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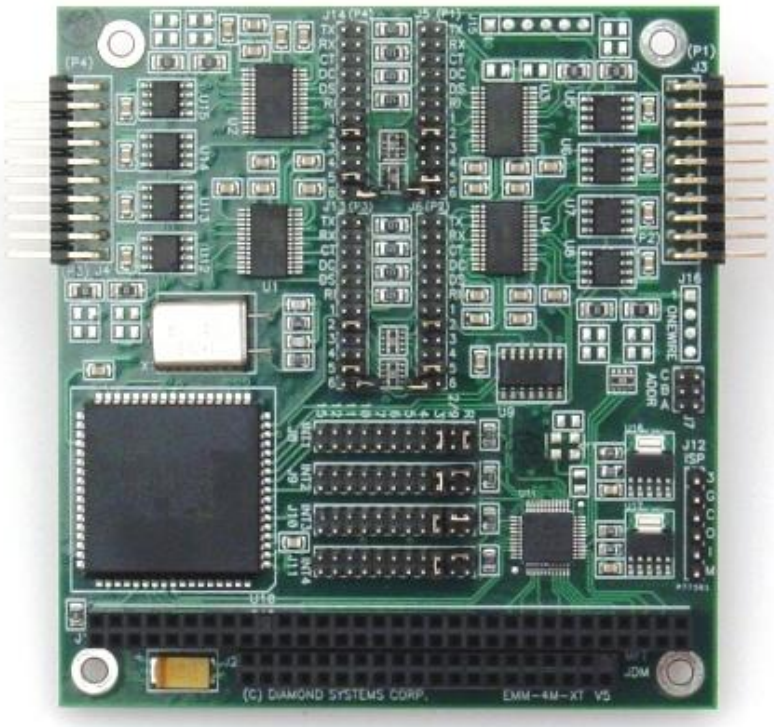
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EMERALD-MM User Manual

4-Channel Multi-Protocol Serial Port PC/104 Module

Rev F.01: May 2016



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1. DESCRIPTION

Emerald-MM is a PC/104 format I/O module with 4 serial ports. Its model number and description are:

EMM-4M-XT 4 ports configurable for RS-232, RS-422, or RS-485

Eight different I/O address combinations can be selected, and 10 different interrupt levels can be assigned to configure each port, allowing operation as COM1 through COM4 as well as many other settings. Two I/O headers are provided, with two serial ports on each header. The board operates on +5V only, eliminating the need for a +12V supply that is often required for serial port operation.

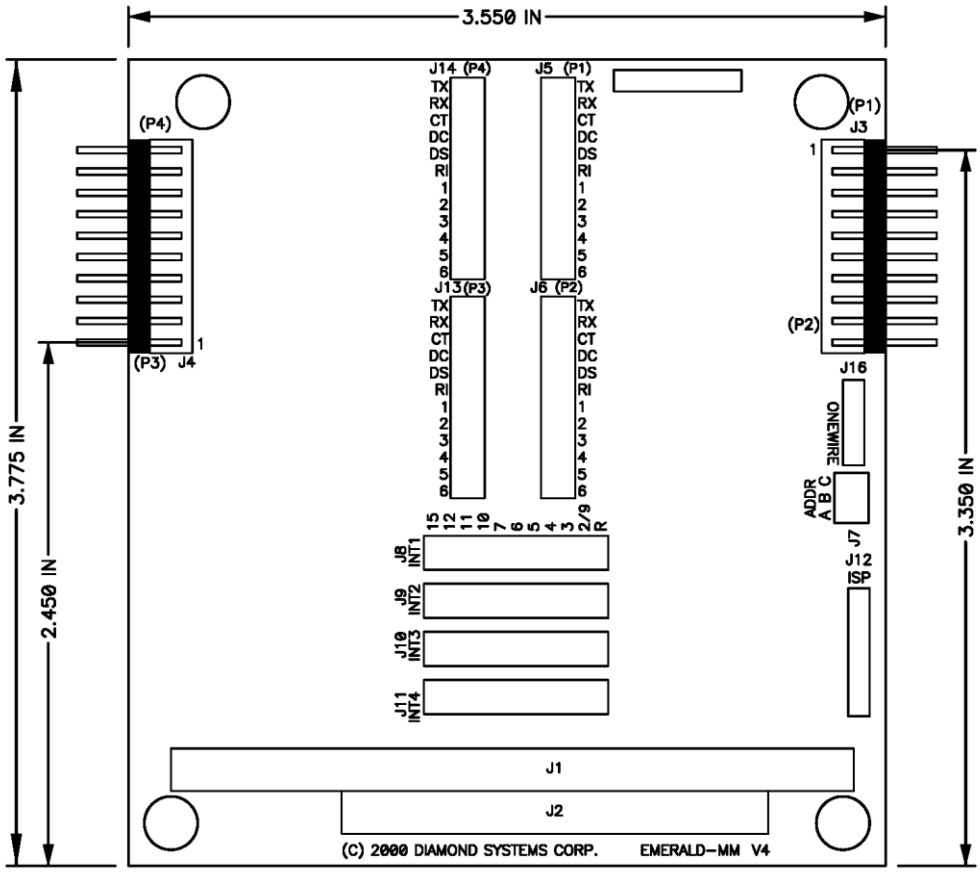
Emerald-MM is based on the 16C554 quad serial port IC. This device contains 4 identical sets of registers, one for each port, and is compatible with the standard PC serial port. Each port contains a 16-byte FIFO. Complete descriptions of these registers may be found in the Appendix. Most users will not need this programming information, as it is normally handled by the operating system's communications software.

2. FEATURES

- 4 16C550-compatible serial ports with 16-byte FIFOs
- RS-232, RS-422, RS-485, and 1-Wire interface capability (depending on the model)
- Up to 115.2kbps in standard configuration (460.8kbps available)
- 8 different I/O address options
- 10 different interrupt level options (using 16-bit PC/104 bus extension)
- I/O lines are short circuit protected
- Dual 20-pin I/O headers, 2 ports per header
- +5V only operation
- Extended temperature (-40^{o}C to +85^{o}C) operation

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3. MECHANICAL DRAWING



Description of Key Elements

J1 PC/104 8-bit bus connector
J2 PC/104 16-bit bus connector
J3 User I/O header for serial ports 1 and 2
J4 User I/O header for serial ports 3 and 4
J5 Configuration for serial port 1
J6 Configuration for serial port 2
J7 I/O address configuration
J8 Interrupt level configuration for port 1
J9 Interrupt level configuration for port 2
J10 Interrupt level configuration for port 3
J11 Interrupt level configuration for port 4
J12 Factory use only
J13 Configuration for serial port 3
J14 Configuration for serial port 4
J16 1-Wire interface (Model EMM-1W-XT only)

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4. SERIAL PORT I/O HEADER PINOUT AND PIN DESCRIPTION

Emerald-MM provides two identical 20-pin headers labeled J3 and J4 for the 4 serial ports. Two ports are contained on each header. Pin 1 and numbers are marked on the board for connector polarity identification.

For 1-Wire interface see page 10.

RS-232 Configuration:

J3

DCD 1	1	2	DSR 1
RXD 1	3	4	RTS 1
TXD 1	5	6	CTS 1
DTR 1	7	8	RI 1
GND	9	10	NC
DCD 2	11	12	DSR 2
RXD 2	13	14	RTS 2
TXD 2	15	16	CTS 2
DTR 2	17	18	RI 2
GND	19	20	NC

J4

DCD 3	1	2	DSR 3
RXD 3	3	4	RTS 3
TXD 3	5	6	CTS 3
DTR 3	7	8	RI 3
GND	9	10	NC
DCD 4	11	12	DSR 4
RXD 4	13	14	RTS 4
TXD 4	15	16	CTS 4
DTR 4	17	18	RI 4
GND	19	20	NC

RS-422 Configuration:

J3

NC	1	2	NC
TXD+ 1	3	4	TXD- 1
GND	5	6	RXD- 1
RXD+ 1	7	8	NC
GND	9	10	NC
NC	11	12	NC
TXD+ 2	13	14	TXD- 2
GND	15	16	RXD- 2
RXD+ 2	17	18	NC
GND	19	20	NC

J4

NC	1	2	NC
TXD+ 3	3	4	TXD- 3
GND	5	6	RXD- 3
RXD+ 3	7	8	NC
GND	9	10	NC
NC	11	12	NC
TXD+ 4	13	14	TXD- 4
GND	15	16	RXD- 4
RXD+ 4	17	18	NC
GND	19	20	NC

RS-485 Configuration:

J3

NC	1	2	NC
TXD/RXD+ 1	3	4	TXD/RXD- 1
GND	5	6	NC
NC	7	8	NC
GND	9	10	NC
NC	11	12	NC
TXD/RXD+ 2	13	14	TXD/RXD- 2
GND	15	16	NC
NC	17	18	NC
GND	19	20	NC

J4

NC	1	2	NC
TXD/RXD+ 3	3	4	TXD/RXD- 3
GND	5	6	NC
NC	7	8	NC
NC	9	10	NC
NC	11	12	NC
TXD/RXD+ 4	13	14	TXD/RXD- 4
GND	15	16	NC
NC	17	18	NC
NC	19	20	NC

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Signal Definitions:

Signal Name	Definition	Direction
RS-232:		
DCD	Data Carrier Detect	Input
DSR	Data Set Ready	Input
RXD	Receive Data	Input
RTS	Request To Send	Output
TXD	Transmit Data	Output
CTS	Clear To Send	Input
DTR	Data Terminal Ready	Output
RI	Ring Indicator	Input
RS-422:		
TXD+, TXD-	Differential Transmit Data	Output
RXD+, RXD-	Differential Receive Data	Input
RS-485:		
TXD/RXD+	Differential Transmit/Receive +	Bi-directional
TXD/RXD-	Differential Transmit/Receive -	Bi-directional
Common to all protocols:		
GND	Ground	--
NC	Not Connected	--

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5. BOARD CONFIGURATION

5.1 Port and Interrupt Register Address Selection

Each peripheral board in the computer system must have a unique I/O address or block of addresses. Emerald-MM actually uses five I/O address blocks: one for each of the four serial ports and one for the interrupt status register. Each port's address block consists of 8 consecutive addresses, while the interrupt status register occupies a single address. The I/O addresses are set with jumper block J7, located at the right edge of the board. Eight different I/O address combinations are selectable. The address shown below for each port is the base address of that port, i.e. the lowest address of the port's I/O address block.

A	B	C	Port 1	Port 2	Port 3	Port 4	Interrupt Status
In	In	In	3F8	2F8	3E8	2E8	220
Out	In	In	3E8	2E8	3A8	2A8	220
In	Out	In	380	388	288	230	224
Out	Out	In	240	248	260	268	224
In	In	Out	100	108	110	118	240
Out	In	Out	120	128	130	138	244
In	Out	Out	140	148	150	158	248
Out	Out	Out	160	168	170	178	24C

5.2 Serial Protocol Selection

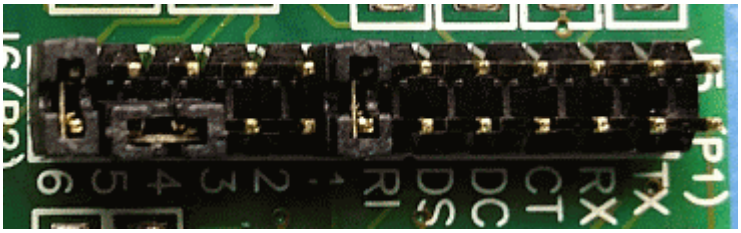
J5:	Port 1 protocol configuration
J6:	Port 2 protocol configuration
J13:	Port 3 protocol configuration
J14:	Port 4 protocol configuration

Depending on the model you have, different protocol configurations are possible. For configurable versions, protocol selection is made by installing jumpers in the positions indicated below in the configuration headers J5, J6, J13, and J14. For fixed protocol versions, the configuration is preset with wire jumpers in these same positions. RS-422 is full-duplex, while RS-485 is half-duplex. In multi-drop mode the transmitter is controlled by the RTS line. This feature requires software control and is not automatic.

Protocol	1	2	3	4	5	6
RS-232 DTE, point to point	Out	In	Out	Out	In	Out
RS-422, point to point	In	Out	In	Out	Out	Out
RS-422, multi-drop	In	Out	In	Out	Out	In
RS-485, multi-drop, echo	In	Out	Out	In	Out	In
RS-485, multi-drop, no echo	In	Out	Out	4 & 5 tied	together	In

{see photo on next page}

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RS-485 Protocol Setting with No Echo

5.3 Configuration for RS-422 and RS-485 Modes

When RS-422 or RS-485 modes are selected, not all signals are used by the line drivers and receivers. Depending on your software configuration, you may need to force some inputs true so that your software will operate correctly. Jumper blocks J5, J6, J13, and J14 provide a means to force the input signals true (connect them to ground, or logic 0) for ports 1 – 4, respectively. The signals that can be controlled in this fashion are CTS, DCD, DSR, and RI. To force an input signal true on a port, install a jumper next to that signal's name on the corresponding header for that port. Jumpers should not be installed in these locations for RS-232 operation.

NOTE: The positions TX and RX are not used for this purpose. Installing jumpers in these locations has an entirely different meaning. See Cable Endpoint Termination below.

5.4 RS-422 / RS-485 Cable Endpoint Termination

In RS-422 or RS-485 networks, termination resistors are normally installed at the endpoints of the cables to minimize reflections on the lines. Emerald-MM provides 120Ω resistors for this purpose. To enable resistor termination, install jumpers in the locations TX and RX of J5, J6, J13, or J14 (for ports 1 – 4, respectively). Termination is only needed, and should only be used, at the cable endpoints. Installing termination resistors at additional points in the network may cause overloading and failure of the line drivers due to the lower impedance caused by multiple resistors in parallel.

5.5 Interrupt Levels

J8:	Port 1 interrupt configuration
J9:	Port 2 interrupt configuration
J10:	Port 3 interrupt configuration
J11:	Port 4 interrupt configuration

Each serial port requires an interrupt level as well as a base I/O address. Four jumper blocks, J8 through J11, are provided to select the interrupt level for each port from among levels 2, 3, 4, 5, 6, 7, 10, 11, 12, and 15. Install a jumper in the position corresponding to the desired interrupt level for each port.

Note: Interrupt levels 2 – 7 are available on the standard 8-bit PC/104 bus header J1. If you are using an 8-bit bus, these are the only levels available to you. Interrupt levels 10, 11, 12, and 15 are available on the 16-bit PC/104 bus extension header J2. If you are using a 16-bit bus, then all 10 levels are available to you. Also, on a system with a 16-bit bus, interrupt level 2 is rerouted to level 9.

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5.6 Interrupt Sharing

On the PC/104 bus, interrupt levels may be shared by multiple devices. For this reason, the interrupt is driven to a logic high level by the device requesting service, and when the device is serviced it tri-states the line rather than driving it low. This technique avoids contention by two devices trying to drive the line with opposing logic levels.

5.7 Interrupt Pulldown Resistor

In order to guarantee valid logic levels on the line when the device is not requesting service, each active interrupt level requires a 1KΩ pulldown resistor. Only one such resistor should be used on each active interrupt line. Each interrupt configuration header on Emerald-MM has a position marked "R" for enabling the pulldown resistor. Install a jumper in this position to connect the resistor, and remove the jumper to disconnect the resistor. If two or more ports are sharing the same interrupt level, install the jumper in the R position for any one of the ports and leave it off the others.

5.8 Interrupt Status Register

The interrupt status register indicates the status of each port's interrupt request line. It operates regardless of whether interrupt sharing is enabled (see below). If two or more ports are sharing the same interrupt level, the status register will still indicate the correct status of each port's interrupt request line.

Bit No.	7	6	5	4	3	2	1	0
Name	X	X	X	X	INT4	INT3	INT2	INT1

Definitions:

X Bit not used; generally reads back as a 1

INT4-1 Status of interrupt request for each port:

0 = no interrupt request active for this port
1 = interrupt request active for this port

5.9 Default Settings

The default settings for Emerald-MM are as follows:

Protocol settings:

All ports set for RS-232

Address/Interrupt settings:

(J7 A B C = In In Out):

Feature	Address	Interrupt level
Port 1	100	3
Port 2	108	3
Port 3	100	3
Port 4	108	3
Interrupt Status	240	

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6. RS-485 TRANSMITTER CONTROL

In an RS-485 network, the same pair of wires is used for both transmit and receive signals. Although any number of nodes can be listening simultaneously, only one can be transmitting or have its transmitter turned on in order for valid data to be transmitted across the network. On Emerald-MM, an RS-485 port's transmitter enable signal is controlled by that port's RTS signal. The RTS signal must be asserted (driven low) to enable the transmitter and deasserted (driven high) to turn off the transmitter.

7. 1-WIRE INTERFACE

In model **EMM-1W-XT**, a 1-Wire interface module (HA7S from Point Six, Inc.) is mounted on the board near the top edge. This port converts the RS-232 signals from port 1 into 1-Wire signals. The user connections for port 1 are made through a separate 4-pin header **J16** on the right side of the board. The port 1 signals on pins 1-10 of J3 may not be used because of conflicts with the RX line being driven by the 1-Wire interface module.

On model EMM-1W-XT, Ports 2, 3, and 4 are fixed in RS-232 mode.

J16 1-Wire Pinout

1	+5
2	Gnd
3	1-Wire
4	Gnd

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8. INSTALLING EMERALD-MM IN WINDOWS NT

1. Run REGEDT32.EXE and go to the following dialog box:

Key_Local_Machine \ System \ CurrentControlSet \ Service \ Serial \ Parameters

2. Add a new key for each serial port by selecting Edit \ Add Key. The following parameters need to be specified for each serial port:

SerialN (N = serial port number, 1, 2, 3, 4, etc.):

Parameter	Type	Value, Comments
DosDevices	REG_SZ	Name of port, e.g. COM5, COM6
ForceFifoEnable	REG_DWORD	0x1 for yes
Interrupt	REG_DWORD	IRQ level in Hex format, e.g. 0x5 for 5 or 0xa for 10
InterruptStatus	REG_DWORD	Address of interrupt status register in Hex, e.g. 0x224
PortAddress	REG_DWORD	Address or port in Hex, e.g. 0x120 for Hex 120
PortIndex	REG_DWORD	Bit position in status register: 0x1 for LSB through 0x4
SharedInterrupts	REG_DWORD	0x1 for yes, 0x0 for no

3. Exit REGEDT32.EXE and restart NT.

See the example on the following page.

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Windows NT Example

The following example is for an EMM-XT board installed on a CPU that already contains 2 serial ports called COM1 and COM2. The address setting combination is A out, B in, C out, and all ports are sharing interrupt level 12. Note that all ports share the same interrupt status register, but the bit position changes.

	Port 1	Port 2	Port 3	Port 4	Interrupt Status Register
Address	0x120	0x128	0x130	0x138	0x244
Interrupt Level	12	12	12	12	

Serial3:

DosDevices	REG_SZ	COM3
ForceFifoEnable	REG_DWORD	0x1
Interrupt	REG_DWORD	0xc
InterruptStatus	REG_DWORD	0x244
PortAddress	REG_DWORD	0x120
PortIndex	REG_DWORD	0x1
SharedInterrupts	REG_DWORD	0x1

Serial4:

DosDevices	REG_SZ	COM4
ForceFifoEnable	REG_DWORD	0x1
Interrupt	REG_DWORD	0xc
InterruptStatus	REG_DWORD	0x244
PortAddress	REG_DWORD	0x128
PortIndex	REG_DWORD	0x2
SharedInterrupts	REG_DWORD	0x1

Serial5:

DosDevices	REG_SZ	COM5
ForceFifoEnable	REG_DWORD	0x1
Interrupt	REG_DWORD	0xc
InterruptStatus	REG_DWORD	0x244
PortAddress	REG_DWORD	0x130
PortIndex	REG_DWORD	0x3
SharedInterrupts	REG_DWORD	0x1

Serial6:

DosDevices	REG_SZ	COM6
ForceFifoEnable	REG_DWORD	0x1
Interrupt	REG_DWORD	0xc
InterruptStatus	REG_DWORD	0x244
PortAddress	REG_DWORD	0x138
PortIndex	REG_DWORD	0x4
SharedInterrupts	REG_DWORD	0x1

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9. SPECIFICATIONS

Serial Port Specifications

No. of serial ports:	4
Protocol:	RS-232, RS-422, RS-485 Jumper selected or fixed, depending on the version
Maximum baud rate:	115kbps standard version 460.8kbps available (**-HS** option)
Communications parameters:	5, 6, 7, or 8 data bits; Even, odd, or no parity
Short circuit protection:	All outputs protected against continuous short circuit

RS-232 mode:

Input impedance:	3KΩ min
Input voltage swing:	±30V max
Output voltage swing:	±5V min, ±7V typical

RS-422, RS-485 modes:

Differential input threshold:	-0.2V min, +0.2V max
Input impedance:	12KΩ min
Input current:	+1.0mA max (V_{IN} = 12V) -0.8mA max (V_{IN} = -7V)
Differential output voltage:	2.0V min (R_L = 50Ω)
High/low states differential output voltage symmetry:	0.2V max

General Specifications

I/O header:	2 20-position (2x10) .025” square pin header on .1” centers; Headers mate with standard ribbon cable (IDC) connectors
Dimensions:	3.55” x 3.775” (PC/104 standard)
Power supply:	+5VDC ±10%
Current consumption:	80mA typical, all outputs unloaded
Operating temperature:	-40°C to +85°C standard
Operating humidity:	5% to 95% noncondensing
PC/104 bus:	8-bit and 16-bit bus headers are installed and used (16-bit header is used for interrupt levels only)

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