Introduction

What is Fault-Tolerant Control?
Fault-tolerance in a control system identifies and compensates for failed system elements and allows repair while continuing to control an industrial process without interruption. A high-integrity control system such as the Trident can be used in critical process applications that require a significant degree of safety and availability.

What is the Trident?
The Trident is a state-of-the-art controller that provides fault tolerance by means of Triple-Modular Redundant (TMR) architecture. TMR integrates three isolated, parallel control systems and extensive diagnostics in one control system. The system uses two-out-of-three voting to provide high-integrity, error-free, uninterrupted process operation with no single point of failure.

The Trident controller uses three identical channels. Each channel independently executes the application in parallel with the other two channels. Specialized hardware and software voting mechanisms qualify and verify all digital inputs and outputs from the field, while analog inputs are subject to a mid-value selection process.

Because each channel is isolated from the others, no single-point failure in any channel can pass to another. If a hardware failure occurs on one channel, the other channels override it. Meanwhile, the faulting module can be easily removed and replaced while the controller is online without interrupting the process.

Setting up applications is simplified with the triplicated Trident system, because it operates as a single control system from a customer’s point of view.

You can terminate sensors and actuators at a single wiring terminal and program the Trident with one set of application logic. The Trident controller manages the rest.

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Extensive diagnostics on each channel, module, and functional circuit immediately detect and report operational faults by means of indicators or alarms. All diagnostic fault information is accessible to the application and the operator. This diagnostic data can be used to modify control actions or to direct maintenance procedures.

Other features of the Trident controller that ensure the highest possible system integrity include:

- Ability to withstand harsh industrial environments.
- Optimized for applications with small to medium point counts.
- Support for remote and distributed I/O.
- Wall- or skid-mounting outside of control room and enclosures.
- Version 2.x supports 25 total I/O Baseplates.
- Hot-spare I/O modules for critical applications where prompt attention from the operator is not possible.
- Integral support for redundant field power and logic power sources.
- Integration of I/O modules with field termination assemblies.
- Field installation and repair at the module level while the controller remains online and without disturbing field wiring.
- Execution of applications developed and debugged using the TriStation 1131 Developer’s Workbench.
- TriStation and Modbus communication from the Main Processors.

What are Typical User-Created Applications?

Each day Trident systems supply increased safety, reliability, and availability to a worldwide installed base. The following sections describe typical applications. For details on the value Trident can bring to your applications, ask your sales representative for additional documentation and customer references.

Emergency Safety Shutdown (ESD)

Trident controllers provide continuous protection for safety-critical units in refineries, petrochemical and chemical plants, and other industrial processes. For example, in reactor and compressor units, plant trip signals—for pressure, product feed rates, expander pressure equalization and temperature—are monitored and shutdown actions taken if an upset condition occurs. Traditional shutdown systems implemented with mechanical or electronic relays may provide shutdown protection, but can also cause dangerous nuisance trips.

Boiler Flame Safety

Process steam boilers are a critical component in most refinery applications. Protection of the boiler from upset conditions, safety interlock for normal startup and shutdown, and flame-safety applications are combined in one integrated Trident system.

In traditional applications, these functions are provided by separate, non-integrated components. With the fault-tolerant, fail-safe Trident controller, the boiler operations staff can use a critical resource more productively while maintaining safety at or above the level of electromechanical protection systems.

What is TriStation?

The TriStation 1131 Developer's Workbench is an integrated tool for developing, testing, and documenting applications for the Trident controller. The programming methodology, user interface, and self-documentation capabilities make TriStation superior to traditional and competing engineering tools. TriStation complies with Part 3 of the IEC 61131 International Standard for Programmable Controllers and follows the Microsoft Windows guidelines for graphical user interfaces.

What about Communication Capabilities?

The Trident controller provides communication capabilities through ports on the Main Processor and Communication Modules.

Ports on the MP support Modbus slave and TriStation protocols.

Ports on the CM support:
- Modbus slave (ASCII or RTU)
- Modbus master (RTU)
- Modbus master or slave (TCP)
- TriStation
- TCP/IP
- TSAA (UDP/IP)
- TSAA with IP multicast (UDP/IP)
- Triconex Time Synchronization (DLC, UDP/IP, or SNTP)
- Triconex Peer-to-Peer (DLC or UDP/IP)
- HP JetDirect (DLC/LLC)

The Communication Baseplate can contain one or two CM Modules.

For more information, see page 41.