Roll-2-Roll Technologies
1110 S Innovation Way Dr
Stillwater, OK 74074
E: sales@r2r.tech
W: https://r2r.tech
P/F: +1-888-290-3215

1DC Series Roll-2-Roll® Sensor - EtherNet/IP, PROFINET, EtherCAT, and Open Modbus Register Map for v 4.3a+

This document provides the complete register map and communication interface specifications for the Roll-2-Roll® Sensors operating with firmware version 4.3a. It serves as the reference for system integrators, control engineers, and automation professionals implementing 1DC sensors in industrial ethernet networks.

The register map detailed in this document defines the data structure, memory organization, and communication protocols for real-time data exchange between 1DC sensors and industrial control systems including PLCs, HMIs, SCADA systems, and custom automation platforms.

These instructions are only for the Firmware Version: 4.3a and above. This document was last edited on July 09, 2025

EtherNet/IP Connection Parameters

An appropriate EDS file may be used to import the module in the PLC.

	Assembly Instance	Size	Bit
Input	100	19	16-bit
Output	150	11	16-bit
Configuration	1	0	8-bit

PROFINET Connection Parameters

Ethernet module configuration value based on the PROFINET GSDML file.

Input Module	Slot 5	32	Bytes
Input Module	Slot 6	8	Bytes
Output Module	Slot 1	16	Bytes
Output Module	Slot 2	8	Bytes

NOTE: For PROFINET systems the 16-bit data from the sensor are split into two bytes and byte swapped. The register map shown below is how the 16-bit data is stored in the sensor and sent out through the ethernet network. The PROFINET PLC might read the data in little endian format with the least significant byte first. So the 16-bit data from the sensor would need to be byte swapped to read the correct 16-bit value.

EtherCAT Connection Parameters

Ethernet module configuration value based on the supplied ECS File. The EtherCAT master will set all the information automatically based on the FMMU setting in the ECS file. The information provided is only for reference.

Input	0x1100	38	8-bit
Output	0x1D00	22	8-bit

Open Modbus/TCP

Reading or writing beyond the size provided here would provide random values.

	Address	Size	Bit	Function Codes Supported
Input	30001	19	16-bit	04
Output	40001	11	16-bit	03 or 06 or 16

Sensor Output and PLC Input

#	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
0	Sensor State Information															
1	Sensor Fault and Status															
2	Reserved for future															
3	Reserved for future															
4	Reserved for future															
5	Left Edge															
6	Right Edge or Contrast Position															
7	Coverage															
8	Left QF								Right QF							
9	Reflection Density															
10	Reserved for future															
11	Min Contrast								Brightness							
12	Gap Count								Thread/Web Count							
13	Keep Out Left								Keep Out Right							
14	Width															
15	Application Page Number															
16	For Future Implementation															
17	For Future Implementation															
18	For Future Implementation															

Sensor State Information

The sensor state register is organized as follows.

Bit #	Value	Label	Description
0-6	0-63	Edge Count	Used for internal purposes for contrast application. Will be explained in detail in future firmware versions.
7	0/1	Teaching Saved	Used for internal purposes for contrast application. Will be explained in detail in future firmware versions.
8 - 10	0/1	Contrast Type	Used for internal purposes for contrast application. Will be explained in detail in future firmware versions.

11	0/1	Teaching	Used for internal purposes for contrast application. Will be explained in detail in future firmware versions.
12	0/1	Brightness State	0: Brightness control is in manual or frozen to user defined value 1: Brightness control is in automatic mode and adjusted by the sensor
13	0/1	Threshold Mode	1: Static thresholding algorithm enabled 0: Dynamic thresholding algorithm enabled
14	0/1	Sensing Mode	0: edge sensing mode 1: contrast position sensing mode
15	0/1	Reserved	Reserved for future

Sensor Status and Fault

The sensor status/fault register is organized as follows.

Bit #	Value	Label	Description
0	0/1	No sensor	0: if a sensor is present 1: if no sensor is connected
1	0/1	Low contrast	0: if measurement contrast is high 1: if measurement contrast is low
2	0/1	No web	0: if web is detected by the sensor 1: if the sensor cannot detect a web
3	0/1	Wrong orientation	0: if sensor orientation is correct 1: if the sensor see an edge in the opposite orientation to which it is set up
4	0/1	Static Threshold	1: Static thresholding algorithm enabled 0: Dynamic thresholding algorithm enabled
5	0/1	Flutter	0: if no flutter is detected 1: if the sensor detects flutter or out of plane movement in the web
8	0/1	Left Sensor	0: if the sensor not set as a left sensor 1: if the sensor is set as a left sensor

9	0/1	Right Sensor	0: if the sensor not set as a right sensor 1: if the sensor is set as a right sensor
10-13	1-15	Number of pixels	The number of pixels in the sensor and the corresponding sensor resolution. 3: 1536 1DC 96 (0.0635 mm) 5: 3052 1DC 192 (0.0635 mm) 9: 6084 1DC 384 (0.0635 mm) 11: 7600 1DC 480 (0.0635 mm) 13: 12148 1DC 768 (0.0635 mm) 15: 15180 1DC 960 (0.0635 mm)
14-15	0-3	Sensing mode	0: edge sensing mode 1: contrast position sensing mode

Note: *If both the left sensor and the right sensor bits are set then the configuration corresponds to center sensor mode. A single sensor may be used to measure the position of the two edges of the web, if the width of the web is smaller than the sensing window of the sensor.*

Left Edge

The Left Edge register provides the absolute position of the leftmost detected edge within the sensor's field of view, measured in pixels from the sensor's reference zero position. This measurement represents the transition point where the sensor detects a change from background to material (or vice versa) when scanning from left to right across the sensing window.

The 1DC sensor employs advanced edge detection algorithms that analyze the intensity gradient across adjacent pixels. The edge position is determined using sub-pixel interpolation techniques, achieving resolution beyond the physical pixel spacing of 0.0635 mm. The algorithm compensates for material variations, ensuring consistent edge detection across different web opacities, colors, and surface textures.

Note: *If the sensor orientation is set to the right sensor then this value would be zero.*

Note: *If the sensor orientation is set to the right sensor or if the sensor mode is contrast, then this value would be meaningless.*

Right Edge or Contrast

This register serves two distinct functions depending on the sensing mode configuration:

1. Edge Sensing Mode - Right Edge Detection
   Measures the absolute position of the rightmost edge within the sensor's field of view. This represents the transition from material to background when scanning left to right. The measurement principles are identical to left edge detection but applied to the opposite web boundary.
2. Contrast Sensing Mode - Contrast Position
   Detects and tracks the position of contrasting features on the web surface, such as:
   a. Printed registration marks
   b. Color transitions or patterns
   c. Coating boundaries
   d. Adhesive tape edges
   e. Label positions

The 1DC utilizes dynamic thresholding algorithms that automatically adapt to varying contrast levels. The system can detect contrast differences as low as 5% reflectivity variation, making it suitable for subtle print detection. The integrated brightness control optimizes illumination for maximum contrast sensitivity.

Note: *While in contrast mode if the sensor sees no contrast then this value would equal to the number of pixels in the sensor.*

In either sensor orientation (left or right) the measured position increases as the web moves from left to right.

Note: *If no sensor bit is set or if no web bit is set then the value in the sensor position output register is meaningless.*

Sensor Orientation	Completely open	Fully covered
Left edge	Number of pixels	0
Right edge	0	Number of pixels

Note: *The output when the web completely covers the sensor or when the web is completely outside the sensor window would be different based on the sensor orientation.*

Note: *If a single web (with two edges) is seen by the sensor, then the width of the web can be obtained by taking the difference between right and left edge positions.*

Note: *If a single web (with two edges) is seen by the sensor, then the centerline of the web can be obtained by taking the average of left and right edge position.*

Coverage

Coverage represents the total number of pixels classified as "material" or "foreground" within the sensor's field of view. This provides an area-based measurement that quantifies how much of the sensor's detection window is occupied by web material versus open space.

The coverage value is computed by summing all pixels that exceed the detection threshold:

Coverage = Σ(pixels classified as material)
For single web: Coverage = Right Edge - Left Edge
For multiple webs: Coverage = Σ(width of each web segment)
Background/Gap calculation: Total Gap = Sensor Pixel Count - Coverage

Note: *When only one web (with both edges within the sensor field of view) is presented to the sensor the coverage value will be the same as the web width, The coverage value is computed based on edges seen by the sensor. Based on the sensor settings, if multiple contrasting features on the web are seen, then coverage value will not be the same as the web width. The coverage will only correspond to all the regions of the sensor image that is classified as the foreground or the web.*

Note: *The complement of coverage is the background or the gap. Sum of all gaps = Number of Pixels - Coverage.*

Quality Factor Registers

The quality of the sensor measurement from the leftmost and rightmost edges are provided in this register. Higher numbers correspond to good quality measurement while a low number indicates lower quality. The value of the quality factor ranges from 0 to 256.

Reflection Density

Reflection density represents the average light intensity reflected from the material between the detected edges, providing a 12-bit measurement (0-4095) of the material's optical properties. This parameter quantifies the material's reflectivity under the sensor's illumination conditions.

Brightness

The brightness register (lower 8 bits of register 11) reports the current LED illumination level as a percentage (0-100%), representing the PWM duty cycle applied to the integrated light source. The 1DC's integrated design ensures optimal coupling between illumination and detection systems.

- Operating Modes Automatic Mode (Bit 12 of Sensor State = 1):
    - Sensor continuously adjusts brightness
    - Optimizes for maximum edge contrast
    - Compensates for material variations
    - Adapts to environmental changes
- Manual/Frozen Mode (Bit 12 of Sensor State = 0):
    - Brightness locked at current/specified value
    - Used for consistent multi-sensor installations
    - Required for certain inspection applications

Minimum Contrast

The minimum contrast parameter (upper 8 bits of register 11) establishes the sensitivity threshold for feature detection in contrast sensing mode. This user-configurable value determines the minimum reflectivity difference required to register as a valid contrast feature.

Thread/Web Count

This register reports the number of distinct material segments (webs, threads, strips, or strings) detected within the sensor's field of view.

Gap Thread Count

When multiple webs or strings or threads are viewed by the sensor, the number or the count of gaps between the webs is provided in the register.

Keepout Left and Keepout Right

Keep out zones define percentage-based exclusion areas from the left and right edges of the sensor's field of view where detection is intentionally disabled. This creates a focused detection window within the full sensor range.

Web Width

This register provides the width output from the sensor. The output depends on the width mode (single or multiple web width).

Note: *The web width measurement provided in this register can be converted to real-world units using this conversion factor of 1 : 0.015875 mm or 1 : 0.000625 in (1/1600 in). So for example if the register value is 10,000 then the value in physical units is 158.75 mm or 6.25 in.*

Note: *The web width measurement output includes the compensation factor that is calculated during the teaching process.*

Note: *The register will have a valid output only after the sensor is taught for the nominal web width.*

Sensor Input and PLC Output

#	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
0	EN	Sensor Command Register														
1	EN	Maximum Brightness Limit							EN	Minimum Brightness Limit						
2	EN	Brightness Override Value							EN	Minimum Contrast						

3	Reserved for future
4	Reserved for future
5	Reserved for future
6	Reserved for future
7	Application Page
8	For Future Implementation
9	For Future Implementation
10	For Future Implementation

Sensor Command Register (Register 0)

The bits in the command register are organized as follow:

Bit #	Value	Label	Description
0	0/1	Brightness Auto	0: Set brightness mode to manual/freeze 1: Set brightness mode to be automatic Bit 15 must be set to 1 in order for this functionality to work.
1	NA	Reserved	Reserved for future use
2	0/1	Sensing Mode	0: edge sensing mode 1: contrast position sensing mode Bit 15 must be set to 1 in order for this functionality to work.
3 - 4	0, 1, 2, 3	Sensor State	0: Disable sensor 1: Left edge mode 2: Right edge mode 3: Centerline mode Bit 15 must be set to 1 in order for this functionality to work.
5	0/1	Static Threshold	1: Static thresholding algorithm enabled 0: Dynamic thresholding algorithm enabled Bit 15 must be set to 1 in order for this functionality to work.
8-14	NA	Reserved	Reserved for future use
15	0/1	Remote Control	1: Enable write to the lower 15-bits 0: Disable write to the lower 15-bits Bit 15 of this 16-bit register acts as a safety precaution. To enable remote changes from the PLC to the lower 15 bits of the sensor, bit 15 must be set (1). Conversely, setting bit 15 to 0 disables write access to the lower 15 bits. This ensures that only intentional writes are permitted.

Note: *When the automatic brightness control bit is cleared, the actual brightness value would be the last automatic value before the operation. If needed, the user can then remotely adjust the brightness value by writing to the brightness register (register 2).*

Note: *Disabling the sensor is not a valid state for 1DC. This change should only be made if absolutely necessary for reasons unknown to us.*

Maximum and Minimum Brightness Limit (Register 1)

Bits 14-8 control the maximum LED brightness, while bits 6-0 manage the minimum. These limits allow the PLC to constrain brightness within a set range, which is especially helpful for reducing background interference when the sensor is in tight spaces with limited room behind the web. To modify these values, set the most significant bit of the corresponding byte to 1; otherwise, the lower 7 bits will be ignored.

Note: *These maximum and minimum limits apply to both automatic and static brightness modes. The upper limit must not be smaller than the lower limit. If it is, both values will be set to the value that was changed last.*

Note: *If bit 15 is not set (or cleared to zero), this will have no effect.*

Note: *The limit value set through ethernet can change from 0 to 125 while the limit value set from the sensor can change from 0 to 100.*

Note: *The limit will take effect even when the brightness is changed manually as well as if allowed to change automatically.*

Brightness and Contrast (Register 2)

Bits 14-8 sets the manual brightness override value, while bits 6-0 changes the minimum contrast value. To modify these values, set the most significant bit of the corresponding byte to 1; otherwise, the lower 7 bits will be ignored.

Note: *When the automatic brightness control bit is cleared, the actual brightness value would be the last automatic value before the operation. If needed, the user can then remotely adjust the brightness value by writing to the brightness register (register 2).*

Note: *Setting the automatic brightness control bit and writing a value to this register will restart the automatic brightness algorithm. The written value serves as the initial condition for the algorithm. It is important to note that the final brightness may or may not stabilize at the override value. This feature can be beneficial for advanced applications.*

Application Page Number

When this register is set to zero, the default register map is loaded.