Digi Connect EM™ & Digi Connect Wi-EM™ Hardware Reference

Seamless migration to total integration.

Making **DEVICE NETWORKING** *easy* ™

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Contents

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About This Guide

Scope of Reference Manual

The scope of this guide is to enable developers to integrate the Digi Connect EM or Digi Connect Wi-EM modules into other devices. Graphics illustrate the placement and dimensions of components for both the modules and the development board. Information for both the Digi Connect EM and the Digi Connect Wi-EM are identical unless called out specifically in the manual.

Kits Contents

This manual is intended for customers who use either the Digi Connect EM/Digi Connect Wi-EM Integration Kit or the Digi Connect EM/Digi Connect Wi-EM Development Kit, which are described below.

About the Integration Kit

The integration kit is the ideal platform for product evaluation, rapid prototyping, and integration of the Digi Connect EM or Digi Connect Wi-EM embedded device server. Targeted specifically at customers who want to take advantage of the Digi Connect EM or Digi Connect Wi-EM embedded device server with Digi plug-and-play firmware functionality, both products enable integration of the Digi Connect EM or Digi Connect Wi-EM embedded module without any extensive embedded software development with all the additional flexibility and benefits of web user interface customization and application specific java applets. Included in the Digi Connect EM or Digi Connect Wi-EM Integration Kits are the following:

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- Complete development board with EIA-232 serial ports, signal status indicators, logic analyzer connectors, test points, and a self-contained GPIO test bed.

- Cables
  - DB-9 to DB-9 Crossover cable
  - DB-9 to DB-9 Modem cable
  - RJ-45 Ethernet Crossover cable

- Loopback plug

- Power supply

- Wrist strap (for grounding)

- Digi Connect CD
  - sample code
  - tools and utilities with source code and libraries
  - Microsoft Windows RealPort drivers

- Full software and hardware documentation

About the Development Kit

The Digi Connect EM or Digi Connect Wi-EM Development Kit is an easy-to-use and royalty-free development platform that significantly reduces traditional design risk and accelerates the overall software development process. Both kits deliver the integrated building blocks to quickly and cost effectively create your own custom firmware for a Digi Connect EM or Digi Connect Wi-EM based high-performance networking solution that fits the specific requirements of your application.

Based on the NET+Works family of platform solutions, the Digi Connect EM or Digi Connect Wi-EM development kits enable you to integrate custom network connectivity into your products quickly by providing a full suite of development tools inlcuding:

- Development board

- Cables

- Power supply

- Hardware debugger
- Complete set of networking protocols and applications software

Related Documentation

See the *NS 7520 Hardware Reference* for information on the NS 7520 chip.

Support Information

To get help with a question or technical problem or make comments and recommendations about Digi products and documentation, use the following contact information.

General	*Customer Service and Support*
Digi International	United States: 1 877-912-3444
11001 Bren Road East	Other Locations: 1 952-912-3444
Minnetonka, MN 55343	www.digi.com/support
U.S.A.	www.digi.com

About the Embedded Module

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C H A P T E R   1

Overview

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Digi Connect EM and Digi Connect Wi-EM Overview

The embedded modules are part of the Digi Connect family of device servers that provide simple, reliable and cost-effective network connections for serial devices. They provide fully transparent serial device connectivity over industry-standard Ethernet connections and allow both equipment manufacturers and systems integrators to network-enable products at a fraction of the time and cost required to develop a custom solution. It is a highly flexible and compact single component solution with a robust on-board TCP/IP stack and 10/100 Base-T Ethernet or wireless support. Features include the following:

- 32-bit NS7520 processor with ARM7TDMI core

- 4MB Flash and 8MB RAM on board

- 2 High Speed Serial Ports

- SPI Master Mode Interface

- 9 General Purpose Input/Output Port Options

- Available with Digi plug-and-play firmware

- NetSilicon NET+Works platform for embedded software development

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From medical systems to building control and industrial automation, in virtually any application where embedded serial connectivity over Ethernet is needed, the embedded module is the ideal choice, delivering high-performance functionality.

Cautions

To guard against damage to the module due to electrostatic discharge (ESD), do not remove it from its protective packaging until you have been properly grounded. To ground yourself, put the wrist strap on (included in the package) and then attach the clip to a metal surface.

■ Input voltage for the module is 3.3 VDC.

Types of Modules
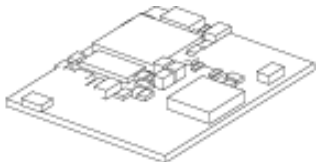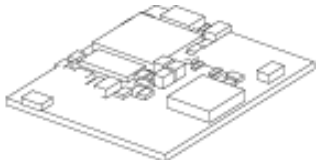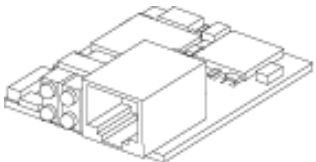
The following describes the three types of Digi Connect EM and three types of Digi Connect Wi-EM modules:
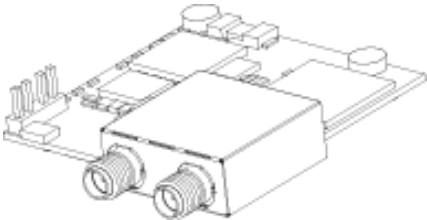
Choosing a Module for Your Product
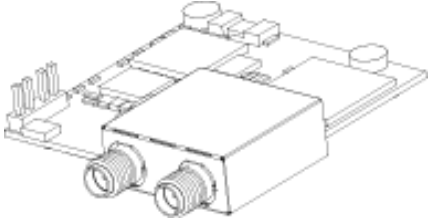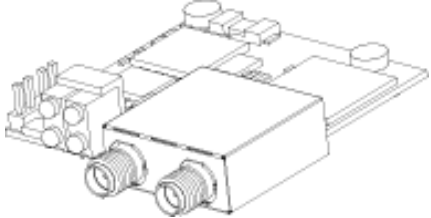
Although any of the embedded modules can be designed into your product, a JTAG header would typically be used only for debugging during the development process. The Digi Connect EM module part number DC-EM-02T-S or DC-EM-02T-C is appropriate when its integrated LEDs and RJ-45 Ethernet connectors are accessible and visible to the end-users of your product. The Digi Connect EM module part number DC-EM-02T-NC or DC-EM-02T-JT is the right choice when you want more control over RJ-45 Ethernet connector and LED locations or when you will provide custom connectors or indicators.

The Digi Connect Wi-EM module part number DC-WEM-02T-C or DC-WEM-02T-S is appropriate when its integrated LEDs are accessible and visible to the end-users of your product. The Digi Connect Wi-EM module part number DC-WEM-02T-JT or DC-WEM-02T-NC is the right choice when you want more control over LED locations or when you will provide custom connectors or indicators.

Please refer to the Digi website www.digi.com for part number and ordering information for the modules

Digi Connect EM Modules		
Model	**Description**	**Figure**
DC-EM-02T-JT	--- Used for development purposes only --- JTAG interface --- Pin headers for Ethernet and LED functionality.	
DC-EM-02T-NC	--- No JTAG interface --- Pin headers for Ethernet and LED functionality --- Ordered independently of development kit for use in your implementation	
DC-EM-02T-S DC-EM-02T-C	--- No JTAG interface --- RJ-45 Ethernet connector and LED array --- Ordered independently of either the development or integration kit for use in your implementation.	

Digi Connect Wi-EM Modules		
Model	**Description**	**Figure**
DC-WEM-02T-JT	--- Used for development purposes only --- JTAG interface --- Pin headers LED functionality --- Dual RP-SMA Antenna Connector.	

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Digi Connect Wi-EM Modules		
Model	Description	Figure
DC-WEM-02T-NC	--- No JTAG interface --- Pin headers LED functionality --- Dual RP-SMA Antenna Connector --- Ordered independently of development kit for use in your implementation	
DC-WEM-02T-C DC-WEM-02T-S	--- No JTAG interface --- LED array --- Dual RP-SMA Antenna Connector --- Ordered independently of either development or integration kit for use in your implementation.	

Note **-S**: No JTAG, w/ LED array, w/RJ-45/antenna connectors, for use with Digi Firmware

-C: No JTAG, w/LED array, RJ-45 / antenna connectors, for use with Custom Firmware

-NC: No JTAG, w/LED pin header, w/o RJ-45 connector (for Digi Connect EM), w/antenna connectors (for Digi Connect Wi-EM), for use with custom firmware (not shown)

-JT: w/ JTAG, w/pin header, w/o RJ-45 connector (for Digi Connect EM), w/ antenna connectors (for Digi Connect Wi-EM), for use with custom firmware development

Digi Connect Wi-EM Antennae

The Digi Connect Wi-EM is available with dual-diversity antenna connectors. The right antenna (P2) is always used for transmit and receive.The left antenna is receive only. The antenna will choose the best signal (pin vs. socket). The Digi Connect Wi-EM always has two antenna connectors but using the second antenna is optional.

The antennae are connected to the module with reverse polarity SMA connectors (sub-miniature size A). The antennae fit the connectors on the module only one way to ensure a

proper connection. The antennae function best when placed perpendicular to each other (one straight, the other up or down) to prevent interference from each other.

Another option for both signal reception and design flexibility is to use an antenna extension cord (Digi part number DC-ANT-E-24DP) to separate the antenna from the module. This allows the module to fit inside your product but the antenna to be placed outside the device.

Connectors: Power and Serial Interface

This single 12-pin, serial interface port (labeled P4 for Digi Connect EM and P5 for Digi Connect Wi-EM) supports 2 TTL serial interfaces, data rates up to 230 Kbps and full-modem control (on port 1). See the figure for help locating pins and the table for pin assignments.

Power and Serial Interface

Top view
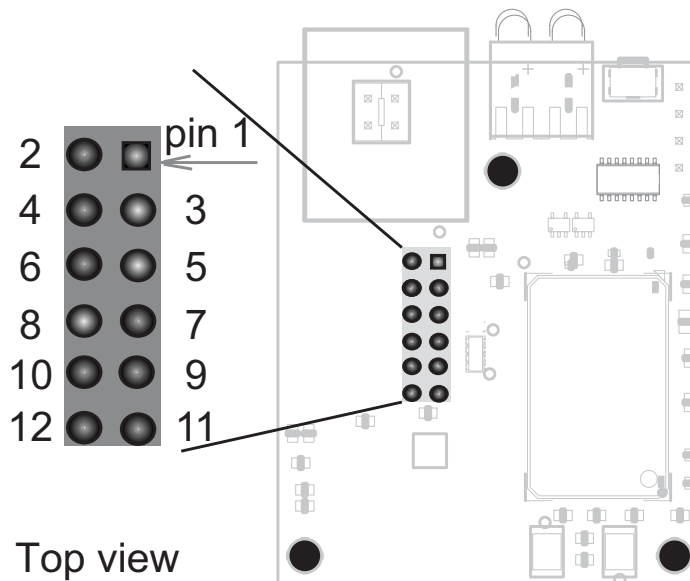
Power and Serial Interface Pin Assignments		
Pin	Signal Name	Description and Notes
1	VCC	+3.3 VDC (input only)
2	GND	Reference Ground for input power
3	RXD/GPIO-7	Port 1 RXD (input)/GPIO-7
4	TXD/GPIO-6	Port 1 TXD (output)/GPIO-6
5	RTS/GPIO-4/SPI_CLK	Port 1 RTS/GPIO-4/SPI clock
6	DTR/GPIO-5	Port 1 DTR (output)/GPIO-5
7	CTS/GPIO-2	Port 1 CTS (input)/GPIO-2
8	DCD/GPIO-1/SPI_EN	Port 1 DCD (input)/GPIO-1/SPI enable
9	DSR/GPIO-3	Port 1 DSR (input)/GPIO-3
10	/RST	Reset (input)
11	RXD/GPIO-9	Port 2 RXD (input)/GPIO-9
12	TXD/GPIO-8	Port 2 TXD (output)/GPIO-8

Connectors: Ethernet Interface

The following table shows the pinout of the RJ-45 connector..

RJ-45 Ethernet Interface							
Pin #	1	2	3	4	5	6	7	8
Signal	TXD+ (Transmit Data)	TXD- (Transmit Data)	RXD+ (Receive Data)	Not used	Not used	RXD- (Receive Data)	Not used	Not used

For a diagram of the Digi Connect Ethernet pin header location and assignments see "Digi Connect EM Pin Header Locations (Top view)" on page 20.

Connectors: Antenna

The Digi Connect Wi-EM has 2 RP-SMA antenna connectors labeled P2 and P3.

Wi-EM Antenna Connectors
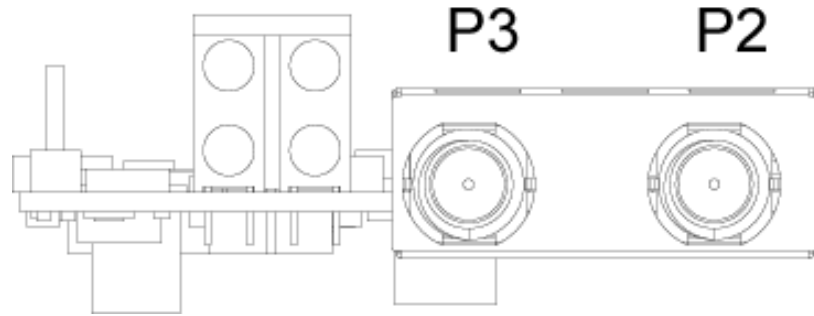
Caution: This Part 15 radio device operates on a non-interference basis with other devices operating at this frequency when using the antennae listed in the Antenna Specification table. Any changes or modification to the product not expressly approved by Digi International could void the user's authority to operate the device.

The antenna is connected to the module with a reverse polarity SMA connector (sub-miniature size A). The antenna only fits on the module one way to ensure a proper connection. Another option for both signal reception and design flexibility is to use an antenna extension cord (Digi part number DC-ANT-E-24DP) to separate the antenna from the module. This allows the module to fit inside your product but the antenna to be placed outside the device.

Antenna Description			
Type	Desktop	Dipole	30 cm Antenna Extension Cord
Part number	DC-ANT-24DT	DC-ANT-24DP	DC-ANT-E-24DP
Gain	1.8 dBi	2 dBi	-.5dB

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Reset Switch

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The behavior of the reset switch is determined by software, which means that it has a predefined behavior in the integration kit. In the development kit, its behavior is determined by your implementation. See the following table for details.

Reset Switch Behavior	
Kit	**Behavior**
Integration	The reset switch does one of the following: ■ If pressed and released immediately, the device is rebooted. ■ If pressed and held down (for about 20 seconds) during power-up, the device is rebooted and restored to the default configuration.
Development	■ The behavior of the switch is user-defined. See "Embedded Module Reset" on page 44 for more information.

Reset Switch Location
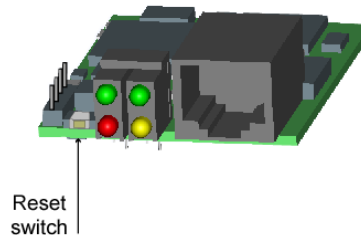
Reset switch

Note The reset switch is in same location for both wired and wireless modules.

Module LEDs

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The modules provide two hardware options for LEDs, with or without on board LED array. The integration kit provides predefined LED behavior. With the development kit, some

LED behavior can be determined by your implementation. See the following table for more information..

LED Behaviors				
LED	**Pin** Header EM	**Integration Kit** **Digi Connect EM**	**Integration Kit** **Digi Connect Wi-EM**	**Development Kit**
Top left (green)	1 (+) 3(-)	Serial port activity: Off - the serial channel is idle. Blinking - serial data is transmitted or received.		This LED is software programmable
Top right (green)	5 (+) 7 (-)	Network link status: Off - no link has been detected. On - a link has been detected.	Network link status: On - unit is associated with an access point Blinking slowly - unit is in ad hoc mode Blinking quickly - unit is scanning for a network	Same as Integration Kit (Network link status)
Bottom left (red)	2 (+) 4 (-)	Diagnostics: Blinking 1-1-1 - starting the operating system. Blinking 1-5-1 - configuration has been returned to factory defaults. **Note:** If other blinking patterns occur, contact Digi Technical Support.		This LED is software programmable
Bottom right (yellow)	6 (+) 8 (-)	Blinking - network data is transmitted or received		This LED is software programmable

Digi Connect EM Pin Header Locations (Top view)
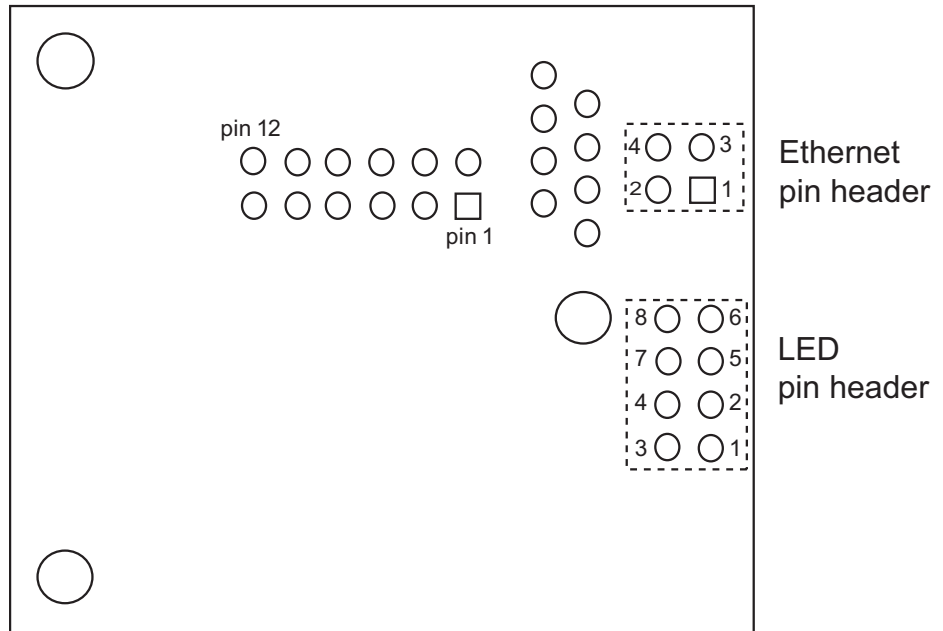
Ethernet pin header, P13

The pins in the Ethernet header are configured as shown:

Pin	Signal
1	Ethernet transmit +
2	Ethernet transmit -
3	Ethernet receive +
4	Ethernet receive -

Led pin header

LED pins and pin header configuration are described in the "LED Behaviors" table on page 19.

Digi Connect Wi-EM Pin Header Locations (Top view)
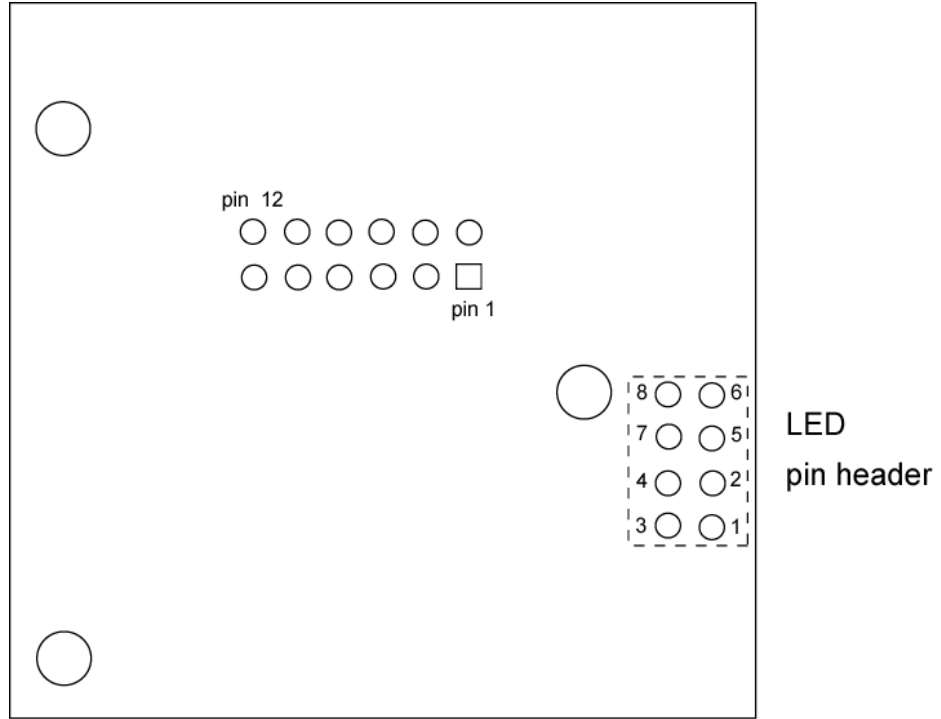
LED pin header

LED pins and pin header configuration are described in the "LED Behaviors" table on page 19.

About the Development Board

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C   H   A   P   T   E   R   2

Overview

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This chapter provides information on the development board, a hardware platform from which you can determine how to integrate the embedded module into your design. For additional information, see the schematic and mechanical drawings. If you have installed the development kit or integration kit, you can access the schematic from the Start menu.

Basic Description

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The development board can be used by both module feature sets with the Integration Kit or the Development Kit.The following graphic is a layout of the development board.

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Basic Description

Serial port 2

Serial port 1

Serial signaling
LEDs

GPIO/serial
switch
banks

GPIO ports

GPIO
LEDs

JTAG connector
for debugger

Logic signal
connector

SPI connector

Status
LEDs

Reset switch

SPI jumper
block

Main
Digi Connect EM
connector

3.3V LED

Ethernet
power LED

Ethernet
connector

Power jack
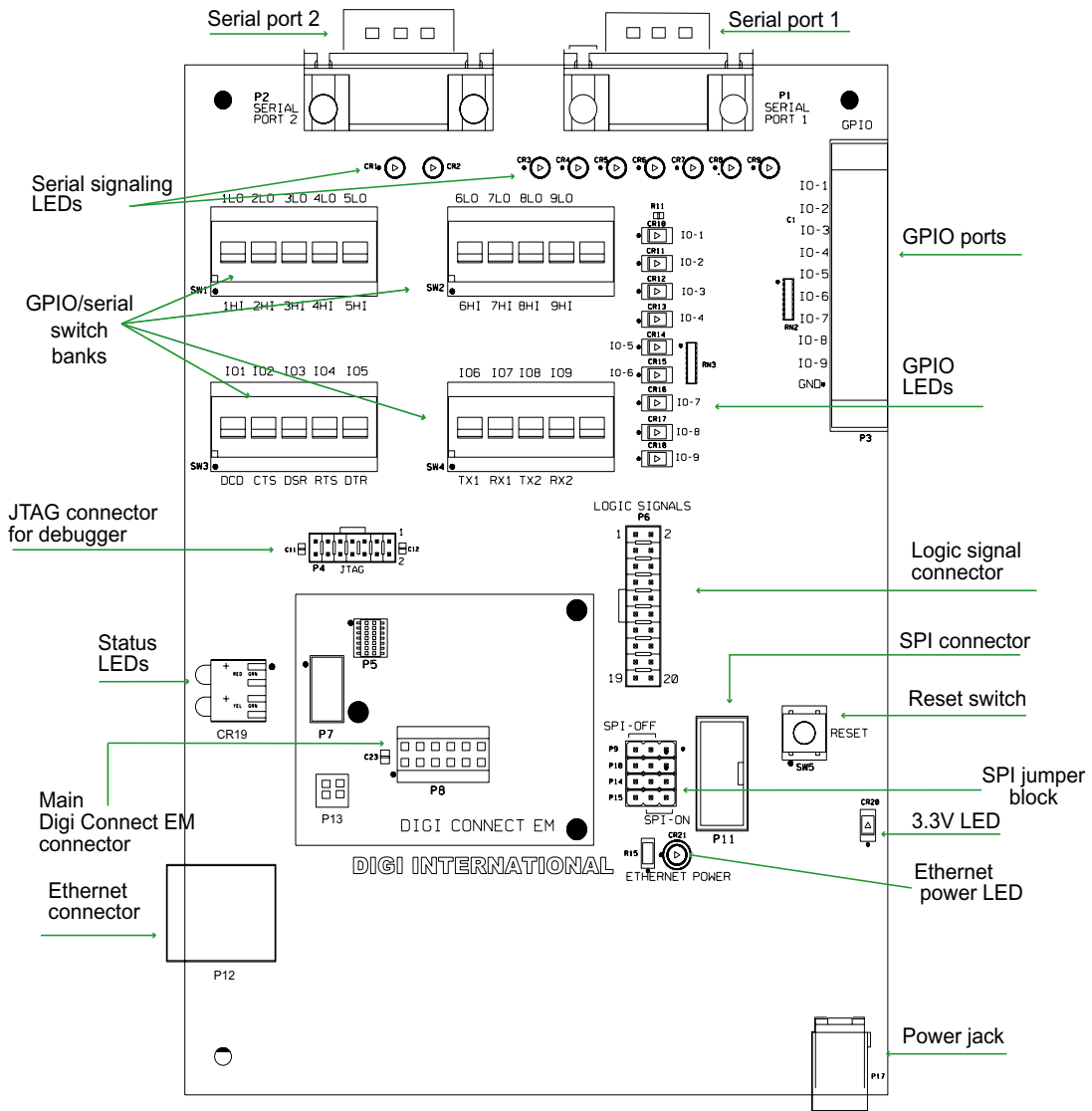
Ports

The development board provides the following ports:

- Serial Port 1 (P1) and Serial Port 2 (P2)
- Ethernet Port (P12)
- GPIO Port (P3)

Serial Port 1 (P1) and Serial Port 2 (P2)

Serial port 1 and port 2 are DB-9 male connectors labeled P1 and P2. Use the following figure and table for pin orientation and pin assignment information.
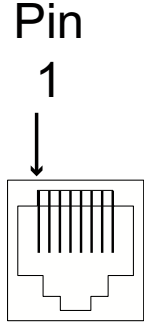
Serial Port Pin Orientation
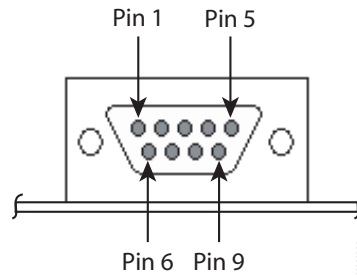
Serial Pin Assignment									
Port	**Signal Pin 1**	**Signal Pin 2**	**Signal Pin 3**	**Signal Pin 4**	**Signal Pin 5**	**Signal Pin 6**	**Signal Pin 7**	**Signal Pin 8**	**Signal Pin 9**
1	DCD	RXD	TXD	DTR	GND	DSR	RTS	CTS	Not Connected
2	Not Connected	RXD	TXD	Not Connected	GND	Not Connected	Not Connected	Not Connected	Not Connected

Ethernet Port (P12)

The Ethernet port of the Digi Connect EM embedded module (labeled P12) is an 8-pin RJ-45 jack meeting the requirements of ISO 8877 for 10/100Base-T. When two descriptions are shown for a pin, the second is for use with 802.3af powered Ethernet.

Ethernet Pin Assignments		
Pin	Signal Name	Figure RJ-45 (P12)
1	TXD+ (Transmit Data)	
2	TXD- (Transmit Data)	
3	RXD+ (Receive Data)	
4	Not used / power (+)	
5	Not used / power (+)	
6	RXD- (Receive Data)	
7	Not used / power (-)	
8	Not used / power (-)	

For additional information about the 802.3af standard, refer to the corresponding IEEE specification.

Note The development board provides a reference design of a POE (Power Over Ethernet) power supply. A schematic for this reference design is installed by the setup program on the CD.

GPIO Port (P3)

The GPIO port is a 10-pin male right-angle connector (labeled P3). See the following figure and table for pin orientation and pin assignments.

GPIO Port Pin Orientation

Pin 1   Pin 10
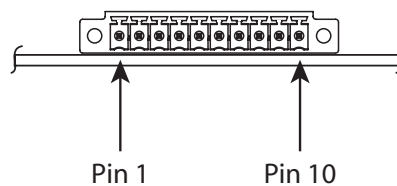
GPIO Port Pin Assignments	
Pin	**Signal Name**
1	GND
2	GPIO-9
3	GPIO-8
4	GPIO-7
5	GPIO-6
6	GPIO-5
7	GPIO-4
8	GPIO-3
9	GPIO-2
10	GPIO-1

Connectors and Blocks

The development board provides the following connectors and blocks:

- JTAG Debugger Connector (P4)
- SPI Connector (P11) and SPI Jumper Block
- Logic Signal Analyzer Header (P6)
- Main Connector (P8)

JTAG Debugger Connector (P4)

This 14-pin male vertical header labeled P4 mates with a JTAG debugger plug (for example, a Macraigor Raven). It is used with the development kit only. See the following figure and table for pin orientation and assignments.

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JTAG Debugger Connector Pin Orientation

	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9	Pin 10	Pin 11	Pin 12	Pin 13	Pin 14
Signal	VCC+	GND	/TRST	GND	TDI	GND	TMS	GND	TCK	GND	TDO	/SRST	VCC+	GND
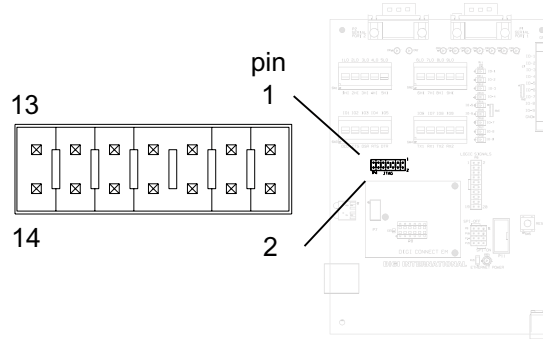
JTAG Debugger Connector Pin Assignments

SPI Connector (P11)

This connector is used for a Serial Peripheral Interface (SPI) connection. When enabled, signals are disconnected from serial port 1 and GPIO connectors. See the following figure and table for pin orientation and pin assignments.

SPI Connector Pin Orientation
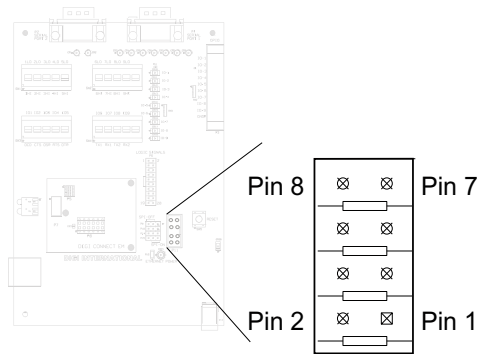
SPI Pin Assignments										
	Pin 1	**Pin 2**	**Pin 3**	**Pin 4**	**Pin 5**	**Pin 6**	**Pin 7**	**Pin 8**	**Pin 9**	**Pin 10**
Signal	SPI-EN	GND	SPI-CLK	GND	SPI-TX	GND	SPI-RX	GND	Not connected	Not connected

SPI Jumper Block

The SPI jumper block determines whether the SPI connector is connected or not. If SPI is off (the default), serial and GPIO signals are routed to switch banks 1 through 4. (See "Serial/GPIO Switch Bank 3 (SW3) and Switch Bank 4 (SW4)" on page 33 and "GPIO Switch Bank 1 (SW1) and 2 (SW2)" on page 34.) If SPI is on, SPI signals are routed to the SPI connector (P11).

The following figures demonstrate how to set the SPI jumper block

SPI Jumper Settings
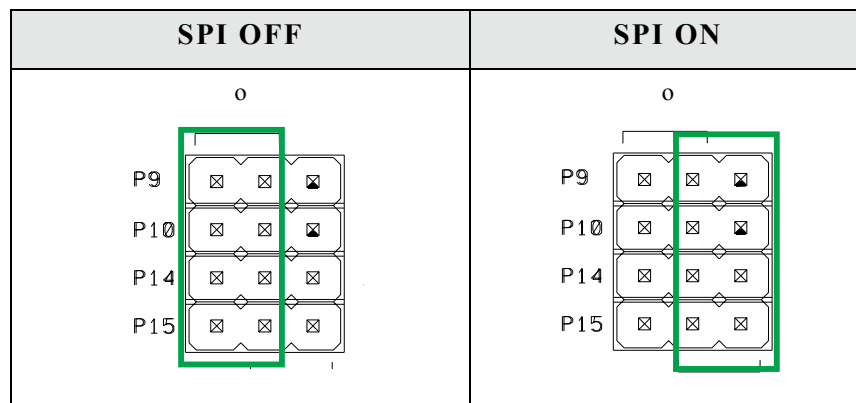
Logic Signal Analyzer Header (P6)

This 20-pin male vertical header (labeled P6) connects a digital signal analyzer (for example, a logic analyzer) to the development board. It is used with the development kit only. See the following figure and table for pin orientation and pin assignments.

Logic Analyzer Header Pin Orientation
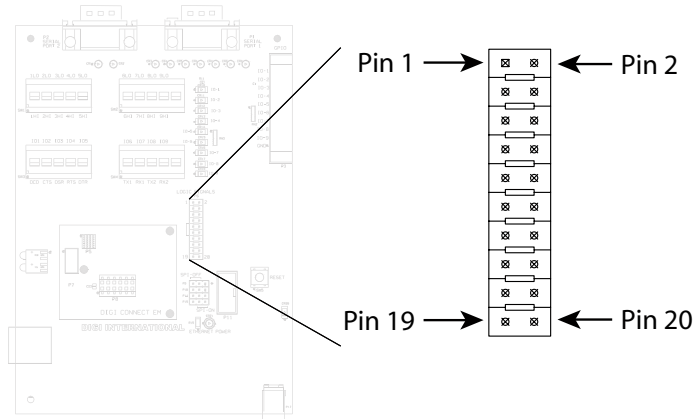
Logic Analyzer Header Pin Assignments	
Pin	**Signal**
1 - 8	Not connected
9	/RST
10	Not connected
11	DTR/GPIO-5
12	TXD-2/GPIO-8
13	CTS/GPIO-2
14	RXD-2/GPIO-9
15	DSR/GPIO-3
16	TXD-1/GPIO-6
17	RTS/GPIO-4/SPI_CLK
18	RXD-1/GPIO-7
19	DCD/GPIO-1/SPI_EN
20	GND

Main Connector (P8)

This 12-pin connector is used to interface with the embedded module. See the following figure for pin orientation.

Main Connector Pin Orientation

Top view
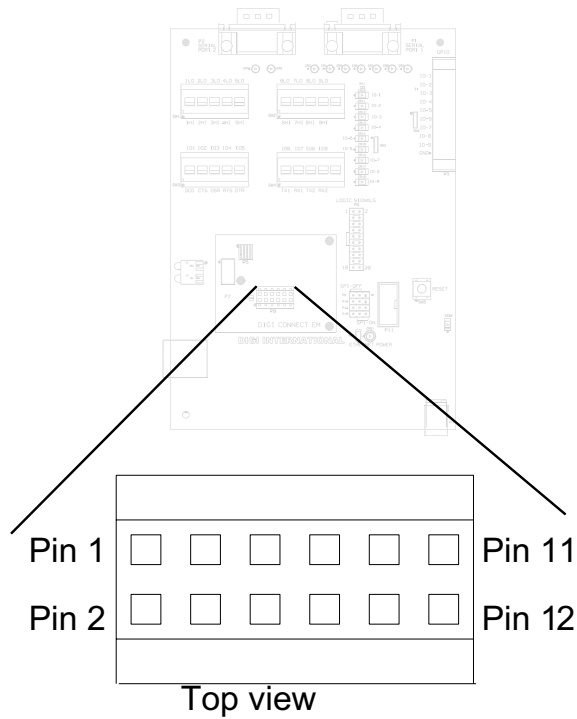
Power Jack (P17)

The Power Jack is a barrel connector that accepts 9 to 30 VDC +/- 5%. The jack is labeled P17. The following table shows the polarity of the power jack.

Power Jack Polarity	
Contact	**Polarity**
Center	+9 to +30 VDC
Outer	Ground

□□□□□□□ 3 1

The following figure schematically represents the polarity of the power jack

Power Jack Polarity Schematic.

Ground   +9 to +30 VDC
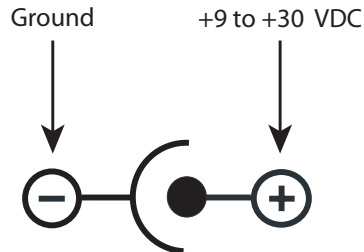
Switches

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The development board provides the following switches:

- Reset Switch (SW5)

- Serial/GPIO Switch Bank 3 (SW3) and Switch Bank 4 (SW4)

- GPIO Switch Bank 1 (SW1) and 2 (SW2)

Reset Switch (SW5)

This push button switch is labeled SW5. Pressing it sets the module's /RST line low, holding the module in a hard reset until the switch is released.

Note: This is a "hard" reset using the /RST pin on the main connector, not a "soft" reset. The reset button on the embedded module performs a "soft" reset (see also "Main Connector (P8)" on page 31).

Serial/GPIO Switch Bank 3 (SW3) and Switch Bank 4 (SW4)

Each switch bank holds five slide switches that enable either serial or GPIO signaling between the development board and the module. When set for GPIO signaling, SW3 works in conjunction with SW1, and SW4 works with SW2. See "GPIO Switch Bank 1 (SW1) and 2 (SW2)" on page 34 for more information. See the following table for SW3 and SW4 switch definitions.

Note: These switches control where the development board routes a signal. They do not reconfigure the NS7520 processor. Software should be configured to track with switch settings. See "GPIO" on page 39 for more information.

GPIO Switch Banks 3 and 4 Settings			
Switch Bank	Switch Number	Left Position	Right Position
SW3	1	DCD	GPIO-1
	2	CTS	GPIO-2
	3	DSR	GPIO-3
	4	RTS	GPIO-4
	5	DTR	GPIO-5
SW4	6	TXD-1	GPIO-6
	7	RXD-1	GPIO-7
	8	TXD-2	GPIO-8
	9	RXD-2	GPIO-9
	10	Not connected	Not connected

GPIO Switch Bank 1 (SW1) and 2 (SW2)

GPIO Switch Bank 1 and Switch Bank 2, labeled SW1 and SW2, are two sets of five slide switches that set GPIO inputs to logic levels of high (switch to left) or low (switch to right).

If the GPIO port is configured as an output, then the switch should always be to the left. If there is an external device connected to P3, the switch should always be set to the left.

Each GPIO port can be used independently.

Notes:

■ These switches do <u>not</u> determine whether the GPIO is an input or output. That is determined by the module software.

■ If GPIO is set to an output by software, switches <u>must</u> be set to the left (high).

■ These switches are used in conjunction with SW3 and SW4.

Development Board LEDs

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The development board contains 21 LEDs labeled CR1 through CR21. The following table lists and describes the LEDs.

LED Descriptions			
Board Label	**Description**	**Color or State**	**Indication**
CR1	TXD-2	Flickering	Serial activity
		Green	Inactive
CR2	RXD-2	Flickering	Serial activity
		Green	Inactive
CR3	CTS	Yellow	Active
		Green	Inactive
		Off	Not connected or signal not being driven

LED Descriptions			
Board Label	**Description**	**Color or State**	**Indication**
CR4	DTR	Yellow	Active
		Green	Inactive
		Off	Not connected or signal not being driven
CR5	TXD-1	Flickering	Serial activity
		Green	Inactive
CR6	RXD-1	Flickering	Serial activity
		Green	Inactive
CR7	RTS	Yellow	Active
		Green	Inactive
		Off	Not connected or signal not being driven
CR8	DCD	Yellow	Active
		Green	Inactive
		Off	Not connected or signal not being driven
CR9	DSR	Yellow	Active
		Green	Inactive
		Off	Not connected or signal not being driven
CR10 -18	GPIO-1 through GPIO-9. (CR10=GPIO-1, CR11=GPIO-2, etc. All can be used for input or output.)	On	Logic high
		Off	Logic low
CR20	3.3V Indicator	On	Power on
		Off	Power off

LED Descriptions			
Board Label	**Description**	**Color or State**	**Indication**
CR21	EPWR, Powered Ethernet Enabled	On	Ethernet power present from external powered Ethernet connector (Ethernet hub or switch)
		Off	No powered Ethernet voltage

Test Points

The development board provides 25 test points that can be identified by board label or test point number. The board labels are adjacent to each test point on the board. The test point numbers are in the development board schematic drawings. The following table lists the test point number, board label, and a brief description of each test point.

Test Point Descriptions		
Test Point	**Board Label**	**Description**
TP2	TXD	TXD-2
TP3	RXD	RXD-2
TP4	CTS	CTS
TP5	DTR	DTR
TP6	TXD	TXD-1
TP7	RXD	RXD-1
TP8	RTS	RTS
TP9	DCD	DCD
TP10	DSR	DSR

Test Point Descriptions		
Test Point	**Board Label**	**Description**
TP11	IO-1	GPIO-1
TP12	IO-2	GPIO-2
TP13	IO-3	GPIO-3
TP14	IO-4	GPIO-4
TP15	IO-5	GPIO-5
TP17	3.3V	3.3V Supply
TP20	RESET	Reset (active low)
TP21	E+	Ethernet Power +
TP22	E-	Ethernet Power -
TP23	V-IN	9-30 VDC Input
TP24	GND	Ground
TP25	GND	Ground
TP26	IO-8	GPIO-8
TP27	IO-7	GPIO-7
TP28	IO-6	GPIO-6
TP29	IO-9	GPIO-9

Programming Considerations

■ ■

C H A P T E R   3

This chapter addresses the embedded modules programming considerations.

Note This chapter applies only to development kit customers.

GPIO

■ ■

General Information

The NS7520 processor supports 16 general purpose I/O (GPIO) lines, some of which are reserved for specific functions and some of which can be customized. These GPIO lines fall into three categories:

- Those labeled "Reserved" in the following table are reserved for a specific use and must <u>not</u> be reprogrammed, or the unit may not operate correctly. Often, these lines are not connected to external interfaces.

- Those labeled "Allocated" in the following table are exposed to an external interface and allocated to a specific use by the software, but they can be customized safely with code modifications.

- Those labeled "Available" are exposed to an external interface, not controlled directly by the software, and can be customized.

■ ■ ■ ■ ■ ■ ■   39

GPIO Registers

Two registers, PORTA and PORTC, govern the 16 GPIO pins. Each is responsible for eight GPIO pins, and each pin has four bits that completely describe its behavior. The four bits that describe the GPIO behavior are its mode (CMODE), direction (CDIR), special function (CSF--only applicable to PORTC), and data value. The first three bits describe the functionality of the GPIO pin. The "data" bit provides the current value of the pin when read and allows control of the value of an output pin when written. Use the following table for information on configuring a bit position in the appropriate register for GPIO input or output.

Configuring a GPIO Pin for Input and Output	
Input	**Output**
■ CMODE = 0 ■ CDIR = 0 ■ CSF = 0	■ CMODE = 0 ■ CDIR = 1 ■ CSF = 0

Since each register controls 8 GPIO lines, it is safest to read the full 32 bit register, modify the bits corresponding to the GPIO line of interest, and then write the full 32 bits back. In this way, the behavior of the other GPIO lines will be preserved.

For more information regarding the format and programming of the GPIO registers, see the *NS7520 Hardware Reference*.

GPIO Pin Use

GPIO Pin Use				
Name	**Register Bit**	**Category**	**External Interface**	**Description**
TXD/ GPIO-6	PORTA7	Allocated	Pin 4 on the main header	Used for port 1 serial transmit but can be reassigned as GPIO input or output. If used with the development board, this pin maps to GPIO-6.
DTR/ GPIO-5	PORTA6	Allocated	Pin 6 on the main header	Used for the port 1 serial DTR signal but can be reassigned as GPIO input or output. If used with the development board, this pin maps to GPIO-5.
See the description	PORTA5, PORTA4	Allocated	Pin 5 on the main header	Since these two processor pins map to the same header pin, one <u>must</u> be configured as an input to avoid contention. Under normal serial conditions, PORTA5 is configured to deliver the port 1 RTS signal and PORTA4 for GPIO input. To use the port for SPI, configure PORTA5 for GPIO input and PORTA4 to deliver SPI clock. When used with the development board, header pin 5 maps to GPIO-4.
RXD/ GPIO-7	PORTA3	Allocated	Pin 3 on the main header	Used for port 1 serial receive but can be reassigned as GPIO input or output. If used with the development board, this pin maps to GPIO-7.

GPIO Pin Use				
Name	**Register Bit**	**Category**	**External Interface**	**Description**
DSR/ GPIO-3	PORTA2	Allocated	Pin 9 on the main header	Used for the port1 serial DSR signal but can be reassigned as GPIO input or output. If used with the development board, this pin maps to GPIO-3.
CTS/ GPIO-2	PORTA1	Allocated	Pin 7 on the main header	Used for the port 1 serial CTS signal but can be reassigned as GPIO input or output. If used with the development board, this pin maps to GPIO-2.
DCD/ GPIO-1	PORTA0	Allocated	Pin 8 on the main header	Used for the port 1 serial DCD signal but can be reassigned as GPIO input or output. If used with the development board, this pin maps to GPIO-1.
TXD2/ GPIO-8	PORTC7	Allocated	Pin 12 on the main header	Used for port 2 serial transmit but can be reassigned as GPIO input or output. If used with the development board, this pin maps to GPIO-8.
Power indicator LED	PORTC6	Allocated	Connected to the red LED	Used as the power indicator (always on) but can be reassigned as a general purpose LED. It must remain a GPIO output for the LED to operate correctly. This LED is lit when the signal is low.
/INIT	PORTC5	Available	Connected to the button on the module	Should be configured as a GPIO input.

GPIO Pin Use				
Name	**Register Bit**	**Category**	**External Interface**	**Description**
Green LED	PORTC4	Allocated	Connected to the green LED (the one above the red LED)	Used as the NET+OS green LED but can be reassigned as a general purpose LED. It must remain a GPIO output for the LED to operate correctly. The LED is lit when the signal is low.
RXD2/ GPIO-9	PORTC3	Allocated	Pin 11 on the main header	Used for port 2 serial receive but can be reassigned as GPIO input or output. If used with the development board, this pin maps to GPIO-9.
Yellow LED	PORTC2	Allocated	Connected to the yellow LED	Used as the NET+OS yellow LED but can be reassigned as a general purpose LED. It must remain a GPIO output for the LED to operate correctly. The LED is lit when the signal is a low.
	PORTC1-PORTC0	Reserved	NA	NA

Embedded Module LEDs

General information

The embedded module has two types of LEDs:

- LEDs connected directly to GPIO pins on the processor and controlled directly in software

- LEDs connected to other hardware components (Ethernet/wireless hardware) and not directly programmable by the operating system

■■■■■■■ 43

For information on LED control, see the *NET+Works BSP Porting Guide*.

About Embedded Module LEDs

Embedded Module LED Description	
LED	**Description**
Green (above yellow LED)	This LED is wired to the network hardware and provides an indication of link status.
Green (the one above the red LED)	This LED is software programmable and is wired to processor GPIO register bit PORTC4 and wired to be lit when low.
Yellow	This LED is software programmable, wired to processor GPIO register bit PORTC2, and wired to be lit when low.
Red	This LED is software programmable, wired to processor GPIO register bit PORTC6, and wired to be lit when low.The default is that this LED indicates power (and is therefore always on).

Embedded Module Reset

Hard Reset

The embedded modules support a hardware reset on pin 10 of the 12-pin header. The unit will be forced into a hard reset if this pin is pulled low. When used with the development board, this pin is wired to reset button SW5, which means it acts as a hard reset button.

Reset Characteristics	
Characteristic	**Specification**
Delay	200 milliseconds (typical)
Threshold	2.93 V
Minimum Hold Time	1 microsecond pulse

Soft Reset

NET+OS provides an internal facility to enact a soft reset, but it is the responsibility of a specific implementation to choose a reasonable trigger to invoke it. One choice is to use a GPIO pin as a signal to trigger a soft reset. The embedded modules have one GPIO pin (PORTC5) which is not normally assigned to any other task named "/INIT." It is an ideal candidate for use as a signal for soft reset. The signal is wired to the push button on the module (next to the LEDs), and is pulled high unless the button is pushed.

The "naresetapp" sample application demonstrates a simple mechanism for monitoring a GPIO pin and then initiating a soft reset when the pin achieves a particular value.

Flash

■ ■

General Information

The embedded modules have 4 MB of flash memory, which is controlled by chip select 0, located at 0x02000000.

Memory

Both modules have 8 MB of SDRAM memory, controlled by chip select 1, located at 0x00000000 in the processor address space and aliased at 0x04000000 and 0x08000000. The application program is loaded at address 0x08080000.

Flash

Specifications

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A P P E N D I X   A

Network Interfaces

■ ■

Digi Connect Wi-EM Embedded Module

- Standard: IEEE 802.11b

- Data Rate: Up to 11 Mbps with automatic fallback

- Frequency: 2.4 GHz

- Modulation: CCK (11/5 Mbps), DQPSK (2 Mbps), DBPSK (1 Mbps)

- Transmit power: 16 dBm typical

- Receive sensitivity:
    - 1Mbps: -92 dBm
    - 2Mbps: -89 dBm
    - 5.5Mbps: -87 dBm
    - 11Mbps: -82 dBm

- Antenna connector: 2 x RP-SMA

Digi Connect EM Embedded Module

- Standard: IEEE 802.3

- Data rate: 10/100 Mbps (auto-sensing)

- Mode: Full or half duplex (auto-sensing)

- Connector: RJ-45 or pin header

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Serial Interface

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Two serial ports, one with full modem control signals and the other with TXD and RXD only.

Data Rates (bps)

....

50, 110, 134, 150, 200, 300, 600, 1200, 2400, 3600, 4800, 9600, 19200, 38400, 57600, 115200, 230400

Flow Control Options

....

RTS/CTS, XON/XOFF, None

Environmental

....

	Digi Connect EM	Digi Connect Wi-EM
Ambient Temperature	-40°F to 185°F (-40°C to 85°C)	-4°F to 185°F (-20°C to 85°C)
Storage Temperature	-40^{0}F to 257^{0}F (-40^{0}C to 125^{0}C)	
Humidty	5% to 90%	
Altitude	12000 feet (3657.60 meters)	

DC Characteristics

....

The following tables provide DC characteristics for operating conditions, inputs, and outputs.

Operating Conditions

Symbol	Description	Min	Typ	Max		Unit
V_{CC}	Supply Voltage	3.14	3.3	3.45		V
n/a	Power Supply Ripple			40		mVpp
I_{CC}	Supply Current	—	—	Digi Connect EM	270	mA
				Digi Connect Wi-EM	400	
I_{IL}	Input Current as "0" (57K pull-up)	—	—	57		μA
I_{IH}	Input Current as "1" (57K pull-up)	-10	—	10		μA
I_{OZ}	HighZ Leakage Current	-10	—	10		μA
I_{OD}	Output Drive Strength	—	—	2		mA
C_{IO}	Pin Capacitance (V_O=0)	—	—	4		pF

Inputs

Symbol	Description	Min	Typ	Max	Unit
V_{IH}	Input High Voltage	2	—	V_{CC}+0.3	V
V_{IL}	Input Low Voltage	V_{SS}-0.3	—	$0.2*V_{CC}$	V

Outputs

Symbol	Description	Min	Typ	Max	Unit
V_{OH}	Output High Voltage	2.4	—	3.45	V
V_{OL}	Output Low Voltage	0	—	0.4	V

Note The embedded modules use a supervisory circuit with a 2.93V reset threshold. When VCC falls to the threshold voltage, a reset pulse is issued, holding the

▪▪▪▪▪▪▪ 49

output in active state. When power rises above 2.93V, the reset remains for approximately 200 ms to allow the system clock and other circuits to stabilize.

Warning The rise time of the 3.3v power supply must be between 700 μS and 140ms and the inrush current must be limited to less than 2 A. A rise time outside of these limits may cause the device to malfunction and give a 3-1-3 diagnostic error.

Mechanical

Module Dimensions		
Dimension	**Digi Connect EM**	**Digi Connect Wi-EM**
Length:	**Fully populated** 2.135 in (54.229 mm) **Pin header model** 1.935 in (49.149 mm)	2.287 in (58.09 mm)
Width:	1.575 in (40.005 mm)	1.885 in (47.879 mm)
Height:	**Fully populated** 0.803 in (20.369 mm) **Pin header model** 0.670 in (17.018 mm)	**Fully populated** 0.785 in (19.939 mm) **Pin header model** 0.653in (16.586 mm)
Weight	.416 oz. (11.793 g)	Antenna -.408 oz. (11.567 g) / .672 oz. (19.051 g) — Total - 1.080 oz. (30.617 g)

Layouts and Dimensions

The following dimensions and layouts are for both the Digi Connect Wi-EM and Digi Connect EM. It is strongly recommended that you consider using the Digi Connect Wi-EM footprint for future flexibility.
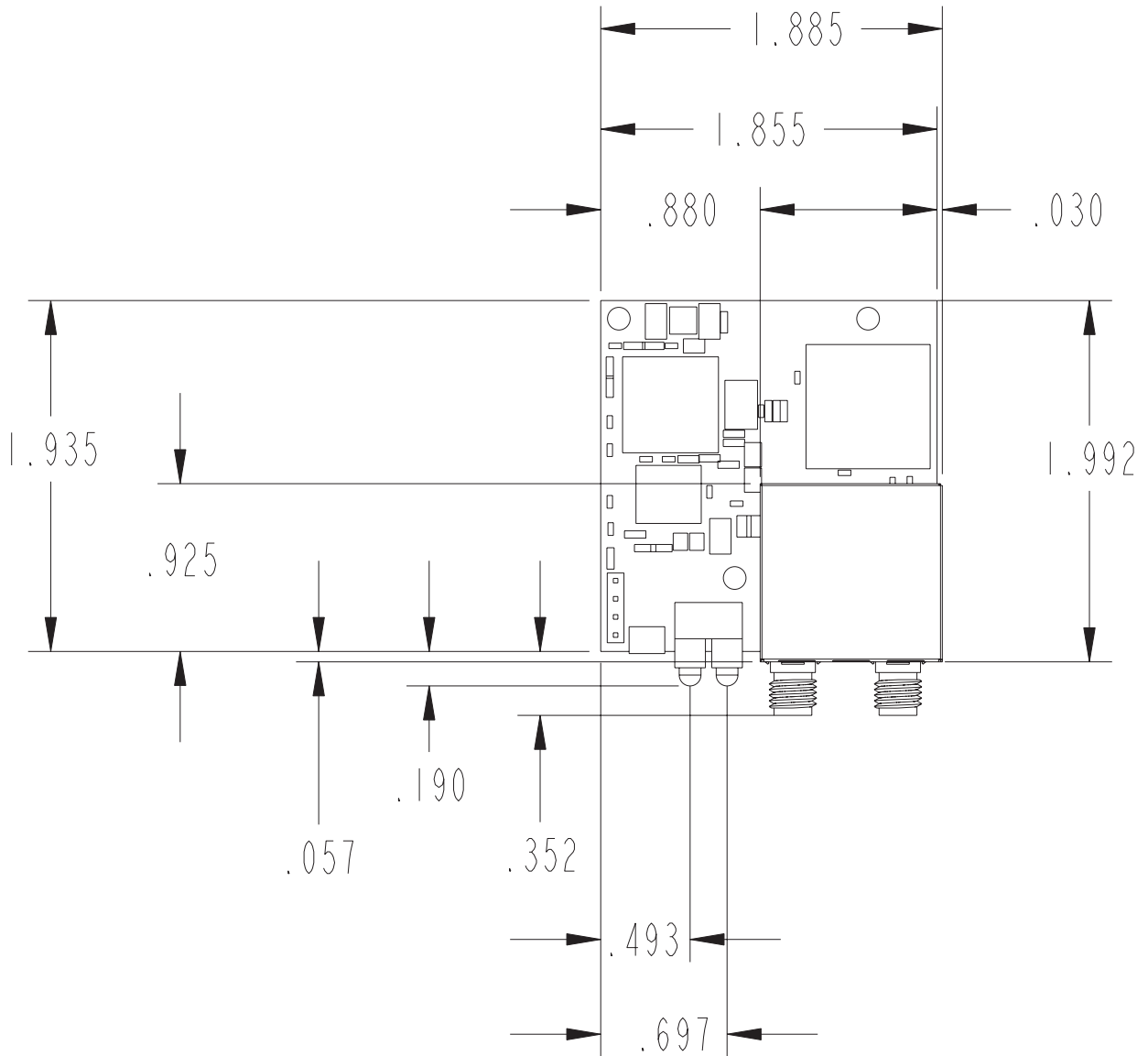
Note All dimensions are in inches. We recommend that you use the Recommended PCB layout (footprint) of the Digi Connect Wi-EM module regardless of which module you have. The benefit of using the wireless footprint will allow you to design your product to go wireless at any time (without difficulty) since the wireless module is slightly larger.

These are the tolerances for the drawings shown in this section:

Measure	Tolerance
.XX	± .02
.XXX	± .010
Angles	± 2 degrees

Digi Connect Wi-EM (w/LED Array)

Top

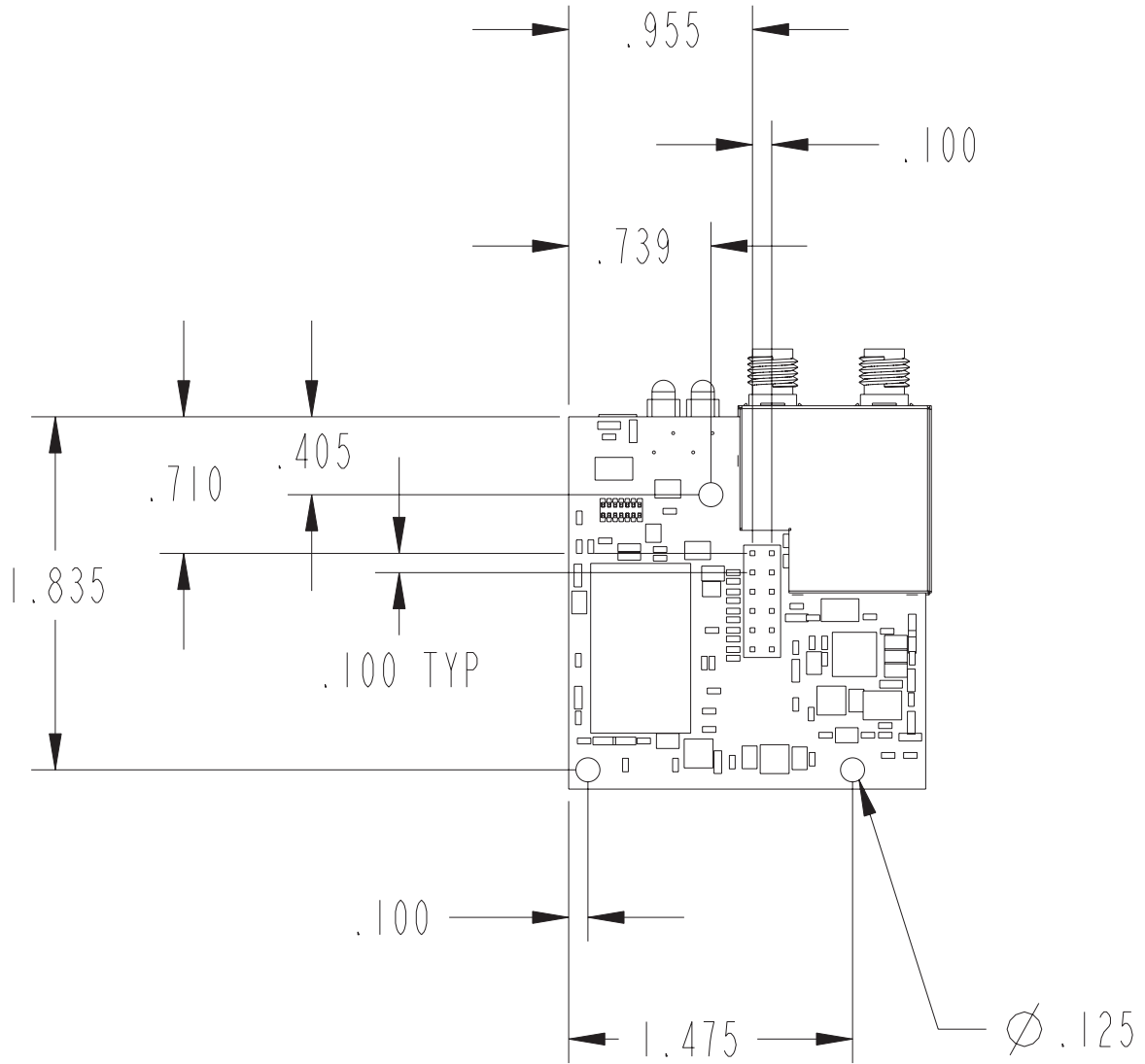**Front**

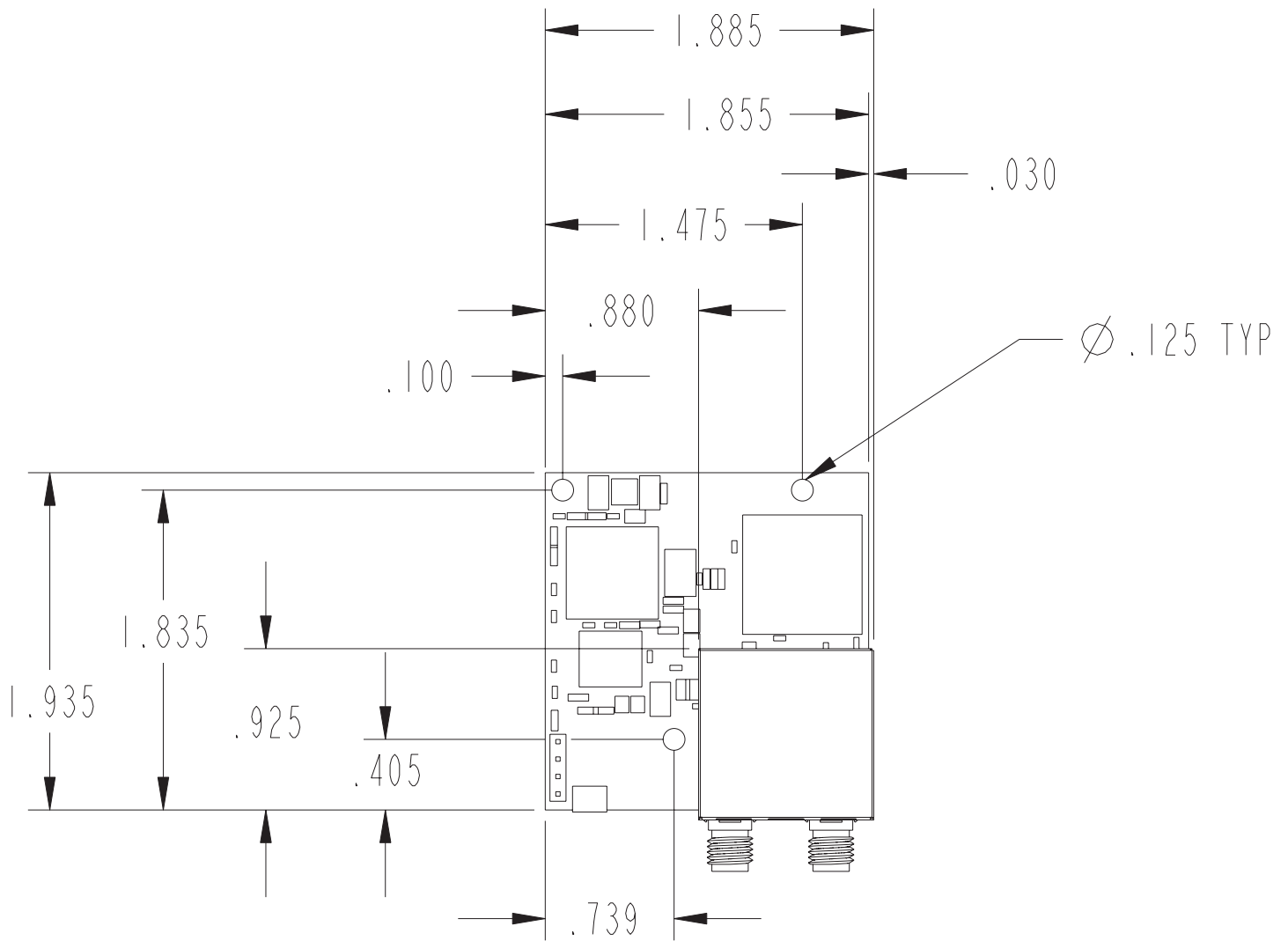.880

1.005

.245

.045

.400

.653

.149

.020

1.060

.365

1.640
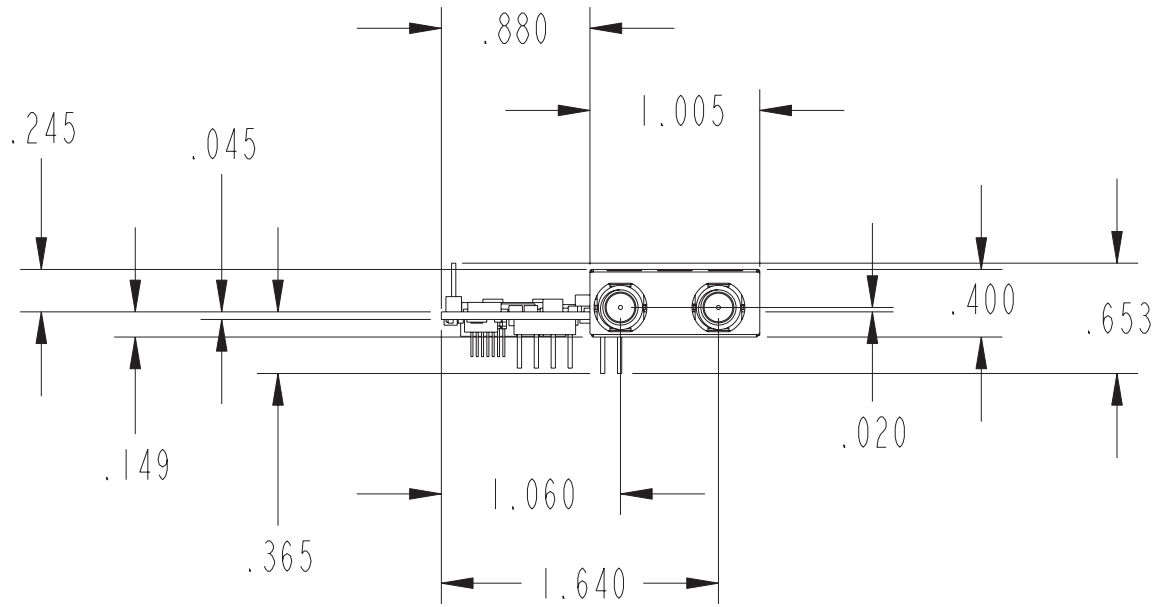
Bottom

Digi Connect Wi-EM (w/LED Pin Headers)

Top

Front

.880

1.005

.245

.045

.400

.653

.149

.020

.365

1.060

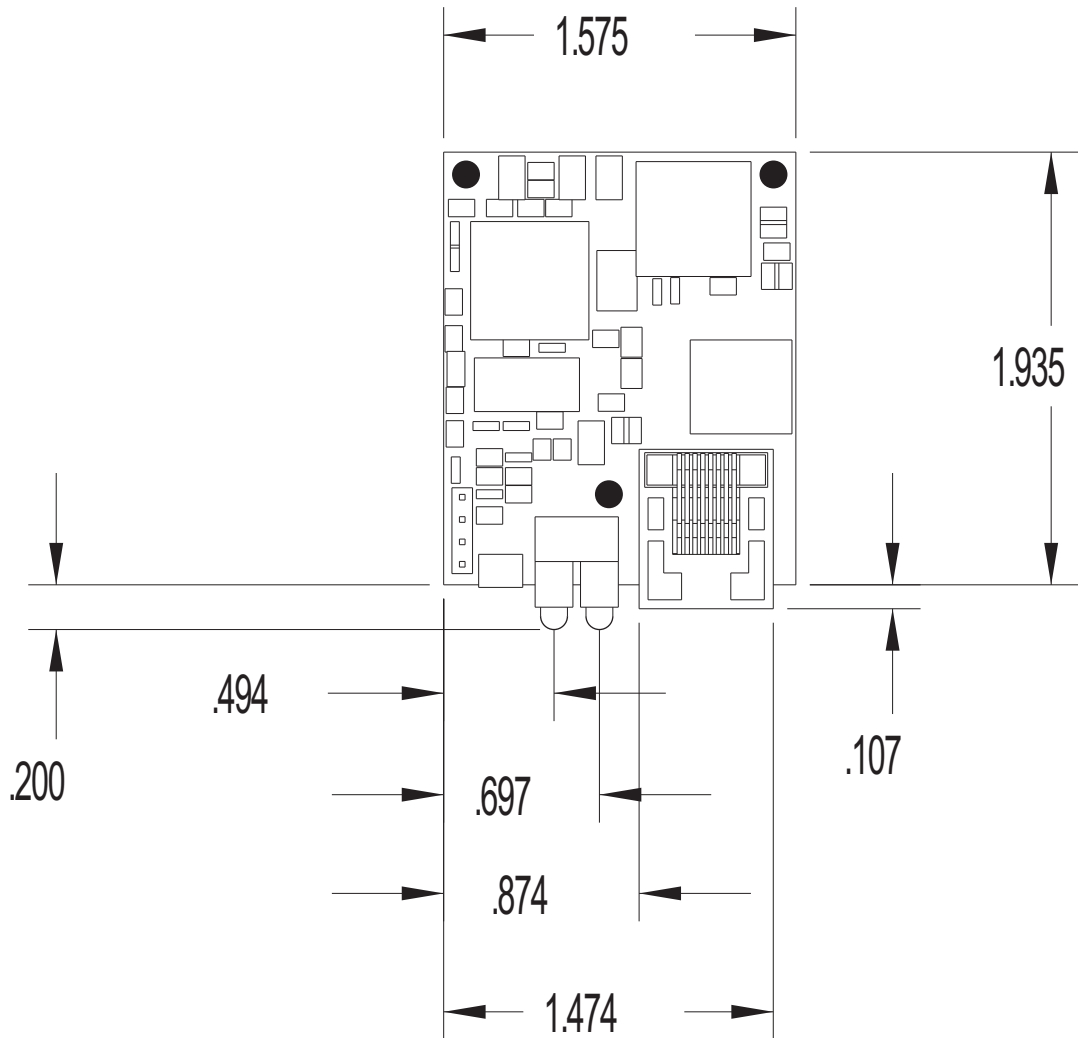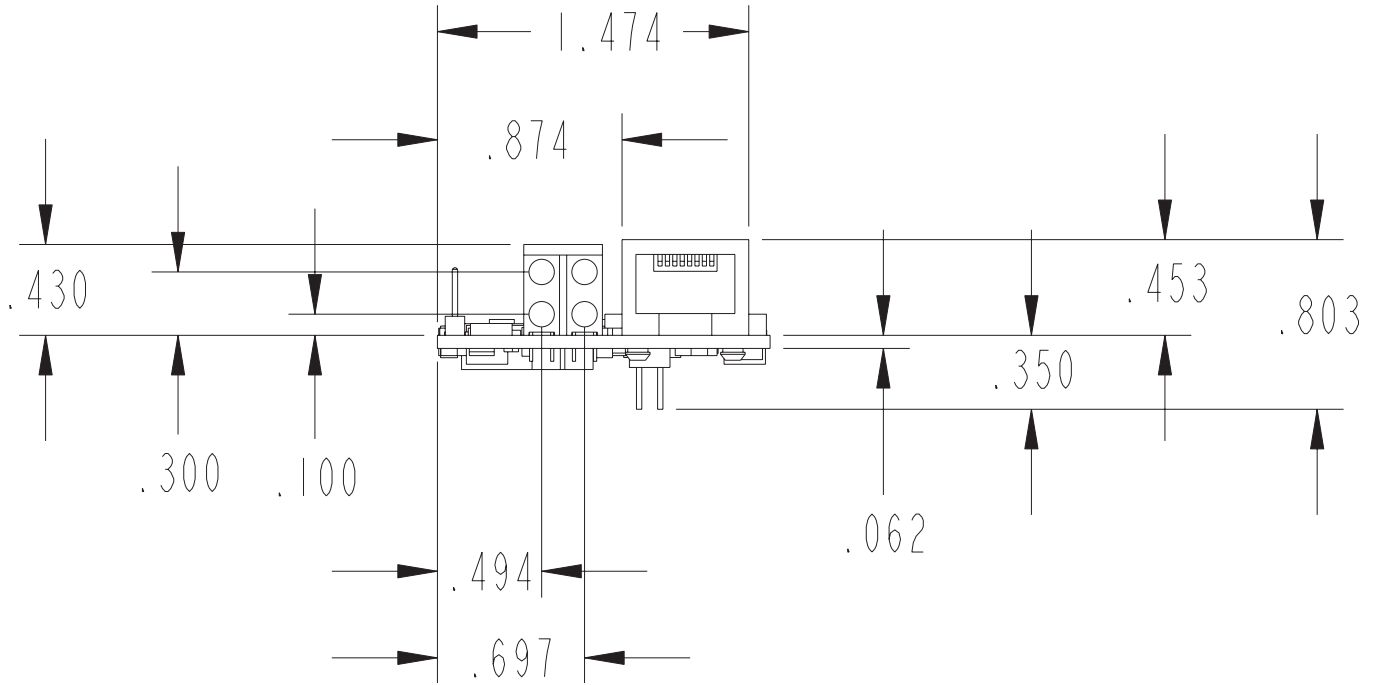1.640

Bottom

.955

.100 TYP

.445

.100 TYP

.057

.710

.973

.100 TYP
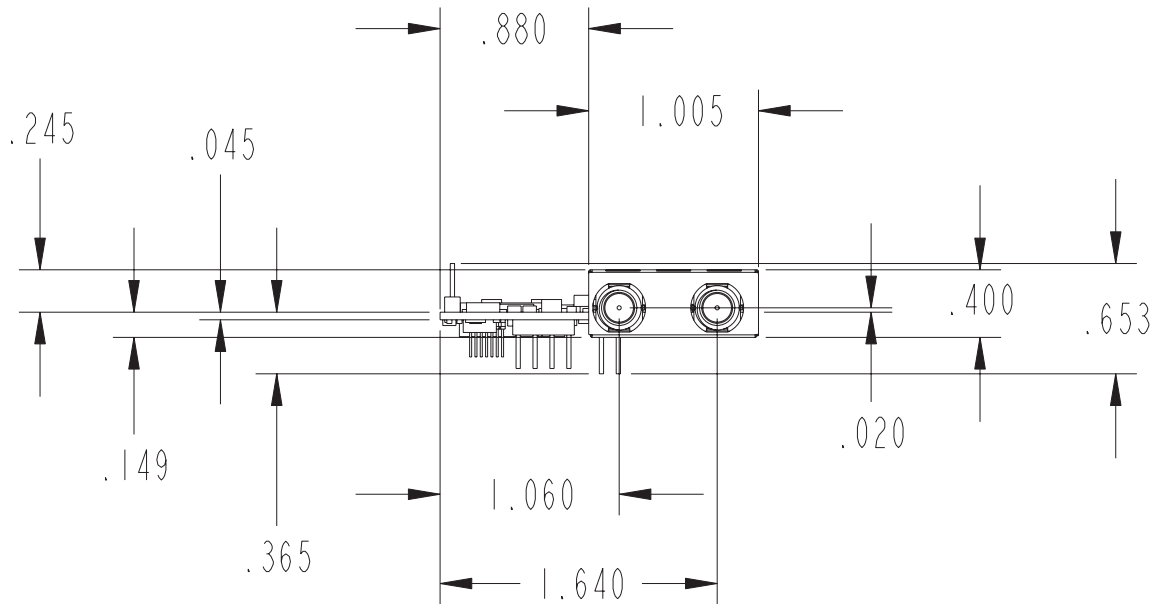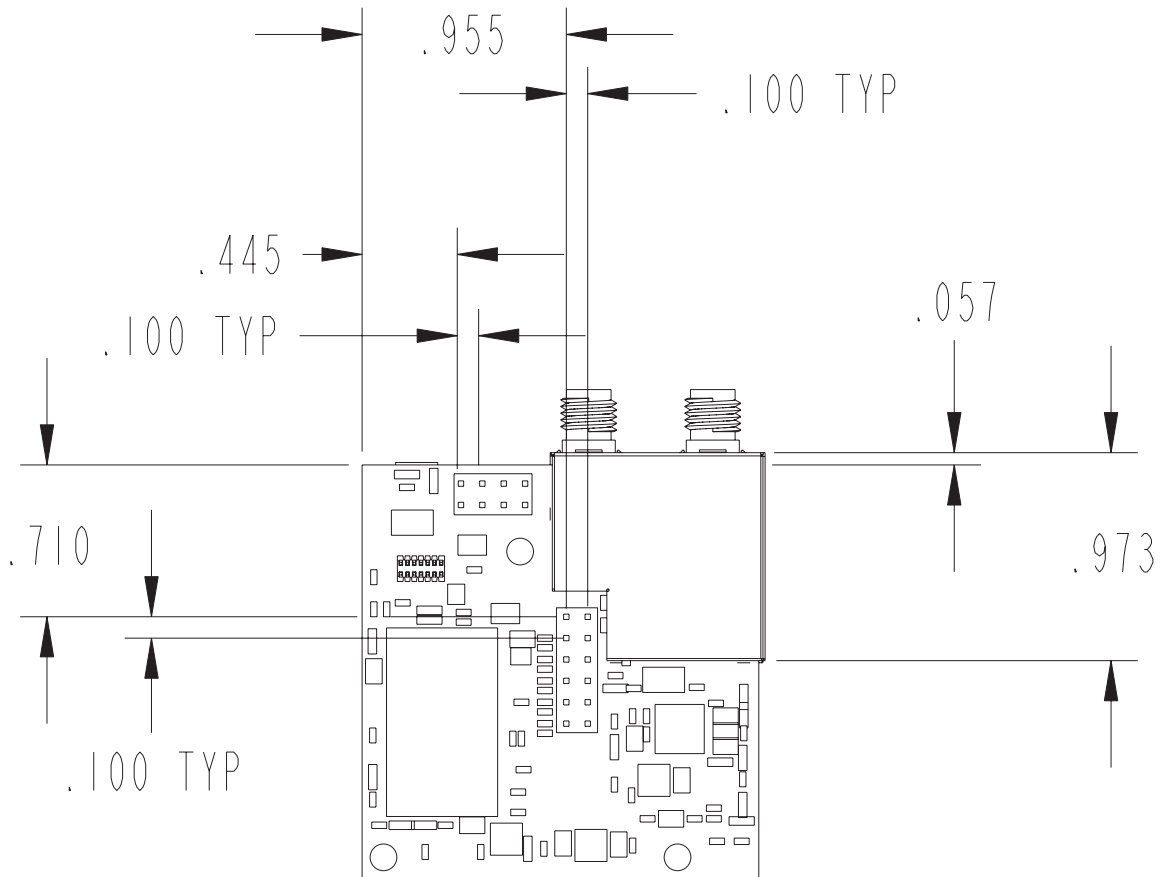
Digi Connect EM (w/RJ-45 and LED Array)

Top

Front

Bottom

.100   TYP

.955

.739

.405

1.835

.710

.100   (TYP)

.100

1.475

Ø.125 TYP
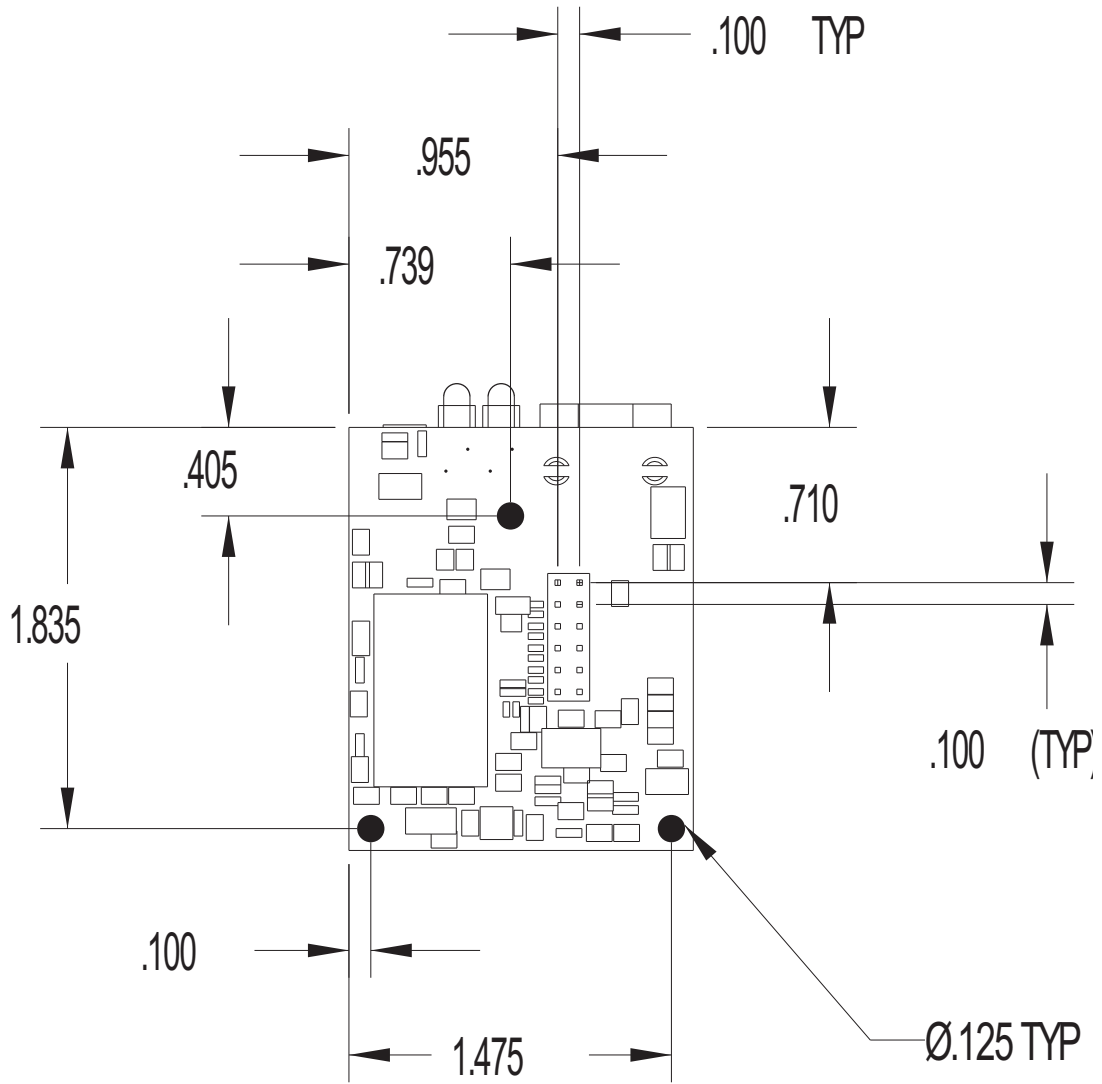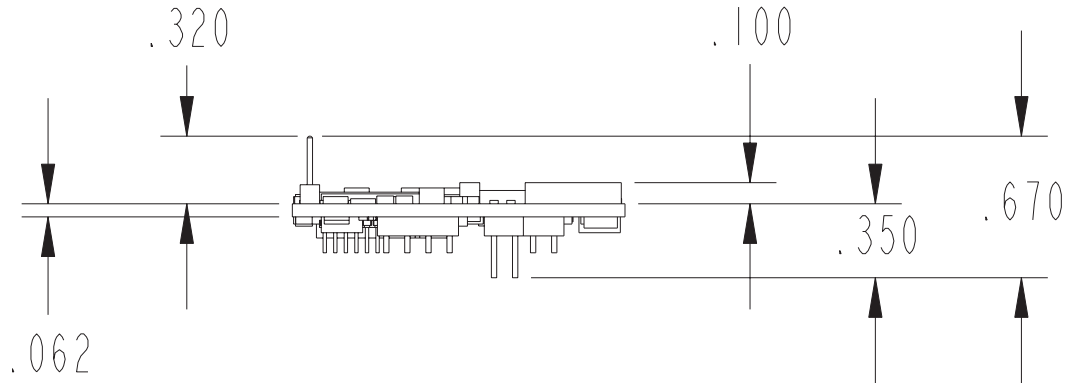
Digi Connect EM (with Ethernet and LED Pin Headers)

Top

Front

.320   .100

.670

.062   .350

Bottom

1.140

.955

.100 TYP

.445

.100 TYP .100

.135

.710

Recommended PCB Layouts

The following graphics are the recommended PCB layouts for the Digi Connect Wi-EM and Digi Connect EM (both populated and unpopulated versions). It is recommended that you use the Digi Connect Wi-EM PCB layout for future flexibility since it is slightly wider than the Digi Connect EM.

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Digi Connect Wi-EM (w/LED Array)

RECOMMENDED PCB LAYOUT
TOL. ± .005

Digi Connect Wi-EM (w/LED Pin Headers)

.0315 TYP

.1805

Ø .035 MIN

.100 TYP

.050 TYP

Pin 1

.710

.4615

.200 .100

Ø .023 TYP
(IF POPULATED)

.445

.100 TYP

.100 TYP

.955

RECOMMENDED PCB LAYOUT
TOl. +.005

■■■■■■■ 65

Digi Connect EM (w/RJ-45 and LED Array)

RECOMMENDED PCB LAYOUT
TOL. ±.005

1.575

.050   TYP

.125

Ø.040 MIN

.100   TYP

.050   TYP

1.935

Pin 1

.710

.460

.200

Ø.028 MIN
(IF POPULATED)

.955

CONNECTOR/
LED AREA

.100   TYP

Digi Connect EM (with Ethernet and LED Pin Headers)

RECOMMENDED PCB LAYOUT
TOL. ±.005

1.575

.100   TYP

.100   TYP

Pin 1

Ø.040 MIN

1.935

.710

.4615

.100

Ø.028 MIN (IF POPULATED)

.1805

.0315 TYP

.445

.135

.955

1.140
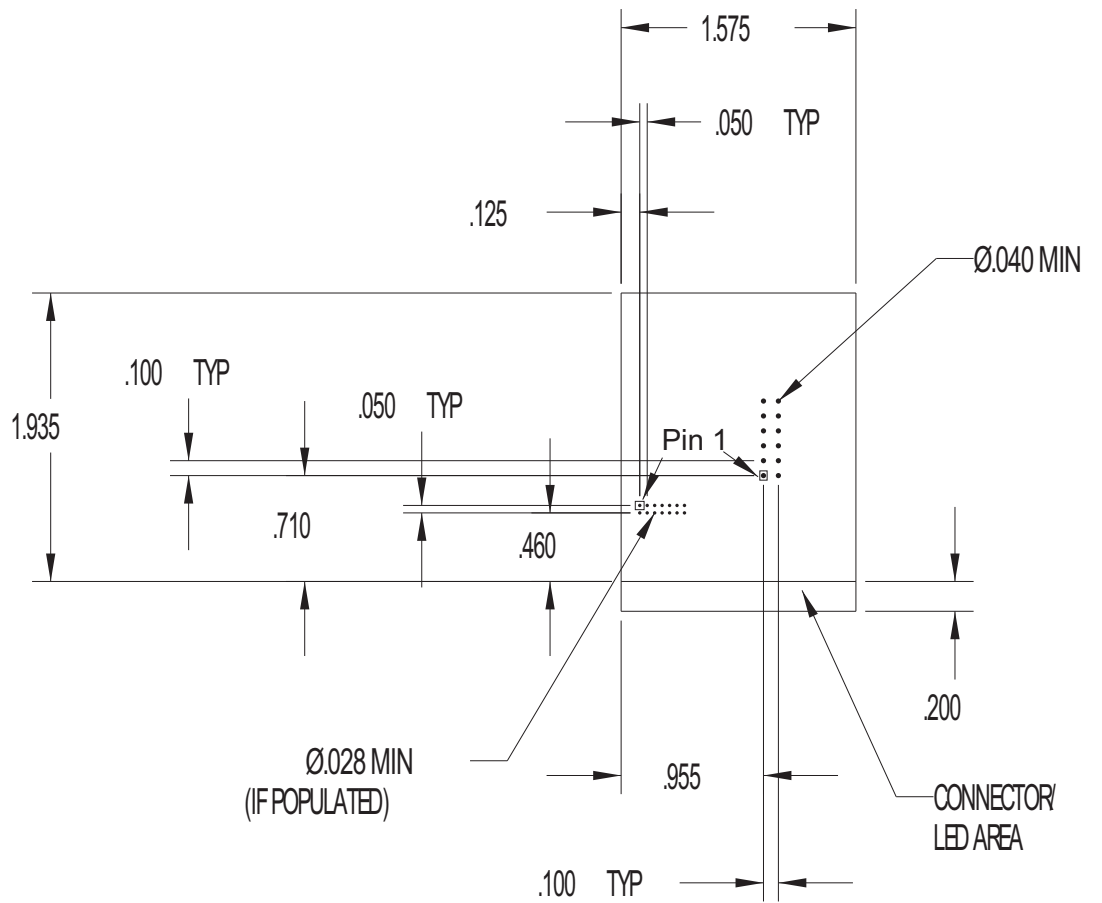
Antenna Information

Antenna Strength

The following diagram demonstrates the strength of the signal received by the antenna on both a horizontal and vertical plane. The diagram shows the magnetic field when the antenna is in a vertical position. The red line represents the horizontal plane and the dotted green lined represents the vertical plane. You can see in the illustration that at 90degrees, the signal strength is (as expected) 0.

Radiation Patterns
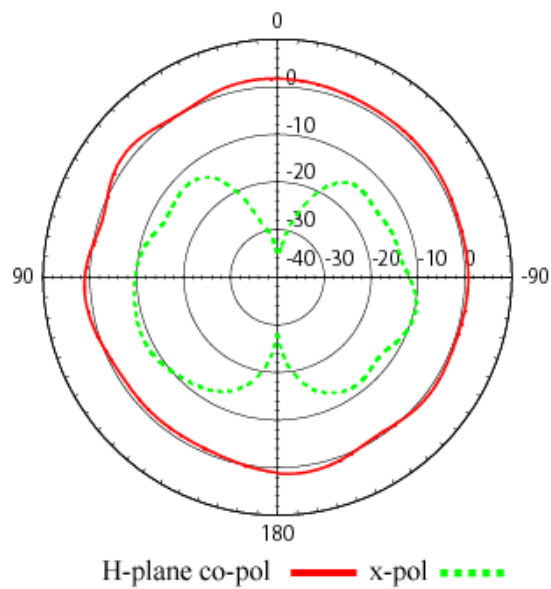
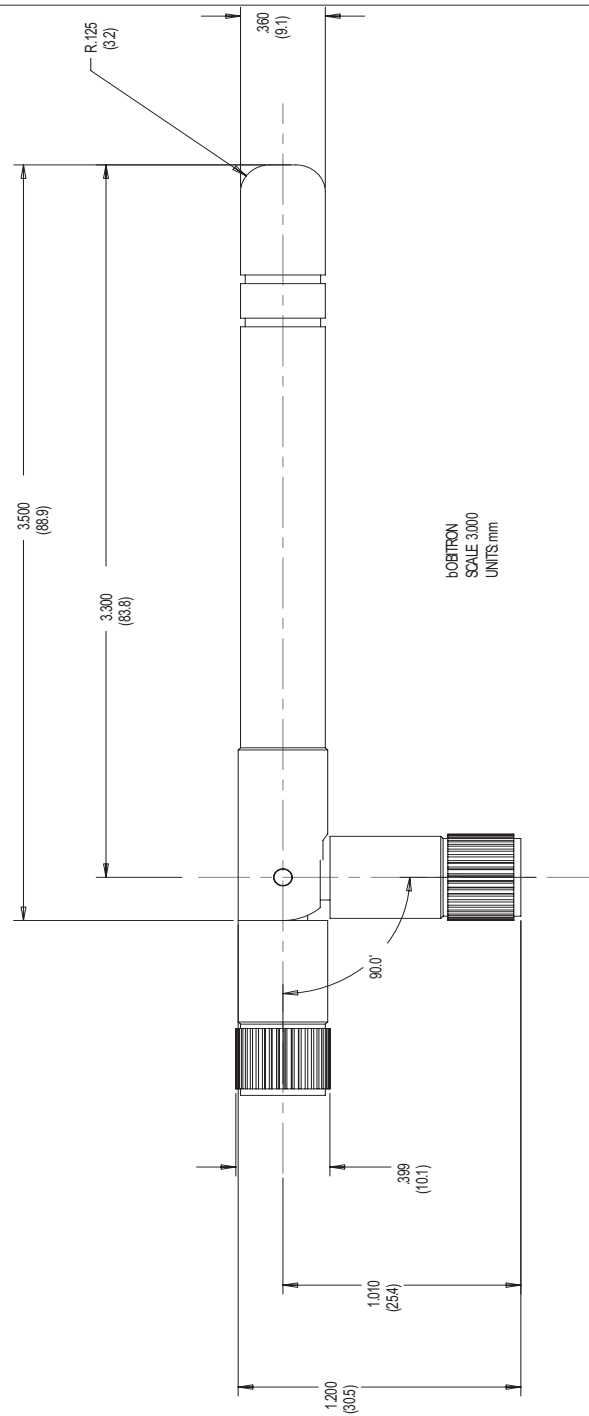## Radiation Patterns for PCB Mount Antenna
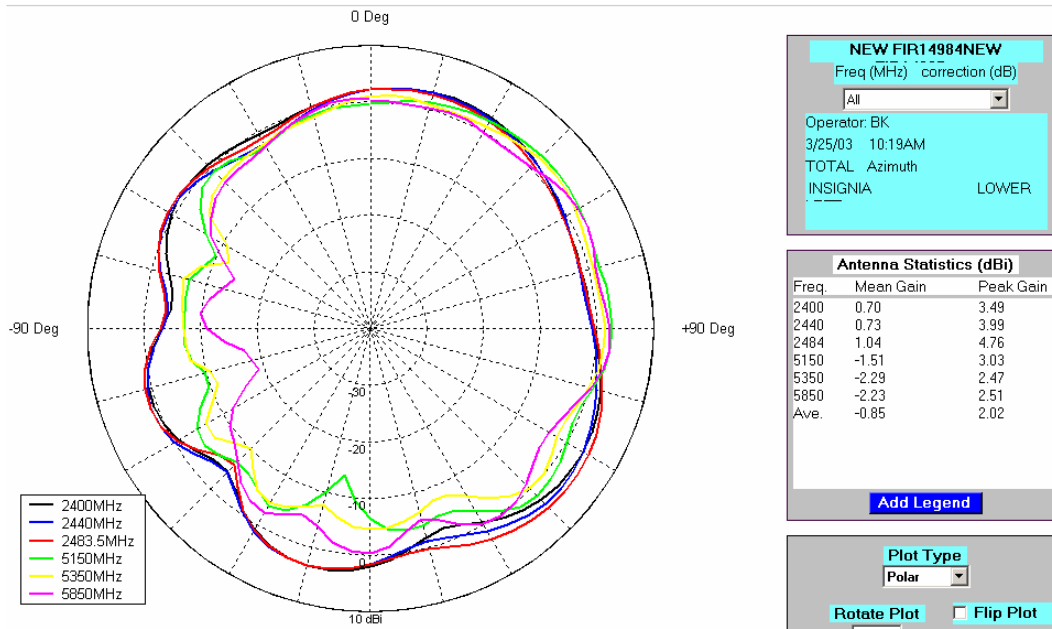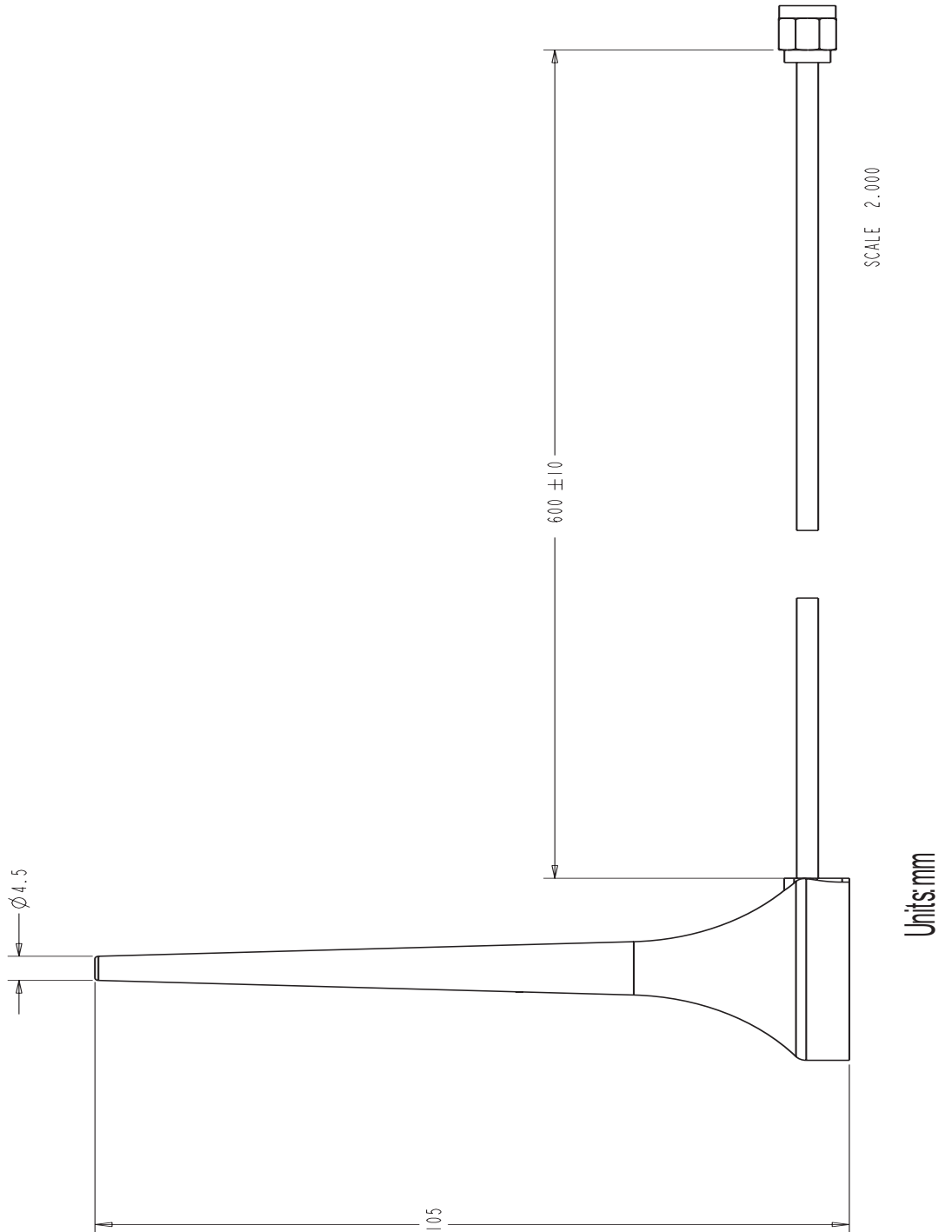
Antenna Specifications for North America

Antenna Description	Dipole	Desktop	*PCB Mount
Frequency	2.4~2.5GHz		2.4~2.5 GHz 4.9~5.9GHz
Power Output	2W	1W	10W
DB Gain	2dBi	1.8dBi	>2dBi
VSWR	< or = 2.0	1.92 max.	< 2.5
Dimension	108.5 mm x 10.0 mm	105 mm x 4.5 mm	24.13 x 10.67 mm
Weight	10.5g	11g	< 1g
Connector	RP-SMA		U.FL
Part Number	DC-ANT-24DP	DC-ANT-24DT	DC-ANT-24SM
* * The PCB mount antenna requires a RP-SMA to U.FL adapter cable(s), or a customized version of the Digi Connect Wi-EM module with an integrated U.FL cable (single antenna). Please contact Digi sales for specific availability information.			

Any antenna matching the in-band and out-of-band signal patterns and strengths of the antenna, whose characteristics are given in the Antenna Description table and the Radiation pattern graphic, may be used with the Digi Connect Wi-EM.

Dipole Antenna Dimensions
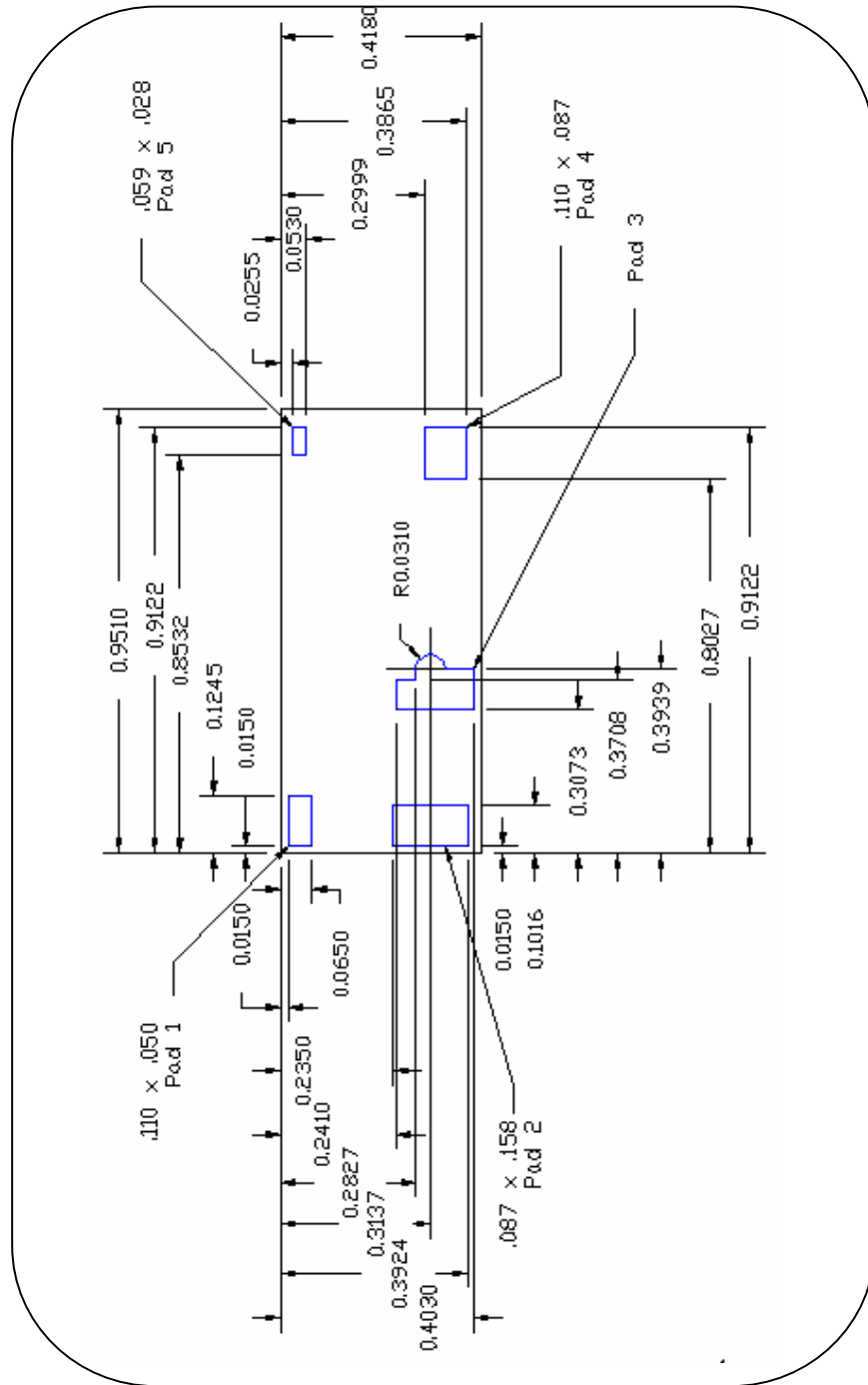
R.125
(3.2)

.360
(9.1)

3.500
(88.9)

3.300
(83.8)

bOBITRON
SCALE 3.000
UNITS mm

90.0°

.399
(10.1)

1.010
(25.4)

1.200
(30.5)

Desktop Antenna Dimensions

SCALE 2.000

600 ±10

⌀4.5

105

Units: mm

PCB Mount Antenna Dimensions

RF Exposure Statement

The Digi Connect Wi-EM module complies with the RF exposure limits for humans as called out in RSS-102. It is exempt from RF evaluation based on its operating frequency of 2.4 GHz, and effective radiated power less than the 3 watt requirement for a mobile device (>20 cm separation) operating at 2.4 GHz.

Safety Statements

To avoid contact with electrical current:

- Never install electrical wiring during an electrical storm.

- Never install an ethernet connection in wet locations unless that connector is specifically designed for wet locations.

- Use caution when installing or modifying ethernet lines.

- Use a screwdriver and other tools with insulated handles.

- You and those around you should wear safety glasses or goggles.

- Do not place ethernet wiring or connections in any conduit, outlet or junction box containing electrical wiring.

- Installation of inside wire may bring you close to electrical wire, conduit, terminals and other electrical facilities. Extreme caution must be used to avoid electrical shock from such facilities. You must avoid contact with all such facilities.

- Ethernet wiring must be at least 6 feet from bare power wiring or lightning rods and associated wires, and at least 6 inches from other wire (antenna wires, doorbell wires, wires from transformers to neon signs), steam or hot water pipes, and heating ducts.

- Do not place an ethernet connection where it would allow a person to use an ethernet device while in a bathtub, shower, swimming pool, or similar hazardous location.

- Protectors and grounding wire placed by the service provider must not be connected to, removed, or modified by the customer.

- Do not touch uninsulated ethernet wiring if lightning is likely!

- Do not touch or move the antenna(s) while the unit is transmitting or receiving.

- Do not hold any component containing a radio such that the antenna is very close to or touching any exposed parts of the body, especially the face or eyes, while transmitting.

- Do not operate a portable transmitter near unshielded blasting caps or in an explosive environment unless it is a type especially qualified for such use

Any *external* communications wiring you may install needs to be constructed to all relevant electrical codes. In the United States this is the National Electrical Code Article 800. Contact a licensed electrician for details.

Certifications

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A P P E N D I X   B

These products comply with the following standards.

FCC Part 15 Class B

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Radio Frequency Interference (RFI)(FCC 15.105)

The Digi Connect EM and Digi Connect Wi-EM embedded modules have been tested and found to comply with the limits for Class B digital devices pursuant to Part 15 Subpart B, of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential environment. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try and correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and the receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.

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Labeling Requirements (FCC 15.19)

This device complies with Part 15 of FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

If the FCC ID / IC ID is not visible when installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module FCC ID / IC ID. This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID: MCQ-50M879" / IC: 1846A-50M879".

Modifications (FCC 15.21)

Changes or modifications to this equipment not expressly approved by Digi may void the user's authority to operate this equipment.

Industry Canada

This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications.

Le present appareil numerique n'emet pas de bruits radioelectriques depassant les limites applicables aux appareils numeriques de la class B prescrites dans le Reglement sur le brouillage radioelectrique edicte par le ministere des Communications du Canada.

Declaration of Conformity

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(In accordance with FCC Dockets 96-208 and 95-19)

Manufacturer's Name:	Digi International
Corporate Headquarters:	11001 Bren Road East Minnetonka MN 55343
Manufacturing Headquarters:	10000 West 76th Street Eden Prairie MN 55344

Digi International declares, that the products:

Product Name:	Digi Connect EM
Model Numbers:	50000873-xx
Product Name:	Digi Connect Wi-EM
Model Numbers:	50000879-xx

to which this declaration relates, meet the requirements specified by the Federal Communications Commission as detailed in the following specifications:

■ Part 15, Subpart B, for Class B Equipment

■ FCC Docket 96-208 as it applies to Class B personal

■ Computers and Peripherals

The products listed above have been tested at an External Test Laboratory certified per FCC rules and has been found to meet the FCC, Part 15, Class B, Emission Limits. Documentation is on file and available from the Digi International Homologation Department.

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International EMC Standards

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The Digi Connect EM and Digi Connect Wi-EM meet the following standards:

| Standards	Digi Connect EM	Digi Connect Wi-EM
Emmissions	AS/NZS 3548	AS/NZS 3548 CISPR 22
		Japan IOH 003NY04114 0000 003GZ0463 0000
		FCC Part 15 Subpart C (FCC ID: MCQ-50M879)
		IC RSS 210 (IC:1846A-50M879)
	FCC Part 15 Subpart B ICES-003 EN 55022 EN 61000-4-2 EN 61000-4-3 EN 61000-4-6 EN 301 489-3 EN 300 328 VCCI	
Immunity	EN 55024	
Safety	UL 60950-1 CSA 22.2 No. 60950--1 EN 60950	

Sample Application:
TTL Signals to EIA-232

■ ■

A   P   P   E   N   D   I   X   C

The following schematic is an example of how to convert the module's TTL signals to
EIA-232.

SAMPLE APPLICATION
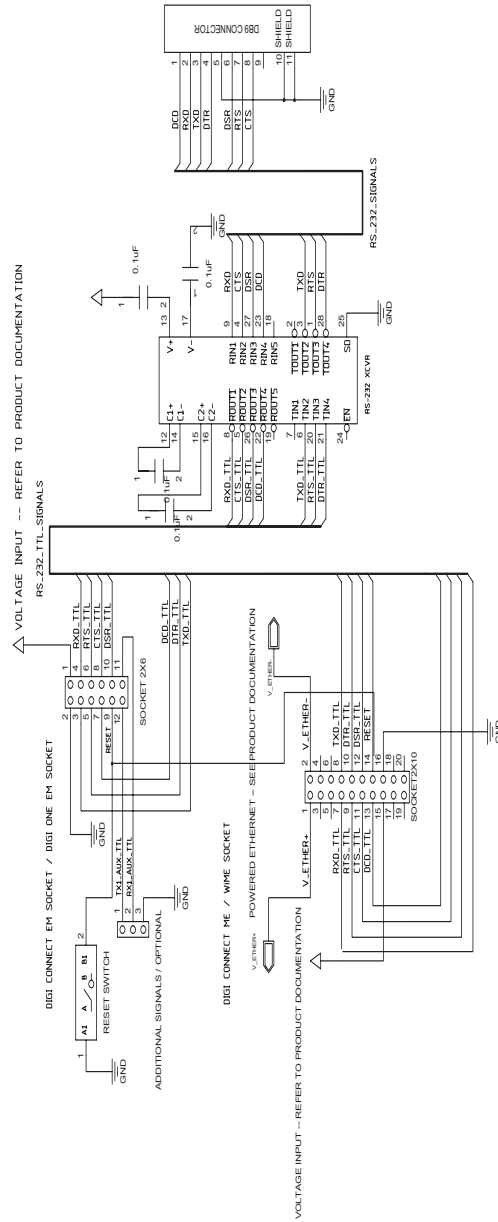
Change Log

The following changes have been made since the last revision of this document.

Revision G

Added tolerances to dimension drawings

Updated Tyco Antenna Specifications

Revision F

Ethernet Pinouts added

Updated Antenna specification

Addressed Vantive 16410 hardware issues

Added product weights

Updated UL labeling description

Revision E

Added Japan certification

Added desktop antenna information

Improve dipole antenna drawing

Reformatted tables for easier reading

Added antenna extension cord information

Added more receive sensitivity information

Added reset hold times

Added VCC *absolute max* ratings

Added power rise time infomation

Combined PCB layouts with improvements