

MR380-1 Series DIN Rail Mount Controller For Use With MR38X Series Fiber Optic Signaling Sensors Instruction Manual

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Revision D



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Revision History

Revision	Date	Notes
A	12/11/2013	<ul style="list-style-type: none">• Initial release
B	7/13/2015	<ul style="list-style-type: none">• Added 50/125 fiber pigtail option• Controller design upgraded to Universal and will work with both 50/125 and 62.5/125 multimode fiber
C	10/15/2015	<ul style="list-style-type: none">• Update with new Camarillo address and tel/fax numbers
C1	03/09/2016	<ul style="list-style-type: none">• Style Update
D	5/18/2016 DRAFT	<ul style="list-style-type: none">• Updated E-STOP from MR380 to MR387• Added Single Mode option

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1. Product Description

1.1. Fiber Optic Emergency Stop Switch

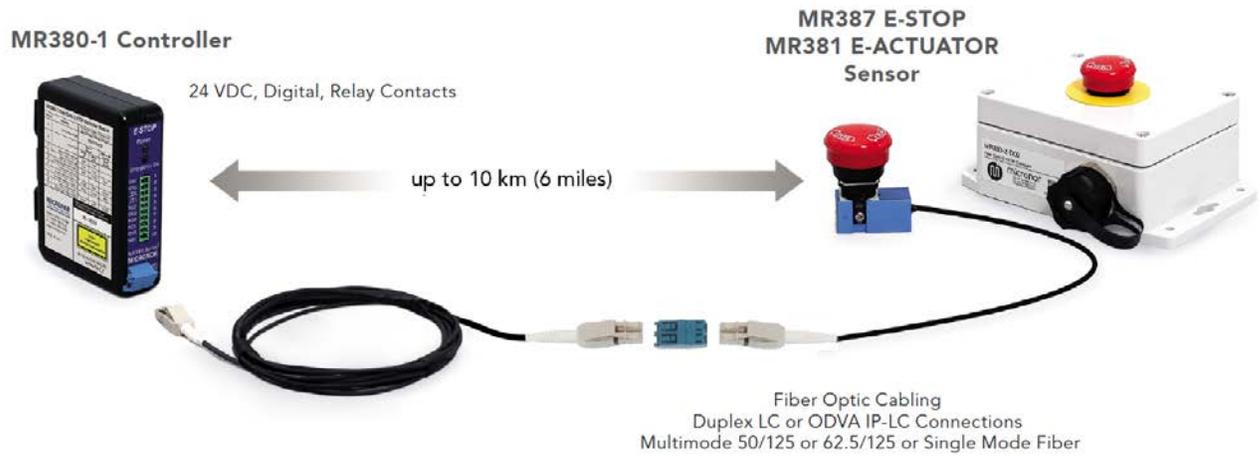


Figure 1. MR387 Series Fiber Optic Emergency Switch & MR380 Series Controller

The MR387 Emergency Stop Switch paired with MR380-1 series Controller provides a new, innovative emergency signaling detection that can be deployed in hazardous environments and over very long distances. The Fiber Optic E-Stop switch employs a photo interrupt scheme operating over a duplex 50/125 μ m or 62.5/125 μ m optical link that allows for reliable signal detection and implements a known default failure state.

The optical signal levels are rated inherently safe *Ex op is*, allowing the sensor to be safely deployed in any type of explosive atmosphere or hazardous location. The entire fiber optic sensor system has a generous system loss budget, allowing for long distance, complex routing, and daisy chaining of multiple switches.

Depressing the switch interrupts the optical signal and the Controller provides both Double Pole Double Throw (DPDT) relay contacts and digital outputs for signal and control. The controller will indicate if there is a broken fiber connection or depressed switch in the system which provides increased safety margin over electrical emergency switches. The controller will always default to the emergency state when: the switch is depressed, in case of a broken fiber, in case of a fiber being disconnected or loss of power to the controller unit.

Figure 2 provides a complete functional overview of the emergency switch system.

1.2. Fields of Application

- Hazardous Environments: Oil & gas mining/extracting, refining
- Medical: MRI environment
- Energy Distribution: E-Switch maybe deployed next to high voltage lines

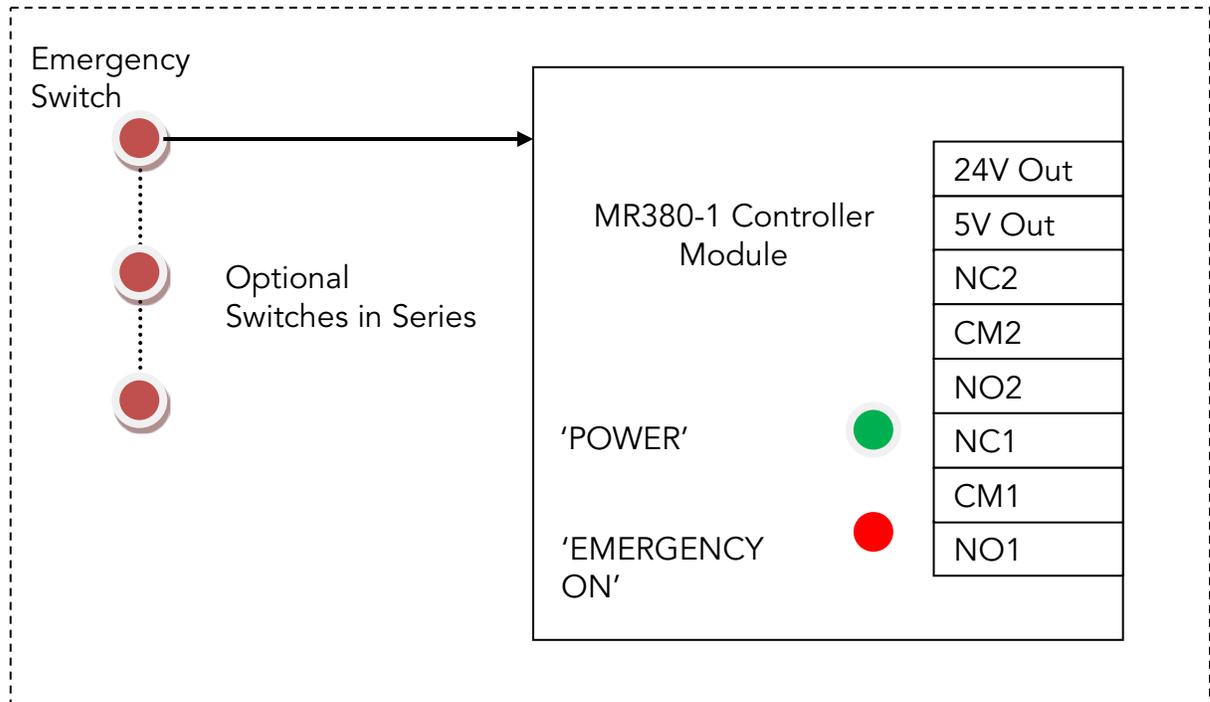


Figure 2. Complete Functional System Overview

1.3. Features

- EMI/RFI Immune
- Wide System Loss Budget
- Complex Routing Capability
- Long Distance Signaling without Interference
- Multiple Switches in Series
- Immune to High Voltage Lines
- Immune to Lightning
- Inherently Safe Mechanical Apparatus
- Multiple E-STOP Switches Can Be Daisy Chained
- Double Pole Double Throw Relay Output
- Digital Signal Out
- ESTOP sensor available with either 50/125 μ m, 62.5/125 μ m and 9/125 μ m pigtailed
- Universal DIN Rail Mountable Controller, works with both 50/125 μ m and 62.5/125 μ m multimode fiber links
- Single mode Controller option available

2. Standard Contents

MR387 ESTOP Sensor:

- MR387-X-LL with multimode fiber size and pigtail length as ordered by customer, terminated with LC duplex connector.
- 2-56 x 3/16 Pan Head Phillips Screws, Qty 2 (installed)
- Instruction Manual (this document, one soft copy supplied with each shipment)

MR380-1 Controller Module:

- MR380-1 Universal Controller Module
- Phoenix Terminal Block (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 Emergency Switch

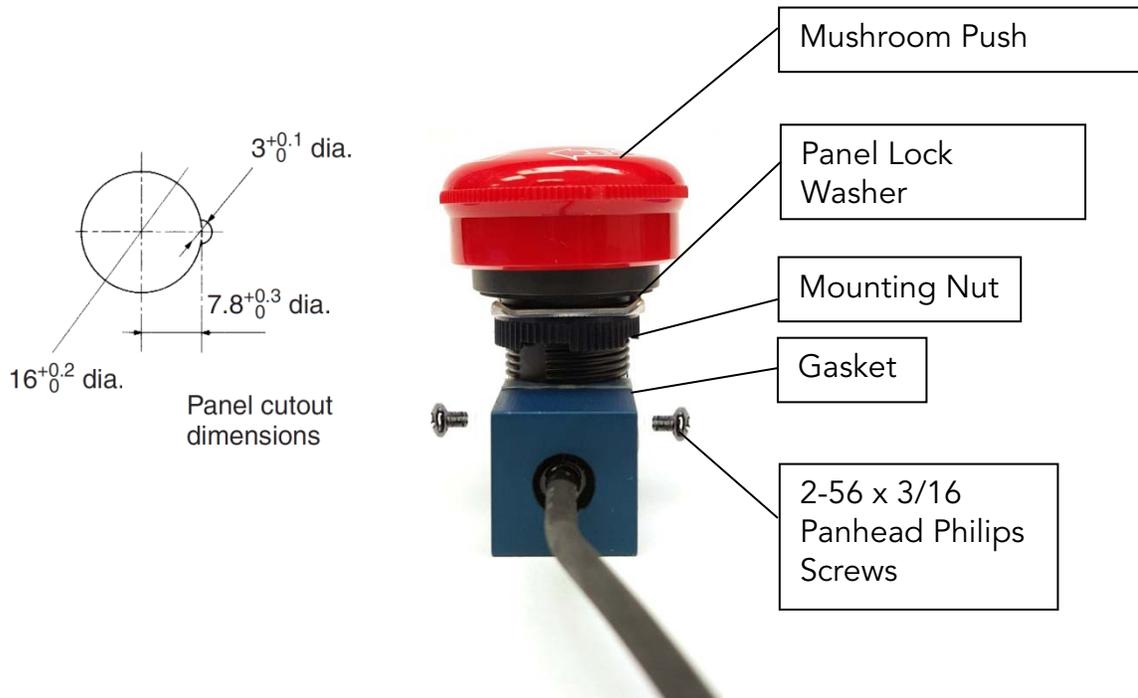


Figure 3. Panel Cut Out Dimensions and Assembly Hierarchy of Emergency Switch

For mounting the sensor switch into a panel, please provide a cut-out as dimensionally shown in [Figure 3](#) and Mechanical Reference Drawing. Refer to [Figure 4](#) for switch orientation. Secure panel-mount switch with all appropriate designations and requirements.



Figure 4. Emergency Switch Orientation Interchangeable when Mounting into Optical Block

3.3. Connecting the Controller

An LC Duplex optical cable is used to interconnect the sensor and controller. The sensor incorporates a 3m optical pigtail (or alternate length as specified by customer). If a longer connection to the controller is required, then an extension cable having LC duplex connector may be used.

Remove LC Duplex connector's dust cap(s) and open the external shutter of the controller. When inserting the LC Duplex connector, 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 MR380-1 Controller

MR380-1 Fiber Optic E-STOP Controller				
Terminal	Description	For Typical Emergency Stop Operation Connect to Terminals 5 & 6 or 8 & 9		
1	+24VDC Power Supply	STATE TABLE		
2	Ground Input			
		Module Powered	Module Not Powered	
		Switch ON	Switch OFF	Switch ON/OFF
3	Digital 24V Normally High	LOW	HIGH	-
4	Digital 5V Normally High	LOW	HIGH	-
5	Normally Closed Relay Contact 2	OPEN	CLOSED	OPEN
6	Common Relay Contact 2	-	-	-
7	Normally Open Relay Contact 2	CLOSED	OPEN	CLOSED
8	Normally Closed Relay Contact 1	OPEN	CLOSED	OPEN
9	Common Relay Contact 1	-	-	-
10	Normally Open Relay Contact 1	CLOSED	OPEN	CLOSED



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

**CLASS 1
LASER PRODUCT
INVISIBLE LASER
RADIATION**

*For Installation In non-hazardous locations only
-5°CStas+55°C*



Figure 7. Front Panel Outputs of MR380-1 Series Controller

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 are lost or damaged, contact Micronor Sales for replacement details.

3.4. System Start-Up & Performance Check

Connect +24VDC supply and ground to the designated terminals on the controller module. Verify that the 'POWER' LED (green) is illuminated. If the emergency switch is not connected, do so at this time and also verify that the 'EMERGENCY ON' LED (red) turns off as the switch is connected.

E-Stop Switch	'Power' LED	'Emergency ON' LED	24V Digital Out	5V Digital Out	Relay Contacts
Not Depressed	ON	OFF	> +20V	> + 4V	No Change
Depressed	ON	OFF	< +1V	< +0.5V	Polarization Change

If the switch is connected and not depressed with both LEDs illuminated, see Section 4 Troubleshooting for additional help.



Figure 8. Properly Functioning Controller with Switch Connected and Not Depressed



Figure 9. Properly Powered Controller with Depressed Switch, Broken Fiber Link, or High Loss

4. Troubleshooting

The following are potential issues and recommended solutions when troubleshooting the MR380 fiber optic emergency stop switch system. For issues not listed, 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 80mA.
- Contact Micronor Sales for further assistance.

4.1.2. 'Emergency ON' illuminated w/Emergency Switch Connected

- Check if emergency switch is 'On' when depressed. If so, reset switch and verify 'Emergency ON' is now off.
- Verify optical link cabling is properly connected and undamaged.
- Verify that the entire fiber optic system does not exceed system loss margin specifications, using either an optical power meter or OTDR.
- Clean all fiber optic connector surfaces using appropriate cleaning materials.
- Contact Micronor Sales for further assistance.

4.1.3. No +24V Digital Out

- Verify solid electrical connection between wires and screw terminal for +24V Digital Out and GND.
- Verify that the controller module is properly powered with +24VDC and grounded.
- Verify emergency switch is connected and 'Emergency ON' is off.
- Contact Micronor Sales for further assistance.

4.1.4. No +5V Digital Out

- Verify solid electrical connection between wires and screw terminal for +5V Digital Out and GND.
- Verify that the controller module is properly powered with +24VDC and grounded.
- Verify emergency switch is connected and 'Emergency ON' is off.
- Contact Micronor Sales for further assistance.

4.1.5. Relay Switching Failure

- Verify solid electrical connection between wires and screw terminal for NO2,NC2, CM2, NO1,NC2,CM1
- Verify that the controller module is properly powered with +24VDC and grounded.
- Verify emergency switch is connected and "Emergency ON" is off
- Verify when switch is depressed, the controller will electro-mechanically switch the state of the relay resulting in a faint 'click' sound.
- Contact Micronor Sales for further assistance.

4.1.6. Damaged Emergency Switch (Fiber)

- Verify controller module outputs optical power by connecting LC loopback directly from one LC connector to the other, shown in Figure 10. 'Power' should be illuminated and 'Emergency ON' should be off.
- Verify undamaged fiber with visual fault finder.
- Verify that the switch has a loss of < 1dB, using optical power meter.
- Clean fiber optic surfaces on the emergency switch using the appropriate cleaning materials.
- Contact Micronor Sales for further assistance.



Figure 10. LC Loopback MR380-1 Check

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.

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6. Specifications

For additional clarification of parameters related to Functional Safety, Laser Safety, Explosive Atmospheres and CE Marking, consult Micronor document 93-0380-01, Declaration of Conformity.

6.1. E-STOP Sensor

Functional Specification:

Description	MR387-X-YY
	Specification
Optical Insertion Loss MR387-2-YY (62.5/125) MR387-3-YY (9/125) MR387-5-YY (50/125)	Insertion Loss <2.5 dB (2 dB typical) <3.5 dB (3 dB typical) <3.5 dB (3 dB typical) To determine maximum distance, consult Optical specifications for the Controller Module.
Mechanical	
Optical Housing Durability	Aluminum, Anodized Finish 100,000 Operations min.

Environmental & Safety Specifications:

Description	MR387-X-YY
	Specification
Temperature Range	-40°C to +65°C (-40°F to +150°F)
Humidity	0% to 90% RH (non-condensing)
Ingress Protection	IP61
Laser Safety	Class 1 Under Normal Installation and Operating Conditions, the Operator has no access or exposure to unsafe optical radiation.
Explosive Atmospheres	Inherently safe, simple mechanical device when used with MR380 Controller
ATEX	EPL Mb/Gb/Gc/Db/Dc
IEC	EPL Mb/Gb/Gc/Db/Dc
NEC	Exempt
Functional Safety Rating	(Consult Controller specifications for all information)

Optical Cabling:

Description	MR387-X-YY
	Specification
Fiber Optic Interface	LC Duplex Connector
Fiber Optic Cable	Where YY is pigtail length in meter
MR387-2-YY	Duplex 62.5/125µm OM-1 Multimode Fiber
MR387-3-YY	Duplex 9/125µm OS-1 Single mode Fiber
MR387-5-YY	Duplex 50/125µm OM-2 Multimode Fiber

Physical Specifications:

Description	MR387-X-YY
	Specification
Mounting	Consult Mechanical Reference Drawing
Housing	Consult Mechanical Reference Drawing
Weight	Sensor with 5 meter pigtail 240 g (6.5 oz)

Specifications subject to change without notice

6.2. E-STOP DIN Controller Module

Functional Specification:

Description	MR380-1-X Specification
Digital Outputs Voltage Output(5V): Voltage Output(24V):	5VDC/2kΩ Load 24VDC/2kΩ Load (Short Circuit Protected)
Relay Contacts Switching Power Rating Current Rating Contact Material DC Rating AC Rating	2x Form C (CO) 60W/62.5VA 2A AgNi, Gold Covered 75 V @ 0.75A; 24 V @ 2A 50 V @ 1A; 24 V @ 2A
Optical Transmitter Power MR380-1-1 MR380-1-2 MR380-1-3 System Loss Budget MR380-1-1 MR380-1-2 MR380-1-3 Maximum Distance	850nm, ~0.1 mW (-10 dBm) 1300nm, ~0.01 mW (-20 dBm) 1310nm, ~0.2 mW (-7 dBm)
	15 dB 13 dB 25 dB
	(See Application Notes)
Interface Electrical Optical	10-pin Screw Terminal, 30-14 AWG (Phoenix Mating Plug, 1803659) NOTE: Electrical connections shall not exceed 3m LC Duplex, 50/125μm OM-2 or 62.5/125μm OM-1 Multimode Fiber, same as MR387 ESTOP sensor ordered

Power Supply Specifications:

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

Environmental and Safety Specifications:

Description	MR380-1-X
	Specification
Temperature Range	-5° to +55°C (23°F to +131°F)
Humidity	0-90% RH (non-condensing)
Ingress Protection	IP50 per IEC 60529
Laser Safety	Per IEC 60825-1
MR380-1-1 MR380-1-2 MR380-1-3	850nm, VCSEL Class 1 (Safe) 1300nm, LED Class 1 (Safe) 1310nm, LASER Class 1 (Safe)
NOTE: Below Applies only to Multimode Controller Units	
Explosive Environments	Inherently safe optical radiation Controller shall be installed in non-hazardous locations only
ATEX	EPL Mb/Gb/Gc/Db/Dc
IEC Ex	EPL Mb/Gb/Gc/Db/Dc
NEC	Exempt
Functional Safety	For MR380 System:
Category	Category 2 per ISO 13849-1
MTTF _d	6.20 E+05 hours (70.8 years)
Performance Level (PL)	PL=c
Safety Integrity Level (SIL)	SIL=1

Physical Specifications:

Description	MR380-1-X
	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	230 g (8.1 oz)

Specifications subject to change without notice

7. Theory of Operation

A functional block diagram is shown in *Figure 11*, showing the Switch Sensor, Optical Link and Controller Module. The switch is connected by a duplex fiber optic cable of readily available 50/125 μm , 62.5/125 μm multi-mode fiber and 9/125 μm single 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 switch is closed or open.

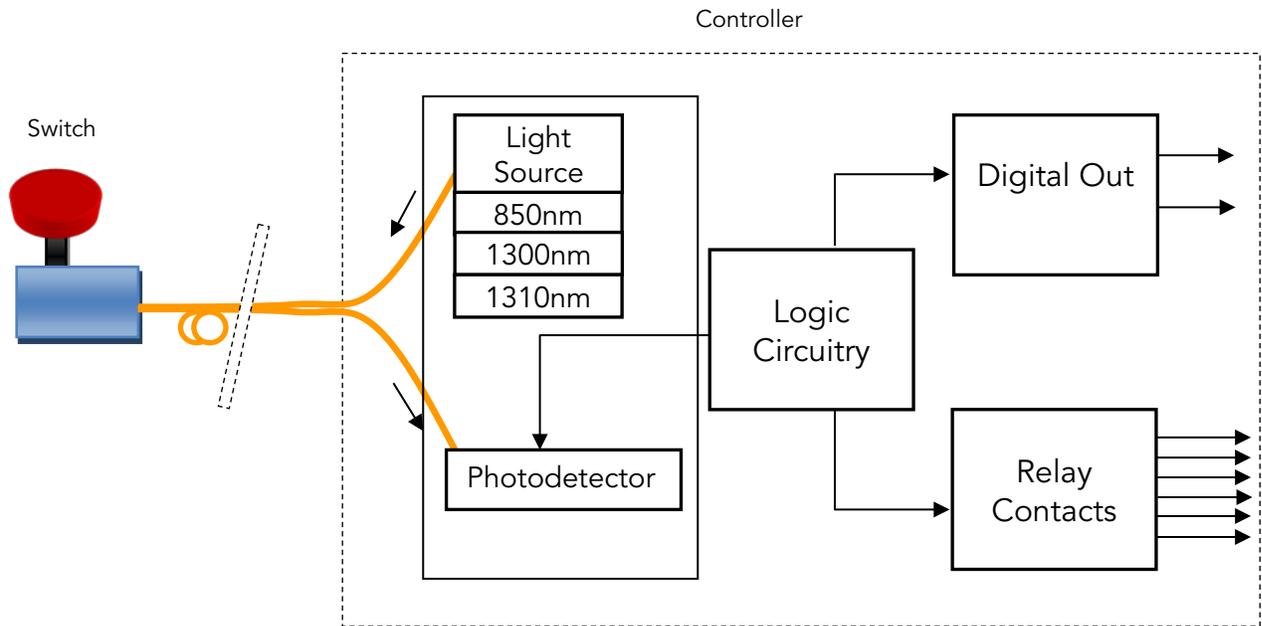


Figure 11 Block Diagram of Basic Theory of Operation for MR387 Fiber Optic E-STOP

The light source power is held constant under normal operating conditions allowing for a known system loss budget when designing 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 switches.

The optical power is then detected by the 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 failure state. If a fiber were to break, poor connection, high loss, or depressed switch the controller would interpret those events as a failure or 'EMERGENCY ON.'

The photo detector outputs a logic signal to the remaining logic circuitry which then interprets high or low levels for the +24V and +5V digital outputs.

8. Application Notes

8.1. Determining System Loss Budget For Chaining Multiple Switches

The MR380-1 controllers have the capacity to chain multiple switches in series permitting that the additional losses fall within the system optical loss budget. *Figure 12* illustrates a system using three MR387-2 switches in series.

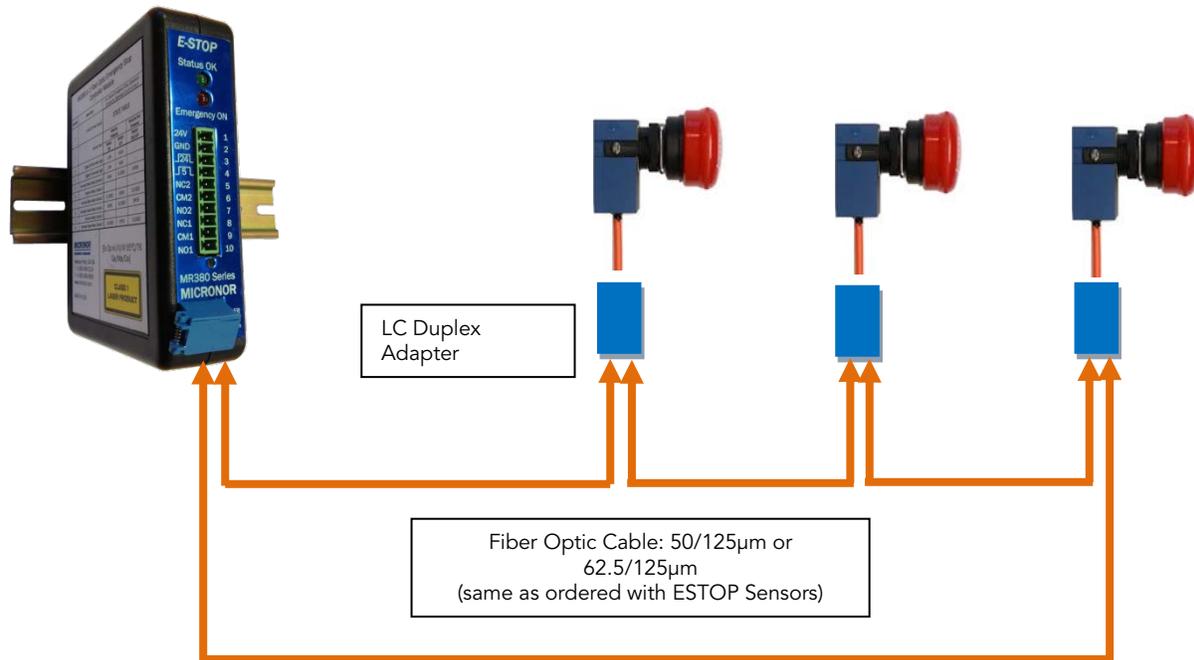


Figure 12 Example System Using Three MR387-2 Switches at 500m Length

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 MR380-1 controller use an 850 nm wavelength source which has a loss characteristic of 3dB/km over glass fiber. In this example, a MR380-1-1 controller module is connected to three MR387-2-XX switches in series. Each sensor represents <2dB loss each. Fiber optic cabling contributes 3 dB/km and each connection <0.5dB. To verify if the system can support three switches at 500m the following calculation can be done.

Component	Loss(dB)	Quantity	Calculation(db)	System Loss(dB)
Length of Fiber	3 dB/km	0.5 km x 2	3	The sum of all losses
Connections	0.5	4	2	
Switches	2	3	6	
Total Loss				11

The total system loss is 11dB, which is under the maximum 15dB system loss margin. Thus, the system should have no issues functioning under this configuration. This system does not take into account the routing scheme of the fiber optic cable. Excess losses caused by sharp bends, temperature exposure, pinching of the fiber should be taken into account when estimating the system loss budget as each variable will increase the system loss.

For more information on System Loss Budget, please refer to Application Note AN118.

9. Mechanical Reference Drawings

See following pages for these mechanical reference drawings

9.1. MR380-1 Controller

9.2. MR381 E-Actuator Sensor

9.3. MR387 E-Stop Sensor

