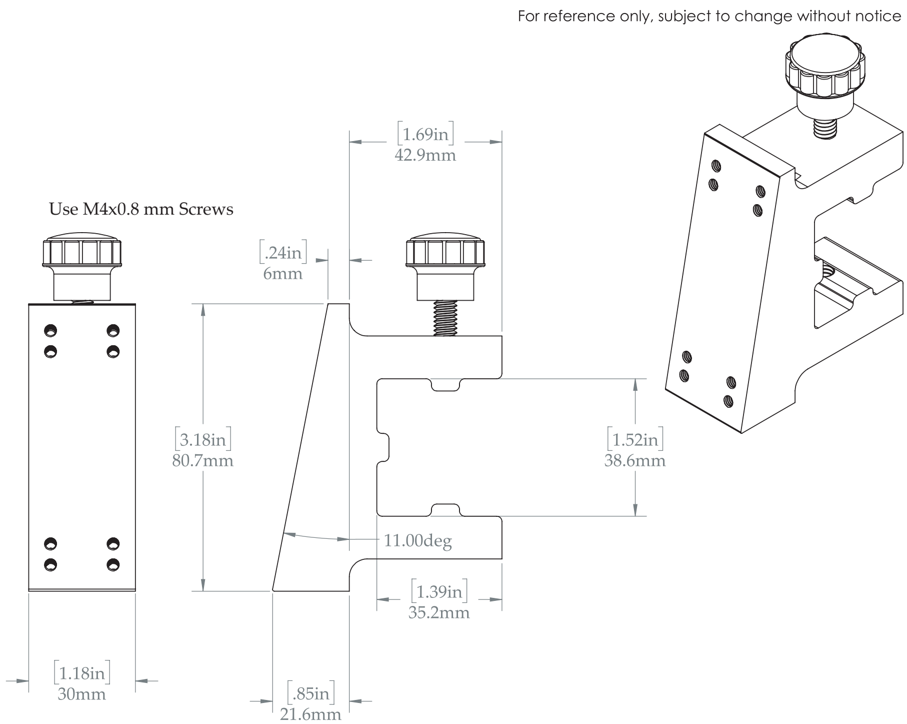


Figure 26: Angled 1.5" Sensor Mounting Bracket for use with 1.5" extrusion

4 Electrical Interface

1DC sensors have industry-standard connection interfaces that ensure simple and reliable electrical integration. The system uses clearly differentiated connectors to prevent mixing of connections, with standardized pinouts that allow for the use of widely available commercial cables rather than proprietary solutions.

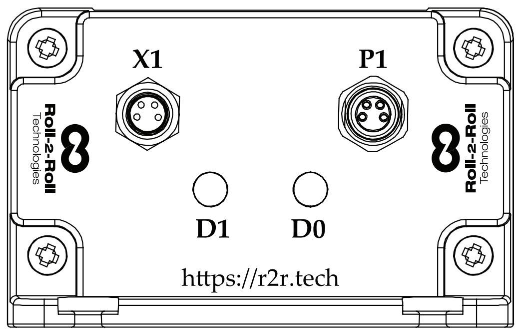


Figure 27: 1DC Connectors, Port Labels and Indicator LEDs

4.1 Power Input (X1)

Power is supplied through port X1, which utilizes an M8 4-pin male connector. This port operates at a 24 V DC power input. This power rail requires a maximum current of 3 Amps.

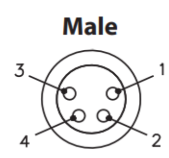
	Pin	Color	Signal
	1	Brown	+24V
	2	White	+24V
	3	Blue	GND
	4	Black	GND

Table 1: Pin Number for M8 Power Input Z2

Info

This port is equipped with protections against reverse polarity, reverse current, overvoltage, and undervoltage.

M8 Input Power Cable

Roll-2-Roll Technologies offers a standard off-the-shelf cable characterized as an M8 axial female to pigtail, with 4 poles, a PUR jacket in yellow color, and a length of 16.4 feet (5 meters). The designated part number is **21218x-5m**. Details on the cable's wiring are available in Figure 28. Any standard off-the-shelf cable that meets a 4 Amps per conductor current rating can serve as a substitute.

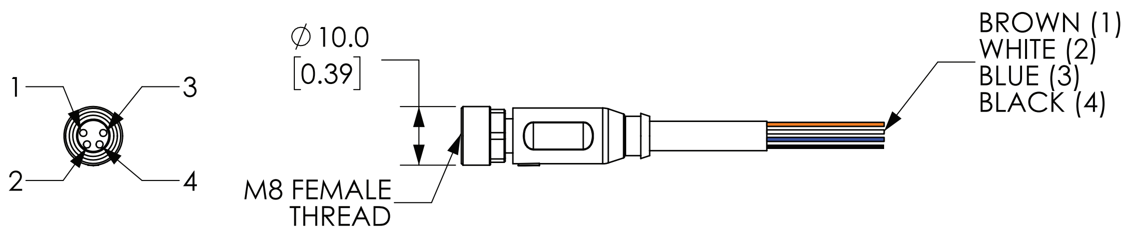


Figure 28: Power Input Cable Wiring Information

Industrial Din Rail Power Supply

Industrial DIN rail mountable power supplies, such as the Mean Well SDR-75-24 or SDR-120-24, can be utilized to provide 24VDC power. These power supplies are available for purchase from Roll-2-Roll Technologies.

4.2 Industrial Ethernet (P1)

Industrial Ethernet is available on the 1DC through port P1, which incorporates one of the standard industrial Ethernet protocols, such as EtherNet/IP, PROFINET, EtherCAT, CC-Link IE Field Basic or Modbus/TCP. Communication with the 1DC sensor is possible using an external PLC or computer via the ethernet interface. Roll-2-Roll Technologies stocks and sells 5m long M8 4-pin Male A-coded ethernet

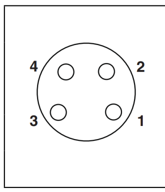
	Pin	Color	Signal
	1	Brown	TD+
	2	White	RD+
	3	Blue	RD-
	4	Black	TD-

Table 2: Signal and Pin Number for M8 4-pin A-coded Female

cables with RJ45 connector manufactured by Phoenix Contact. Here is a list of suggested manufacturers

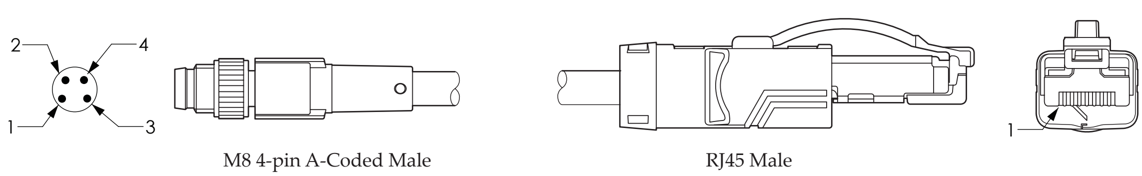


Figure 29: M8 to RJ45 cable information

and their respective cable part numbers:

1. Phoenix Contact: 1407354 (5m)
2. Turck: RSGS 4M RJ45S 4413-xM (x is the cable length in meters)

> **Info**
> *Consult the ethernet register map document for comprehensive details on commissioning through industrial ethernet options.*

4.3 LED Indicator D0 and D1

The LED indicator shows a dual color green and yellow LED. The color and status of the two LEDs have different meaning based on the network device being used.

EtherNet/IP

Indicator	Color	State	Meaning
D0	● (green)	On	A connection to the Ethernet exists
	● (green)	Off	The device has no connection to the Ethernet
	● (yellow)	Flashing	The device sends/receives Ethernet frames
D1	● (green)	On	Connected: If the device has at least one established connection (even to the Message Router), the network status indicator shall be steady green.
	● (green)	Flashing	No connections: If the device has no established connections, but has obtained an IP address, the network status indicator shall be flashing green.
	● (red)	On	Duplicate IP: If the device has detected that its IP address is already in use, the network status indicator shall be steady red.
	● (red)	Flashing	Connection timeout: If one or more of the connections in which this device is the target has timed out, the network status indicator shall be flashing red. This shall be left only if all timed out connections are reestablished or if the device is reset.
	● (green)● (red)	Flashing (red/green)	Self-test: While the device is performing its power up testing, the network status indicator shall be flashing green/red.
	● (green)● (red)	Off	Not powered, no IP address: If the device does not have an IP address (or is powered off), the network status indicator shall be steady off.

PROFINET

Indicator	Color	State	Meaning
D0	● (green)	On	A connection to the Ethernet exists
	● (green)	Off	The device has no connection to the Ethernet
	● (yellow)	Flickering[1]	The device sends/receives Ethernet frames
	● (yellow)	Off	The device does not sends/receives Ethernet frames

Continued on next page

[1]The yellow led turns on and off with a frequency of approximately 10 Hz to indicate high Ethernet activity: on for approximately 50 ms, followed by off for 50 ms. The yellow led turns on and off in irregular intervals to indicate low Ethernet activity.

Indicator	Color	State	Meaning
D1	● (green)	On	Watchdog timeout or “channel, generic or extended diagnosis present” or system error
	● (green)	Flashing (1Hz, 3s)[2]	DCP signal service is initiated via the bus.
	● (red)	On	No configuration or low speed physical link or no physical link.
	● (red)	Flashing (2Hz)[3]	No data exchange.
	● (red)● (green)	Off	No error

EtherCAT

Indicator	Color	State	Meaning
D0	● (green)	On	A link is established
	● (green)	Flashing	The device sends/receives Ethernet frames
	● (green)	Off	No link established
	● (Yellow)	Off	This LED is not used.
D1	● (off)	Off	The device is in INIT state.
	● (green)	Blinking	The device is in PRE-OPERATIONAL state.
	● (green)	Single Flash	The device is in SAFE-OPERATIONAL state.
	● (green)	On	The device is in OPERATIONAL state.
	● (red)	Blinking[4]	Invalid Configuration: General Configuration Error.
	● (red)	Single Flash[5]	Local Error: Slave device application has changed the EtherCAT state autonomously.
	● (red)	Double Flash[6]	Process Data Watchdog Timeout: A process data watchdog timeout has occurred. Possible reason: Sync Manager Watchdog timeout.

Open Modbus/TCP

Indicator	Color	State	Meaning
D0	● (green)	On	A connection to the Ethernet exists
	● (green)	Off	The device has no connection to the Ethernet
	● (yellow)	Flashing	The device sends/receives Ethernet frames
D1	● (green)	On	Connected: At least one TCP connection is established by the Open Modbus/TCP.
	● (green)	Flashing (1Hz)	The Open Modbus/TCP task is Ready but not configured yet.

Continued on next page

[2] The indicator turns on and off with a frequency of 1 Hz for 3 seconds: “green” for 500 ms, followed by “off” for 500 ms.
[3] The indicator turns on and off with a frequency of 2 Hz: “red” for 250 ms, followed by “off” for 250 ms.
[4] The indicator turns on and off with a frequency of 2.5 Hz: on for 200 ms, followed by off for 200 ms.
[5] The indicator shows one short flash (200 ms) followed by a long off phase (1,000 ms).
[6] The indicator shows a sequence of two short flashes (each 200 ms), separated by a short off phase (200 ms). The sequence is finished by a long off phase (1,000 ms).

Indicator	Color	State	Meaning
	● (green)	Flashing (5Hz)	The Open Modbus/TCP task is configured but is waiting for communication.
	● (green)	Off	The Open Modbus/TCP task is not Ready
	● (red)	ON	Active communication error
	● (red)	Flashing (2Hz)[7]	System Error

CC-Link IE Field Basic

Indicator	Color	State	Meaning
D0	● (green)	On	**Link:** The station is linked to the Ethernet, but does not send/receive Ethernet frames.
	● (green)	Flickering (load dependent) [8]	**Activity:** The station is linked to the Ethernet and sends/receives Ethernet frames.
	● (green)	Off	The station has no link to the Ethernet.
	● (yellow)	Off	This LED is not used.
D1	● (green)	On	Station in operation and cyclic transmission in progress.
	● (green)	Blinking[9] (2.5 Hz)	Station in operation and cyclic transmission stopped.
	● (green)	Flickering[10] (10 Hz)	Station not configured.
	● (red)	On	Communication error.
	● (red)	Triple Flash[11]	DPM watchdog has expired.
	● (red)	Off	Station is disconnected.

[7] On/Off Ratio = 25%

[8] **Flickering (load dependent)**: The indicator turns on and off with a frequency of approximately 10 Hz to indicate high Ethernet activity: on for approximately 50 ms, followed by off for 50 ms. The indicator turns on and off in irregular intervals to indicate low Ethernet activity.

[9] **Blinking (2.5 Hz):** The indicator turns on and off with a frequency of 2.5 Hz: “on” for 200 ms, followed by “off” for 200 ms.

[10] **Flickering (10 Hz):** The indicator turns on and off with a frequency of 10 Hz: “on” for 50 ms, followed by “off” for 50 ms.

[11] **Triple Flash:** The indicator shows a sequence of three short flashes (each 200 ms), separated by a short off phase (200 ms). The sequence is finished by a long off phase (1,000 ms).

5 Safety Instruction

The 1DC sensor is an electrical device that operates at a low voltage (24 V DC). However, it does present certain safety requirements that must be strictly adhered to to ensure the safe and effective operation of the system.

5.1 Instructions for Installation and Commissioning

The 1DC sensor must be properly transported and stored before being professionally installed. The sensor should not be installed or commissioned for operation if discernible damage is observed. Only qualified individuals should perform the installation, commissioning, operation and maintenance of the system.

☞ Warning

- *Never install or use a sensor that appears damaged.*
- *Any installation work around a web guide (that uses the sensor for feedback control) or the machine (that takes physical action based on the sensor feedback) should be done with the power to the sensor turned off.*
- *Adhere to appropriate lockout/tagout procedures while commissioning the Roll-2-Roll® Sensor.*
- *Never use cables that appear to be damaged.*
- *Always connect all cables before turning on the power to the sensor.*
- *Please read this product manual thoroughly before installation and commissioning.*

5.2 Instructions for Use

Any personnel tasked with operating the sensor should familiarize themselves with the general functional principles of the system.

✍ Note

- *Please read this datasheet and thoroughly and follow its instructions.*
- *Please read and adhere to the warning labels that are affixed to the device.*
- *Be aware of all applicable national, state and local requirements for accident prevention and environmental protection.*

5.3 Proper Use

The sensor is designed exclusively for indoor use. It can be integrated into industrial and laboratory equipment that processes materials in the web form or any material moving on a conveyor. The sensor is designed for application in machinery that processes continuous materials. Any implementation beyond the aforementioned parameters should be referred to Roll-2-Roll Technologies for endorsement.

5.4 Improper Use

Any use of the equipment that falls outside of the following guidelines shall be considered improper use and voids any warranty of the equipment:

☞ Warning

- *Outdoor use or exposure to direct sunlight*
- *Any modifications made without Roll-2-Roll Technologies' consent*
- *Any use of accessories not approved or recommended by Roll-2-Roll Technologies*
- *Any use outside the general specifications*

5.5 Static Discharge and Grounding

Plastic webs, especially, can generate notable static voltage potential when moved over rollers. To ensure proper grounding of the sensor without external ground wires, shielded Ethernet cables, with their shield attached to the nut, should be utilized. Therefore, it is crucial to choose suitable Ethernet cables, and Roll-2-Roll Technologiesoffers recommended options.

✍ Note

Avoid creating ground loops when grounding.

6 Maintenance

6.1 Cleaning Procedures

The 1DC Sensor is constructed to require minimal maintenance; however, periodic cleaning is advised to maintain peak functionality. The sensor's surface should be routinely wiped to eliminate any dust that could gather and hinder the sensor's accuracy.

Recommended Cleaning Materials

- Lens cleaning solutions commercially available for optical equipment
- Microfiber cloths designed for optical surfaces
- Non-pressurized compressed air cans for dust removal
- Isopropyl alcohol (70-99%) for stubborn contamination

Cleaning Process

1. Power down the sensor before performing any cleaning operations
2. Optionally, use compressed air to gently blow away loose dust and debris
3. If needed, lightly dampen a microfiber cloth with lens cleaning solution
4. Wipe the sensor lid gently in one direction, avoiding circular motions
5. For stubborn spots, apply a small amount of isopropyl alcohol to a clean microfiber cloth and wipe gently
6. Allow the sensor to completely dry before powering on again

Note

- *Never use petroleum-based products as these can damage the sensor cover and affect its performance*
- *Avoid abrasive materials that could scratch the optical surface*
- *Do not spray cleaning solutions directly onto the sensor surface*
- *Never use excessive pressure when wiping the sensor*
- *Avoid touching the cleaned surface with bare fingers*

Info

Roll-2-Roll Technologiesoffers an optional anti-static coating for the sensor surface to minimize dust buildup.

6.2 Preventive Maintenance

Regular preventive maintenance will help ensure the long-term reliability and performance of the sensor system.

Monthly Maintenance

- Visual inspection of sensor mounting for stability
- Check for dust accumulation on sensor lid and clean if necessary

- Verify proper cable connections and routing
- Inspect for any signs of physical damage or environmental exposure

Quarterly Maintenance

- Thoroughly clean sensor optical surfaces following the cleaning procedure
- Check for proper alignment and working distance relative to the web
- Inspect for any signs of wear on mounting brackets or hardware

Environmental Considerations

- In dusty environments, increase the frequency of inspection and cleaning
- For high-humidity applications, check more frequently for condensation
- If exposed to chemical vapors, increase inspection frequency and check for any signs of material degradation

Roll-2-Roll Technologies

Simple to Use Products for Challenging Problems