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ramix inc ™

*Hardware Reference Manual*

# *PMC422 and PMC422/FP Eight Port Serial Controller*

*DDC No. Rx-URMH 069 Rev B*
*Issued 29 October 2003*

*it's all about connexions*

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# 1 Introduction

The PMC422 and PMC422/FP implement a versatile Eight Port Serial Controller in PMC (PCI Mezzanine Card) format. Signaling characteristics of each port can be controlled for RS232, RS422 or RS485 operation (this does not apply to the PMC422FP). The signaling protocol configuration is per pair of channels, providing four independent configuration settings. The Serial interfaces are implemented using an Octal UART, which combines compatibility with the most commonly used components (16C550 compatible register set), with full support of PCI attributes (e.g., 32 bit data transfers) for increased performance. This allows rapid integration to legacy systems, while providing an evolutionary path for enhanced software to improve performance.

## 1.1 Features

### 1.1.1 PMC422 and PMC422/FP

- 8 independent serial channels
- Programmable baud rate from 100Bits/sec to 921.6KBits/sec (*with default Crystal at 14.7456 MHz)
- UART register sets compatible with 16C550
- 64 Byte FIFO per channel
- Full PCI compatibility (32Mhz/32bit)
- Signaling characteristics of each channel pair (RS232/RS422/RS485) configured with DIP switch
- 8 bit switch input for application-specific use
- I/O routing options:
  - For the PMC422: 4 Ports front connection (RJ45) (RS232 Mode only), 8 Ports rear (‘J4’)
  - For the PMC422/FP: 8 Ports front connection (SCSI-68), 8 Ports rear (‘J4’)

***Note**: Customer may specify the speed of the Crystal.

Traditional single and multi-port Serial Interfaces place a high overhead on the host processor by requiring per-character-attention (i.e., each received and transmitted character generates interrupts and programmed I/O from the host). Seven features of the PMC422 and the PMC422/FP remove this overhead:

- Data transfer in Byte, Word, and Double-word, capable of Read/Write Burst
- FIFO buffers to avoid data overrun (64 Bytes on each port)
- Transmit and Receive FIFO Level Counters
- Automatic RTS/CTS or DTR/DSR Flow Control
- Automatic Xon/Xoff Software Flow Control
- Interrupt Source Register for all 8 ports
- RS485 Half-duplex Control with Selectable Delay

Each of the two ports has individually programmable line drivers to set any of the most popular signaling types: RS232, RS422, RS485 (full duplex and half duplex with termination or non-termination option). The signaling characteristics are set with on-board switches. The baud rate of each serial port is separately programmable:



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supported rates are from 150bps to 6.2 Mbps (NB: range is dependant upon the crystal. Special frequencies can be requested at time of purchase.)

In addition, the PMC422 and PMC422/FP have a 16-bit general purpose Timer/Counter with 8 general-purpose inputs. The 8 bits can be set with switches on-board and read by the host. A total of 256 combinations are possible.

### *1.1.2 PIM (PMC I/O Module) per VITA standard VITA 36-199X*

The PIM422 is designed to give rear access I/O when used in conjunction with RAMiX's PMC421, PMC422 or PMC423. The PIM module mates to rear transition modules (refer to the assembly diagram in section 5), which have been designed to the PIM standard.

The PMC specification provides for user defined I/O to exit the PMC through one or more 64 pin connectors. This user I/O is commonly employed to bring I/O to the rear of the system in order to augment or replace the I/O available on the PMC's bezel at the front.

The benefits of using a PMC module to add functionality at the system integration level (as opposed to being designed onto the host board) are well known. The development of the PIM standard now allows for a uniform method to route this I/O to the system panel.



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# 2 Theory of Operation

The PMC422 and PMC422/FP are flexible solutions for integrating multiple serial I/O channels onto an SBC (Single Board Computer). Efficiently packaging eight channels onto a single PMC makes effective use of the few PMC locations available. Routing I/O to the rear (via the 'J4' connector to the host card) enhances flexibility in developing economical and non-intrusive cabling solutions. Each serial port is implemented with an independent UART (Asynchronous Receiver and Transmitter) with a separate programmable baud rate. Accessing the UART controllers via PCI integrates more effectively to modern SBC implementations than proprietary or legacy devices.

Traditional UART controllers are limited to 8 bit access, incurring all bus protocol overhead for every character transferred (and control operations). The Octal UART utilized on the PMC422 and PMC422/FP support 32 bit transfers, allowing four characters to be transferred in a single bus operation. Reducing programmed I/O operations is critical to achieving good performance in PCI systems. While the extended transfer options offer an opportunity to maximize performance, in many cases the first (and sometimes only) criteria is software development and integration. The 16C550 register set definition is in common usage for serial I/O devices in all environments. Maintaining compatibility with this de facto standard, can markedly reduce the time required to integrate the PMC422 and PMC422/FP into existing software environments. Having the software integration based upon earlier drivers reduces the risk of unexpected (and undesirable) changes in application interfaces, which can be critical when creating an evolutionary improvement to existing systems.

## 2.1 Functional Description

The architecture of the PMC422 is illustrated in the block diagram. There are two major components:

- Octal UART. This single device incorporates all 8 UARTs with a PCI interface. It connects (via the PMC connectors) to the PCI bus on the host card.
- Signal Drivers There is one driver per UART channel. The Signal Driver controls the electrical signaling protocol for the channel. Signal protocols supported are: RS-232, EIA-530, RS-422, RS-485, and RS-489. Operation is controlled via on card DIP switches. Each pair of UART channels is controlled by one configuration switch package. Thus, up to four different signal protocols may be configured.

There is an eight bit input port on the Octal UART Controller that is connected to a pair of DIP Switches. This feature may be used to create a system ID, or other configuration input for use by application-specific software.

### 2.1.1 Outputs

Each UART channel has four signal pairs:

Tx - Transmitted data from the UART

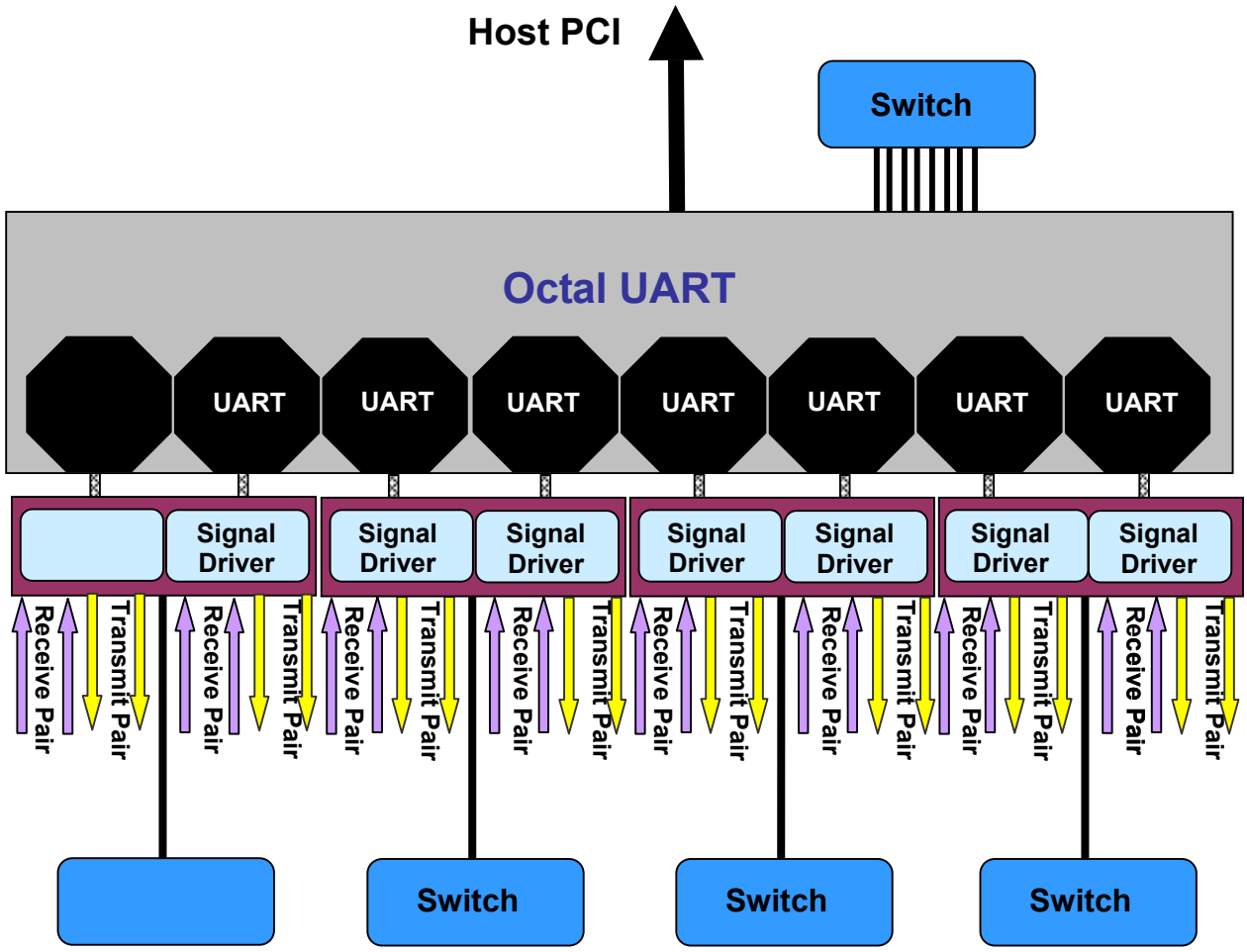
Rx - Received data to the UART

RTS - Ready to Send Output from the PMC422 when the UART RTS is asserted

CTS - Clear to Send Input to the PMC422 routed to the CTS input of the UART



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As the PMC422 supports differential signaling, (e.g., RS-422) each direction (Transmit & Receive) has two associated lines (i.e., a Negative and Positive leg). For single ended signaling protocols (e.g., RS-232) the Negative line of the pair should be used.

### *2.1.2 Port Configuration*

The attributes of each port are controlled by switches in DIP packages (four switches per package).

One set of switches controls the signal protocol: on this switch package, the combination of the four switches selects the signaling protocol (e.g., RS232, RS422 etc.). Ports are controlled in pairs, thus, each of the four switch packages control two ports.



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A separate switch pack, the four switches are divided between two channels, two switches on the package per-channel. (These attributes are controlled on a per-port basis). These switches control an additional two attributes of each channel:

- Transmit Output disabled when RTS (Ready To Send) is not active. This option allows the transmit driver to be totally disabled (put in tri-state) if RTS is not present. The RTS signal comes from the UART, and can be controlled from the host application software. When the controlling switch is off, the Transmitter for the channel is always active.
- Connect the negative leg of Rx and Tx together.

Both of these latter configuration options (connecting Tx and Rx, and making output software controlled) are necessary when supporting RS485-half duplex. In that protocol, the communication system can be used as a multi-drop bus, thus, multiple devices on the bus may drive the transmit line. By allowing software to tri-state the transmit line, the PMC422 can support this mode of operation. When not actually sending data, the output is disabled (via software manipulation of RTS), and other devices may drive the bus.

For operation in any other mode (i.e., not RS485-half duplex) Tx/Rx should not be shorted together, and Tx may be always enabled. (Example: to operate channel 0 in RS485 half duplex mode, switches 1 and 3 on switch pack 5 would be CLOSED. In any other mode, they would be OPEN).



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# 3 Hardware Installation

This chapter provides unpacking, hardware preparation and installation procedures for the PMC422 module.

## 3.1 Unpacking Instructions

RAMiX boards are protected by an anti-static envelope and/or wrapping. Observe anti-static precautions and work at an approved anti-static workstation when unpacking the board.

> ***Note***: Customer may specify the speed of the Crystal. The PMC422 is shipped in an individual, reusable shipping box. When you receive the shipping container, inspect it for any evidence of physical damage. If the container is damaged, request that the carrier's agent be present during unpacking and inspection of the unit.

Unpack the PMC422 module from shipping carton. Check and verify that all items are present by referring to the packing list.

## 3.2 Included Items

Each PMC422 is shipped with the following items:

- PMC422 PMC Assembly

## 3.3 Handling

Electronic assemblies use devices that are sensitive to static discharge; this applies to both the PMC422 and the host board onto which it will be mounted. Observe anti-static procedures when handling these boards. The PMC422 should be in an anti-static plastic bag or conductive foam for storage or shipment.

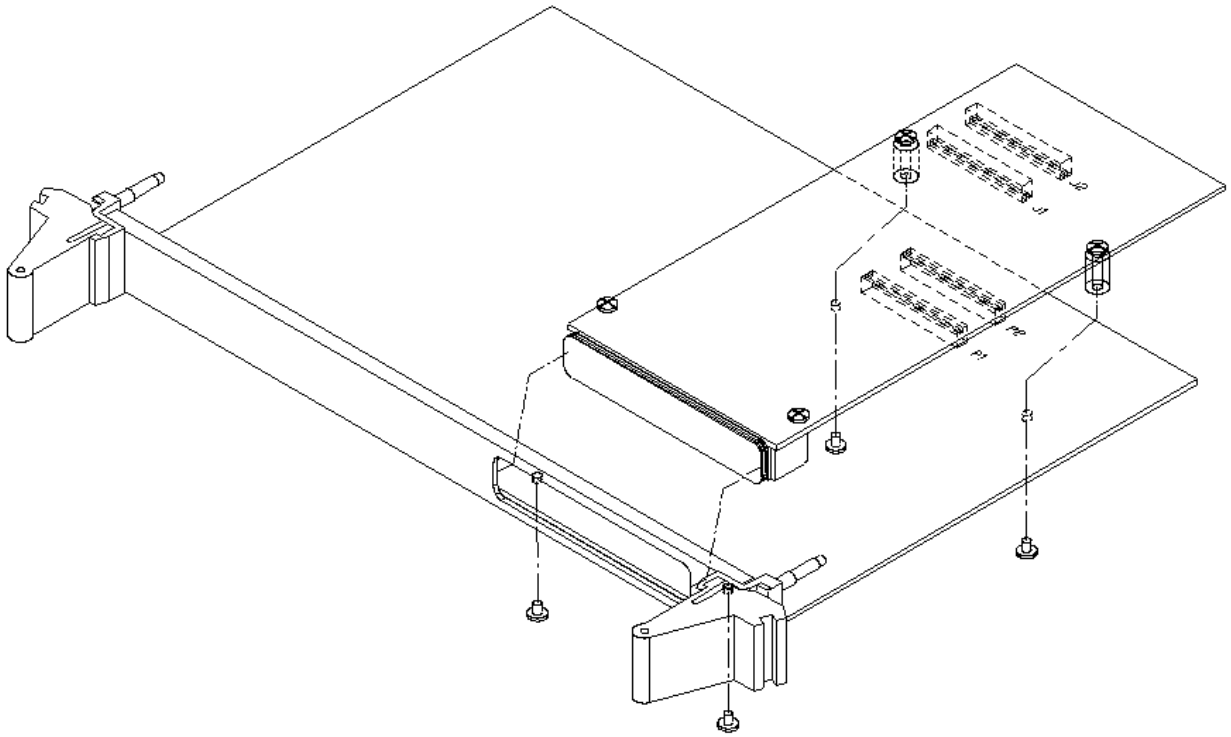
## 3.4 PMC422 INSTALLATION

The PMC422 Module is now ready for installation. Turn all system power off. Remove the host board from the chassis (if currently installed). Locate the PMC connectors on the host board. Carefully plug the PMC422 into the mating connectors on the host's printed circuit board. Be sure module is seated properly into CMC connectors on the host. Use screws to fasten module into host PCB. Reference the assembly diagram on the next page.

> ***Note***: The host card may have two, three or four CMC connectors. Only two (J1 and J2) are essential for the PCI connection. If present, the 'J4' connector routes signals to the host card (usually to connector on the backplane). If not present, only the 4 front panel serial ports can be used, these ports will function correctly.



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1. Remove the four screws from bottom of the stand-offs of the PMC422.
2. Line-up the connectors on the host PCB to the mating connectors on the PMC422.
3. Push the PMC422 down (make sure the connectors are positioned properly).
4. Use the four screws to connect the PMC422 stand-offs to the host PCB.

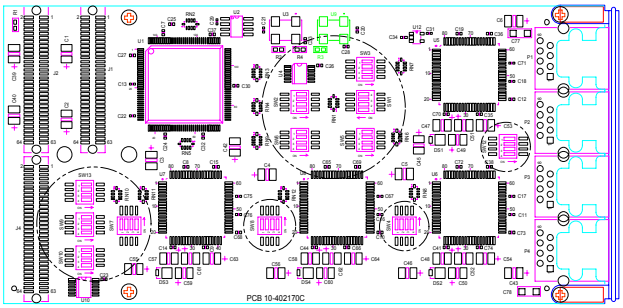


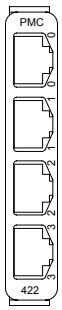
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# 4 Mechanical Information and Front Panel Layout

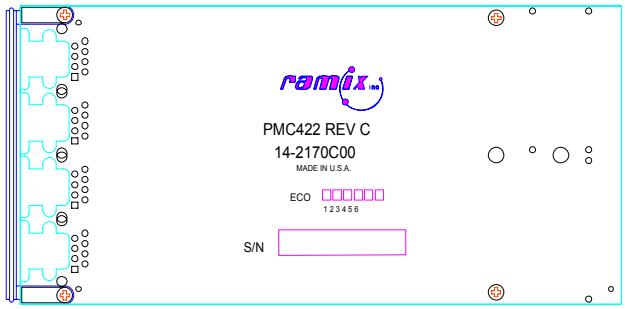
## 4.1 PMC422 Top/Bottom Drawings

TOP SIDE



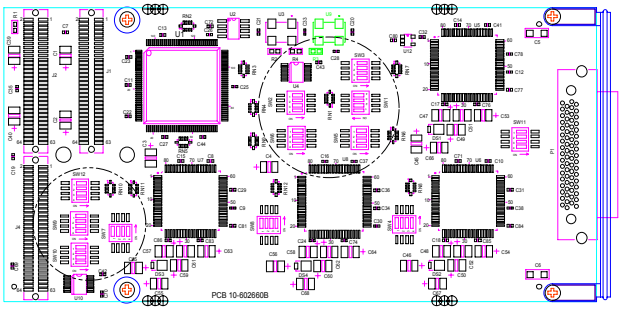



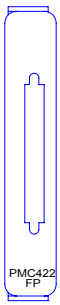

BOTTOM SIDE



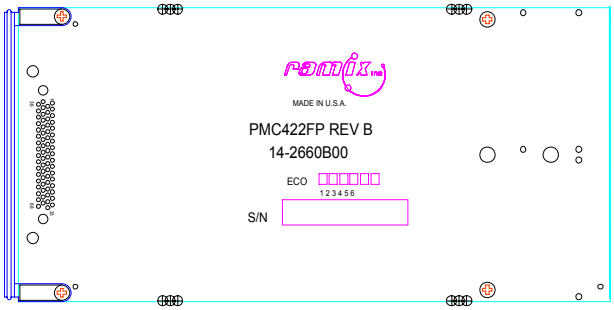

## 4.2 PMC422/FP Top/Bottom Drawings

TOP SIDE




BOTTOM SIDE



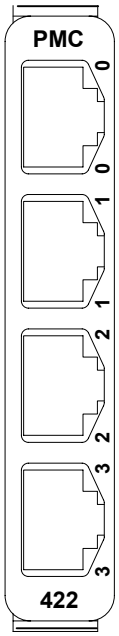



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# 5 Front Panel Connectors and Indicators

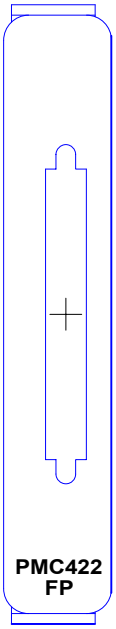
## 5.1 PMC422 and PMC422/FP

**PMC422**




The front panel of the PMC422 has four RJ45 connectors for serial ports 0-3.

**PMC422/FP**




The front panel of the PMC422FP has a 68 pin hi-density SCSI connector for serial ports 1-8.

***Note***: These ports are also available on the rear 'J4' connector.

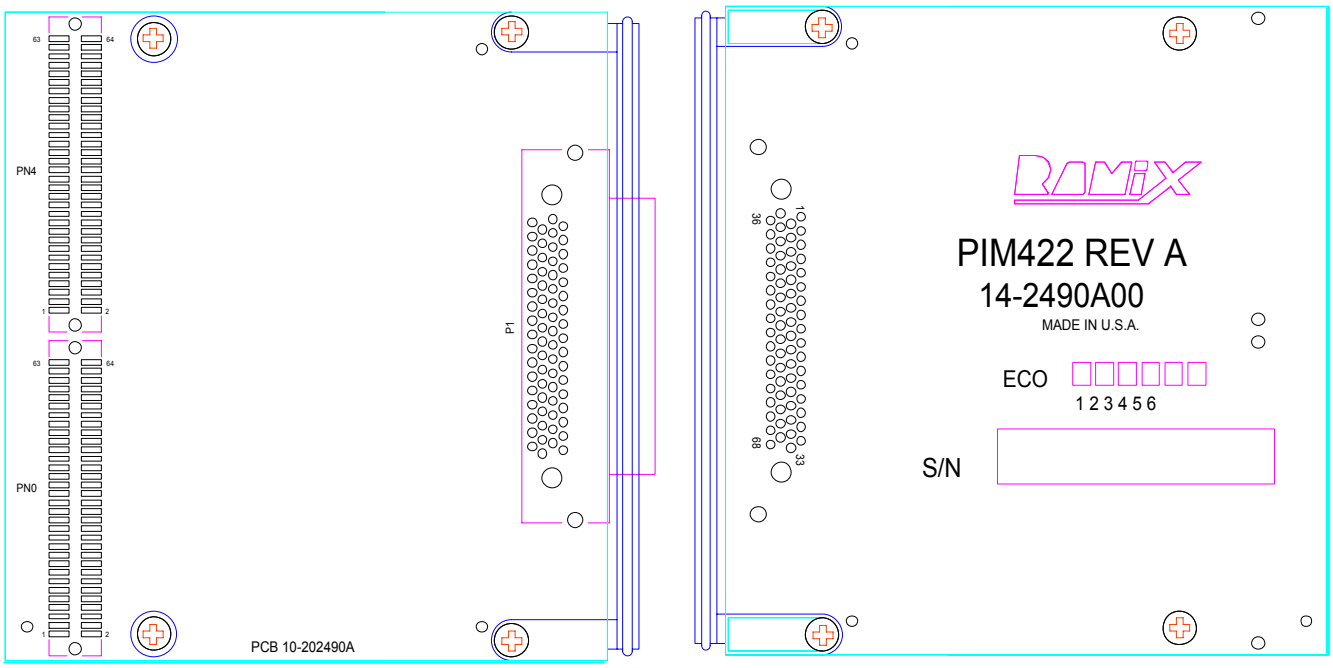
There are no indicators on the PMC422 front panel.



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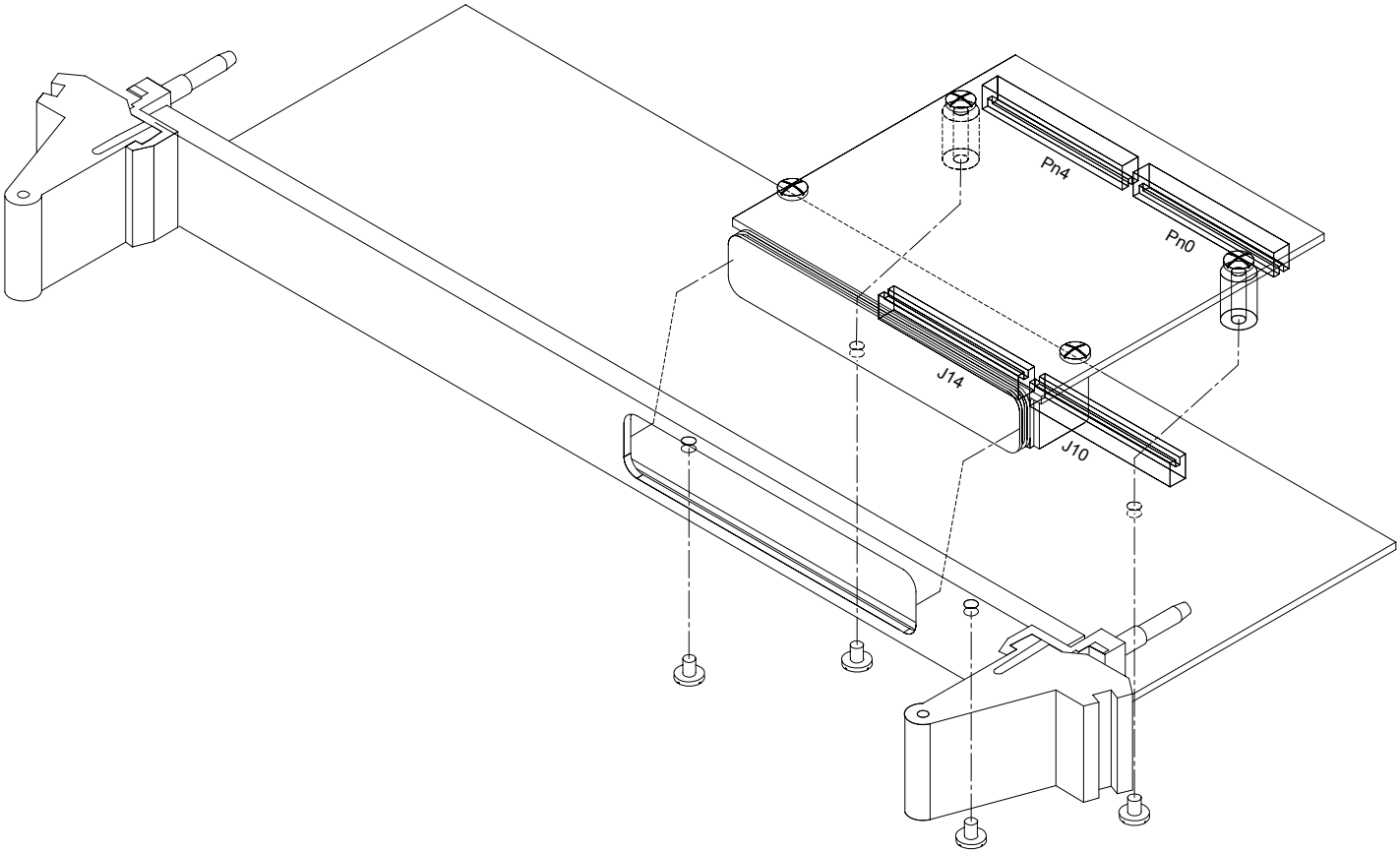
**PIM422**

## *5.2 PIM422*






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## 5.3 Configuration Options (On board Switch Settings)

Several 4-switch DIP packages are used to control the signaling protocol and RS485 mode for the UART channels.

In the following sections there are two types of tables:

- Describing the function of each individual switch in the 4-switch package
- Describing the association between a switch package and the channels it controls.

In the first case there is a column labeled “Switch” with and description of the state of the four switches on a pack. The numbering is as on the DIP switch pack.

In the second case there is a column labeled “Switch Pack”, the number indicates the location. This number is visible on the PMC card, (as part of the white silk screened letters).

### 5.3.1 Signaling Protocol

Table 1 presents the relationship between switch position and the signaling protocol. In this table, a “1” indicates the switch is “Open” or “Off”. A “0” indicates the switch is “Closed” or “On”.

| Switch | TriState | RS232 | V.35 | RS422 w/Term | RS422 | RS449 | EIA530 | EIA-530A | V.36 |
|---|---|---|---|---|---|---|---|---|---|
| 4321 | 0000 | 0010 | 1110 | 0100 | 0101 | 1100 | 1101 | 1111 | 0110 |

***Table 1: Switch position and signaling protocol***

The settings from Table 1 are used by four switch packs each of which configures a pair of channels from Table 2. The factory setting configures all channels for RS232 signaling.

| Switch Pack | Channels | Factory Default |
|---|---|---|
| 3 | 0 &1 | 0010 |
| 4 | 2 & 3 | 0010 |
| 7 | 4 & 5 | 0010 |
| 8 | 6 & 7 | 0010 |

***Table 2: Signaling switch pack and channel number***

### 5.3.2 RS485 Half-Duplex Mode

RS485 half-duplex mode is controlled for each channel by switches from two different switch packs. Table 3 defines the function for each of the first set of switches.

| Switch | Function when closed |
|---|---|
| 1 | Connect RTS to Tx Enable for channel n |
| 2 | Connect RTS to Tx Enable for channel n+1 |
| 3 | Connect nRx to nTx for channel n |
| 4 | Connect nRx to nTx for channel n+1 |

***Table 3: RS485 half-duplex mode switch settings for negative legs and RTS***



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The switch packs from Table 3 are present on all PMC422 and PMC422/FP cards. The relationship between the switch packs and UART channels is presented in Table 4.

| Switch Pack | Channels | Factory Default |
|---|---|---|
| 5 | 0 & 1 | 1111 |
| 6 | 2 & 3 | 1111 |
| 9 | 4 & 5 | 1111 |
| 10 | 6 & 7 | 1111 |

***Table 4: RS485 switch pack and channel number***

A further set of switch packs is available to configure the positive side of RS485 data signals. The function of switches from these switch packs is presented in Table 5.

| Switch | Function when closed |
|---|---|
| 1 | Connect pRx to pTx for channel n |
| 2 | Connect pRx to pTx for channel n+1 |
| 3 | Connect pRx to pTx for channel n+2 |
| 4 | Connect pRx to pTx for channel n+3 |

***Table 5: RS485 half-duplex mode switch settings for positive signals***

Table 6 shows the assignment of switch pack to channels for the positive pins. The switch pack number varies across cards from the PMC422 family and is not present on all revisions of the cards. Only cards with the switch packs present are listed in the table.

| PMC422 Rev C Switch Pack | PMC422/FP Rev B Switch Pack | Channels | Factory Default |
|---|---|---|---|
| 12 | 11 | 0 – 3 | 1111 |
| 13 | 12 | 4 – 7 | 1111 |

***Table 6: RS485 positive pin switch pack and channel number***

### *5.3.3 Card "ID" Switch*

On the PMC422 and the PMC422/FP, there are two switch packs that for which the switch configuration can be read from the host. This feature is available to create a "location" ID, capability ID or other application specific solution.

| Switch Pack | Bits | Factory Default |
|---|---|---|
| 1 | 0 – 3 | 1111 |
| 2 | 4 – 7 | 1111 |

The setting of these bits can be read from the MPIO register of the UART.



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## 5.4 Pinout Assignments

### 5.4.1 PMC422 and PMC422/FP 'J4' Pinout

| Pin # | Function | Pin # | Function | Pin # | Function | Pin # | Function |
|---|---|---|---|---|---|---|---|
| 1 | NRX0 | 17 | NRX2 | 33 | NRX4 | 49 | NRX6 |
| 2 | PRX0 | 18 | PRX2 | 34 | PRX4 | 50 | PRX6 |
| 3 | NTX0 | 19 | NTX2 | 35 | NTX4 | 51 | NTX6 |
| 4 | PTX0 | 20 | PTX2 | 36 | PTX4 | 52 | PTX6 |
| 5 | NRTS0 | 21 | NRTS2 | 37 | NRTS4 | 53 | NRTS6 |
| 6 | PRTS0 | 22 | PRTS2 | 38 | PRTS4 | 54 | PRTS6 |
| 7 | NCTS0 | 23 | NCTS2 | 39 | NCTS4 | 55 | NCTS6 |
| 8 | PCTS0 | 24 | PCTS2 | 40 | PCTS4 | 56 | PCTS6 |
| 9 | NRX1 | 25 | NRX3 | 41 | NRX5 | 57 | NRX7 |
| 10 | PRX1 | 26 | PRX3 | 42 | PRX5 | 58 | PRX7 |
| 11 | NTX1 | 27 | NTX3 | 43 | NTX5 | 59 | NTX7 |
| 12 | PTX1 | 28 | PTX3 | 44 | PTX5 | 60 | PTX7 |
| 13 | NRTS1 | 29 | NRTS3 | 45 | NRTS5 | 61 | NRTS7 |
| 14 | PRTS1 | 30 | PRTS3 | 46 | PRTS5 | 62 | PRTS7 |
| 15 | NCTS1 | 31 | NCTS3 | 47 | NCTS5 | 63 | NCTS7 |
| 16 | PCTS1 | 32 | PCTS3 | 48 | PCTS5 | 64 | PCTS7 |

The table above documents the pin-out of the 'J4" connector to the serial channels. In general, these signals will be routed on the host card to the chassis backplane.

All signal and control lines may be signal ended or differential, depending upon the protocol configured for each channel. When configured to use a differential signaling mode (e.g., RS422) each pair is used. When configured for a single ended signaling mode (e.g., RS232) only the Negative signal line is used.

Each channel has 2 signal pairs (NRXC and PRXC - Negative and Positive Receive for channel C, and NTXC and PTXC - Negative and Positive Receive for channel C).

Each channel has 2 control pairs (NRTSC and PRTSC - Negative and Positive Ready To Send for channel C and NCTSC and PCTSC - Negative and Positive Clear To Send for channel C).



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### 5.4.2 PMC422 Front Panel Pin Out

PMC422 RJ45 Pinout (P1 - P4)

| | |
|---|---|
| 1 | N/C |
| 2 | NRTS |
| 3 | GND |
| 4 | NTX |
| 5 | NRX |
| 6 | GND |
| 7 | NCTS |
| 8 | N/C |

### 5.4.3 PMC422/FP Front Panel Pinouts

| Port # | Signal | Front Panel Pin | |
|---|---|---|---|
| | | Positive | Negative |
| 0 | RX | 2 | 1 |
| | TX | 4 | 3 |
| | RTS | 6 | 5 |
| | CTS | 8 | 7 |
| 1 | RX | 36 | 35 |
| | TX | 38 | 37 |
| | RTS | 40 | 39 |
| | CTS | 42 | 41 |
| 2 | RX | 11 | 10 |
| | TX | 13 | 12 |
| | RTS | 15 | 14 |
| | CTS | 17 | 16 |
| 3 | RX | 45 | 44 |
| | TX | 47 | 46 |
| | RTS | 49 | 48 |



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| | | | |
|---|---|---|---|
| | CTS | 51 | 50 |
| 4 | RX | 19 | 18 |
| | TX | 21 | 20 |
| | RTS | 23 | 22 |
| | CTS | 25 | 24 |
| 5 | RX | 53 | 52 |
| | TX | 55 | 54 |
| | RTS | 57 | 56 |
| | CTS | 59 | 58 |
| 6 | RX | 28 | 26 |
| | TX | 30 | 29 |
| | RTS | 32 | 31 |
| | CTS | 34 | 33 |
| 7 | RX | 62 | 60 |
| | TX | 64 | 63 |
| | RTS | 66 | 65 |
| | CTS | 68 | 67 |
| Signal Ground is located on Pins 9, 27, 43, and 61. | | | |

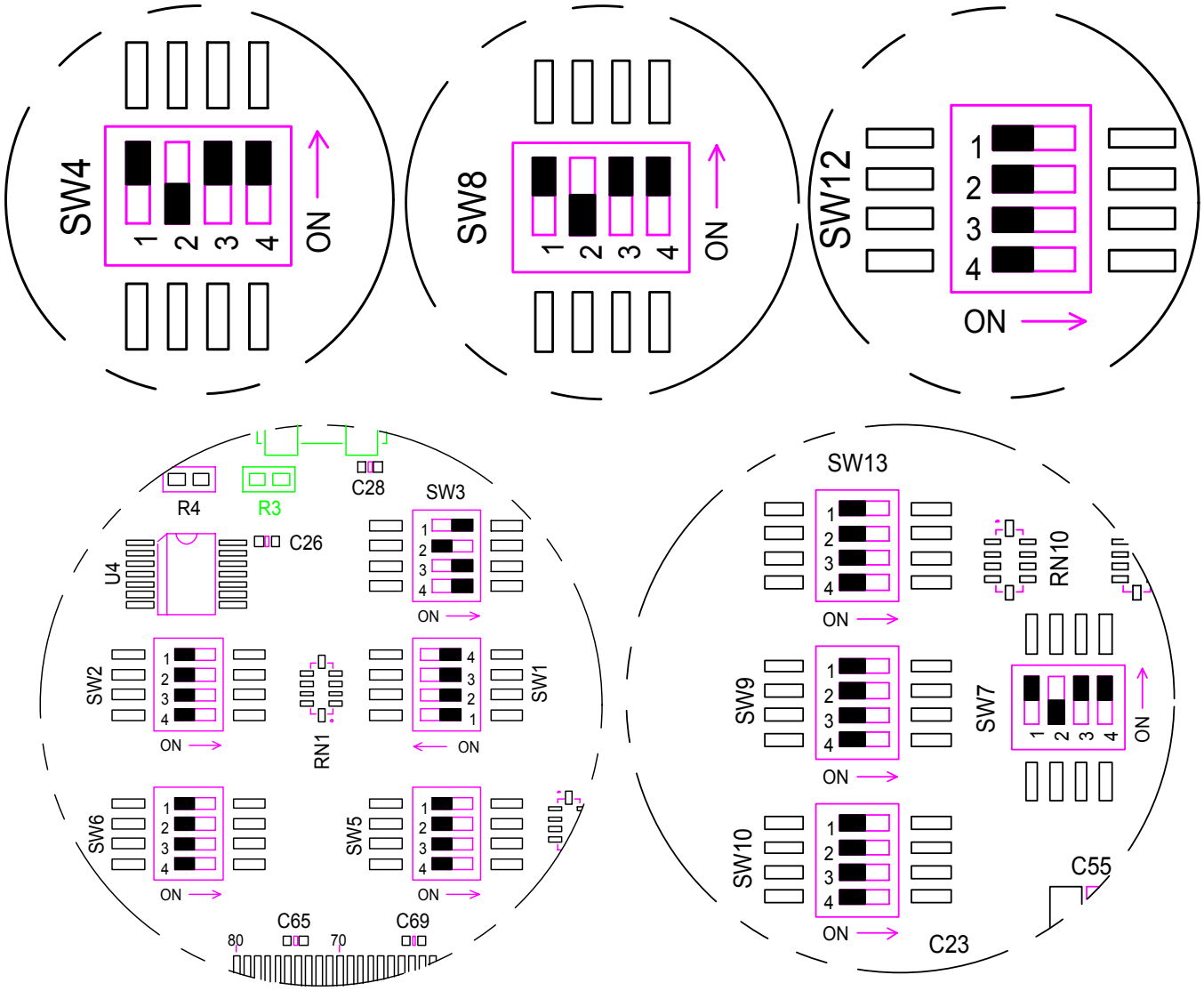
***Note***: Cable assembly is available for 8 port (SCSI-68 Pin) to DB9 (8) (RAMiX Part No.: 12-0600000).



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## 5.5 Switch Settings

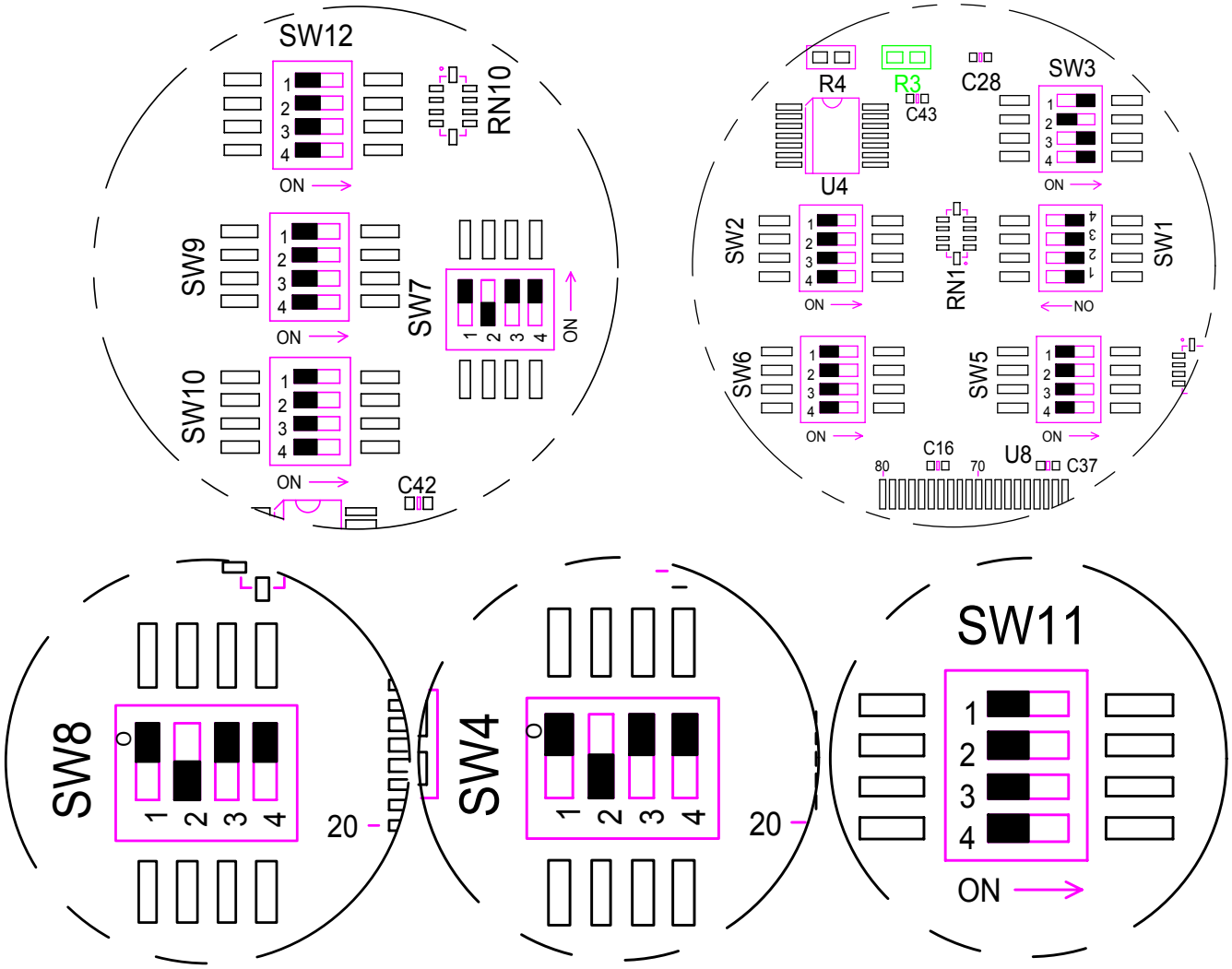
### 5.5.1 PMC422






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### *5.5.2 PMC422/FP*






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# 6 Functional Specifications

## 6.1 PMC422

PMC422 8-port Serial, 4 ports with RJ45 connectors front or 8 ports rear

| | |
|---|---|
| **Power** | **3 Total Watts** |
| **@ 3.3 V** | **0.3 Amp** |
| **@ 5 V** | **0.4 Amp** |
| **Form Factor** | |
| **PMC** | **Single Slot** |
| **MTBF** | |
| **MIL 217-F Nav Shel 25 Deg. C** | **253000 Hours** |
| **Temperature** | |
| **Operating** | **0 to +60° C** |
| **Storage** | **-40 to +85° C** |
| **Humidity** | |
| **Operating** | **5% to 95% Non-Condensing** |
| **Storage** | **5% to 95% Non-Condensing** |

| | |
|---|---|
| **Conformal Coating** | **Yes, additional charge** |

| | |
|---|---|
| **PCI Bus Characteristics** | |
| **Signaling** | **3 & 5V** |
| **Specification** | **2.2** |
| **Speed** | **33MHz** |
| **Width** | **32** |
| **Not Connected** | |

| | |
|---|---|
| **Serial Characteristics** | |
| **Ports** | |
| **RS485 / RS422 / RS232** | |
| **Port Routing** | |
| **Front** | **(4) RJ45 Serial ports (RS232 Mode Only)** |
| **Rear** | **(8) Serial ports via Rear I/O** |

| | |
|---|---|
| **Transition Module available** | **PIM422** |



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## 6.2 PMC422/FP

PMC422/FP PMC Serial, Front I/O 8 Channel Connection

| | |
|---|---|
| **Power** | **3 Total Watts** |
| **@ 3.3 V** | **0.3 Amp** |
| **@ 5 V** | **0.4 Amp** |
| **Form Factor** | |
| **PMC** | **Single Slot** |
| **MTBF** | |
| **MIL 217-F Nav Shel 25 Deg. C** | **253000 Hours** |
| **Temperature** | |
| **Operating** | **0 to +60° C** |
| **Storage** | **-40 to +85° C** |
| **Humidity** | |
| **Operating** | **5% to 95% Non-Condensing** |
| **Storage** | **5% to 95% Non-Condensing** |

| | |
|---|---|
| **Conformal Coating** | **Yes, additional charge** |

| | |
|---|---|
| **PCI Bus Characteristics** | |
| **Signaling** | **3 & 5V** |
| **Specification** | **2.2** |
| **Speed** | **33MHz** |
| **Width** | **32** |
| **Not Connected** | |

| | |
|---|---|
| **Serial Characteristics** | |
| **Ports** | |
| **RS485 / RS422 / RS232** | |
| **Port Routing** | |
| **Front** | **(8) Serial ports via 68 pin SCSI (Cable # 06-2600000 available)** |
| **Rear** | **(8) Serial ports via Rear I/O** |

## 6.3 PIM422

PIM422 PIM Transition Module for PMC421, PMC422 or PMC423



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| | |
|---|---|
| **Power** | **0 Total Watts** |
| **MTBF** | |
| **MIL 217-F Nav Shel 25 Deg. C** | **600000 Hours** |
| **Temperature** | |
| **Operating** | **0 to +60° C** |
| **Storage** | **-40 to +85° C** |
| **Humidity** | |
| **Operating** | **5% to 95% Non-Condensing** |
| **Storage** | **5% to 95% Non-Condensing** |



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