The Embedded I/O Company

TEWS TECHNOLOGIES

TPMC860

4 Channel Isolated Serial Interface RS232

Version 1.0

User Manual

Issue 1.0.4

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TPMC860-10R

4 channel isolated serial interface RS232

Style Conventions

Hexadecimal characters are specified with prefix 0x, i.e. 0x029E (that means hexadecimal value 029E).

For signals on hardware products, an ‚Active Low' is represented by the signal name with # following, i.e. IP_RESET#.

Access terms are described as:

W	Write Only
R	Read Only
R/W	Read/Write
R/C	Read/Clear
R/S	Read/Set

Issue	Description	Date
1.0	First Issue	July 2001
1.1	Correction Figure “PCI Header”	March 2003
1.2	New address TEWS LLC	September 2006
1.0.3	New User Manual Issue Notation	November 2012
1.0.4	Correction in Table 7-1 and Table 7-2: UART channel notation changed from A-D to 0-3.	August 2017

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1 Product Description

The TPMC860 is a standard single-width 32 bit PMC module with four channels of high performance RS232 interface. Each of the four channels is isolated from the system and against each other by optocoupler and on board DC/DC converter per channel.

The serial channels are accessible through a DB25 connector mounted in the front panel and via P14 I/O. Each channel has a 64 byte transmit FIFO and a 64 byte receive FIFO to significantly reduce the overhead required to provide data to and get data from the transmitter and receivers. The FIFO trigger levels are programmable.

The TPMC860 supports Receive Data (RxD), Transmit Data (TxD), Ready-To-Send (RTS), Clear-To-Send (CTS) and isolated GND per channel. The baud rate is individually programmable up to 460.8 kbaud for each channel.

Interrupts are supported. All channels generate interrupts on PCI interrupt INTA. For fast interrupt source detection the TPMC860 provides a special Interrupt Status Register.

Each RS232 receiver input and transmitter output is protected against electrostatic discharge (ESD) up to +/- 15kV according to IEC 1000-4-2.

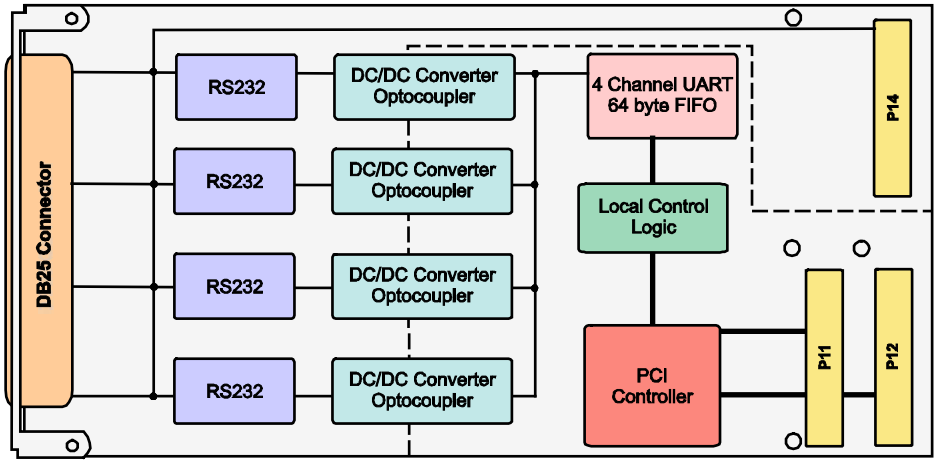

Figure 1-1 : Block Diagram

2 Technical Specification

PMC Interface		
Mechanical Interface	PCI Mezzanine Card (PMC) Interface Single Size	
Electrical Interface	PCI Rev. 2.1 compliant 33MHz / 32bit PCI 3.3V and 5V PCI Signaling Voltage	
On Board Devices		
PCI Target Chip	PCI9030 (PLX Technology)	
UART Controller	ST16C654 (4 channel UART)	
I/O Interface		
Number of RS232 Channels	4	
FIFO	64 byte transmit FIFO, 64 byte receive FIFO per channel	
Interrupts	PCI INTA for all channels, on board Interrupt Status Register	
I/O Signals / Channel	TX, RX, RTS, CTS, isolated GND	
Maximum Transfer Rate	Each channel programmable up to 460.8k baud	
ESD Protection	+/- 15kV Human Body Model, +/- 6kV IEC1000-4-2 model	
I/O Connector	DB25 female connector PMC P14 I/O (64 pin Mezzanine Connector)	
Physical Data		
Power Requirements	33mA typical @+3.3V DC 237mA typical @+5V DC	
Temperature Range	Operating Storage	-40°C to +85 °C -55°C to +125°C
MTBF	258706 h MTBF values shown are based on calculation according to MIL-HDBK-217F and MIL-HDBK-217F Notice 2; Environment: G_B 20°C. The MTBF calculation is based on component FIT rates provided by the component suppliers. If FIT rates are not available, MIL-HDBK-217F and MIL-HDBK-217F Notice 2 formulas are used for FIT rate calculation.	
Humidity	5 – 95 % non-condensing	
Weight	85 g	

Table 2-1 : Technical Specification

3 Local Space Addressing

3.1 PCI9030 Local Space Configuration

The local on board addressable regions are accessed from the PCI side by using the PCI9030 local spaces.

PCI9030 Local Space	PCI9030 PCI Base Address (Offset in PCI Configuration Space)	PCI Space Mapping	Size (Byte)	Port Width (Bit)	Endian Mode	Description
0	0x18	MEM	64	8	Little	access of all TPMC860 register

Table 3-1 : PCI9030 Local Space Configuration

3.2 Local I/O Space

Not used by the TPMC860.

3.3 Local Memory Space

All local registers of the TPMC860 are accessible in the memory space of the PMC module.

Address range: PCI Base Address 2 for Local Address Space 0 + (0x00 to 0x24).

UART controller channel 0:	PCI Base Address 2 + (x000 to 0x07)
UART controller channel 1:	PCI Base Address 2 + (0x08 to 0x0F)
UART controller channel 2:	PCI Base Address 2 + (0x10 to 0x17)
UART controller channel 3:	PCI Base Address 2 + (0x18 to 0x1F)
FIFO Ready Register CH0-CH3:	PCI Base Address 2 + (0x20)
Interrupt Status Register:	PCI Base Address 2 + (0x24)

PCI Base Address:	**PCI9030 PCI Base Address 2 (Offset 0x18 in PCI Configuration Space).**

3.3.1 Register Map

Each of the four isolated serial channels of the TPMC860 is accessed in the PCI Memory Space by two sets of registers. Both register sets have a common register, the Line Control Register (LCR). Bit 7 of the Control Register is used to switch between the two register sets of a channel.

3.3.2 Register Set of each channel

Register Set 1 is only accessible if bit 7 of the Line Control Register (LCR, Address: PCI Base Address 3 + Channel Offset + 0x03) is set to ‘0’. After reset Register Set 1 is accessible.

PCI Base Address + Channel Offset +	Read Mode	Write Mode	Size
0x00	Receive Holding Register	Transmit Holding Register	Byte
0x01	Interrupt Enable Register	Interrupt Enable Register	Byte
0x02	Interrupt Status Register	FIFO Control Register	Byte
0x03	Line Control Register	Line Control Register	Byte
0x04	Modem Control Register	Modem Control Register	Byte
0x05	Line Status Register (LCR)	-	Byte
0x06	Modem Status Register	-	Byte
0x07	Scratchpad Register	Scratchpad Register	Byte

Table 3-2 : Register Set 1

To get access to Register Set 2 of the serial channels bit 7 of the Line Control Register must be set to '1'. The Enhanced Feature Registers, Xon-1/2 and Xoff-1/2 registers are only accessible if the LCR is set to '0xBF'.

PCI Base Address + Channel Offset +	READ/WRITE	Size	Comment
0x00	LSB of Divisor Latch	Byte	LCR bit-7 set to '1'
0x01	MSB of Divisor Latch	Byte	LCR bit-7 set to '1'
0x02	Enhanced Feature Register	Byte	LCR is set to '0xBF'
0x03	Line Control Register (LCR)	Byte	Always accessible
0x04	Xon-1 Word	Byte	LCR is set to '0xBF'
0x05	Xon-2 Word	Byte	LCR is set to '0xBF'
0x06	Xoff-1 Word	Byte	LCR is set to '0xBF'
0x07	Xoff-2 Word	Byte	LCR is set to '0xBF'

Table 3-3 : Register Set 2

3.3.3 Special Registers

The TMPC860 provides two special registers. For fast status detection there is a FIFO Status Register for channel 0 to channel 3 and an Interrupt Status Register for all four channels.

Offset to PCI Base Address 2	Register Name	Size (Bit)
0x20	FIFO Ready Register Channel 0 - Channel 3	8
0x24	Interrupt Status Register	8

Table 3-4 : Special Register

3.3.3.1 FIFO Ready Register Channel 0-3

The FIFO Ready Register FIFORDY1 is a byte wide read only register. The FIFO Ready Register provides the status of the transmit and receive FIFO's of channel 0 to channel 3. Each TX and RX channel (0-3) has its own 64 byte FIFO. When any of the TX/RX FIFO's become empty/full, the status bit associated with the TX/RX function of channel 0-3 is set in the FIFO Ready Register.

Bit	Symbol	Description	Access	Reset Value
7	RXRDY Channel 3	RX Ready Bit for channel 0-3 0 = the corresponding receive FIFO is above the programmed trigger level or a time-out has occurred 1 = the receiver is ready and is below the programmed trigger level	R	
6	RXRDY Channel 2			
5	RXRDY Channel 1			
4	RXRDY Channel 0			
3	TXRDY Channel 3	TX Ready Bit for channel 0-3 0 = the corresponding transmit FIFO is full. This channel will not accept any more transmit data 1 = one or more empty locations exist in the corresponding FIFO	R	
2	TXRDY Channel 2			
1	TXRDY Channel 1			
0	TXRDY Channel 0			

Table 3-5 : FIFO Ready Register Channel 0-3

3.3.3.2 Interrupt Status Register

The Interrupt Status Register is a byte wide read only register located in the PCI Memory Space (PCI Base Address2 +0x24) and reflects the interrupt status of the four UART channels. It is useful for fast interrupt source detection.

Bit	Symbol	Description	Access	Reset Value
7:4		Not used	-	-
3	Interrupt Channel 3	Interrupt Status of Channel 0-3 1 = indicates interrupt is pending on channel 0-3 0 = no interrupt on channel 0-3	R	0x0
2	Interrupt Channel 2			
1	Interrupt Channel 1			
0	Interrupt Channel 0			

Table 3-6 : Interrupt Status Register (Address 0x24)

Each of the four serial channels generates interrupts on the local interrupt 1 of the PCI target chip, which is mapped to PCI interrupt INTA.

If the “PCI Interrupt Enable” of the PCI target chip is disabled (INTCSR Bit 6 is set to ‘0’) the Interrupt Status Register can be used as a polling register for interrupts of the four serial controller.

Interrupts from the four serial channels can be individual enabled by the ST16C654 serial controller. After reset all UART interrupts are disabled.

4 PCI9030 Target Chip

4.1 PCI Configuration Registers (PCR)

4.1.1 PCI9030 Header

PCI CFG Register Address	Write '0' to all unused (Reserved) bits				PCI writeable	Initial Values (Hex Values)
	31 24	23 16	15 8	7 0		
0x00	Device ID		Vendor ID		N	035C 1498
0x04	Status		Command		Y	0280 0000
0x08	Class Code			Revision ID	N	070200 0A
0x0C	BIST	Header Type	PCI Latency Timer	Cache Line Size	Y[7:0]	00 00 00 00
0x10	PCI Base Address 0 for MEM Mapped Config. Registers				Y	FFFFFF80
0x14	PCI Base Address 1 for I/O Mapped Config. Registers				Y	FFFFFF81
0x18	PCI Base Address 2 for Local Address Space 0				Y	FFFFFFC0
0x1C	PCI Base Address 3 for Local Address Space 1				Y	00000000
0x20	PCI Base Address 4 for Local Address Space 2				Y	00000000
0x24	PCI Base Address 5 for Local Address Space 3				Y	00000000
0x28	PCI Cardbus Information Structure Pointer				N	00000000
0x2C	Subsystem ID		Subsystem Vendor ID		N	000A 1498
0x30	PCI Base Address for Local Expansion ROM				Y	00000000
0x34	Reserved			New Cap. Ptr.	N	000000 40
0x38	Reserved				N	00000000
0x3C	Max_Lat	Min_Gnt	Interrupt Pin	Interrupt Line	Y[7:0]	00 00 01 00
0x40	PM Cap.		PM Nxt Cap.	PM Cap. ID	N	4801 48 01
0x44	PM Data	PM CSR EXT	PM CSR		Y	00 00 0000
0x48	Reserved	HS CSR	HS Nxt Cap.	HS Cap. ID	Y[23:16]	00 00 4C 06
0x4C	VPD Address		VPD Nxt Cap.	VPD Cap. ID	Y[31:16]	0000 00 03
0x50	VPD Data				Y	00000000

Table 4-1 : PCI9030 Header

4.1.2 PCI Base Address Initialization

PCI Base Address Initialization is scope of the PCI host software.

PCI9030 PCI Base Address Initialization:

1. Write 0xFFFF_FFFF to the PCI9030 PCI Base Address Register.
2. Read back the PCI9030 PCI Base Address Register
3. For PCI Base Address Registers 0:5, check bit 0 for PCI Address Space.

   Bit 0 = '0' requires PCI Memory Space mapping

   Bit 0 = '1' requires PCI I/O Space mapping

   For the PCI Expansion ROM Base Address Register, check bit 0 for usage.

   Bit 0 = ‘0’: Expansion ROM not used

   Bit 0 = ‘1’: Expansion ROM used
4. For PCI I/O Space mapping, starting at bit location 2, the first bit set determines the size of the required PCI I/O Space size.

   For PCI Memory Space mapping, starting at bit location 4, the first bit set to '1' determines the size of the required PCI Memory Space size.

   For PCI Expansion ROM mapping, starting at bit location 11, the first bit set to '1' determines the required PCI Expansion ROM size.

   For example, if bit 5 of a PCI Base Address Register is detected as the first bit set to ‘1’, the PCI9030 is requesting a 32 byte space (address bits 4:0 are not part of base address decoding).
5. Determine the base address and write the base address to the PCI9030 PCI Base Address Register. For PCI Memory Space mapping the mapped address region must comply with the definition of bits 3:1 of the PCI9030 PCI Base Address Register.

After programming the PCI9030 PCI Base Address Registers, the software must enable the PCI9030 for PCI I/O and/or PCI Memory Space access in the PCI9030 PCI Command Register (Offset 0x04). To enable PCI I/O Space access to the PCI9030, set bit 0 to '1'. To enable PCI Memory Space access to the PCI9030, set bit 1 to '1'.

Offset in Config.	Description	Usage
0x10	PCI9030 LCR’s MEM	Used
0x14	PCI9030 LCR’s I/O	Used
0x18	PCI9030 Local Space 0	Used

Table 4-2 : PCI9030 Base Address Usage

4.2 Local Configuration Register (LCR)

After reset, the PCI9030 Local Configuration Registers are loaded from the on board serial configuration EEPROM.

The PCI base address for the PCI9030 Local Configuration Registers is PCI9030 PCI Base Address 0 (PCI Memory Space, Offset 0x10 in the PCI9030 PCI Configuration Register Space) or PCI9030 PCI Base Address 1 (PCI I/O Space, Offset 0x14 in the PCI9030 PCI Configuration Register Space).

Do not change hardware dependent bit settings in the PCI9030 Local Configuration Registers.

Offset from PCI Base Address	Register	Value	Description
0x00	Local Address Space 0 Range	0x0FFF_FFC0	Used memory space
0x04	Local Address Space 1 Range	0x0000_0000	Not used
0x08	Local Address Space 2 Range	0x0000_0000	Not used
0x0C	Local Address Space 3 Range	0x0000_0000	Not used
0x10	Local Exp. ROM Range	0x0000_0000	Not used
0x14	Local Re-map Register Space 0	0x0000_0001	Address Offset for Memory
0x18	Local Re-map Register Space 1	0x0000_0000	Not used
0x1C	Local Re-map Register Space 2	0x0000_0000	Not used
0x20	Local Re-map Register Space 3	0x0000_0000	Not used
0x24	Local Re-map Register ROM	0x0000_0000	Not used
0x28	Local Address Space 0 Descriptor	0x5000_8080	Local Timing Address Space 0
0x2C	Local Address Space 1 Descriptor	0x0000_0000	Not used
0x30	Local Address Space 2 Descriptor	0x0000_0000	Not used
0x34	Local Address Space 3 Descriptor	0x0000_0000	Not used
0x38	Local Exp. ROM Descriptor	0x0000_0000	Not used
0x3C	Chip Select 0 Base Address	0x0000_0011	UART-Register
0x40	Chip Select 1 Base Address	0x0000_0027	Special Register
0x44	Chip Select 2 Base Address	0x0000_0023	Not used
0x48	Chip Select 3 Base Address	0x0000_0000	Not used
0x4C	Interrupt Control/Status	0x0041	Interrupt Configuration
0x4E	EEPROM Write Protect Boundary	0x0030	No write protection
0x50	Miscellaneous Control Register	0x0078_0000	Retry Delay = max.(reset value)
0x54	General Purpose I/O Control	0x26D2_0249	All GP I/Os are outputs
0x70	Hidden1 Power Management data select	0x0000_0000	Not used
0x74	Hidden 2 Power Management data scale	0x0000_0000	Not used

Table 4-3 : PCI9030 Local Configuration Register

4.3 Configuration EEPROM

After power-on or PCI reset, the PCI9030 loads initial configuration register data from the on board configuration EEPROM.

The configuration EEPROM contains the following configuration data:

- Address 0x00 to 0x27 : PCI9030 PCI Configuration Register Values
- Address 0x28 to 0x87 : PCI9030 Local Configuration Register Values

See the PCI9030 Manual for more information.

Address	Offset							
	0x00	0x02	0x04	0x06	0x08	0x0A	0x0C	0x0E
0x00	0x35C	0x1498	0x0280	0x0000	0x0702	0x000A	0x000A	0x1498
0x10	0x0000	0x0040	0x0000	0x0101	0x4801	0x4801	0x0000	0x0000
0x20	0x0000	0x4C06	0x0000	0x0003	0x0FFF	0xFFC0	0x0000	0x0000
0x30	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0001
0x40	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000
0x50	0x5000	0x8080	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000
0x60	0x0000	0x0000	0x0000	0x0011	0x0000	0x0027	0x0000	0x0023
0x70	0x0000	0x0000	0x0030	0x0041	0x0078	0x0000	0x0249	0x26D2
0x80	0x0000	0x0000	0x0000	0x0000	0xFFFF	0xFFFF	0xFFFF	0xFFFF
0x90	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF
0xA0	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF
0xB0	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF
0xC0	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF
0xD0	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF
0xE0	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF
0xF0	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF	0xFFFF

Table 4-4 : Configuration EEPROM

4.4 Local Software Reset

The PCI9030 Local Reset Output LRESETo# is used to reset the on board local logic.

The PCI9030 local reset is active during PCI reset or if the PCI Adapter Software Reset bit is set in the PCI9030 local configuration register CNTRL (offset 0x50).

CNTRL[30] PCI Adapter Software Reset:

Value of 1 resets the PCI9030 and issues a reset to the Local Bus (LRESETo# asserted). The PCI9030 remains in this reset condition until the PCI Host clears this bit. The contents of the PCI9030 PCI and Local Configuration Registers are not reset. The PCI9030 PCI Interface is not reset.

5 Configuration Hints

5.1 PCI Interrupt Control / Status

The UART generates an interrupt on pin INTA# of the PCI bus. The interrupt status can be read at the Interrupt Status Register INTCSR of the PCI Controller PCI9030.

Bit	Symbol	Description	Access	Reset Value
31:8	-	Not used	R	0
7	SINT	Software Interrupt	R/W	0
6	PINT Enable	PCI Interrupt Enable	R/W	1
5	LINT2 Status	Local Interrupt 2 Status (not in use)	R	0
4	LINT2 Polarity	Local Interrupt 2 Polarity	R/W	0
3	LINT2 Enable	Local Interrupt 2 Enable	R/W	0
2	LINT1 Status	Local Interrupt Status (UART)	R	0
1	LINT1 Polarity	Local Interrupt 1 Polarity	R/W	0
0	LINT1 Enable	Local Interrupt 1 Enable	R/W	1

Table 5-1 : Interrupt Control/Status Register (INTCSR, PCI Base Address 0 + 0x4C)

The local interrupt 1 reflects the four channel UART interrupts. Bit 2 will be set if bit 0 is set and an interrupt is generated on one or more UART channels. For more information see chapter “Interrupt Status Register”. This register will be initialized from the on board EEPROM after power-on with the above shown initial values.

6 Programming Hints

6.1 Baud Rate Programming Formula

Each of the four serial isolated channels of the TPMC860 contains a programmable baud rate generator. The clock of the ST16C654 can divided by any divisor from 1 to $2^{16} - 1$. The divisor can be programmed by the LSB and the MSB of the Divisor Latch Register. After reset the MCR bit 7 of each channel is default '0' and the value of LSB and MSB is 0xFFFF.

The basic formula of baud rate programming is:

$$\frac{7.3728MHz}{16 * DIVISOR * (1 + 3 * MCR\_BIT7)}$$

Baud Rate MCR bit 7=0	Baud Rate MCR bit 7=1	Divisor
200	50	0x0900
300	75	0x0600
600	150	0x0300
1200	300	0x0180
2400	600	0x00C0
4800	1200	0x0060
9600	2400	0x0030
19.2K	4800	0x0018
28.8K	7200	0x0010
38.4K	9600	0x000C
76.8K	19.2K	0x0006
153.6K	38.4K	0x0003
230.4K	57.6K	0x0002
460.8K	115.2K	0x0001

Table 6-1 : Baud Rate Programming Table

7 Pin Assignment – I/O Connector

7.1 Mezzanine Card I/O Connector P14

Pin	Signal	Function
1	GND_0	Isolated Ground UART 0
2	TX0	Transmit Data UART 0
3	RX0	Receive Data UART 0
4	RTS0	Request to Send UART 0
5	CTS0	Clear to Send UART 0
6	GND_1	Isolated Ground UART 1
7	TX1	Transmit Data UART 1
8	RX1	Receive Data UART 1
9	RTS1	Request to Send UART 1
10	CTS1	Clear to Send UART 1
11	GND_2	Isolated Ground UART 2
12	TX2	Transmit Data UART 2
13	RX2	Receive Data UART 2
14	RTS2	Request to Send UART 2
15	CTS2	Clear to Send UART 2
16	GND_3	Isolated Ground UART 3
17	TX3	Transmit Data UART 3
18	RX3	Receive Data UART 3
19	RTS3	Request to Send UART 3
20	CTS3	Clear to Send UART 3
21..64	NC	Not connected

Table 7-1 : Mezzanine Card I/O Connector P14

7.2 Front panel DB25 Connector

Pin	Signal	Function
1	TX0	Transmit Data UART 0
2	RTS0#	Request to Send UART 0
3	GND_0	Isolated Ground UART 0
4	TX1	Transmit Data UART 1
5	RTS1#	Request to Send UART 1
6	GND_1	Isolated Ground UART 1
7	TX2	Transmit Data UART 2
8	RTS2#	Request to Send UART 2
9	GND_2	Isolated Ground UART 2
10	TX3	Transmit Data UART 3
11	RTS3#	Request to Send UART 3
12	GND_3	Isolated Ground UART 3
13	NC	Not connected
14	RX0	Receive Data UART 0
15	CTS0#	Clear to Send UART 0
16	GND_0	Isolated Ground UART 0
17	RX1	Receive Data UART 1
18	CTS1#	Clear to Send UART 1
19	GND_1	Isolated Ground UART 1
20	RX2	Receive Data UART 2
21	CTS2#	Clear to Send UART 2
22	GND_2	Isolated Ground UART 2
23	RX3	Receive Data UART 3
24	CTS3#	Clear to Send UART 3
25	GND_3	Isolated Ground UART 3

Table 7-2 : Front panel DB25 connector