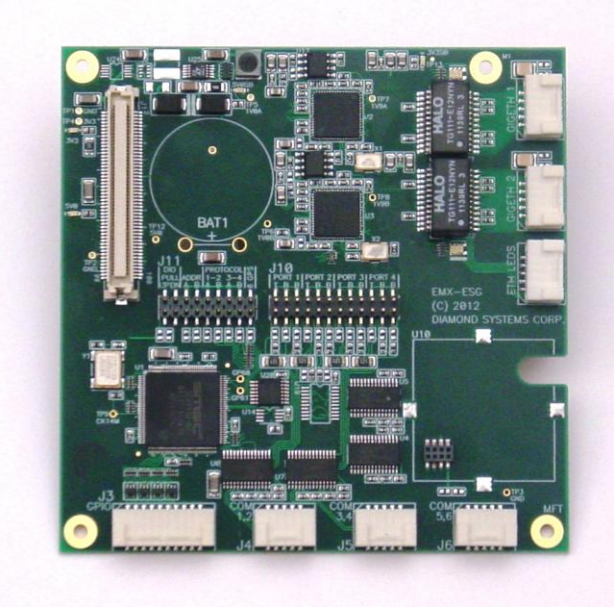
EMX-ESG User Manual

EMX I/O Module with 2 Gigabit Ethernet, 6 Serial Ports, and 14 GPIO



Revision	Date	Comment
A.0	2/17/2013	Initial Release
A.1	3/5/15	Jumper information enhanced

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1. IMPORTANT SAFE HANDLING INFORMATION

WARNING!

ESD-Sensitive Electronic Equipment

Observe ESD-safe handling procedures when working with this product.

Always use this product in a properly grounded work area and wear appropriate ESD-preventive clothing and/or accessories.

Always store this product in ESD-protective packaging when not in use.

Safe Handling Precautions

This product contains a high density connector with many connections to sensitive electronic components. This creates many opportunities for accidental damage during handling, installation and connection to other equipment. The list here describes common causes of failure found on boards returned to Diamond Systems for repair. This information is provided as a source of advice to help you prevent damaging your Diamond (or any vendor's) boards.

ESD damage – This type of damage is usually almost impossible to detect, because there is no visual sign of failure or damage. The symptom is that the board eventually simply stops working, because some component becomes defective. Usually the failure can be identified and the chip can be replaced. To prevent ESD damage, always follow proper ESD-prevention practices when handling computer boards.

Damage during handling or storage – On some boards we have noticed physical damage from mishandling. A common observation is that a screwdriver slipped while installing the board, causing a gouge in the PCB surface and cutting signal traces or damaging components.

Another common observation is damaged board corners, indicating the board was dropped. This may or may not cause damage to the circuitry, depending on what is near the corner. Most of our boards are designed with at least 25 mils clearance between the board edge and any component pad, and ground / power planes are at least 20 mils from the edge to avoid possible shorting from this type of damage. However these design rules are not sufficient to prevent damage in all situations.

A third cause of failure is when a metal screwdriver tip slips, or a screw drops onto the board while it is powered on, causing a short between a power pin and a signal pin on a component. This can cause overvoltage / power supply problems described below. To avoid this type of failure, only perform assembly operations when the system is powered off.

Sometimes boards are stored in racks with slots that grip the edge of the board. This is a common practice for board manufacturers. However our boards are generally very dense, and if the board has components very close to the board edge, they can be damaged or even knocked off the board when the board tilts back in the rack. Diamond recommends that all our boards be stored only in individual ESD-safe packaging. If multiple boards are stored together, they should be contained in bins with dividers between boards. Do not pile boards on top of each other or cram too many boards into a small location. This can cause damage to connector pins or fragile components.

Power supply wired backwards – Our power supplies and boards are not designed to withstand a reverse power supply connection. This will destroy each IC that is connected to the power supply (i.e. almost all ICs). In this case the board will most likely will be unrepairable and must be replaced. A chip destroyed by reverse power or by excessive power will often have a visible hole on the top or show some deformation on the top surface due to vaporization inside the package. **Check twice before applying power!**

Overvoltage on analog input – If a voltage applied to an analog input exceeds the design specification of the board, the input multiplexor and/or parts behind it can be damaged. Most of our boards will withstand an erroneous connection of up to ±35V on the analog inputs, even when the board is powered off, but not all boards, and not in all conditions.

Overvoltage on analog output – If an analog output is accidentally connected to another output signal or a power supply voltage, the output can be damaged. On most of our boards, a short circuit to ground on an analog output will not cause trouble.

Overvoltage on digital I/O line – If a digital I/O signal is connected to a voltage above the maximum specified voltage, the digital circuitry can be damaged. On most of our boards the acceptable range of voltages connected to digital I/O signals is 0-5V, and they can withstand about 0.5V beyond that (-0.5 to 5.5V) before being damaged. However logic signals at 12V and even 24V are common, and if one of these is connected to a 5V logic chip, the chip will be damaged, and the damage could even extend past that chip to others in the circuit.

2. INTRODUCTION

EMX-ESG is an EMX compact format I/O module featuring two PCI Express gigabit Ethernet ports, an LPC UART with 6 serial ports, and 24 GPIO lines. It uses two PCIe x1 links and one LPC clock on the EMX bus.

2.1 Features

2.1.1 Main Feature List

- 2 Gigabit Ethernet ports on pin headers, with on-board magnetics
- 6 serial ports: 4 offer RS-232/422/485 capability, 2 offer RS-232/logic level capability
- 14 GPIO lines, 3.3V logic levels with 5V compatibility
- Socket for installation of Condor 2626 GPS receiver
- Operating System Support
  - Windows Embedded Standard 7
  - Linux 2.6
  - QNX
  - Windows CE 6

2.1.2 Mechanical, Electrical, Environmental

- EMX Compact form factor: 3.74” x 3.74” (95mm x 95mm)
- -40°C to +85°C ambient operating temperature without a fan
- MIL-STD-202G shock/vibration compatible
- Power input requirements: +5VDC +/- 5%

2.2 Cable List

Part No.	*Cable Description*
6981315	Gigabit Ethernet cable
6981316	Dual serial cable
6981322	GPIO cable

3. FUNCTIONAL OVERVIEW

3.1 Functional Block Diagram

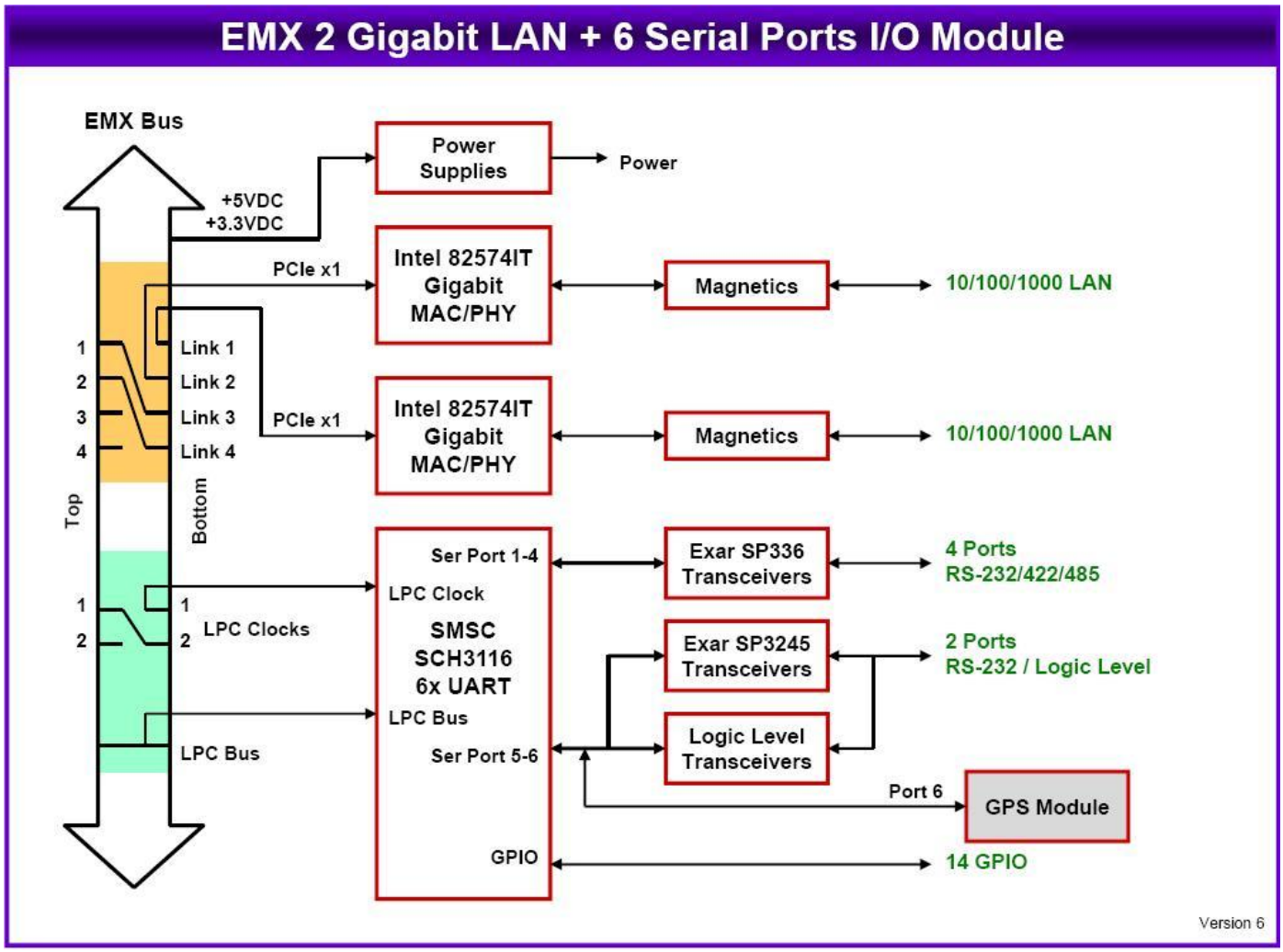

Figure 1. EMX-ESG Functional Block Diagram

3.2 Ethernet

Each Ethernet port consists of an Intel 82574IT PCIe x1 Ethernet MAC/PHY. Magnetics and configuration EEPROM are included on the board to provide a complete circuit.

3.3 Serial Ports

EMX-ESG includes an SMSC SCH3116 6-port UART to provide 6 serial ports. Ports 1-4 use Exar SP336 multiprotocol transceivers to support RS-232, RS422, and RS-485. On these ports, signals TX, RX, CTS, and RTS are available in RS-232 mode. In RS-485 mode, the transmitter is controlled by the RTS line.

Ports 5-6 have only TX and RX signals. These ports offer RS-232 or logic level I/O. These ports can optionally be used to communicate with an installed GPS receiver. To do so, both the RS-232 and logic level transceivers are disabled.

Serial ports 1-2 share one SP336 for protocol selection, and ports 3-4 share a second SP336. Each SP336 requires 2 jumpers for protocol selection, connected to mode pins M0 and M2. Mode pin M1 is tied high for all protocols.

Ports 1-4 each require 3 jumpers for termination and bias resistors when configured for RS-422 or RS-485 mode. The termination resistor value is 121 ohms 1%, and the bias resistors are 4.75K ohms 1%.

Ports 5-6 use an SP3245 for RS-232 mode or a logic level driver for logic level signals. Configuration is done as an assembly option – both transceivers cannot be simultaneously installed for the same port. Each port can be configured separately. Two jumpers are required for each port to provide independent enable / disable signals for each driver/transceiver chip in case a GPS module is installed.

All protocol selection and termination / bias resistor selections are made with jumpers. The board contains 0-ohm resistors that may be installed in place of all jumpers for a more rugged assembly.

3.4 General Purpose I/O

The EMX-ESG offers 14 general purpose digital I/O lines which are provided on an I/O connector. These lines offer 3.3V logic levels with 5V compatibility. The ports have programmable direction with I/O buffers for protection. The buffer direction control signals are derived from three other GPIO lines on the SCH3116. On power-up, the digital I/O ports are in input mode. The digital I/O lines have jumper-configured pull-up/down resistors.

3.5 GPS

EMX-ESG supports a Condor C2626 23-channel GPS receiver.

4. BOARD OUTLINE AND LAYOUT

4.1 EMX-ESG Board Drawings

The following diagrams show the locations for all connectors and jumpers which are described in the next section.

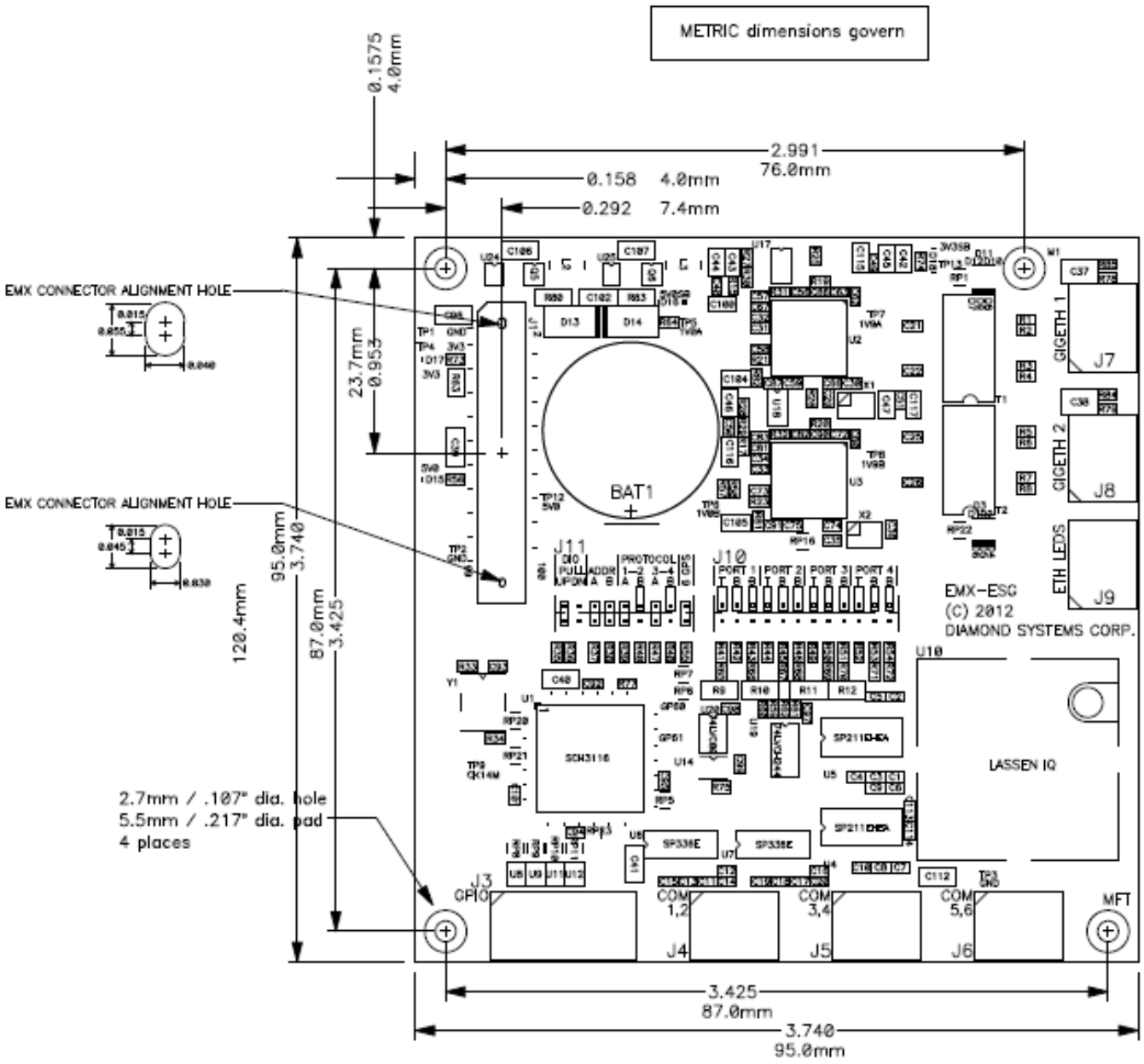

Figure 2: EMX-ESG Top Drawing (Connectors and Jumpers)

5. CONNECTOR AND JUMPER LIST

5.1 Connector List

The following table summarizes the functions of the EMX-ESG's interface connectors. Refer to the Figure 2 for connector and jumper locations. Signal functions relating to all of EMX-ESG's interface connectors are discussed in detail in Section 6 of this document. Other connectors and jumper blocks on the board are reserved for Diamond Systems' use only.

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Connector	*Function*
J1	EMX Top
J2	EMX Bottom (not shown on drawing)
J3	GPIO
J4, J5, J6	Serial Ports
J7, J8	Ethernet Ports
J9	Ethernet LEDs
U10	GPS

5.2 Jumper List

See Section 7 for information on configuring jumpers.

Jumper	*Function*
J10	Serial Port Termination jumper
J11	Address and Protocol jumper

As a custom assembly option, EMX-ESG was designed with 0-ohm resistors that may be installed in place of the jumpers for a more rugged assembly.

6. CONNECTOR PINOUT AND PIN DESCRIPTION

6.1 EMX Top (J1)

Signal names in parenthesis are signals going to the specified pin number of the bottom connector (J2). NC means no connects between top and bottom connectors on this board.

GND	**2**	**1**	GND
(NC) PCIe TX1+	**4**	**3**	PCIe TX4+ (J2-10)
(NC) PCIe TX1-	**6**	**5**	PCIe TX4- (J2-12)
GND	**8**	**7**	GND
(NC) PCIe TX2+	**10**	**9**	PCIe TX3+ (J2-04)
(NC) PCIe TX2-	**12**	**11**	PCIe TX3- (J2-06)
GND	**14**	**13**	GND
(NC) PCIe RX1+	**16**	**15**	PCIe RX4+ (J2-22)
(NC) PCIe RX1-	**18**	**17**	PCIe RX4- (J2-24)
GND	**20**	**19**	GND
(NC) PCIe RX2+	**22**	**21**	PCIe RX3+ (J2-16)
(NC) PCIe RX2-	**24**	**23**	PCIe RX3- (J2-18)
GND	**26**	**25**	GND
(NC) PCIe CLK1+	**28**	**27**	PCIe CLK4+ (J2-34)
(NC) PCIe CLK1-	**30**	**29**	PCIe CLK4- (J2-36)
GND	**32**	**31**	GND
(NC) PCIe CLK2+	**34**	**33**	PCIe CLK3+ (J2-28)
(NC) PCIe CLK2-	**36**	**35**	PCIe CLK3- (J2-30)
+3.3V	**38**	**37**	+3.3V
(NC) PCIe CLKRQ1-	**40**	**39**	PCIe CLKRQ4- (J2-42)
(NC) PCIe CLKRQ2-	**42**	**41**	PCIe CLKRQ3- (J2-40)
+3.3V	**44**	**43**	+3.3V
(J2-46) SATA TX+	**46**	**45**	USB1+ (J2-45)
(J2-48) SATA TX-	**48**	**47**	USB1- (J2-47)
+3.3V	**50**	**49**	+3.3V
(J2-52) SATA RX+	**52**	**51**	USB2+ (J2-51)
(J2-54) SATA RX-	**54**	**53**	USB2- (J2-53)
+3.3V	**56**	**55**	+3.3V
(J2-58) RSRV	**58**	**57**	RSRV (J2-57)
(J2-60) RSRV	**60**	**59**	RSRV (J2-59)
+5V	**62**	**61**	+5V
(J2-64) RSRV	**64**	**63**	RSRV (J2-63)
(J2-66) RSRV	**66**	**65**	RSRV (J2-65)
+5V	**68**	**67**	+5V
(J2-70) SMB CLK	**70**	**69**	RSRV (J2-69)
(J2-72) SMB DAT	**72**	**71**	RSRV (J2-71)
(J2-74) SMB ALRT-	**74**	**73**	+5V
+5V	**76**	**75**	RSRV (J2-75)
+5V	**78**	**77**	RSRV (J2-77)
(J2-80) LPC AD0	**80**	**79**	+5VSB
(J2-82) LPC AD1	**82**	**81**	+5VSB
(J2-84) LPC AD2	**84**	**83**	VBAT
(J2-86) LPC AD3	**86**	**85**	WAKE- (J2-85)
(J2-88) LPC FRM-	**88**	**87**	I/O CTRL 1 (J2-87)
(J2-90) LPC SERIRQ-	**90**	**89**	I/O CTRL 2 (J2-89)
(J2-92) LPC DRQ	**92**	**91**	USB OVC- (J2-91)
(NC) LPC CLK1	**94**	**93**	I/O RDY (J2-93)
(J2-94) LPC CLK2	**96**	**95**	DEV RST- (J2-95)
GND	**98**	**97**	HOST RST- (J2-97)
GND	**100**	**99**	GND

Connector description: Samtec BTH-060-09-F-D-A-K-TR

6.2 EMX Bottom (J2)

Signal names in parenthesis are going to the specified pin number of the top connector (J1). NC means no connects between top and bottom connectors on this board. GND means tied to ground on this board.

GND	**2**	**1**	GND
(J1-03) PCIe TX1+	**4**	**3**	PCIe TX4+ (NC)
(J1-05) PCIe TX1-	**6**	**5**	PCIe TX4- (NC)
GND	**8**	**7**	GND
(J1-03) PCIe TX2+	**10**	**9**	PCIe TX3+ (NC)
(J1-05) PCIe TX2-	**12**	**11**	PCIe TX3- (NC)
GND	**14**	**13**	GND
(J1-21) PCIe RX1+	**16**	**15**	PCIe RX4+ (NC)
(J1-23) PCIe RX1-	**18**	**17**	PCIe RX4- (NC)
GND	**20**	**19**	GND
(J1-15) PCIe RX2+	**22**	**21**	PCIe RX3+ (NC)
(J1-17) PCIe RX2-	**24**	**23**	PCIe RX3- (NC)
GND	**26**	**25**	GND
(J1-33) PCIe CLK1+	**28**	**27**	PCIe CLK4+ (NC)
(J1-35) PCIe CLK1-	**30**	**29**	PCIe CLK4- (NC)
GND	**32**	**31**	GND
(J1-27) PCIe CLK2+	**34**	**33**	PCIe CLK3+ (NC)
(J1-29) PCIe CLK2-	**36**	**35**	PCIe CLK3- (NC)
+3.3V	**38**	**37**	+3.3V
(J1-41) PCIe CLKRQ1-	**40**	**39**	PCIe CLKRQ4- (NC)
(J1-39) PCIe CLKRQ2-	**42**	**41**	PCIe CLKRQ3- (NC)
+3.3V	**44**	**43**	+3.3V
(J1-46) SATA TX+	**46**	**45**	USB1+ (J1-45)
(J1-48) SATA TX-	**48**	**47**	USB1- (J1-47)
+3.3V	**50**	**49**	+3.3V
(J1-52) SATA RX+	**52**	**51**	USB2+ (J1-51)
(J1-54) SATA RX-	**54**	**53**	USB2- (J1-53)
+3.3V	**56**	**55**	+3.3V
(J1-58) RSRV	**58**	**57**	RSRV (J1-57)
(J1-60) RSRV	**60**	**59**	RSRV (J1-59)
+5V	**62**	**61**	+5V
(J1-64) RSRV	**64**	**63**	RSRV (J1-63)
(J1-66) RSRV	**66**	**65**	RSRV (J1-65)
+5V	**68**	**67**	+5V
(J1-70) SMB CLK	**70**	**69**	RSRV (J1-69)
(J1-72) SMB DAT	**72**	**71**	RSRV (J1-71)
(J1-74) SMB ALRT-	**74**	**73**	+5V
+5V	**76**	**75**	RSRV (J1-75)
+5V	**78**	**77**	RSRV (J1-77)
(J1-80) LPC AD0	**80**	**79**	+5VSB
(J1-82) LPC AD1	**82**	**81**	+5VSB
(J1-84) LPC AD2	**84**	**83**	VBAT
(J1-86) LPC AD3	**86**	**85**	WAKE- (J1-85)
(J1-88) LPC FRM-	**88**	**87**	I/O CTRL 1 (J1-87)
(J1-90) LPC SERIRQ-	**90**	**89**	I/O CTRL 2 (J1-89)
(J1-92) LPC DRQ	**92**	**91**	USB OVC- (J1-91)
(J1-96) LPC CLK1	**94**	**93**	I/O RDY (J1-93)
(NC) LPC CLK2	**96**	**95**	DEV RST- (J1-95)
GND	**98**	**97**	HOST RST- (J1-97)
GND	**100**	**99**	GND

Connector description: Samtec BSH-060-01-F-D-A

6.3 GPIO (J3)

A 26-pin connector provides 14 GPIO lines from the SCH3116, identified as ports A, B, and C. These lines have 3.3V logic levels with 5V input tolerance. The connector also provides access to the 1PPS signal from an optional installed GPS module.

GP22	**2**	**1**	GP21
GP30	**4**	**3**	GP27
GP33	**6**	**5**	GP32
GP37	**8**	**7**	GP36
GP42	**10**	**9**	GP40
GP47	**12**	**11**	GP46
GP61	**14**	**13**	GP60
+3V3	**16**	**15**	1PPS
GND	**18**	**17**	+3V3
GND	**20**	**19**	GND

Connector description: JST ZPD series, SMT right angle; part no. SM20B-ZPDSS-TF

The GPIO lines come from the GPxx pins on SCH3116 chip and are mapped as the following:

SIGNAL	SCH3116 PIN#
GP21	37
GP22	38
GP27	36
GP30	110
GP32	39
GP33	40
GP36	41
GP37	42
GP40	3
GP42	90
GP46	32
GP47	33
GP60	94
GP61	93

6.4 Serial Ports (J4, J5, J6)

The SCH3116 offers 6 serial ports. In RS-232 mode, ports 1-4 have TX, RX, CTS, and RTS signals, while ports 5-6 have only TX and RX signals. The following pinouts are the pin definition of the SP336 transceiver when its protocol is switched between RS-232, RS-422, and RS-485. Each I/O connector supports 2 serial ports.

RS-232

TX1	2	1	RX1
NC	4	3	Gnd
RTS1	6	5	CTS1
CTS2	8	7	RTS2
RX2	10	9	TX2

TX3	2	1	RX3
NC	4	3	Gnd
RTS3	6	5	CTS3
CTS4	8	7	RTS4
RX4	10	9	TX4

TX5	2	1	RX5
NC	4	3	Gnd
NC	6	5	NC
NC	8	7	NC
RX6	10	9	TX6

RS-422

TX1+	2	1	RX1+
NC	4	3	Gnd
TX1-	6	5	RX1-
RX2-	8	7	TX2-
RX2+	10	9	TX2+

TX3+	2	1	RX3+
NC	4	3	Gnd
TX3-	6	5	RX3-
RX4-	8	7	TX4-
RX4+	10	9	TX4+

RS-485

TX/RX1+	2	1	NC
NC	4	3	Gnd
TX/RX1-	6	5	TX/RX2-
NC	8	7	NC
NC	10	9	TX/RX2+

TX/RX3+	2	1	NC
NC	4	3	Gnd
TX/RX3-	6	5	TX/RX4-
NC	8	7	NC
NC	10	9	TX/RX4+

Connector description: JST ZPD series, SMT right angle; part no. SM10B-ZPDSS-TF

6.5 Ethernet Ports (J7, J8)

Each Ethernet port has its own 10-pin connector, of which 8 pins are used.

NC	2	1	NC
DA+	4	3	DA-
DB+	6	5	DB-
DC+	8	7	DC-
DD+	10	9	DD-

Connector description: JST ZPD series, SMT right angle; part no. SM10B-ZPDSS-TF

6.6 Ethernet LEDs (J9)

Each Ethernet port has 3 LED signals that may be used to drive indicator LEDS. These signals are available on an I/O connector. The signals also drive on-board LEDs. LED1 is the link indicator; an LED is connected between this signal and +3.3VDC. LED2 and LED3 are speed indicators. A bi-color LED may be connected directly across these two signals. It will display one color for 100Mbps and the second color for 1000Mbps speeds. Alternatively, a separate LED can be connected between each of these signals and +3.3VDC for a 3 LED display. No external resistors are needed with these signals.

P1LED1	**2**	**1**	P2LED1
P1LED2	**4**	**3**	P2LED2
P1LED3	**6**	**5**	P2LED3
+3.3VSB	**8**	**7**	+3.3VSB
NC	**10**	**9**	NC

Connector description: JST ZPD series, SMT right angle; part no. SM10B-ZPDSS-TF

6.7 GPS (U10)

The GPS module connector is a 2x4 .1” / 2.54mm pitch female socket. The VCC pin is jumper-selectable between +3.3V and +5V derived from the EMX connector.

GND	**2**	**1**	NC
1PPS	**4**	**3**	NC
RXDB	**6**	**5**	TXDB
3V BAT	**8**	**7**	+3.3V

Connector example: Samtec Model no. SLW-104-01-G-D

7. JUMPER CONFIGURATION INFORMATION

7.1 Serial Port Termination (J10)

Serial ports 1-4 each require three jumpers per port for 120 ohm termination and bias resistors. The default configuration with no jumpers installed is shown below.

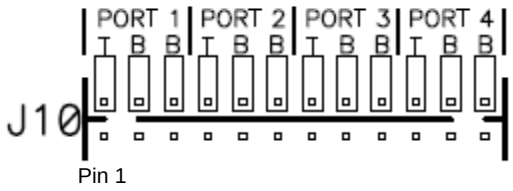

Figure 3: Serial Port Termination Jumper Block

Pins	*Termination Enable/Disable*
1-2 no jumper	Port1 termination disabled (default)
1-2 jumper	Port1 termination enabled
3-4, 5-6 no jumpers	Port1 RS-422/485 bias disabled (default)
3-4, 5-6 jumpers	Port1 RS-422/485 bias enabled
7-8 no jumper	Port2 termination disabled (default)
7-8 jumper	Port2 termination enabled
9-10, 11-12 no jumpers	Port2 RS-422/485 bias disabled (default)
9-10, 11-12 jumpers	Port2 RS-422/485 bias enabled
13-14 no jumper	Port3 termination disabled (default)
13-14 jumper	Port3 termination enabled
15-16, 17-18 no jumpers	Port3 RS-422/485 bias disabled (default)
15-16, 17-18 jumpers	Port3 RS-422/485 bias enabled
19-20 no jumper	Port4 termination disabled (default)
19-20 jumper	Port4 termination enabled
21-22, 23-24 no jumpers	Port4 RS-422/485 bias disabled (default)
21-22, 23-24 jumpers	Port4 RS-422/485 bias enabled

7.2 Address and Protocol (J11)

Jumper J11 provides the configuration jumpers for the GPIO, serial port addresses and protocols and GPS as outlined below.

The general purpose DIO pull-up/down setting is configured with two jumpers, one for pull-up (default) and the other pull-down.

The base address for the SCH3116 is configured with two jumpers that connect pull-up/down resistors to the DTR1 (A) and RTS1 (B) signals. These pins are read by the SCH3116 at power-up to define its base address:

DTR1	RTS1	Base address
0	0	0x162E (default)
0	1	0x164E
1	0	0x002E
1	1	0x004E

Ports 1-2 2 jumpers for RS-232/422/485 configuration (RS-232 default)

Ports 3-4 2 jumpers for RS-232/422/485 configuration (RS-232 default)

Set COM6 to either serial port F or the GPS socket.

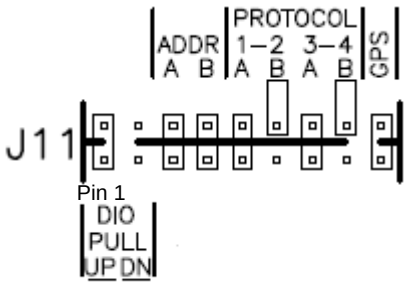

Figure 4: Address and Protocol Jumper Block

Pins	*Setting*
1-2 jumper (no 3-4 jumper)	DIO pull up to +5V (default)
3-4 jumper (no 1-2 jumper)	DIO pull up to +3.3V
5-6, 7-8 jumpers	Base address 0x162E (default)
5-6 jumper, 7-8 no jumper	Base address 0x164E
5-6 no jumper, 7-8 jumper	Base address 0x002E
5-6, 7-8 no jumpers	Base address 0x004E
9-10, 11-12 jumpers	COM1, COM2 loopback
9-10 jumper, 11-12 no jumper	COM1, COM2 RS-232 (default)
9-10 no jumper, 11-12 jumper	COM1, COM2 RS-485
9-10, 11-12 no jumpers	COM1, COM2 RS-422
13-14, 15-16 jumpers	COM3, COM4 loopback
13-14 jumper, 15-16 no jumper	COM3, COM4 RS-232 (default)
13-14 no jumper, 15-16 jumper	COM3, COM4 RS-485
13-14, 15-16 no jumpers	COM3, COM4 RS-422
17-18 no jumper	COM6 set to Serial Port F (default)
17-18 jumper	COM6 set to GPS

8. SPECIFICATIONS

8.1 General Functions

- 2 Gigabit Ethernet ports based on Intel 82574IT Ethernet chips
- 4 RS-232/422/485 ports
- 2 RS-232 ports (3.3V logic level optional)
- All six serial ports from SMSC SCH3116 UART
- 14 general purposed digital I/O lines
    - Programmable direction with I/O buffers
    - 3.3V logic level with 5V compatibility
- Supports Condor C2626 23-channel GPS receiver
- EMX stackable I/O expansion

8.2 Mechanical, Electrical, Environmental

- EMX Compact form factor: 3.74” x 3.74” (95mm x 95mm)
- Operating temperature of -40°C to +85°C (-40°F to +185°F) ambient without a fan
- Operating humidity of 5% to 95% non condensing
- MIL-STD-202G shock/vibration compatible
- Power input requirements: +5VDC +/- 5% or +3.3VDC +/- 5%
- MTBF: tbd hours
- Weight: 3.2oz (90.7g)