MICRONOR
automation components

MR382 Series
Fiber Optic U-Beam
Instruction Manual

Doc No: 98-0382-01
Revision C1 dated 10-20-2016

MICRONOR INC.
900 Calle Plano, Suite K
Camarillo, CA 93012
USA
Tel +1-805-389-6600
Fax +1-805-389-6605
sales@micronor.com
www.micronor.com

For Support in Europe:

MICRONOR AG
Pumpwerkstrasse 32
CH-8105 Regensdorf
Switzerland
Tel +41-44-843-4020
Fax +41-44-843-4039
sales@micronor.ch
www.micronor.com

Revision History

Revision	Date	Notes
A	4/18/2014	Initial release
B	5/6/2015	Change sensor IL to <8dB and same reference under controller specs
C	10/15/2015	Changed with new Camarillo Address and Tel/Fax numbers
C1	10/20/2016	Added Explosive Atmosphere specification

File Reference

98-0382-01_C1_MR382_Data_Sheet_Released_20Oct2016

Table of Contents

List of Figures

1. Product Description

1.1. Fiber Optic U-Beam Sensor

The MR382-2 and MR382-8 U-Beam Sensor paired with MR382-1 series Controller provides an innovative photo interruption system that can be deployed in hazardous environments and over very long distances. The Fiber Optic U-Beam Sensor operates with a known light path and optical power budget over standard duplex 62.5/125 multimode fibers that allows for reliable signal detection and implements a known default interrupted state.

The optical signal levels are far below safety hazard thresholds, thus the system may be safely deployed in hazardous environment. The entire fiber optic system has generous system loss budget, allowing for long distance and complex routing. For very long distances, the controller is available with a long wavelength light source.

Blocking the light path over the sensor to a power level below the receiver sensitivity will trigger the circuitry in the controller with digital line driver output signals. There also exists a frequency to analog voltage converter output that may be used to monitor speed. The controller will indicate if there is a broken fiber connection, high loss, or interrupted sensor in the system allowing for easier troubleshooting when a system failure or error occurs.

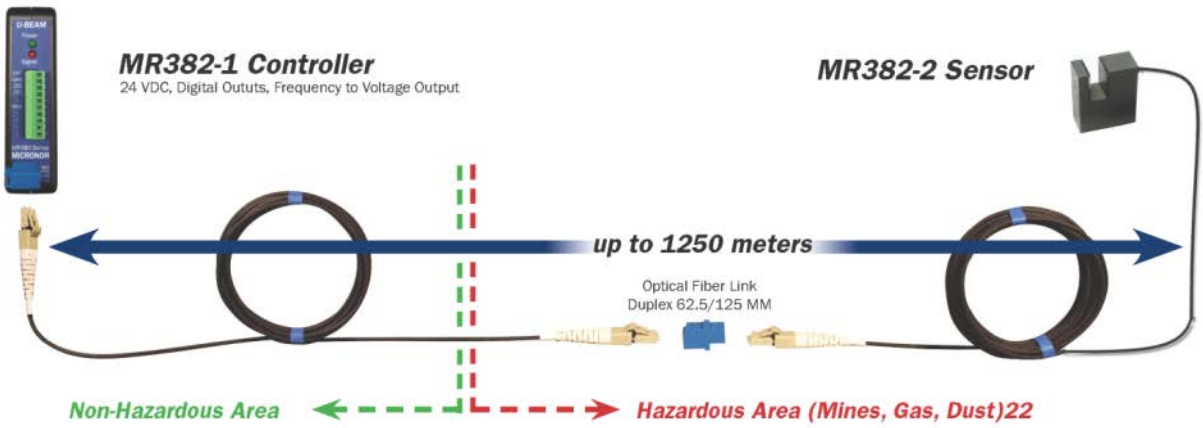


Figure 1. MR382 Series Fiber Optic U-Beam Sensor System

1.2. Fields of Application

- Hazardous Environments: Oil & Gas, mining/extracting, refining
- Medical: MRI environments
- Communications: EMI/RFI environments
- Energy Distribution: High Voltage, long distance sensing

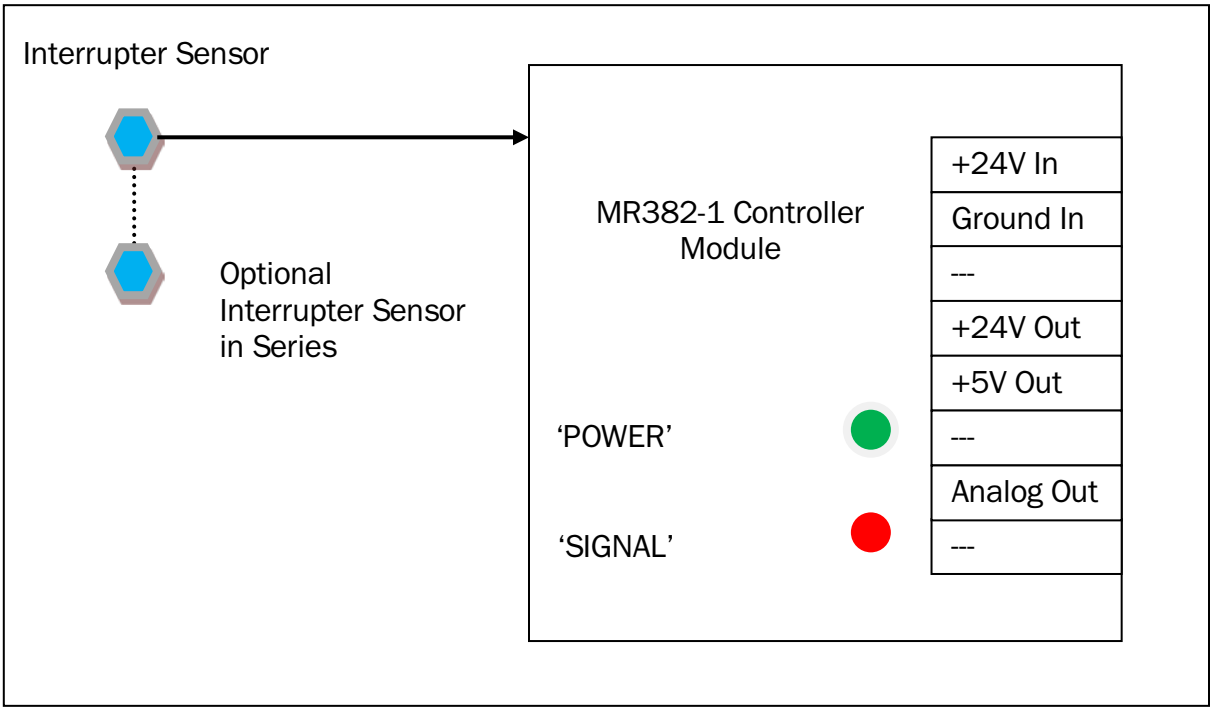


Figure 2. Complete Functional System Overview

1.3. Features

- Immunity to EMI, RFI and Ground Loops
- Wide System Loss Budget
- Complex Routing Capability
- Long Distance Signaling without Interference
- Multiple Interrupter Sensors in Series
- Immune to High Voltage
- Immune to Lightning
- Inherently Safe Mechanical Apparatus
- Utilizes Standard 62.5/125µm Communications Fiber
- Visual Feedback Upon Interruption
- Digital Line Driver Output
- Frequency to Voltage Analog Out
- DIN Rail Mountable Controller

2. Standard Contents

MR382-2:

- MR382-2 Emergency Switch with fiber cable length as ordered by customer, terminated with LC Duplex connector.
- 4-40x ¾ Pan Head Phillips Mounting screws, Qty 3
- Instruction Manual (this document, one soft copy supplied with each shipment.)

MR382-1 Controller Module:

- MR382-1 Controller Module
- Phoenix Contact(1879599) inserted as part of unit
- Instruction Manual (this document, one soft copy supplied with each shipment.)

3. Installation and Operation

3.1. Mounting the Controller Module

The controller unit may be best mounted on DIN rails or by securing the mounting clip to a solid surface. There is a single mounting clip. Both mounting schemes are shown below in Figures 3 and 4.

Figure 3. DIN Rail Mount

Figure 4. Mounting Clip Mount

3.2. Connecting the Controller

A duplex fiber optic cable is used to interconnect the sensor and controller. The sensor incorporates an optical pigtail, as specified by customer. If a longer connection to the controller is required then an extension fiber cable having LC duplex connector may be used.

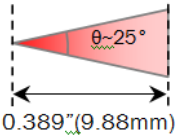
Open the external shutter of the controller and remove the dust cap from the cable and interconnect the two. Insert the LC connector as shown; there should be a positive click when the connector is engaged properly. Avoid repeated fiber optic disconnects to reduce likelihood of surface contamination.

Electrical Connections MR382-1 Controller

MR382-1 Fiber Optic U-BEAM Controller Module

Terminal	Description	Detail
1	+24VDC Power Supply Input	40mA Min.
2	Ground Input	-
3	Digital 24V Normally High	2kΩ Min. Load
4	Digital 5V Normally High	2kΩ Min. Load
5	-	-
6	Frequency to Analog Voltage Out	0V to +10V(1V/kHz) 2kΩ Min. Load See User Manual for Requirements
7-10	NOT USED	**Simplified Beam Profile**

Product conforms to 21 CFR 1040 and IEC 60825-1:2004 at date of manufacture:

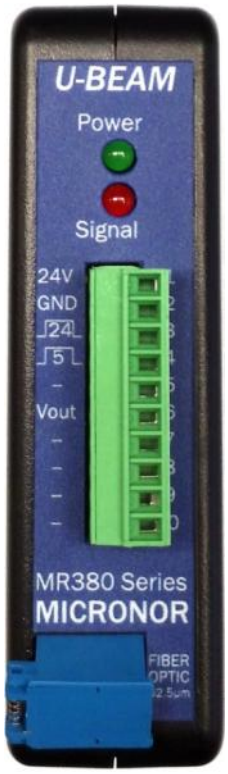


MICRONOR
automation components
Newbury Park, CA USA
T +1 805 499 0114
F +1 805 499 6585
www.micronor.com

MADE IN USA

[Ex Op is I/II/III 55°C/T6 Ga/Ma/Da] CE

CLASS 1
LASER PRODUCT
INVISIBLE LASER RADIATION



The contact on the controller module uses a Phoenix Contact screw terminal. For more information, consult Controller specifications given in Section 6.2. If connectors lost or damaged, contact sales associate for replacement details.

3.3. System Start-Up

Apply a +24VDC supply and ground to the designated terminals on the controller module. Verify that the 'POWER' LED, green, is illuminated and 'SIGNAL' LED, red is off. If the U-BEAM sensor is not connected, do so at this time and also verify that the 'SIGNAL' LED, red, turns on as the switch is connected. If the switch is connected and both 'SIGNAL' LED is not illuminated see Section 4 -TROUBLESHOOTING for additional help.

Figure 5. Properly Functioning Controller with U-Beam Sensor Connected and Signal Through

Figure 6. Properly Functioning Controller with U-Beam Sensor Connected and Signal Interruption, Broken Fiber or High Loss

4. Troubleshooting

The following are potential issues and recommended solutions when troubleshooting the fiber optic emergency switch system. For issues not listed and for any other questions, please contact Micronor Sales.

4.1. Potential Issues & Solutions

4.1.1. 'POWER' not illuminated when controller powered

- Verify solid electrical connection between wires and screw terminal for both +24VDC and GND.
- Verify controller module power supply is +24VDC with a current output of at least 40mA.
- Contact Micronor Sales for further assistance.

4.1.2. 'SIGNAL' not illuminated with U-Beam Sensor Connected

- Check if U-Beam optical path is blocked, if so clear pathway and clean glass surfaces with microfiber cloth and verify 'SIGNAL' is now on.
- Verify fiber optic cabling used is properly connected and undamaged.
- Verify that the entire fiber optic system does not exceed system margin loss listed in specifications, using an optical power meter or OTDR
- Clean fiber optic surfaces on the emergency switch cabling using the appropriate cleaning materials.
- Contact Micronor Sales for further assistance.

4.1.3. Damaged U-Beam Sensor (Fiber/Optics)

- Verify controller module outputs optical power by connecting LC loopback directly from one LC connector to the other, as shown in Figure 7. 'POWER' should be on and 'SIGNAL' should be on.
- Verify undamaged fiber with visual fault finder.
- Clean and wipe away collected dirt or dust obstructing optical path way on sensor head with microfiber cloth.
- Verify that the switch has a loss of < 7dB, using optical power meter.
- Clean fiber optic surfaces on the LC connectors using the appropriate cleaning materials.
- Contact Micronor Sales for further assistance.

Figure 7. LC Loopback Connection

4.2. Damaged In Shipment

In the event of a damaged instrument, write or call your nearest MICRONOR office in the U.S. A. Please retain the shipping container in case reshipment is required for any reason.

If you receive a damaged instrument you should:

1) Report the damage to your shipper immediately.
2) Inform MICRONOR
3) Save all shipping cartons.

Failure to follow this procedure may affect your claim for compensation.

5. Warranty Information

Warranty

MICRONOR INC. warrants this product to be free from defects in material and workmanship for a period of 1 (one) year from date of shipment. During the warranty period we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, write or call your local MICRONOR INC. representative, or contact MICRONOR INC. headquarters. You will be given prompt assistance and return instructions. Send the instrument, transportation prepaid, to the indicated service facility. Repairs will be made and the instrument returned transportation prepaid. Repaired products are warranted for the balance of the original warranty period, or at least 90 days.

Limitations of Warranty
This warranty does not apply to defects resulting from unauthorized modification or misuse of any product or part. This warranty also does not apply to Fiber Optic Connector interfaces, fuses or AC line cords. This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability of fitness for a particular use. MICRONOR INC. shall not be liable for any indirect, special or consequent damages.

Contact Information:

Micronor Inc.
900 Calle Plano, Suite K
Camarillo, CA 93012
USA

Phone +1-805-389-6600
Fax +1-805-389-6605
Email sales@micronor.com
URL www.micronor.com

For Europe:

Micronor AG
Pumpwerkstrasse 32
CH-8015 Regensdorf
SWITZERLAND

Phone +41-44-843-4020
Phone +41-44-843-4039
Email sales@micronor.ch
URL www.micronor.ch

6. Specifications

6.1. Sensor

Functional Specification:

Description	MR382-2-XX Specification
Optical	Insertion Loss <8.0 dB To determine maximum distance, consult Optical specifications for the Controller Module.
Light Path* Fork A Fork B Length	 ø0.007”(0.178mm) ø0.1”(2.54mm) 0.388”(9.85mm) Consult Drawing for Fork Designation
Mechanical	Body Material: Aluminum, Anodized Finish

Environmental Specifications:

Description	MR382-2-XX Specification
Temperature Range	-40° to +65° C
Humidity	0% to 95% RH (non-condensing)
Ingress Protection	IP65
Laser Safety	Under Normal Installation and Operating Conditions, the Operator has no access or exposure to unsafe optical radiation.
Explosive Atmospheres	Inherent safe, simple mechanical device when used with MR382-1 Controller IECEx Test Report GB/CML/ExTR 16.0105.00/00
ATEX	CE EPL Mb/Gb/Gc/Db/Dc
IEC Ex	EPL Mb/Gb/Gc/Db/Dc
NEC	Exempt

Optical Cabling:

Description	MR382-2-XX Specification
Fiber Optic Interface	LC Duplex Plug
Fiber Optic Cable	LC duplex 62.5/125um Multimode Fiber (Cable Length According to Customer Purchase Order)

Physical Specifications:

Description	MR382-2-XX
	Specification
Mounting	Consult Mechanical Reference Drawing
Housing	Consult Mechanical Reference Drawing
Weight	Sensor with 5 meter pigtail 0.115 kg (4.05 oz)

6.2. Controller Module

Functional Specification:

Description	MR382-1-1 Specification
Bandwidth	30 kHz
Digital Outputs Voltage Output(5V): Voltage Output(24V):	(Short Circuit Protected) 5VDC/2k& Load 24VDC/2k& Load
Analog Output Frequency to Voltage Converter	0V to +10VDC/2k& Load (1kHz/V Conversion)[1] (40%-60% Duty Cycle Requirement)[2] (<2% Linearity) [3] <u>Notes:</u> 1. Contact Micronor Sales for Special Requirements. 2. See Section 8 - Application Notes 3. Valid if Duty Cycle Parameter Satisfied
Optical Transmitter Power	850nm >-10dBm(0.1mW)
Receiver Sensitivity	High>-15dB Low<-21dB
System Loss Budget	15 dB (7 dB if sensor IL deducted)
Maximum Distance	Lesser of 15dB round-trip link loss or 1.25 km (See Application Notes) Contact Micronor Sales for applications with longer distance
Interface Electrical Optical	 10-pin Screw Terminal 30-14 AWG (Phoenix Mating Plug, 1803659) NOTE: Electrical connections shall not exceed 3m LC-Duplex Connector- 62.5/125µm Multimode Fiber

Power Supply Specifications:

Description	Specification
Power Supply Input	+24VDC, <80mA

Environmental Specifications:

Description	MR382-1-1 Specification
Temperature Range	-5° to +55° C
Humidity	0% to 90% RH (non-condensing)
Ingress Protection	IP50
Laser Safety	Under Normal Installation and Operating Conditions, the Operator has no access or exposure to unsafe laser radiation.
Explosive Atmospheres	Inherently Safe Optical Radiation Controller shall be installed in non-hazardous location only Power supply shall be current limited to 200mA IECEx Test Report GB/CML/ExTR 16.0105.00/00
ATEX	CE EPL Mb/Gb/Gc/Db/Dc
IEC Ex	EPL Mb/Gb/Gc/Db/Dc
NEC	Exempt
Functional Safety Category	For MR382 System: Category 2 per ISO 13849-1
$MTTF_d$	6.48 E+05 hours (74.0 years)
Performance Level (PL)	PL=c
Safety Integrity Level (SIL)	SIL=1

Physical Specifications:

Description	Specification
Mounting	35mm DIN Rail (See Drawing)
Housing	11.4 x 8.9 x 3.2 cm (4.50 x 3.50 x 1.25 inches)
Weight	240 g (8.5 oz)

7. MR382 Theory of Operation

The functional block diagram shows the two main components, the sensor is connected by a duplex fiber optic cable of readily available 62.5/125µm multi-mode fiber. The transmit fiber guides steady optical power from a near IR light source to the optical switch. A second receive fiber returns the light relaying if the sensor is interrupted or not.

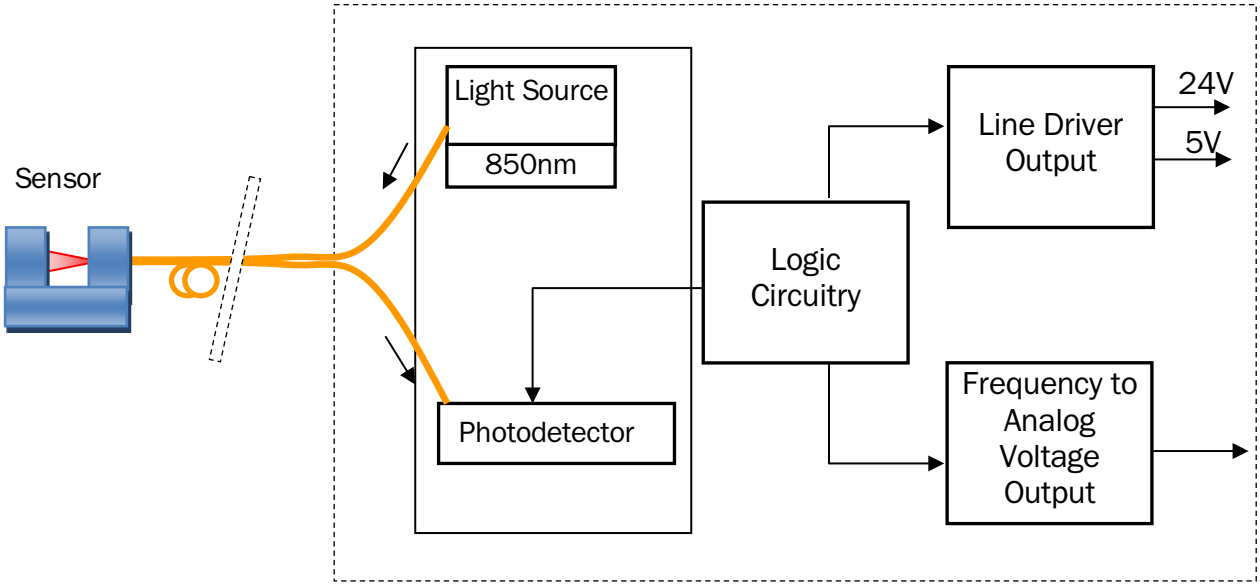


Figure 8. Block Diagram of MR382 Operation

The light source is held constant under normal operating conditions allowing for a known system loss budget when designing for a system. The optics within the switch itself are designed to couple maximum light back into the receive fiber allowing for long distance and chaining multiple sensors.

The optical power is then detected by the Schmitt Trigger Photodetector and translated into a logic signal depending on the power level. The photodetector operates with an active low signal scheme allowing for a known interrupted state. If a fiber were to break, poor connection, high loss, or interrupted sensor the controller would interpret those events as an interrupt.

The photodetector outputs the logic signal to the remaining logic circuitry which is translated into line driver signals +24V and +5V. Similarly the frequency of the interrupts is also converted into an analog voltage output.

8. Application Notes

8.1. Interrupting Scheme

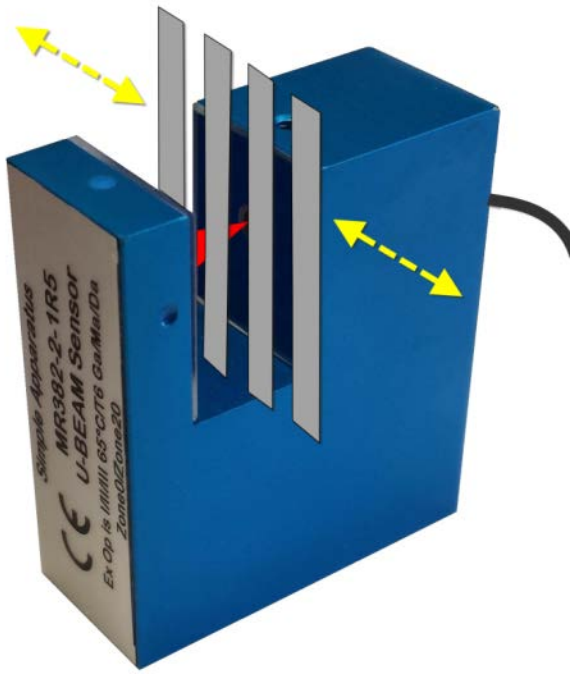


Figure 9. 3D U-Beam Interruption Representation

The photo interrupter employs a Schmitt Trigger scheme of sensing logic high and logic low levels of light. The sensitivity is listed in the specification section of this document. Below is a diagram of the light path and its conical shape.

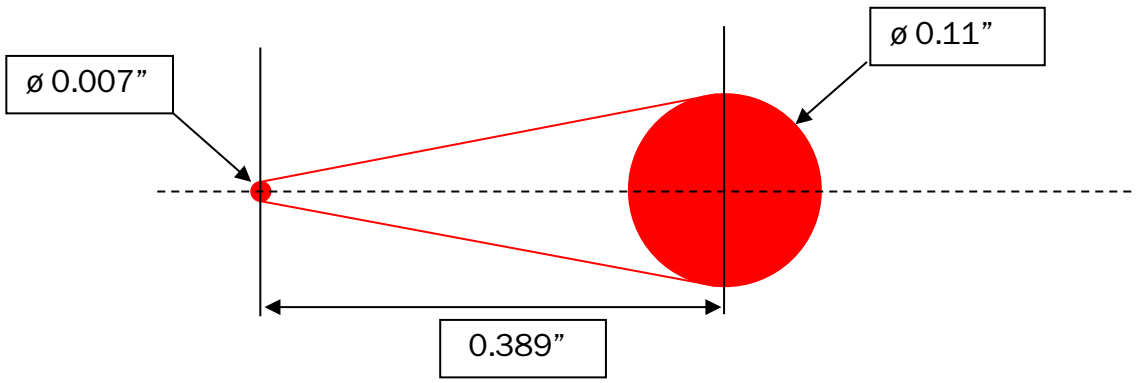


Figure 10. Generalized Beam Profile

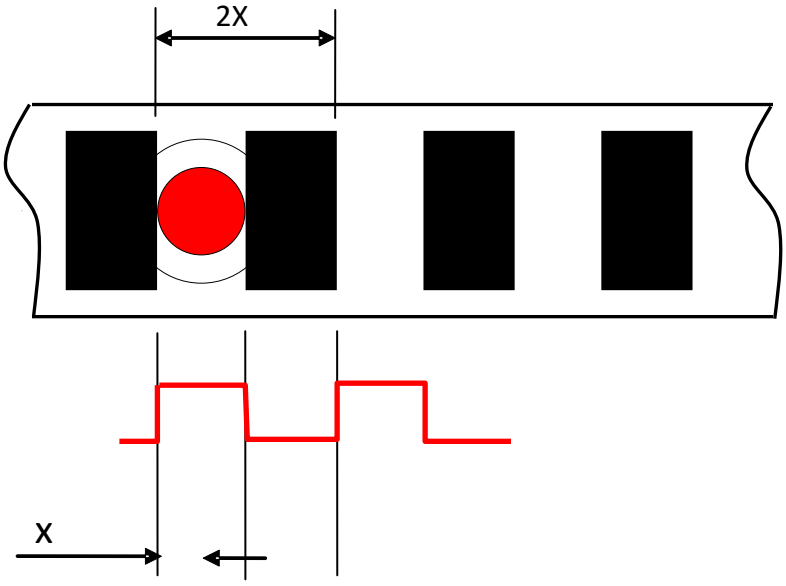


Figure 11. Ideal Signal Interruption Representation

The spacing of each interruption must be at least as wide as the cross sectional diameter, **X** in Figure 8, where the beam is interrupted. This is essential for tracking speed and a duty cycle of 40-60% is required for accuracy. Simple index and counting applications require only that the interrupt and non-interrupt durations exceed the beam diameter where the non-interrupt may exceed any value greater than the beam diameter.

For example, if the beam were to be interrupted toward the middle at 0.180", the resulting diameter of the beam would be ideally 0.081" - the value of **X** for Figure 11.

It is critical to provide an interrupt scheme that would inhibit the light path to the triggering point of the internal detector. There must also be enough optical power to overcome the hysteresis of the trigger to reverse the detector state.

The profile of light intensity emitted from the fiber is show in Figure 9. The bulk of the optical power is condensed toward the center of the core; take into account the power distribution when designing an interrupt scheme.

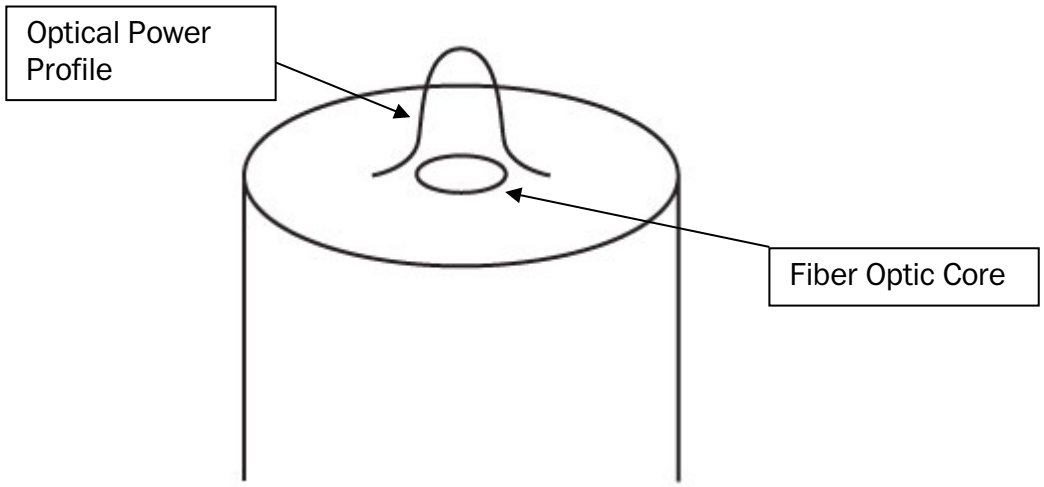


Figure 12. Ideal Optical Power Distribution in Optical Fiber

Additionally if the interrupt scheme involves the light passing through a medium other than free air, then refractive indexes must be taken into account as they will effectively change focal points of the photo interrupter sensor head and will result in less optical power for the entire system.

8.2. Determining System Constraints

The MR382-1 controllers have the capacity to chain two sensors in series permitted the system loss budget allows it. The following will diagram a system using a MR382-1-1 controller, one MR382-2 sensor, and three separate fiber connections.

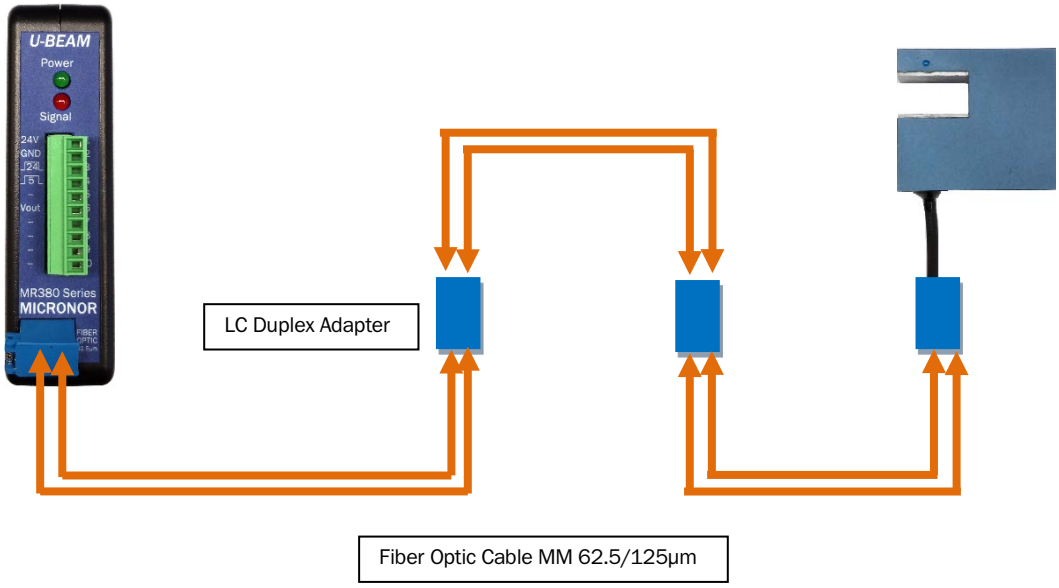


Figure 13. Example of Optical Link With Multiple Segments

With a system loss budget of 15dB it is possible to estimate if a system can sustain reliable detection with multiple switches, multiple connections and various cable lengths. The MR382-1-1 controllers use an 850nm wavelength source which has a loss characteristic of 3dB/km over glass fiber. In this example a MR382-1-1 controller module will be used with one MR382-2 sensor which represent <7dB loss along with fiber optic cabling and connections approximated with an insertion loss of <0.5dB per connection. To check if the system can support these components at 500m the following calculation can be done.

Component	Loss(dB)	Quantity	Calculation(db)	System Loss(dB)
Length of Fiber	3/km	1(km)	3	The sum of all losses
Connections	0.5	4	2	
Switches	7	1	7	
Total Loss				12

The total system loss is 12dB, less than the budget specified; this system should have no issue function under these parameters. This system does not take into account the routing scheme of the fiber optic cable. Sharp bending, temperature exposure, pinching of the fiber should be taken into account when estimating the system loss budget.

9. Reference Documents

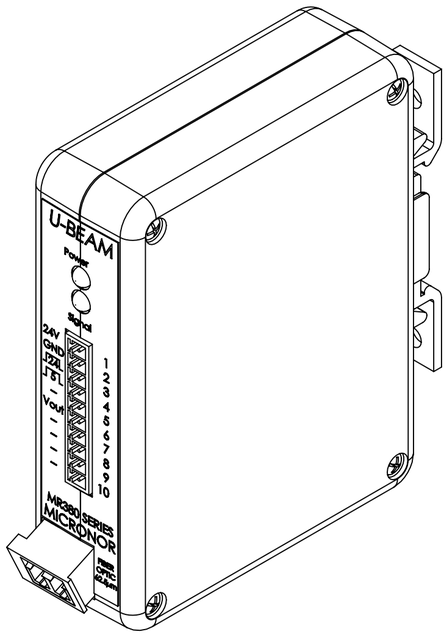
See following pages for these documents.

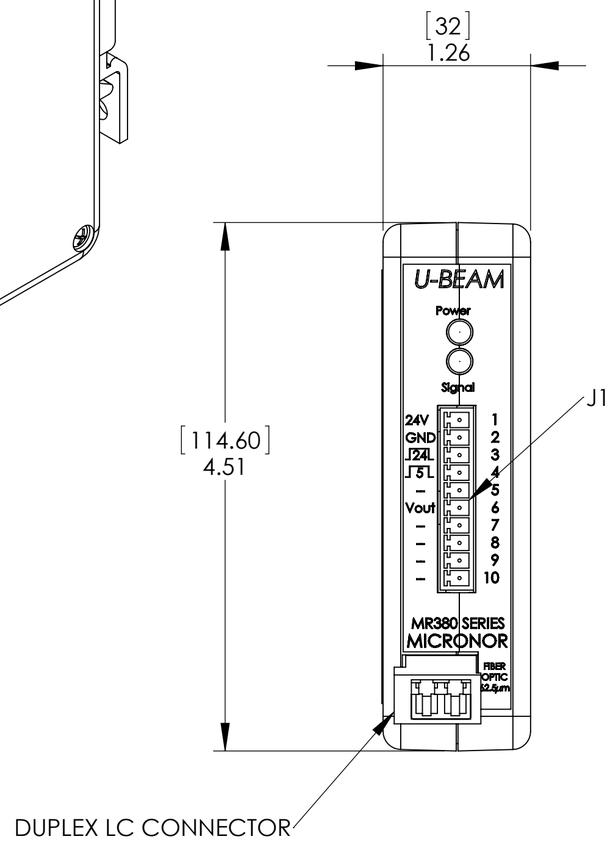
9.1. MR382-1 Controller Reference Drawing

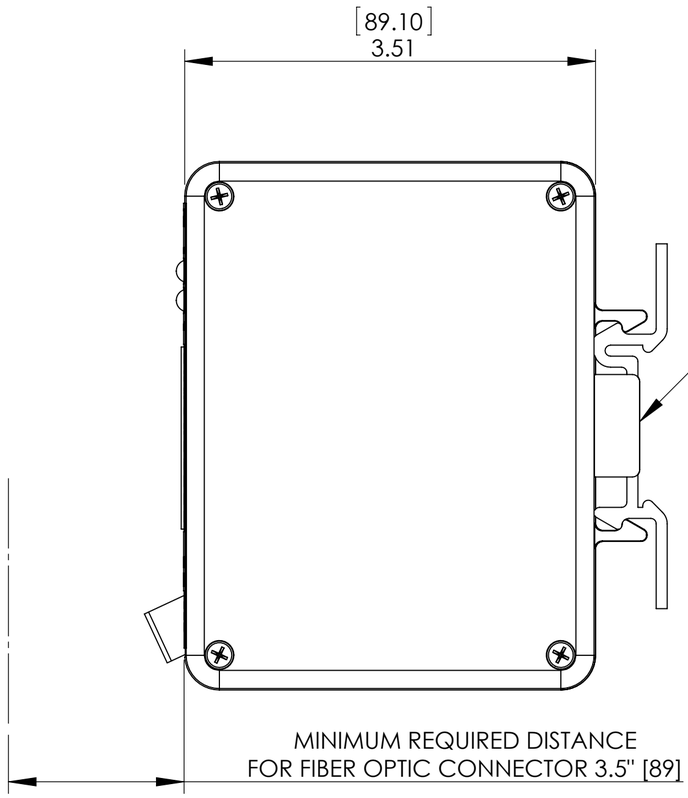
9.2. MR382-2 Sensor Reference Drawing

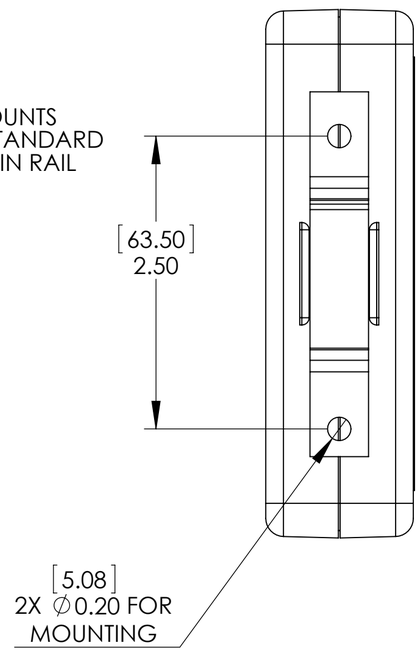
9.3. MR380-0 Declaration of Conformity

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	NEW RELEASE	9-24-13	RGB









J1 PHOENIX CONTACT P/N: 1803358
(10 PIN TERMINAL), MATING PLUG P/N: 1803659

TERMINAL	DESCRIPTION
1	+24VDC Power Supply Input
2	Ground Input
3	Digital 24V Normally High
4	Digital 5V Normally High
5	--
6	Frequency to Analog Voltage Out
7	--
8	--
9	--
10	--

1 WARNING: KEEP CONNECTOR COVERS IN PLACE DURING STORAGE, TO PROTECT FIBER OPTIC INTERFACES.

NOTES: UNLESS OTHERWISE SPECIFIED

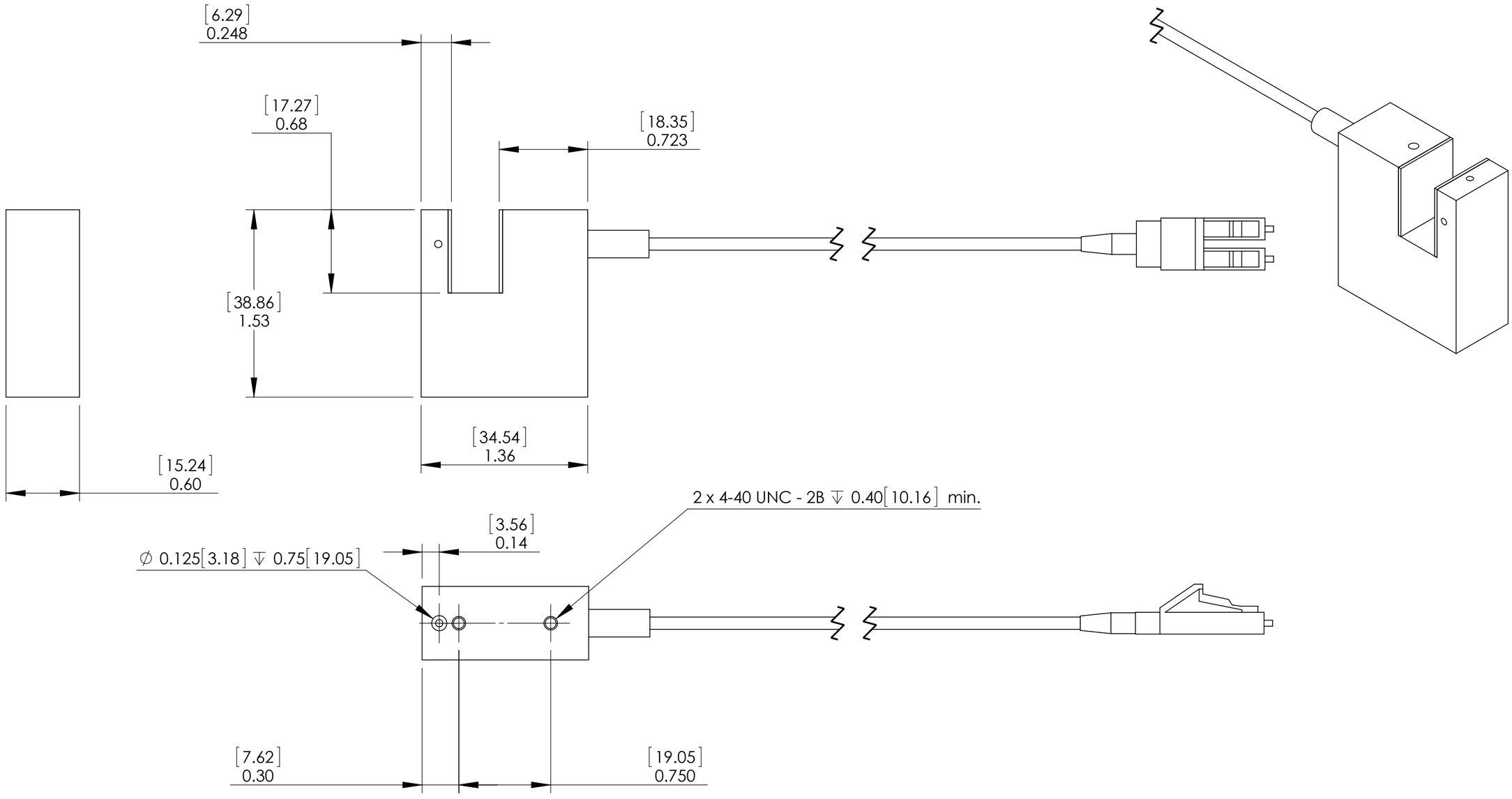
UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES TOLERANCES: ANGULAR: ± .5° TWO PLACE DECIMAL ±.02 THREE PLACE DECIMAL ±.005 FOUR PLACE DECIMAL ±.0010	DRAWN	R BOYER	9-24-13
	CHECKED		
	ENG APPR.		
	MFG APPR.		
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
MATERIAL	COMMENTS:		
FINISH			
DO NOT SCALE DRAWING			

MICRONOR INC.
NEWBURY PARK, CA (805) 499-0114

TITLE:
MR382-1
CONTROLLER MODULE

SIZE	DWG. NO.	REV
C	MR382-1	A
SCALE: 1:1	WEIGHT:	SHEET 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	NEW RELEASE	9-16-13	RGB



PART NUMBER ORDERING CODE

MR382 - 2 - 003

- CABLE LENGTH IN METERS
  - 003 = 3 METERS (STANDARD)
  - 005 = 5 METERS
  - 010 = 10 METERS (RECOMMENDED LENGTH FOR MRI APPLICATIONS)
  - CONSULT FACTORY FOR OTHER LENGTHS
- 2 = STANDARD
- 8 = MRI COMPATIBLE

3 WARNING: AVOID SHARP BENDS AND CABLE PINCHING. KEEP BEND RADIUS GREATER THAN 0.5 INCH [13MM].

2 WARNING: KEEP CONNECTOR COVERS IN PLACE DURING STORAGE, TO PROTECT FIBER OPTIC INTERFACES.

1 WARNING: DO NOT DROP UNIT. DROPPING OR OTHER SEVERE SHOCK IMPACTS MAY DAMAGE UNIT.

NOTES: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES TOLERANCES: ANGULAR: ± .5° TWO PLACE DECIMAL ±.02 THREE PLACE DECIMAL ±.005 FOUR PLACE DECIMAL ±.0010	DRAWN	R BOYER	9-11-13
	CHECKED		
	ENG APPR.		
	MFG APPR.		
INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.		
MATERIAL	COMMENTS:		
FINISH			
DO NOT SCALE DRAWING			

MICRONOR INC.
NEWBURY PARK, CA (805) 499-0114

TITLE:
U-BEAM SENSOR

SIZE	DWG. NO.	REV
C	MR382	A
SCALE: 3:2	WEIGHT:	SHEET 1 OF 1

900 Calle Plano, Suite K
Camarillo, CA 93012 USA
T +1-805-389-6600
F +1-805-389-6605
www.micronor.com

Declaration of Conformity

We

Micronor Inc.
900 Calle Plano, Suite K, Camarillo, CA 93012, USA

declare that the product

Fiber Optic Signaling Sensor System	**Item Code(s)**
Controller Modules (Multimode Only)	**MR380-0, MR380-1, MR380-2, MR382-1**
Sensors	**MR381, MR382, MR383, MR384, MR385, MR386, MR387**
Country of Origin: Camarillo, CA USA	

to which this declaration relates in conformity with the following standards, normative documents and/or customer requirements:

Requirement	MR380 Controllers (Multimode)	MR380 Sensors
1. Laser Safety	Class 1 laser devices per IEC 60825	Exempt
2. ATEX Directive	Sensor and Controller are exempt: Not considered to have an independent source of ignition. (a) Optical sources which meet the Class I limits are considered suitable for use in locations with an EPL of Mb, Gb, Gc, Db or Dc as per Clause 1 (3) of IEC 60079-28:2015 Ed 2. IECEx GB/CML/ExTR 16.0105/00, R1198C/00, Evaluated by Notified Body 2503, Certification Management Limited, Unit 1 Newport Business Park, New Port Road, Ellesmere Port, CH65 4LZ, United Kingdom	
3. Functional Safety	For MR387 E-Stop Sensor and MR380-1 DIN Rail Mount Controller Only: SIL=1, PL=c, SFF=97.85%, DC=75.76%	
4. Low Voltage Directive	Exempt	Exempt
5. EMC Directive	MR380-0, Exempt MR380-1/MR380-2/MR382-2, Passed	Exempt
6. CE Mark	Applicable	Applicable

Place: Camarillo, CA, USA
Date of Issue: 27-Sept-2016

Dennis Horwitz
Micronor Inc.
Vice President, Sales and Marketing
dennis@micronor.com

Ref: N:\Declaration of Conformity\MR380-X Controller DOC\DOC_MR380_MM_RevC Sept-2016\MICRONOR_98-0380-05_MR380 Declaration of Conformity_RevC_DRAFT_21-Sept-2016.docx