T91 - How to Select the Right Machinery Safety Logic System
The Big Picture

Distributed Inputs
Connection systems
Sensors [e.g. Interlock switch]

Networks
Logic Solver [e.g. Programmable Controller]
Logic Solver [e.g. Modular Relay]

Distributed Outputs
Actuators [e.g. Contactors]

ACTUATOR

SENSOR

LOGIC SOLVER

CONTROL SYSTEM

Rockwell Automation has the broadest portfolio of safety sensors, safety logic systems, and safety actuators
The Big Picture - Safety Logic Devices

Safety Logic Devices

- Safety Logic devices monitor the status of safety input devices, make decisions, and tell the safety output devices what to do.
- In many cases, these devices are capable of testing the input devices:
  - Electromechanical devices like E-Stops
  - N/A for OSSDs like Light Curtains
- In many cases, they monitor the safety output devices.
Agenda

Introduction

Safety Logic System Functionality and Purpose

Types of Safety Logic Systems

Market Segments

Differences in Safety Logic Systems

Determining the Best Safety System for You

How Rockwell Automation can Help
Logic Functionality

Monitoring → Control → Diagnostics

Monitoring

Control

Diagnostics
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There are 3 safety logic architectures that can be used to provide safety control:

- Dedicated Relay
- Modular Relay or Controller
- Safety PLC’s

Safety PLC’s

Modular Relays & Safety Controllers

Dedicated Relay
Safety Market Segmentation of 2009

- The largest market for safety products is with the low to mid range OEMs.

30% of respondents use **contemporary/integrated** safety solutions.

70% use hard-wired relay-based safety systems.

Source: *Control Design* Magazine Survey, June 2009
Safety Market Segmentation of Today

Cutting & slicing Machines  Shrink Wrappers  Form Fill & Seal Machines  Palletizers & De-palletizers  Case Packer Systems  Food & Beverage Bottle labeling  Integrated Bottling Lines

Discrete safety  Modular & Programmable safety  Integrated safety

40% of the market  30% of the market  30% of the market

Low end safety relay market  Mid level safety relay & controller market  High level safety controller market
The Project Safety Market Segmentation

- Cutting & Slicing Machines
- Shrink Wrappers
- Form Fill & Seal Machines
- Palletizers & De-palletizers
- Case Packer Systems
- Food & Beverage Bottle Labeling
- Integrated Bottling Lines

Discrete safety: 34% of the market

Modular & Programmable safety: 33% of the market

Integrated safety: 33% of the market

- Low end safety relay market
- Mid level safety relay & controller market
- High level safety controller market
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Discrete Safety Systems Characteristics

Discrete safety systems tend to use Micro controllers and simple safety relay solutions with 1 zone of control & little to no motion control and less than 10 safety I/O:

Simple safety input monitoring and power isolation

Simple safety input monitoring and drive control

**Benefits:**

- Low cost
- Simple installation
- Just enough control for small applications
- Easy diagnostics at the relay
Modular & Programmable Safety systems require more than discrete safety systems but need low cost solutions. These systems use modular controllers and have less than 30 points of safety I/O, 2 to 4 zones of control, 1 to 8 axes of motion control, and 2-6 screens of visualization.

Benefits:
- Low to medium cost
- Simple installation
- Just enough control for the application
- Easy diagnostics at the relay and HMI
- Expandable
- Networkable
- Can do some zone control
Integrated Safety solutions in tend to be solutions that are large, complex and distributed. These systems often have multiple zones of control, distributed I/O, multiple axis of motion control, high I/O counts and complex standard & safety needs.

**Benefits:**
- Scalable
- Networkable
- Modular
- Easy diagnostics via communications to a common HMI screen.
- Expandable
- Flexible
- Productivity Gains
- Efficiency Gains
These Integrated Systems use Contemporary Safety Solutions that enhance machinery operations!

- **ControlLogix chassis**
- **PowerFlex 755 Armor**
- **Block I/O**
- **EtherNet/IP**
- **PV+ EOI Safety Relay**
- **Stratix 8000**
- **Kinetix 6000**
- **DeviceNet**
- **POINT I/O**

Data & diagnostics can be displayed on one HMI.

- **Safety relays & contactors may not be required.**

**Benefits**

- Information enabled.
- Fewer components.
- Less training.
- Streamlined maintenance.
- Optimal connectivity with multiple networks.

Data & diagnostics can now be integrated into GuardLogix. Data & diagnostics can be displayed on one HMI.

- Fewer components.
- Less training.
- Streamlined maintenance.
- Optimal connectivity with multiple networks.

Safety relays & contactors may not be required.
Integrated Safety Systems

Shared assets across standard & safety control drive cost savings and add significant value throughout the manufacturing process.
Competitive solutions typically require 2 or 3 different software packages and 20-30% more engineering and design time than the equivalent safety system from Rockwell Automation!
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- How Rockwell Automation can Help
Which Safety System is Best for You? Follow the safety lifecycle to find out!

1. Hazard or Risk Assessment
   Identify Hazards & estimate the associated risk

2. Functional Safety System Requirements
   Based on:
   - Risk Assessment
   - System performance
   - Applicable standards

3. Design and Verification
   - System Architecture
   - Safety critical circuit design
   - Guarding design
   - Validation protocol

4. Installation and Validation
   - Final site assembly
   - Commissioning/Validation
   - Training
   - Final Risk Assessment Validation

5. Maintain and Improve
   - Verify that system requirements operate within specified parameter for Production and Safety
   - Preventative maintenance and system upgrades

Follow the Safety Life Cycle!

Complete Safety Functions with all of the necessary documentation.
Step 1: Do a Risk Assessment!

- ISO-13849-1 identifies a risk assessment as the means of determining risk levels, associated risk reduction methodologies, and the type of safety system performance that needs to be implemented.
- Risk assessments also help identify each hazard that needs to be safeguarded.
Step 2: Develop a Functional Specification!

- A Functional Safety Specification helps determine the proper safety function needed to protect people from each hazard on the machine/system.

- Functional specifications determine the following:
  - Safety system needs for each mode of operation.
  - Safety function(s) needed to mitigate each hazard/risk.
  - Safety system structure & technologies (Zones/Safe Speed/Safe Direction).
Step 3: Determine the system architecture and design criteria

- A Functional Safety Specification helps determine the proper mitigation techniques, the number of safety functions, and the system structure that is to be implemented.

- Now we need to determine the best logic solution for the machine/system.

- Things to consider:
  - What kind of system flexibility is needed?
  - Is the system hard-wired or distributed via networks?
  - Is the system large or small?
  - Does the system change functionality based on the mode of operation?
  - Does the system need to be expandable?
  - What type of process/machine controller used?
  - What are my maintenance people familiar with?
Factors in Determination of Design

- Category, PL, or SIL level requirement
- Functional requirements
- Compatible interfaces to sensors and actuators
- System size / footprint
- System complexity – Logic Requirements
- Process complexity
- Zoning requirements
- Safety Monitoring / Diagnostics / Information
- Documentation, Validation, Reporting
- Cost
## Cultural Factors that Drive the Relay/Controller and GuardLogix Selection Process

### Relay & Controller
1. Customer does not use automation products
2. Customer’s Maintenance staff does not use PCs and is not software literate
3. Customer not clear on how safety systems will impact his business, plant, machinery, or processes
4. Customer very happy with SLCs, MicroLogix or similar low end PLC solutions

### GuardLogix
1. Customer is a sophisticated user of automation
2. Customer Uses Integrated Architecture / Logix
3. Customer has challenging applications and can deal with overhead to “get started”
4. Customer has numerous potential applications and wants to maximize productivity
Safety Logic System Options (Control Devices)

Safety PLCs - Functionality
- Certified up to SIL 3 / Cat 4
- IEC 61311 Programming
- Safety Specific Instructions
- Standard Networking Options
- Local or Distributed Safety I/O
- Safety Networking Options
- Discrete, Analog & High Speed Counter I/O

Safety Relays - Functionality
- Certified to Cat 4
- Electromechanical or Electronic
- Dedicated or Expandable
- Application Specific Units - Mats, Light Curtains
- Standard Networking Options - Diagnostics

Standards allow usage of programmable electronic safety controls.
Safety Relay/Safety Controller/Safety PLC Selection Matrix

Safety Relays
- 1 Zone
- Local/Hardwired I/O
- Simple Safety Logic
- 1 to 2 dual channel Inputs
- 2 to 3 outputs

Safety Controllers & Expandable Relays
- 1 to 3 Zones
- Local & Distributed I/O
- Simple & Complex Safety Logic
- 1 to 20 dual channel Inputs
- 1 to 25 outputs
- Basic Diagnostics thru PLC

Safety PLCs
- More Than 3 Zones
- Distributed I/O
- Simple & Complex Safety & Standard Logic
- 1 to 200 dual channel Inputs
- 1 to 200 outputs
- Advanced HMI Diagnostics
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Rockwell Automation Helps Customers with the Complex Subject of Safety

- Rockwell Automation has several tools that have been developed to help customers design safety systems quickly, easily, and accurately with minimal efforts.
- Several of these tools can be seen in the safety booth this year at Automation Fair:
  - Safety Automation Builder (SAB)
  - Safety Functions
  - Safety Accelerator Toolkit
  - Connected Component Building Blocks
- The following slides will show how these new tools can help improve your safety knowledge and design efforts.

Visit our Technical Team in the Safety Booth on the Automation Fair tradeshow floor for a full demonstration of these tools!
Safety System Design Tools

**Safety Automation Builder**
The Safety Automation Builder software package that allows users to import images of their machines. Users can identify hazardous access points and the associated hazards in order to develop a list of safety products that will be used to mitigate the risk. This gives the customer a complete drawing, a bill of material and SISTEMA calculation.

**Safety Functions Program**
The Safety Functions Program is building block approach to designing safety systems. Each building block has a complete documentation package that includes a description of each safety function, an electrical schematic, a bill of material, a SISTEMA verification calculation and a verification and validation plan.

**Safety Accelerator Toolkit**
This toolkit provides easy to use system design, programming, and diagnostic tools to assist you in the rapid development and deployment of your safety systems using GuardLogix, Compact GuardLogix, or SmartGuard 600 Controllers, Guard I/O, and Safety Devices. The toolkit includes a risk assessment and system design guide, hardware selection guide, CAD drawings, safety logic routines, and operator status and diagnostic faceplates.

**Connected Components Building Blocks**
These building blocks are tools that help customers develop safety solutions that utilize component class safety solutions. These building blocks include sample programs, electrical schematics and configuration documents that help in the configuration and start-up of safety systems.

Design tools to help users design safety systems quickly, easily and accurately with minimum effort!
### Complete Safety System Design & Verification Tool


![Complete Safety System Layout](image)

**Performance Level Verification**

**Complete Bill of Material**

<table>
<thead>
<tr>
<th>Catalog Number</th>
<th>Description</th>
<th>Diff</th>
<th>List Ea</th>
<th>Typical Delivery</th>
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<tbody>
<tr>
<td>445L-P4E0600FP</td>
<td>Micro 400 Safety Light Curtain, Pair, Res 30mm, Pt Ht 600mm</td>
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<td>$1,220.00</td>
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<td>M12 to RJ45, 5 meter</td>
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<td>Ribbon cable 10 pin for 2 extension</td>
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<td>440R-P226AGS-NNR</td>
<td>Multi function Controller for GuardShield Light Curtains</td>
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<tr>
<td>440R-D22R2</td>
<td>Guardmaster Safety Relay, 2 Dual Channel Universal Inputs, 1 N.C. Solid State Auxiliary Outputs</td>
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<td>$402.99</td>
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<td>100S-C37EJ14BC</td>
<td>MCS 100S-C Safety Contactor, 37A, 24V DC Inv/Elec. Coiil, Bifurcated Contact</td>
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<td>Digital Input Module, 16 Inputs, 24V DC</td>
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</table>

*Note: Performance Level Verification is a key feature of the SAB tool, ensuring all safety requirements are met before installation.*
Safety Function: Emergency Stop
Products: Light Curtain / GuardLogix
Safety Rating: PLe, Cat. 4 to EN ISO 13849.1 2008

Introduction
Important User Information
General Safety Information
Safety Function Realization
Setup and Wiring
Configuration
Programming
Falling Edge Reset
Calculation of PFHd
Verification and Validation Plan
Additional Resources
IA Safety Accelerator Toolkit
Development Tools and Quick Start Guide

Preconfigured Logic

Quick Start Manual

Follow These Steps
1. Open the Guard Logic application file.
   - Page 34
2. Configure your Guard I/O modules.
   - Page 35
3. Create your safety logic modules.
   - Page 36
4. Develop your safety device logic.
   - Page 37
5. Save and download your program.
   - Page 48

Create Your Safety Input Interface Logic

For our robot cell application example, we included all the Estop steps, the Light Curtain, and
two Interlocking switches to activate the
Safety Cell Inputs OK state tag.

Add Safety Output Logic

1. From the DeviceBox, open the appropriate
   safety output device instances for your safety
   category.
2. Select all the runs in the Routine, right-click,
   and choose CopyAll.
3. In your application, open the routine you
   want to copy the logic into.
Pre-designed Building Blocks with source code, drawings and quick-start guide to help you develop safety solutions!
Questions

PUBLIC INFORMATION