Introduction to Safety PLCs
GuardLogix & CIP Safety

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Agenda

- Basic Functionality
- Product Introduction
- Getting Started Programming
- Application Example
- Application Techniques
Stand-Alone vs Integrated Safety

- **Stand-Alone Safety**
  - Performs only safety tasks
    - GSR Safety Relay
    - 440C-CR30 Configurable Safety Relay

- **Integrated Safety Controller**
  - Performs both safety and standard tasks
    - GuardLogix and Compact GuardLogix
Why Integrated Safety

- Benefits of Programmable Safety Solutions
  - Flexibility
  - Productivity
  - Reduce Wiring Costs
  - Zone Control
  - Diagnostics
  - Integration
  - Reliability
  - Expandability
  - Security
  - Certification
GuardLogix – Redundant Safety

- Primary Processor
  - Full Standard Logix Functionality (Everything)
  - Isolated Safety Task (protected memory)
- Secondary Processor
  - Fully isolated Safety
SIL 3 Communications – CIP Safety

- CIP Safety SIL3 Safety Extensions
- SIL3 Certification per IEC 61508
  - Enables PLe and Category 4 for 13849

DIVERSITY - Standard & CRC + Complemented data & Complemented CRC
DUALITY - Standard and Complemented data
DIAGNOSTICS - Standard & Complemented CRC and Timing

CRC = Cyclic Redundant Check
CIP Safety – Safety Function: Light Curtain to Contactors
CIP Safety – Safety Function: Light Curtain to Network Safe Torque Off

- CIP Safety on EtherNet/IP
- Standard EtherNet/IP
- Discrete Hardwiring

Public

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Safety Processors – Scalable PLd or PLe

- **PLd**
  - GuardLogix® 5580
  - Compact GuardLogix® 5380

- **PLe**
  - GuardLogix® 5570 With Partner
  - Compact GuardLogix® 5370
  - Compact GuardLogix® L4xS

ISO 13849-1:2015; Figure A.1

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Compact GuardLogix® 5380 Controller

With or Without Motion

- **High Performance CPU**
  - Optimized for faster safety reaction time
- **Scalable Safety Level**
  - SIL CL2, Up to PLd
  - SIL CL3, Up to PLe (Target 4/2019)
- **1-Gb Embedded Ethernet/IP Port**
  - Dual Port – Single or Dual IP
- **Drive and Motion Safety Instructions**
  - New Drive Safety Instructions with Kinetix® 5700 ERS4 drive
    - Safe feedback scaling, Safe Stop 1, Safe Stop 2, Safe Operation Stop
    - Safe Limited Speed, Safe Limited Position
    - Safe Brake Control with external brake, Safe Direction
- **Increased Scalability**
  - Standard memory options ranging from 0.6 MB - 10 MB
  - Safety memory options ranging from 0.3 MB - 5 MB
  - Support for up to 180 EtherNet/IP nodes per controller
  - Motion support for up to 32 axes per controller

List Price Starting At $1320
# Ethernet Guard I/O - Family Comparison

<table>
<thead>
<tr>
<th>Guard I/O Platforms</th>
<th>Point</th>
<th>Compact Block</th>
<th>Armor Block</th>
<th>Compact 5000</th>
<th>Flex 5000</th>
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</thead>
<tbody>
<tr>
<td>Input</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Discrete</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>12/2018</td>
<td>2019 (16ch)</td>
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<tr>
<td>Analog</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>2021</td>
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<tr>
<td>Output</td>
<td></td>
<td></td>
<td></td>
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<td>2019 (16ch)</td>
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<td>0.5 A / Ch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 A / Ch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2019 (16ch)</td>
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<tr>
<td>Sourcing/BP</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 A / Ch</td>
<td></td>
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<td></td>
<td></td>
<td>2019 (4ch)</td>
</tr>
<tr>
<td>Relay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IP20</td>
<td></td>
<td>IP20</td>
<td>IP67</td>
<td></td>
<td>IP20</td>
</tr>
</tbody>
</table>

Future
442G Multifunctional Access Box – CIP Safety

- Safety Functions
  - Emergency Stop
  - Guard Door Close
  - Guard Door Lock Monitoring
  - Guard Door Lock
  - Enabling Switch Input

- Cat4/PLe
- RFID: door position, bolt position, lock status
- Dual Port Ethernet (M12)
- Dual Port 24VDC (M12)

80% reduction in wiring vs discrete
## CIP Safety - Drive Portfolio

<table>
<thead>
<tr>
<th>CIP Safety Drive Platforms</th>
<th>K5500</th>
<th>K5700 ERS3</th>
<th>K5700 ERS4</th>
<th>PF527</th>
<th>PF755 S3</th>
<th>PF755 S4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe Torque Off</td>
<td>Hardwire</td>
<td>ERS</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td></td>
<td>Network</td>
<td>ERS2</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Safe Monitor Functions</td>
<td>Speed</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Position</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Safety I/O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4I / 2O</td>
<td></td>
</tr>
</tbody>
</table>

Future
GuardLogix
CIP Safety on Ethernet/IP
GuardLogix

- **Safety Task**
  - Time Based
  - Ladder

- **Safety I/O Configuration**

- **Safety Instruction Palettes**
Safety: I/O Configuration

GuardLogix

- Program all I/O as Single Input and Outputs

- Suggest Point Status
Safety: Certified Application Instructions

- Example: TÜV Certified DSC

- Provides the same functionality as:
  - 16 rungs of logic
  - 2 Timers
  - 5 Latching coils
  - 3 One shots
  - Significant glue logic

- Results
  - Significant reduction in memory usage
  - Much easier maintenance
Safety: GuardLogix Safety Instructions

GuardLogix

DCS – Dual Control Stop

Redundant Input Monitor  
- with advanced diagnostics

Usage: E-stop, Guard Door CIs, Safety Prox, etc.

F1 = Online Help

Fault Codes

<table>
<thead>
<tr>
<th>Fault Code</th>
<th>Description</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>00H</td>
<td>No fault.</td>
<td>None.</td>
</tr>
<tr>
<td>20H</td>
<td>The Input Status input transitioned from ON (1) to OFF (0) while the instruction was executing.</td>
<td>Reset the fault.</td>
</tr>
</tbody>
</table>
| 4000H      | Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault Channel A was in the active state. Channel B was in the safe state. | Check the wiring.  
  * Perform a functional test of the device (put Channel A and Channel B in a safe state).  
  * Reset the fault.  |
| 4001H      | Channel A and Channel B were in an inconsistent state for longer than the Discrepancy Time. At the time of the fault Channel A was in the safe state. Channel B was in the active state. | Check the wiring.  
  * Perform a functional test of the device (put Channel A and Channel B in a safe state).  
  * Reset the fault.  |
Safety: GuardLogix Safety Instructions

GuardLogix
CROUT – Configurable Redundant Output
Redundant Output
- with advanced diagnostics

Usage: Electro-mechanical outputs: Contactor, Guard Door Lk, etc

F1 = Online Help

Fault Codes

<table>
<thead>
<tr>
<th>Fault Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>08H</td>
<td>No Fault</td>
</tr>
<tr>
<td>29H</td>
<td>The Output Status input transitioned from ON (1) to OFF (0) while the instruction was executing</td>
</tr>
<tr>
<td>29H</td>
<td>The Output Status input transitioned from ON (1) to OFF (0) while the instruction was executing</td>
</tr>
<tr>
<td>5000H</td>
<td>Feedback 1 and Feedback 2 turned OFF (0) unexpectedly</td>
</tr>
<tr>
<td>5001H</td>
<td>Feedback 1 turned OFF (0) unexpectedly</td>
</tr>
<tr>
<td>5002H</td>
<td>Feedback 2 turned OFF (0) unexpectedly</td>
</tr>
<tr>
<td>5003H</td>
<td>Feedback 1 and Feedback 2 turned OFF (0) unexpectedly</td>
</tr>
<tr>
<td>5004H</td>
<td>Feedback 1 turned OFF (0) unexpectedly</td>
</tr>
</tbody>
</table>
HMI – DCS Faceplate

HMI Diagnostics – Normal Condition

For the Operator: (Global PB)

GuardLogix Standard Instruction:

For the Troubleshooter: (Pop-up)
HMI – CROUT Faceplate

HMI Diagnostics – Normal Condition

For the Operator: (Global PB)

GuardLogix Standard Instruction:

For the Troubleshooter: (Pop-up)
HMI – CROUT Faceplate

HMI Diagnostics – Fault Condition

For the Operator: (Global PB)

For the Troubleshooter: (Pop-up)
Safety Event Tracking

- Identify issues related to the use of Safety systems
- Actionable KPI’s
  - Monitor Safety Systems at the Machine
  - Safety System Testing and Reliability Testing

Stop Time Dashboard

- Date: 10/24/2016
- Shift: 1
- Line: InstaCola
- Cell: Filling Line

Stop Time Degradation

<table>
<thead>
<tr>
<th>Event Time</th>
<th>Safety Test</th>
<th>Target Stop Time</th>
<th>Stop Time (Sec)</th>
<th>Delta</th>
<th>Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>07:15:31</td>
<td>FillerD Light Curtain 2 Tripped</td>
<td>1.75</td>
<td>1.196</td>
<td>(0.554)</td>
<td>-31.64 %</td>
</tr>
<tr>
<td>07:15:35</td>
<td>FillerD Light Curtain 3 Tripped</td>
<td>1.75</td>
<td>1.237</td>
<td>(0.513)</td>
<td>-29.33 %</td>
</tr>
<tr>
<td>08:12:02</td>
<td>FillerD EStop Activated</td>
<td>1.75</td>
<td>1.693</td>
<td>(0.057)</td>
<td>-9.20 %</td>
</tr>
<tr>
<td>08:12:58</td>
<td>FillerD Light Curtain 1 Tripped</td>
<td>1.75</td>
<td>1.029</td>
<td>(0.721)</td>
<td>-41.18 %</td>
</tr>
<tr>
<td>08:12:13</td>
<td>FillerD Light Curtain 2 Tripped</td>
<td>1.75</td>
<td>1.593</td>
<td>(0.157)</td>
<td>-8.97 %</td>
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<tr>
<td>08:12:18</td>
<td>FillerD Light Curtain 3 Tripped</td>
<td>1.75</td>
<td>1.129</td>
<td>(0.639)</td>
<td>-36.01 %</td>
</tr>
<tr>
<td>08:20:21</td>
<td>FillerD Light Curtain 1 Tripped</td>
<td>1.75</td>
<td>1.075</td>
<td>(0.677)</td>
<td>-38.68 %</td>
</tr>
<tr>
<td>08:20:27</td>
<td>FillerD Light Curtain 1 Tripped</td>
<td>1.75</td>
<td>1.059</td>
<td>(0.799)</td>
<td>-46.00 %</td>
</tr>
<tr>
<td>08:20:53</td>
<td>FillerD Light Curtain 1 Tripped</td>
<td>1.75</td>
<td>1.297</td>
<td>(0.454)</td>
<td>-25.88 %</td>
</tr>
<tr>
<td>08:25:35</td>
<td>FillerD Light Curtain 1 Tripped</td>
<td>1.75</td>
<td>1.960</td>
<td>0.210</td>
<td>12.02 %</td>
</tr>
</tbody>
</table>
GuardLogix

Typical Application

- Safety zone with integrated safety logic
- Multiple zones requiring supervisory control
- Zones with shared hazards

Key Specification Steps:
1) I/O Count: determine location and platform
2) Determine zone unique considerations – before programming
Speed Control System – Now: CompactGuardLogix and Kinetix® 5700

- 5380 Compact GuardLogix®
- Multifunction Access Box - CIP™
- Enabling Switch
- Kinetix® 5700 ERS4
Safety Application Technique

• Fully documented safety functions:
  Google: Literature Library
  Search: safety-at GuardLogix
Tools
Safety Functions Library

Each safety function includes:

- System descriptions of operations
- Bill of material
- Electrical drawings
- SISTEMA calculations
- Verification & validation plans

Review Safety Application Technique
Questions?