ICS Regent + Plus®

PD-7033

Monitored Guarded Output Modules

24 VDC, 110 VAC and 120 VDC
(T7481/T7481A, T7484 and T7488/T7488A)

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Monitored Guarded output modules provide Guarded control and line monitoring for sixteen field loads. Three types of modules are available for interfacing to outputs powered from 24 VDC, 110 VAC, or 120 VDC field power supplies. These modules are called Guarded because each module's dual-redundant design ensures that no single fault within the module will inadvertently apply power to an output. These modules also monitor the output field wiring for open and short circuit faults. Individual output line status is available to application programs.

Features

- Sixteen Guarded outputs (in two groups of eight).
- Fault tolerant operation when connected in parallel with another module of the same type.
- Hot-replaceable.
- Complete, automatic testing of all output circuits.
- Automatic line monitoring detects open and short field wiring circuits.
- Individual front panel indicators on each module show module fault/active status and shutdown state; additional indicators show output status and load/fuse fault for each point.
- Fuses accessible from front panel.
- 2500 minimum electrical isolation between field and logic circuits.
- TÜV certified, Risk Class 5.

Each module's triplicated Safetybus interface ensures that no Regent system failure will inadvertently apply power to an

output. Extensive fault detection and redundant critical circuits ensure that each module operates in a fail-safe manner.

Two monitored Guarded output modules can be connected in parallel to obtain fault tolerant control of power to loads. In this parallel module configuration, either module can be removed and replaced while the other Guarded module continues to control the loads without interruption.

Module Operation

A block diagram of a typical monitored Guarded digital output module is shown in Figure 1.

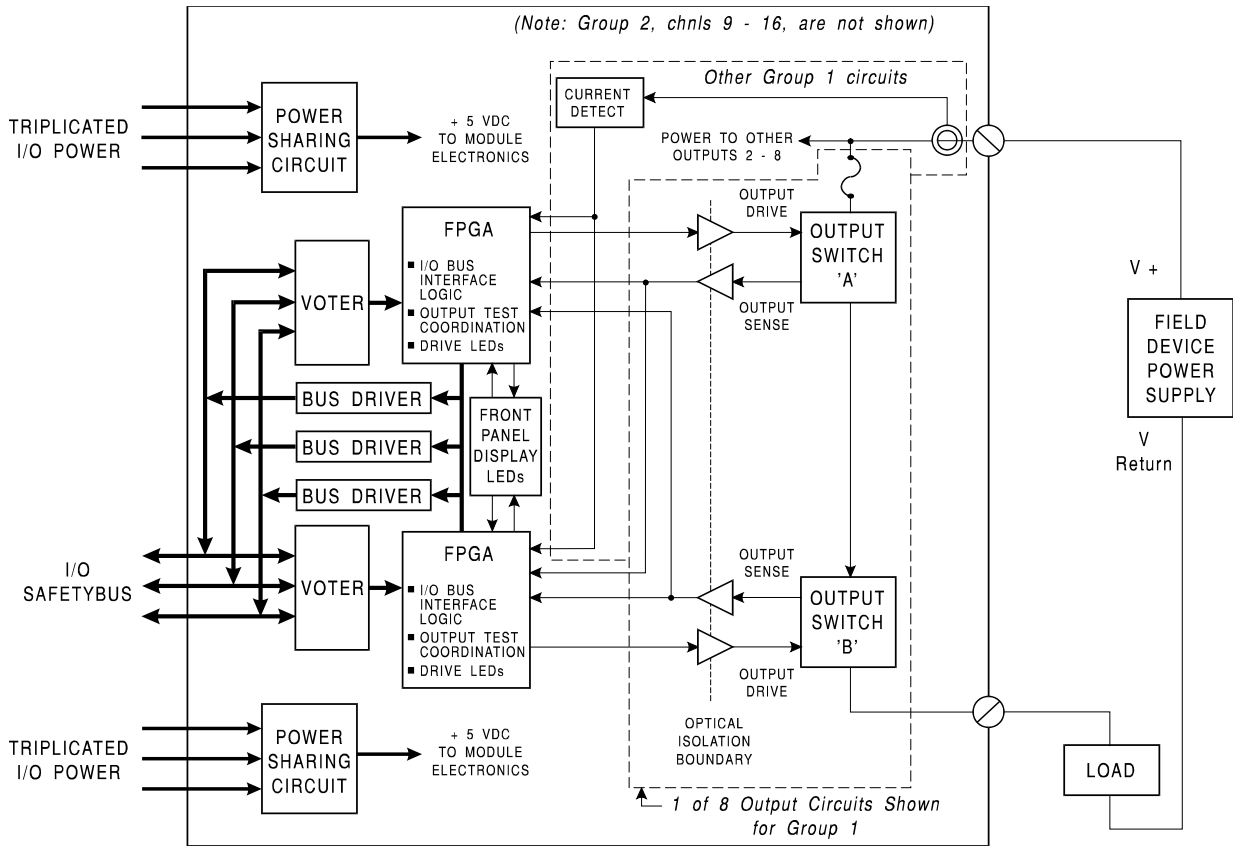

Figure 1. Block Diagram of a Monitored Guarded Digital Output Module.

The processor modules send triplicated write data commands over the I/O Safetybus to the monitored Guarded output module. Onboard the output module the triplicated data are routed to two independent voters which provide voted data to associated field programmable gate arrays (FPGA). Each FPGA independently operates one of the two output control switches. The two output switches are connected in series with the load.

When both output switches are on, current will flow through the output and energize a field load. If either switch is off, current will not flow through the output and the load will be de-energized. This combination of series output switches and independent drive signals produces fail-safe activation of the load. Single failures can only affect one of the output drive signals or switches. A single failure will result in either continued correct control or a fail-safe output as shown in Table 1.

Table 1. Output States After Switch Failure.

Case	Commanded Output State	Switch Failed State	Actual Output to Load	Remarks
1	On	On	On	Continued correct control. Automatic testing detects stuck-on switch. If output is subsequently commanded off, output will turn off.
2	On	Off	Off	Fail-safe output. Automatic testing detects stuck-off switch.
3	Off	On	Off	Continued correct control. Automatic testing detects stuck-on switch. If output is subsequently commanded on, output will turn on.
4	Off	Off	Off	Fail-safe output. Automatic testing detects stuck-off switch. If output is subsequently commanded on, output will remain off.

To achieve fault tolerance, two monitored Guarded output modules are used with their outputs connected in parallel. This configuration provides for continued correct control even

when one output switch fails off (cases two and four in Table 1). The module failure is automatically detected and the module can be removed and replaced without interrupting output control.

Testing and Diagnostics

Automatic testing is performed on the monitored guarded output modules as well as the field load connections.

Module Testing

Each voter and FPGA logic section of the Guarded output modules are automatically tested by the processor modules. Discrepant data are sent through one of three legs of the I/O Safetybus to determine whether the module's voters are able to outvote the incorrect data. A failure to return the correct majority-voted result to the processors produces an I/O module error indication at the processor modules and a module fault indication at the I/O module.

Each type of module has a unique identification code that is read by the controller. This code lets the controller know which type of module is installed in each I/O chassis slot and how to address that module and its points specifically. If a module is removed, or is replaced with a module of a different type, the processor modules will indicate an I/O module error.

Loopback logic tests periodically write data to the module and then read it back to determine whether the module's I/O bus interface logic is functioning correctly.

Output Circuit Testing

The output circuits of the monitored guarded output module are automatically tested to detect failures in the redundant output switch circuits on-board the module and also to detect open and short circuits in the output field wiring and load devices.

Output Switch Testing

To detect a failure in the redundant output switch circuits, each output switch is checked for turn-on and turn-off capability. Periodically, each output switch circuit on the module is tested for its ability to change its current state.

During testing, the output state is changed; outputs that are on are turned off and outputs that are off are turned on.

When two monitored guarded output modules are wired in parallel for fault tolerance, the output circuit testing of the dual modules is coordinated. The test coordination is automatically performed by the system when the modules are properly configured for dual mode (see Configuration, starting on page 17). When dual modules are tested, the second module's outputs are turned off momentarily while the first module's outputs are tested. Subsequently, the first module's outputs are turned off while second module's outputs are tested.

When an output switch is tested, the test pulse duration is nominally 250 msec, and is insufficient to affect the state of most field loads. With modules configured in dual mode, the maximum test pulse may be 425 msec if one module has a switch failure. The output circuit test interval will range from 1 to 60 seconds, depending on the quantity of I/O configured in the system.

If an output switch doesn't change state when tested, an output switch fault is detected. An output switch failure is annunciated as a module fault. An I/O module fault is indicated by the module FAULT LED on the module, the red I/O fault LEDs on the processor modules and the system control relay fault bit for the module assembly and slot.

Load and Fuse Monitoring and Testing

During output switch testing, the module also monitors the change in current flow in the field power for the outputs. The sensed state changes of the output switches and the field power current are reported back to the processor modules. The triplicated processor modules use this information to identify if an open load, shorted load or blown fuse condition exists.

Any of these load/fuse fault conditions are annunciated via the LOAD/FUSE fault LEDs on the face of the module and the Fault Name variables configured for each point. Load/Fuse faults are not reported as module faults and so do not turn on the red Module FAULT LED or associated system variable control relay fault bit. The Fault Name variables should be

monitored by the application program or external operator interface equipment to dispatch maintenance personnel to correct the field connection problem.

Note:

Field faults such as open load, shorted load, blown fuse and absence of field power, will mask an output switch fault. When load/fuse faults are detected, they should be repaired as soon as possible.

If the health of spare, unused output points is important, then a minimum load device should be connected to these points.

Front Panel

Figure 2 shows the physical features of the monitored Guarded output modules. The front panel of each module contains a module active and fault status indicator, a shutdown indicator, as well as output fuses, output status indicators and load/fuse fault indicators for the output circuits.

Active/Fault Status Indicators

These green and red LEDs indicate the overall health of the module and output circuits. During normal operation, the green ACTIVE indicator flashes at the controller's scan rate. If a module fault is detected, the red FAULT indicator turns on and the green ACTIVE indicator turns off.

Shutdown Indicator

Upon loss of communications with the controller, output modules enter either a shutdown or hold fault mode. If the I/O unit is set to shutdown, the red SHUTDOWN indicator will turn on when communications with the controller are lost. If the I/O unit is set to hold, the SHUTDOWN indicator will always be off (see page 16, Fault Mode Jumper).

Note: When the module is installed in the I/O chassis or when logic power (from the I/O power supply modules) is first applied to the module, it will be in the shutdown mode until the first output scan, regardless of the fault mode jumper settings. Also, removing two I/O transceiver modules, two I/O power supply modules, or two power legs will cause the module to be in the shutdown mode.

Safety Considerations

TÜV The Monitored Guarded output modules are TÜV certified to Risk Class 5 for safety critical outputs. The modules are approved for de-energize to trip safety critical outputs in single or dual module configurations.

The modules are also approved for energize to trip safety critical outputs in dual module configuration, but only if the fault name variables are configured and used to automatically alarm and annunciate the detection of load/fuse faults to plant operations personnel.

Specifications

Safetybus Power	1.5 load units
Number of Outputs	16 circuits divided into two groups of 8 circuits each

	T7481 (81A)	T7484	T7488 (88A)
Voltage Range	18 to 36 VDC	90 to 130 VAC	95 to 140 VDC
Frequency	N/A	47 to 63 Hz	N/A
Load Current			
(0 to 40° C)	2 amp	0.7 amp	1.0 amp
derating (at 60° C)	1.5 amp	0.5 amp	0.75 amp
Minimum Load	20 mA (5mA)	20 mA	35 mA (5mA)
On State Drop	1.0 V, maximum	2.5 V, maximum	2.0 V, maximum
Surge Current			
incandescent, capacitive loads:	3.5 amps, peak	3.5 amps, peak	3.5 amps, peak
inductive loads:	7 amps for 20 msec	3 amps for 20 msec	3 amps for 20 msec
Output Leakage			
single, fail-safe module:	5 mA, (700ua) maximum	5.5 mA, maximum	5.5 mA, (700ua) maximum
dual, fault-tolerant modules:	7.5 mA, (1 mA) maximum	8.5 mA, maximum	8.5 mA, (1 mA) maximum

	T7481/81A	T7484	T7488/88A

Fusing (front mounted)	One 3 amp, 250 V, fast acting (3AB), rectifier type, per output Littelfuse 322-003	One 2 amp, 250 V, fast acting (3AB), rectifier type, per output Littelfuse 322-002	One 2 amp, 250 V, fast acting (3AB), rectifier type, per output Littelfuse 322-002
Turn-On Delay	0.5 msec	0.5 msec	0.5 msec
Turn-Off Delay	0.5 msec	0.5 msec	0.5 msec
Output Test Duration	250 msec for single or dual modules, max of 425 msec if switch fault (dual modules only)	250 msec for single or dual modules, max of 425 msec if switch fault (dual modules only)	250 msec for single or dual modules, max of 425 msec if switch fault (dual modules only)
Heat Dissipation	30 Watts, 101 BTUs/hour	27 Watts, 92 BTUs/hour	27 Watts, 92 BTUs/hour
Over Voltage Protection	70 VDC, continuous 100 VDC, 5 seconds	275 VAC, continuous 450 VAC, 5 seconds	275 VAC, continuous 450 VAC, 5 seconds

Isolation	2500 volts minimum (field wiring to control logic) 2500 volts minimum (output group 1-8 to output group 9-16)
Operating Temperature	0° to 60° C (32° to 140° F)
Storage Temperature	-40° to 85° C (-40° to 185° F)
Operating Humidity	0 to 95% relative humidity, non-condensing
Vibration 10 to 55 Hz:	±0.15mm
Shock Operating:	15 g, ½ sine wave, 11 msec

Electromagnetic Interference	
• IEC 801 Part 2 - Electrostatic Discharges	Level 3: Contact discharge of 6 kV
• IEC 801 Part 3 - Radiated Electromagnetic Fields	Level 3: 10 V/M, 27 MHz - 500 MHz
• IEC 801 Part 4 - Transients and Bursts	Level 4: 2 kV, 2.5 kHz for t=60 sec
• IEC 801 Part 5 - Surge Immunity	Level 3: 2 kV
• ANSI/IEEE C37.90 - Surge Withstand Capability	2.5 kV damped 1 MHz sine wave, 4 kV bi-directional impulse, 10 nsec rise time, fast transient
Safety	Certified to DIN V VDE 0801 for Risk Class 5. Also designed to meet UL 508 and CSA 22.2, No. 142-M1981
Dimensions	
Height:	12.6" (320 mm)
Width:	1.27" (32 mm)
Depth:	10.12" (257 mm)
Weight	4.2 lbs (1.8 kg)