Attn：Smiling
Mobile/WhatsApp/Wechat:+86 18050035902
Email: info@htechplc.com

PD-T8311

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

Issue Record

Issue					
Number	Date	Revised by	Technical Check	Authorised by	Modification
9	Oct 05	J W Clark			Format
10	Nov 06	N Owens	I Vince	P Stock	Specification
11	Dec 06	N Owens	I Vince	P Stock	Cable distance
12	Mar 07	N Owens	I Vince	P Stock	System INI

This page is intentionally blank

Table of Contents

1. Description....8
1.1. Overview....9
1.2. Power Distribution....9
2. Installation....10
2.1. Module Installation....10
2.2. Module Insertion and Removal....10
2.2.1. Module Replacement....11
2.3. Expander Bus Connection....12
2.3.1. Cable Assembly Replacement....12
2.4. Trusted™ Module Polarisation/Keying....13
3. Application....14
3.1. Message Forwarding....14
3.2. Control Signal Forwarding....14
3.3. I/O Complex Equipment Definition T8311....15
3.3.1. Voltage Level Format....16
3.4. Module Information....17
3.5. System Initialisation File....17
3.6. Expander Chassis IMB Connector (SK1)....18
3.7. Expander chassis Bus Connector (PL4)....19
4. Operation....20
4.1. Operating Modes....20
4.1.1. Standby....20
4.1.2. Active....20
4.1.3. Expander Interface Module Active/standby Control....20
4.2. Communication Busses....21
4.2.1. Expander bus....21
4.2.2. Inter-Module Bus....21
4.3. Front Panel....22
4.3.1. *Healthy* Indicator`....23
4.3.2. *Active* Indicator....23
4.3.3. *Standby* Indicator....23
5. Fault Finding and Maintenance....24
5.1. PCBS and Connectors....24
5.2. Troubleshooting....24
6. Specifications....26

Figures

Figure 1 Functional Block Diagram 8
Figure 2 Module Polarisation 13
Figure 3 Module Front Panel 22

Tables

Table 1 Chassis Connector (SK1) Pinout 18
Table 2 Chassis Bus Connector (PL4) 19
Table 3 Troubleshooting Guide 25

Notice

The content of this document is confidential to ICS Triplex Technology Ltd. companies and their partners. It may not be given away, lent, resold, hired out or made available to a third party for any purpose without the written consent of ICS Triplex Technology Ltd.

This document contains proprietary information that is protected by copyright. All rights are reserved.

Microsoft, Windows, Windows 95, Windows NT, Windows 2000, and Windows XP are registered trademarks of Microsoft Corporation.

The information contained in this document is subject to change without notice. The reader should, in all cases, consult ICS Triplex Technology Ltd. to determine whether any such changes have been made. From time to time, amendments to this document will be made as necessary and will be distributed by ICS Triplex Technology Ltd.

Information in this documentation set may be subject to change without notice and does not represent a commitment on the part of ICS Triplex Technology Ltd.

The contents of this document, which may also include the loan of software tools, are subject to the confidentiality and other clause(s) within the Integrator Agreement and Software License Agreement.

No part of this documentation may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, for any purpose, without the express written permission of ICS Triplex Technology Ltd.

Disclaimer

The illustrations, figures, charts, and layout examples in this manual are intended solely to illustrate the text of this manual.

The user of, and those responsible for applying this equipment, must satisfy themselves as to the acceptability of each application and use of this equipment.

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained herein does not purport to cover all details or variations in hardware or software, nor to provide for every possible contingency in connection with installation, operation, or maintenance. Features may be described herein which are present in all hardware or software systems. ICS Triplex Technology Ltd. assumes no obligation of notice to holders of this document with respect to changes subsequently made.

ICS Triplex Technology Ltd. makes no representation or warranty, expressed, implied, or statutory with respect to, and assumes no responsibility for the accuracy, completeness, sufficiency, or usefulness of the information contained herein. No warranties of merchantability or fitness for purpose shall apply.

Revision and Updating Policy

All new and revised information pertinent to this document shall be issued by ICS Triplex Technology Ltd. and shall be incorporated into this document in accordance with the enclosed instructions. The change is to be recorded on the Amendment Record of this document.

Precautionary Information

WARNING

Warning notices call attention to the use of materials, processes, methods, procedures or limits which must be followed precisely to avoid personal injury or death.

CAUTION

Caution notices call attention to methods and procedures which must be followed to avoid damage to the equipment.

Notes:

Notes highlight procedures and contain information to assist the user in the understanding of the information contained in this document

Warning

RADIO FREQUENCY INTERFERENCE

Most electronic equipment is influenced by Radio Frequency Interference (RFI). Caution should be exercised with regard to the use of portable communications equipment around such equipment. Signs should be posted in the vicinity of the equipment cautioning against the use of portable communications equipment.

MAINTENANCE

Maintenance must be performed only by qualified personnel, otherwise personal injury or death, or damage to the system may be caused.

Caution

HANDLING

Under no circumstances should the module housing be removed.

Associated Documents

Product Descriptions (PD) provide product specific information.

The **Safety Manual** contains the recommended safety requirements for the safety system design.

The **PD8082B – Toolset Suite** provides specific guidance on system configuration and application generation.

The **Operator and Maintenance Manual** contains general guidelines on maintenance and diagnostic procedures.

For technical support email: support@icstriplex.com

1. Description

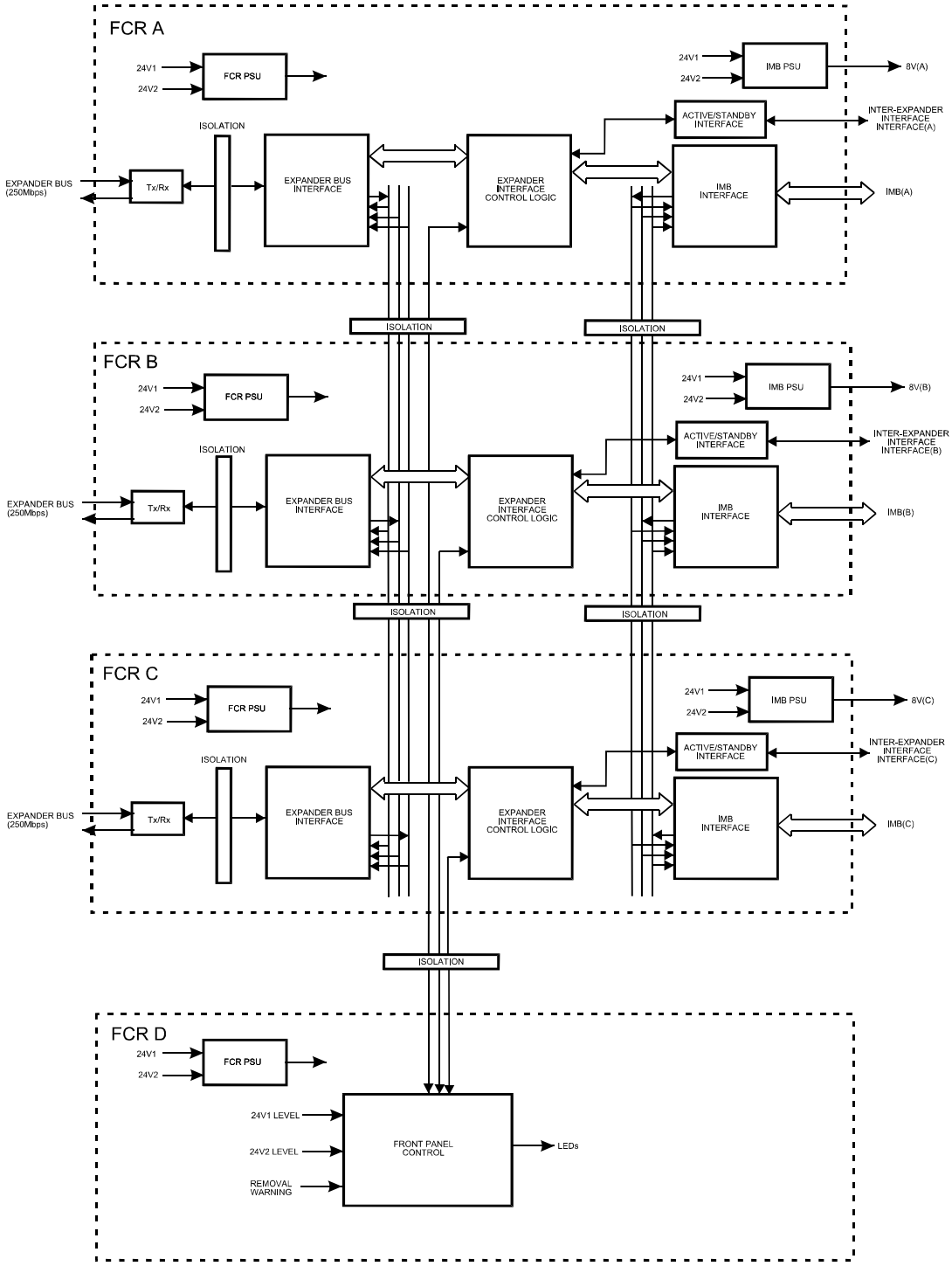

Figure 1 Functional Block Diagram

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.

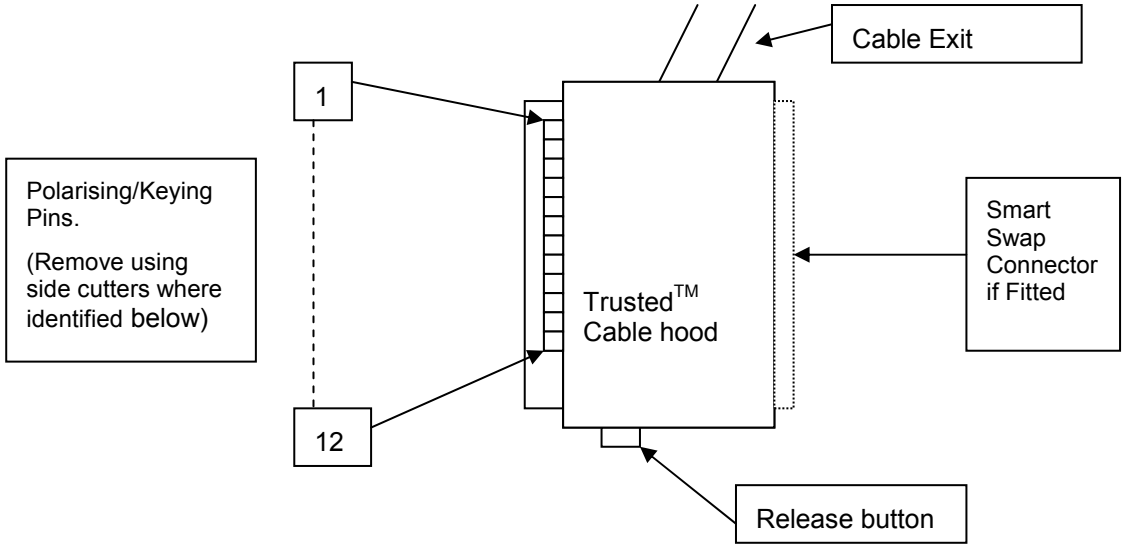

Figure 2 Module Polarisation

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.

3.3. I/O Complex Equipment Definition T8311

The Expander Interface requires no configuration to the module itself.

Each module fitted in a Trusted™ system requires an entry in the I/O Connection table, specifying its chassis and slot number. The I/O Complex Equipment Definition allows control of the module's functions, and provides information on its status. For information on editing the I/O Connection table, refer to PD-8082B. The definition for this module is described below.

OEM PARAMETERS

OEM parameter	Valid numbers	Description
TICS_CHASSIS	1	This value is fixed (expander interface modules may only be placed in the processor chassis) and is included for consistency with other modules in the Trusted™ range.
TICS_SLOT	1 - 8 (Chassis 1)	The processor chassis slot number in which the primary expander interface module is placed. By definition, this must be an odd numbered slot. The secondary module, if configured, resides in an even numbered slot adjacent, and to the right of the primary.

CONFIGURATION

PHYSICAL MODULE:

RACK 1: [XIM_0]	16 ANALOGUE inputs	Channel 1: Not used Channel 2: 24V dc Feed 1 (always 0) Channel 3: 24V dc Feed 2 (always 0) Channel 4: Not used Channel 5: Not used Channel 6: Not used Channel 7: Slice A Rx Error Count Channel 8: Slice B Rx Error Count Channel 9: Slice C Rx Error Count Channels 10 to 16: Not used
RACK 2: (INFO)	11 INTEGER inputs	Channel 1:Chassis position of AM Channel 2:Slot position of AM Channel 3:Indication of global health of AM 1 – No slice errors and module is responding 0 – Some error has been found Channel 4:Current state of AM Channel 5:Chassis position of SM 0 – No partner exists Channel 6:Slot position of SM 0 – No partner exists Channel 7:Indication of global health of SM 1 – No slice errors and module is responding 0 – Some error has been found Channel 8:Current state of SM Channel 9:Slice information of modules. See **Note** Channel 10:Is AM the Primary Module 1 – Yes 0 – Not Channel 11:Not used

APPENDIX:

Note:

Bit 0 AM slice A:
1 - Slice is responding and there are no slice errors.
0 - Slice is either NOT responding or there is a slice error.

Bit 1 AM slice B:
1 - Slice is responding and there are no slice errors.
0 - Slice is either NOT responding or there is a slice error.

Bit 2 AM slice C:
1 - Slice is responding and there are no slice errors.
0 - Slice is either NOT responding or there is a slice error.

Bit 3 AM ejectors open:
1 - AM ejectors open.
0 - AM ejectors closed.

Bit 4 SM slice A:
1 - Slice is responding and there are no slice errors.
0 - Slice is either NOT responding or there is a slice error.

Bit 5 SM slice B:
1 - Slice is responding and there are no slice errors.
0 - Slice is either NOT responding or there is a slice error.

Bit 6 SM slice C:
1 - Slice is responding and there are no slice errors.
0 - Slice is either NOT responding or there is a slice error.

Bit 7 SM ejectors open:
1 – SM ejectors open.
0 - SM ejectors closed.

3.3.1. Voltage Level Format

The voltage level is reported as an integer, with the units being $^{1}/_{512}$V. This may be used directly, scaled arithmetically or scaled using the conversion tables.

When used directly the value may be considered as a fixed-point binary value, i.e.:

Bit																
15	14	13	12	11	10	9	8	7		6	5	4	3	2	1	0
Sign	Integer								·	Fractional						

To scale the value arithmetically simply divide the returned ‘integer’ by 512 to return the voltage as either a REAL or INTEGER as required.

The input conversion tables may be used to convert the input value to engineering units, in this case voltage. This is the recommended method where the value is not to be used directly. The full-scale range for this number format is decimal ±256, corresponding to physical range –32768 to +32767.

3.4. Module Information

The following information is recorded by the TMR Expander Interface Module and made available to the TMR Processor.

- Expander Bus link quality, including receive error counts for each communications link and link status.
- Received message error, on a per link/FCR basis, including frame error, checksum error and discrepancy.
- HIFT Clock, master and slave clock status, and master/slave switching.
- FCR watchdog status.
- Current active/standby status.
- IMB status information.
- Module type code and serial number.
- Module removed flap status.

3.5. System Initialisation File

This module requires a simple entry in the system INI configuration. Within this entry, the System Configurator allows the connection of expansion chassis to each port on the expander interface. There is no further configuration required. For details of editing the system INI configuration, please refer to PD-8082.

In the system INI configuration, the module should be defined in both the primary position and the secondary (hot swap spare) position. This is required to enable the module to be hot swapped. The chassis allocation only needs to be set up in one of the positions; it will be automatically copied to the other position.

3.6. Expander Chassis IMB Connector (SK1)

SK1 is a 185-way DIN41642 type connector.

CONNECTOR SK1 PINOUT					
PIN	**E**	**D**	**C**	**B**	**A**
2	CHASSIS_GND	CHASSIS_GND	CHASSIS_GND	CHASSIS_GND	CHASSIS_GND
3					
4	IMB_+24V_RTN	IMB_+24V_RTN	IMB_+24V_RTN	IMB_+24V_RTN	IMB_+24V_RTN
5					
6	IMB_+24V_1	IMB_+24V_1	IMB_+24V_1	IMB_+24V_1	IMB_+24V_1
7					
8	IMB_+24V_2	IMB_+24V_2	IMB_+24V_2	IMB_+24V_2	IMB_+24V_2
9					
10					
11	IMBA_CMDN_RSP	GND	IMBA_IOM_SELN	IMBA_INTLK_N	IMBA_MN/X_ID
12	IMBA_D0	GND	IMBA_D1		IMBA_SLOT0_ID
13	IMBA_D2	GND	IMBA_D3		IMBA_SLOT1_ID
14	IMBA_D4	GND	IMBA_D5		IMBA_SLOT2_ID
15	IMBA_D6	GND	IMBA_D7		IMBA_SLOT3_ID
16		GND			
17	IMBA_IOM_CK1	GND	IMBA_SFTY_WDOG	GND	IMBA_+6.5V
18	IMBA_IOM_CK2	GND	IMBA_PWR_FAIL	GND	IMBA_+6.5V
19					
20	IMBB_CMDN_RSP	GND	IMBB_IOM_SELN	IMBB_INTLK_N	IMBB_MN/X_ID
21	IMBB_D0	GND	IMBB_D1		IMBB_SLOT0_ID
22	IMBB_D2	GND	IMBB_D3		IMBB_SLOT1_ID
23	IMBB_D4	GND	IMBB_D5		IMBB_SLOT2_ID
24	IMBB_D6	GND	IMBB_D7		IMBB_SLOT3_ID
25		GND			
26	IMBB_IOM_CK1	GND	IMBB_SFTY_WDOG	GND	IMBB_+6.5V
27	IMBB_IOM_CK2	GND	IMBB_PWR_FAIL	GND	IMBB_+6.5V
28					
29	IMBC_CMDN_RSP	GND	IMBC_IOM_SELN	IMBC_INTLK_N	IMBC_MN/X_ID
30	IMBC_D0	GND	IMBC_D1		IMBC_SLOT0_ID
31	IMBC_D2	GND	IMBC_D3		IMBC_SLOT1_ID
32	IMBC_D4	GND	IMBC_D5		IMBC_SLOT2_ID
33	IMBC_D6	GND	IMBC_D7		IMBC_SLOT3_ID
34		GND			
35	IMBC_IOM_CK1	GND	IMBC_SFTY_WDOG	GND	IMBC_+6.5V
36	IMBC_IOM_CK2	GND	IMBC_PWR_FAIL	GND	IMBC_+6.5V
37					
38	CHASSIS_GND	CHASSIS_GND	CHASSIS_GND	CHASSIS_GND	CHASSIS_GND

Table 1 Chassis Connector (SK1) Pinout

3.7. Expander chassis Bus Connector (PL4)

PL4 is a 96-way DIN41612, C-type connector.

Pin	CONNECTOR PL4 PINOUT		
	A	B	C
1	TXA3+	TXA2+	TXA1+
2	TXA3-	TXA2-	TXA1-
3	TXA6+	TXA5+	TXA4+
4	TXA6-	TXA5-	TXA4-
5	RXA1+	LB_A_ACTN/STB_1	TXA7+
6	RXA1-	LB_A_ACTN/STB_2	TXA7-
7	RXA4+	RXA3+	RXA2+
8	RXA4-	RXA3-	RXA2-
9	RXA7+	RXA6+	RXA5+
10	RXA7-	RXA6-	RXA5-
11	GND	GND	GND
12	TXB3+	TXB2+	TXB1+
13	TXB3-	TXB2-	TXB1-
14	TXB6+	TXB5+	TXB4+
15	TXB6-	TXB5-	TXB4-
16	RXB1+	LB_B_ACTN/STB_1	TXB7+
17	RXB1-	LB_B_ACTN/STB_2	TXB7-
18	RXB4+	RXB3+	RXB2+
19	RXB4-	RXB3-	RXB2-
20	RXB7+	RXB6+	RXB5+
21	RXB7-	RXB6-	RXB5-
22	GND	GND	GND
23	TXC3+	TXC2+	TXC1+
24	TXC3-	TXC2-	TXC1-
25	TXC6+	TXC5+	TXC4+
26	TXC6-	TXC5-	TXC4-
27	RXC1+	LB_C_ACTN/STB_1	TXC7+
28	RXC1-	LB_C_ACTN/STB_2	TXC7-
29	RXC4+	RXC3+	RXC2+
30	RXC4-	RXC3-	RXC2-
31	RXC7+	RXC6+	RXC5+
32	RXC7-	RXC6-	RXC5-

Table 2 Chassis Bus Connector (PL4)

4. Operation

4.1. Operating Modes

4.1.1. Standby

Standby is the default mode of operation for the module, once internal supply levels are established. In this mode the module may respond to command messages addressed to the module itself over the IMB. Communication between the Controller Chassis IMB and the Expansion Chassis is inhibited.

4.1.2. Active

In the active mode, the module is responsible for the forwarding of messages from the Controller Chassis IMB to the Expander Bus, and response messages from the Expander Bus to the Controller Chassis IMB. The module also provides all of the functions available within the Standby mode of operation.

4.1.3. Expander Interface Module Active/standby Control

The TMR Expander Interface Modules transition between active and standby (and vice-versa) is controlled by command messages generated by the TMR Processor. Interlocks are incorporated within the TMR Expander Interface Module to ensure that both modules within an active/standby configuration can not assume active mode operation.

Where both modules within a pair are installed, the TMR Processor determines which module should be active depending on its condition. Where both modules are healthy, the active operation defaults to the left-most module.

4.2. Communication Busses

4.2.1. Expander bus

Each TMR Expander Interface Module contains a Bus Interface, isolation components and transceivers to the Expander Bus. The triplicated Expander Bus provides communication interconnection between the TMR Processor Chassis and the Expander Chassis at a data transfer rate of 1.5GMbps via UTP cables.

4.2.2. Inter-Module Bus

Each TMR Expander Interface Module FCR contains a Bus Interface to the Inter-Module Bus. The triplicated Inter-Module Bus provides communication interconnection between modules in the TMR Controller Chassis, at a data transfer rate of up to 12.5Mbps.

The Inter-Module Bus handles the following triplicated signals:

Data	-	8-bit, bi-directional bus.
Control	-	Bus clocks, module enables and bus direction control.
System Watchdog	-	System Watchdog signal to the modules.
Power Fail	-	System power fail warning to modules.
Slot	-	Indicating the left or right Trusted™ TMR Expander Processor slot position to the Trusted™ TMR Processor.
Chassis ID	-	a 4-bit code indicating the chassis number or id.

4.3. Front Panel

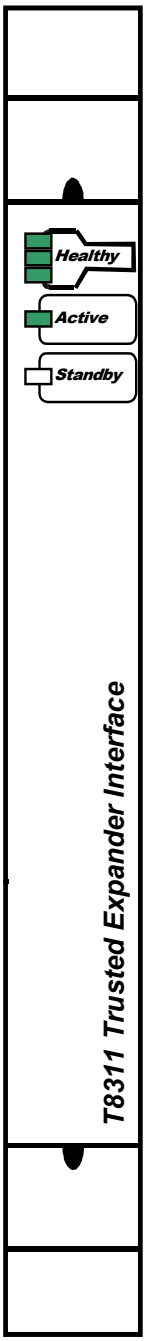

Figure 3 Module Front Panel

4.3.1. *Healthy* Indicator`

Three LEDs, one for each of the three channels, indicating the overall health of each processor channel:

LED 1	=	Channel A
LED 2	=	Channel B
LED 3	=	Channel C.

A steady green LED indicates a healthy module; a flashing red indicates a fault in the corresponding channel.

4.3.2. *Active* Indicator

This LED is green when the module is in the ‘Active’ mode.

4.3.3. *Standby* Indicator

A steady green LED when the module is in the ‘Standby’ mode.

5. Fault Finding and Maintenance

5.1. PCBS and Connectors

The TMR Expander Interface Module comprises a single PCB assembly fitted with two connectors, one each for the Expander Chassis IMB (SK1) and Expander Bus (PL4). These are detailed below.

5.2. Troubleshooting

Symptom	Possible Cause	Solution
All front panel indicators off	Lack of power	If all other modules within the chassis also show no indicators, check the power distribution and connection to the chassis.
	Front panel interface (FCR D) failure	Check if other modules within the chassis have LEDs illuminated. Check if it is possible to communicate with other modules within the chassis – using either the chassis board type (T8300) or the diagnostic utility. If communications is possible and this is the only Expander Processor installed, the failure is within FCRD and the module should be replaced, If another Expander Processor module is installed, check its status indication. If the other module is indicating active mode, check if communications with the potentially faulty module is possible (again using either the Expander Chassis board or diagnostic utility). If communications is possible, note the information returned as part of the Expander Processor board and then initiate the module replacement.
Single FCR indicator flashing RED	Single main FCR failure.	The module will continue to provide communications between the expander bus and the modules within the chassis. However, the module should be replaced as soon as practical.
Multiple FCR indicating flashing RED	Multiple failure.	This condition may be indicated briefly during module power-up, but in other circumstances, this indicates a failure beyond the modules fault tolerant capabilities. If the failed module is not the active module, it should be removed immediately. A replacement module should be installed as soon as practical. If the module was the active module, the system will attempt to switch to the standby, if it is installed and if the failures do not occur simultaneously.
Flashing standby indicator	Software detected fault	This indicates that the TMR Processor has detected a fault within the module and has switched to the previously standby module. The faulted module should be removed as soon as possible and a replacement installed as soon as practical.

Symptom	Possible Cause	Solution
Both active or standby LEDs OFF	LED failure	This condition may be indicated briefly during module power-up. If another Expander Processor module is installed within the same chassis, use its indicators to verify the active/standby mode of this module. To avoid confusion it is recommended that this module be replaced at some convenient time, initiating the active/standby changeover to the other module if necessary.
All other modules within the chassis indicate standby mode.	TMR Processor not running (faulted, or application not started).	Verify the condition of the TMR processor and start the application as necessary.
	Expander Processor Fault	Verify the Expander Processor is faulty by checking the reported condition within the T8300 chassis board or the diagnostic utility. If the module is shown not to be responding, replace the module immediately.
	Expander Bus Fault	Verify that the fault is not the result of a failed Expander Processor (see above). Check that the Expander Bus is connected correctly at both the Processor and Expander Chassis. Check that the Expander Processor(s) are installed in the correct slot(s).
	Expander Processor not installed.	Ensure a healthy Expander Processor module is installed in the correct slot.
Minor BIU errors counters incrementing	Interface Module Fault	The error counters for a single module will be incrementing. Check the values using the diagnostic utility. If the count exceeds a defined limit, the system will attempt to indicate this fault by setting the corresponding healthy LED on the module to red flashing. Replace the faulty interface module.
	Expander Processor Fault	The error counters for all the modules within the corresponding chassis will be incrementing. Check the values using the diagnostic utility. If the count exceeds a defined limit, the system will attempt to indicate this fault by setting the corresponding healthy LED on the module to red flashing. Replace the faulty Expander Processor module as soon as possible.

Table 3 Troubleshooting Guide

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.)

This page is intentionally blank