



C&E ADVANCED
TECHNOLOGIES

Banner Engineering Safety-related Products

Overview and application to collaborative robot operations

Collaborative Automation



YASKAWA

© 2018 YASKAWA ALL RIGHTS RESERVED

July 19, 2018

4

Sensors

Safety

Vision

Motion

Automation

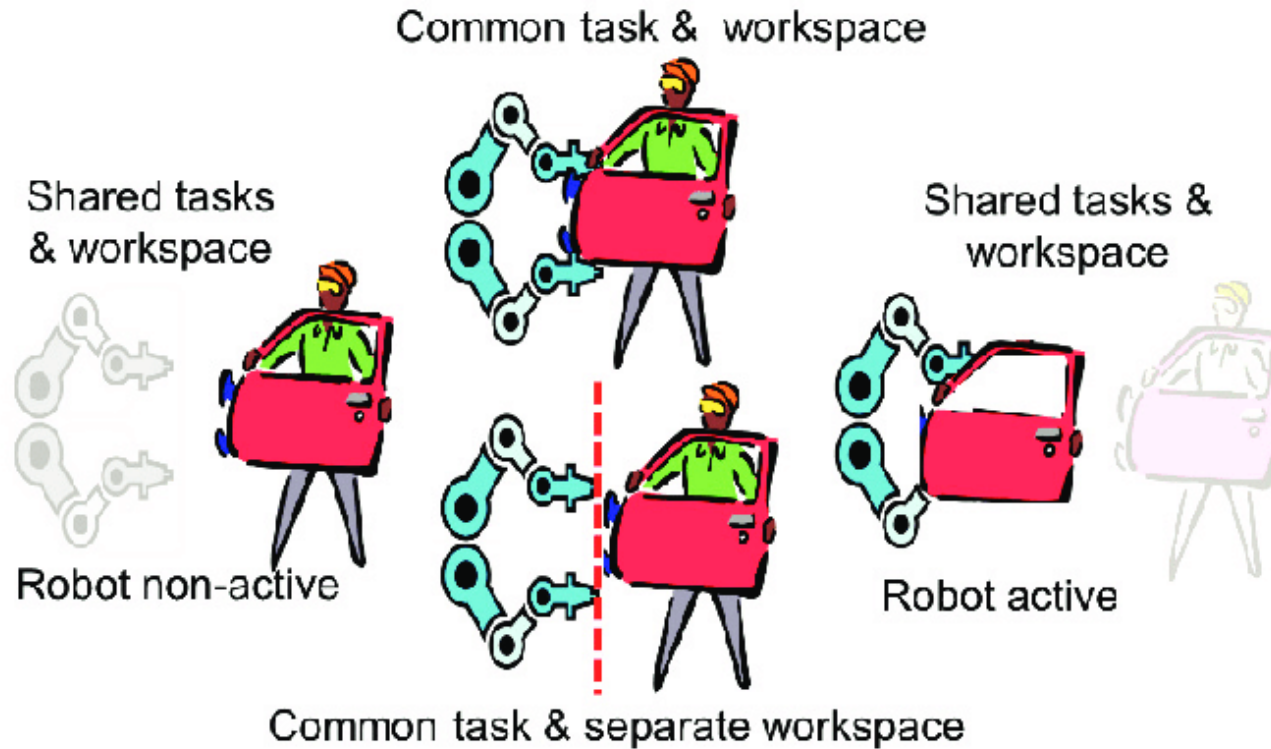
Controls

Presented by: Steve Wright, P.E., CSP

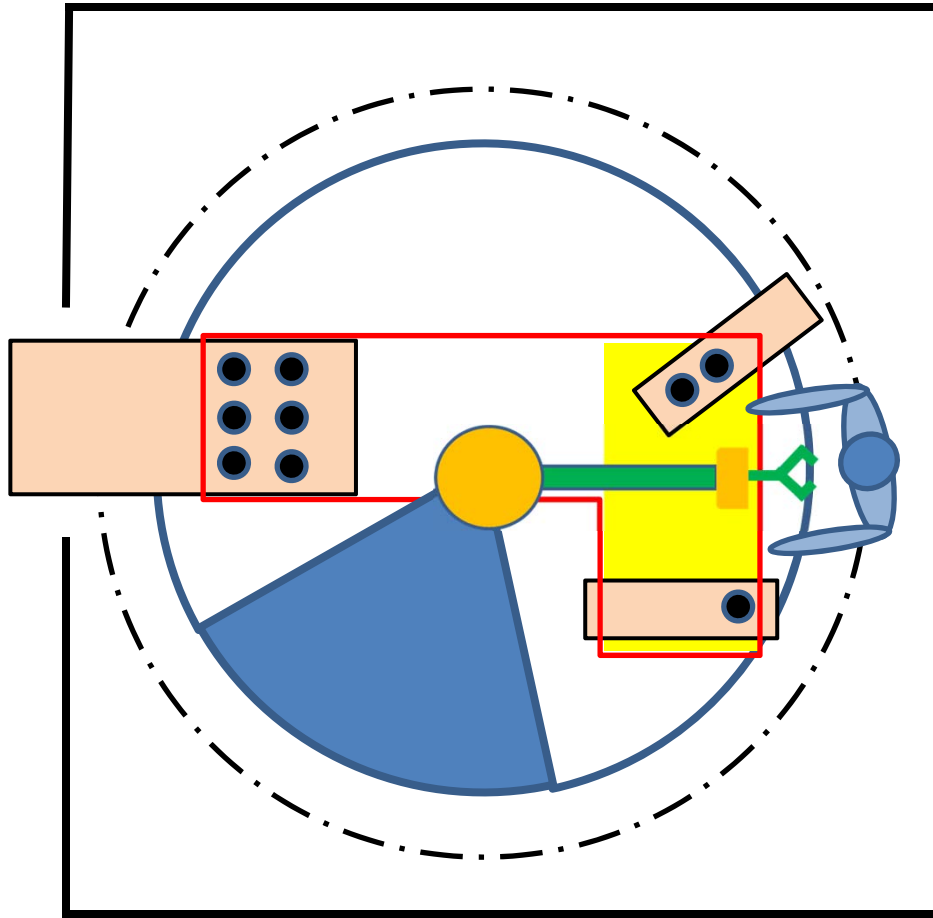
C&E Safety Specialist






A Single Source..A Total Solution

Tasks and work spaces



Robotic space definitions



-  SAFEGUARDED SPACE
-  MAXIMUM SPACE
-  RESTRICTED SPACE
-  OPERATING SPACE
-  COLLABORATIVE SPACE

Collaborative robot safety strategies

Safety-Rated Monitored Stop

The robot system is only allowed to enter the Collaborative space when the operator is not present in that space. The operator may enter if the robot motion is stopped and the Safety-Rated Monitored Stop function is active

Hand Guiding

Robot motion is only achieved through direct guiding input of an operator. Before the operator can enter the collaborative space and perform hand-guiding, the robot must come to a Safety-Rated Monitored Stop.

Speed and separation monitoring

In this method the robot system and operator may both move concurrently in the collaborative space. Risk is reduced by maintaining a protective separation distance between the operator and the robot. When the distance decreases below the protective separation distance the robot stops. When the robot system reduces speed, the separation distance decreases correspondingly.

Power and force limiting

Physical contact between the robot and the operator can occur. Specially designed robots can reduce the force or torque to keep the hazards of contact events below threshold values.

Indicators & operators for situational awareness



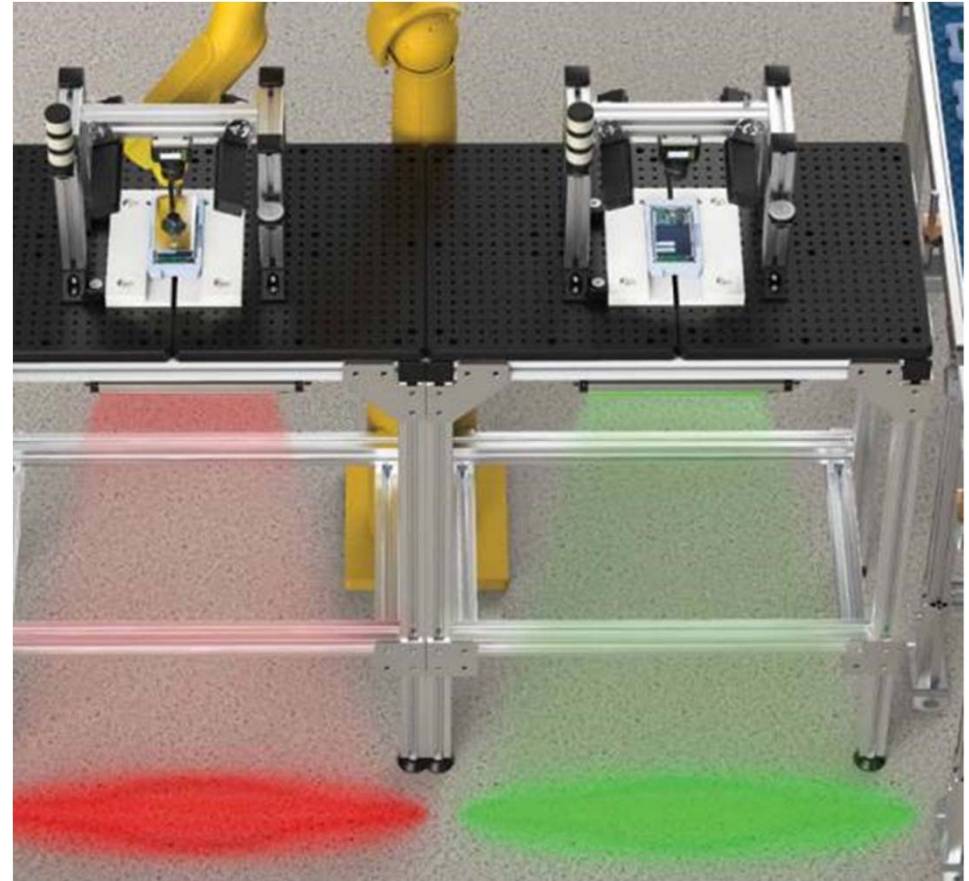
S22 Pro Panel mount



K50 Multi-color



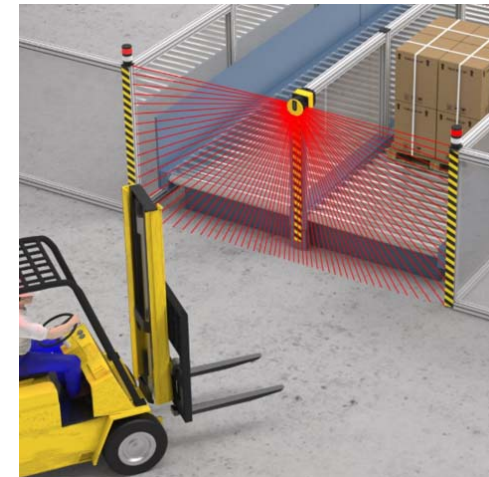
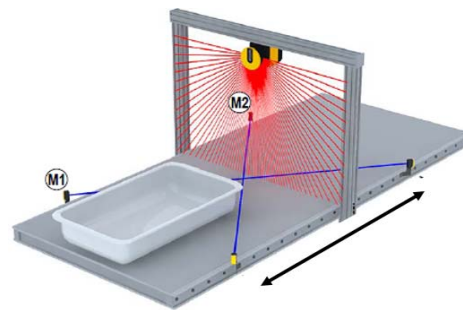
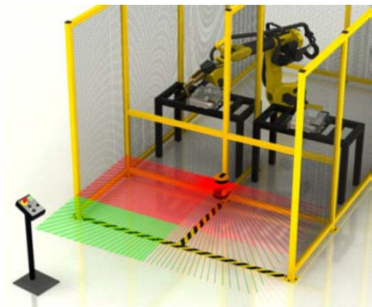
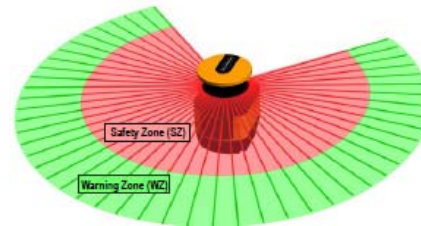
Tower lights



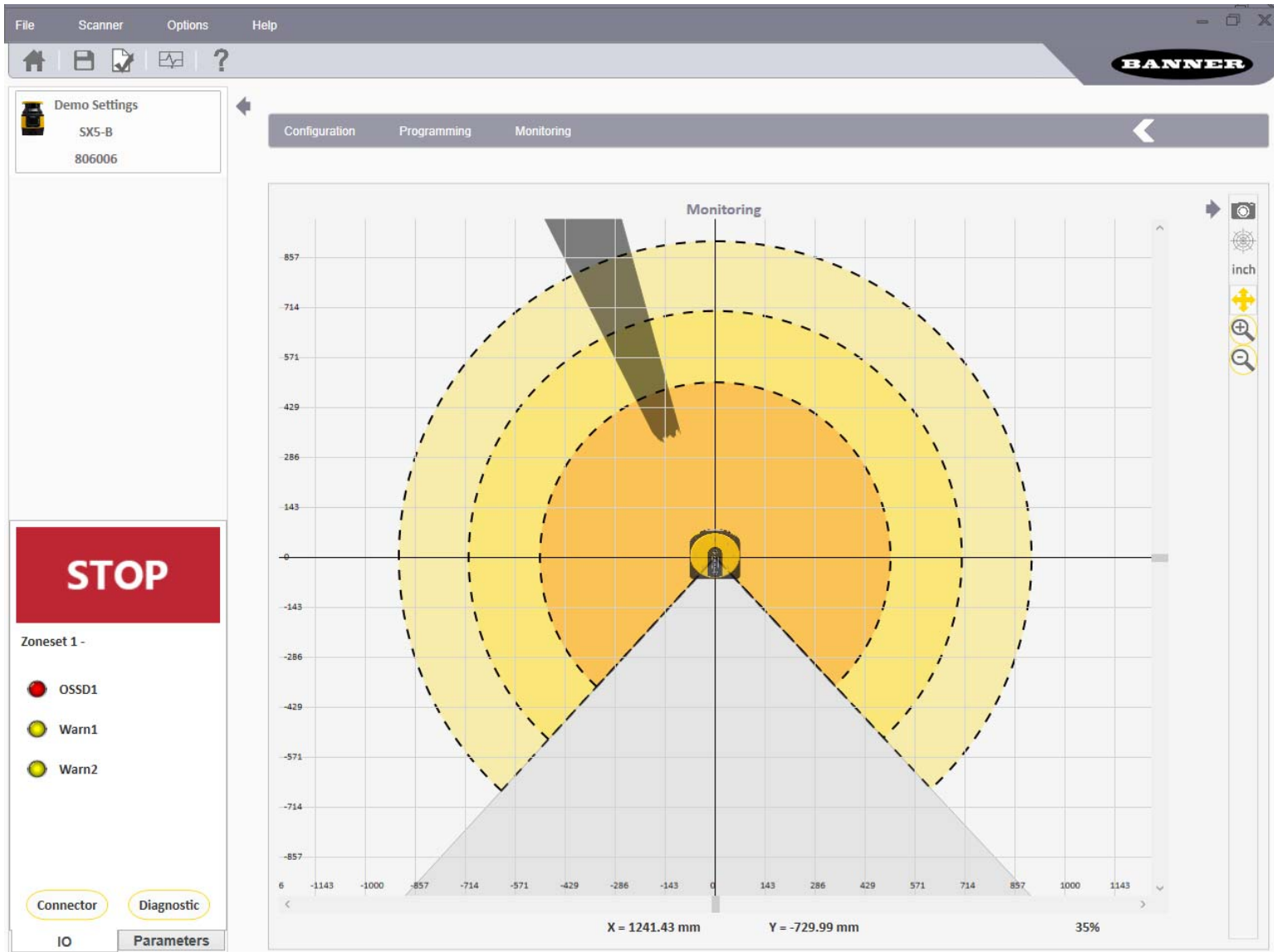
WLS28-2 EZ-STATUS

SX5-B laser area scanner

- Product Highlights
 - 5.5 m Safety Zone range,
 - 40 m Warning Zone range
 - 275-degree sensing angle
 - 3 assignable Inputs/Outputs wires
 - Storage for 1-6 zone set configurations
 - Horizontal and Vertical applications
 - Muting & Override
 - Display screen for diagnostics and set-up
 - Intuitive software



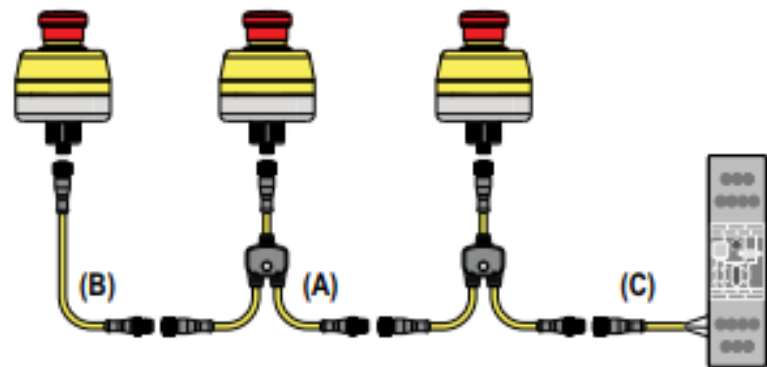
SX5-B zone display



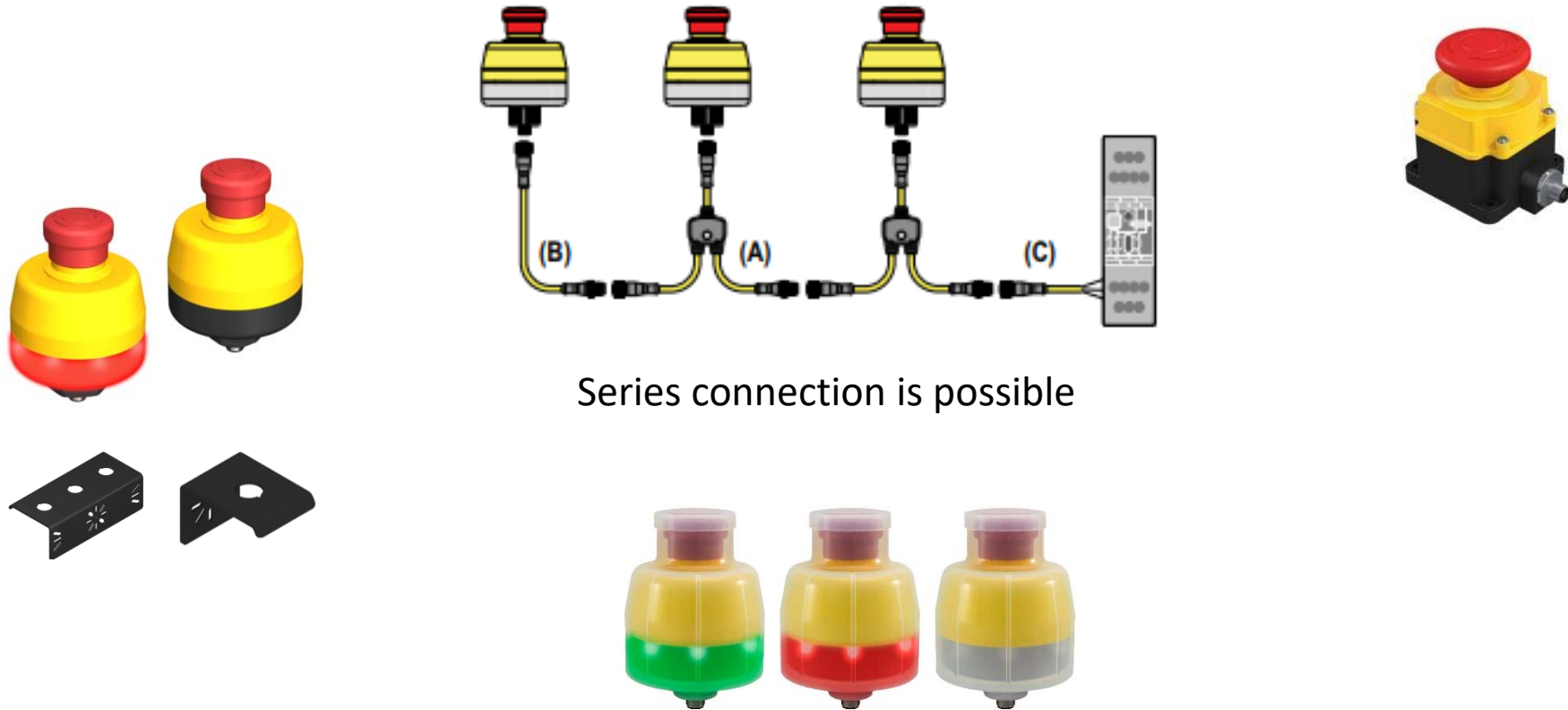
Tour the Banner products: SSA-EB Emergency Stop devices



IP69K rating with wash down cover



Emergency Stop Pushbuttons – 30mm mounted features



Series connection is possible

IP69K rating with wash down cover

Illuminated series connection



Banner Emergency Stop Pushbuttons – Rope pull overview



RP-RM83F



RP-LM40D



RP-QM90D



RP-LS42F



RP-QM72D

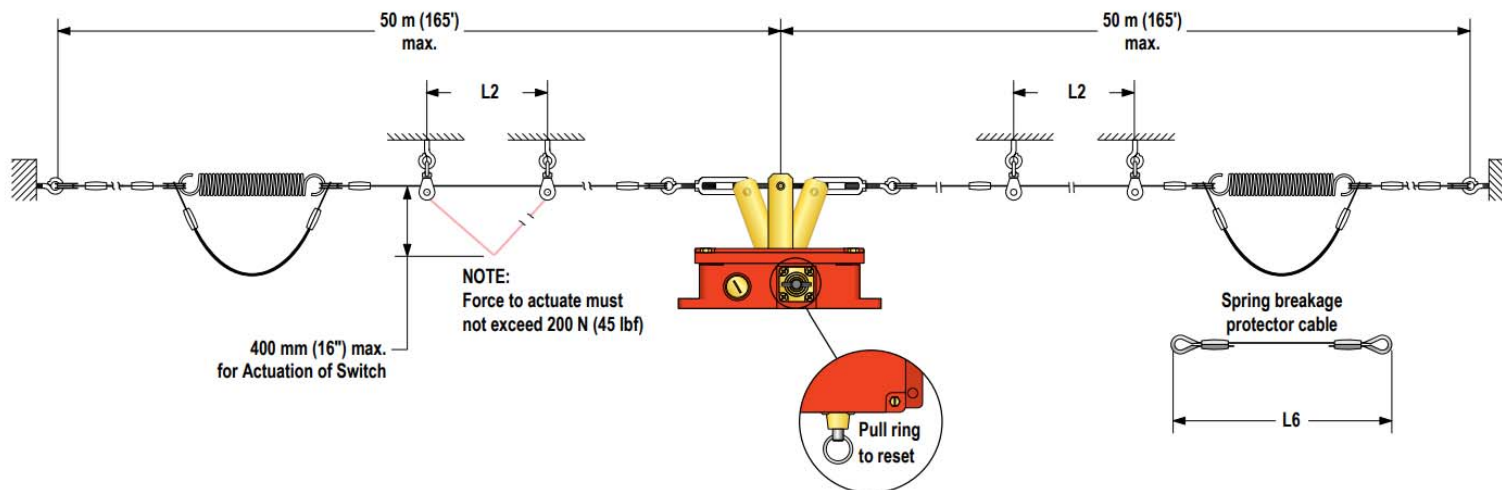
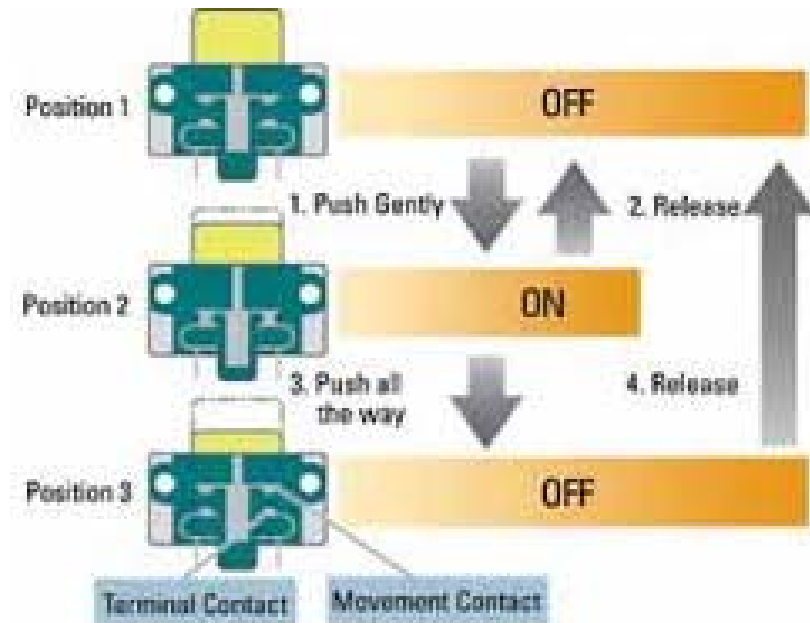


Figure 4. Assembly of Rope and Hardware

Springs Used	Max. Span Between Pulleys (L2)	Spring Breakage Protector Cable Length (L6)
Tensioning Spring #1	1 m to 2 m (3 ft to 6.5 ft)	380 mm to 410 mm (15.0 inches to 16.1 inches)
Tensioning Spring #2	2 m to 2.5 m (6.5 ft to 8 ft)	310 mm to 320 mm (12.2 inches to 12.6 inches)

ED1G Grip-style Enabling Device



Banner safety interlock switches – 4 Types per ISO 14119

Type 1 – Position switch that can be operated without a specific external actuator.



SI-LS31H



SI-LS31R



SI-LM40



SI-HG63 & SI-HG80

Banner safety interlock switches – 4 Types per ISO 14119

Type 2 – Position switch that can only be operated with a specific external actuator.



SI-QS83D & SI-QS90D



SI-LM40MV



SI-LS83 & SI-LS100



SI-LS42 & SI-QM100

Banner safety interlock switches – 4 Types per ISO 14119

Type 4 – Interlocking device with non-contact actuated position switch with a coded actuator.



SI-MAG

Active Opto-Electronic Protective Devices – Safety Light Curtains



HEAVY-DUTY TYPE 4

Robust safety light curtains for harsh industrial environments.

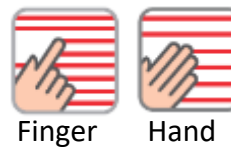


280 to 2400 mm
Range up to 18 meters

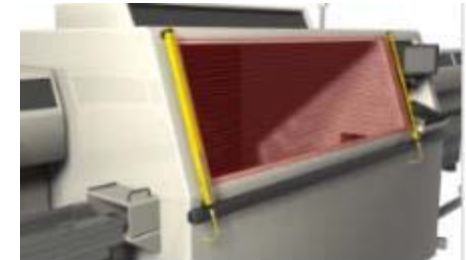


COMPACT TYPE 4

Compact safety light curtains for safety in tight spaces.



160 to 1250 mm
Range up to 7 meters



TYPE 2

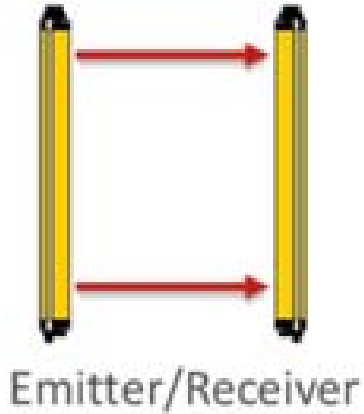
Cost-effective safety light curtain for lower risk applications.



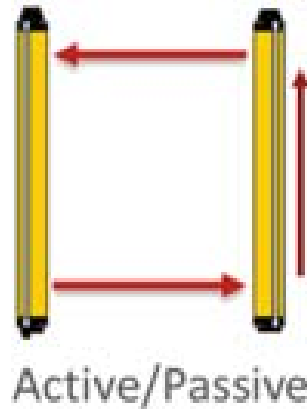
150 to 1800 mm
Range up to 15 meters



Perimeter Guarding - SGS Grids



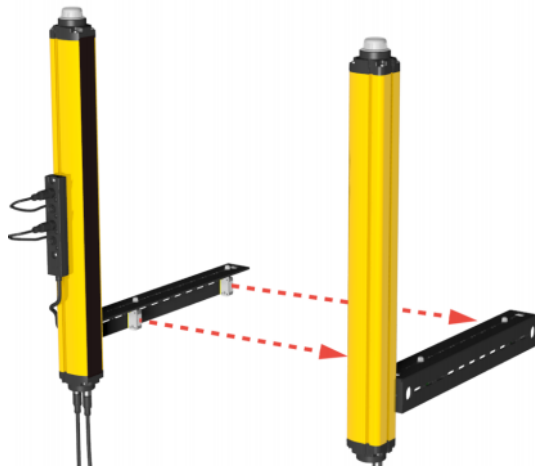
Longer range:
0.5 – 30 meter for std
6 – 60 meter for non-muting long range models



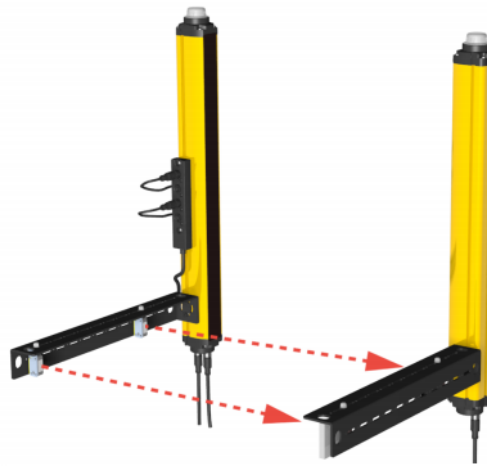
Less wiring, shorter range:
0.5 – 8 meter



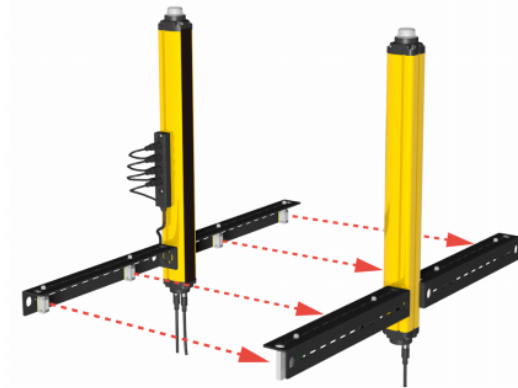
L Configuration (Right Side)



L Configuration (Left Side)



T Configuration



Evaluation & Logic devices – Safety Interface Modules



Universal modules
UM-FA-9A, UM-FA-11A



Safe Speed
SSM-FM-11A10, SSM-FM-11A20



E-Stop & Gate modules
ES-UA-5A, ES-VA-5A
ES-FA-9AA, ES-FA-11AA
GM-FA-10J



Interface modules
IM-T-9A, IM-T-11A



Two-hand 2HATD
AT-FM-10K
AT-GM-11KM, AT-HM-11KM



Extension modules



Safety Mat
SM-GA-5A, SM-HA-5A



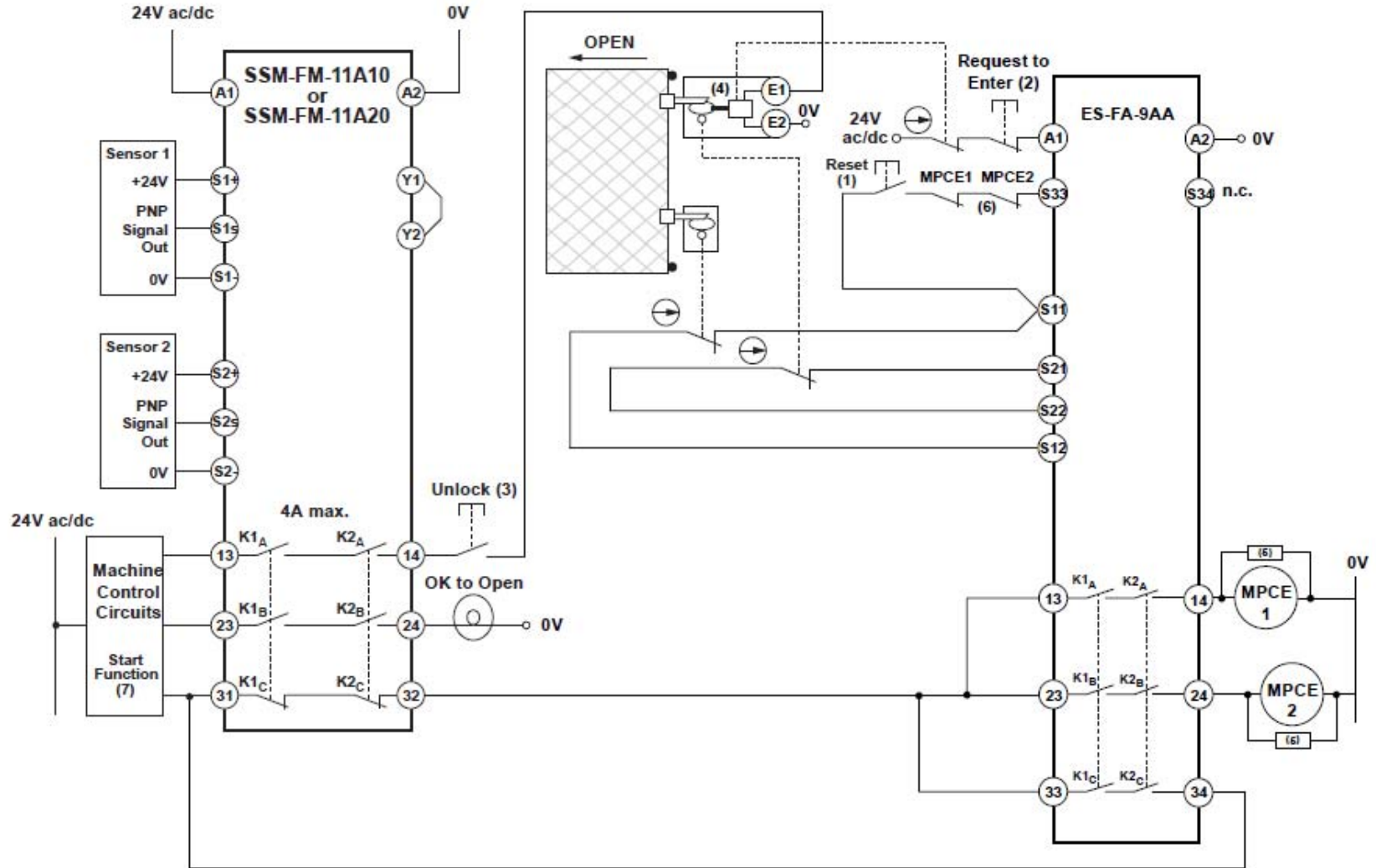
Interface modules
SR-IM-9A, SR-IM-11A



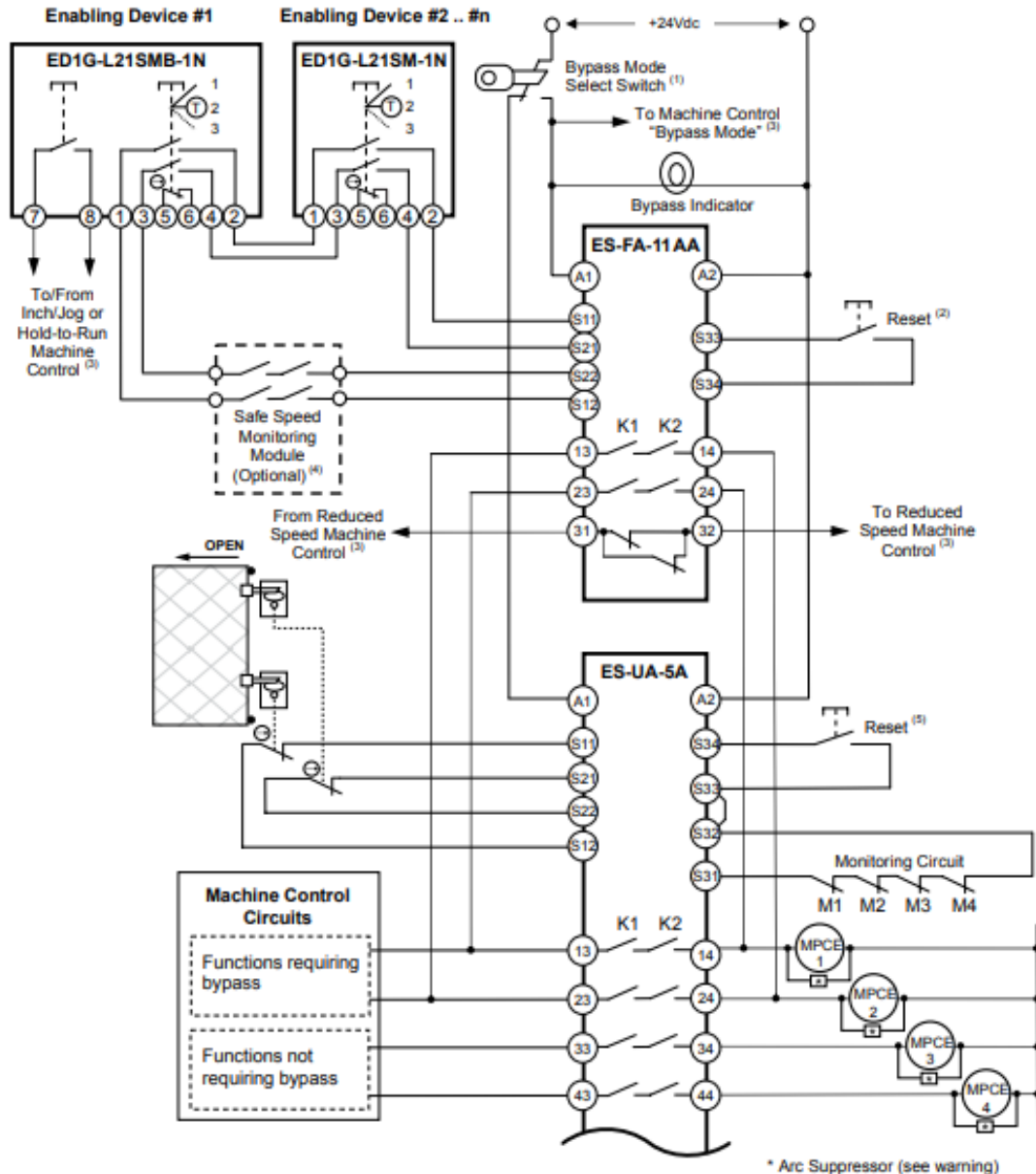
Muting
MMD-TA-11B, MMD-TA-12B

Access control with multiple safety interface modules

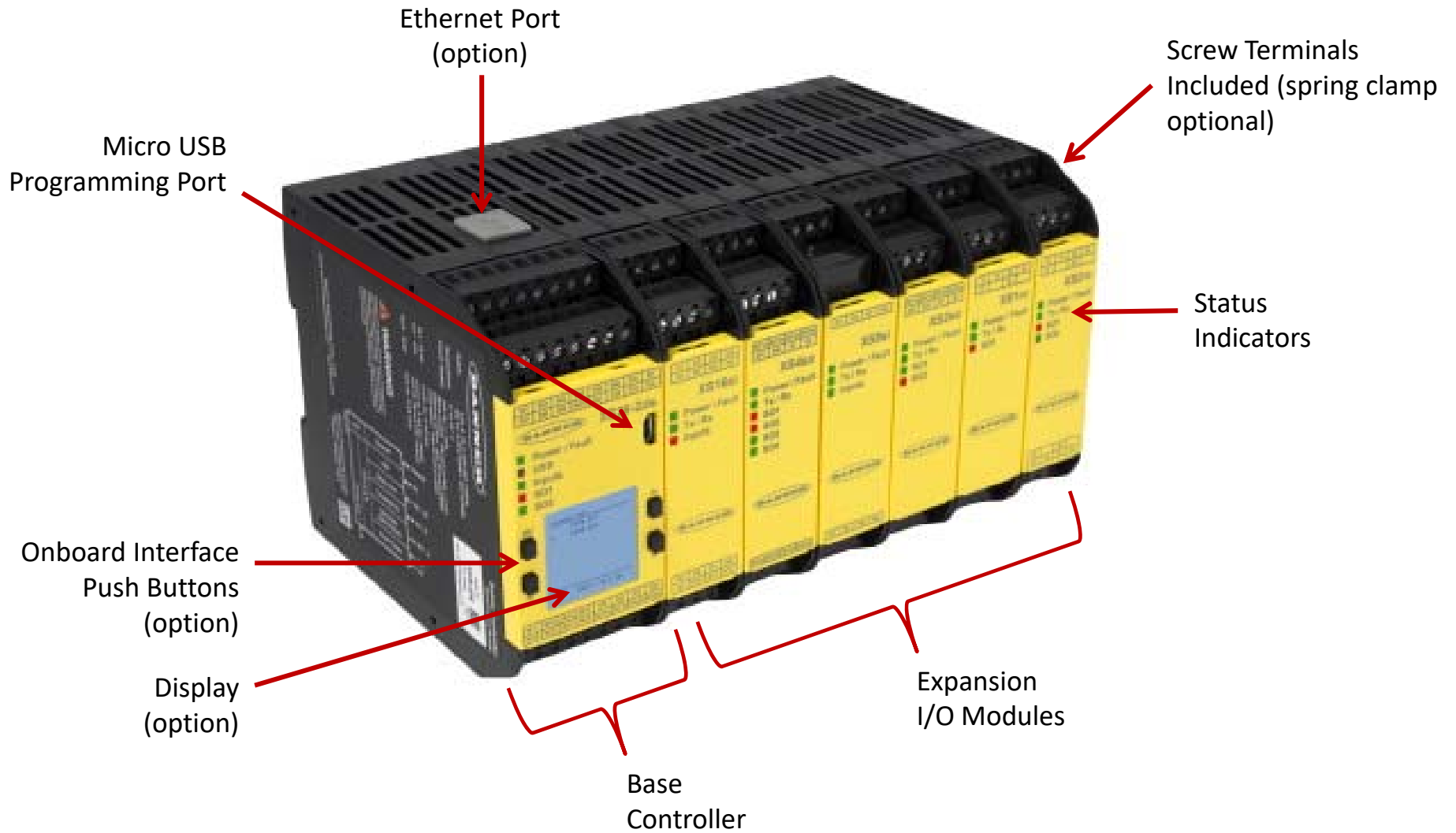
From SSM-FM data sheet



Enabling device & safety interface modules



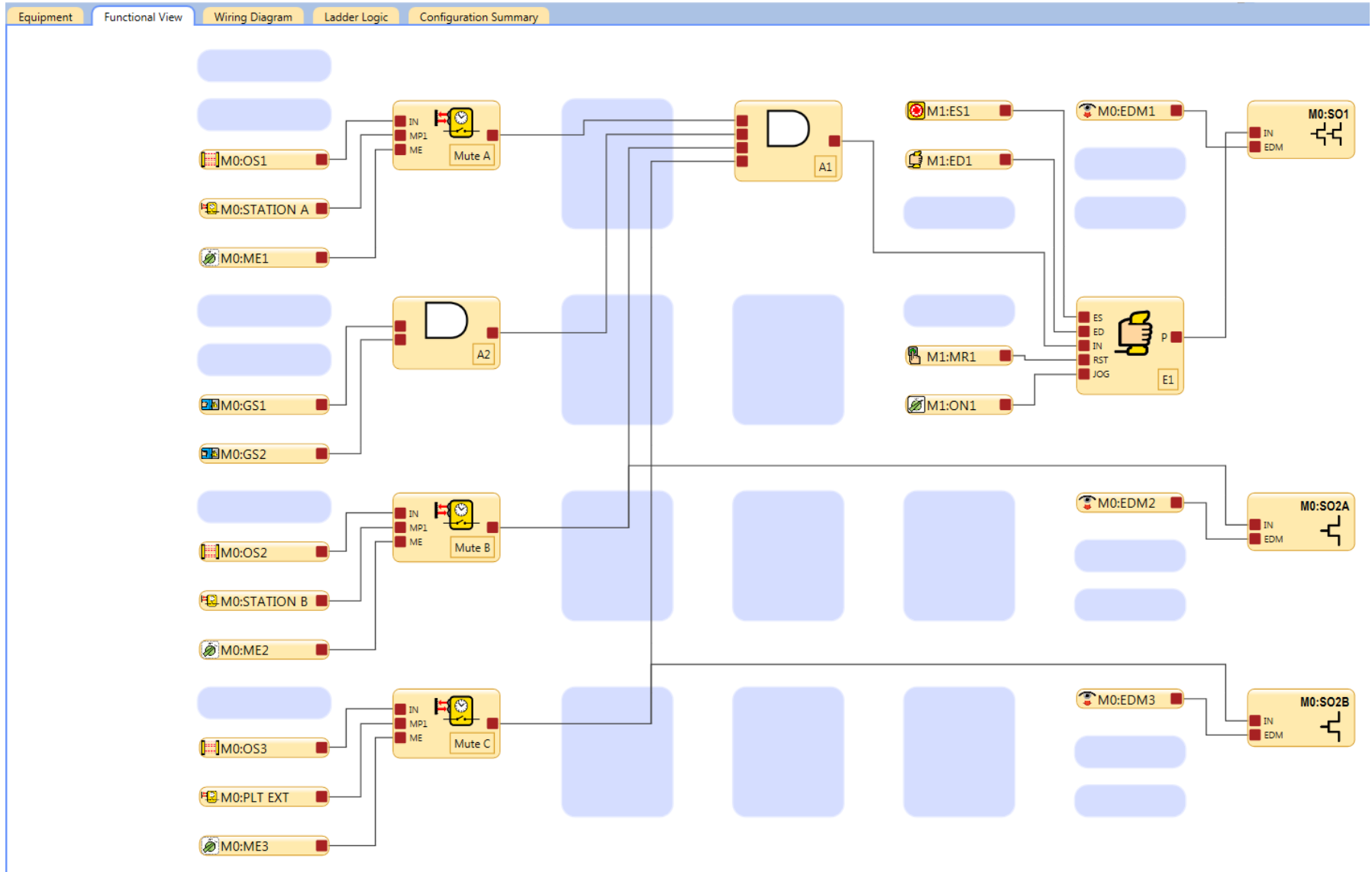
Evaluation & Logic devices – Configurable Safety Controller XS26-2de



Why use the SC/XS26 Safety Controller?

General Circuit Symbols		Circuits shown in Run State						Circuits shown in Stop State	
		ES 	GS 	OS 	RP 	PS 	SM 	THC 	ED
1 & 2 Terminal Single Channel (see note 1)		Cat 2	Cat 2	Cat 2	Cat 2	Cat 2			
2 & 3 Terminal Dual Channel (See note 2)		Cat 3	Cat 3	Cat 3	Cat 3	Cat 3	Type IIIa Cat 1 Type IIIb Cat 3	Cat 3	
2 Terminal Dual Channel PNP w/ Integral monitoring (see note 3)		Cat 4	Cat 4	Cat 4	Cat 4	Cat 4	Type IIIa Cat 1	Cat 4	
3 & 4 Terminal Dual Channel (see notes 2 & 4)		Cat 4	Cat 4	Cat 4	Cat 4	Cat 4	Type IIIa Cat 1 Type IIIb Cat 3	Cat 4	
2 & 3 Terminal Dual Channel Complementary			Cat 4	Cat 4	Cat 4	Cat 4		Cat 4	
2 Terminal Dual Channel Complementary PNP			Cat 4	Cat 4	Cat 4	Cat 4		Cat 4	
4 & 5 Terminal Dual Channel Complementary			Cat 4				Type IIIc Cat 4	Cat 4	
4 Terminal Dual Channel Complementary PNP			Cat 4				Type IIIc Cat 4	Cat 4	
4 Terminal Safety Mat							Cat 3		

SC/XS26 Software



SC/XS26 Software - Diagnostics

Equipment ⚙️ Functional View ⚙️ Wiring Diagram ⚙️ Ladder Logic Configuration Summary Simulation Mode ⚙️

SO2a		M0:SO2A
SO2b		M0:SO2B
24V		24V dc Power
0V		
+ IO6		Terminals available for all circuit types
+ IO7		
+ IO1		Convertible terminals available (one shared use remaining)
+ IO2		

Module Position: 0

Module: M0:XS26-2de

SC/XS26 Software - Diagnostics

Equipment | Functional View | Wiring Diagram | Ladder Logic | Configuration Summary

Modules

M0: XS26-2de
M1: XS8si

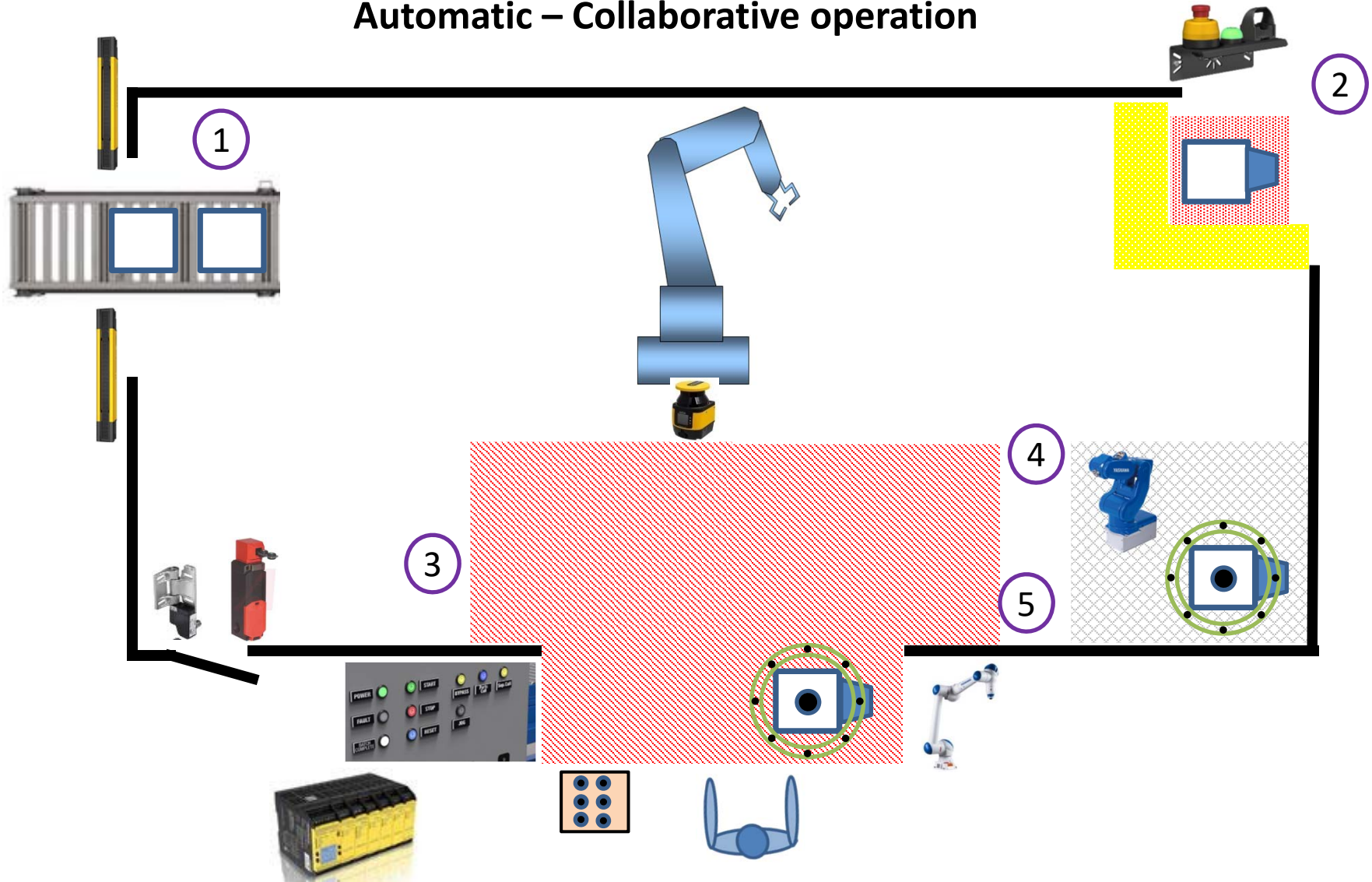
Configuration

Name: New Config
Project: New Project
Author:
CRC: unconfirmed

M0:XS26-2de Inputs

<p>Type: Optical Sensor</p> <p>Name: OS1</p> <p>Module: M0</p> <p>Circuit Type: Dual-Channel PNP</p> <p>Terminals: IN3, IN4</p> <p>Simultaneity: Simultaneous</p> <p>Debounce Closed-Open: 6 ms</p> <p>Debounce Open-Closed: 50 ms</p> <p>Startup Test: Disabled</p> <p>Output: Mute A</p> <p>Safety Outputs: M0:SO1</p>	<p>Type: Optical Sensor</p> <p>Name: OS2</p> <p>Module: M0</p> <p>Circuit Type: Dual-Channel PNP</p> <p>Terminals: IN5, IN6</p> <p>Simultaneity: Simultaneous</p> <p>Debounce Closed-Open: 6 ms</p> <p>Debounce Open-Closed: 50 ms</p> <p>Startup Test: Disabled</p> <p>Output: Mute B</p> <p>Safety Outputs: M0:SO1, M0:SO2A</p>	<p>Type: Optical Sensor</p> <p>Name: OS3</p> <p>Module: M0</p> <p>Circuit Type: Dual-Channel PNP</p> <p>Terminals: IN7, IN8</p> <p>Simultaneity: Simultaneous</p> <p>Debounce Closed-Open: 6 ms</p> <p>Debounce Open-Closed: 50 ms</p> <p>Startup Test: Disabled</p> <p>Output: Mute C</p> <p>Safety Outputs: M0:SO1, M0:SO2B</p>	<p>Type: Muting Sensor Pair</p> <p>Name: STATION A</p> <p>Module: M0</p> <p>Circuit Type: Dual-Channel 2 terminal</p> <p>Terminals: IN9, IN10</p> <p>Debounce Closed-Open: 50 ms</p> <p>Debounce Open-Closed: 50 ms</p> <p>Output: Mute A</p> <p>Safety Outputs: M0:SO1</p>	<p>Type: Muting Sensor Pair</p> <p>Name: STATION B</p> <p>Module: M0</p> <p>Circuit Type: Dual-Channel 2 terminal</p> <p>Terminals: IN11, IN12</p> <p>Debounce Closed-Open: 50 ms</p> <p>Debounce Open-Closed: 50 ms</p> <p>Output: Mute B</p> <p>Safety Outputs: M0:SO1, M0:SO2A</p>	<p>Type: Mute Enable</p> <p>Name: ME1</p> <p>Module: M0</p> <p>Circuit Type: Single-Channel 1 terminal</p> <p>Terminals: IN1</p> <p>Output: Mute A</p> <p>Safety Outputs: M0:SO1</p>
<p>Type: Muting Sensor Pair</p> <p>Name: PLT EXT</p> <p>Module: M0</p> <p>Circuit Type: Dual-Channel 2 terminal</p> <p>Terminals: IN13, IN14</p> <p>Debounce Closed-Open: 50 ms</p> <p>Debounce Open-Closed: 50 ms</p> <p>Output: Mute C</p> <p>Safety Outputs: M0:SO1, M0:SO2B</p>	<p>Type: Gate Switch</p> <p>Name: GS1</p> <p>Module: M0</p> <p>Circuit Type: Dual-Channel 3 terminal</p> <p>Terminals: IO1, IN15, IN16</p> <p>Simultaneity: Simultaneous</p> <p>Debounce Closed-Open: 6 ms</p> <p>Debounce Open-Closed: 50 ms</p> <p>Startup Test: Disabled</p> <p>Output: A2</p> <p>Safety Outputs: M0:SO1</p>	<p>Type: Gate Switch</p> <p>Name: GS2</p> <p>Module: M0</p> <p>Circuit Type: Dual-Channel 3 terminal</p> <p>Terminals: IO2, IN17, IN18</p> <p>Simultaneity: Simultaneous</p> <p>Debounce Closed-Open: 6 ms</p> <p>Debounce Open-Closed: 50 ms</p> <p>Startup Test: Disabled</p> <p>Output: A2</p> <p>Safety Outputs: M0:SO1</p>	<p>Type: Mute Enable</p> <p>Name: ME2</p> <p>Module: M0</p> <p>Circuit Type: Single-Channel 1 terminal</p> <p>Terminals: IN2</p> <p>Output: Mute B</p> <p>Safety Outputs: M0:SO1, M0:SO2A</p>	<p>Type: Mute Enable</p> <p>Name: ME3</p> <p>Module: M0</p> <p>Circuit Type: Single-Channel 1 terminal</p> <p>Terminals: IO8</p> <p>Output: Mute C</p> <p>Safety Outputs: M0:SO1, M0:SO2B</p>	
<p>Type: External Device Monitoring</p> <p>Name: EDM1</p> <p>Module: M0</p> <p>Circuit Type: Single-Channel 1 terminal</p> <p>Terminals: IO3</p> <p>Output: M0:SO1</p> <p>Safety Outputs: M0:SO1</p>	<p>Type: External Device Monitoring</p> <p>Name: EDM2</p> <p>Module: M0</p> <p>Circuit Type: Single-Channel 1 terminal</p> <p>Terminals: IO4</p> <p>Output: M0:SO2A</p> <p>Safety Outputs: M0:SO2A</p>	<p>Type: External Device Monitoring</p> <p>Name: EDM3</p> <p>Module: M0</p> <p>Circuit Type: Single-Channel 1 terminal</p> <p>Terminals: IO5</p> <p>Output: M0:SO2B</p> <p>Safety Outputs: M0:SO2B</p>			

Automatic – Collaborative operation



Collaborative Automation



YASKAWA

© 2018 YASKAWA ALL RIGHTS RESERVED |

July 19, 2018 |

8

Steve Wright, P.E., CSP
Safety Specialist
Cell: 937 510-5918
swright@ceadvancedtech.com

Heavy-duty Type 4 safety light curtains



Broad Feature Set

LS Series Full Feature Heavy-Duty Type 4



Simple, Low-Cost

LS Basic Series Heavy-Duty Type 4 for Simple Applications

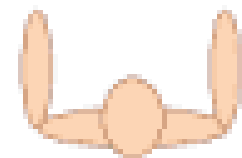
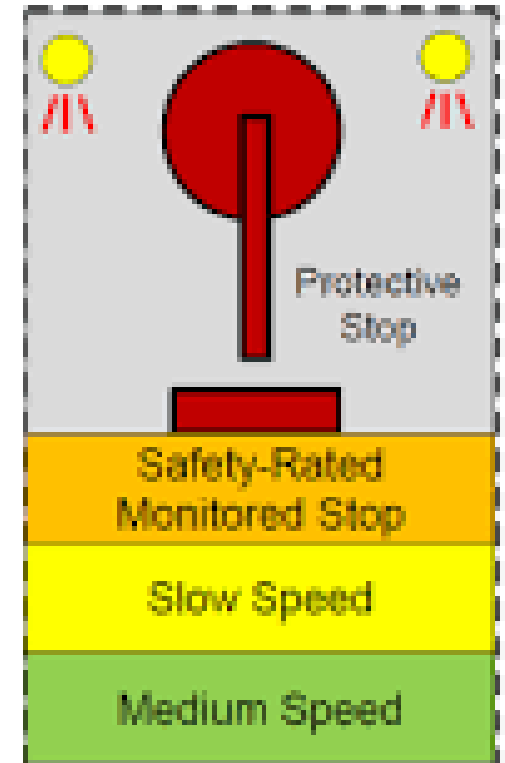
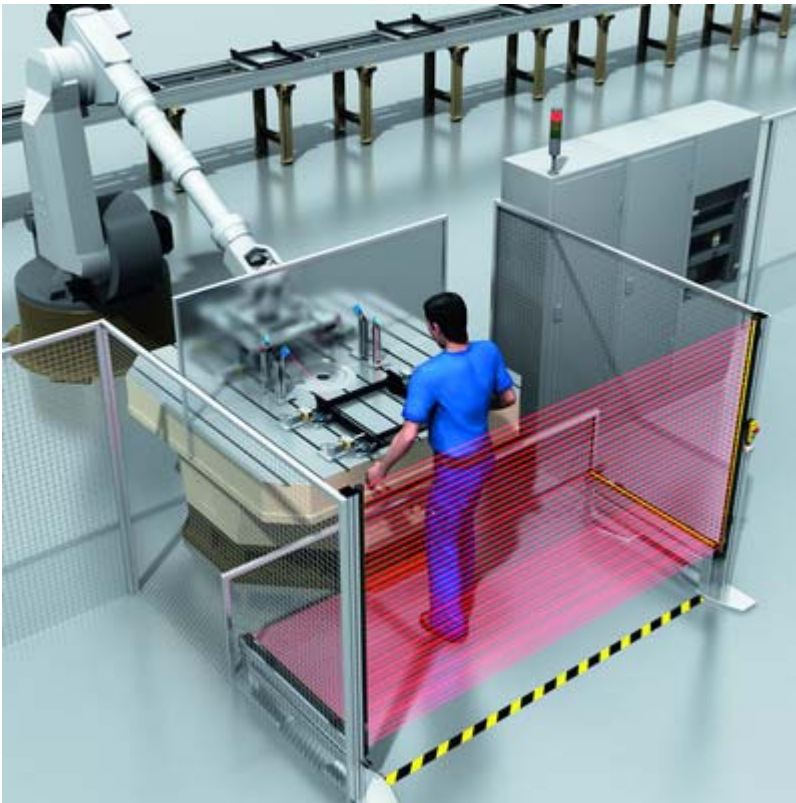


Traditional Type 4

14/30 Series Traditional Heavy-Duty Type 4

Slide Title

- Template bulleted list



Looks easy, right?

Summary of Safety-Rated Monitored Stop (SRMS) Conditions

ROBOT POSITION RELATIVE TO COLLABORATIVE WORKSPACE	OPERATOR POSITION RELATIVE TO COLLABORATIVE WORKSPACE	
	OUTSIDE	INSIDE
OUTSIDE	CONTINUE	CONTINUE
INSIDE & MOVING	CONTINUE	PROTECTIVE STOP
INSIDE AT SAFETY-RATED MONITORED STOP	CONTINUE	CONTINUE

Safety Interlock switches – 4 Types per ISO 14119

- Type 1 – Position switch that can be operated without a specific external actuator.
- Type 2 – Position switch that can only be operated with a specific actuator
- Type 3 – interlocking device with non-contact position switch with uncoded actuator.
- Type 4 – interlocking device with non-contact position switch with coded actuator.

Mechanical	Physical Contact	Uncoded	Rotary arm	Type 1	SI-LS31R
			Linear arm		SI-LM40D, SI-LS31H
			Hinge		SI-HG63, SI-HG80
		Coded	Tongue	Type 2	SI-LM40MV, SI-QS83D, SI-QS90D SI-LS83, SI-LS100 SI-LS42 & SI-QM100
Trapped Key	-				
Non-contact	Inductive	Uncoded	Ferric	Type 3	-
	Magnetic		Magnet, solenoid		
	Capacitive				
	Ultrasonic				
	Optic	Coded		Coded magnet	Type 4
	Magnetic		Coded RFID	-	
	RFID		Optically coded tag	-	
	Optic				

Perimeter Guarding



Emitter/Receiver Models

SGS Safety Grid System

2, 3 & 4 beam models emitter/receiver full feature line-up.



Active/Passive Models

SGS Safety Grid System

2, 3 & 4 beam active/passive models reduce cost and setup by only requiring wiring to the active side.

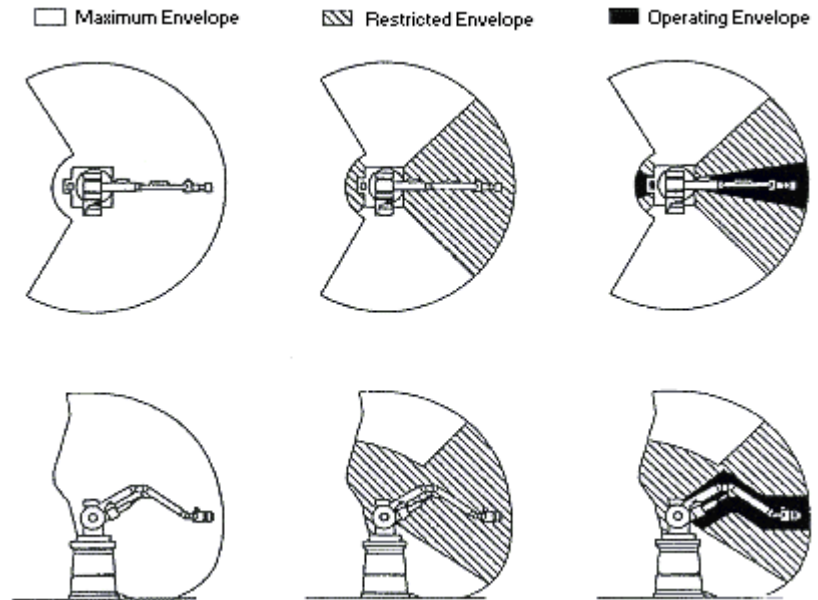
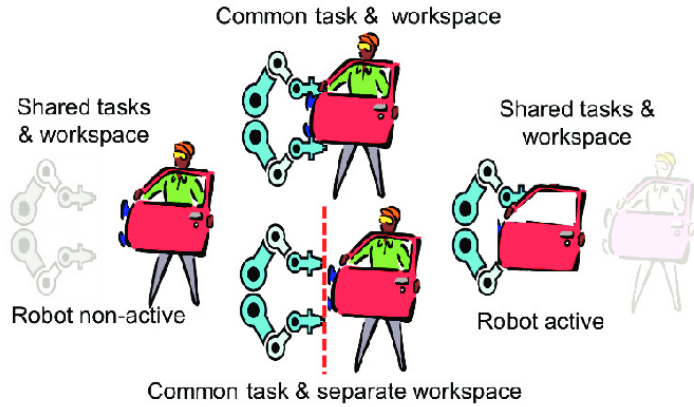


Single Beam

Single Beam Safety Light Devices

Single beam emitter/receiver models with a compact size for small openings.

Collaborative operations



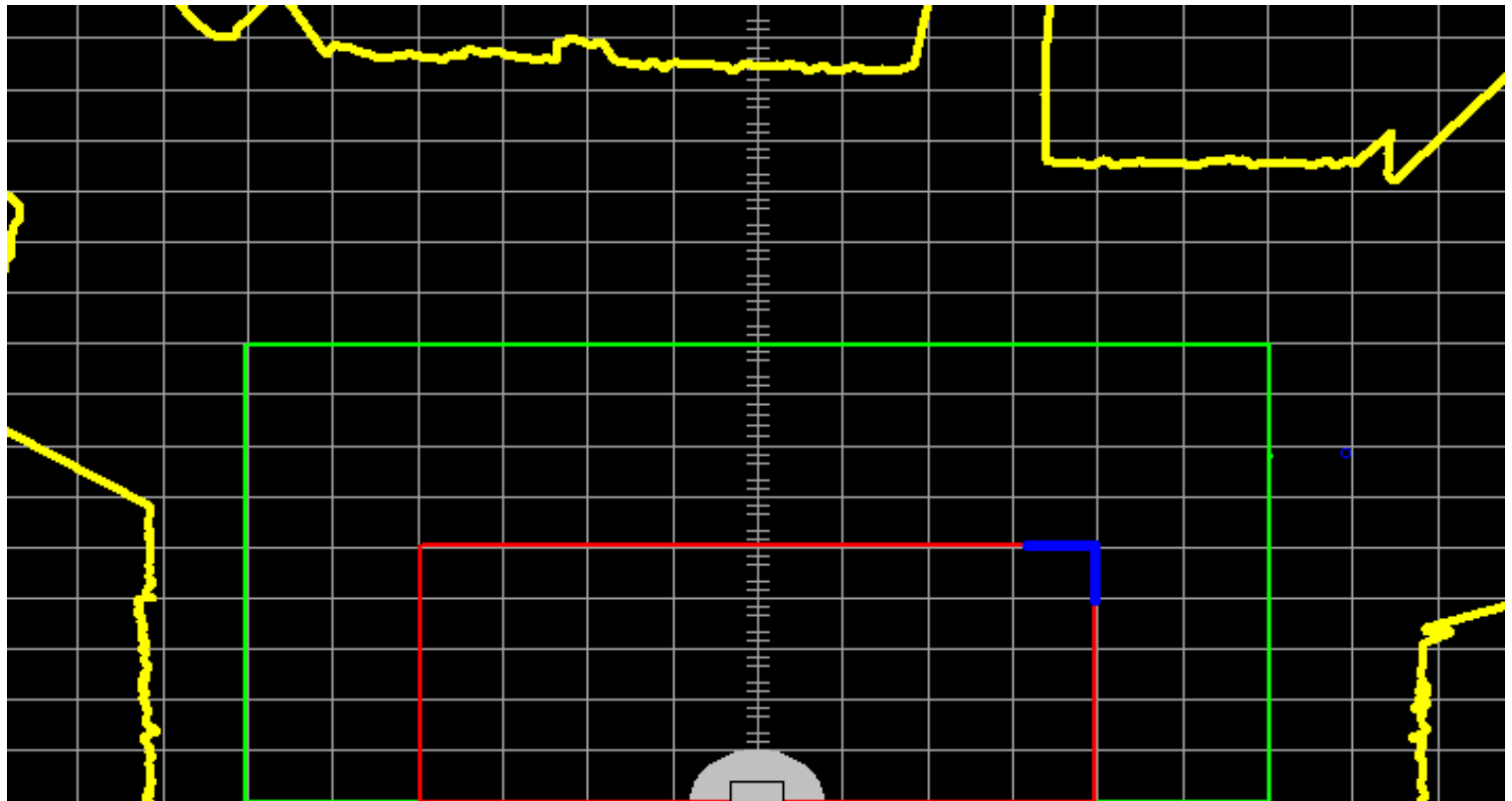
Safety Laser Scanner



AG4-4E & -6E



SX5-B



SC22 Safety Controller



System Settings

Network Settings

Notes

Safety Input Devices

- ▲ SAFETY MAT (K1 & K2, IM-T-9A)
- ▲ E-STOP (K1 & K2, IM-T-9A, SPARE)
- ▲ GATE 1 (IM-T-9A)
- ▲ GATE 2 (IM-T-9A)
- ▲ K1 (K1 & K2)
- ▲ K2 (IM-T-9A)

Non-Safety Input Devices

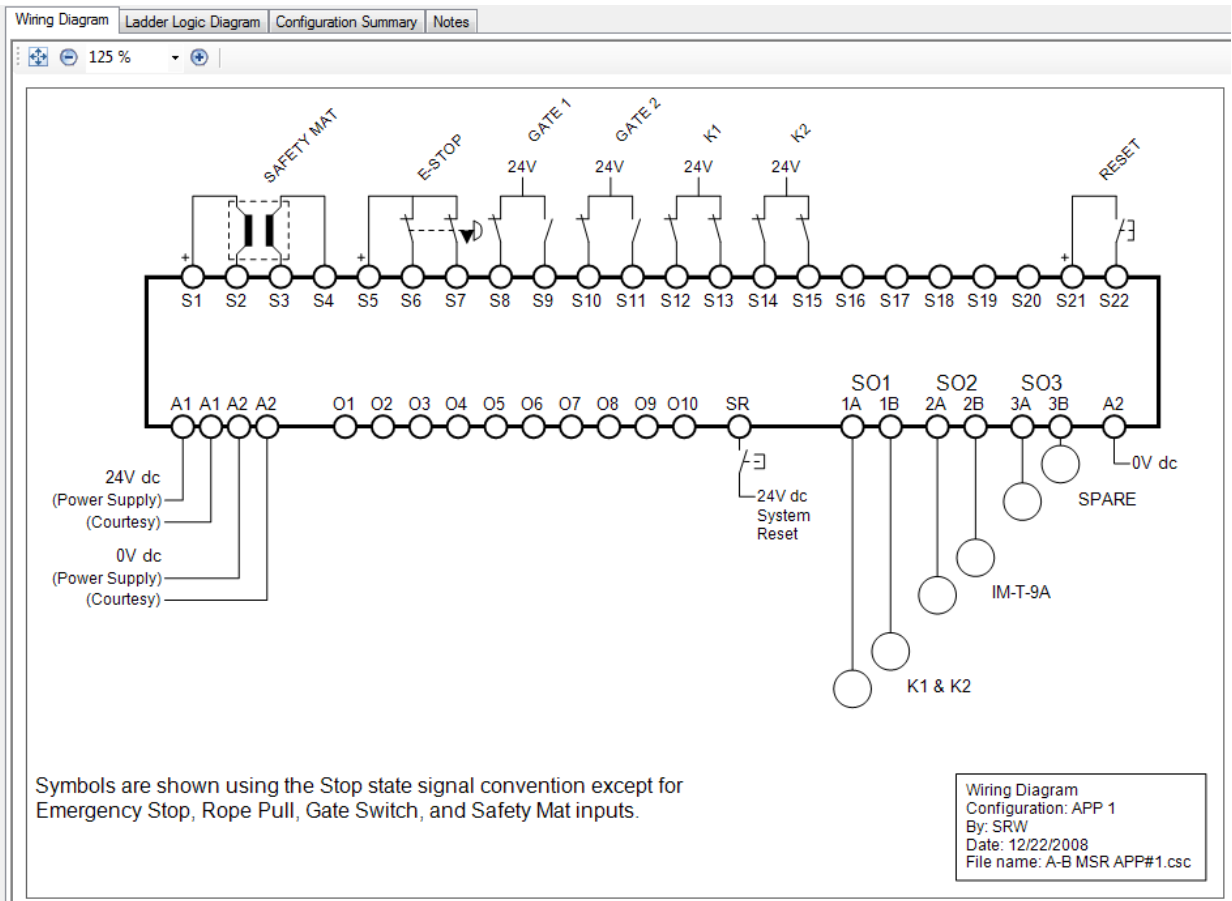
- RESET (K1 & K2, IM-T-9A)

Safety Outputs

- SO1: K1 & K2
- SO2: IM-T-9A
- SO3: SPARE

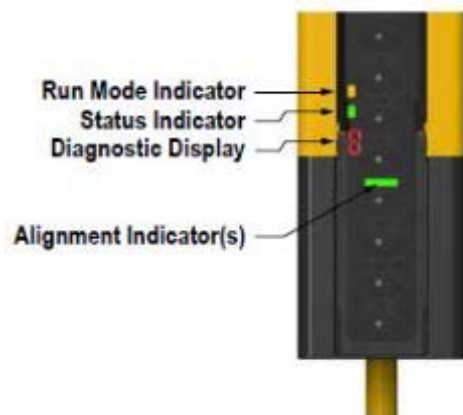
Status Outputs

- O1
- O2
- O3
- O4
- O5
- O6
- O7
- O8
- O9
- O10



EZ-Screen LS

- 14, 23, 40 mm resolution
- 280 to 1820 mm Defined Area
- Range from 0.1 to 12 meters
- IP65/IP67
- Standalone and Cascade models
- Trip output
- 1-channel or no EDM
- 2 scan codes possible
- Remote Fixed Blanking on Cascade models
- Cascade is configured automatically

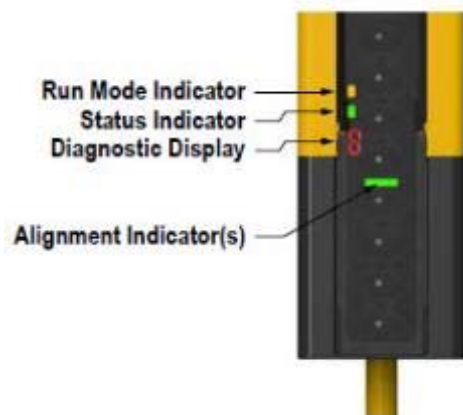


Optional
status light



EZ-Screen LS Basic

- 23 mm resolution
- Defined area: 10 lengths from 350 mm to 1820 mm
- Range from 0.1 to 8 meters
- IP65/IP67
- Standalone only models
- Trip output
- Auxiliary Fault Output
- 1-channel or no EDM
- 2 scan codes possible
- Mounting hardware ordered separately



EZ-Screen 14/30 Original

- 14mm and 30mm resolution
- Defined area:
 - 14mm res: 150 to 1800 mm 6 meter maximum range
 - 30mm res: 150 to 2400 mm 18 meter maximum range
- Reduced Resolution & Fixed Blanking
- IP65/IP67
- Standalone and Cascade models
- Trip or Latch output
- Auxiliary Output
- 1-channel or no EDM
- 2 scan codes possible



Compact Type 4 light curtains



Broad Feature Set

**LP Series Full Feature
Compact Type 4**



Simple, Low-Cost

**LP Basic Series Compact
Type 4 for Simple
Applications**



Simple, Low-Cost

**SLC4 Series Very Compact
Type 4 for Simple
Applications**

EZ-Screen LP Full Feature Type 4

- 14mm and 25mm resolution
- Defined area: 270mm to 1810mm
- 100 mm to 7 meter maximum range
- Reduced Resolution & Fixed Blanking
- IP65
- Standalone and Cascade models
- Trip or Latch output
- Auxiliary Output
- 1-channel or no EDM
- 2 scan codes possible



EZ-Screen LP Basic Type 4

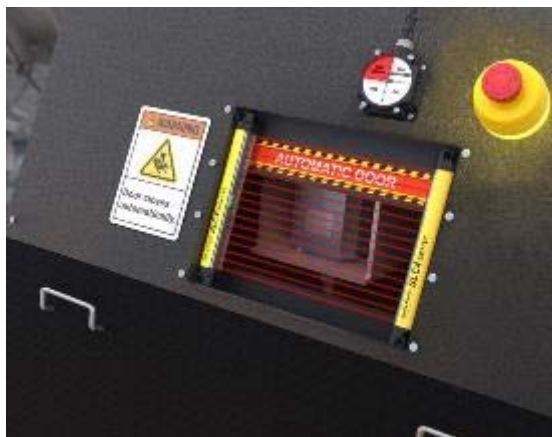
- 14mm and 25mm resolution
- Defined area: 270, 410, 550, 690 mm
- 100 mm to 4 meter maximum range
- Reduced Resolution & Fixed Blanking
- IP54
- Standalone models
- Trip output
- Auxiliary Output
- 2 scan codes possible
- Mounting hardware ordered separately



EZ-Screen SLC4

Banner's shortest compact Safety Light Screen for safety in tight spaces

- 14mm or 24mm resolution
- Defined areas 160mm, 240mm, and 320mm.
- Sensing range up to 2 meters
- Factory installed 300mm pigtail with 4 pin M12 connector
- Alignment & Zone Status LED Indication
- 2 m range
- IP54 enclosure



Automation Expo May 21st

Embassy Suites Murfresboro