Trusted™ TMR Expander Interface

Introduction

The Trusted™ TMR Expander Interface module resides in the Trusted™ Controller Chassis and provides the 'master' interface between the Inter-Module Bus (IMB) in the Controller Chassis and the Expander Bus. The Expander Bus allows multiple chassis systems to be implemented using UTP cable connections whilst maintaining the fault tolerant, high bandwidth IMB capabilities.

The module provides fault containment for the Expander Bus, the module itself and the IMB in the Controller Chassis, ensuring that the effects of these potential faults are localised and system availability maximised. The module is fault tolerant with HIFT TMR architecture. Comprehensive diagnostics, monitoring and testing provide rapid fault identification. Hot standby and module spare slot configurations are supported, allowing automatic and manual repair strategies.

Features

- Triple Modular Redundant (TMR), fault tolerant (3-2-0) operation
- Hardware Implemented Fault Tolerant (HIFT) architecture
- Dedicated hardware and software test regimes which provide very fast fault recognition and response times
- Automatic fault handling without nuisance alarming
- Hot replacement
- Front panel indicators that show module health and status.
- TÜV Certified IEC 61508 SIL 3

1. Description

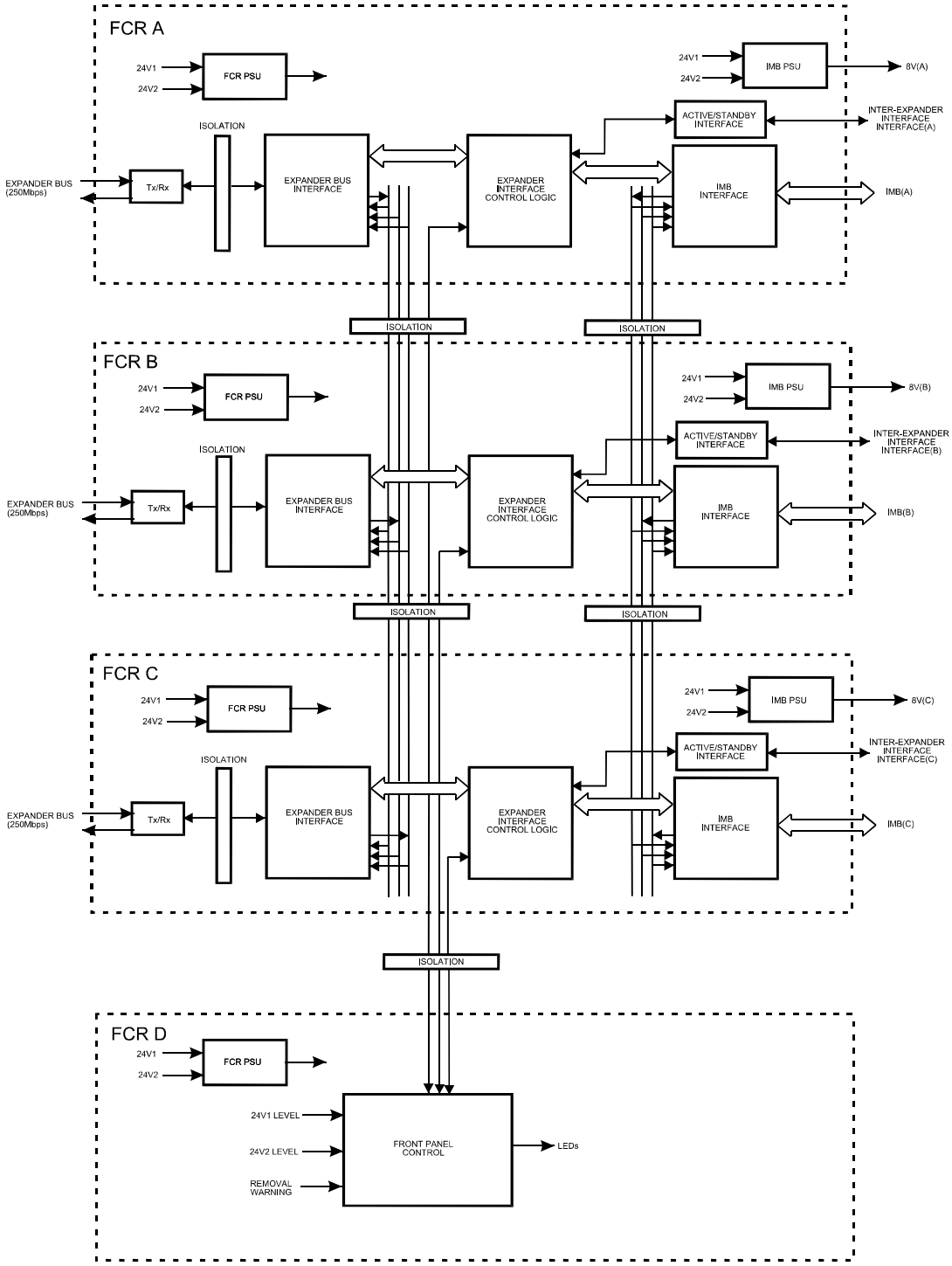

Figure 1 Functional Block Diagram

1.1. Overview

The TMR Expander Interface is a fault tolerant design based on TMR architecture arranged in a lock-step configuration. Figure 1 shows, in simplified terms, the basic structure of the TMR Expander Interface.

The module has three main fault containment regions (FCR A, B and C). Each of the main FCRs contains interfaces to the Expander Bus and Inter-Module Bus (IMB), an active/standby interface to the other TMR Expander Interface in the chassis, control logic, communications transceivers and power supplies.

Communication between the module and the TMR Processor is via the IMB on the backplane of the Controller Chassis. The IMB provides fault tolerance and high bandwidth communications between the Interface Modules and the TMR Processor. All transactions are voted, localising faults to the IMB should they occur.

Communication between the Interface Module and the TMR Expander Processor in the Expander Chassis is via the Expander Bus. The Expander Bus is triplicated, point-to-point architecture. Each channel of the Expander Bus comprises separate command and response media. Voting is provided at the Expander Bus Interface to ensure that cable faults are tolerated, and the remainder of the Expander Processor operates in a fully triplicated mode, even in case of cable faults occurring.

A fourth FCR (FCR D) provides the non-critical monitoring and display functions and is also part of the inter-FCR Byzantine voting structure.

Isolation is provided between FCRs wherever interfaces are required, to ensure that faults can not propagate between them.

1.2. Power Distribution

The TMR Expander Interface Module derives its internal voltages from dual redundant +24V dc power supplied via the module connector from the Trusted™ Controller Chassis backplane. Each FCR derives the required supplies independently.

2. Installation

2.1. Module Installation

The Expander Interface Modules may reside in any of the I/O slots within the Controller Chassis. The modules are installed in pairs with the left-hand module occupying an odd numbered slot. The Expander Interface must **NOT** be installed in these other module locations, **as this may cause damage to the module**.

The two Interface slots must be interconnected using the Expander Interface Adaptor Unit T8312.

The Expander Interface Modules are connected to the Expander Processor Modules by the Expander Interface Hot Link Cable TC-301 via the Trusted™ Expander Interface Adaptor Unit T8312.

The connection to remote Expander Chassis is via the Trusted™ Fibre Optic Tx/Rx Unit using the Expander Interface Adaptor to Fibre Tx/Rx Unit (Remote Expanders) Cable TC-302.

2.2. Module Insertion and Removal

CAUTION:

THE MODULE CONTAINS STATIC SENSITIVE PARTS. STATIC HANDLING PRECAUTIONS MUST BE OBSERVED. SPECIFICALLY ENSURE THAT EXPOSED CONNECTOR PINS ARE NOT TOUCHED. UNDER NO CIRCUMSTANCES SHOULD THE MODULE HOUSING BE REMOVED.

Before installation, visually inspect the module for damage. Ensure that the module housing appears undamaged and inspect the I/O connector at the back of the module for bent pins. If the module appears damaged or any pins are bent, do not install the module. Do not try to straighten bent pins. Return the module for replacement.

Ensure that the module is of the correct type.

Record the module type, revision and serial number of the module before installation.

If the module is to reside in a new chassis, or the system is being configured for the first time, ensure that the chassis address has been set correctly before installing the modules. See Controller Chassis Product Description (PD-8100) for further details.

To install the module:

1. Ensure that the cable assembly is correctly located.
2. Release the ejector tabs on the module using the release key. Ensure that the ejector tabs are fully open.
3. Holding the ejectors, carefully insert the module into the intended slot.
4. Push the module fully home but pressing on the top and bottom of the module fascia.
5. Close the module ejectors, ensuring that they click into their locked position.

2.2.1. Module Replacement

The replacement module must be inserted in to the vacant processor slot, ensuring that the module is correctly located and the ejector tabs are closed (see 2.2). The newly installed module will perform its power-up sequence.

Ensure that the LED indicators on the newly installed module are as follows:

LED 1 Healthy A	Steady Green
LED 2 Healthy B	Steady Green
LED 3 Healthy C	Steady Green

If the original module has reported faults, the TMR Processor may automatically initiate the changeover to the newly installed module. Manual changeover may be initiated either using the ejector tabs on the original module or using commands via the diagnostic interface. To initiate the changeover using the ejector tabs use the following sequence:

1. Release both the top and bottom ejector tabs on the original module using the ejector release tool. DO NOT remove the module.
2. Wait until the original module indicates that it is in the standby mode of operation and the newly installed module is in the active mode.
3. Remove the original module.

Note: Under no circumstances remove a module that is indicating ACTIVE mode. Removal of an active module may result in modules within the chassis adopting their default (shutdown) state, and initiate shutdown states via the application program.

In Hot-standby configurations, with both Expander Interface Modules installed, the faulted module may be either the active or the standby module. In most cases the system will automatically switch to the healthiest module, therefore only the standby module will require replacement. To replace the active module follow the steps described above. To replace the standby module:

1. Release both the top and bottom ejectors tabs on the standby module using the ejector release tool.
2. Ensure that the other module is indicating the active mode of operation.
3. Remove the standby module.

In Hot-standby configurations, the replacement module should then be installed in the position where the previous module was removed. This module will become the standby module.

2.3. Expander Bus Connection

Further details of the Expander Bus cable assembly are provided in the associated Product Description (PD-TC300).

2.3.1. Cable Assembly Replacement

It is not intended that the cable should need replacement, however this may be achieved by replacement of the complete cable assembly that requires that the system be shutdown. To remove a cable:

1. Ensure that the correct chassis and slot positions are selected.
2. Ensure the associated chassis slots are not occupied by modules.
3. Press in the hood release button and slide the hood downwards.
4. Remove the hood from the chassis slot by sliding down and rearward.

To insert a new or replacement cable:

1. Ensure that the correct chassis and slot positions are selected.
2. Ensure that the associated chassis slots are not occupied by modules.
3. Present the connector to the chassis backplate slot, taking care to align the lugs of the connector with the cut-outs of the slot.
4. Push the connector hood in and upwards into the slot until the latch engages with the backplate lip.
5. Ensure that the connector hood is secure in its position.

Where it is critical to maintain system operation additional chassis may be installed and on-line operation maintained by transferred control to modules within that chassis using the I/O modules SmartSlot capability.

2.4. Trusted™ Module Polarisation/Keying

All Trusted™ Modules have been Keyed to prevent insertion into the wrong position within a chassis. The polarisation comprises two parts. The module and the associated field cable.

Each module type has been keyed during manufacture. The organisation responsible for the integration of the Trusted™ system must key the cable by removing the keying pieces from the cable so that they correspond with the bungs fitted to the associated module prior to fitting.

Trusted™ Module Polarisation/Keying.

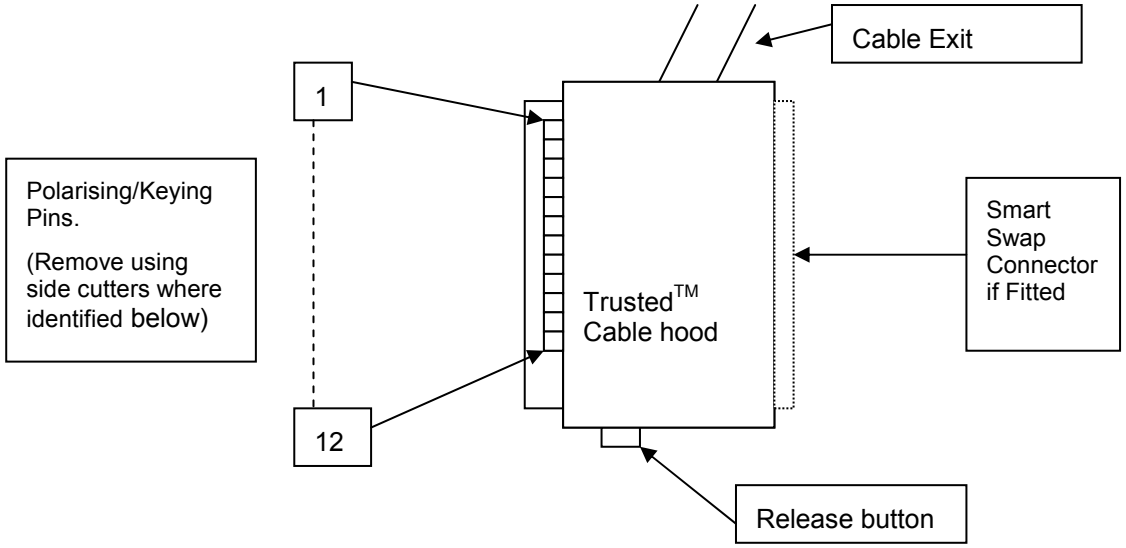

Figure 2 Module Polarisation

For Cables with Companion slot installations both keying strips must be polarised.

For This Module (T8311) remove keying pins 1,2,6.

3. Application

3.1. Message Forwarding

The primary function of the Expander is to provide a method of extending the IMB beyond a single processor chassis. The active TMR Expander Interface Module receives messages from the processor chassis IMB/backplane and forwards them to the Expander Bus when its slot position is enabled. Similarly, the active TMR Expander Processor Module forwards all messages received from the Expander Bus to the addressed Expander Chassis IMB.

For other command messages the response message received by the active Expander Processor from the addressed module is passed to the Expander Bus and hence to the TMR Expander Interface Module. The active TMR Expander Interface Module then passes the message to the Processor Chassis IMB, subject to the prevailing IMB control signals.

The messages received from the controller chassis IMB at the TMR Expander Interface Module are re-synchronised and majority voted (Byzantine voted) before being passed to the triplicated Expander Bus. Similarly, messages received by the TMR Expander Processor Module from the Expander Chassis IMB are re-synchronised and majority voted before onward transmission.

Messages received from the Expander Bus at both the TMR Expander Interface Module and TMR Expander Processor Module are re-synchronised and majority voted before being passed to the associated IMB.

Errors in messages are corrected, and therefore masked using this method. This, however, makes it important that discrepancies in faults in these signals are detected and the information made available for fault reporting purposes to avoid latent fault issues.

3.2. Control Signal Forwarding

The active TMR Expander Processor Module continually monitors and transmits the state of the following signals:

- Power Failure Warning
- System Watchdog
- Command Response Control

All three signals are fully triplicated. These signals are distributed to all of the attached Expander Busses. The TMR Expander Processor Modules forward the received state of these signals to the Expander Chassis IMB. The direction of these signals is always from TMR Processor to TMR Expander Interface to TMR Expander Processor to interface (I/O) module.

As with the message forwarding, these signals are re-synchronised and majority voted, i.e. Byzantine voted at the TMR Expander Interface and TMR Expander Processor Modules. The signals are synchronous within the Expander Chassis even in the case of a fault within the Processor Chassis.

6. Specifications

Voltage Range	20 to 32V dc
Maximum Load	40W
Heat Dissipation	40W
Use with Chassis	T8300
Module Clocks	50MHz
Expander Bus Data Rate	250Mbps
I/O Interface	Expander Chassis backplane
Expander Comms Max Distance	
Using TC-301 copper cable	30m
Using fibre converters	10km
Operating Temperature	-5°C to 60ºC (13°F to 140°F)
Non-operating Temperature	-25°C to 70°C (-25°F to 158°F)
Operating Humidity	5 to 95% RH
Environmental Specifications	Refer to Document 552517
Dimensions	
Height:	266mm (10.5ins)
Width	31mm (1.2ins)
Depth:	303mm (12.0ins)
Weight	1.14kg (2.5lbs.)