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User's Manual

PMCFW2

**IEEE1394
PMC Module**

Board Revision **A**
Manual Revision **A** 14 November 2000

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Table Of Contents

<u>Contents</u>	<u>Page</u>
1. Introduction	1
1.1 Scope	1
1.2 PMCFW2 Part Numbers	1
2. Overview	2
2.1 Board Layout	2
2.2 Features	3
2.3 Applications	3
3. Operation	4
3.1 Block Diagram	4
3.2 TSB12LV26 IEEE1394 Controller	4
3.2.1 Major Features	5
3.3 TSB41AB3 IEEE1394a-2000 PHY	5
3.4 EEPROM	7
3.5 Power Supplies	8
4. Installation	9
5. Configuration	10
5.1 LED Indicators	10
6. Connections	11
6.1 Front Panel Connector	11
6.2 IEEE1394 Connection Details	11
6.3 PCI Connections	12
7. Programming	13
7.1 Windows® Software	13
7.2 Configuration EEPROM	13
7.3 TSB12LV26 IEEE1394 Controller	13
8. Specification	14
8.1 On-Board Functions	14
8.1.1 TSB12LV26 IEEE1394 Controller	14
8.1.2 TSB41AB3 IEEE1394a-2000 PHY	14
8.2 Board Configuration	14
8.3 PMC Interface	14
8.4 Operating Environment	14
Appendix A - Data Sheets & Manual References	15
A.1 TSB12LV26 IEEE1394 Controller	15
A.2 TSB41AB3 IEEE1394a-2000 PHY	15
A.3 IEEE1394-1995 Specification	15
A.4 IEEE1394a-2000 Specification	15
A.5 1394 Open Host Controller Interface Specification / Release 1.00	15
A.6 PMC Specification	15
A.7 NM24C02 EEPROM	15

List of Figures

Figure	Page
Figure 1 Board Layout Topside	2
Figure 2 Board Layout Underside	2
Figure 3 Block Diagram.....	4
Figure 4 PHY and Port Power Supplies	8
Figure 5 IEEE1394 Connections	11
Figure 6 IEEE1394 6-pin to 6-pin Cable.....	11
Figure 7 IEEE1394 6-pin to 4-pin Cable.....	11

1. Introduction

1.1 Scope

This manual provides:-

- A getting started guide.
- Configuration details.
- A user reference guide.
- Details of implementation specific considerations for major devices.
- General Hardware Description.

This user manual *does not* provide:-

- Detailed data on the operation of the IEEE1394 controller device.
- Detailed data on the operation of the EEPROM.
- Details on the content of the PMC specification.
- Details on the content of the IEEE1394 specifications.

Information is provided to allow the module to be integrated into a system and configured by the system engineer. The User manual is intended for use by system integrators, service personnel, software engineers and end users.

Unless otherwise stated, address information is in hexadecimal notation.

1.2 PMCFW2 Part Numbers

Part Number	Description
853-10420	IEEE1394 PMC Module with LED indication
853-10421 *	IEEE1394 PMC Module without indication

* Note: the version without LED indication is to special order for high volume quantities only.

2. Overview

2.1 Board Layout

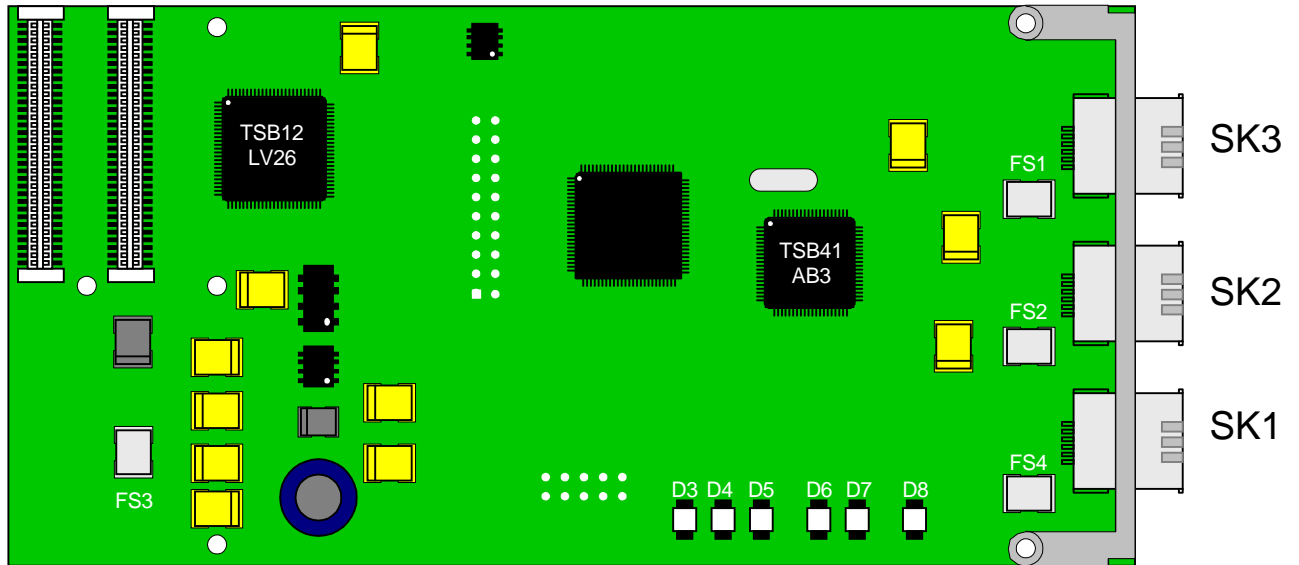


Figure 1 Board Layout Topside

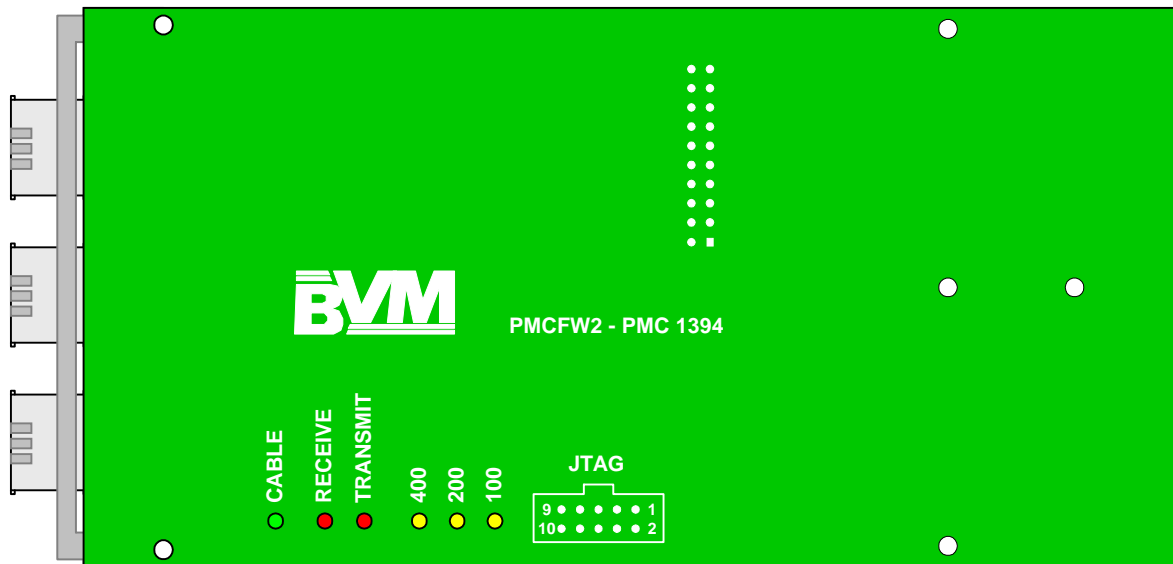


Figure 2 Board Layout Underside

2.2 Features

- Conforms to PMC standard IEEE P1386.1/Draft 2.3 9th October 2000.
- Conforms to PCI Local Bus Specification Revision 2.2.
- 32-bit PCI single chip IEEE1394 OHCI controller (Texas TSB12LV26).
- Conforming to IEEE1394-1995 and IEEE1394a-2000 for data rates up to 400Mbits/sec.
- Single chip three port cable transceiver/arbiter PHY (Texas TSB41AB03).
- Configuration EEPROM (1Kbit) for PCI subsystem, subsystem vendor ID and other configuration information.
- PHY power is taken from either PCI +12V or cable power enabling a powered down PMC module to forward IEEE1394 data packets.
- Alternate power provider (does not supply power to the cable).

2.3 Applications

- High performance storage interface for industrial PC's or servers.
- Interface to high performance hard disc's.
- Interface to Video equipment for video capture/play-back and editing.
- Interface to document scanners.

3. Operation

3.1 Block Diagram

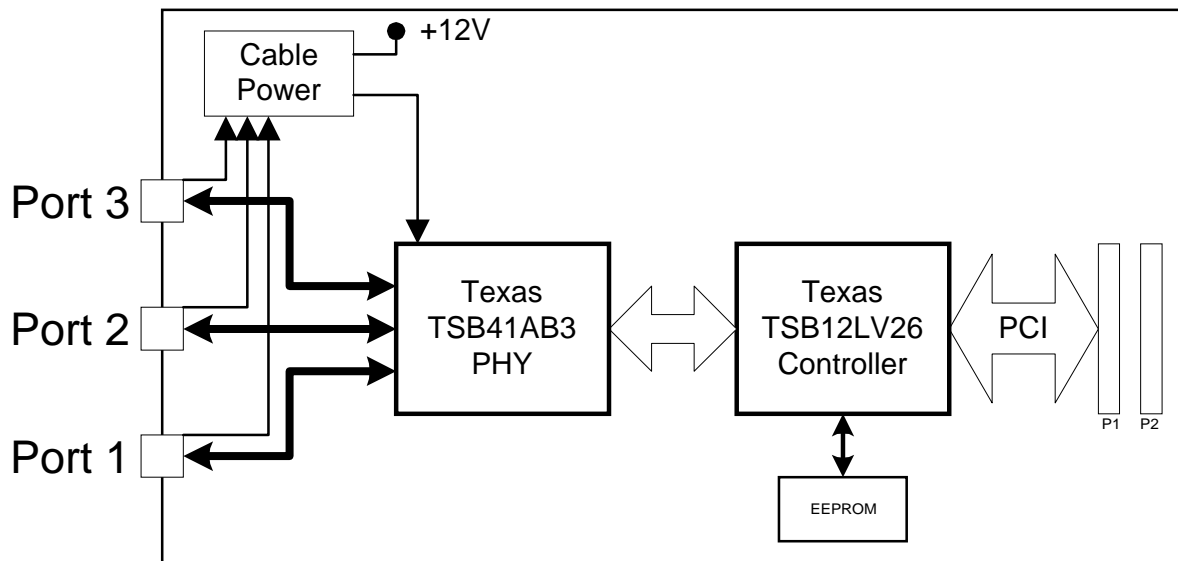


Figure 3 Block Diagram

3.2 TSB12LV26 IEEE1394 Controller

The PMCFW2 uses a Texas Instruments TSB12LV26, which is a PCI-to-1394 host controller compatible with the latest PCI Local Bus, PCI Bus Power Management Interface, IEEE1394-1995 and IEEE1394 Open Host Controller Interface Specifications (OHCI). The chip provides the IEEE1394 link function, and is compatible with serial bus data rates of 100 Mbits/sec, 200 Mbits/sec, and 400 Mbits/sec.

As required by the IEEE1394 Open Host Controller Interface (OHCI) and IEEE1394a Specifications, internal control registers are memory mapped and non-prefetchable. The PCI configuration header is accessed through configuration cycles specified by PCI, and provides Plug-and-Play (PnP) compatibility. Furthermore, the TSB12LV26 is compliant with the PCI Bus Power Management Interface Specification, as per the PC99 requirements. The TSB12LV26 supports the D0, D2, and D3 power states.

The TSB12LV26 design provides PCI bus master bursting, and is capable of transferring a cache-line of data at 132Mbytes/s after connection to the memory controller. Since PCI latency can be large, deep FIFO's are provided to buffer IEEE1394 data.

The TSB12LV26 provides physical write posting buffers and a highly tuned physical data path for SBP-2 performance. The TSB12LV26 also provides multiple isochronous contexts, multiple cache-line burst transfers, advanced internal arbitration, and bus holding buffers on the PHY/Link interface.

3.2.1 Major Features

- 3.3V core logic with universal PCI interfaces compatible with 3.3V and 5V PCI signalling environments.
- Supports serial bus data rates of 100, 200, and 400 Mbits/sec.
- Supports physical write posting of up to three outstanding transactions.
- Serial ROM interface supports 2-wire devices.
- Supports external cycle timer control for customised synchronisation.
- Implements PCI burst transfers and deep FIFO's to tolerate large host latency.
- Provides two general-purpose I/O signals.
- Supports CLKRUN.

3.3 TSB41AB3 IEEE1394a-2000 PHY

The PMCFW2 uses a TSB41AB3 PHY, which provides the digital and analogue transceiver functions needed to implement a three-port node in a cable-based IEEE1394 network. Each cable port incorporates two differential line transceivers. The transceivers include circuitry to monitor the line conditions as needed for determining connection status, for initialisation and arbitration, and for packet reception and transmission.

The TSB41LV03 uses a 24.576MHz crystal as a reference - an internal oscillator drives an internal phase-locked loop (PLL) which generates the required 393.216MHz reference signal. This reference signal is internally divided to provide the clock signals used to control transmission of the outbound encoded strobe and data information. A 49.152MHz clock signal, supplied to the associated LLC for synchronisation of the two chips, is used for re-synchronisation of the received data. The power-down (PD) function is disabled on the PMCFW2.

Data bits to be transmitted through the cable ports are received from the LLC on two, four, or eight parallel paths (depending on the requested transmission speed). They are latched internally in the TSB41AB3 in synchronisation with the 49.152MHz system clock. These bits are combined serially, encoded, and transmitted at 98.304, 196.608, or 392.216Mbits/sec (referred to as S100, S200, and S400 speed respectively) as the outbound data-strobe information stream. During transmission, the encoded data information is transmitted differentially on the TPB cable pair(s), and the encoded strobe information is transmitted differentially on the TPA cable pair(s).

During packet reception the TPA and TPB transmitters of the receiving cable port are disabled, and the receivers for that port are enabled. The encoded data information is received on the TPA cable pair, and the encoded strobe information is received on the TPB cable pair. The received data-strobe information is decoded to recover the receive clock signal and the serial data bits. The serial data bits are split into 2, 4 or 8-bit parallel streams (depending upon the indicated receive speed), re-synchronised to the local 49.152MHz system clock and sent to the associated LLC. The received data is also transmitted (repeated) on the other active (connected) cable ports.

Both the TPA and TPB cable interfaces incorporate differential comparators to monitor the line states during initialisation and arbitration. The outputs of these comparators are used by the internal logic to determine the arbitration status. The TPA channel monitors the incoming cable common-mode voltage. The value of this common-mode voltage is used during arbitration to set the speed of the next packet transmission. In addition, the TPB channel monitors the incoming cable common-mode voltage on the TPB pair for the presence of the remotely supplied twisted-pair bias voltage.

The TSB41AB3 provides a 1.86V nominal bias voltage for port termination. The PHY contains three independent TPBIAS circuits. This bias voltage, when seen through a cable by a remote receiver, indicates the presence of an active connection.

The line drivers in the TSB41AB3, operating in a high-impedance current mode, are designed to work with external 112Ω line-termination resistor networks in order to match the 110Ω cable impedance. One network is provided at each end of a twisted-pair cable. Each network is composed of a pair of series-connected 56Ω resistors. The midpoint of the pair of resistors that is directly connected to the twisted-pair A terminals is connected to its corresponding TPBIAS voltage terminal. The midpoint of the pair of resistors that is directly connected to the twisted-pair B terminals is coupled to ground through a parallel R-C network. The values of the external line-termination resistors are designed to meet the standard specifications when connected in parallel with the internal receiver circuits. An external resistor connected between the R0 and R1 terminals sets the driver output current, along with other internal operating currents.

When the power supply of the TSB41AB3 is 0V while the twisted-pair cables are connected, the TSB41AB3 transmitter and receiver circuitry presents a high-impedance signal to the cable and does not load the TPBIAS voltage at the other end of the cable.

The PC0–PC2 signals are used to indicate the default power-class status 4 for the PMCFW2 (node may be powered from the bus and is using up to 3 W). The C/LKON signal is used as an input to indicate that the node is a contender for bus manager.

The TSB41AB3 supports suspend/resume as defined in the IEEE1394a-2000 specification. The suspend mechanism allows pairs of directly-connected ports to be placed into a low-power conservation state (suspended state) while maintaining a port-to-port connection between IEEE1394 bus segments. While in the suspended state, a port is unable to transmit or receive data transaction packets. However, a port in the suspended state is capable of detecting connection status changes and detecting incoming TPBias. When all three ports of the TSB41AB3 are suspended all circuits except the bandgap reference generator and bias detection circuits are powered down resulting in significant power savings. For additional details of suspend/resume operation refer to the 1394a-2000 specification - referenced in "A.4 IEEE1394a-2000 Specification (on page 15)".

The port transmitter and receiver circuitry is disabled during power down (when the PD input terminal is asserted high), during reset (when the RESET input terminal is asserted low), when no active cable is connected to the port, or when controlled by the internal arbitration logic. The TPBias output is disabled during power down, during reset, or when the port is disabled as commanded by the LLC.

The CNA (cable-not-active) terminal provides a high when there are no twisted-pair cable ports receiving incoming bias (i.e. they are either disconnected or suspended), and can be used along with LPS to determine when to power down the TSB41AB3. When the PD terminal is asserted high, the CNA detection circuitry is enabled (regardless of the previous state of the ports) and a pull-down is activated on the RESET terminal so as to force a reset of the TSB41AB3 internal logic.

The LPS (link power status) terminal works with the C/LKON terminal to manage the power usage in the node. The LPS signal from the LLC is used in conjunction with the LCtrl bit to indicate the active/power status of the LLC. The LPS signal is also used to reset, disable, and initialise the PHY-LLC interface (the state of the PHY-LCC interface is controlled solely by the LPS input regardless of the state of the LCtrl bit).

The LPS input is considered inactive if it remains low for more than 2.6μs and is considered active otherwise. When the TSB41AB3 detects that LPS is inactive, it will place the PHY-LLC interface into a low-power reset state in which the CTL and D outputs are held in the logic zero state and the LREQ input is ignored; however, the SYSCLK output remains active. If the LPS input remains low for more than 26μs, the PHY-LLC interface is put into a low-power disabled state in which the SYSCLK output is also held inactive. The PHY-LLC interface is also held in the disabled state during hardware reset. The TSB41AB3 will continue the necessary repeater functions required for normal network operation regardless of the state of the PHY-LLC interface. When the interface is in the reset or disabled state and LPS is again observed active, the PHY will initialise the interface and return it to normal operation.

When the PHY-LLC interface in the low-power disabled state, the TSB41AB3 will automatically enter a low-power mode if all ports are inactive (disconnected, disabled, or suspended). In this low-power mode, the TSB41AB3 disables its internal clock generators and also disables various voltage and current reference circuits, depending on the state of the ports (some reference circuitry must remain active in order to detect new cable connections, disconnection's, or incoming TPBias, for example). The lowest power consumption (the ultra-low power sleep mode) is attained when all ports are either disconnected, or disabled with the port's interrupt enable bit cleared. The TSB41AB3 will exit the low-power mode when the LPS input is asserted high or when a port event occurs which requires that the TSB41AB3 become active in order to respond to the event or to notify the LLC of the event (e.g. incoming bias is detected on a suspended port, a disconnection is detected on a suspended port, a new connection is detected on a non-disabled port, etc.). The SYSCLK output will become active (and the PHY-LLC interface will be initialised and become operative) within 7.3ms after LPS is asserted high when the TSB41AB3 is in the low-power mode.

The PHY uses the C/LKON terminal to notify the LLC to power up and become active. When activated, the C/LKON signal is a square wave of approximately 163ns period. The PHY activates the C/LKON output when the LLC is inactive and a wake-up event occurs. The LLC is considered inactive when either the LPS input is inactive, as described above, or the LCtrl bit is cleared to 0. A wake-up event occurs when a link-on PHY packet addressed to this node is received, or conditionally when a PHY interrupt occurs. The PHY de-asserts the C/LKON output when the LLC becomes active (both LPS active and the LCtrl bit set to 1). The PHY also de-asserts the C/LKON output when a bus-reset occurs unless a PHY interrupt condition exists which would otherwise cause C/LKON to be active.

3.4 EEPROM

The PMCFW2 is fitted with 1Kbit of EEPROM using a 24C02 device, which is supplied pre-programmed by BVM.

The contents of the EEPROM are read by the TSB12LV23 on coming out of reset and are used to set up the control registers after reset, allowing the following to be set:

- PCI interface configuration.
- PCI Subsystem and Subsystem Vendor ID.
- IEEE1394 configuration parameters.
- IEEE OUI (Organisation Unique Identifier).

See section "7.2 Configuration EEPROM (on page 13)" and the information referenced "A.7 NM24C02 EEPROM (on page 15)" for further details.

3.5 Power Supplies

Figure 4 (below) shows the power supply arrangements for the TSB41LV03 and the 3 ports. Power for the TSB41LV03 is supplied (via a switching regulator) from either the PMC +12V supply (via a Schottky diode) or the IEEE1394 cable power if the PMC power is not present.

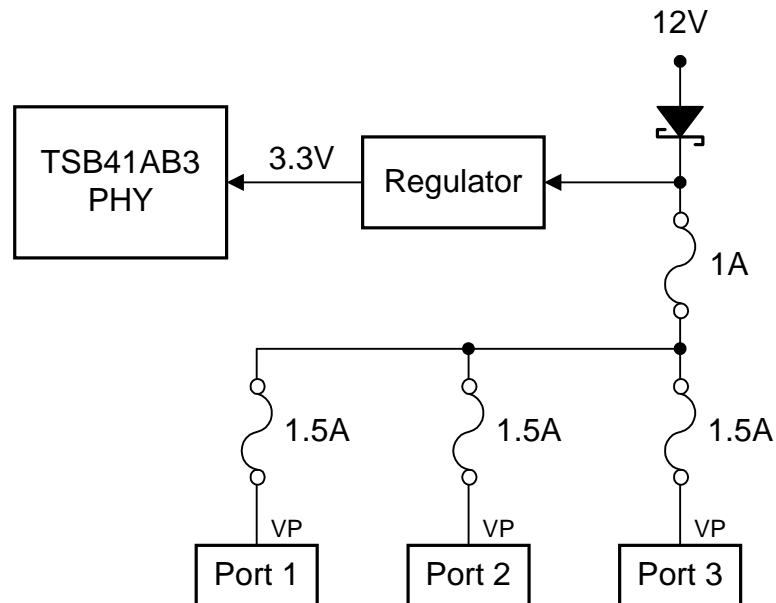


Figure 4 PHY and Port Power Supplies

The 1.5A reset-able fuses (Raychem SMD150) on the ports are designed to prevent excessive current if ports are accidentally shorted and the 1A fuse to protect the PMC +12V supply. Note that the PMCFW2 is not capable of providing external power from its ports other than the IEEE1394 requirement of 3W per port to power up other PHY'S on the IEEE1394 bus. The TSB41AB3 is configured to "advertise" itself during configuration as class 4 and alternate power provider.

4. Installation

1. PMC modules should only be installed when the host carrier board is in a powered-off condition to avoid damage to the PMC module and host carrier board. Normal ESD protection procedures should be followed to avoid damage to the board.
2. After removing any blanking panels on the host carrier front panel, the PMC module should be offered up to the host carrier site and the front panel carefully positioned through the host carrier front panel opening, taking care not to damage the EMC gasket on the PMC module front panel.
3. The PMC module should be fixed to the host carrier using four M2.5 x 6mm pan-head screws into the four fixing holes provided (two on the front panel and two on the spacers).
4. There is no voltage keying on the PMCFW2, it will work in both +3.3V and +5V host carriers.
5. The PMCFW2 can be used with standard IEEE1394 6-way cables - see section "6.1 Front Panel Connector (on page 11)".
6. The installation can be tested using standard Windows[®] 98SE, Windows[®] ME or Windows[®] 2000 software for IEEE1394(OHCI). The on-board LED's will assist this process - see section "5.1 LED Indicators (on page 10)".

5. Configuration

5.1 LED Indicators

Six LED indicators are fitted, which can be viewed from the top of the board when it is fitted onto a host carrier. The functions are shown below in order (1st closest to the front-panel).

LED Name	Function	Colour
CABLE	Lit when cable attached	GREEN
RECEIVE	Lit when receiving	RED
TRANSMIT	Lit when transmitting	RED
400	TX/RX @ 400Mbps/sec	YELLOW
200	TX/RX @ 200Mbps/sec	YELLOW
100	TX/RX @ 100Mbps/sec	YELLOW

Notes:

1. The LED's are only valid when the PMCFW2 has been correctly initialised by device drivers.
2. Sometimes the transmit LED comes on upon power-up, until correctly initialised by device drivers.
3. The cable LED is lit when a powered-up cable (i.e. connected to another device) is attached to any port.
4. All LED's are stretched by mono-stable to about 10th second.
5. When a IEEE1394 system is idle one board will be transmitting isochronous packets (125µs) @ 100Mbps/sec all the time (the isochronous resource manager) and all the others receiving this data.

6. Connections

6.1 Front Panel Connector

The PMCFW2 provides 3 IEEE1394 ports through the front panel. Figure 5 (below) shows the IEEE1394 connections viewed from the front panel, as per the IEEE1394-1995 specification.

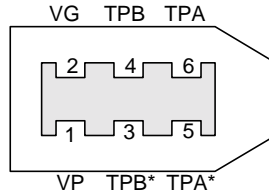


Figure 5 IEEE1394 Connections

6.2 IEEE1394 Connection Details

Cable assemblies consist of two plug connectors, either the 6-pin connector specified by IEEE standard 1394-1995 (with power) or the 4-pin connector defined by IEEE1394a (without power), joined by a length of cable. The PMCFW2 provides the 6-pin connector (with power), but can connect to a 6-pin or 4-pin IEEE1394 peripheral device.

The suggested maximum length of a cable assembly is 4.5m. This is to ensure that the maximum configuration of a set of cables does not exceed the length over which the end-to-end signal propagation delay would be exceeded. Longer cable lengths are possible if special consideration is given to the actual serial bus system topology to be used - see the IEEE1394a standard referenced in section "A.4 IEEE1394a-2000 Specification (on page 15)" for further information.

Figure 6 (below) shows the 6-pin connector to 6-pin connector cable assembly, and Figure 7 (below) shows the 6-pin connector to 4-pin connector cable assembly. The two signal pairs “cross” in the cable to effect a transmit-to-receive interconnection.

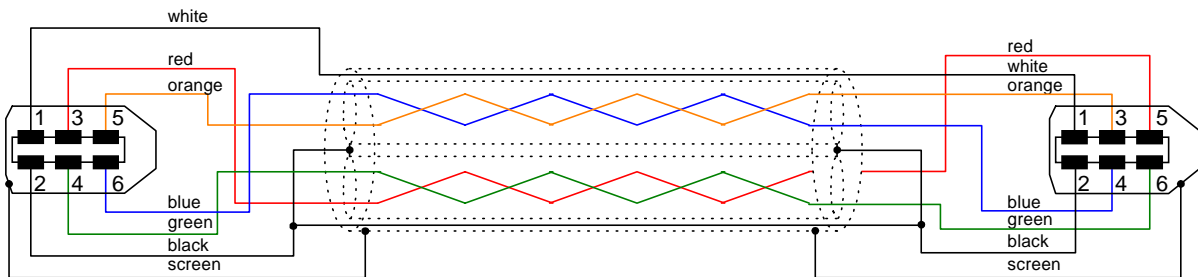


Figure 6 IEEE1394 6-pin to 6-pin Cable

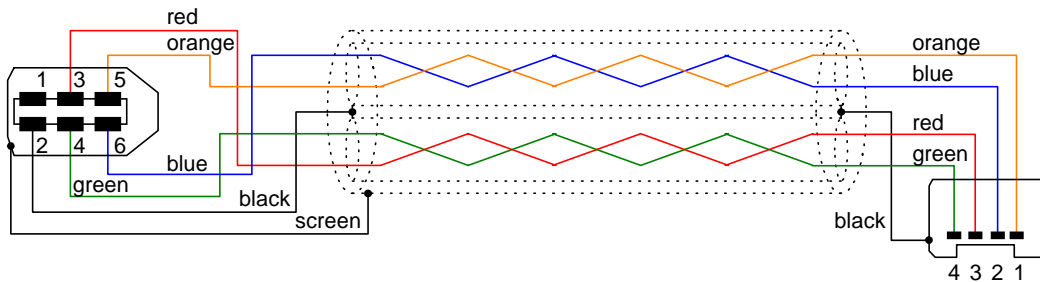


Figure 7 IEEE1394 6-pin to 4-pin Cable

6.3 PCI Connections

P1 and P2 provide the standard PCI signals on the PMC module, as defined in the PMC specification and reproduced for reference purposes below.

P1 32 Bit PCI				P2 32 Bit PCI			
Pin	Signal Name	Signal Name	Pin	Pin	Signal Name	Signal Name	Pin
1	TCK	-12V	2	1	+12V	TRST#	2
3	Ground	INTA#	4	3	TMS	TDO	4
5	INTB#	INTC#	6	5	TDI	Ground	6
7	BUSMODE1#	+5V	8	7	Ground	PCI-RSVD*	8
9	INTD#	PCI-RSVD*	10	9	PCI-RSVD*	PCI-RSVD*	10
11	Ground	PCI-RSVD*	12	11	BUSMODE2#	+3.3V	12
13	CLK	Ground	14	13	RST#	BUSMODE3#	14
15	Ground	GNT#	16	15	3.3V	BUSMODE4#	16
17	REQ#	+5V	18	17	PME#	Ground	18
19	V (I/O)	AD[31]	20	19	AD[30]	AD[29]	20
21	AD[28]	AD[27]	22	21	Ground	AD[26]	22
23	AD[25]	Ground	24	23	AD[24]	+3.3V	24
25	Ground	C/BE[3]#	26	25	IDSEL	AD[23]	26
27	AD[22]	AD[21]	28	27	+3.3V	AD[20]	28
29	AD[19]	+5V	30	29	AD[18]	Ground	30
31	V (I/O)	AD[17]	32	31	AD[16]	C/BE[2]#	32
33	FRAME#	Ground	34	33	Ground	PMC-RSVD	34
35	Ground	IRDY#	36	35	TRDY#	+3.3V	36
37	DEVSEL#	+5V	38	37	Ground	STOP#	38
39	Ground	LOCK#	40	39	PERR#	Ground	40
41	SDONE#	SBO#	42	41	+3.3V	SERR#	42
43	PAR	Ground	44	43	C/BE[1]#	Ground	44
45	V (I/O)	AD[15]	46	45	AD[14]	AD[13]	46
47	AD[12]	AD[11]	48	47	Ground	AD[10]	48
49	AD[09]	+5V	50	49	AD[08]	+3.3V	50
51	Ground	C/BE[0]#	52	51	AD[07]	PMC-RSVD	52
53	AD[06]	AD[05]	54	53	+3.3V	PMC-RSVD	54
55	AD[04]	Ground	56	55	PMC-RSVD	Ground	56
57	V (I/O)	AD[03]	58	57	PMC-RSVD	PMC-RSVD	58
59	AD[02]	AD[01]	60	59	Ground	PMC-RSVD	60
61	AD[00]	+5V	62	61	ACK64#	+3.3V	62
63	Ground	REQ64#	64	63	Ground	PMC-RSVD	64

7. Programming

7.1 Windows® Software

The PMCFW2 is both an Open Host Controller Interface 1.0 (OHCI) and IEEE1394a compliant Link-layer device (LYNX), and support for this is built in to Windows®98SE, Windows®ME and Windows®2000. Additional software may be supplied by peripheral vendors.

7.2 Configuration EEPROM

The EEPROM is supplied pre-programmed by BVM, and contains the BVM PCI Subsystem Vendor ID, which is 15C0 (hexadecimal) and the PCI Subsystem ID, which is 0131 (hexadecimal).

The EEPROM also contains other PCI, OHCI and IEEE1394 configuration parameters, including the OUI (Organisationally Unique Identifier). This is used to identify each node on an IEEE1394 network with a unique 64-bit ID. The BVM OUI is 00-80-FB-12-xx-xx-xx-xx. Where 00-80-FB is the BVM OUI, 12 is the BVM product number and xx-xx-xx-xx is the unique 32-bit board identifier.

See the information referenced in "A.7 NM24C02 EEPROM (on page 15)" for further details.

7.3 TSB12LV26 IEEE1394 Controller

See the information in the TSB12LV26 OHCI-Lynx PCI-Based IEEE 1394 Host Controller Data Manual referenced in "A.1 TSB12LV26 IEEE1394 Controller (on page 15)".

8. Specification

8.1 On-Board Functions

8.1.1 TSB12LV26 IEEE1394 Controller

Texas Instruments TSB12LV26 PCI-to-IEEE1394 Host Controller.
 PCI Local Bus Revision 2.2.
 PCI Bus Power Management Interface Revision 1.1.
 IEEE 1394-1995, 1394a, and 1394 Open Host Controller Interface.
 IEEE1394 link data rates of 100 Mbits/sec, 200 Mbits/sec, and 400 Mbits/sec.
 PC99 compatible.

8.1.2 TSB41AB3 IEEE1394a-2000 PHY

Texas Instruments TSB41AB3 IEEE1394a-2000 3-Port Cable Transceiver/Arbiter.
 2 differential line transceivers per port.
 Connection status monitoring, initialisation, and arbitration functions.
 Packet reception and transmission.

8.2 Board Configuration

EEPROM: 2Kbits - PCI & IEEE1394 Configuration
 LED Indicators (6): CABLE, RECEIVE, TRANSMIT, 400, 200, 100

8.3 PMC Interface

Bus Interface: PCI 2.2 compliant
 Bus Width: 32-bit
 Data Transfer: PCI 2.2 Bus Mastering
 Interrupts: PCI INT #A
 Memory Address: BIOS assigned
 PCI configuration: DWORD, WORD & BYTE

8.4 Operating Environment

Dimensions: 74.0mm x 149.0mm (single PMC size)
 Power: +3.3V TBDmA typical, +12V TBDmA typical when idle
 +3.3V TBDmA typical, +12V TBDmA typical when connected
 Environmental: 0 to 70 °C, 95% humidity non-condensing (extended range to order)

Appendix A - Data Sheets & Manual References

A.1 TSB12LV26 IEEE1394 Controller

TSB12LV26 OHCI-Lynx PCI-Based IEEE1394 Host Controller Data Manual - SLLS366A - March 2000.

(<http://www.ti.com>)

A.2 TSB41AB3 IEEE1394a-2000 PHY

TSB41AB3 IEEE1394a Three Port Cable Transceiver/Arbiter - SLLS418A - June 2000 - revised September 2000.

(<http://www.ti.com>)

A.3 IEEE1394-1995 Specification

IEEE Standard for a High Performance Serial Bus - SH94364 - 30 August 1996.

(<http://www.ieee.org>)

A.4 IEEE1394a-2000 Specification

Standard for a High Performance Serial Bus (Amendment) - SH94821 - 30 March 2000.

(<http://www.ieee.org>)

A.5 1394 Open Host Controller Interface Specification / Release 1.00

1394 Open Host Controller Interface Specification Release 1.00 - 20 October 1997.

(<ftp://ftp.austin.ibm.com/pub/chrptech/1394ohci>)

A.6 PMC Specification

IEEE Draft Standard Physical and Environmental Layers for PCI Mezzanine Cards: PMC P1386.1/Draft 2.3 9th October 2000.

(<http://www.ieee.org>)

A.7 NM24C02 EEPROM

NM24Cxx Standard 2-Wire Bus Interface Serial EEPROM Family - TL/D/12588.

(<http://www.fairchildsemi.com>)

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