Understanding and Designing Safety Applications

Presented by: Henry Gilliland, Eric Hanley, Greg Taylor, Kevin York

Agenda Timing

- {40 minutes} Safety Standards Explanation
- {15 minutes} GuardLink and Guardmaster 440R Safety Diagnostics
- {05 minutes} Live Demonstration - GuardLink
- {15 minutes} Break/Q&A
- {20 minutes} CIP Safety and Integrated Safety Explanation
- {10 minutes} Safety Controllers Overview
- {10 minutes} GuardLogix Software (Studio 5000)
- {10 minutes} Live Demonstration - GuardLogix Software (Studio 5000)
- {15 minutes} Break/Q&A
- {20 minutes} CIP Safety MAB and Light Curtains and Area Scanner
- {10 minutes} Live Demonstration - Area Scanner
- {15 minutes} Drive Safety and CIP encoder
- {15 minutes} Safety IO platforms
- {15 minutes} Live Demonstration - Integrated Safety Machine

Safety Standards Explanation with Greg Taylor

Functional Safety Engineer, Machinery

(TÜV Rheinland #16444 / 18)

Business Lead – Intelligent Devices

Rockwell Automation

Some Standards to know & love …

Rockwell Automation

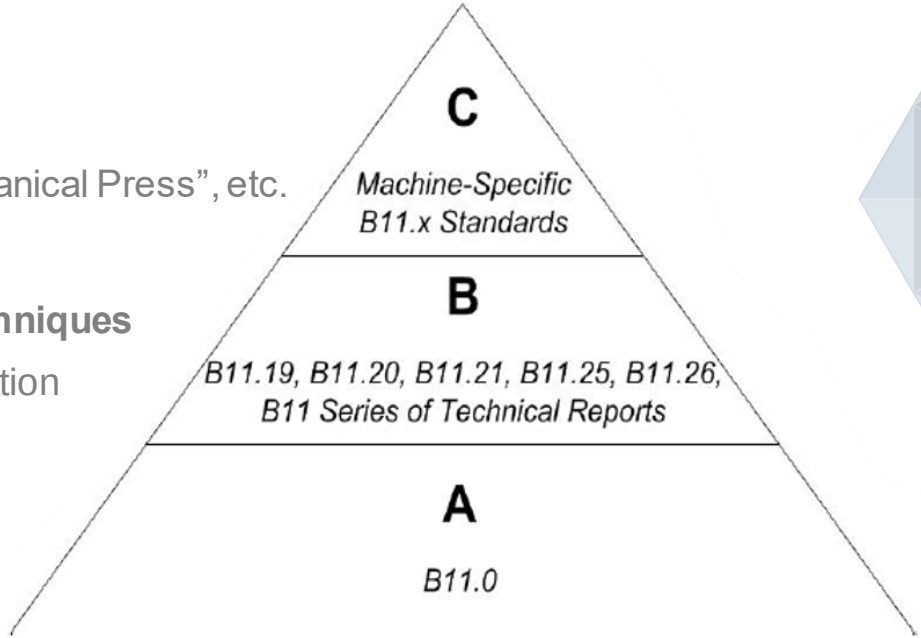
Standards in “Types”

Machine Safety Standards

e.g., “Conveyors” or “Robots” or “Mechanical Press”, etc.

“Generic” approaches, reduction techniques

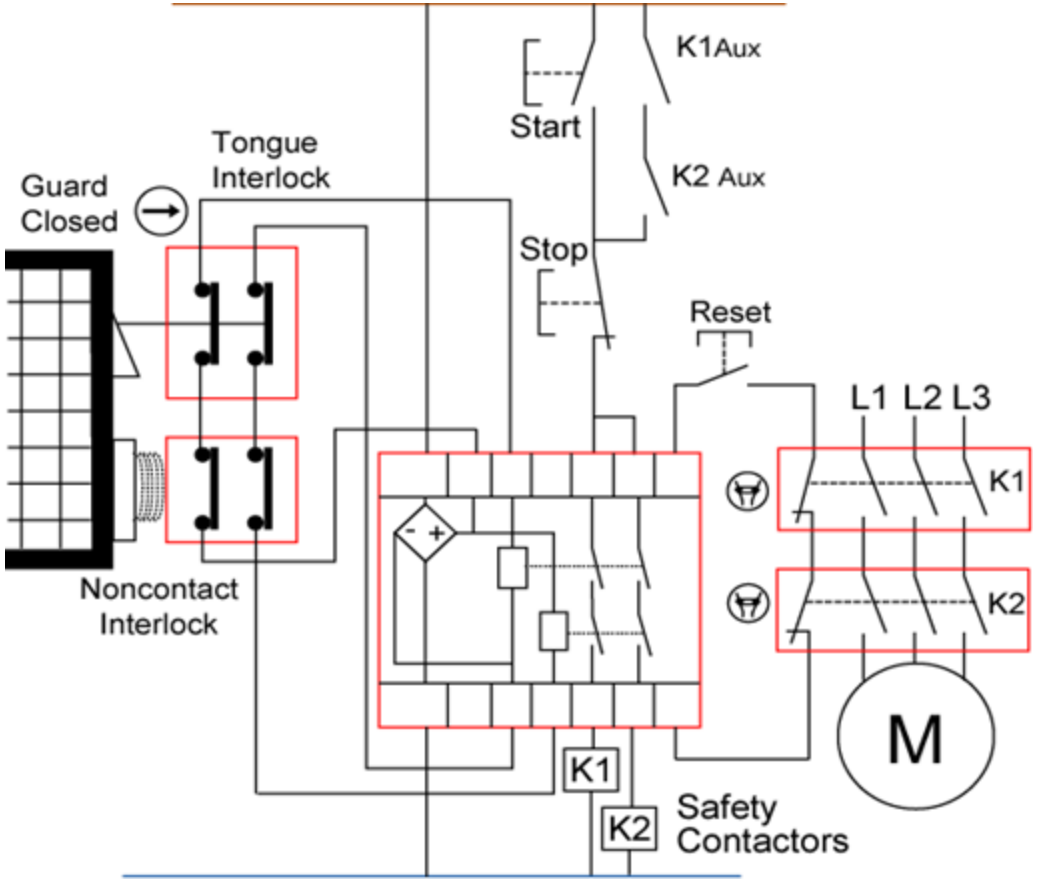
Engineering practices, devices & integration



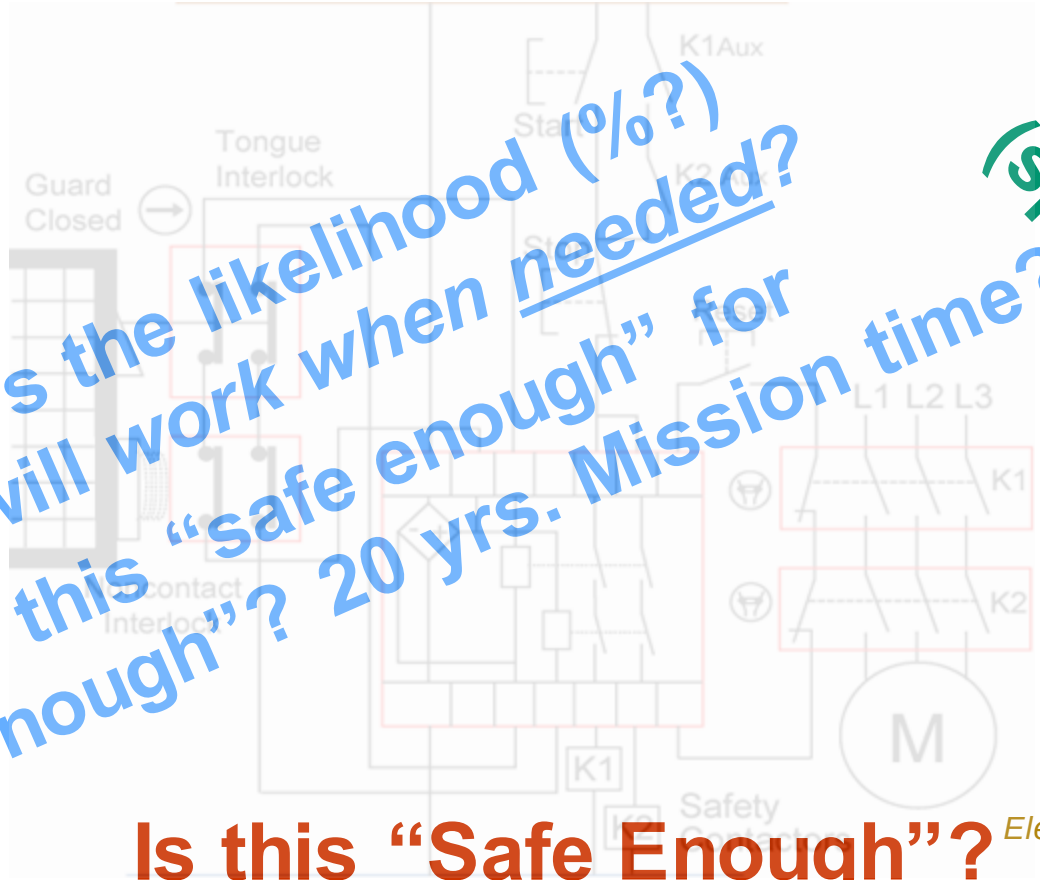
Some Relevant Standards for Context

- **ANSI B11.0-2020: Safety Of Machinery (note – harmonized with ISO 12100)**
- **ANSI B11.26, Machines Functional Safety For Equipment: General Principles For The Design Of Safety Control Systems Using ISO 13849-1**
- **ANSI B11.19-2019: Performance Requirements for Risk Reduction Measures: Safeguarding and other Means of Reducing Risk**
- **NFPA79 (aligns with ISO 60204-1) – Electrical / Controls Design requirements**
- **NFPA70 / National Electrical Code**
- **ANSI/RIA R15.06-2012: Industrial Robots and Systems – Safety Requirements**
- **ISO 10218 (Parts -1 and -2) Robot Safety Standards (now harmonized as ANSI RIA15.06)**
- **RIA TR R15.306 Robots / Risk Assessment Technical Report**
- **ISO 13849 (Parts -1 and -2) Safety Related Parts of Control Systems (SRP/CS)**
- **Note also – IEC 62061, most pertinent to electronics & software-based devices/systems (Safety Integrity Levels)**
- **New & evolving applications & approaches:**
  - ***RIA TR R15.606-2016*** *Collaborative* Robot Safety ("TR 606"), or ISO/TS 15066:2016
  - **ANSI/RIA R15.08**, Industrial Mobile Robot Safety, addressing robots with *mobile bases* (under development)

Example “Functional Safety” Control System



Example “Functional Safety” Control System



What’s the likelihood (%?)
This will work when *needed*?
Is this “safe enough” for
“*long* enough”? 20 yrs. Mission time?

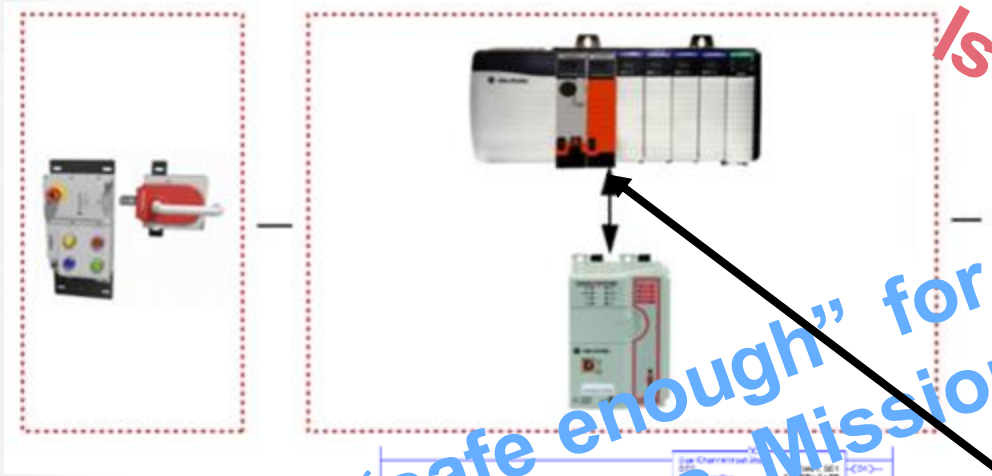
Is it “overdesigned”
(spent too much $?)

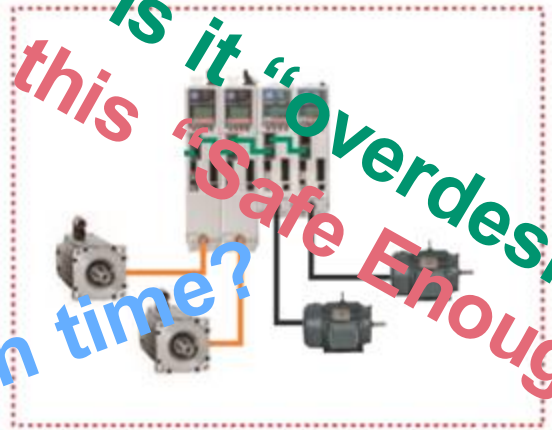
Is this “Safe Enough”?

Electromechanical stuff = wear & tear

Rockwell Automation

Example “Functional Safety” Control System





Is it “overdesigned”

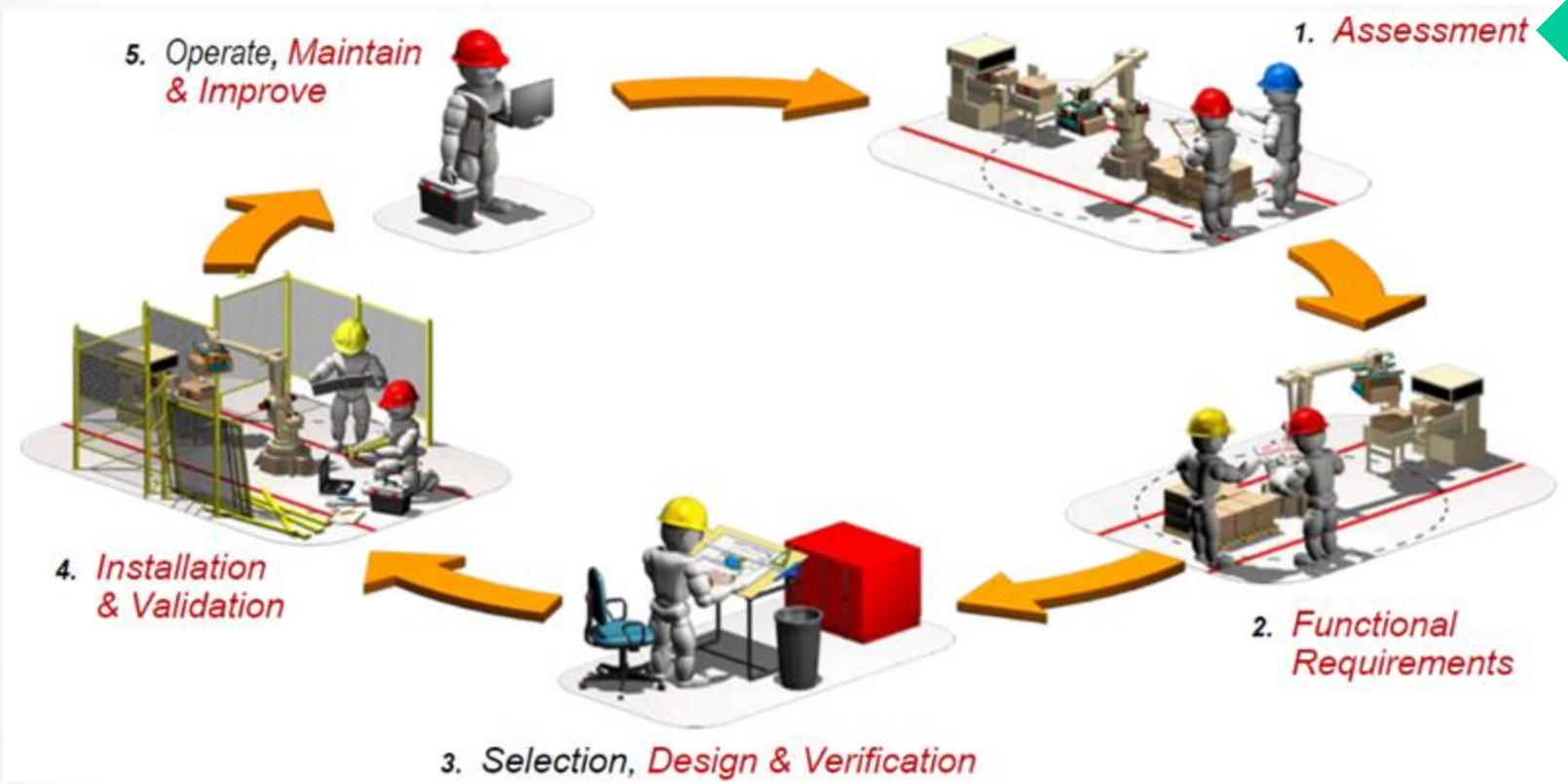
Is this “Safe Enough”?

Is this “safe enough” for “long enough”? 20 yrs. Mission time?

Electronics stuff = time & temperature failures

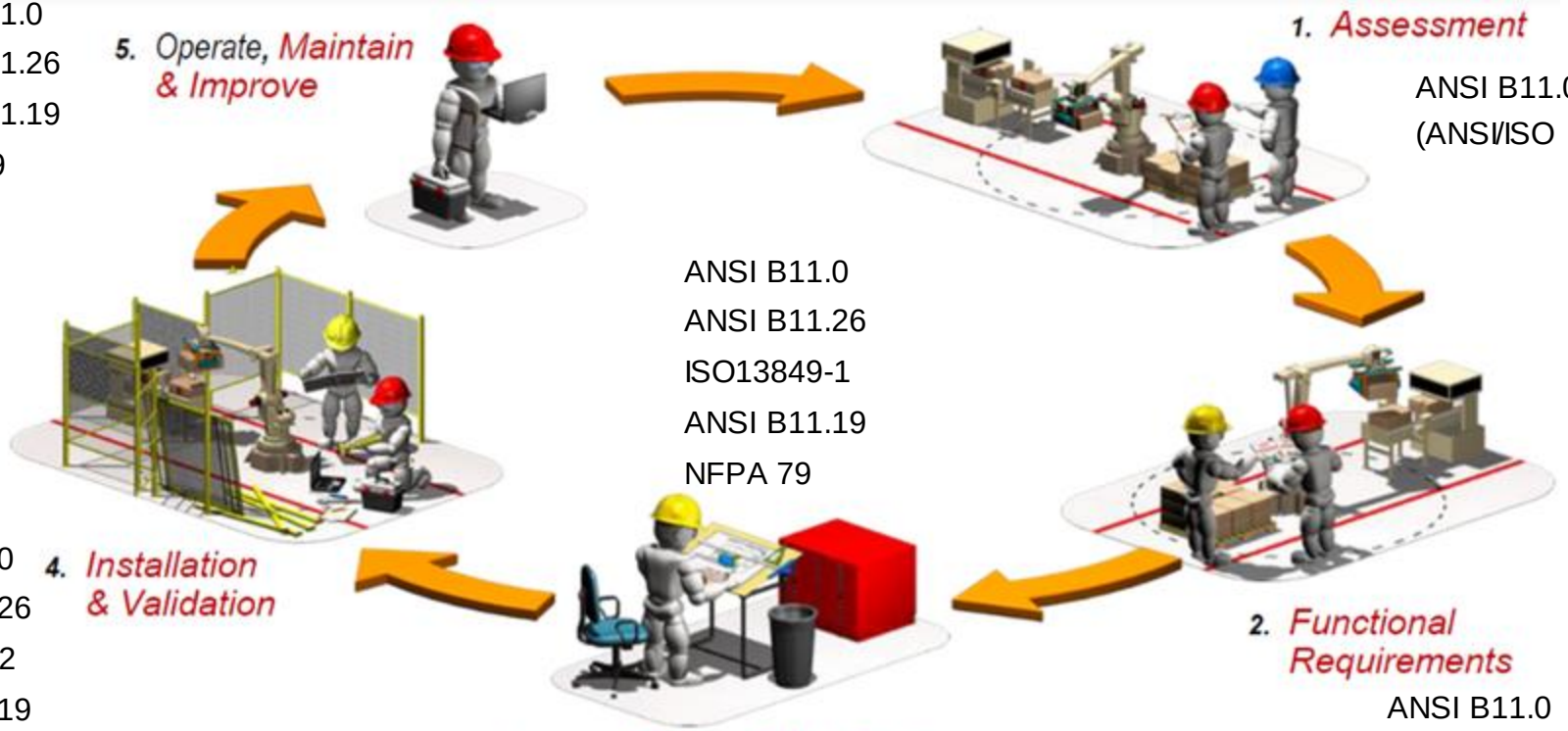
Rockwell Automation

Machine Safety Lifecycle



Machine Safety Lifecycle

ANSI B11.0
ANSI B11.26
ANSI B11.19
NFPA 79
LOTO



ANSI B11.0
(ANSI/ISO 12100

ANSI B11.0
ANSI B11.26
ISO13849-1
ANSI B11.19
NFPA 79

ANSI B11.0
ANSI B11.26
ISO13849-2
ANSI B11.19
NFPA 79

ANSI B11.0
ANSI B11.26
ISO13849-1

Are risk assessments required?

IEC 610508-1 – Functional safety of electrical/electronic/programmable electronic safety-related systems

For hardware safety integrity it is necessary to apply quantified reliability estimation techniques in order to assess whether the target safety integrity, as determined by the risk assessment, has been achieved, taking into account random hardware failures (see IEC 61508-2, 7.4.5).

RIA 15.06 – Industrial Robots and Robot System Requirements

"A Risk Assessment **shall be** performed and is no longer optional"

"Selection of a category 0 or category 1 stop (in accordance with IEC60204-1) function shall be determined from the risk assessment"

YES!!

NFPA 79 – Electrical Standard for Industrial Machinery

"The risks associated with the hazards identified by the risk assessment shall be reduced such that the safety performance determined by the risk assessment is met"

ISO 13849 – Safety of Machinery (PL)

"From the risk assessment (see ISO 12100) at the machine, the designer shall decide the contribution to the reduction of risk which needs to be provided by each relevant safety function which is carried out by the SRP/CS(s)."

IEC 62061– Safety of Machinery (SIL)

"**5.2.4.1** The safety integrity requirements for each SRCF shall be derived from the risk assessment to confirm the necessary risk reduction can be achieved. In this standard, a safety integrity requirement is expressed as a target failure value for the probability of dangerous failure per hour of each SRCF."

ANSI B11.19 – Performance Requirements for Safeguarding

"Selection of the safeguarding requires task and hazard identification, and the application of documented risk assessment and risk reduction of the total production system."

Rockwell Automation

Machine Risk Assessment: Document it …"write it down"

1. Ga… …bout machine
   - …
   - …
   - …
2. …
3. …
   - Pinch
   - Crush
   - Electrocution
   - Lacerations …

Task Type	Area	Task Specific	Injury Type	Body Parts Affected	Origin / Cause	Energy / Hazard Source	S	E	A	Initial Risk Rating	PLr	Cat. Structure	Current Safeguards	Recommendations	S	E	A	Residual Risk Rating
Normal Operation	3. East Side	3. Normal Operation	Mech: Entanglement	Fingers, hands	18. Spur gears	Electrical	S3	E1	A3	HIGH	PLd	3	[Engineered Solution] - Fixed guarding on side of machine prevents full body access to spur gears. Possibly able to reach over guarding to hazard. [Training/Procedures] - Building has restricted access during normal operation. LOTO procedures in place - central location that operators have access to, pre-harvest training (once per year) on all applicable procedures, SOP (work instruction) in place, pre-startup safety review annually [Awareness] - None [PPE] - Safety glasses, hard hat, gloves, safety shoes, hearing protection	[System Redesign] - Upgrade circuitry to Cat 3 [Engineered Solution] - Add movable guarding with gate door to extend between machines with mechanical means of escape. Add locking gate switch that requires both adjacent machines to be shut down before entering area. Must move electrical disconnect to outside of guarding. Install trapped key system to gate switches. Add compliant Estops. [Training/Procedures] - include new guarding in training and procedures for machine. If guarding is removed, machine must be under LOTO [Awareness] - Post signage for hazard, paint guards safety yellow [PPE] - N/A	S3	E0	A1	LOW
Normal Operation	3. East Side	3. Normal Operation	Mech: Entanglement	Fingers, Hands	19. Roller drive gear box shafts	Electrical	S3	E1	A3	HIGH	PLd	3	[Engineered Solution] - Fixed guarding on side of machine prevents full body access to shafts. Possibly able to reach over guarding to hazard. [Training/Procedures] - Building has restricted access during normal operation. LOTO procedures in place - central location that operators have access to, pre-harvest training (once per year) on all applicable procedures, SOP (work instruction) in place, pre-startup safety review annually [Awareness] - None [PPE] - Safety glasses, hard hat, gloves, safety shoes, hearing protection	[System Redesign] - Upgrade circuitry to Cat 3 [Engineered Solution] - Add movable guarding with gate door to extend between machines with mechanical means of escape. Add locking gate switch that requires both adjacent machines to be shut down before entering area. Must move electrical disconnect to outside of guarding. Install trapped key system to gate switches. Add compliant Estops. IF new guarding is placed behind ladder, add fixed guarding to prevent access to hazards. [Training/Procedures] - include new guarding in training and procedures for machine. If guarding is removed, machine must be under LOTO [Awareness] - Post signage for hazard, paint guards safety yellow [PPE] - N/A	S3	E0	A1	LOW

From ANSI B11.0

ANSI B11.0 Safety System Development (Assessment)

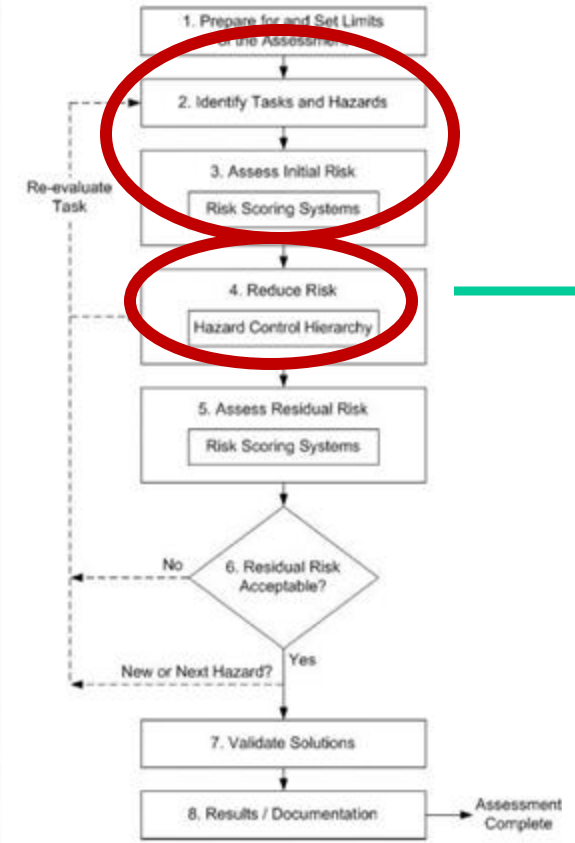


Table 3 — The Hazard Control Hierarchy

Most Preferred → Least Preferred

Classification	Risk Reduction Measures	Examples	Influence on Risk Factors
Inherently Safe by Design	Design Out (Elimination or Substitution)	• eliminate pinch points (increase clearance) • intrinsically safe (energy containment) • automated material handling (robots, conveyors, etc.) • redesign the process to eliminate or reduce human interaction • reduce force, speed, etc. through selection of inherently safe components • substitute less hazardous chemicals	• impact on overall risk (elimination) by affecting severity and probability of harm • may affect severity of harm, frequency of exposure to the hazard under consideration, and/or the possibility of avoiding or limiting harm depending on which method of substitution is applied.
Engineering Controls	Guards, Control Functions and Devices	• guards • interlock devices • presence sensing devices (light curtains, safety mats, area scanners, etc.) • two-hand control and two-hand trip devices • alternative methods to lockout to control hazardous energy	• greatest impact on the probability of harm (occurrence of hazardous events under certain circumstance) • minimal if any impact on severity of harm
Administrative Controls	Awareness Means	• lights, beacons, and strobes • computer warnings • signs and labels • beepers, horns, and sirens	• potential impact on the probability of harm (avoidance) • no impact on severity of harm
	Information for Use (Training and Procedures)	• safe work procedures • training	• potential impact on the probability of harm (avoidance and/or exposure) • no impact on severity of harm
	Administrative Safeguarding Methods	• safe-holding safeguarding method	• potential impact on the probability of harm (avoidance and/or occurrence) • no impact on severity of harm
	Supervision	• supervisory control of configurable elements	
	Control of Hazardous Energy	• lockout / tagout	
	Tools	• workholding equipment • hand tools	• potential impact on the probability of harm (avoidance and/or occurrence) • potential impact on severity of harm
	Personal Protective Equipment (PPE)	• safety glasses and face shields • ear plugs • gloves • protective footwear • respirators	• potential impact on the probability of harm (avoidance) • potential impact on severity of harm

ANSI B11.0 Risk Reduction Hierarchy

Classification	Risk Reduction Measures	Examples	Influence on Risk
		• eliminat…	…ation method of substitution is applied.
Controls	…uards, Control Functions and Devices	• interlock devices • presence sensing devices (light curtains, safety mats, area scanners, etc.) • two-hand control and two-hand trip devices • alternative methods to lockout to control hazardous energy	• greatest impact on the probability of harm (occurrence of hazardous events under certain circumstance) • minimal if any impact on severity of harm

Informative Note 1: *Not all potential risk reduction measures are feasible. Many factors determine if the risk reduction measure is feasible. It is necessary to evaluate the application of the risk reduction measure against the following factors:*

- *regulatory obligations and introduction of new hazards;*
- *effectiveness and machine performance;*
- *usability and productivity;*
- *durability, maintainability and ability to clean;*
- *ergonomic impact;*
- *economic and technological feasibility.*

(Preview of Step 3…) ANSI B11.0:2020

6.5.1.3 Engineering controls

Where feasible, engineering controls (guards, control functions and devices) shall be provided to reduce risk. See ANSI B11.19 and/or the machine-specific standard (or other relevant safety standards) for details on engineering controls.

Informative Note 1: *Where hazards cannot be eliminated, guards and devices and administrative controls are usually used together to reduce risk to an acceptable level.*

Risk Assessment "Scoring Systems" – Elements of Risk

6.4 Assess initial risk

The risks associated with each hazard shall be assessed using the following steps:

1) Select a risk scoring system (6.4.1);
2) Assess risk using the risk factors of the risk scoring system (6.4.2);
3) Derive a risk level (6.4.3).

Continuous exposure?
Once an hour?
Once a month?

Risk *related to the considered hazard* is a function of **Severity of harm** *that can result from the considered hazard* and **Probability of occurrence** *of that harm*

Bruise?
Cut?
Break?
Loss of limb?

Easy to avoid?
Slow moving machine?
Not possible to avoid?
Can't see see it coming?

From ANSI B11.0

Risk Scoring Systems

All include the elements of:

- **Severity**
- **Probability**

Table 2 — Example Risk Scoring System

Probability of Occurrence of Harm	Severity of Harm			
	Catastrophic	Serious	Moderate	Minor
Very Likely	High	High	High	Medium
Likely	High	High	Medium	Low
Unlikely	Medium	Medium	Low	Negligible
Remote	Low	Low	Negligible	Negligible

Probability is often represented by:

- Frequency of Exposure
- Likelihood or Possibility of Avoidance

Sample 2: RISK SCORE = FREQUENCY * LIKELIHOOD * SEVERITY

SCORING LEGEND		
FACTOR	SCORE	REPRESENTS
Frequency: How often the activity presenting the hazard occurs (how often is the employee exposed)	1	Hazard occurs less than once per month
	2	Hazard occurs less than once per week
	3	Hazard occurs less than once per day
	4	Hazard occurs more than once a day
	5	Hazard occurs continuously
Likelihood: How likely is it that the potential impact of the hazard will actually happen? (has it happened before and/or could it happen?)	1	Very unlikely
	2	Unlikely
	3	Possible
	4	Probable
	5	Very likely
Severity: What is the most severe injury or illness that could **reasonably** occur from the impact?	1	First aid
	2	Medical only
	3	Lost time, full recovery
	4	Lost time, permanent impairment, or multiple lost time
	5	Death or permanent disability

From ANSI B11.0

Risk Estimation / Scoring Systems & Models

HRN – "Hazard Rating Number"

- The likelihood of occurrence (LO)
- The frequency of exposure (FE)
- The degree of possible harm (OPH)
- The number of persons at risk (NP)

LO FE DPH NP=H.R.N.
0.1 X 0.1 X 4 X 1=0.04
Degree of risk: = Negligible

LO FE DPH NP=H.R.N.
2 X 5 X 4 X 1=40
Degree of risk: = Significant

N° Persons	Factor
1-2 Persons	1.00
3 -7 Persons	2.00
8 -15 Persons	4.00
16 - 50 Persons	8.00
More than 50	12.00

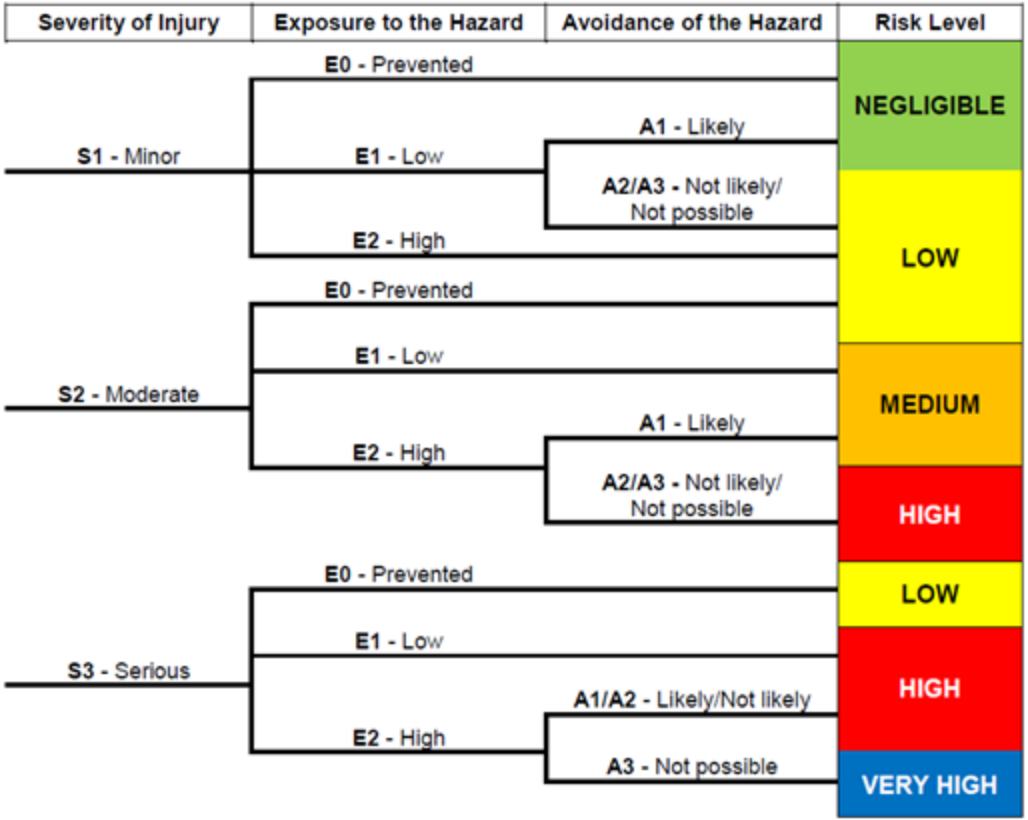
Frequency	Factor
Annual	0.50
Monthly	1.00
Weekly	1.50
Daily	2.50
Hourly	4.00
Constant	5.00

Probability	Factor
Little/low possibility, under extreme circumstances	0.03
Highly improbable, but still likely	1.00
Improbable, but still possible	1.50
Possible, but unusual	2.00
Although improbable, it may occur	5.00
Probable , Not surprising	8.00
Probable , Can be expected	10.00
Certain , No doubt	15.00

Max. Loss	Factor
Scratch, bruise	0.10
Burn, cut, short illness	0.50
Minor bone fracture or minor temporary illness	2.00
Major bone fracture or major temporary illness	4.00
Loss of a limb, eye or hearing, permanent	6.00
Loss of two limbs, eyes or hearing, permanent	10.00
Fatality	15.00

HRN Result	Min.	Max	Colour
Negligible	0	5	
Low but relevant	5	50	
High	50	500	
Unacceptable	500	10000000000	

Risk Scoring System (using RIA TR R15.306-2016)



What Is “Functional Safety?”

Formal Definition: “part of the overall safety relating to the EUC and EUC control system that depends on the correct functioning of E/E/PE safety related systems and other risk reduction measures”
(IEC 61508-4 2010)

Practical Definition: Use of an automation system to guarantee safety of people

Risk Estimation (using RIA TR R15.306-2016)

Factor	Rating	Criteria (Examples) – choose most likely *Read criteria from the top for each factor*
Injury Severity	Serious S3	Normally non-reversible; likely will not return to the same job after recovery from incident: – fatality – limb amputation – long term disability – chronic illness **If any of the above are applicable, the rating is SERIOUS**
	Moderate S2	Normally reversible; likely will return to the same job after recovery from incident: – broken bones – severe laceration – short hospitalization – short term disability – lost time (multi-day) – fingertip amputation (not thumb) **If any of the above are applicable, the rating is MODERATE**
	Minor S1	First aid; no recovery required before returning to job: – bruising – small cuts – no loss time (multi-day) – does not require attention by a medical doctor **If any of the above are applicable, the rating is MINOR**

Risk Estimation (using RIA TR R15.306-2016)

Factor	Rating	Criteria (Examples) – choose most likely *Read criteria from the top for each factor*
Exposure[1]	Prevented E0	– Exposure to hazard(s) is eliminated/ controlled/ limited by inherently safe design measures. – Use of guards prevents exposure or access to the hazard(s) (see Part 2, 5.10). If an interlocked guard is selected, the following bullet must also be met. – If functional safety is used as a risk reduction measure, the implemented functional safety performance (PL) meets or exceeds the required functional safety performance (PL_r). See Part 2, 5.2. **If any of the above are applicable, the rating is PREVENTED**
	High E2	– Typically more than once per day or shift – Frequent or multiple short duration – Situations which could lead to increases in the duration of a task, not to include teaching tasks **If any of the above are applicable, the rating is HIGH**
	Low E1	– Typically less than or once per day or shift – Occasional short durations **If either of the above are applicable, the rating is LOW**

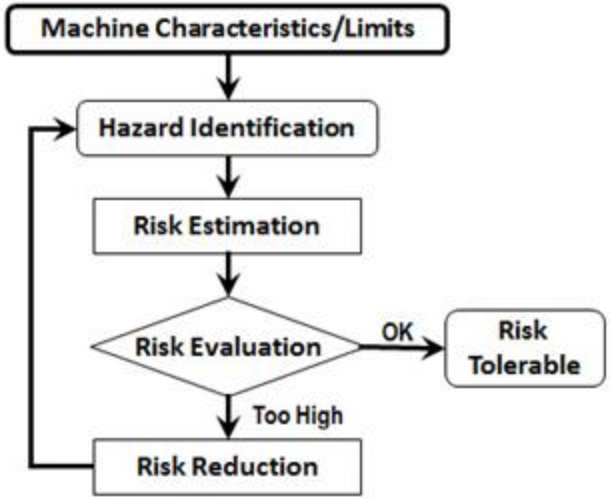
Risk Estimation (using RIA TR R15.306-2016)

Factor	Rating	Criteria (Examples) – choose most likely *Read criteria from the top for each factor*
Avoidance	Not possible A3	– Insufficient clearance to move out of the way and safety-rated reduced speed control is not used – The robot system or cell layout causes the operator to be trapped, with the escape route toward the hazard – Safeguarding is not expected to offer protection from the process hazard (e.g. explosion or eruption hazard) **If any of the above are applicable, the rating is NOT POSSIBLE**
	Not likely A2	– insufficient clearance to move out of the way and safety-rated reduced speed control is used – obstructed path to move to safe area – hazard is moving faster than reduced speed (250 mm/sec) – inadequate warning/reaction time – the hazard is imperceptible **If any of the above are applicable, the rating is NOT LIKELY**
	Likely A1	– sufficient clearance to move out of the way – hazard is incapable of moving greater than reduced speed (250 mm/sec). – adequate warning/reaction time – positioned in a safe location away from the hazard **If any of the above are applicable, the rating is LIKELY**

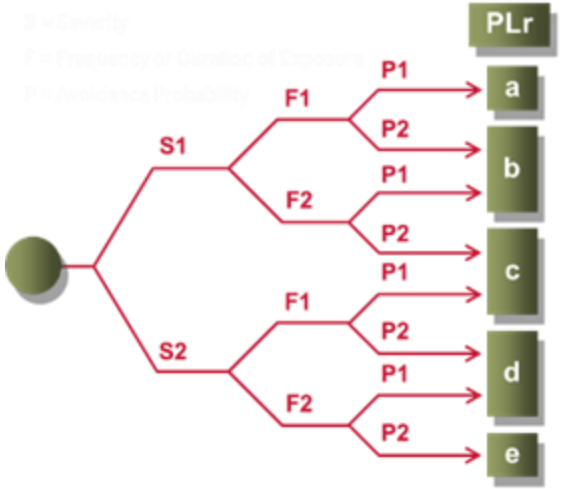
Step 1 Wrap-up: Risk assessment & Circuit Performance

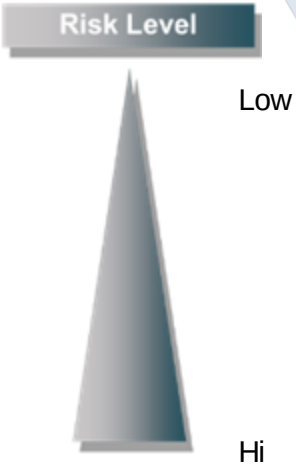
- **Determine the level of safety required**

Risk Assessment Process (ANSI B11.0 & ISO12100)



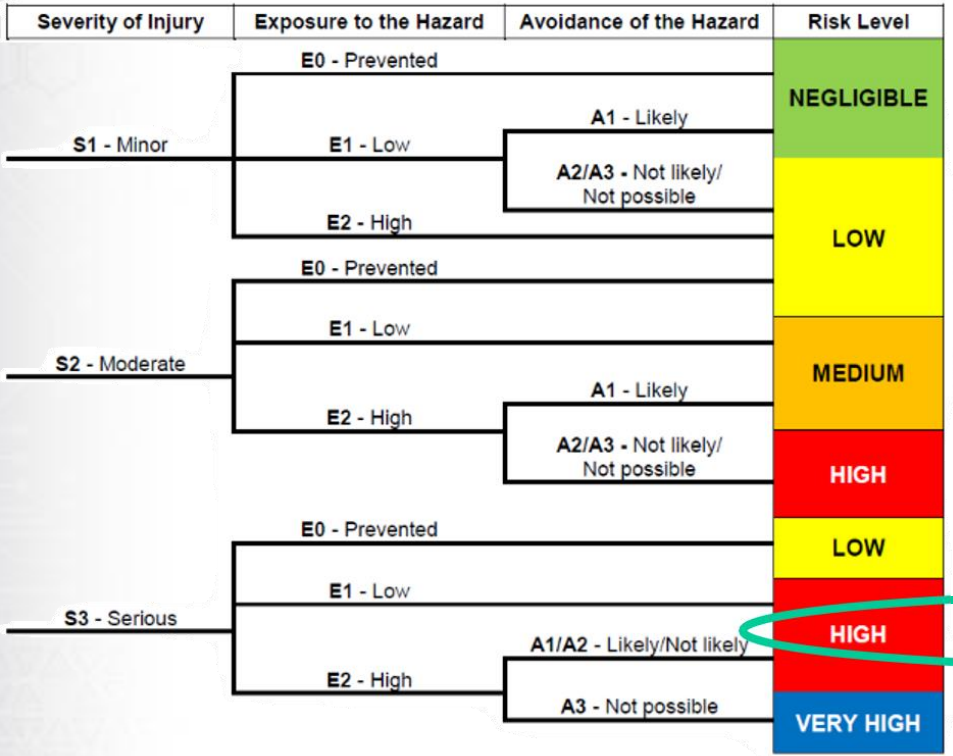
Choose appropriate circuit Performance Level ISO 13849-1 Annex A





S = Severity
F = Frequency or Duration of Exposure
P = Avoidance Probability

IF we use a circuit - Circuit Performance



TR R15.306:

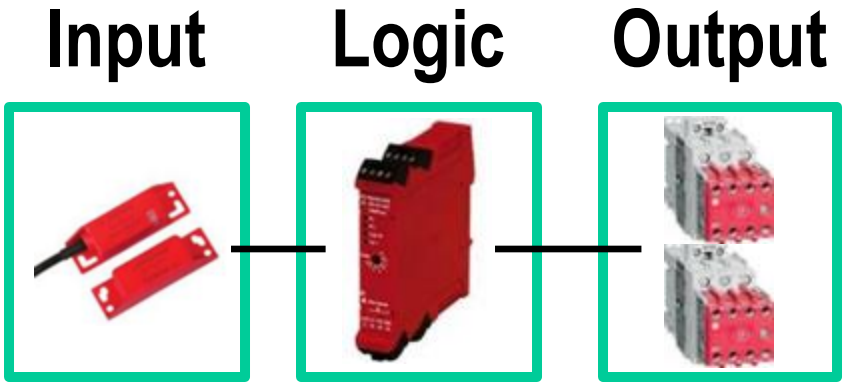
Comment: Ple "not typically applicable to robot system"

Risk Level	PL_r	Structure Category
NEGLIGIBLE (see 6.5.3.1)	b	-
LOW	c	2
MEDIUM	d	2
HIGH	d	3
VERY HIGH (see 6.5.3.2)	e	4

STEP 2: Safety Functional requirements specification

For each safety function, the characteristics (see Clause 5) and the required performance level shall be specified and documented in the safety requirements specification. (13849-1 4.2.2)

- **Safety Function - function of the machine whose failure can result in an immediate increase of the risk(s)**
- **System components include**
  - Input
  - Logic
  - Output



Examples of “Safety Function” Descriptions

Safety Function Requirements

When the E-stop button is pressed or the guard gate is opened, these actions stop hazardous motion by removing power to the motor. When the E-stop is released and the guard gate is closed, power to the motor and hazardous motion does not resume until the safety system is reset, and a secondary action (Start button is pressed and released) occurs. Faults at the E-stop, gate interlock switch, wiring terminals, or safety relay are detected before the next safety demand.

The PowerFlex 525 drive monitors itself for input, internal, and output faults. When the PowerFlex 525 drive detects a fault, it turns off its outputs and removes power to the motor. The fault must be corrected, and power to the drive cycled, before the drive can be restarted. Faults at the safe torque-off (STO) inputs on the PowerFlex 525 drive can go undetected.

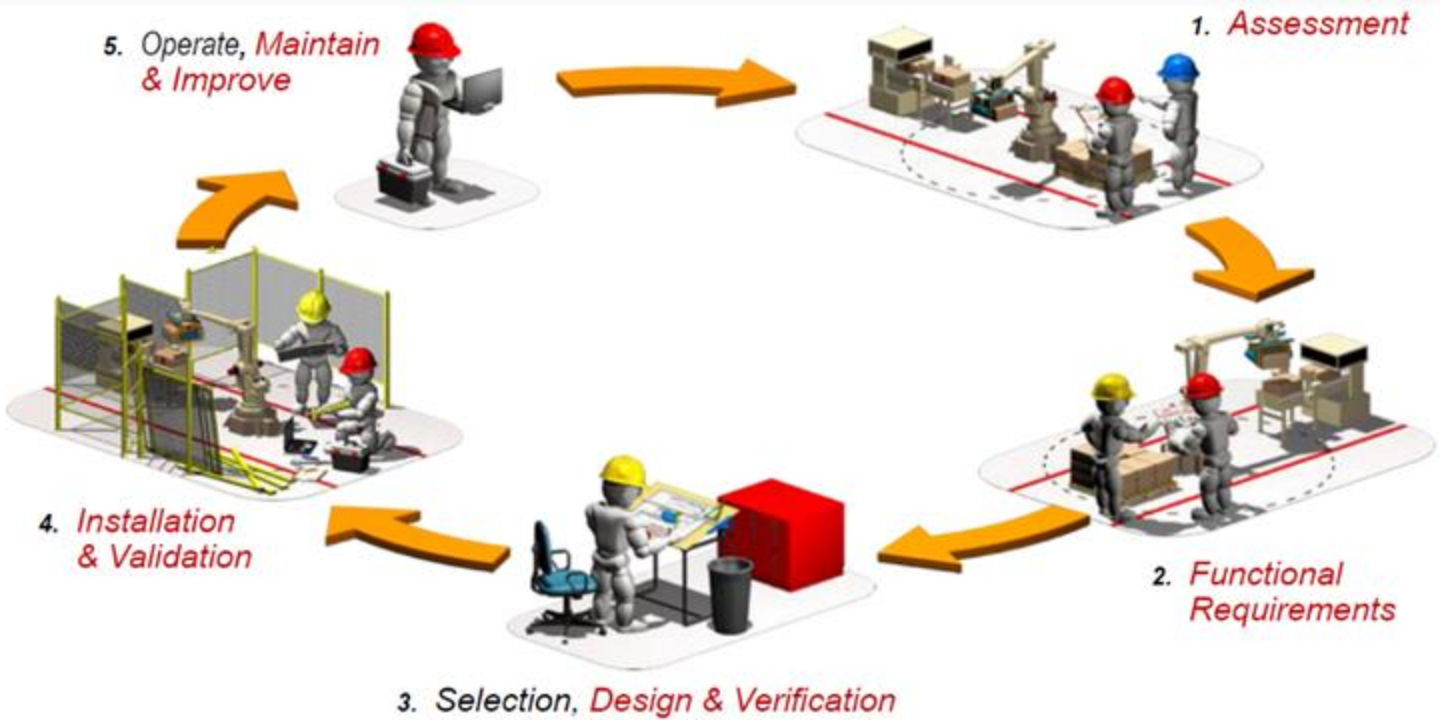
The safety functions in this application technique each meet or exceed the requirements for Category 3, Performance Level d (CAT. 3, PLd), per ISO 13849-1 and control reliable operation per ANSI B11.19.

Safety requirements specification (SRS)

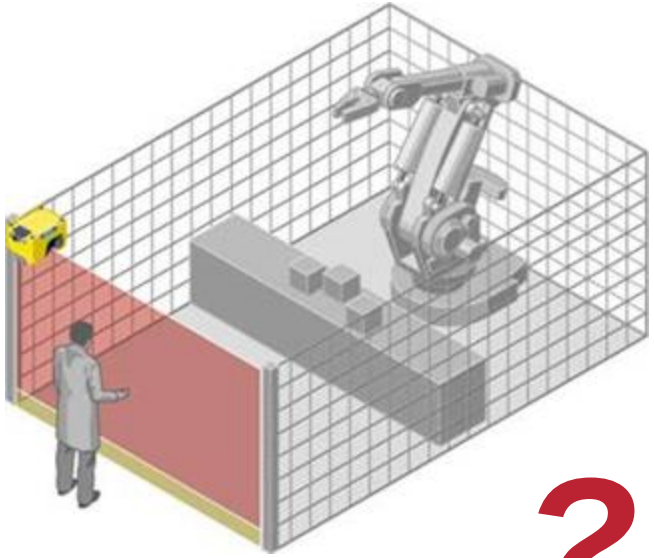
- **SRS describes the characteristics of the safety-related parts of a control system (SRP/CS)**
- **Needed for the design and technical realization of the control system**

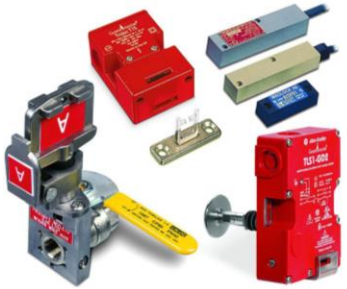
Item	Safety Control Function	Stop Category	Stop Time Required?	Performance Level Required			Potential Energy Sources?	Impacts Modes of Operation			
				Elect	Pneu	Hydr		Norm	Maint	Setup	Other
S3	SafeGuard Initiated Safety Stop - Zone	Cat 1	No	PLd	N/A	N/A	No	Yes	Yes	Yes	Yes
Applicable Safety Standards Include:	ISO 13849-1, ISO 13850, ISO 12100, ISO 60204-1										
Associated Safety Function:	Safety-related Stop Initiated by a Safeguard - Zone										
Input Safety Hardware:	Safety Locking Gate Switches										
Safety Logic Hardware:	GuardLogix Safety Controller GuardLogix Safety Partner ControlLogix EtherNet Bridge Module										
Output Safety Hardware:	1734 Safety Point IO Modules on EtherNet Safety Control Relays Safety VFD Drive - enable, safe off (Metering Drive) Locking Gate Switch Solenoids										
Additional Output Interfacing:	Door/Gate open/close status Door/Gate locked status										
Triggering Event:	Opening of interlocked safety gate										
Machine Stop Response:	Request to Enter pushbutton actuation is sensed by the Safety Controller Cycle stop initiated for each adjacent Machine After motion stops: Locking gate solenoid unlocks to grant access to cell between Huskers										
Safe State:	Motion in affected zone is stopped Safe-off VFD drive in safe state										
Additional Resources:	Multi-functional access box – Guardmaster 442G, EthernetIP, 2 pushbutton, unique coded (Qty 20) 442G-MABE1 Escape Release, Standard Shaft										
Notes:	Mechanical escape to be mounted on inside of door directly opposite of handle to allow for emergency escape if personnel were to be trapped inside of locked gate. Metal plates shall be mounted between gate handle and escape latch to prevent personnel from reaching through with object to open gate door without proper sequence of operation Padlock to be placed on gate door by each person entering cell to prevent door from closing and locking behind them										

STEP 3: Design the System & Verify Meeting Requirements



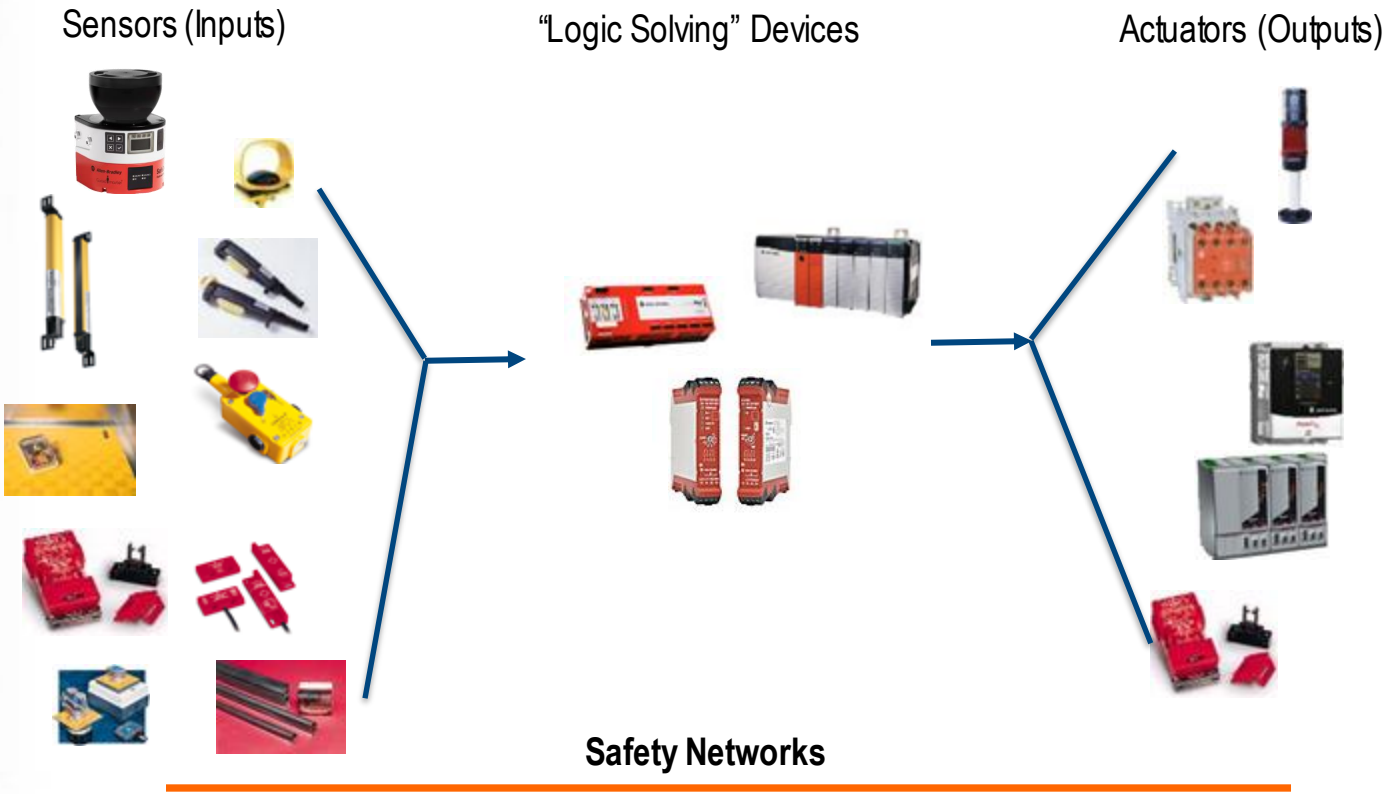
So, where do we start in order to achieve Functional Safety?





Rockwell Automation

SRP/CS: Safety-Related Parts of the Control System

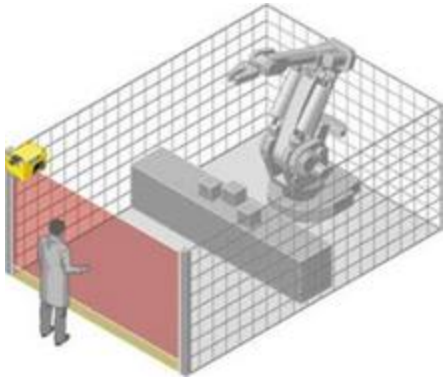


Functional Safety Design

- **IF** ***we're going to use Electrical/Electronic/Programmable Electronics/Pneumatics/Hydraulics as part of the Safety System to be implemented,***

- THEN *we need to <u>design</u>, <u>verify</u> & <u>validate</u> that system is adequate for the requirements*

  - HOW *do we do that???*



Functional Safety Design

Decide & Design appropriate levels of

- **Redundancy?**
- **Diagnostics & Monitoring?**
- **Component & System Reliability?**
- **Other System Design criteria?**

Functional Safety Design

Door / Gate Interlock Switch

Safety Monitoring Relay

Safety-Rated Motor Control

Safety Design Requirements

So, what are "categories" and how do they relate to "Performance Levels" ???

(& what about "SIL" ????)

Simple Category B Structure

6.2.3 Category B

The SRP/CS shall, as a minimum, be designed, constructed, selected, assembled and combined in accordance with the relevant standards and use basic safety principles for the specific application to withstand

— the expected operating stresses, e.g. the reliability with respect to breaking capacity and frequency,

— the influence of the processed material, e.g. detergents in a washing machine, and

— other relevant external influences, e.g. mechanical vibration, electromagnetic interference, power supply interruptions or disturbances.

There is no diagnostic coverage (DC_{avg} = none) within category B systems and the $MTTF_D$ of each channel can be low to medium. In such structures (normally single-channel systems), the consideration of CCF is not relevant.

The maximum PL achievable with category B is PL = b.

NOTE When a fault occurs it can lead to the loss of the safety function.

Simple Category B Structure

A simple circuit can use traditional control devices that are not safety rated. This is the lowest level of safety circuits.

Cat B requires "basic safety principles" See annexes of ISO 13849-2

Single Channel without Monitoring Category 1 Structure

6.2.4 Category 1

For category 1, the same requirements as those according to 6.2.3 for category B shall apply. In addition, the following applies.

SRP/CS of category 1 shall be designed and constructed using well-tried components and well-tried safety principles (see ISO 13849-2).

A "well-tried component" for a safety-related application is a component which has been either

a) widely used in the past with successful results in similar applications, or

b) made and verified using principles which demonstrate its suitability and reliability for safety-related applications.

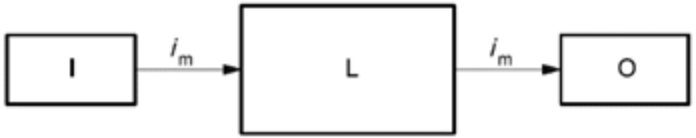
Newly developed components and safety principles may be considered as equivalent to "well-tried" if they fulfil the conditions of b).

The decision to accept a particular component as being "well-tried" depends on the application.

NOTE 1 Complex electronic components (e.g. PLC, microprocessor, application-specific integrated circuit) cannot be considered as equivalent to "well tried".

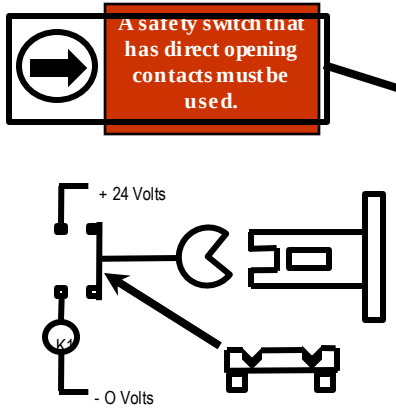
The $MTTF_D$ of each channel shall be high.

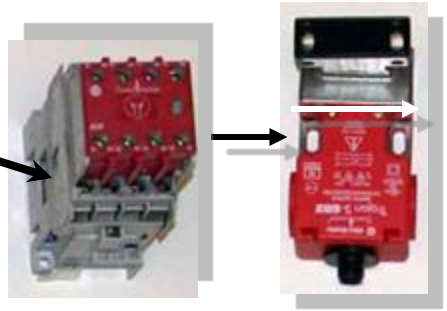
The maximum PL achievable with category 1 is PL = c.



Single Channel without Monitoring Category 1 Structure

A single channel safety circuit requires that we use well-tried safety components.





Since there is no monitoring a device with direct driven contacts must be used so that it will fail to a safe state!

Single Channel with Monitoring –

Category 2 Architecture

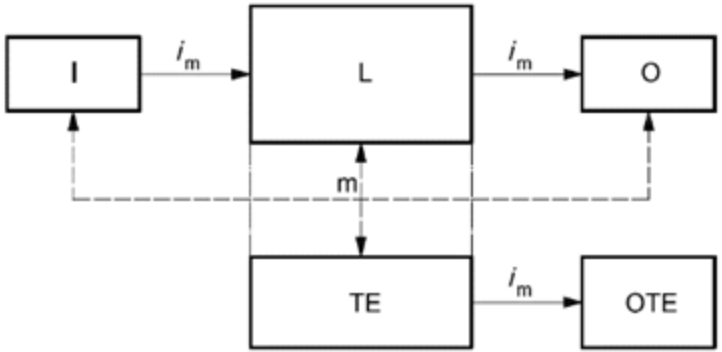
6.2.5 Category 2

For category 2, the same requirements as those according to 6.2.3 for category B shall apply. "Well-tried safety principles" according to 6.2.4 shall also be followed. In addition, the following applies.

SRP/CS of category 2 shall be designed so that their function(s) are checked at suitable intervals by the machine control system. The check of the safety function(s) shall be performed

— at the machine start-up, and

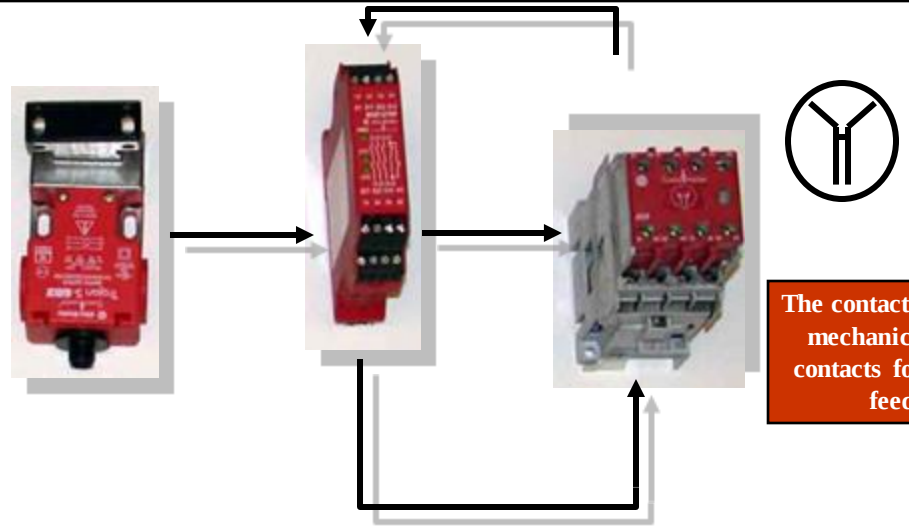
— prior to the initiation of any hazardous situation, e.g. start of a new cycle, start of other movements, immediately upon on demand of the safety function and/or periodically during operation if the risk assessment and the kind of operation shows that it is necessary.



Single Channel with Monitoring –

Category 2 Architecture

A single channel safety circuit with monitoring requires that we use well-tried safety components along with testing for faults.



The contactor must have mechanically linked contacts for diagnostic feedback.

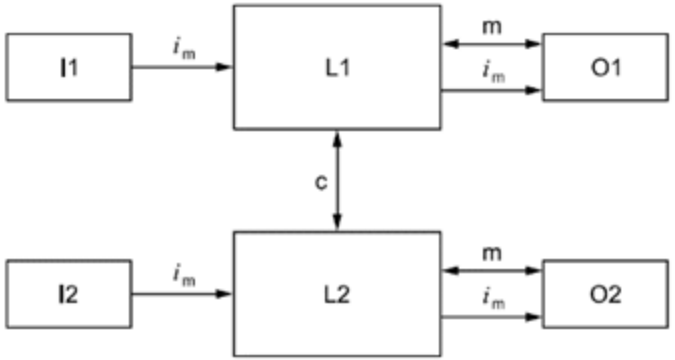
Dual Channel with diagnostics & testing –

Category 3 Architecture

6.2.6 Category 3

For category 3, the same requirements as those according to 6.2.3 for category B shall apply. "Well-tried safety principles" according to 6.2.4 shall also be followed. In addition, the following applies.

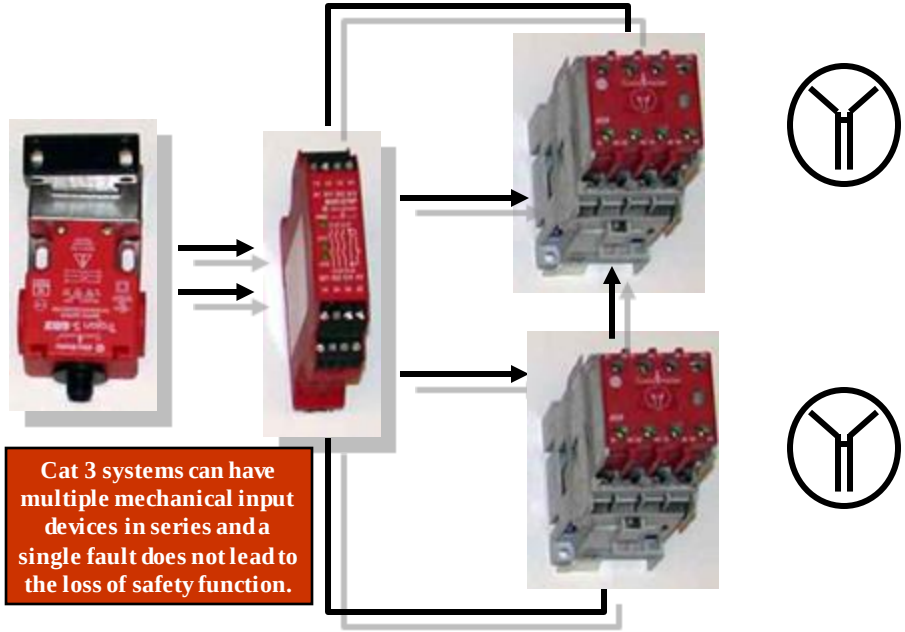
SRP/CS of category 3 shall be designed so that a single fault in any of these parts does not lead to the loss of the safety function. Whenever reasonably practicable, the single fault shall be detected at or before the next demand upon the safety function.



Dual Channel with diagnostics & testing –

Category 3 Architecture

Using mechanical contractors.



Dual Channel with Continuous Diagnostics – Category 4 Architecture

6.2.7 Category 4

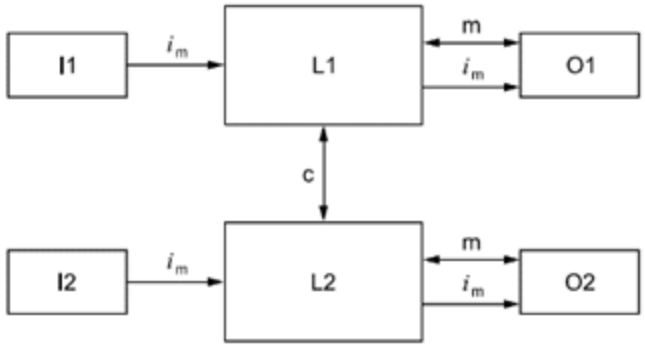
For category 4, the same requirements as those according to 6.2.3 for category B shall apply. "Well-tried safety principles" according to 6.2.4 shall also be followed. In addition, the following applies.

SRP/CS of category 4 shall be designed such that

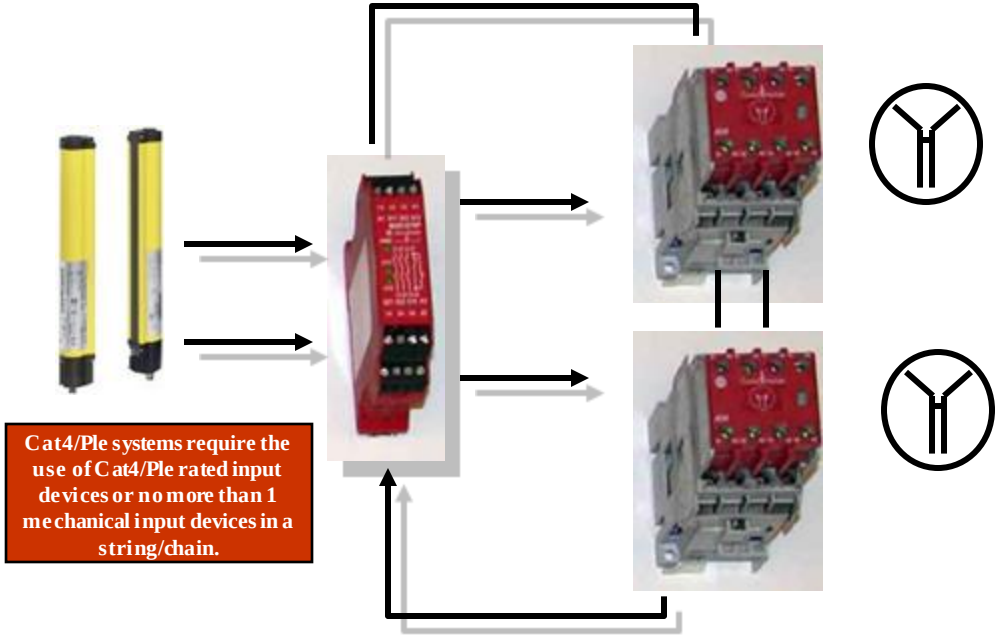
— a single fault in any of these safety-related parts does not lead to a loss of the safety function, and

— the single fault is detected at or before the next demand upon the safety functions, e.g. immediately, at switch on, or at end of a machine operating cycle,

but if this detection is not possible, then an accumulation of undetected faults shall not lead to the loss of the safety function.



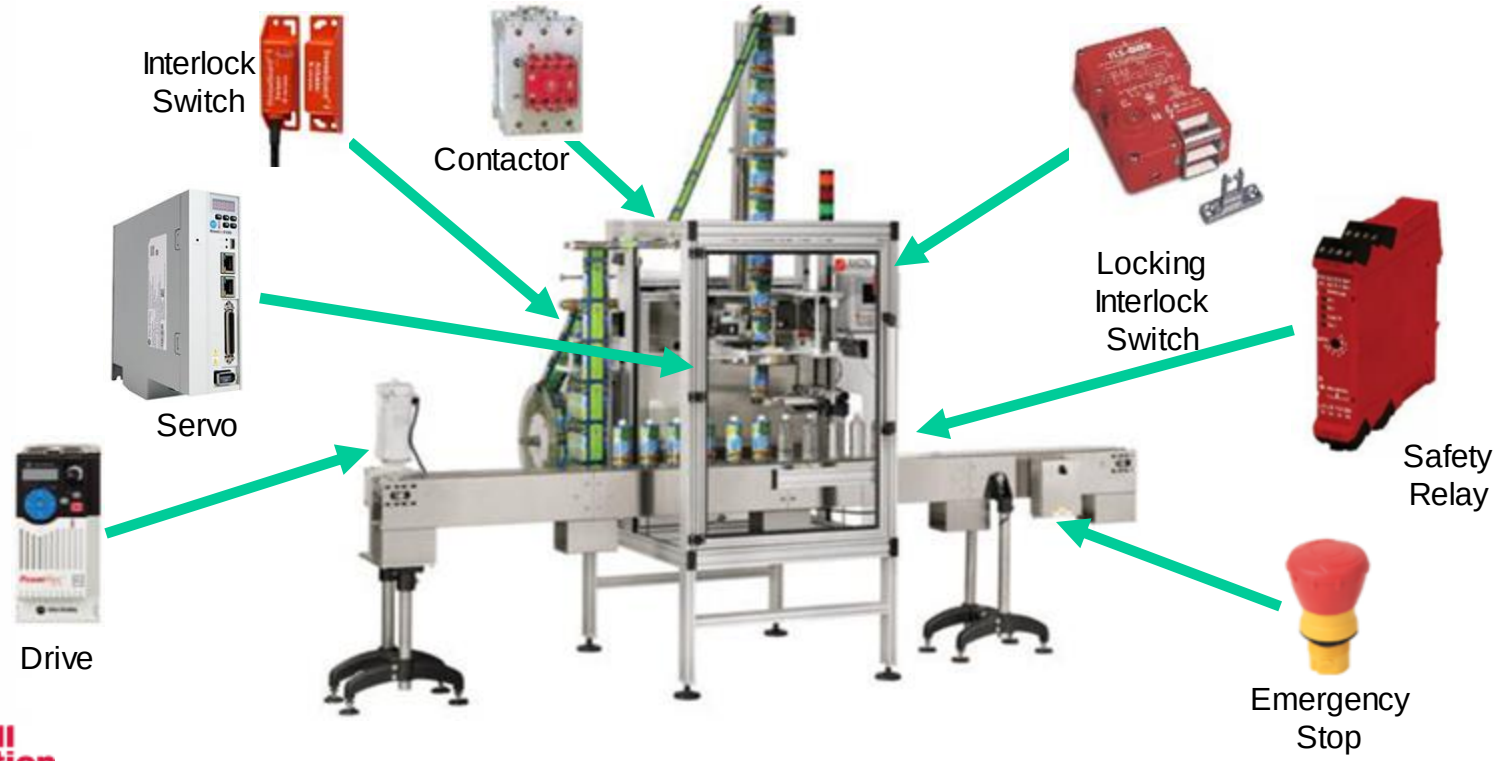
Dual Channel with Continuous Diagnostics – Category 4 Architecture



Cat4/Ple systems require the use of Cat4/Ple rated input devices or no more than 1 mechanical input devices in a string/chain.

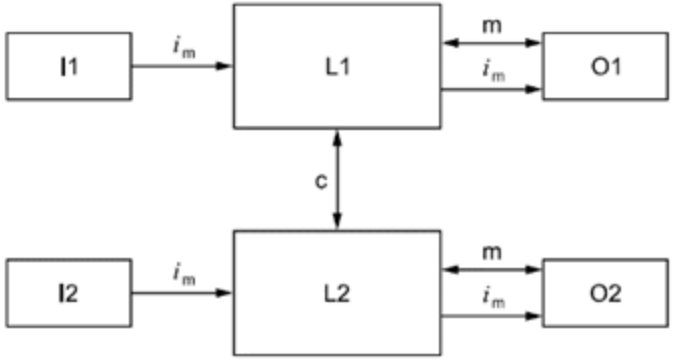
Selection, design, and verification

- Specify bill of material for each safety function control system safety devices



Design to, and verify, Performance Level (PL)

- **PL is based on combination of**
  - Category (Architecture)
  - MTTFd
  - Diagnostic Coverage
  - Common Cause Failures (CCF)



$$MTTF_D = 2/3\left[MTTF_D(ch1) + MTTF_D(ch2) - \frac{1}{\frac{1}{MTTF_D(ch1)} + \frac{1}{MTTF_D(ch2)}}\right]$$

$$DCavg = \frac{\frac{DC1}{MTTFd1} + \frac{DC2}{MTTFd2} + \cdots + \frac{DCN}{MTTFdN}}{\frac{1}{MTTFd1} + \frac{1}{MTTFd2} + \cdots + \frac{1}{MTTFdN}}$$

Table F.1 — Scoring process and quantification of measures against CCF

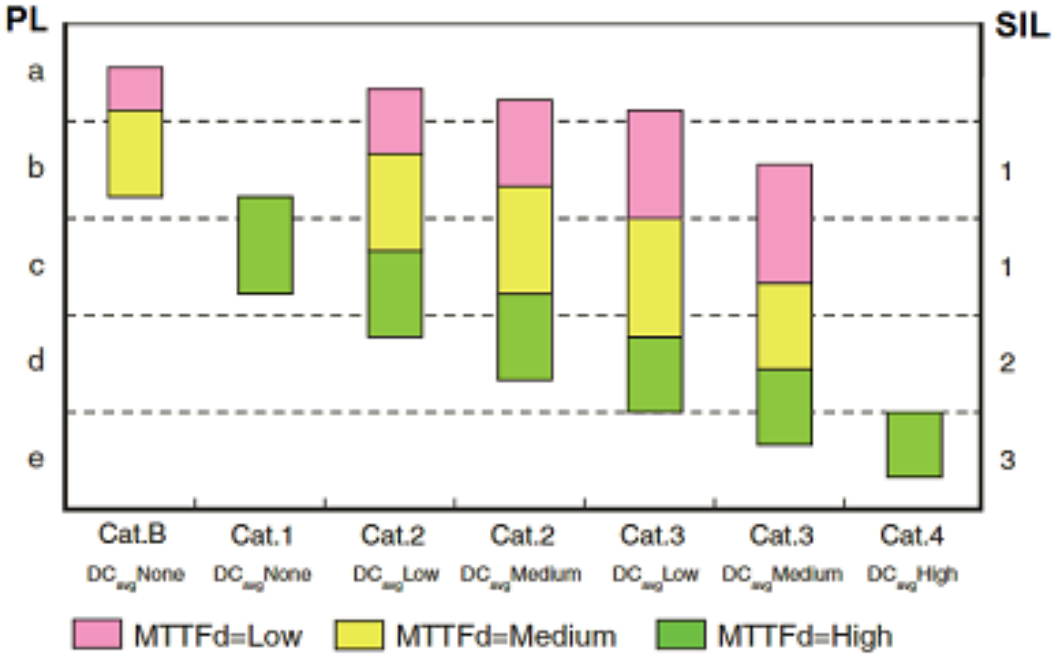
No.	Measure against CCF	Score
1	**Separation/ Segregation**	
	Physical separation between signal paths: separation in wiring/piping, sufficient clearances and creep age distances on printed-circuit boards.	15
2	**Diversity**	
	Different technologies/design or physical principles are used, for example: first channel programmable electronic and second channel hardwired, kind of initiation, pressure and temperature, Measuring of distance and pressure, digital and analog, Components of different manufactures.	20
3	**Design/application/experience**	
3.1	Protection against over-voltage, over-pressure, over-current, etc.	15
3.2	Components used are well-tried.	5
4	**Assessment/analysis**	
	Are the results of a failure mode and effect analysis taken into account to avoid common-cause-failures in design.	5
5	**Competence/training**	
	Have designers/ maintainers been trained to understand the causes and consequences of common cause failures?	5
6	**Environmental**	
6.1	Prevention of contamination and electromagnetic compatibility (EMC) against CCF in accordance with appropriate standards. Fluidic systems: filtration of the pressure medium, prevention of dirt intake, drainage of compressed air, e.g. in compliance with the component manufacturers' requirements concerning purity of the pressure medium. Electric systems: Has the system been checked for electromagnetic immunity, e.g. as specified in relevant standards against CCF? For combined fluidic and electric systems, both aspects should be considered.	25
6.2	Other influences Have the requirements for immunity to all relevant environmental influences such as, temperature, shock, vibration, humidity (e.g. as specified in relevant standards) bee considered?	10
	Total	[max. achievable 100]

Total score	Measures for avoiding CCF[a]
65 or better	Meets the requirements
Less than 65	Process failed ⇨ choose additional measures

[a] Where technological measures are not relevant, points attached to this column can be considered in the comprehensive calculation.

Design to, and verify, Performance Level (PL)

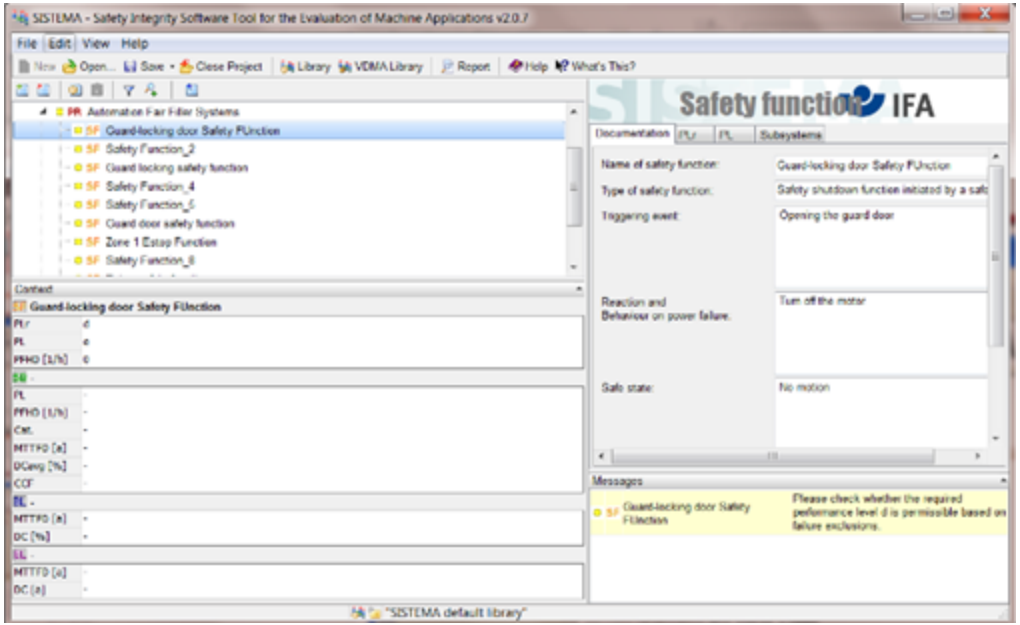
- **PL is based on combination of**
  - Category (Architecture)
  - MTTFd
  - Diagnostic Coverage
  - Common Cause Failures (CCF)



SISTEMA

Safety Integrity Software Tool for the Evaluation of Machine Applications

- **Free software tool, and libraries of component's data**
- **A Tool to help streamline Application of the Control Standard EN ISO 13849-1**



SISTEMA – Produces verification and detailed reporting

SISTEMA - Safety Integrity Software Tool for the Evaluation of Machine

Project name: Automation Fair Filler Systems

File date: 18/02/2020 06:08:06 Report date: 2/18/2020 Checksum: d256f25761b3b9b024dfa85f417ad6ff

Project name: Automation Fair Filler Systems

Project file name:	C:\Program Files (x86)\PST\SafetyAutomationBuilder\RASWin\1 Automation Fair Filler Systems.sem
Creation date:	-
Project status:	
Project number:	
Project version:	
Authors:	BCBomber
Project managers:	
Inspectors:	
Dangerous point/machine:	NAUSRICTQBRXF2
Documentation:	
Document:	
Version of software:	2.0.7 build 2
Version of standard:	ISO 13849-1:2015, ISO 13849-2:2012
Checksum:	d256f25761b3b9b024dfa85f417ad6ff
Options:	☑ Use DC intermediate levels for calculation of PFHD (more precise) ☐ MTTFD capping for category 4 lower from 2500 to 100 years
Status:	yellow
Note:	There are warnings with yellow status listed for this project (or it's subordinate basic elements). Please consider these hints.

Print options

☑ Show device details
☑ Show documentations on SF, SB, BL and EL
☑ Show CCF and DC measures in detail
☑ Show requirements on PL and Category
☑ Show parameter documentations on PLr, PL, Category, CCF, MTTFD and DC
☑ Show messages

Contained safety functions

SF Name: Guard-lockingdoorSafetyFUnction — Required: PLr d — Reached: PL e — PFHD [1/h]: 0 — Status: yellow
SF Name: SafetyFunction_2 — Required: PLr d — Reached: PL e — PFHD [1/h]: 0 — Status: yellow
SF Name: Guardlockingsafetyfunction — Required: PLr d — Reached: PL e — PFHD [1/h]: 0 — Status: yellow
SF Name: SafetyFunction_4 — Required: PLr d — Reached: PL e — PFHD [1/h]: 0 — Status: yellow
SF Name: SafetyFunction_5 — Required: PLr d — Reached: PL e — PFHD [1/h]: 0 — Status: yellow
SF Name: Guarddoorsafetyfunction — Required: PLr d — Reached: PL e — PFHD [1/h]: 0 — Status: yellow

SISTEMA a free of charge tool from IFA — Page 1 / 12

SISTEMA - Safety Integrity Software Tool for the Evaluation of Machine

Project name: Automation Fair Filler Systems

File date: 18/02/2020 06:08:06 Report date: 2/18/2020 Checksum: d256f25761b3b9b024dfa85f417ad6ff

SF Safety function: Guard locking safety function

Safety function type:	Safety shutdown function initiated by a safeguard
Triggering event:	Openign the safety door
Reaction and Behaviour on power failure:	Turn off the motor
Safe state:	no motion
Operation mode:	
Demand rate:	
Running-on time:	
Priority:	
Documentation:	
Document:	

Required Performance Level Safety function

PLr (by direct input):	d
Documentation:	
Document:	
Source (e.g. standard):	
File:	

Performance Level Safety function

Reached PL: e — PFHD [1/h]: 0

Status / Messages Safety function

Status:	yellow
Message [Status of Message]:	- Please check whether the required performance level d is permissible based on failure exclusions. [yellow]

STEP 4: Installation & Validation

Does my safety system work as specified?

Abnormal Operation Verification - The GuardLogix safety system properly responds to all foreseeable faults with corresponding diagnostics. E-Stop Input Tests			
Test Step	Validation	Pass/Fail	Changes/Modifications
1	While Running, remove the Channel 1 wire from the Safety I/O. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication. Restore Channel 1 and repeat for Channel 2.		
2	While Running, short the Channel 1 of the Safety I/O to +24VDC. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication. Verify unable to reset and restart with fault. Restore Channel 1 and repeat for Channel 2.		
3	While Running, short the Channel 1 of the Safety I/O to (-) 0VDC. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication Restore Channel 1 and repeat for Channel 2.		
4	While Running, short the Channels 1 & 2 of the Safety I/O. Both contactors should de-energize. Verify proper machine status indication and RSLogix 5000 safety application program indication. Restore Channel 1 & 2 wiring.		

Validation:

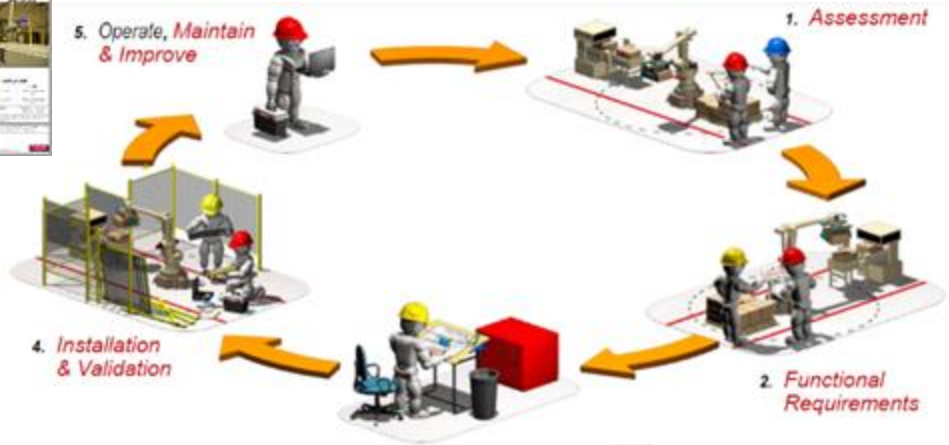
- Specific instructions regarding the validation of each safety function
  - Normal operation test:
    - safety input, logic, output
  - Abnormal operation test
    - Shorting wires, breaking connections, removing wires, etc.

ISO 13849-2 Part 2: Validation

Validation – Safe Response to Faults

SensaGuard Input Tests			
Test Step	**Validation**	**Pass/Fail**	**Changes/Modifications**
1	While the system continues to run, remove the SensaGuard channel 1 wire from the safety I/O. Both contactors de-energize. Verify proper machine status indication and safety application program indication. Restore channel 1 and repeat for channel 2.		
2	While the system continues to run, short the SensaGuard channel 1 wire of the safety I/O to 24V DC. Both contactors de-energize. Verify proper machine status indication and safety application program indication. Restore channel 1 and repeat for channel 2.		
3	While the system continues to run, short the SensaGuard channel 1 wire of the safety I/O to 0V DC. Both contactors de-energize. Verify proper machine status indication and safety application program indication. Restore channel 1 and repeat for channel 2.		
4	While the system continues to run, short SensaGuard channels 1 and 2 of the safety I/O. Both contactors de-energize. Verify proper machine status		

Introducing some Machine safety lifecycle tools



Proposal Works

SISTEMA

Safety Automation Builder

Rockwell Automation

Safety Functions Documents – Example Application Techniques

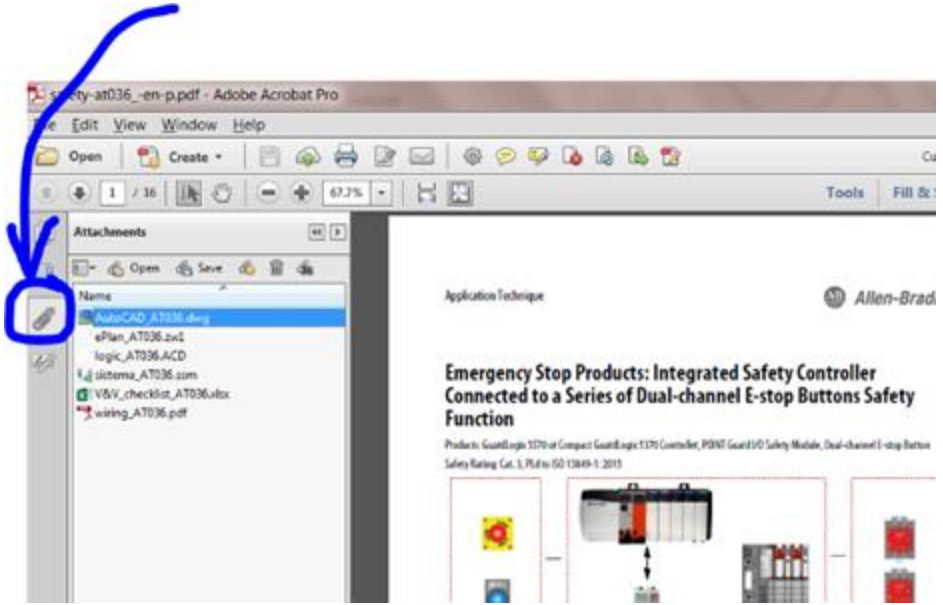
- Well over 100 examples
- BOM, Wiring, Configuration/Programming
- Verification & Validation
- Some now have .DXF, .ACD, other files attached

Click or Scan:

Link here: www.machinesafetysolutions.com

Safety Functions Documents – Example Application Techniques

- Many now have attachments
- In Adobe, click the *paperclip icon*
  - AutoCad & ePlan files
  - .ACD file for Logix
  - SISTEMA File
  - Verification & Validation checklists



Click or Scan:

Link here: www.machinesafetysolutions.com

www.machinesafetysolutions.com

- Whitepapers
- Videos
- Blog topics
- Application Examples
- Engineering Resources
- Self Maturity Self-Assessment tools
- Smart Safety Devices & Systems
- Software tools
- And more … !

Questions?

Rockwell Automation

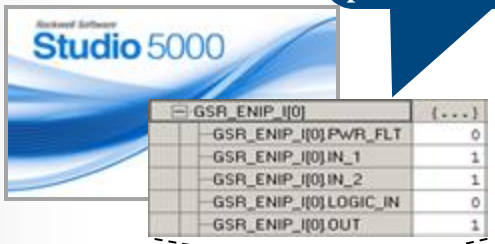
GuardLink and GuardMaster Ethernet Safety Diagnostics

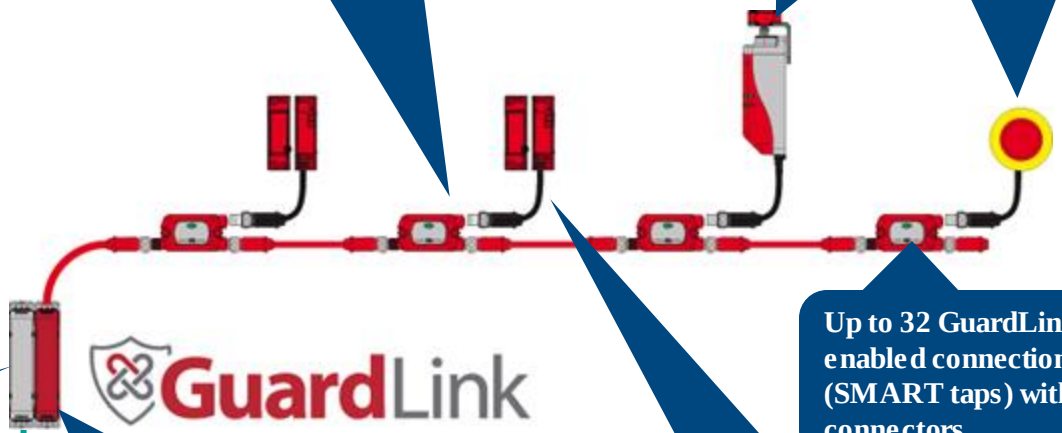
GuardLink Overview

Add-on Profile in Studio 5000 Logix Designer® to seamlessly integrate with Logix5000™ controller platform

Up to 1000 m link distance, max 90 m between devices and 30 m from the tap to the device

Generic safety devices– electromechanical contacts (EMSS) and with solid state output (OSSD)





Up to 32 GuardLink enabled connection taps (SMART taps) with M12 connectors

440R-ENETR EtherNet/IP™ interface to share diagnostics over network

Guardmaster® Dual GuardLink (DG) safety relay – GuardLink-enabled safety relay supporting two links

PLe / SIL3

Functional Safety Type Approved TÜVRheinland FS

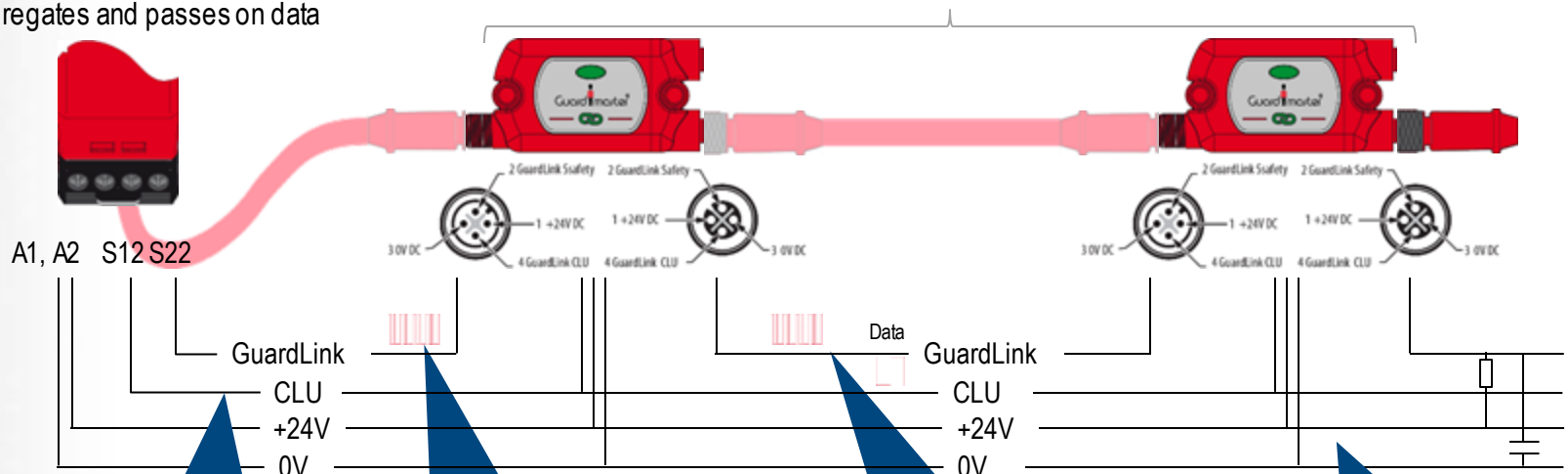
Trunk and drop topology with standard four (trunk) or five/ eight (drop)-wire conductor patch cords

GuardLink Technology Overview

GuardLink master
Manages GuardLink comms.
Executes the safety function
Aggregates and passes on data

GuardLink slave
Monitors safeguarding device
Creates and repeats safety pattern

GuardLink Terminator
Terminates open wires
Determines last device on Link



CLU – Command, Lock and Unlock
Connection to manage operation modes and initiate lock/unlock

Unique safety pattern to achieve PLe/CL SIL3

Safety or diagnostics on the same single wire

Distribution of 24V across GuardLink devices - Same 0V reference required for master and slaves

GuardLink Voltage Drop Calculator

- **Allows you to build your GuardLink system and calculate whether the system will need additional power from a GuardLink Passive Power Tap (440S-PF5D4)**
  - To calculate the voltage drop of the next segment after the Power Tap, you will need to fill out another Voltage Drop Calculator spreadsheet

Allen-Bradley Guardmaster GuardLink

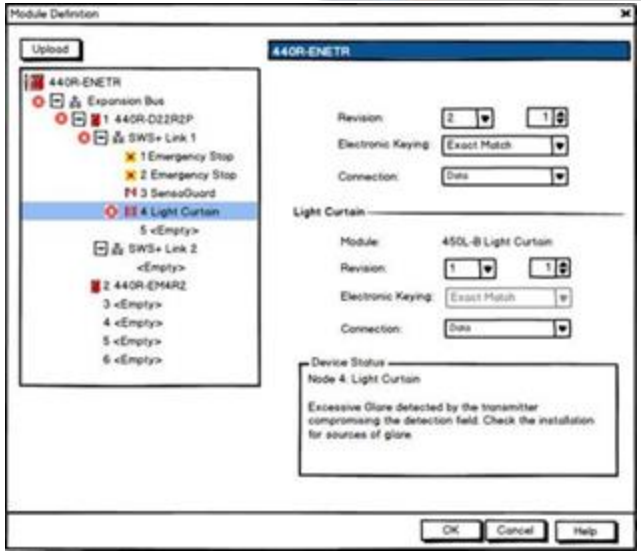
Supply Voltage (20.4 to 26.4)	24	V
Link Cable Wire Gauge	18 (0.823)	AWG (mm^2)
Link Wire Resistance	0.02095	ohms/m

Tap	Link Cable Length (m)	Safety Device	User Defined Device Current (mA)	Tap + Device Current (mA)	Total Current (mA)	Voltage level @ Tap
1	5	SensaGuard Series B		67	616	23.84
2	5	SensaGuard Series B		67	549	23.69
3	5	SensaGuard Series B		67	482	23.56
4	5	SensaGuard Series B		67	415	23.45
5	2	800F E-stop		40	348	23.40
6	5	SensaGuard Series B		67	308	23.32
7	5	SensaGuard Series B		67	241	23.26
8	5	SensaGuard Series B		67	174	23.21
9	5	SensaGuard Series B		67	107	23.18
10	2	800F E-stop		40	40	23.18
11				0	0	NA
12				0	0	NA

GuardLink and Guardmaster Integration

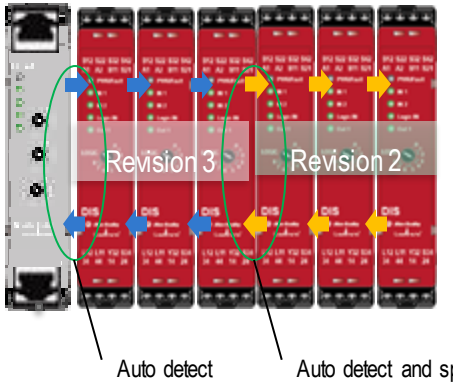
- **Easy integration within Studio 5000® v20 and newer**
- **Single software required for product configuration**
- **Tags are automatically populated in the controller**
- **Tags when using the AOP, allowing for easy integration into Studio 5000™ program**

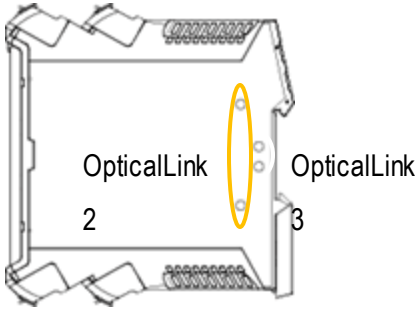
Name	Value	Style	Data Type
ENETR_IP120:I.Relay1_GSR_DG	{...}		AB:GSR_DG:I:0
ENETR_IP120:I.Relay1_GSR_DG.SafetyInput01	1	Decimal	BOOL
ENETR_IP120:I.Relay1_GSR_DG.SafetyInput02	0	Decimal	BOOL
ENETR_IP120:I.Relay1_GSR_DG.PtS12	1	Decimal	BOOL
ENETR_IP120:I.Relay1_GSR_DG.PtS22	0	Decimal	BOOL
ENETR_IP120:I.Relay1_GSR_DG.PtS32	0	Decimal	BOOL
ENETR_IP120:I.Relay1_GSR_DG.PtS42	0	Decimal	BOOL
ENETR_IP120:I.Relay1_GSR_DG.PtS11	0	Decimal	BOOL
ENETR_IP120:I.Relay1_GSR_DG.PtS21	0	Decimal	BOOL
ENETR_IP120:I.Relay1_GSR_DG.PtX2	0	Decimal	BOOL



Optical Link Compatibility

- **440R-ENETR series B supports both Optical Link 2.0 and Optical Link 3.0**
- **Optical Link is a communication protocol based on a non-contact infrared interface and a protocol similar to Modbus**
- **Optical Link is used to communicate across up to six Guardmaster® Safety Relays (GSR) and gather data by a gateway to share this with superior control**
- **Optical Link is designed for auto-addressing – No configuration required**
- **GSR with Optical Link 3.0 will allow a pass-through of data over Optical Link 2.0 to allow combination of multiple GSR variants**
- **Required to group GSR modules with Optical Link 3.0 modules next to the 440R-ENETR module and Optical Link after them to them to the right**





	Optical Link 2.0	Optical Link 3.0
Connectivity	2 hole discrete IR circuits	1 hole IR transceiver
Baud rate	9600 bps	115200 bps

GuardLink and GuardMaster

Live Demonstration

Questions?

break

Start Again 9:15 AM

CIP Safety and Integrated safety Explanation

General Discussion of Networked Safety

Motivation for Networked Safety

- Increased Flexibility
- Reduced Cost
- Improved maintainability
- Increased physical distances
- Ease of use and implementation
- Simplicity
- Reduced Wiring
- Improved Visualization
- Networks are standard for everything else

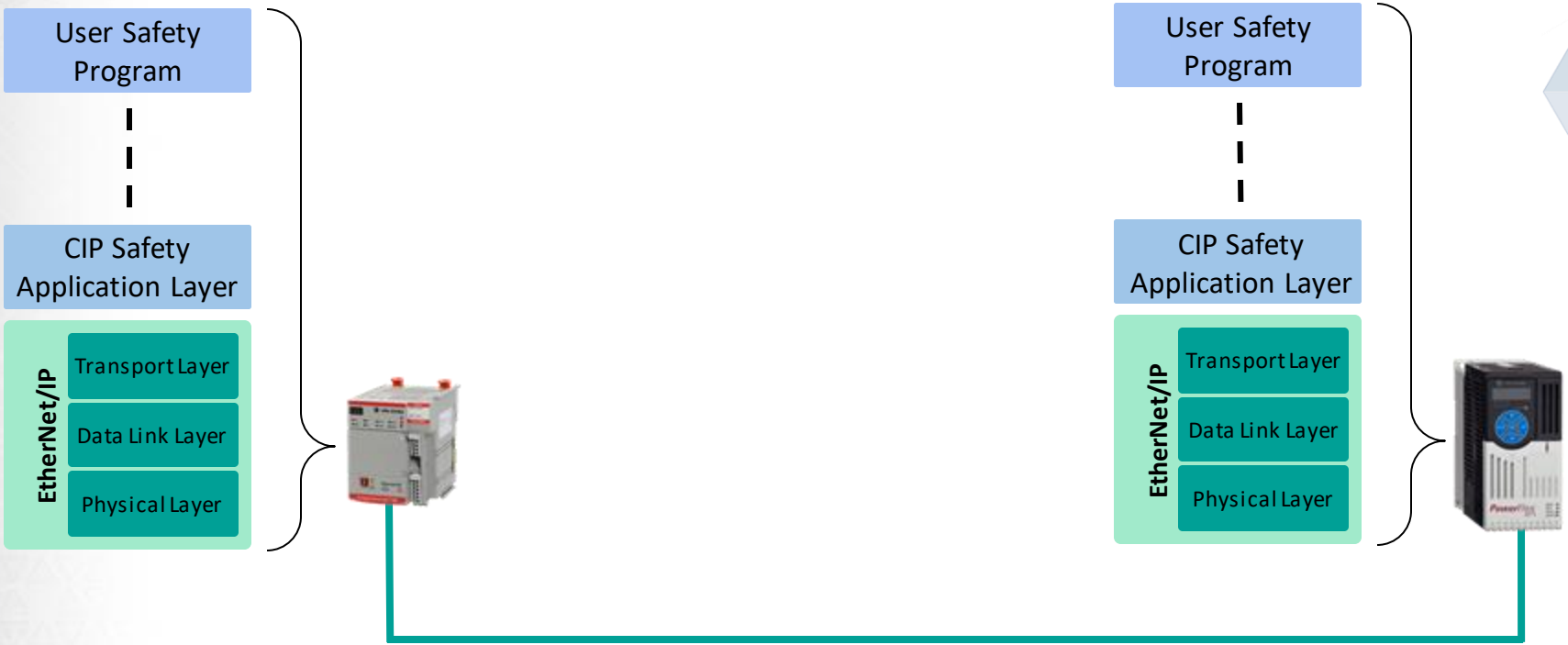
Concerns with Networked Safety

- Network Reliability
- Safety Data Integrity
- Unacceptable Delay
- Corruption
- Unintended repetition
- Incorrect sequence
- Loss
- Unacceptable delay
- Insertion
- Masquerade
- Addressing

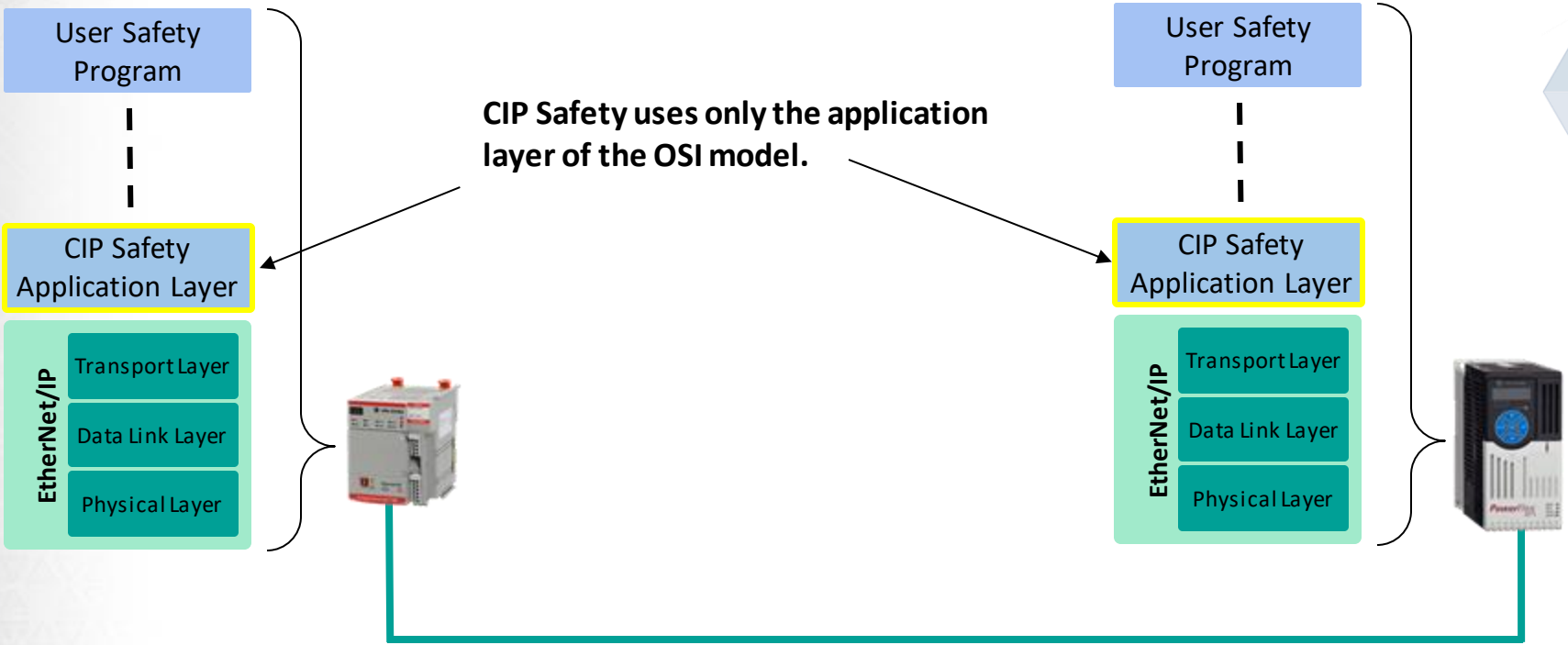
ODVAs CIP Safety Protocol

ODVA is a standards development organization and membership association whose members comprise the world's leading industrial automation companies. ODVA works to advance open, interoperable information and communication technologies in industrial automation.

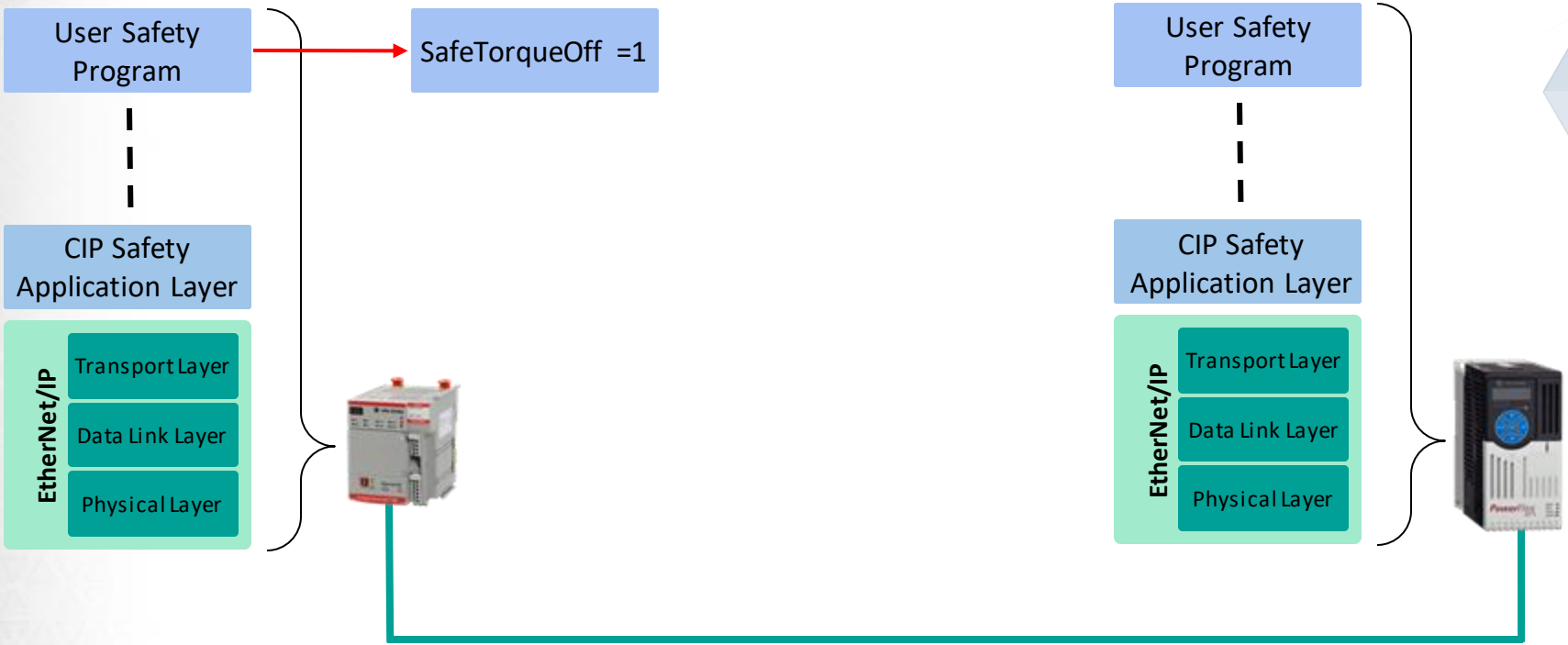
How does it work and how is it safe?



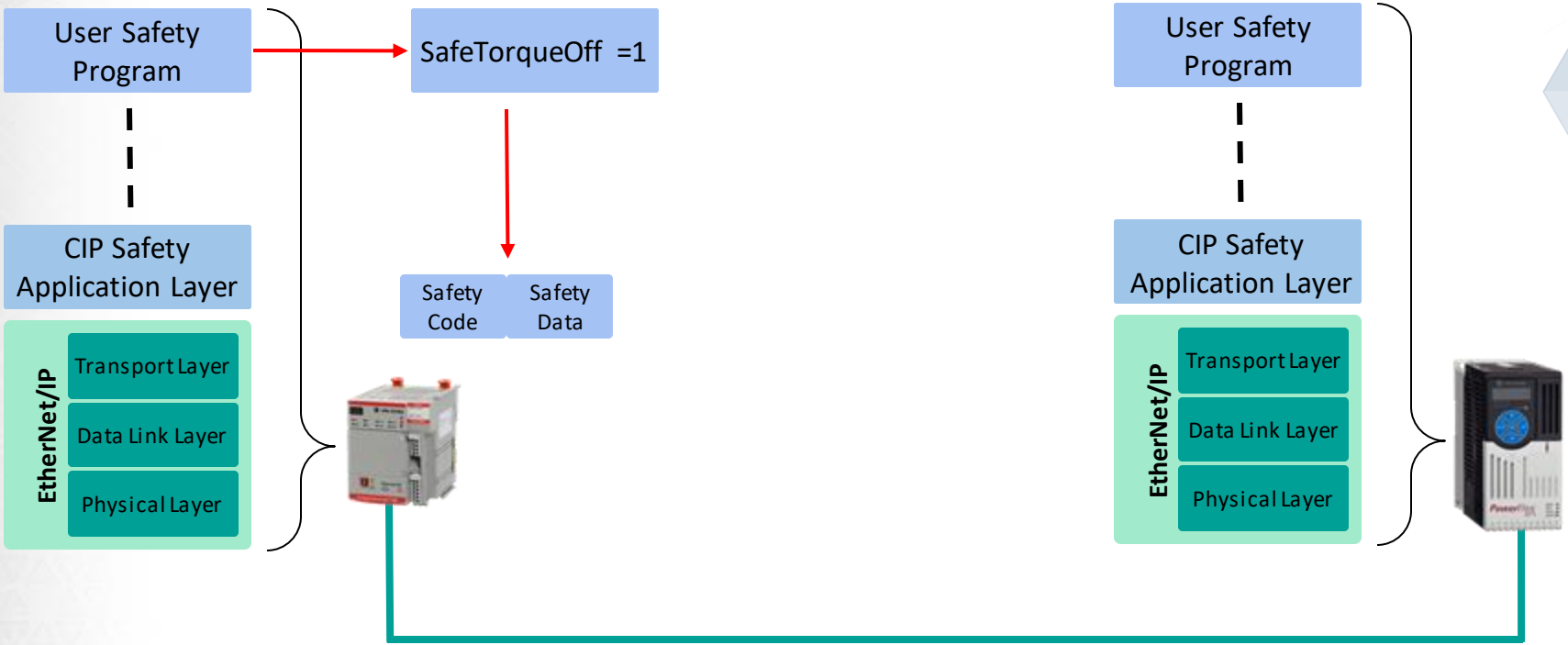
Safety Layer in the CIP (Common Industrial Protocol)



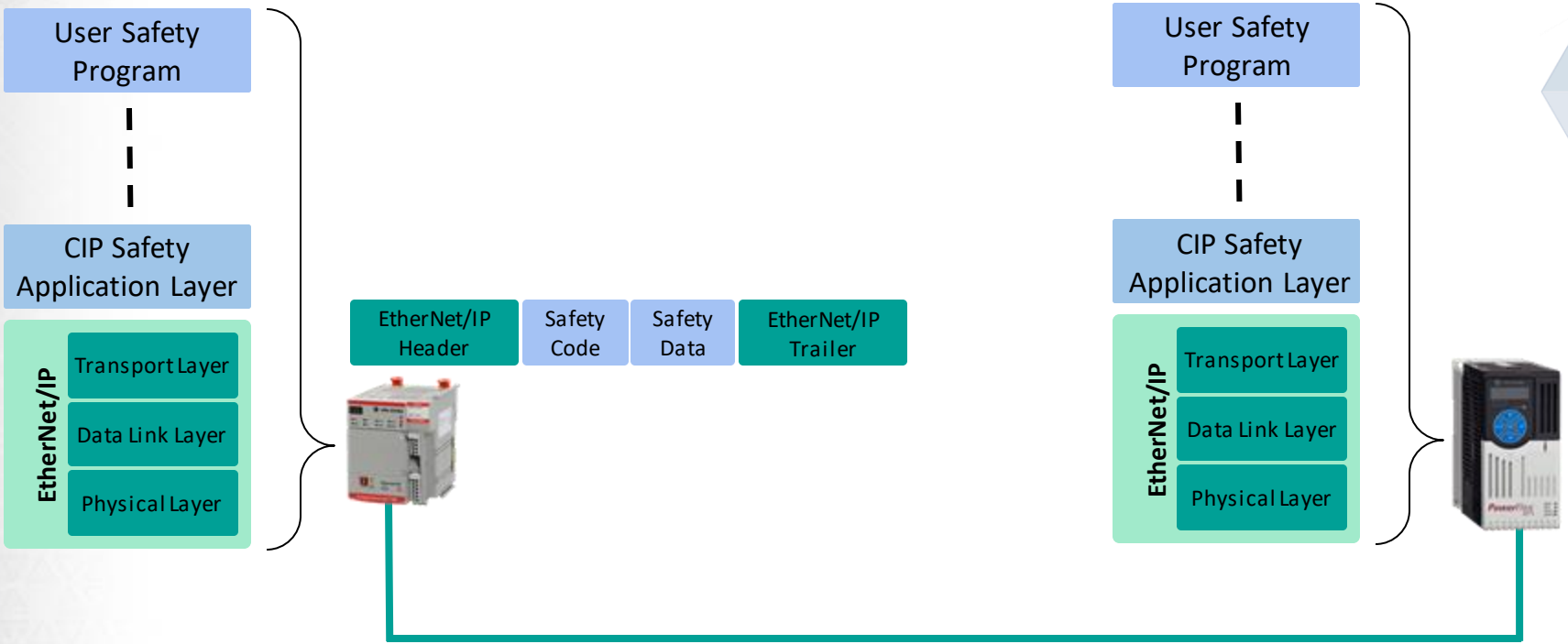
CIP Safety Information Transmission



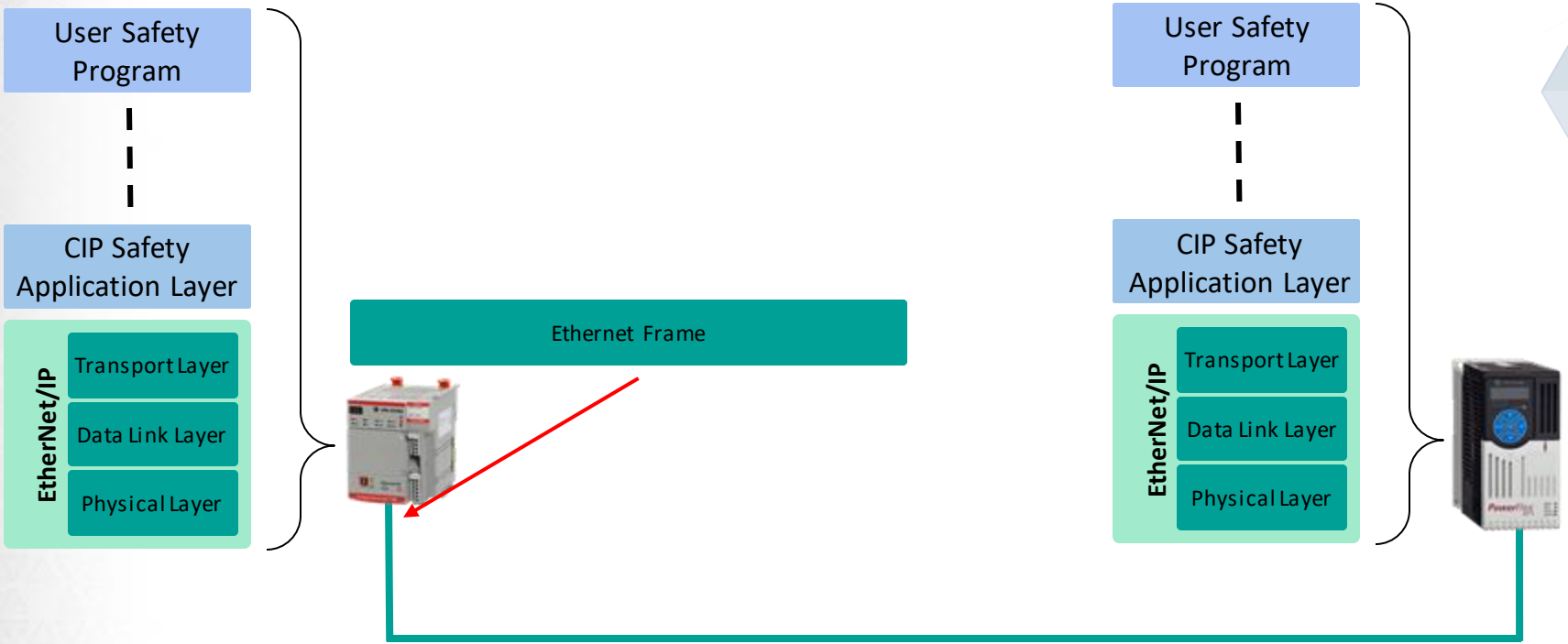
CIP Safety Information Transmission



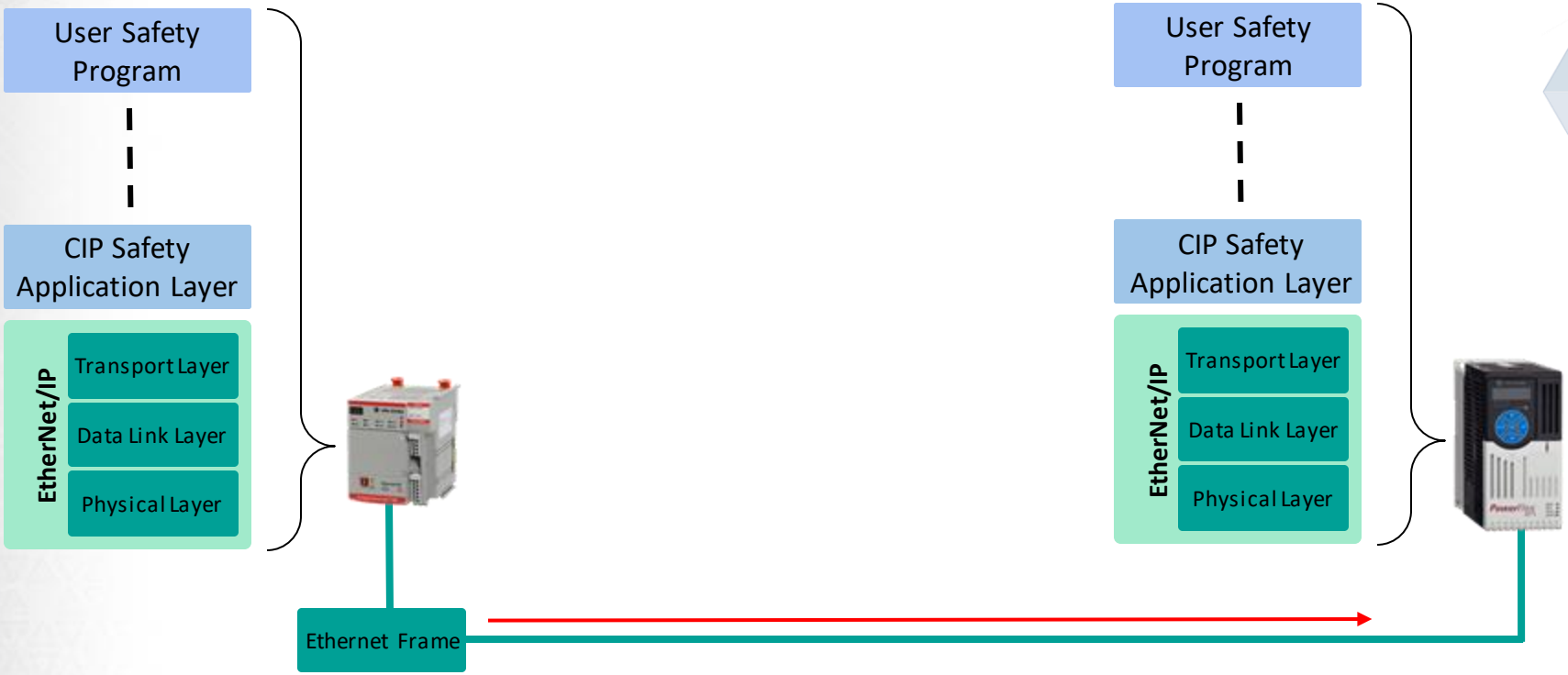
CIP Safety Information Transmission



CIP Safety Information Transmission

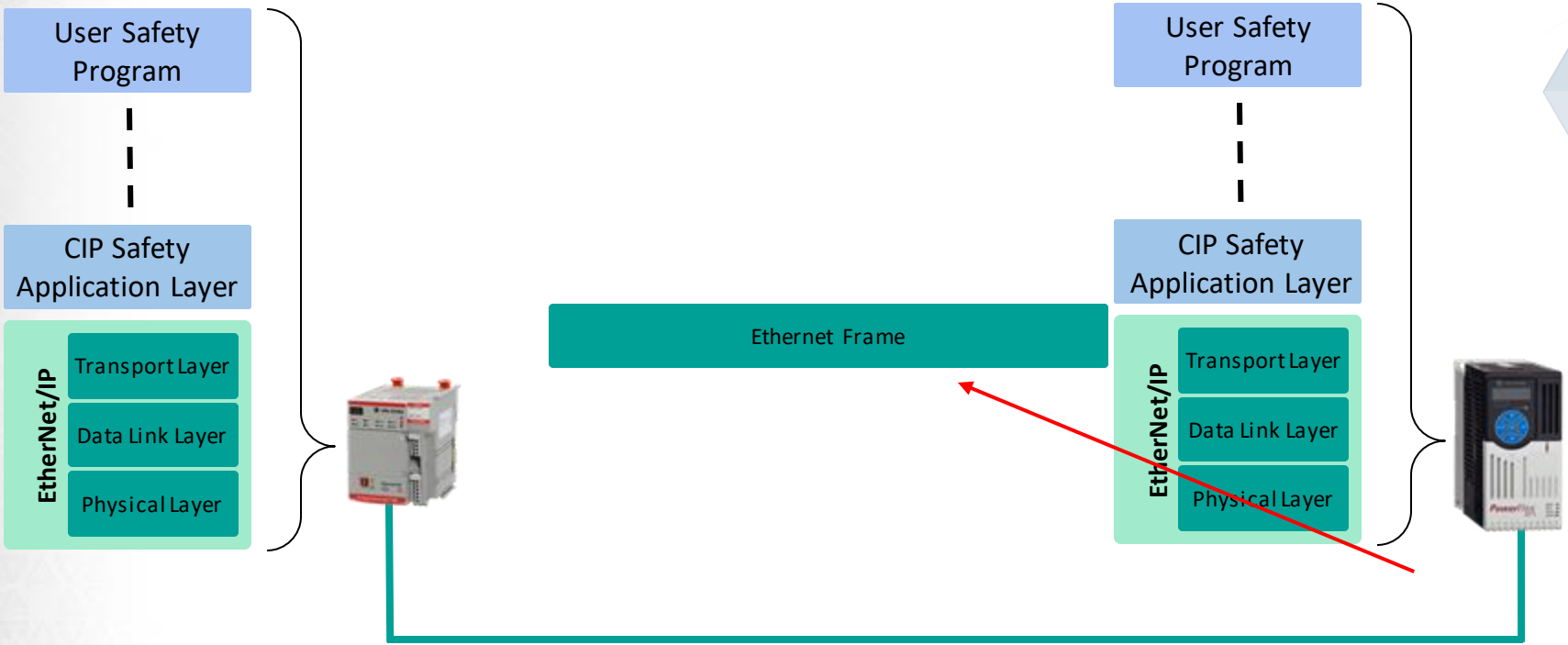


CIP Safety Information Transmission

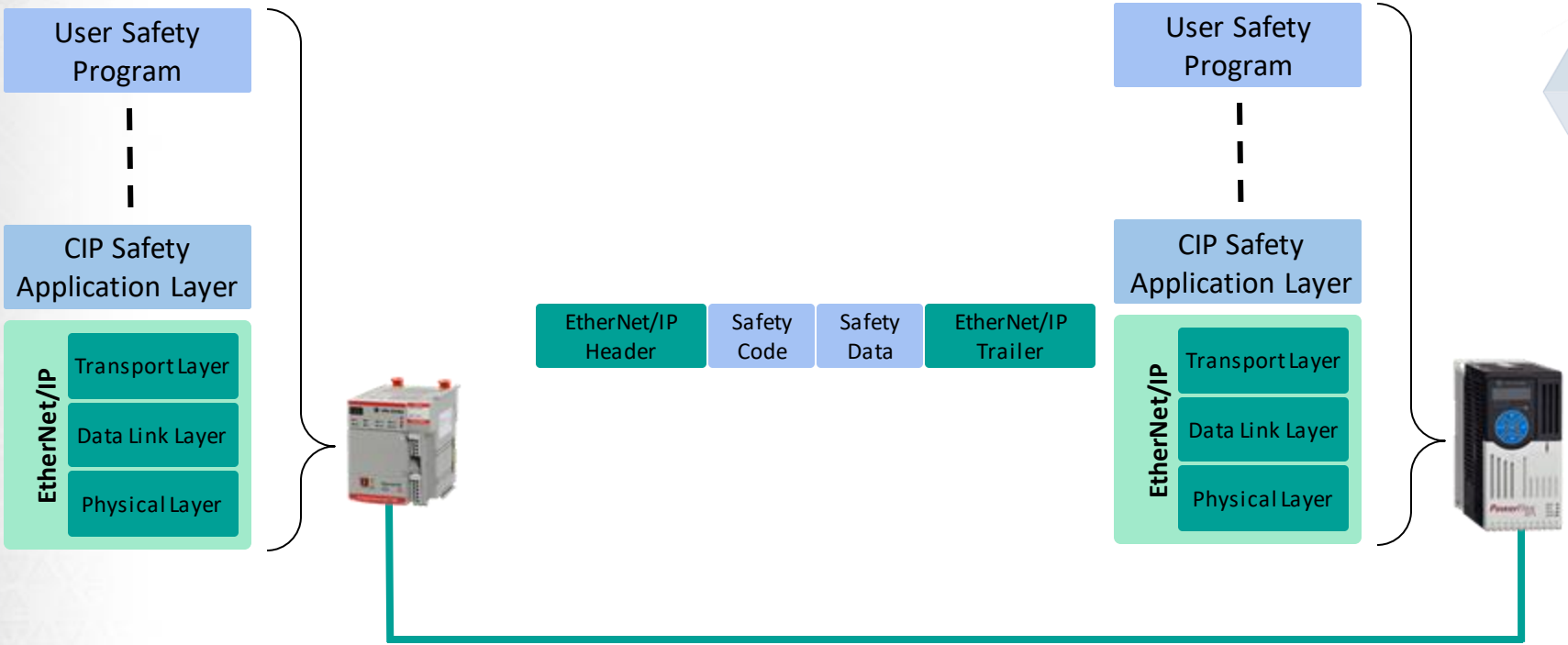


CIP Safety Information Transmission

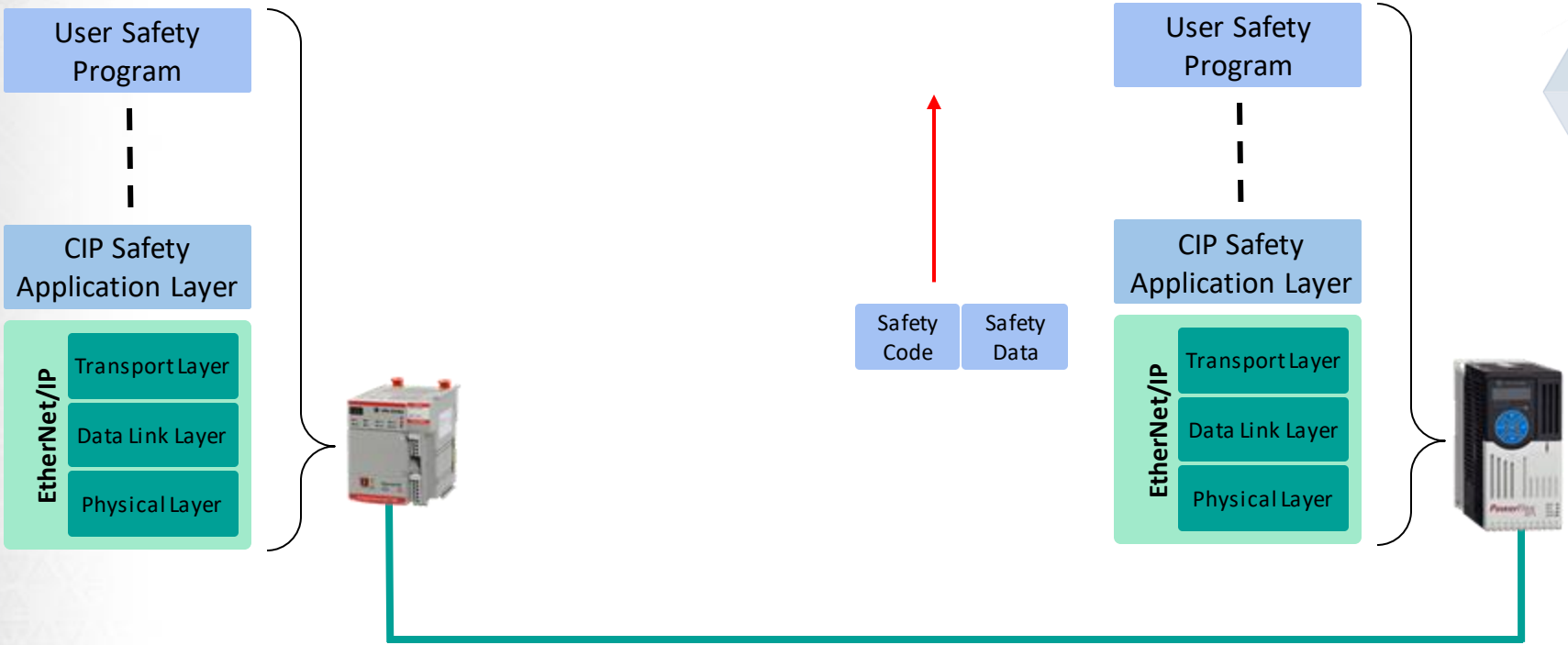
CIP Safety Information Transmission



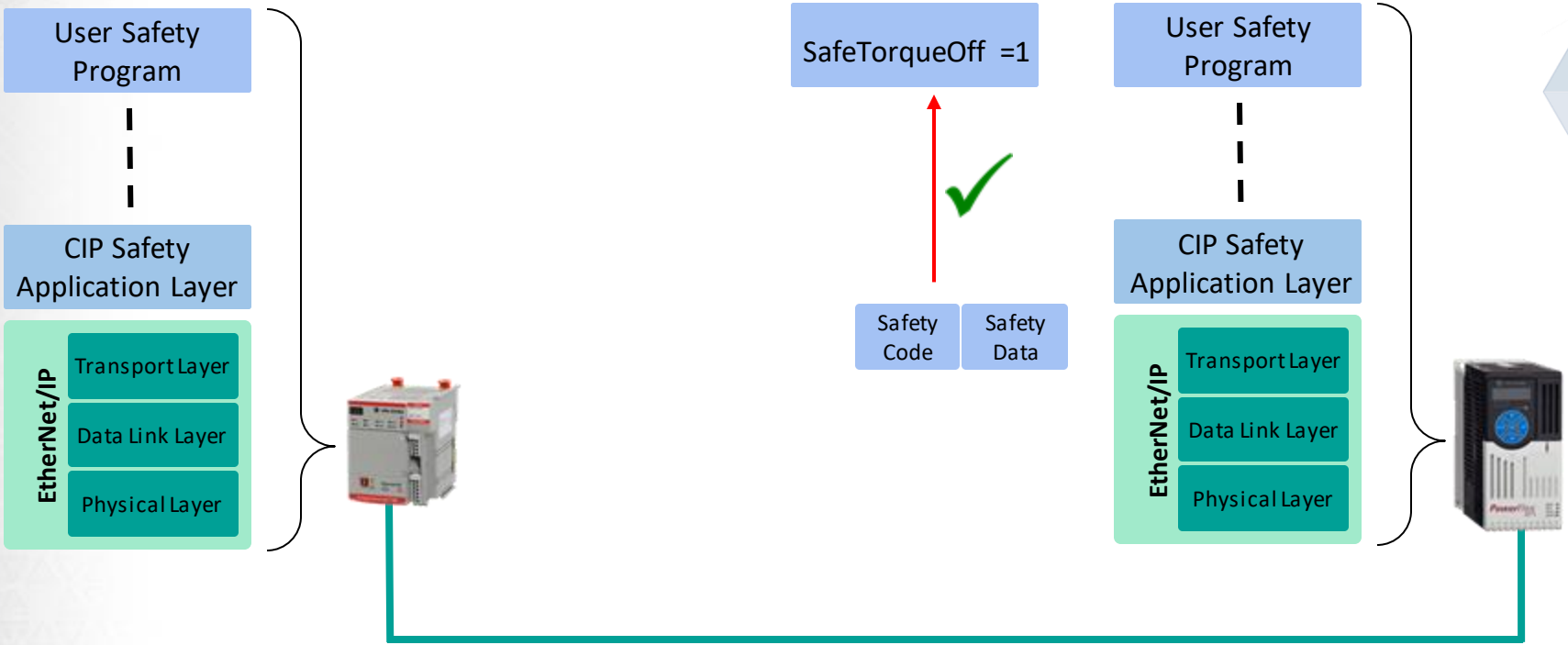
CIP Safety Information Transmission



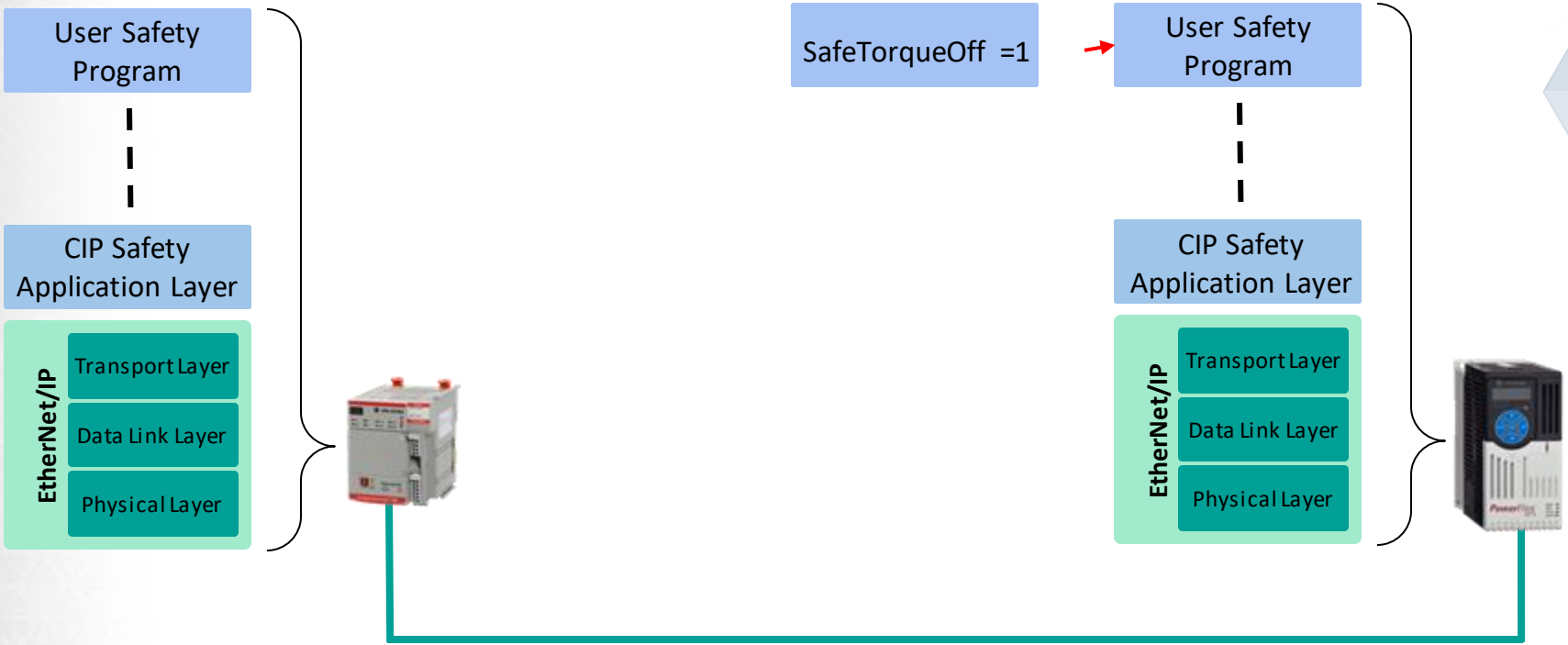
CIP Safety Information Transmission



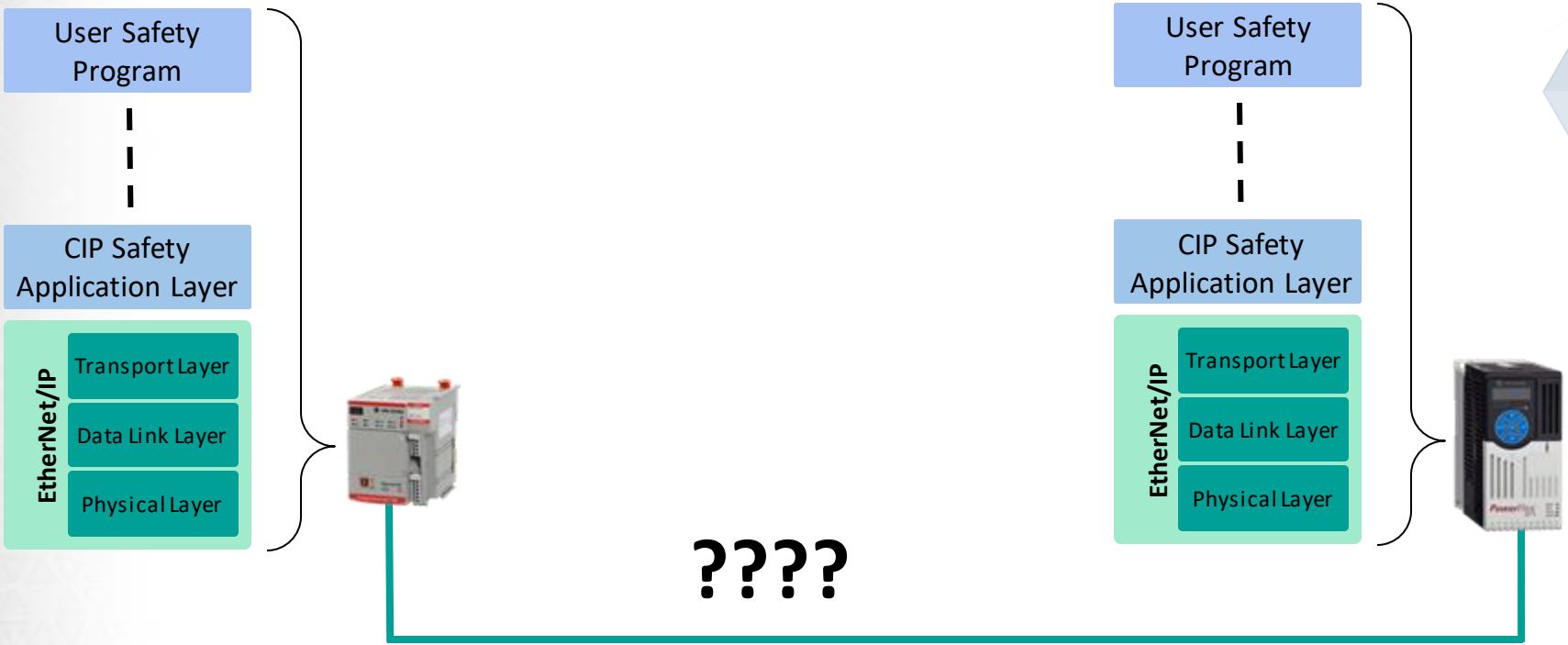
CIP Safety Information Transmission



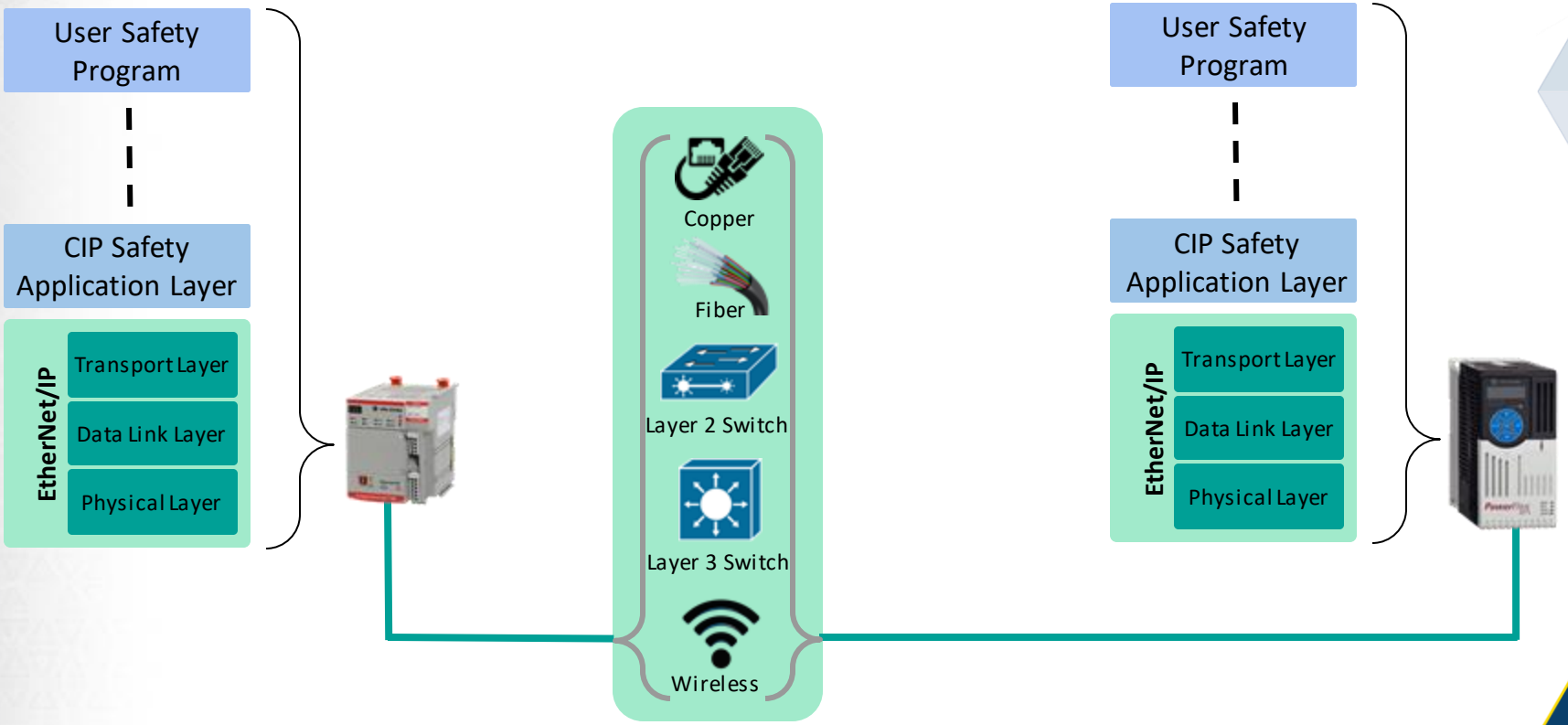
CIP Safety Information Transmission



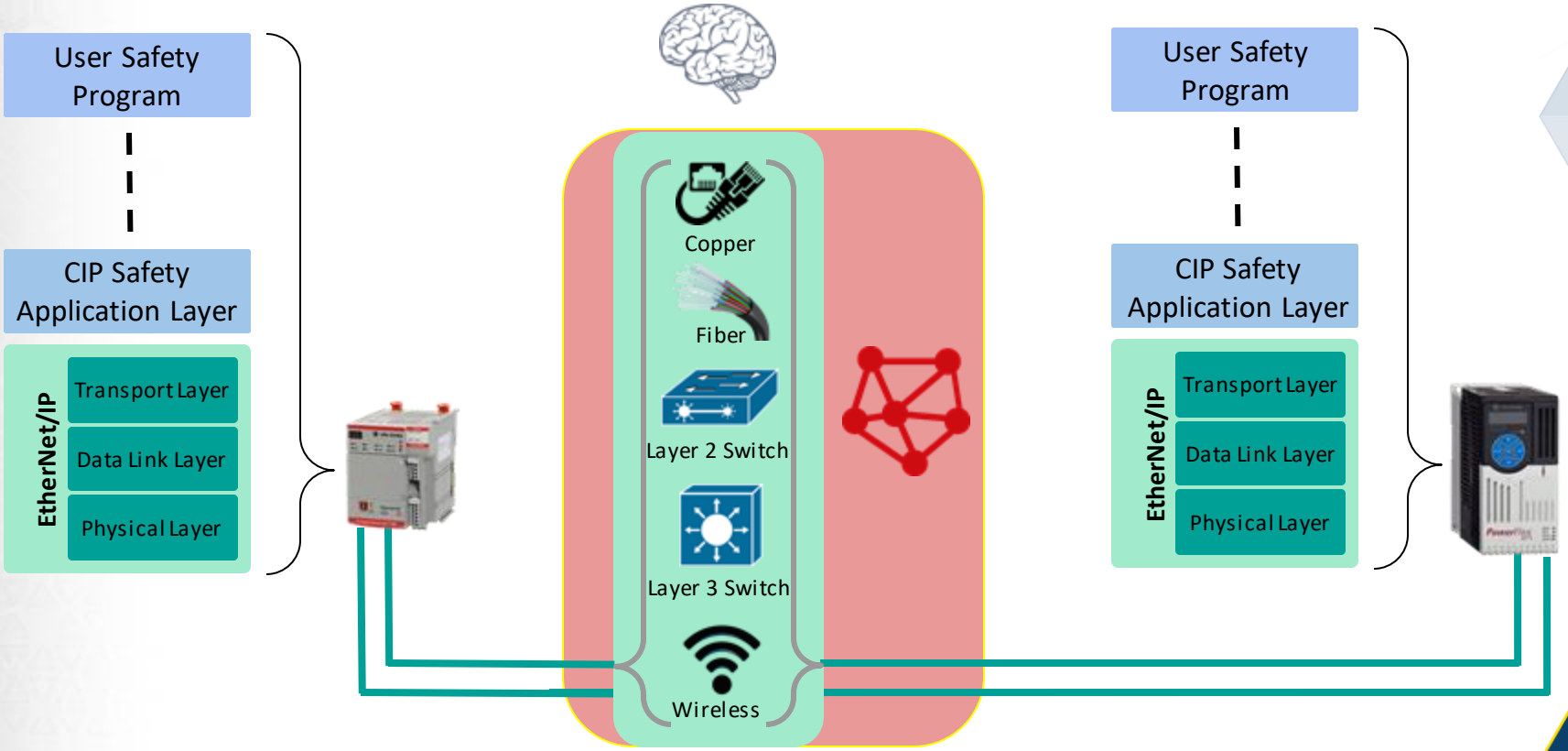
Network Reliability?



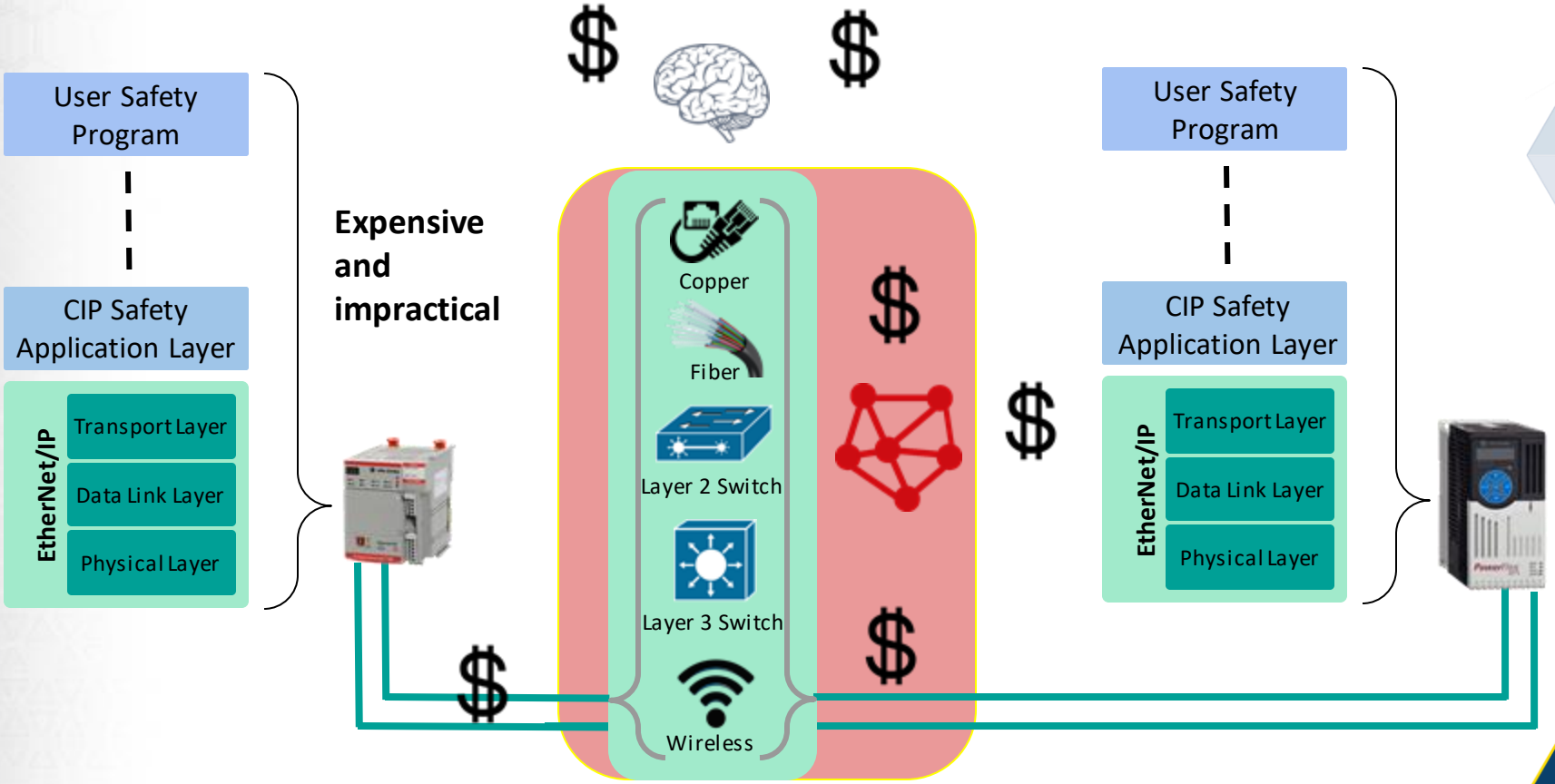
Network Reliability?



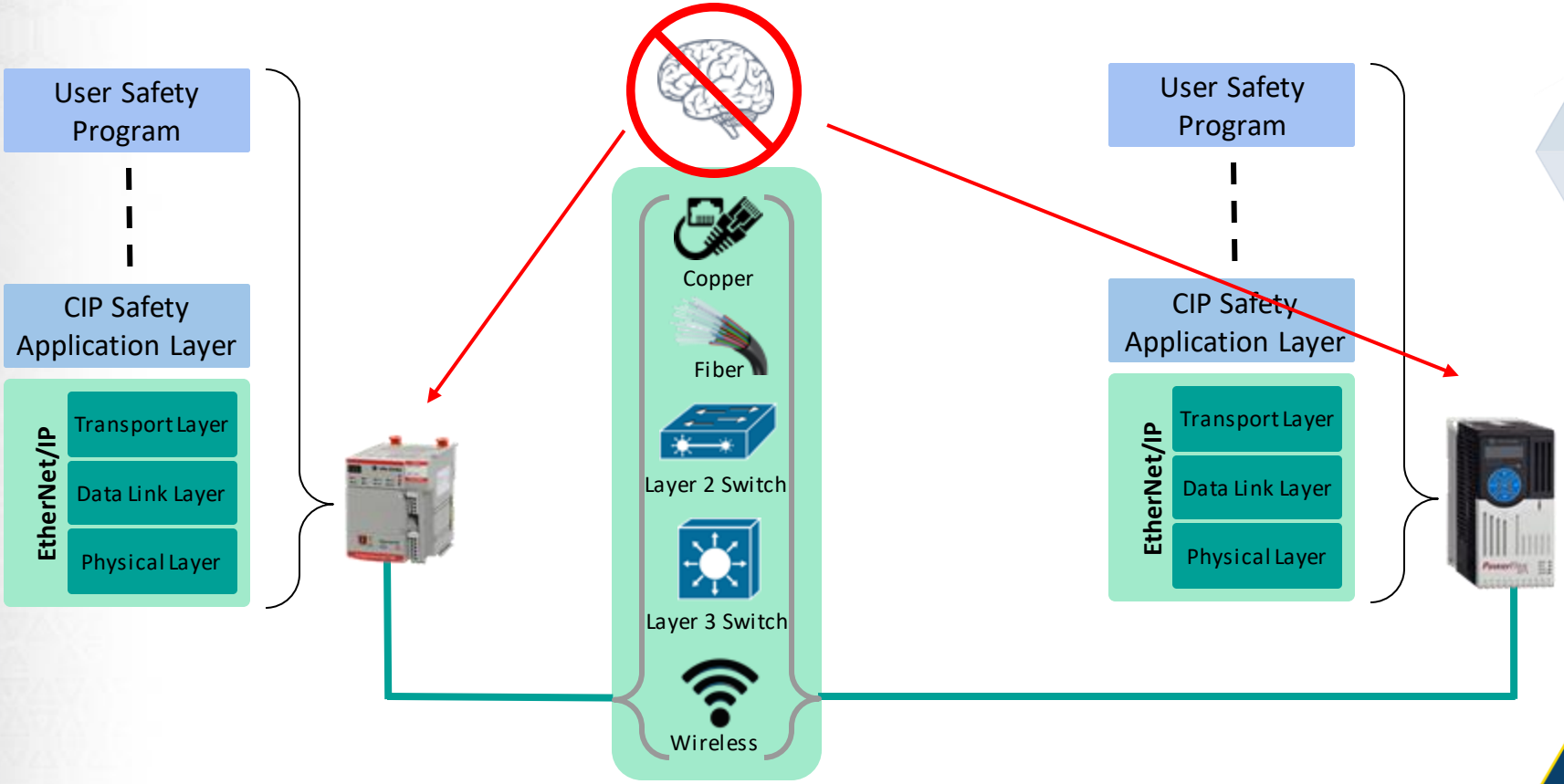
Safety Rated Network?



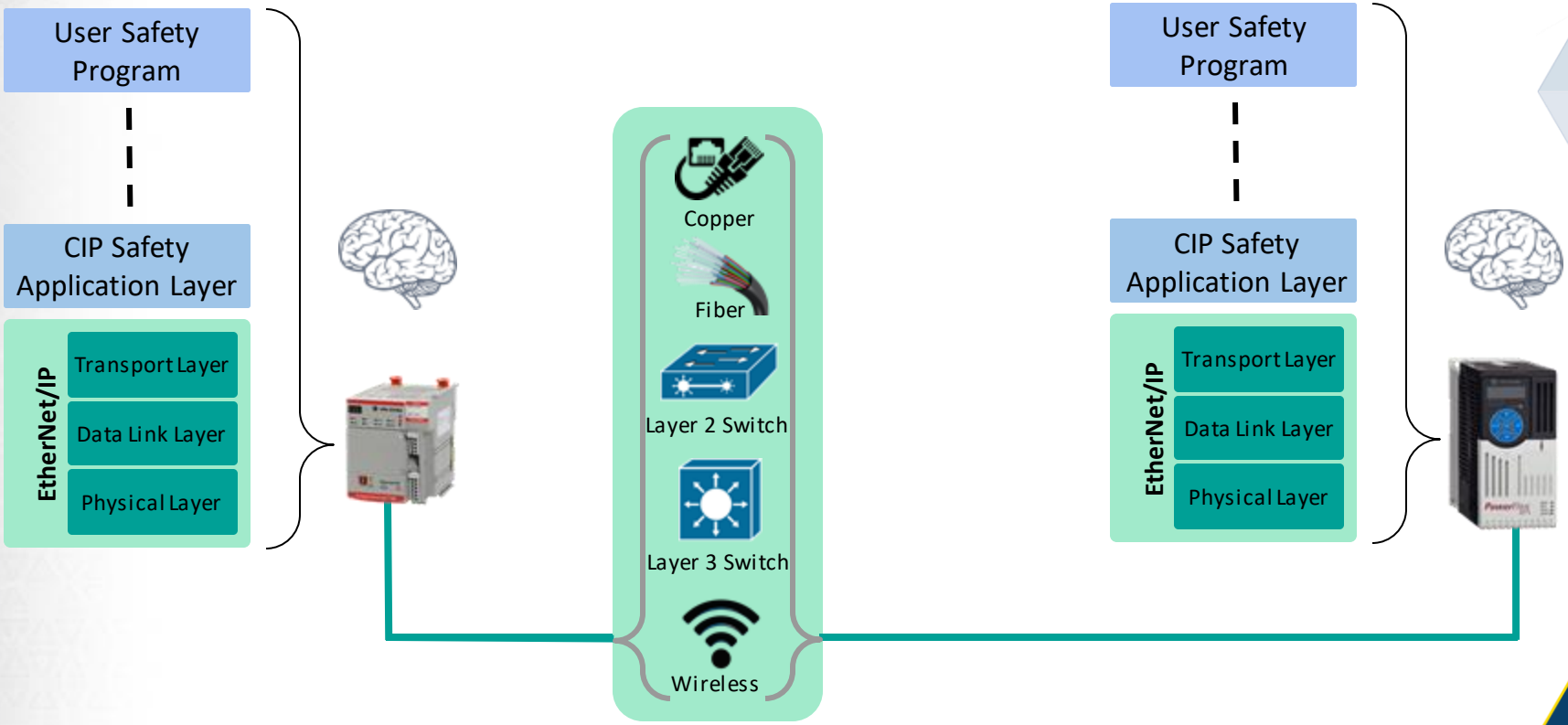
Safety Rated Network?



Safety Rated Network?

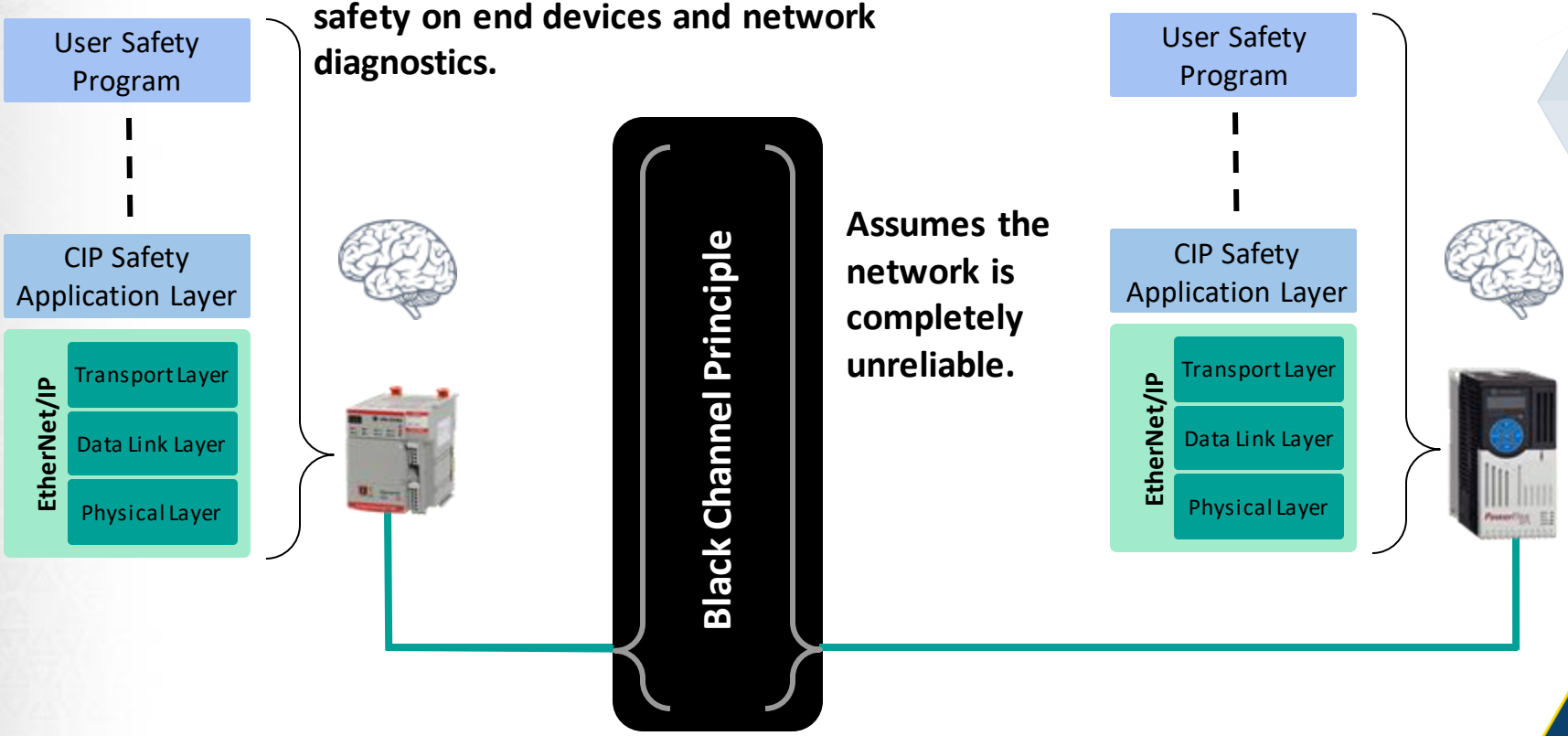


How is CIP Safety safe

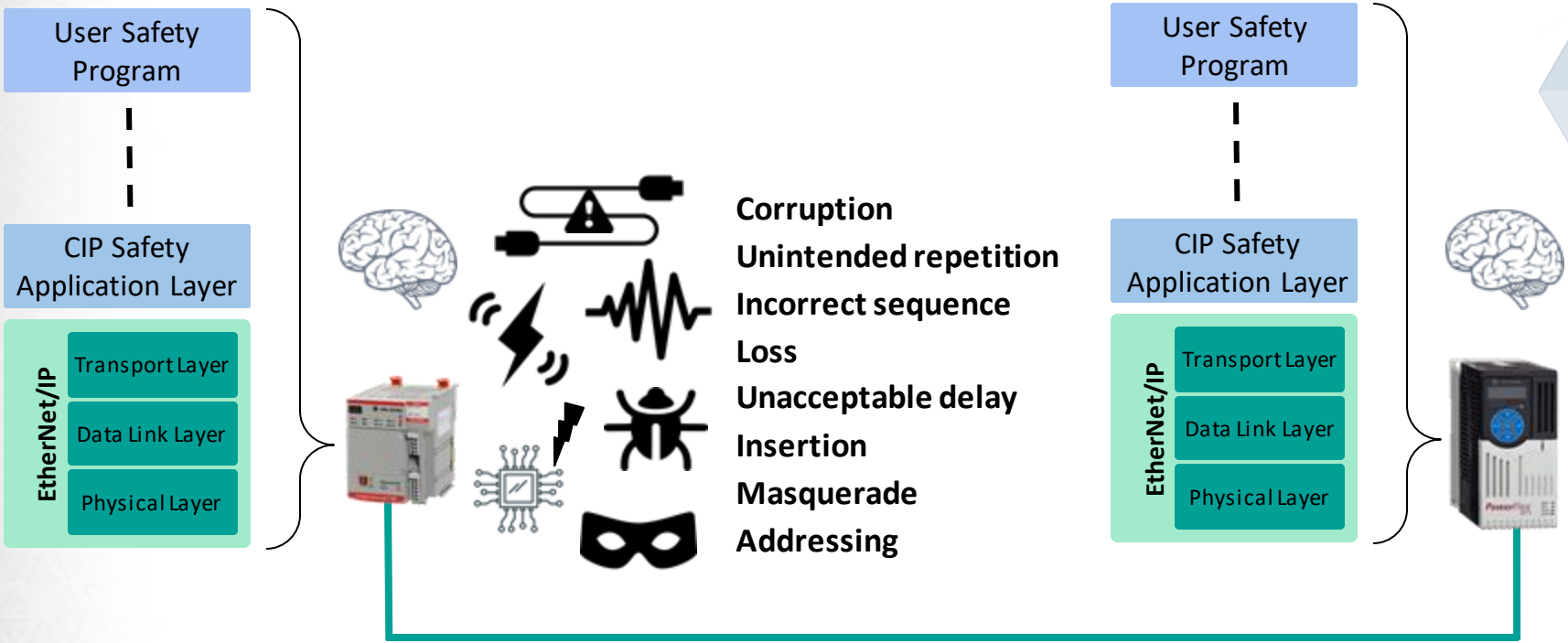


Black Channel Principle

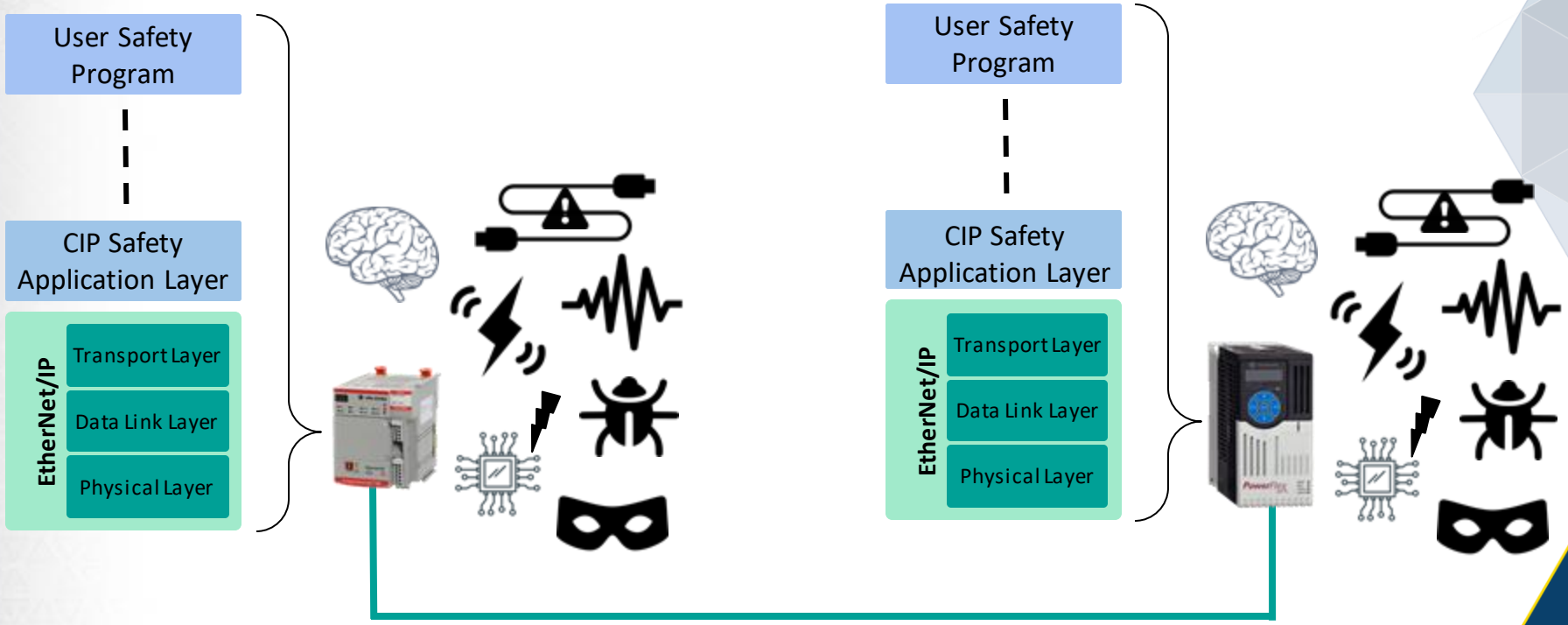
Places responsibility for maintaining safety on end devices and network diagnostics.



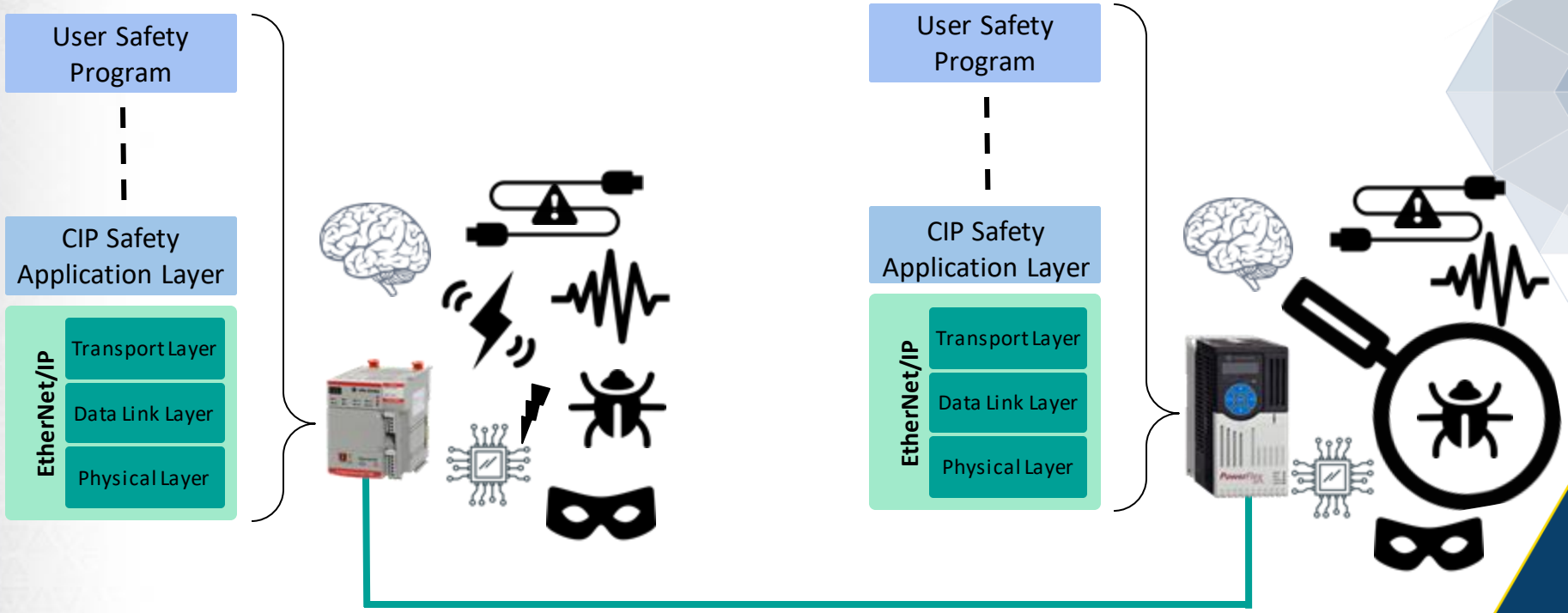
Error Detection and Verified Safety



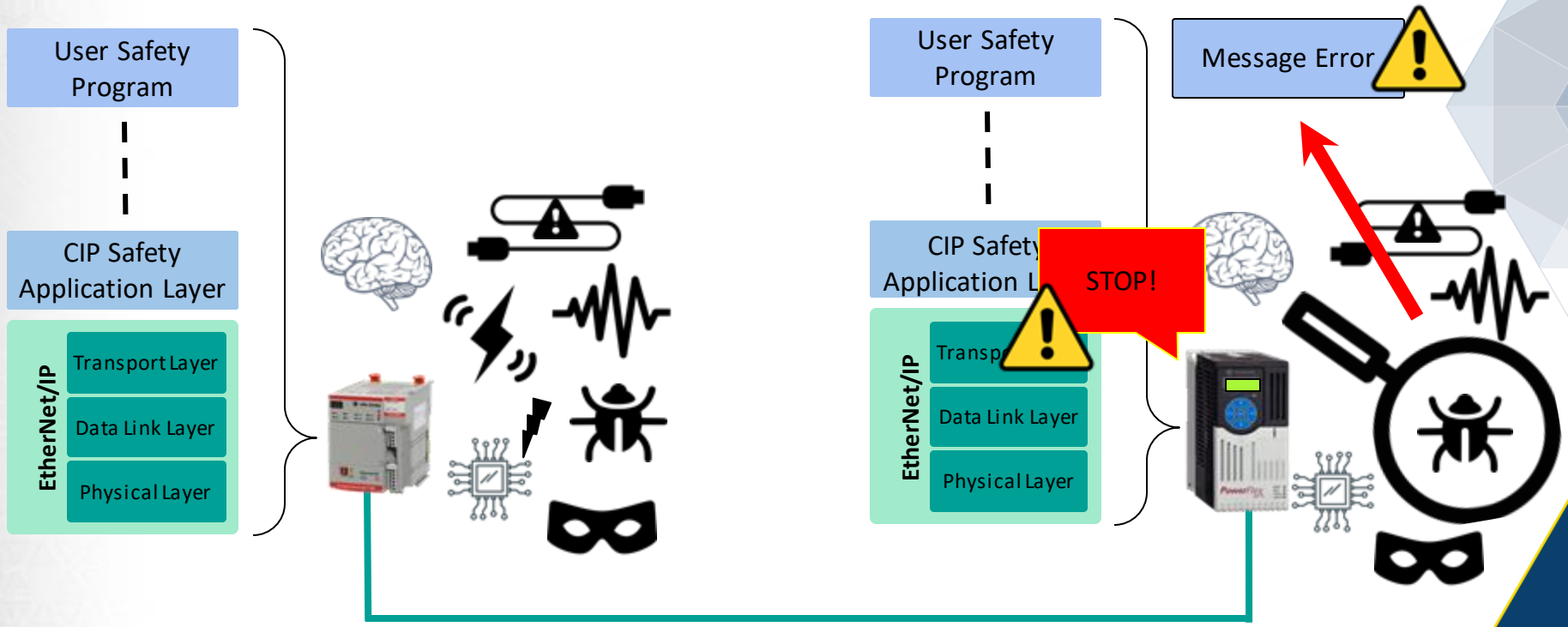
Error Detection and Verified Safety



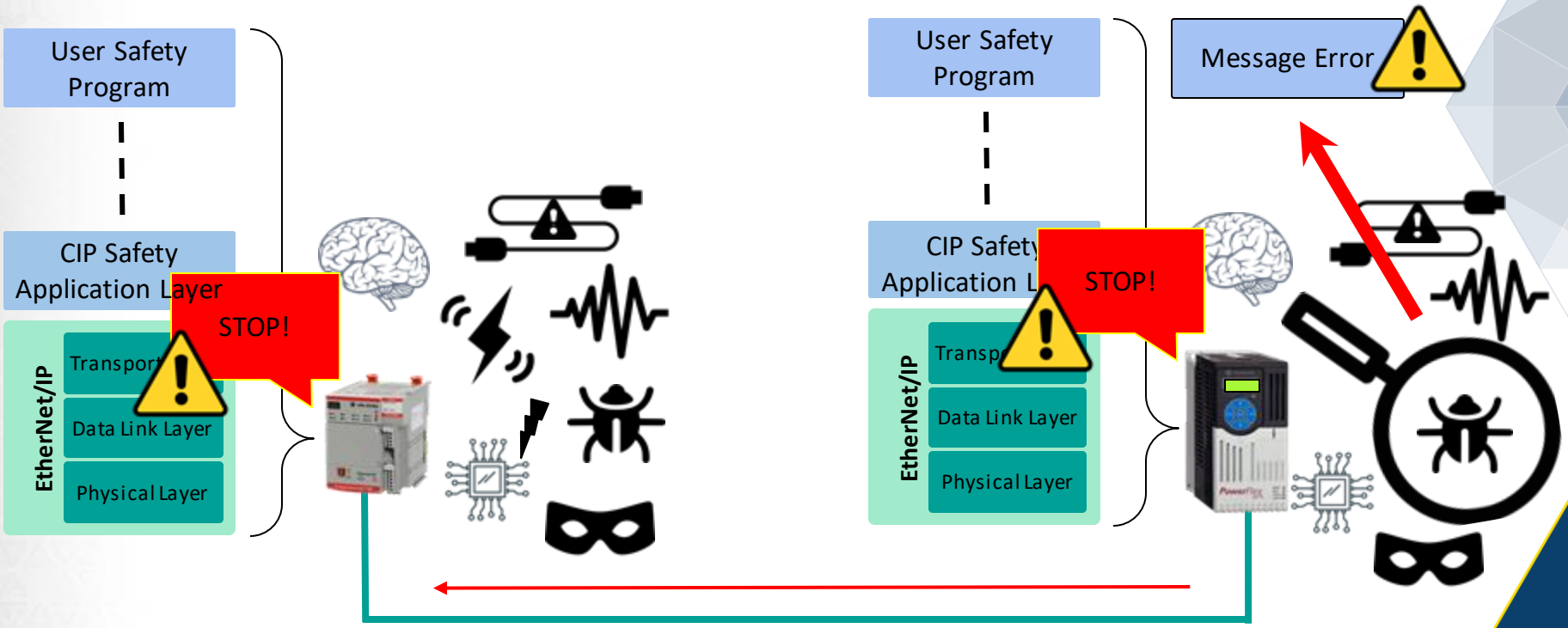
Error Detection and Verified Safety



Error Detection and Verified Safety

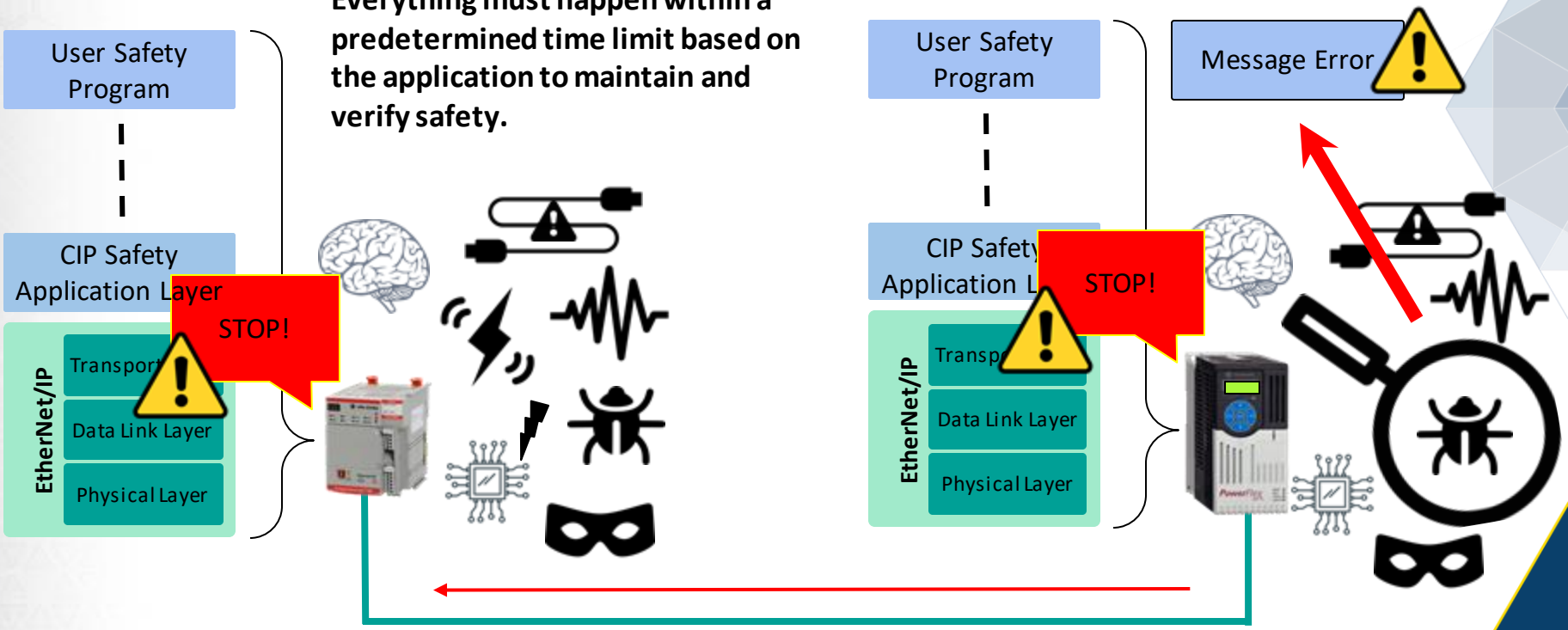


Error Detection and Verified Safety



Error Detection and Verified Safety

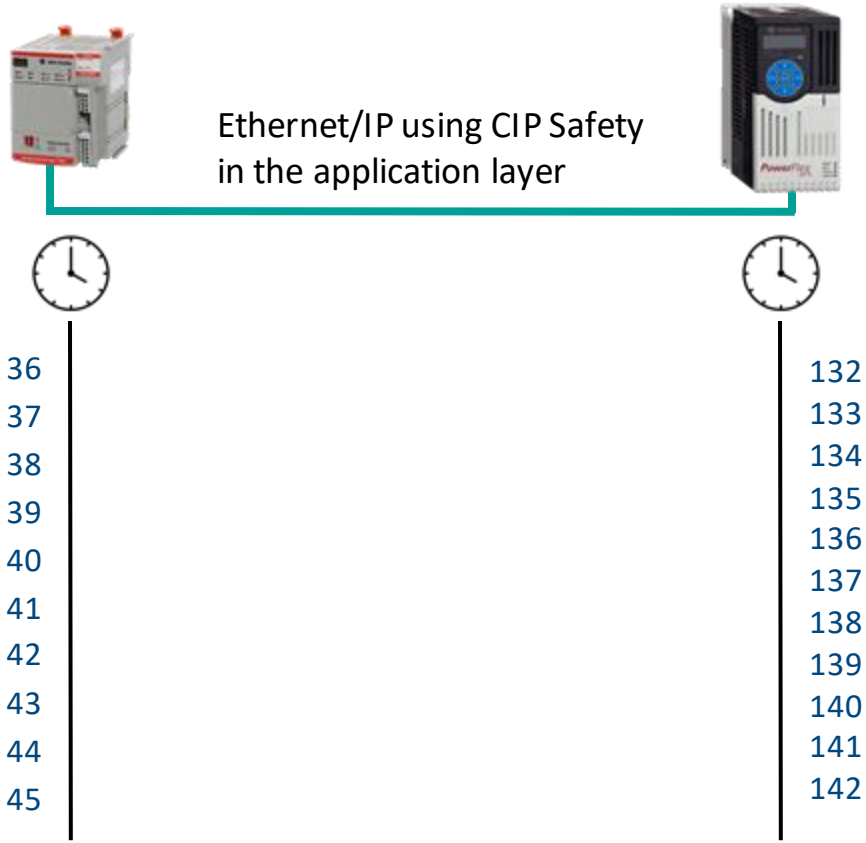
Everything must happen within a predetermined time limit based on the application to maintain and verify safety.



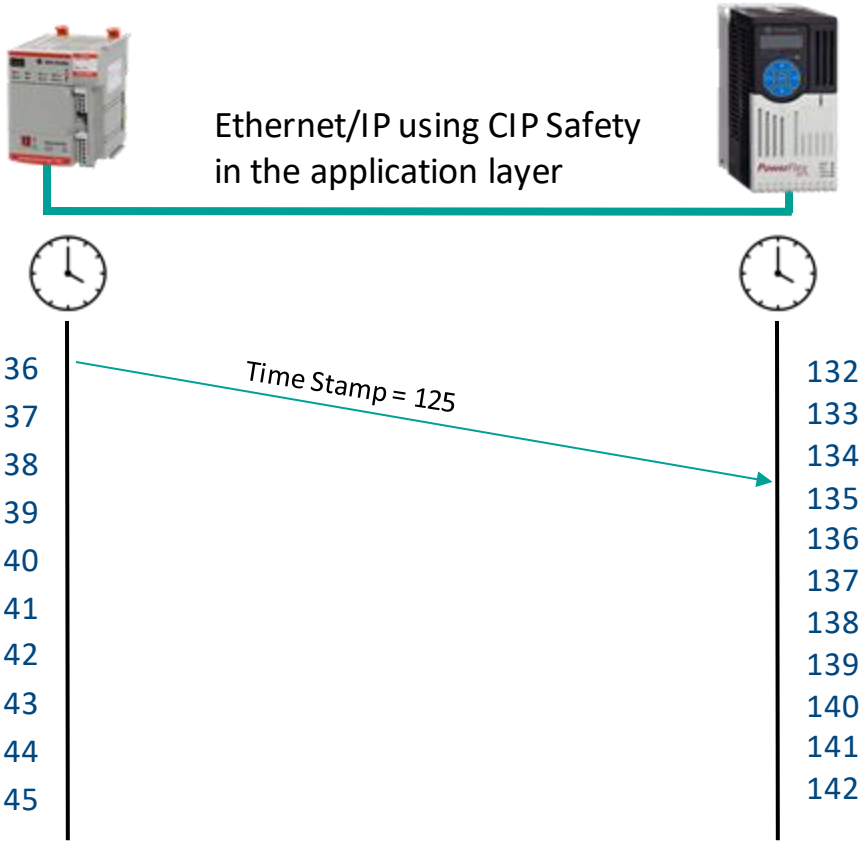
Error Detection Measures

Communication errors	Measures to detect communication errors				
	Time expectation via time stamp	*ID for send and receive*	*Safety CRC*	*Redundancy with cross checking*	*Diverse measures*
Message repetition	X		X		
Message loss	X		X		
Message insertion	X	X	X		
Incorrect sequence	X		X		
Message corruption			X	X	
Message delay	X				
Coupling of safety and safety data		X			
Coupling of safety and standard data	X	X	X	X	X
Increased age of data in bridge	X				

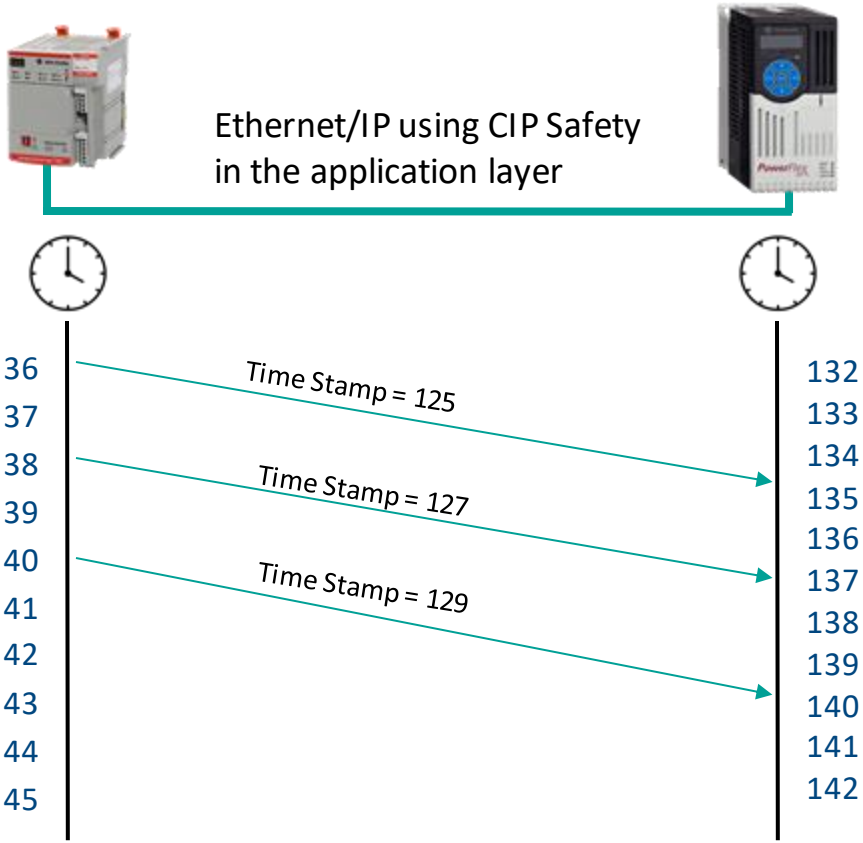
Time Expectation and Offset



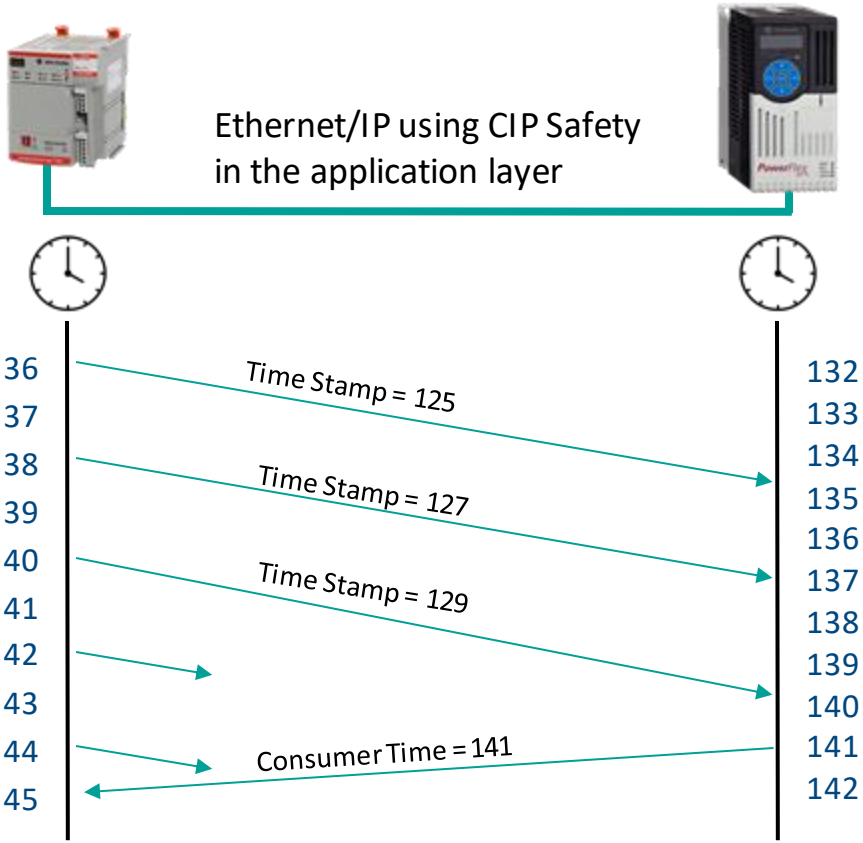
Time Expectation and Offset



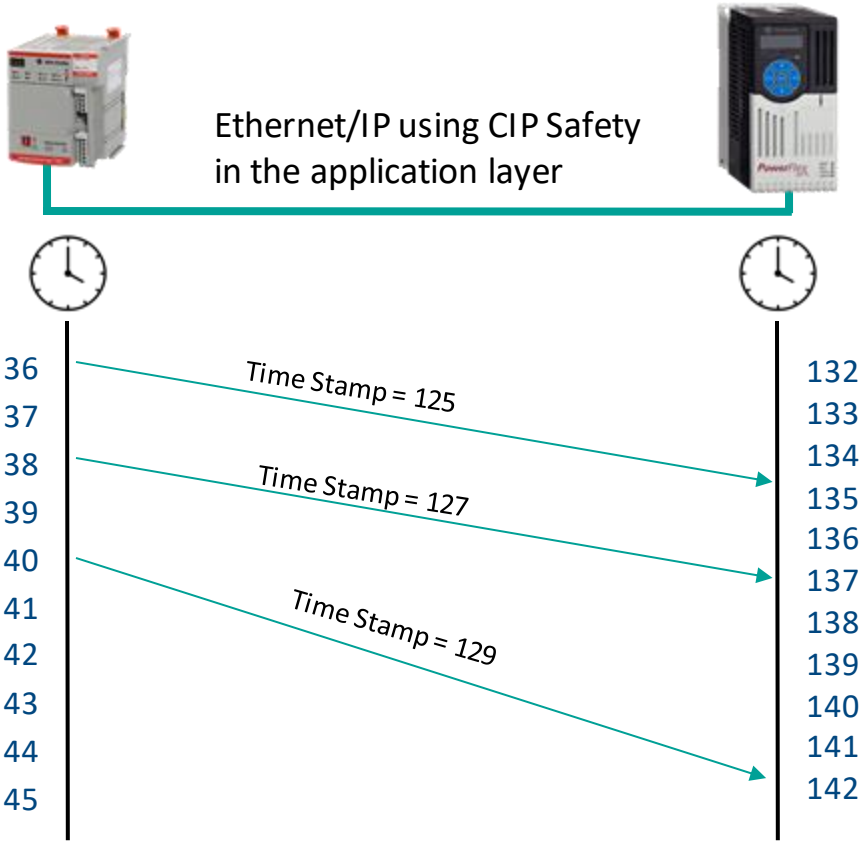
Time Expectation and Offset



Time Expectation and Offset



Time Expectation and Offset

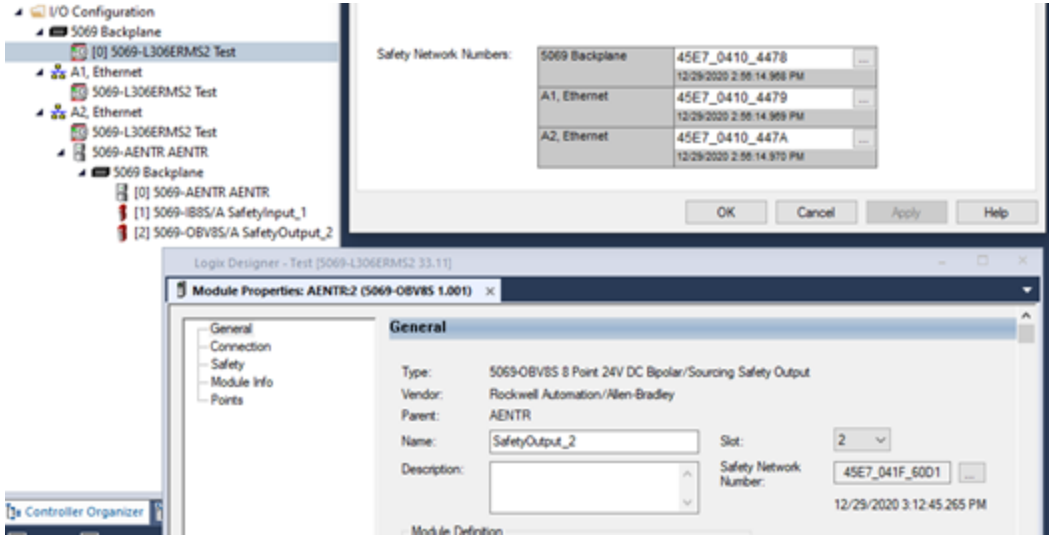


CIP Safety Configuration Implementation

CIP Safety provides the following protection measures to help ensure the integrity of configuration:

- **Safety network number (SNN)**
- **Configuration ownership**
- **Configuration locking**
- **Password protection**

The SNN provides a unique network identifier for each network in the safety system. The safety network number combined with the local device address allows any device in the safety system to be uniquely addressed.



ODVAs CIP Safety Protocol - TUV Certified

ODVA®

EtherNet/IP™

CIP Safety™

TÜVRheinland® CERTIFIED

Certificate

No.: 968/EL 373.05/20

Product tested	CIP Networks Library Volume 5, CIP Safety Edition 2.19	**Certificate holder**	ODVA, Inc. 2370 E. Stadium Blvd. #1000 Ann Arbor, MI 48104 USA
Type designation	CIP Safety on DeviceNet, CIP Safety on EtherNet/IP, CIP Safety on SERCOS		
Codes and standards	IEC 61784-3:2017 EN ISO 13849-1:2015		IEC 61508 Parts 1-7:2010
Intended application	The CIP Networks Library, Volume 5: CIP Safety Edition 2.19 meets the requirements of the IEC 61784-3. It can be used as a safety communication layer (SCL) in applications up to SIL 3 according to IEC 61508 and EN ISO 13849-1 for Category 4 / PL e and enables vendors to build CIP Safety devices for DeviceNet, EtherNet/IP and SERCOS in compliance with these standards.		

Valid until 2025-05-04

The issue of this certificate is based upon an examination, whose results are documented in Report No. 968/EL 373.05/20 dated 2020-05-04.
This certificate is valid only for products which are identical with the product tested.

TÜV Rheinland Industrie Service GmbH
Bereich Automation
Funktionale Sicherheit
Am Grauen Stein, 51105 Köln

Köln, 2020-05-04

Certification Body Safety & Security for Automation & Grid

Dipl.-Ing. Gebhard Bouwer

Questions?

Safety Controller Overview

Integrated Architecture System

Single controller for standard and safety control

- No extra time for data integration
- Better diagnostics and easy data sharing up to HMI

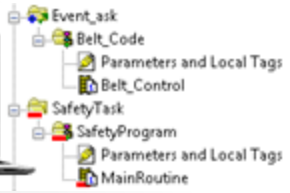
Name	Usage
CIP_Safety_Acting	Public
Reset	Local

Parameter Connections (2:0)

Connection	\UN01_ExampleMachine.CIP_Safe_Otl_Demand
Connection	\UN01_ExampleMachine.CIP_Safety_Demand

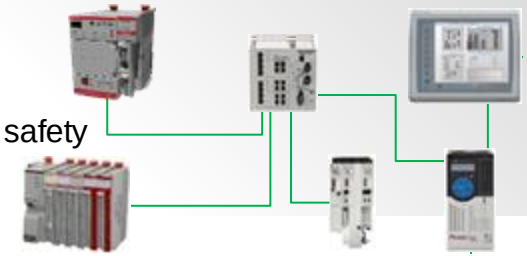
Single software for standard and safety control

- Same look and feel; speeds up application building
- Design flexibility saves time



Single network for standard and safety control

- No special network or gateways for I/O
- Ability to mix and match safety and standard I/O



Capable and flexible

- Certified safety instructions (more than 100)
- Also facilitates creating your own Add-On Instruction

Compact GuardLogix Controllers

Multiple disciplines

Flexible and scalable

One common design environment

- **Compact GuardLogix® 5370 controllers**
  - Integrated Motion on EtherNet/IP up to 16 axes @ 2 axis/ms
  - Integrated safety up to SIL 3, PLe Cat. 4 versions
  - IP67-rated wash down protection
  - Conformal coated versions
- **Compact GuardLogix® 5380 controllers**
  - Integrated Motion on EtherNet/IP up to 32 axes @ 32 axis/ms
  - 1 gigabit (Gb) embedded Ethernet port enables high-speed I/O and motion control for up to 180 nodes
  - Integrated safety up to SIL 3, PLe Cat. 4 versions
  - Conformal coated versions
  - Enhanced security features

GuardLogix Controllers

Multiple disciplines

Flexible and scalable

One common design environment

- **GuardLogix® 5570 controllers**
  - Integrated Motion on EtherNet/IP™ up to 100 axes
  - Integrated safety up to SIL 3, PLe CAT 4 versions
  - On-Machine™ versions
  - Conformal coat and extreme environment versions
  - Removal insertion under power

- **GuardLogix® 5580 controllers**
  - Integrated Motion on EtherNet/IP™ up to 256 axes
  - 1 gigabit (Gb) embedded Ethernet port enables high-speed I/O and motion control for up to 300 nodes
  - Scalable Safety up to PLd or up to PLe with safety partner
  - Conformal coat versions
  - Removal insertion under power
  - Enhanced security features

Scalable Safety Level

Up to PLd (Cat. 3)
SIL CL2
1oo1 Architecture

Up to Ple (Cat. 4)
SIL CL3
1oo2 Architecture

First in scalable Safety Performance Levels (PLs) and Safety Integrity Levels (SILs) for machine safety

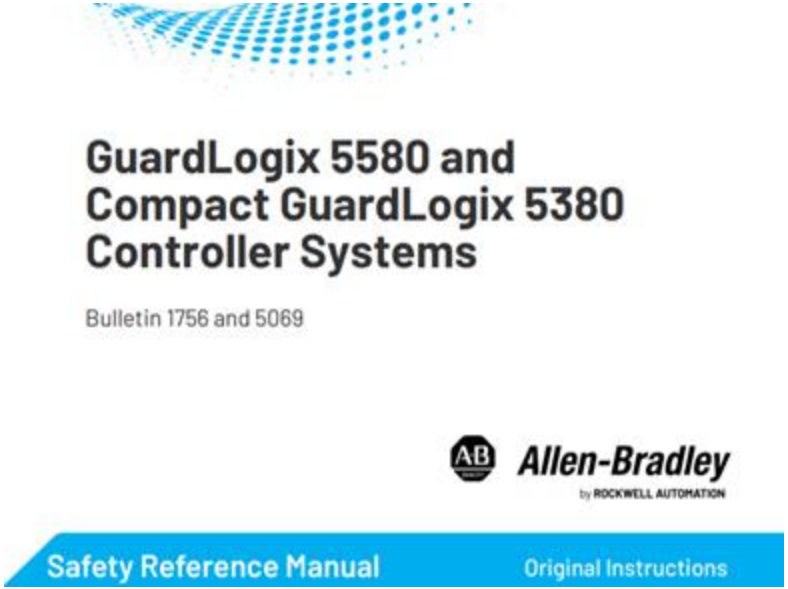
- The risk assessment is the key to defining the safety requirements
- Right Sizing" can create compliant designs
  - Optimized for cost and performance
  - Help achieve the safety, cost and timing targets for each project
- Just the right amount of safety for your unique application.

Questions?

Safety Software Overview

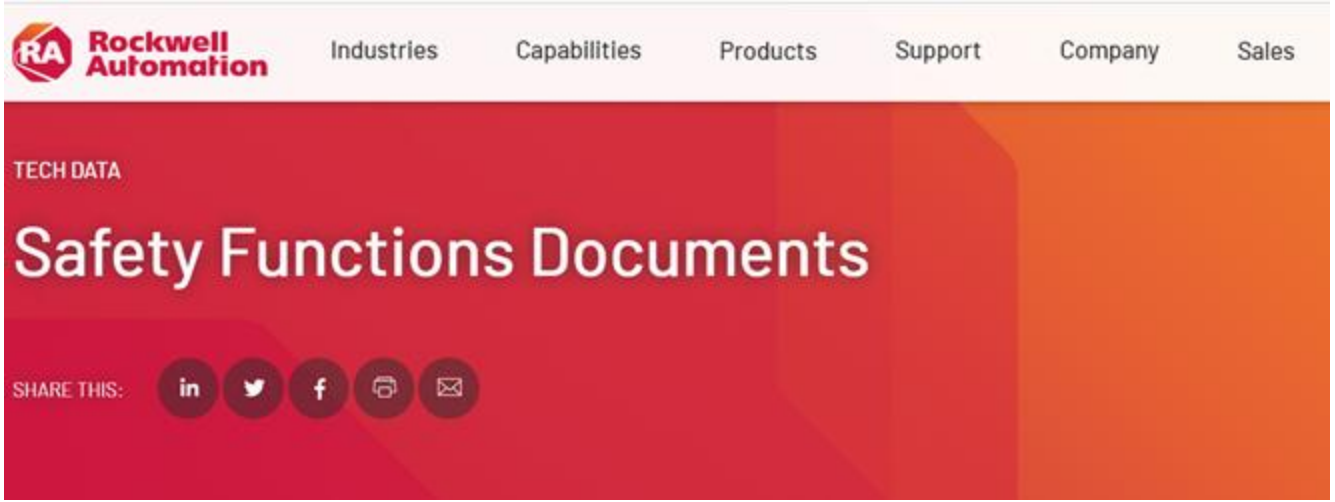
GuardLogix Software (Studio 5000)

- **General Requirements:**
  - Checklists have been executed from Appendix D in Reference Manual
  - Approved Controller, IO and devices were used for the system
  - Safety Task has been created with keeping standard logic separate
    - Mapping tool will help
  - **Safety program utilizes appropriate instruction set**
  - Safety signature has been generated and verified with a upload and download



Studio 5000 Logix Designer Application

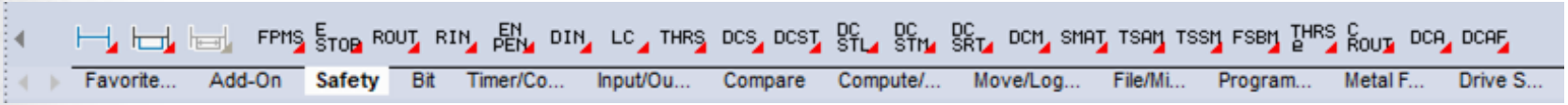
- **Rockwell Pre-Engineered**
  Safety Functions Covered:
  - Access/Door Guarding
  - E-Stops
  - Hand Control
  - Presence Sensing
  - Process
  - Subsystems



Safety Task

- **How the safety task is scanned is a large reason for GuardLogix 5580 SIL 2 safety integrity.**
  - Safety Task is a Periodic Task
  - At periodic rate, Logic Core and Diagnostic Core execute safety task.
    - Logic Core scans standard and safety tasks
    - Diagnostic Core provides diagnostics by running the safety task and comparing the results to the logic core
  - Safety input data 'frozen'; does not change during scan
  - If results are OK, the safety output data packet is transmitted to the safety outputs
- **There are an additional two (2) comparisons for the GuardLogix 5580 SIL 3 architecture. The same comparison, as described above, happens on the 5580 Partner. A third comparison between the 5580 Primary and 5580 Partner over the backplane.**
  - (Note that this third comparison is how the GuardLogix controllers prior to 5580 scanned the safety task)

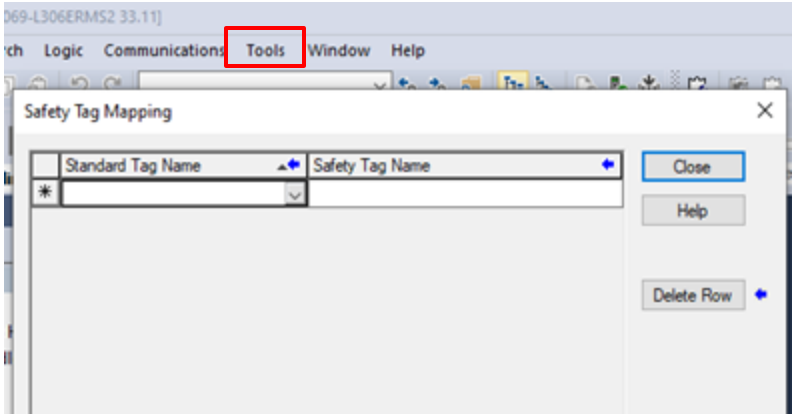
Safety Instructions



- **Legacy Instructions**
  - ESTOP: Two safety inputs to control one output and has a 500ms inputs-inconsistent timeout value
  - LC: Two safety inputs from a light curtain to control one output
  - ROUT: Monitors the state of one input to control and monitor two outputs
- **Preferred Instructions**
  - DCS: Dual-input safety devices to provide a stop function such as an E-stop, light curtain, or gate switch
  - DCSTM: Same as DCS but includes the added capability to mute the safety device from output
  - DCM: Most generic dual-input safety device monitoring
  - CROUT: Configurable to control and monitor redundant outputs

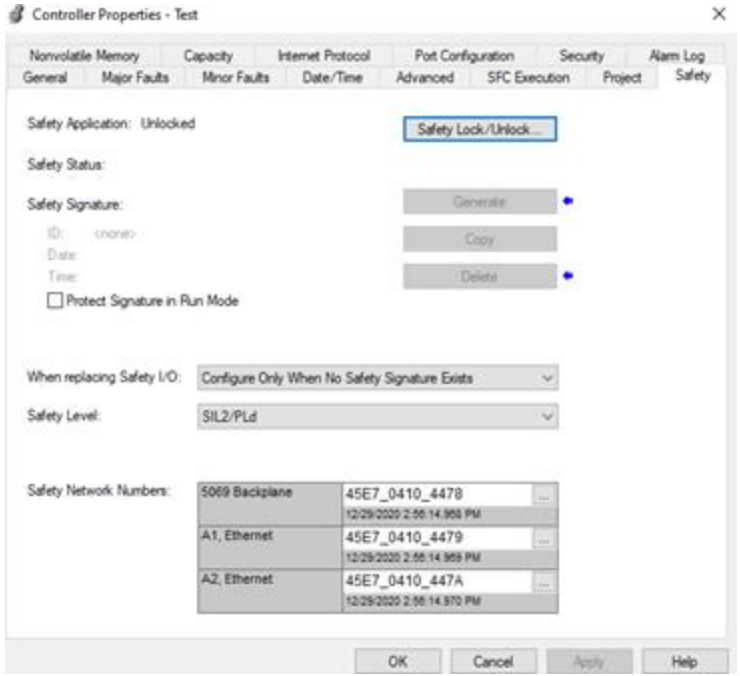
Tag Mapping

- **The mapping tool exists for one reason; to make sure that someone does not INADVERTENTLY use standard tags in the safety task**
  - An example of a standard input being used in a safety routine is a reset pushbutton
  - The mapping takes place once (and only once) prior to executing the safety task
- **The editor permits using safety and standard tags with three rules:**
  - To use a standard tag in the safety task, the standard tag must first be mapped to a safety tag using the mapping tool
  - Safety tags cannot be driven in the standard programs
    - The editor will not accept a rung if a safety tag is an output on that rung
  - Aliased tags cannot be placed into the mapping tool



Safety Signature

- **The safety signature is a UNIQUE identifier (validation) for the safety portion of a GuardLogix project**
  - It combines a CRC of the program, along with a TIME and DATE stamp
  - You must be online and in Program mode to generate a safety signature
- **After the safety signature is generated, you can no longer edit the safety task, either online or offline**
  - The safety signature has to be deleted to edit the safety task
  - Forcing of safety I/O is prohibited
  - SAFETY RUN status indicator on controller goes solid green



STUDIO 5000 GUARDLOGIX

Live Demonstration

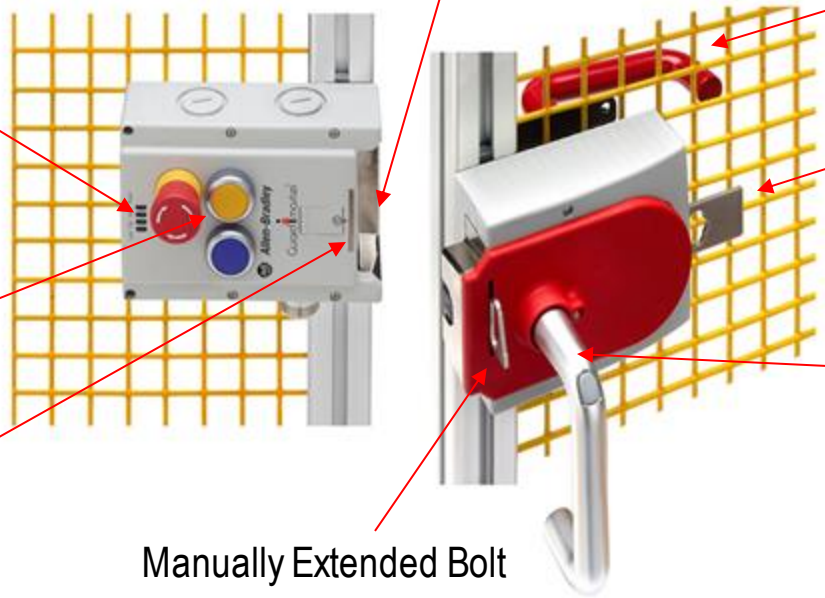
Questions?

break

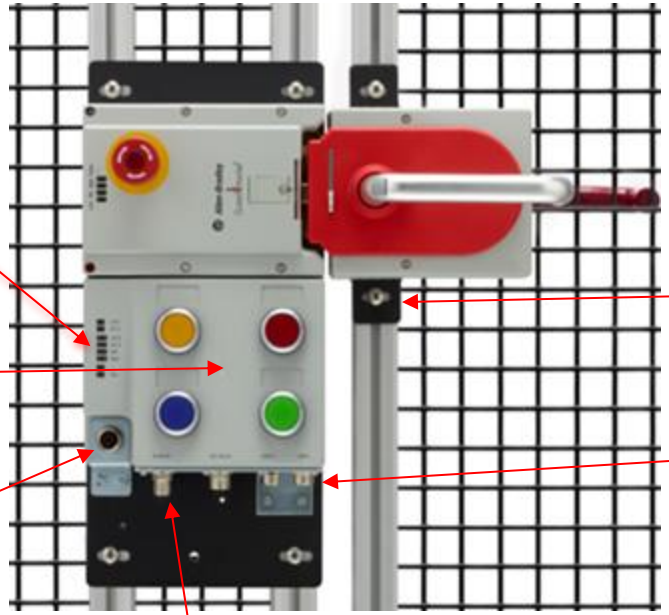
Start Again 10:20 AM

442G Multifunctional Access Box

442G Multifunctional Access Box



442G Multifunctional Access Box Ethernet/IP



MAB Simplified Installation Example

GaurdLogix

Add-on Profile populates descriptive tags reducing programming time

Ethernet/IP

Safety and standard devices communicate on the same network

CIP Safety

Discrete-wired MAB

Point I/O

CIP MAB

CIP Safety

<u>1 Cable with up to 24 signals</u>

Safety In/Out – 2 or 4

E-stop – 4 or 5

Lock Command - 1

Push buttons – 2 to 6

Reset – 1

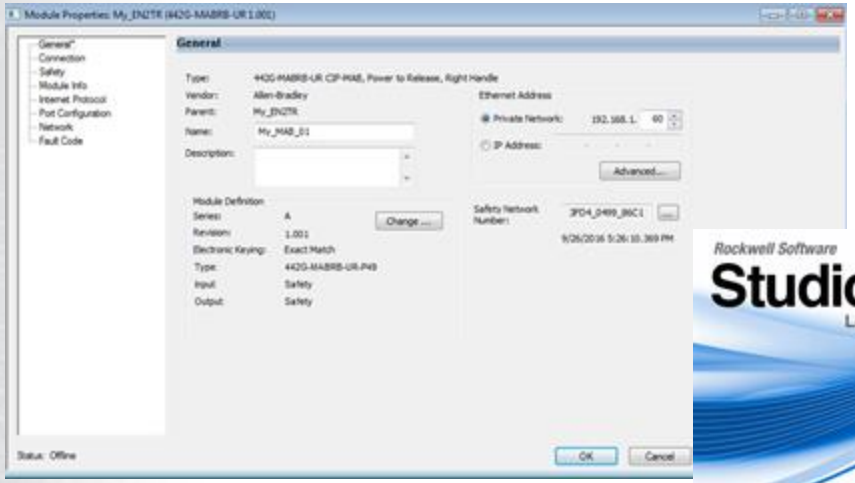
Diagnostics (AUX) – 4

Power - 3

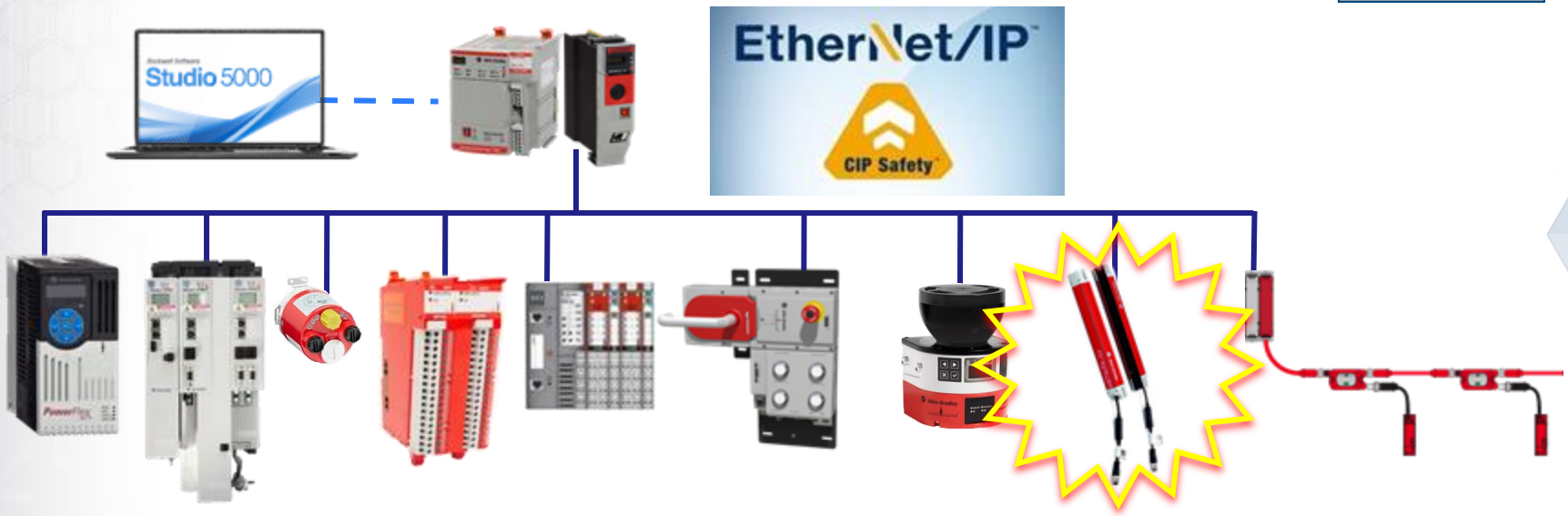
Up to 83% reduction in wiring

MAB Software Configuration

- **Single, user-friendly software environment for programming, configuration, and maintenance**
- **Creates meaningful tag names for I/O and diagnostics with correct data types**
- **Provides for easy duplication of devices**
- **Eliminates I/O mismatch errors**
- **Convenient online help a mouse click away**
- **Compatible with V20 and later**



Questions?

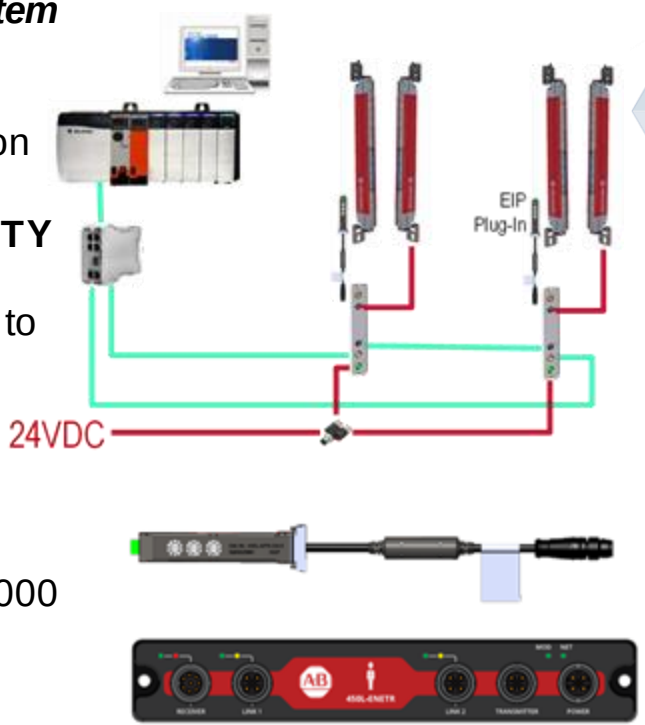


450L GuardShield™
CIP Safety Light Curtains

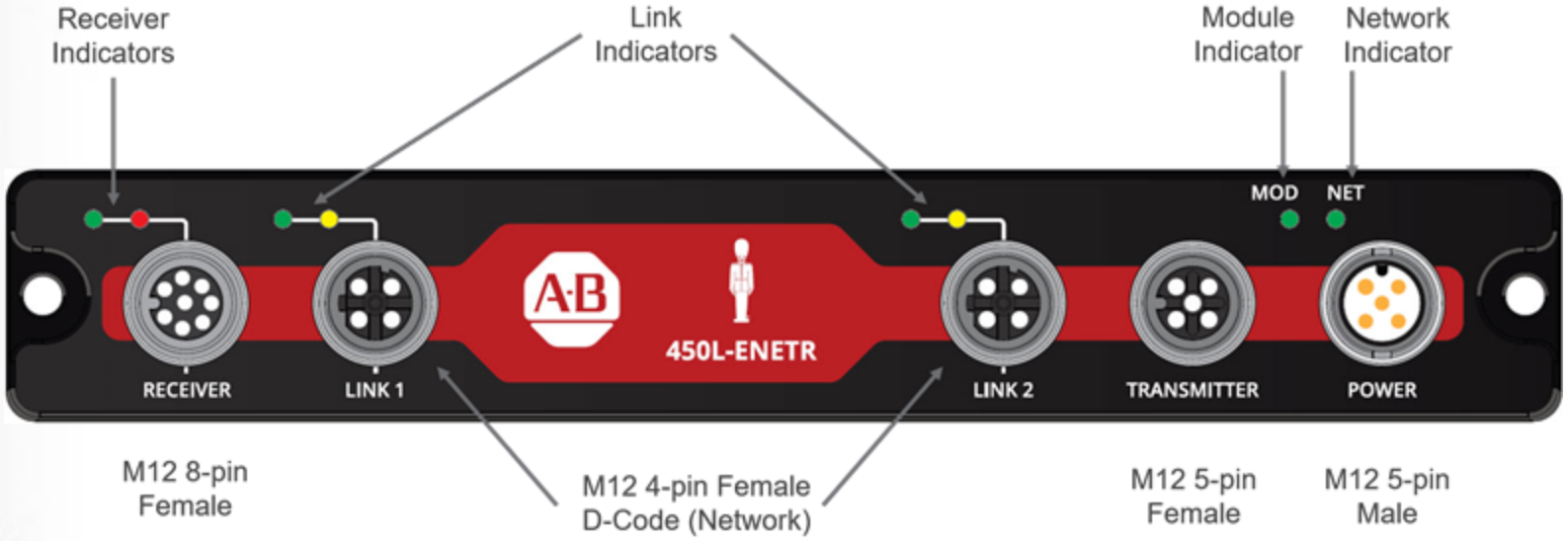
450L GuardShield™ Safety Light Curtains CIP Safety over EtherNet/IP™

CIP Safety over EtherNet/IP enables Premier Integration of the 450L GuardShield Light Curtain in a GuardLogix® Control System and drives attachment through Smart components.

- Perform SIL3 PLe safety functions over EtherNet/IP connection
- Reduced system cost – reduction in wiring of safety circuit
- **Convert any 450L safety light curtain into a SMART SAFETY sensor**
- Enables communication of diagnostics and status information to Logix Systems
- Enables CIP safety over EtherNet/IP to support safety requirements
- Supports DLR to cascade multiple 450L or other EtherNet/IP products
- Allows configuration of 450L features within AOP for Studio 5000
- **Safety Light Curtain resolutions**
  - **14 mm Finger protection**
  - **30 mm Hand protection**



450L CIP Safety over EtherNet/IP - Module Connector Overview



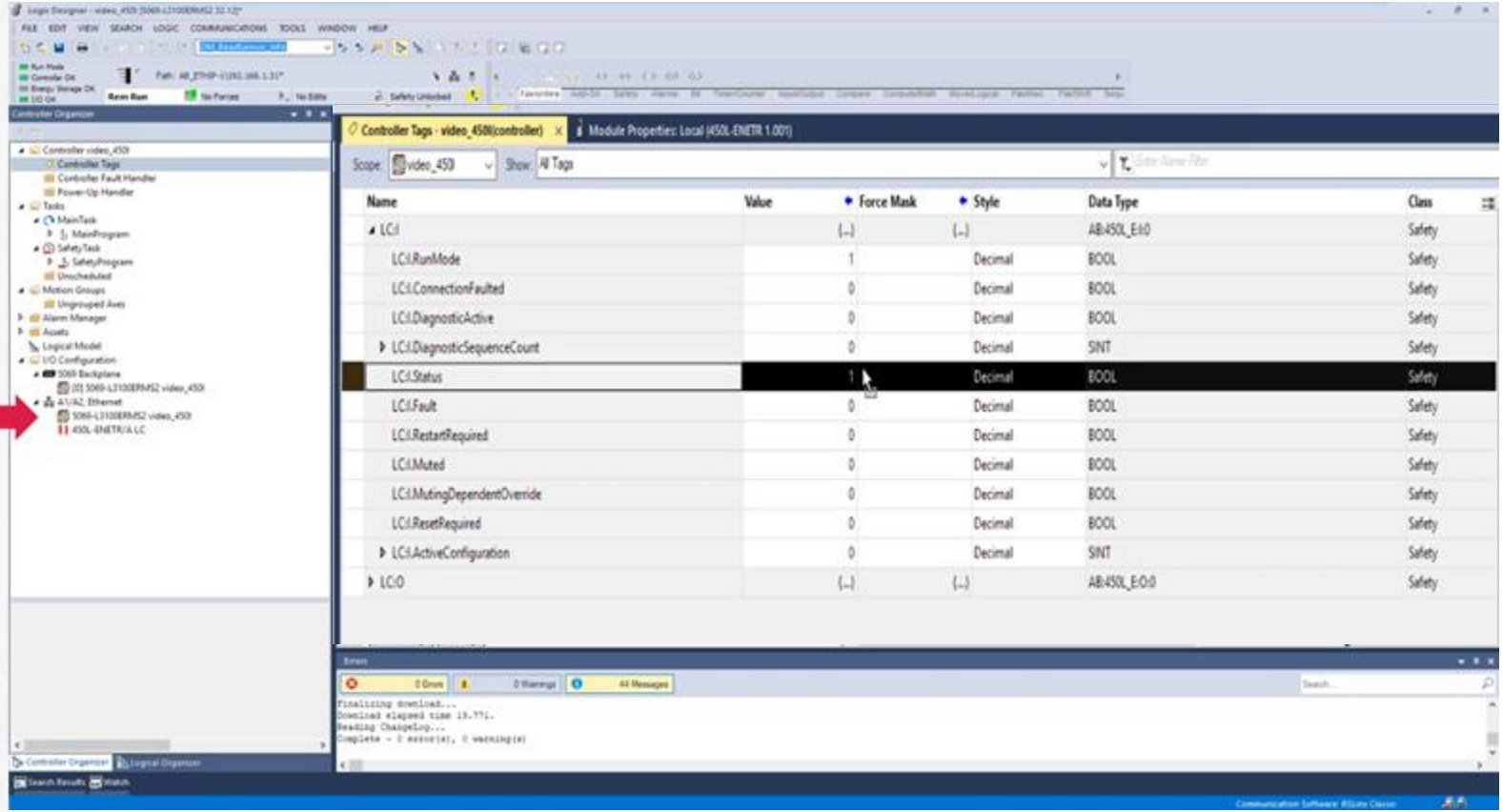
450L-ENETR

450L CIP Safety over EtherNet/IP - Module Connector Overview

Set the IP Address of the light curtain with the rotary dials or by using BootP. If the rotary dials are used then the IP address format will be [192.168.1.XYZ].

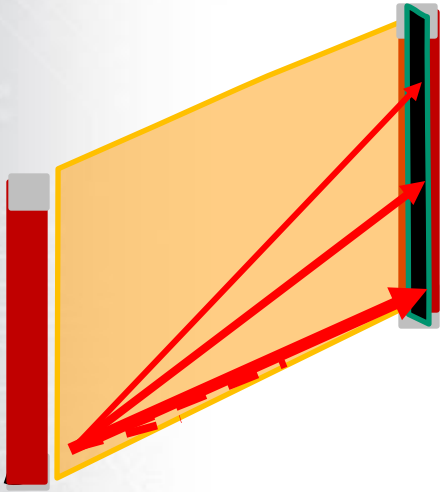
450L-APR-EN-8

450L CIP Safety over EtherNet/IP - Example Studio 5000 Logix Designer® View



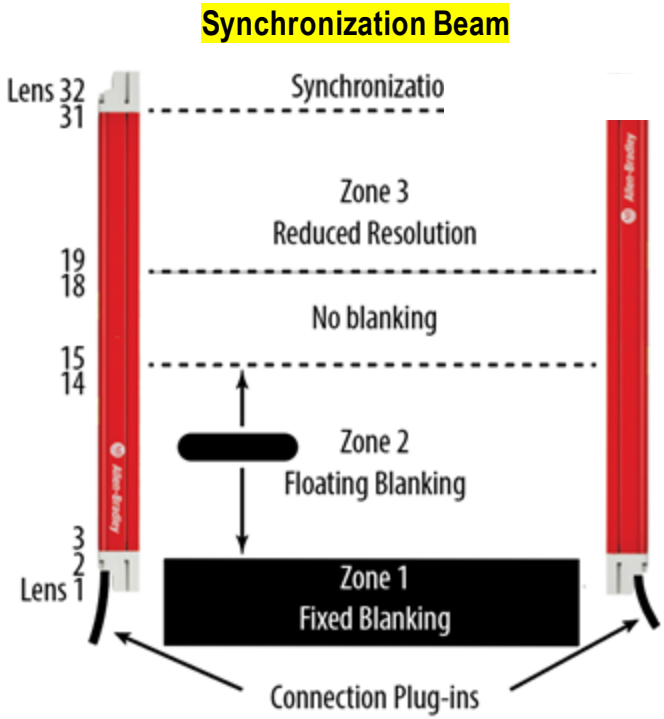
Alignment and Blanking

- Patented Integrated Laser Alignment System
  - For quick and easy installation



Start/Stop Laser

Laser Target



Three Zone Blanking Example With Finger Resolution

450L CIP Safety over EtherNet/IP - Cost and Requisites

<u>Minimum Requirements</u>

450L LC fw 5.002

LC fw 5.001 is field upgradeable

Older versions of LC are not field upgradeable

RSLogix5000 V24

Revisions before V32 have limited capability to change configurations in program mode

Questions?

SafeZone 3 Safety Laser Scanner
CIP Safety Over EtherNet/IP

SafeZone 3 Safety Laser Scanner

Replaceable optic cover

Status LEDs

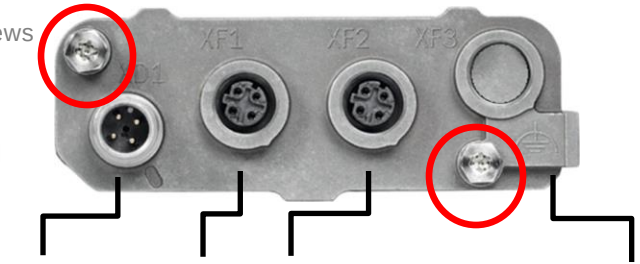
Push buttons to scroll through menu

Multi-colored display screen

Network status LEDs

DHCP is enabled, requires BootP to set IP address

SafeZone 3 Safety Laser Scanner



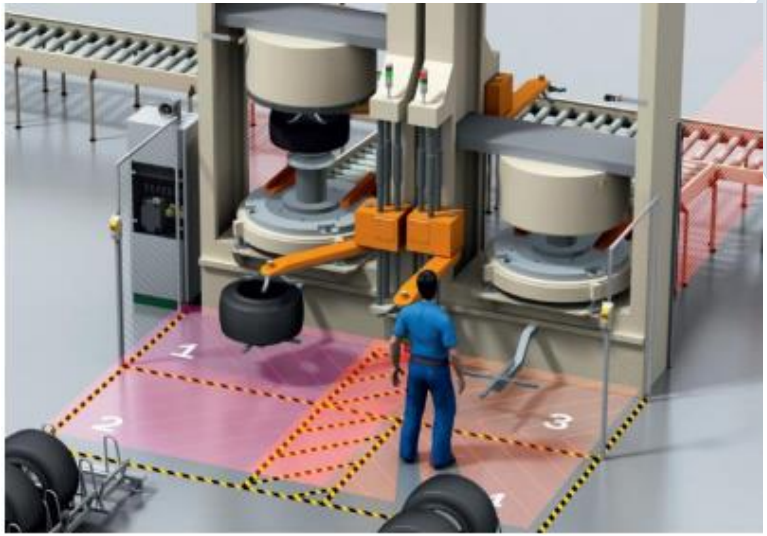
System plug mounting location

- **The SafeZone 3 requires a system plug (442L-SZNCPMOD) which stores the scanner configuration and network information**
- **The system plug can be installed in either the back or bottom of the SafeZone 3 scanner depending on how the scanner will be mounted in the application**
- **This diecast system plug has a 4-pin M12 qd power connection (XD1), two 4-pin D-Coded M12 qd EtherNet connectors (XF1 & XF2) as well as an alternative grounding connection (FE).**
- **Because the system plug stores the configuration, if a scanner head is damaged, the system plug can be removed from the scanner and assembled to a new scanner. The new scanner pulls the configuration information from the system plug and the SafeZone 3 is back on-line.**
- **The system plug cables do not need to be removed and the system plug can stay powered during swap**

SafeZone 3 Safety Laser Scanner

Technical Data	
Safety Integrity Level **Performance level**	**2** **d**
Dimensions	135 mm x 110 mm x 110 mm
Safety field range	5.5 meters
Scanning angle	275°
Response time	Minimum: 60 ms
Resolution	30/40/70/150/200 mm
Fields	8
Monitoring cases **Simultaneously Monitored**	8 4
Functions	Restart Interlock, Multiple sampling, Reference Contour
Enclosure rating	IP 65
Temperature range	-10°C (14°F)...+ 50°C (122°F)

Increased functionality results in expanded application solutions

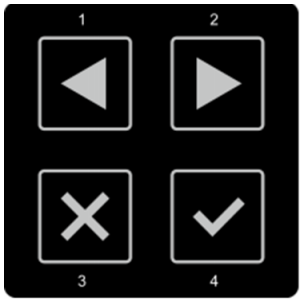


Configuring 4 simultaneous protective fields allows the SafeZone 3 to monitor 4 separate areas simultaneously thereby controlling several hazardous points without having to switch between preconfigured field sets.

SafeZone 3 Safety Laser Scanner

- **Hardware**: type code, part numbers, serial numbers, firmware versions, functional scope of device
- **Configuration**: device name, application name, checksum, date of last configuration, functional scope of the configuration
- **Network:** MAC id address, IP address, sub-network
- **Data output**: status, target IP address

- **Intrusion history**: position and time of the last 10 objects in a protective field that have led to a safety output switching to the OFF state.
- **Message history**: error code and error type of the last 10 error messages.
- **Service**: currently measured contamination of the optics cover, operating hours, number of power-up processes.



- Restart the safety laser scanner.

Keypad provides access to the SafeZone 3 Display Menu

Arrow Buttons 1 and 2 allow scrolling through menu.

Button 3 is Back

Button 4 is OK

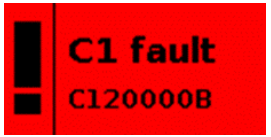
- Set the display brightness and contrast.

- **The menu offers access to the main areas of device information, diagnostics, device restart and settings**

SafeZone 3 Safety Laser Scanner

Bright Multicolor Text Display

Easy-to-understand displays, providing current status and diagnostic information

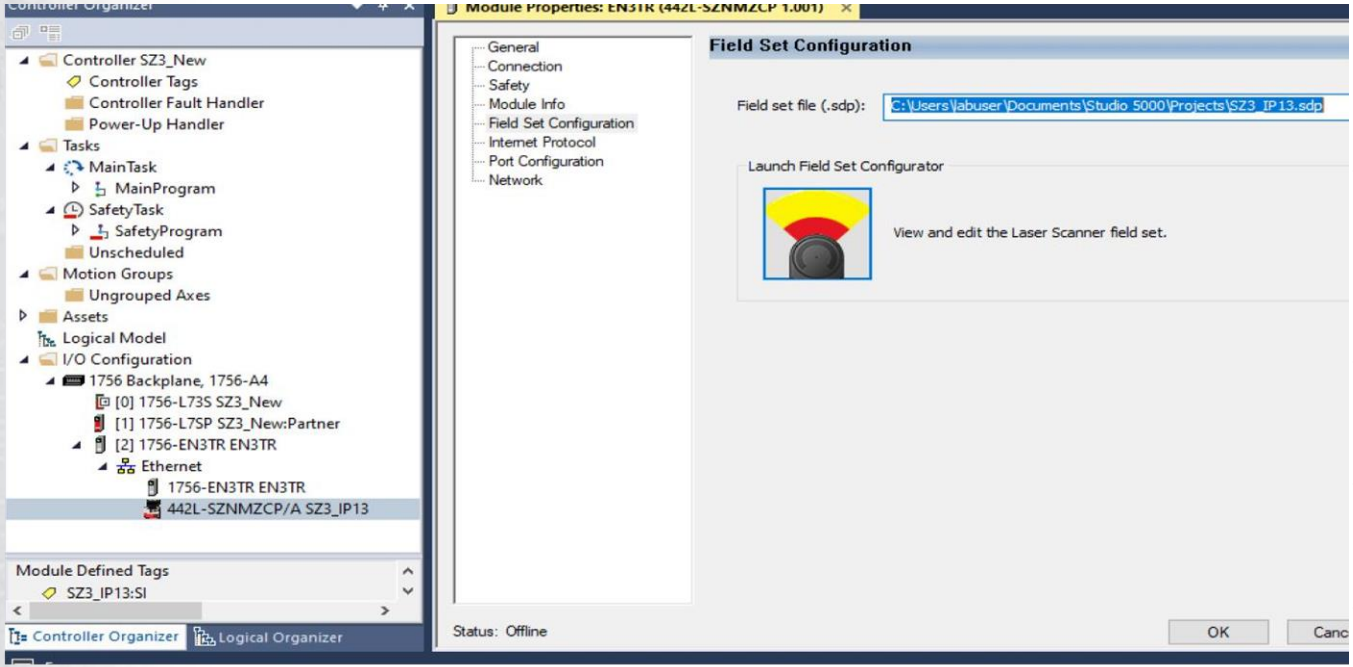


- **More than 20 different display screens show current information about the safety laser scanner's status**
- **The display screen switches off after 60 seconds if all fields are clear and no other notification is displayed**

SafeZone 3 Safety Laser Scanner

- **442L AOP and EDS File**

SafeZone 3 uses a standard Rockwell AOP with the addition of the Field Set Configuration tab



- **SafeZone 3 EDS File and AOP can be downloaded from the Rockwell PCDC site** Search PCDC Results (rockwellautomation.com)
- **EDS file provides the SafeZone 3 icon in the I/O tree**
- **Field Set Configuration tab in the AOP is the SafeZone 3 programming tool**
- **Double clicking on the scanner icon launches the configuration tool**

SAFE ZONE 3 LASER SCANNER

Live Demonstration

Questions?

Advanced Safety Features with Kinetix and Powerflex Drives

Integrated safety functions

Non-integrated safety system

Integrated safety with safety functions for drives and motion

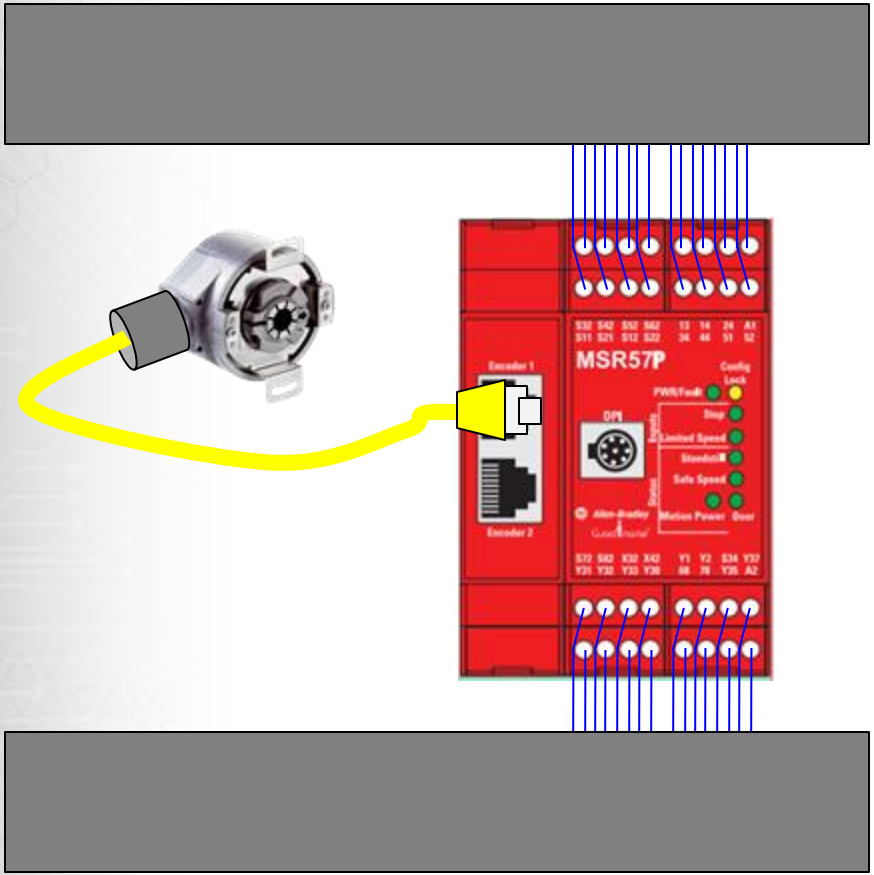
- **Safety functions for VFDs and motion are becoming increasingly integrated**
  - Using drives with controller safety functions can mean that we can omit electromechanical components and their associated wiring, which was required previously
  - Even safety-relevant signals can be transmitted via CIP Safety, reducing the complexity and expense of wiring

Drive control terms

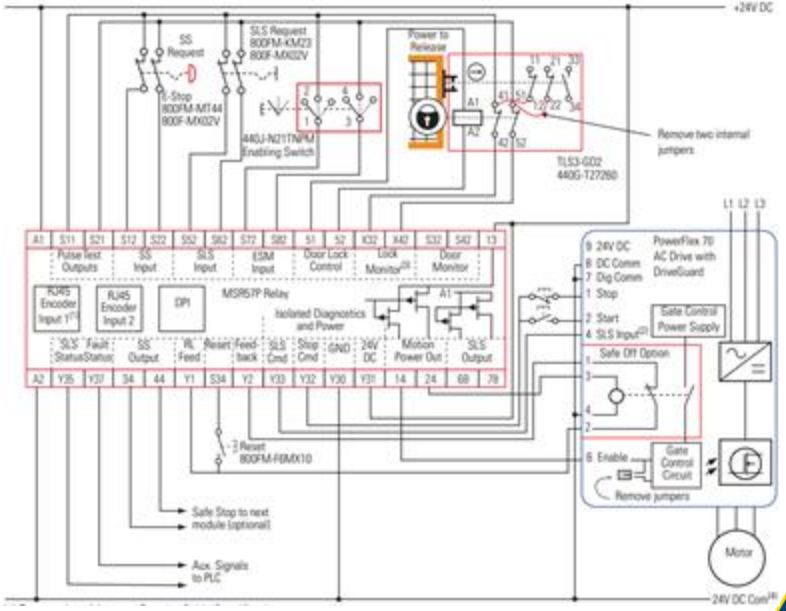
- IEC 61800 Adjustable speed electrical power drive systems
  - Part 5-2: Functional safety requirements
    - **Stopping functions**
      - Safe Torque Off (STO)
      - Safe Stop 1 (SS1)
      - Safe Stop 2 (SS2)
  - **Output Function:**
    - Safe Brake Control (SBC)

- **Safety Monitoring Requirements**
  - Safe Operating Stop (SOS)
  - Safely-Limited Speed (SLS)
  - Safe Speed Monitor (SSM)
  - Safe Speed Range (SSR)
  - Safely-Limited Position (SLP)
  - Safely-Limited Increment (SLI)
  - Safe Direction (SDI)
  - Safely-Limited Acceleration (SLA)
  - Safe Acceleration Range (SAR)
  - Safely-Limited Torque (SLT)
  - Safe Torque Range (STR)
  - Safe Motor Temperature (SMT)
  - Safe Cam (SCA)

Old Way - Speed and position control system – Kinetix® drive or Powerflex® drive

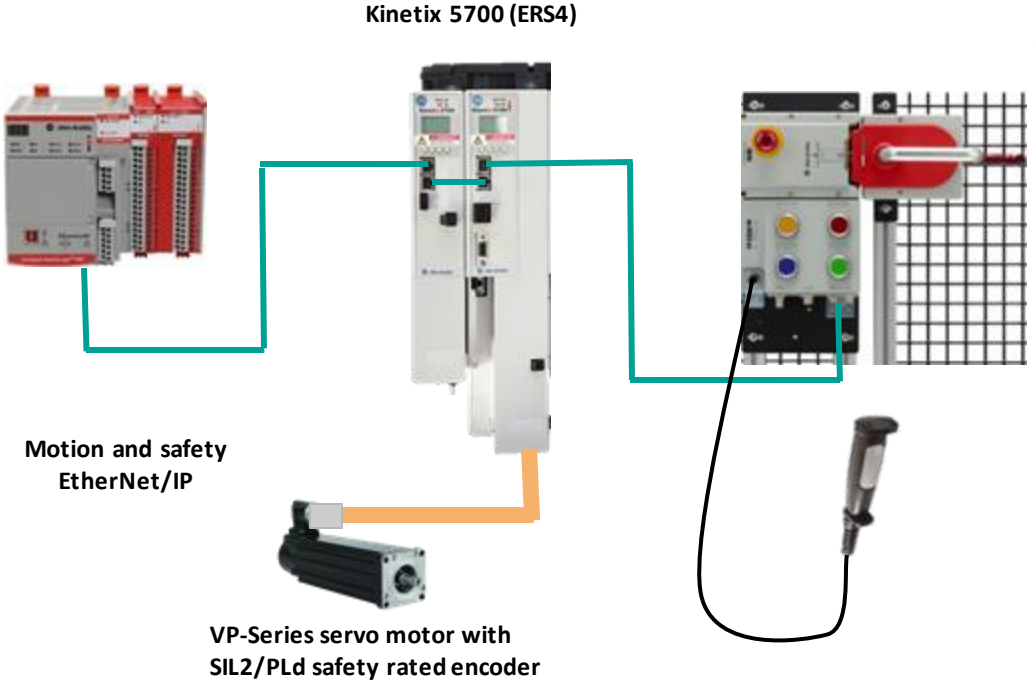


- E-stop
- Safe-Limited Speed guard door
- Lock monitor
- Enabling switch
- PowerFlex® STO drive



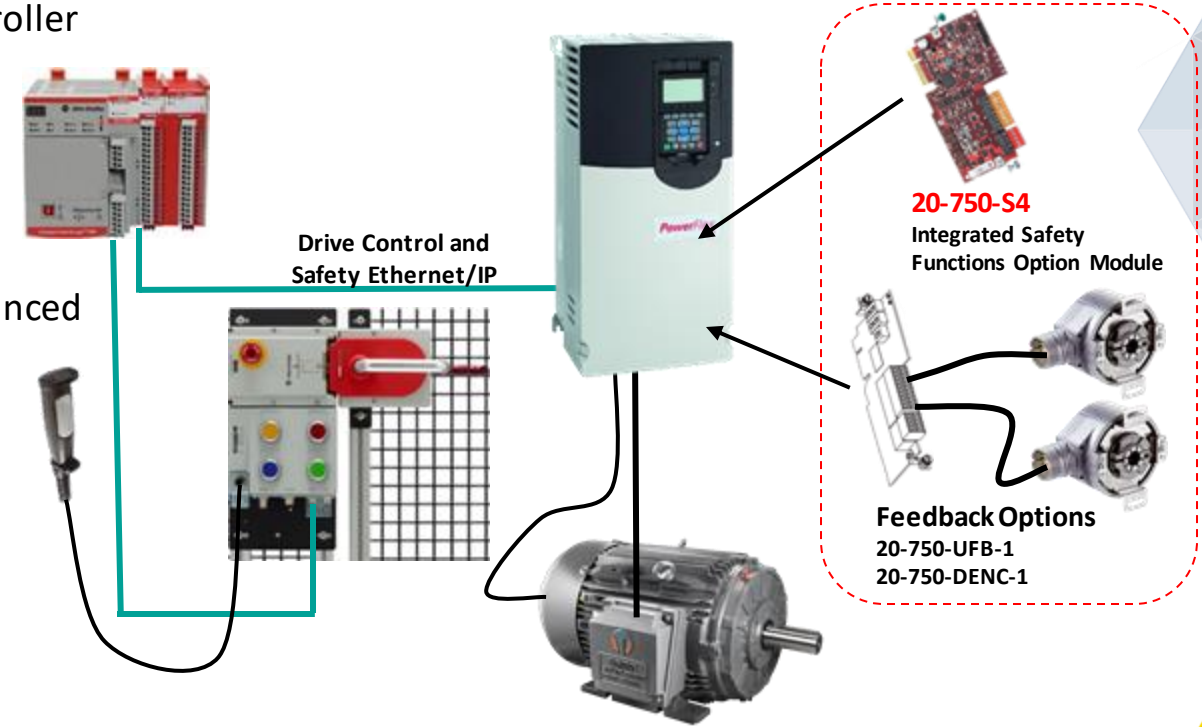
Speed and position control system - Kinetix® 5700 drive

- 5380 Compact GuardLogix controller
- Multifunction access box - CIP
- Enabling switch
- Kinetix 5500 or 5700 drive
  - 5500-ERS (Hardwire STO)
  - 5500-ERS2 (CIP Safety STO)
  - 5700-ERS3 (CIP Safety STO)
  - 5700-ERS4 (Integrated Advanced Safety)



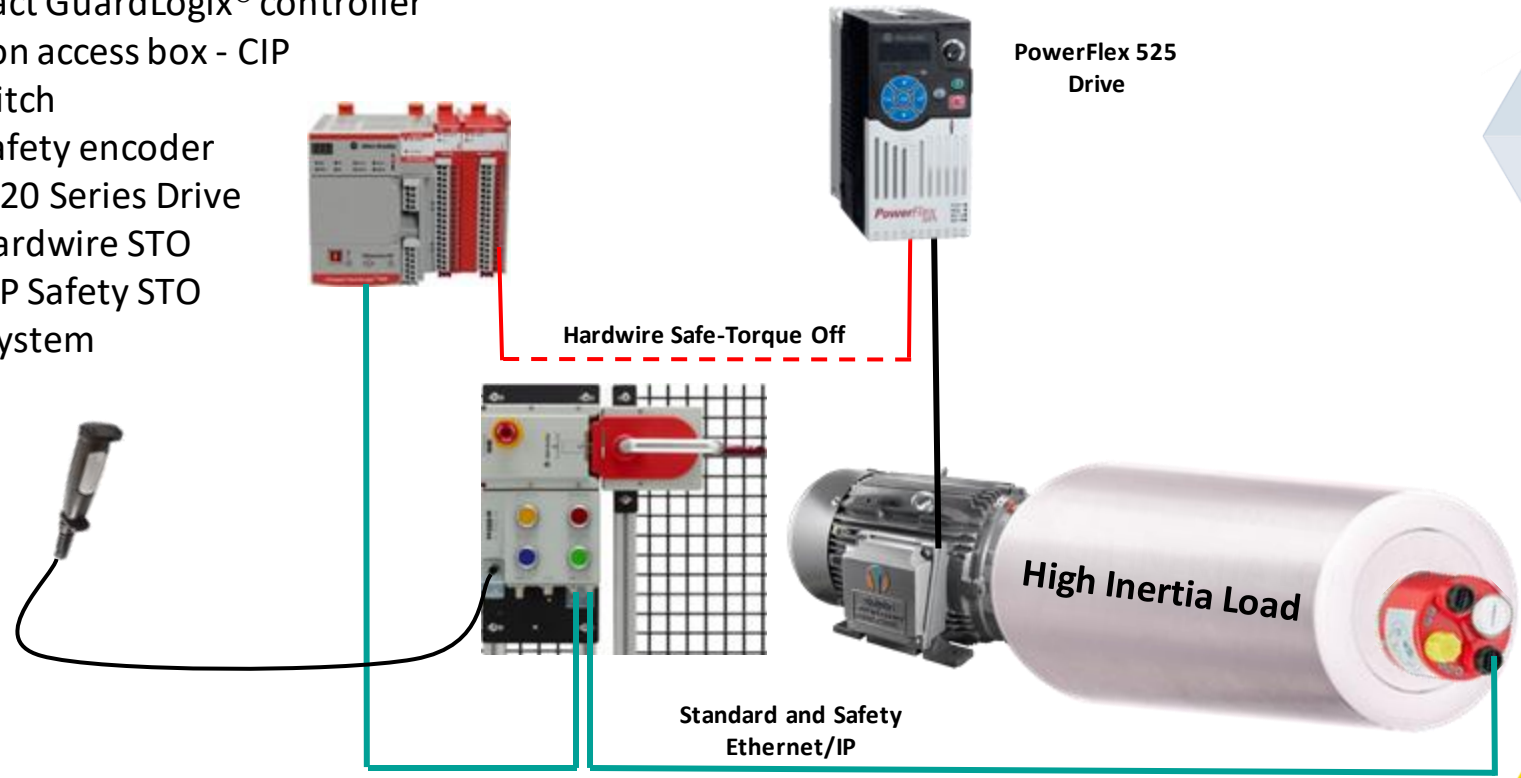
Speed and position control system
PowerFlex® 755 drive

- 5380 Compact GuardLogix® controller
- Multifunction access box - CIP
- Enabling switch
- PowerFlex® 755 drive
  - 20-750-S (Hardwire STO)
  - 20-750-S3 (CIP Safety STO)
  - 20-750-S4 (Integrated Advanced Safety)

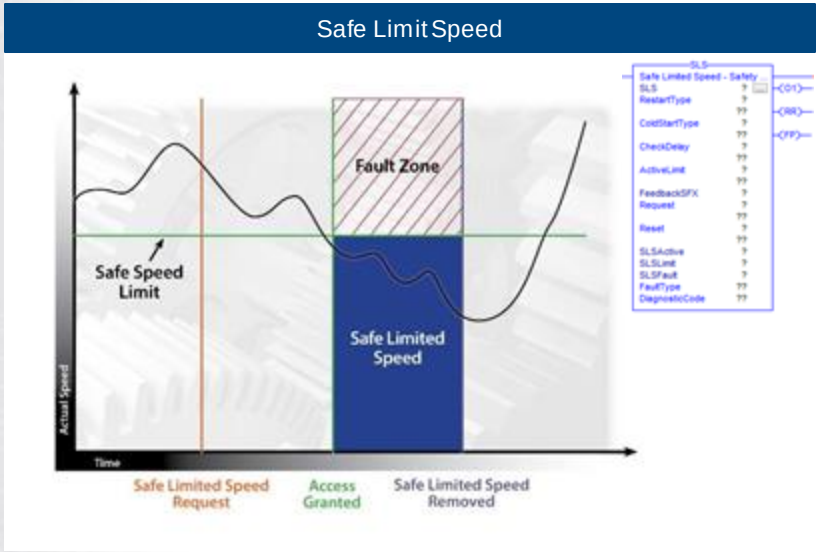


Speed and position control system
843ES CIP Safety encoder

- 5380 Compact GuardLogix® controller
- Multifunction access box - CIP
- Enabling switch
- 843ES CIP Safety encoder
- PowerFlex 520 Series Drive
  - 525 Hardwire STO
  - 527 CIP Safety STO
- PLe Safety System



Integrated safety functions



- **The safety functions within drives and servos are the certified building blocks for modern safety systems**
  - Properly engineered and validated systems can provide
    - Improved asset utilization like reduced floor space
    - Improved machine cycle times
    - Increased system yield
    - Improved operator ergonomics
    - Reduced repetitive stress injuries
    - Pre-certified safety functions reduce the amount of engineering and testing required
  - These capabilities are fundamentally changing the way that people and machinery can interact, by leveraging the strength and diligence of the machine with the flexibility and intelligence of the human

Drive safety instructions: Safe Feedback Scaling (SFX)

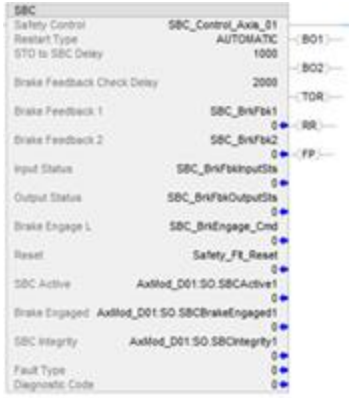
- Scaling velocity and position feedback to engineering units
  - From Safety Drive Input to Safety Task
- Outputs:
  - Position in “position unit”
  - Speed in “position unit / time”
  - Unwind cycles
- Outputs used as inputs to the drive safety instructions
- Safety home:
  - Redefine the axis position
  - Define an absolute position safety reference point

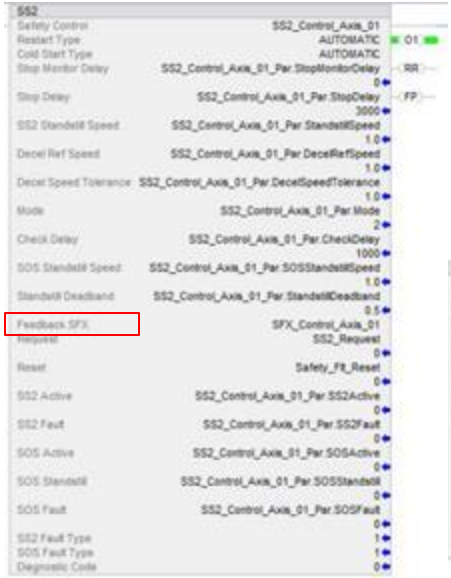
Drive safety instructions

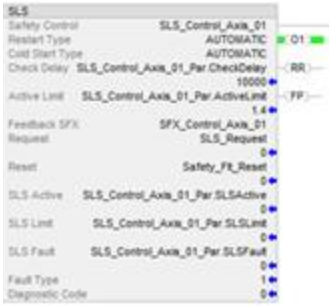
IEC-61800-5-2 › Adjustable speed electrical power drive systems – Safety requirements - Functional

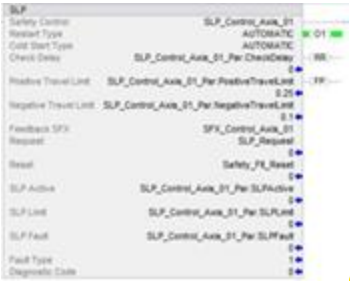
- SFX (Safe Feedback Scaling)
- SS1 (Safe Stop 1)
- SS2 (Safe Stop 2)
- SOS (Safe Operating Stop)
- SLS (Safely-limited Speed)
- SLP (Safety-limited Position)
- SDI (Safe Direction)
- SBC (Safe Brake Control with external brake)

- ONLY in Compact GuardLogix® 5380 and GuardLogix® 5580 controllers



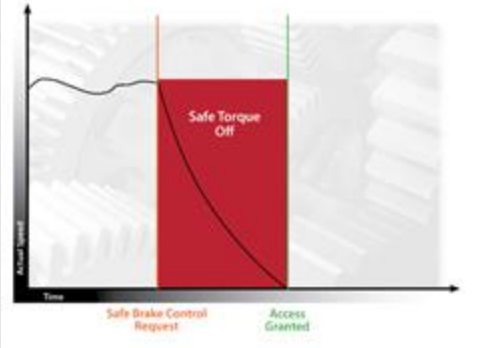






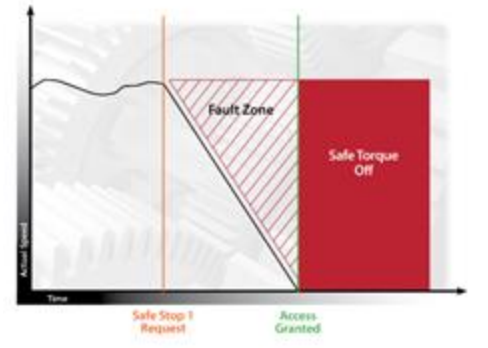
Safe Stop functions

Safe Torque Off



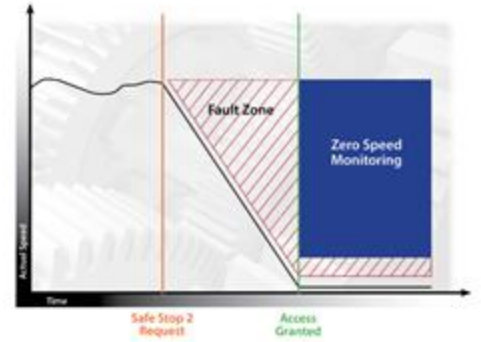
Removes power that can cause rotation or motion. The drive will not provide **energy** to the motor, which can generate torque or force.

Safe Stop 1



Initiates and monitors the motor deceleration rate within set limits to stop the motor and initiate the Safe Torque Off (STO) function when the motor speed is below a specified limit.

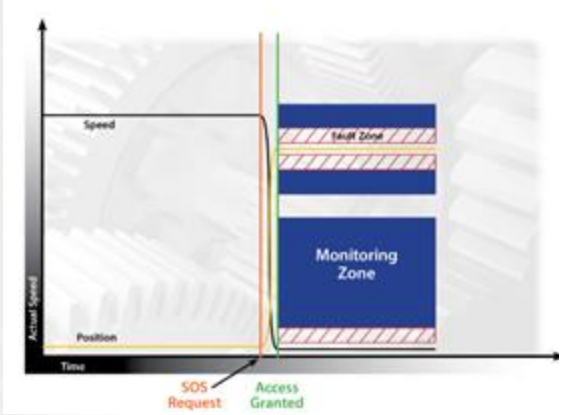
Safe Stop 2



Initiates and monitors the motor deceleration rate within set limits to stop the motor and initiates the Safe Operating Stop function when the motor speed is **below a specified limit.**

Safe Stop functions

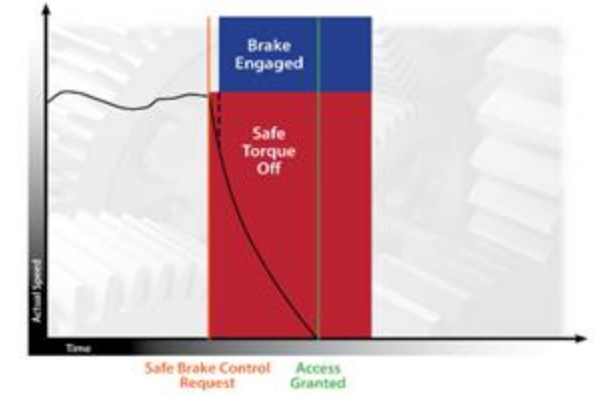
Safe Operating Stop (SOS)



Can monitor either position or speed of motor while stopped

The SOS function helps prevent the motor from deviating more than a defined amount from the stopped position. The drive provides energy to the motor to enable it to **resist external forces.**

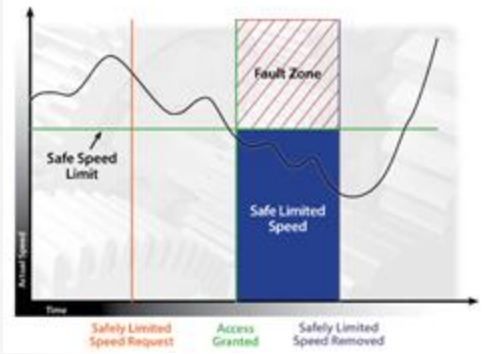
Safe Brake Control



Provides a safe output signal to control an **external brake**. The SBC function is coordinated with the STO function.

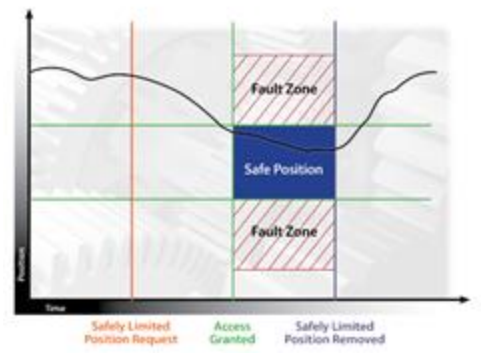
Safe Monitoring functions

Safely-limited Speed



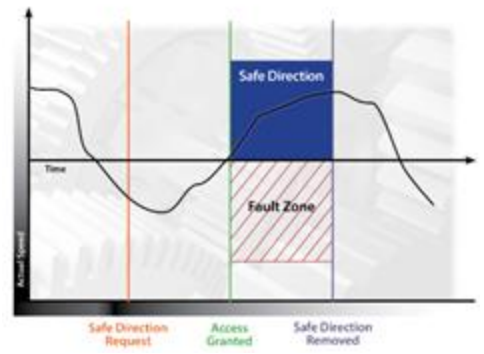
The SLS function helps prevent the motor from exceeding the specified speed limit.

Safety-limited Position



The SLP function helps prevent the motor shaft from exceeding the specified position limit.

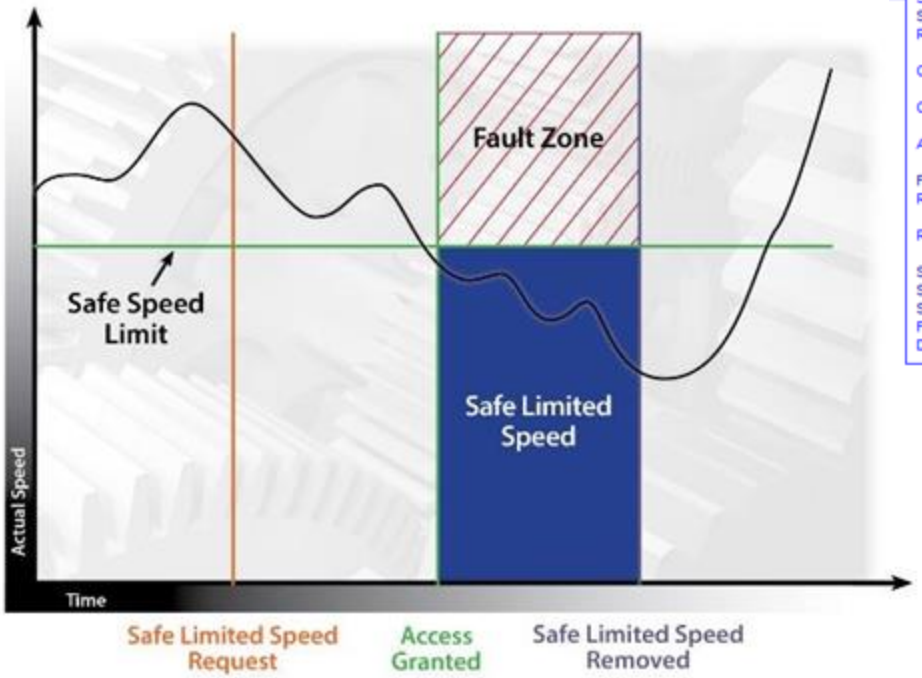
Safe Direction



The SDI function helps prevent the motor shaft from moving in the unintended direction.

http://machinesafetysolutions.com/

Safe Limit Speed



SLS

Questions?

Safety IO Platforms

Safety IO Platforms

ControlLogix® controllers

Chassis-based I/O modules
- I/O diagnostics for detection of both system and field-side failures
- Electronic keying to help prevent replacement errors
- Wide range of modules from high performance to process control

Compact 5000™ modules

Discrete machine I/O modules
- High-performance Compact 5000™ I/O modules for CompactLogix™ 5380 and ControlLogix® 5580 controllers
- High-density Compact I/O™ for CompactLogix™ 5370 controllers

FLEX™ I/O modules, FLEX 5000™ I/O modules

Process distributed I/O modules
- High-performance FLEX 5000™ I/O modules for CompactLogix™ 5380 and ControlLogix® 5580 controllers
- High-channel density on a distributed platform

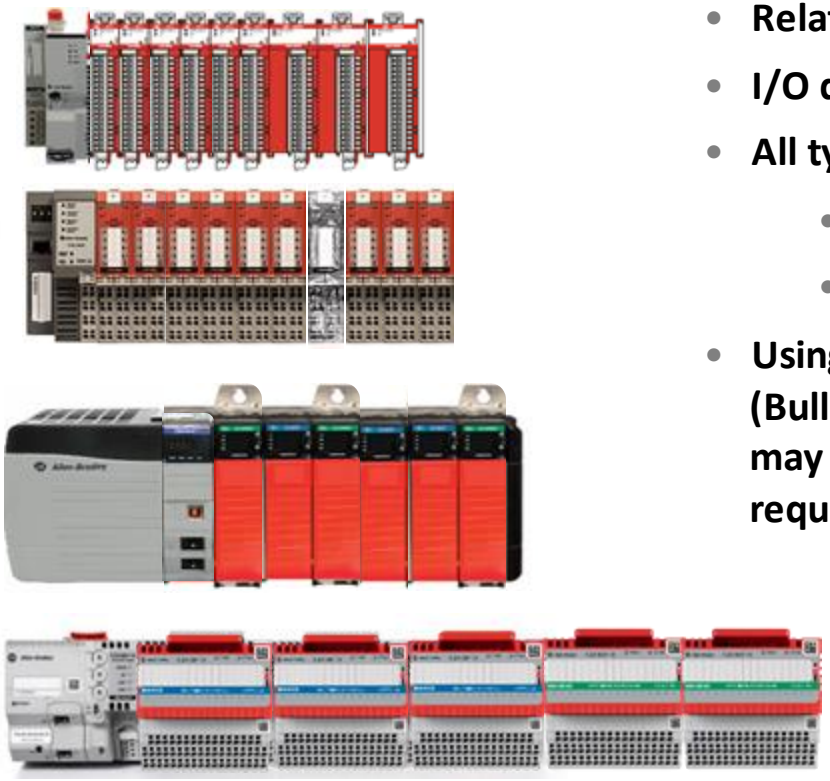
POINT I/O™ modules

Smart machine distributed I/O modules
- Low-cost platform with lower density inputs and outputs
- Compact design makes installation easier
- Machine safety, specialty, and I/O-Link options available

ArmorBlock® I/O modules

On-Machine™ I/O modules
- IP67 rated modules
- Reduces wiring and panel space
- Quick connect for daisy chaining modules
- Analog, digital, specialty, machine safety, and I/O-Link options available

Comparable Safety I/O Density



- **Relative size compared**
- **I/O density shown: 48 input + 24 output**
- **All typical hardware included**
  - Adapter
  - Power supply
- **Using ControlLogix® safety I/O modules (Bulletin 1756) for remote power supply may further optimize panel space requirements.**

Key Features at a Glance

Enabling customer compliance with a secure, common user experience and scalable safety ratings

Machine focus

- Compact 5000™ I/O modules (Bulletin 5069)
- Optimized footprint fits tight panels
- Highest performance platform
- Broadest price range
- Local or distributed usage

Distributed and harsh duty focus

- FLEX 5000™ I/O modules (Bulletin 5094)
- Fixed field wiring termination
- Hold last state feature
- Operating temperature -40…+70 °C (-40...+158 °F)
- Fiber and copper media
- Mount horizontal or vertical
- Distributed usage only

Integrated Architecture® focus

- ControlLogix® I/O modules (Bulletin 1756)
- Leverage on rack-based portfolio values
- Hold last state feature
- Local or distributed usage

IO Considerations

	As used with CIP Safety™ Logix controllers			
Distinguishing feature	**Compact 5000™ I/O module Bulletin 5069**	**POINT I/O™ module Bulletin 1734**	**FLEX 5000™ I/O module Bulletin 5094**	**ControlLogix® I/O module Bulletin 1756**
Max SIL/PL rating	SIL 3/PLe	SIL 3/PLe	SIL 3/PLe	SIL 3/PLe
Fixed field wiring terminals	No	Yes	Yes	No
I/O module types available	DI, DO	AI, DI, DO	DI, DO, relay AI+AO in future	DI, DO
Channel isolation	None	None	Yes, in analog and relay	None
Demand rate	Low & High	Low & High	Low & High	Low & High
Controller support	5380/5580 series only	5370/5570 series 5380/5580 series	5380/5580 series only	5380/5580 series only

Key features distinguish each platform, along with user preference

Maximum Safety Reaction Time

FLEX 5000™ I/O modules
ControlLogix® I/O and
Compact 5000™ I/O modules

6 ms input
4.5 ms output

POINT I/O™ modules

16.2 ms input
6.2 ms output

ControlLogix 1756 I/O modules overview

1756 ControlLogix® I/O modules, with CIP Safety™ technology

- **New** - chassis-based, **local** I/O
- Can also be used as distributed I/O via bridging/routing
- **New** - enhanced reaction time (compared to POINT Guard I/O™ modules)

Flexible

- Any ControlLogix® safety I/O module can be used in combination with all other standard ControlLogix® I/O modules
- Use with Compact GuardLogix® 5380 or GuardLogix® 5580 controllers (Studio 5000® software V32 or newer release required)

Safety rated:

- Up to SIL 3, PLe Certified Modules
- Digital input modules: **1756-IB16S – 16 channels (each SIL 3 rated)**
  - Sinking input type
- Digital output modules: **1756-OBV8S – 8 channels (each SIL 3 rated)**
  - **New** - one module covers both sourcing and bipolar type outputs
  - 8 sourcing outputs or 8 bipolar outputs per module, user configurable
  - **New** - Hold last state feature, maintain output on communications loss

High density I/O platform, for 1756 I/O users
Use to satisfy fail to safe machinery and shutdown applications

CompactLogix 5069 I/O modules overview

- **Supports both single and dual channel configuration**
- **Single channel - Safety CAT 3, in applications rated up to and including PL d/SIL 2 with safety pulse test enabled**
- **Dual channels - Safety CAT 4, in application rated up to and including PL e/SIL 3 with safety pulse test enabled**
- **Diagnostic capability:**
  - Short circuit, muting lamp error, over & critical temperature, field power OFF, internal fault, overload detection with test output

- **Supports bipolar and sourcing type configuration**
- **Fault of one channel does not shut down the whole module**
  - Only the affected group is shut down
  - POINT Guard I/O™ shuts down the whole module
- **Single channel - Safety CAT 4, in applications rated up to and including PL d/SIL 2 with pulse test enabled, IEC 60947 for contactors/actuators**
- **Dual channel - Safety CAT 4, in application rated up to and including PL e/SIL 3 with wiring according to EN 13849 and safety pulse test enabled**
- **Diagnostic capability:**
  - Short circuit, no load (open wire), overload, over & critical temperature, field power OFF, dual channel fault (only sourcing mode)

Flex 5094 I/O modules overview

Safety digital 16 input

- SIL 3, PLe, Cat. 4 single channel[#]
- 6 ms safety reaction time*
- 8 test output: pre-assigned
- Test output rating: 0.2 A
- Overload detection with test output

Safety digital 16 output

- SIL 3, PLe, Cat. 4 single channel[#]
- 4.5 ms safety reaction time*
- Output rating: 0.5 A
- 1.8 A surge current for 150 ms*
- Safety mode, safety pulse mode

Safety relay 4 output

- SIL 3, PLe, Cat. 4 single channel[#]
- 20 ms safety reaction time*
- Output rating:
  - 2 A – 4 channel 24V DC/120-240AC
  - 4 A – 2 channel only – 24V DC
- 100K cycles @ 2 A resistive load
- Safety mode

[#]Module SIL Capability. See FLEX 5000™ modules technical data (5094-TD001) for more details.
**Conditions apply*

FLEX 5000™ safety HART I/O modules

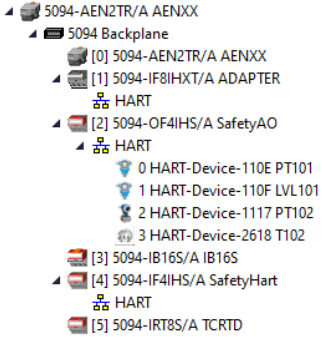
- **Analog 4-channel isolated current/voltage/HART safety modules**

Features and benefits

- 4-channel to channel isolated input and output modules
- Up to SIL 3, PLe, Cat. 4 single channel
- Up to 10 ms safety reaction time
- Each channel can be configured as current, voltage or HART individually
- HART V7, V6 and V5 support
- Current sourcing of isolated loop power
- Readback functionality for outputs
- Per channel diagnostics with time stamp and protection
- New Logix feature – highly integrated HART (HIH)
  - Visible access to HART devices
  - HART bus in Studio 5000 Logix Designer® application I/O configuration tree
  - Device connection fault status representation in I/O tree
  - Add and replace HART devices online
  - Integrated device information view

Catalog 5094-IF4IHS
Catalog 5094-IF4IHSXT

Catalog 5094-OF4IHS
Catalog 5094-
OF4IHSXT



FLEX 5000™ safety specialty I/O modules

- **Safety modules for temperature and frequency measurement**

Safety thermocouple/RTD input modules

Features and benefits

- 8-channel RTD/thermocouple safety input Modules
- Four isolated groups of two channels per group.
- 2-wire, 3-wire and 4 wire RTD mode
- Thermocouple with built-in per channel CJC
- Up to SIL 3, PLe, Cat. 4 single channel
- Up to 10 ms safety reaction time

Catalog 5094-IRT8S

Safety frequency input modules

Features and benefits

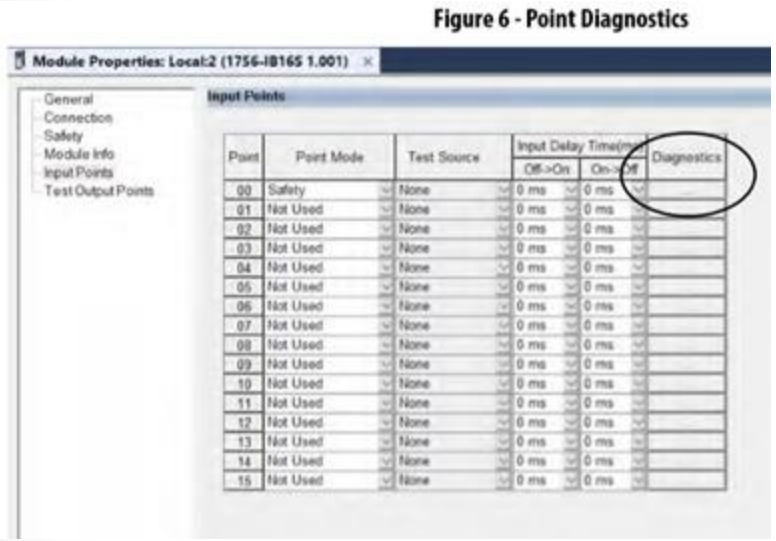
- 2-channel Isolated frequency input Modules
- Supports AC and DC signal frequency measurements
- Supports frequency, acceleration, and direction
- Supports up to 50KHz input measurement.
- Up to SIL 3, PLe, Cat. 4 single channel
- Up to 10 ms safety reaction time

Catalog 5094-IJ2IS

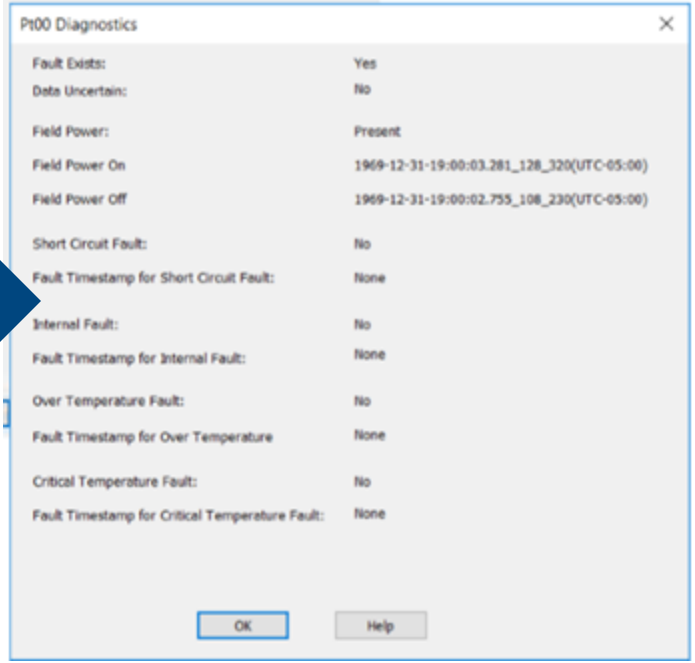
New online module diagnostics

- NEW tags within each Add-on Profile
- Individual tags per channel
- No messaging needed!

Figure 6 - Point Diagnostics

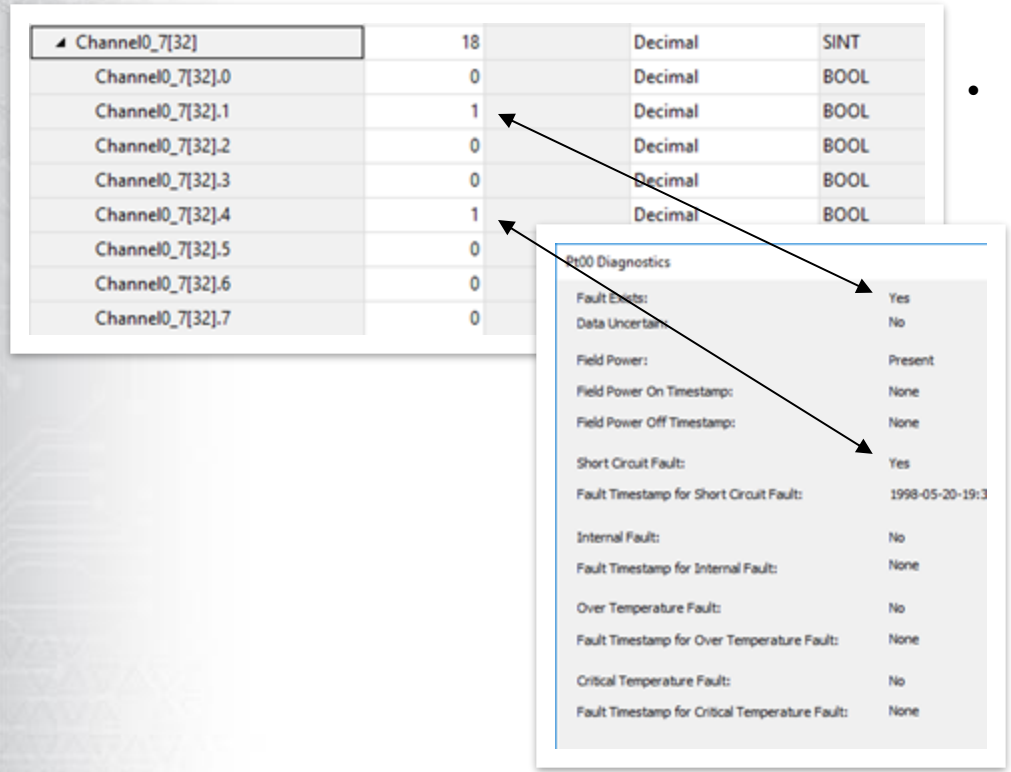


CLICK

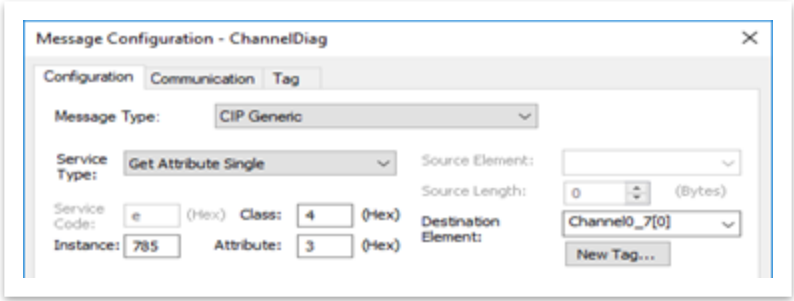


New tags added to accompany diagnostics

In ControlLogix®, Compact 5000™ and FLEX 5000™ safety I/O modules



- **Assembly instances to access data shown in the popup window**
- **Example: Catalog 1756-IB16S**
  - **Instance for input channels 0-7**
  - **Instance for input channels 8-15 (not shown)**
  - **Instance for test output channels 0-7 (not shown)**



Questions?

Integrated Machine Safety Demonstration

Task: Provide feedback on survey being sent out based on today's content and training