



SMARTMESH-XD™ PM2140-1/PM2040-1

2.4 GHz Wireless Embedded Network Manager

Product Description

The Dust Networks SmartMesh-XD™ PM2140-1/PM2040-1 Embedded Manager uses the Time Synchronized Mesh Protocol (TSMP) to provide unmatched network reliability and ultra low-power consumption. The PM2140-1/PM2040-1 Embedded Manager acts as both a gateway and a network manager for up to 250 DN2140 motes, and creates a self-configuring, reliable wireless mesh network.

The PM2140-1/PM2040-1 is a purpose-built single board computer that provides configuration, management, and gateway functionality for a network of DN2140 motes. The PM2140-1/PM2040-1 includes a 2.4 GHz wireless transceiver, processor, and memory, embedded networking software, and multiple interfaces to host systems, including PPP and Ethernet. PM2140-1/PM2040-1 Embedded Managers run advanced algorithms that continually optimize network performance and reliability to accommodate changing RF and environmental conditions. The combination of extremely high reliability and low power consumption enables applications that require very low installation cost for low-maintenance, long-term deployments.

The PM2140-1/PM2040-1 also hosts a well-defined application interface that allows programmatic access to network control commands, performance statistics, and connectivity details. Typically designed into controllers or gateways, PM2140-1/PM2040-1 Embedded Managers provide a simple and low-risk means to integrate advanced mesh networking intelligence into monitoring and control products.

Key Features

Hands-off Network Management

- Uses Time Synchronized Mesh Protocol (TSMP) for high reliability (>99.9% typical network reliability) and interference rejection
- Automatic self-organizing mesh networking capability built in
- Active load balancing for real-time network topology optimization to reduce latency and increase battery life

Robust Design

- Industrial temperature range -40°C to $+85^{\circ}\text{C}$
- Rugged design for industrial environments

Fast and Low-risk Integration

- Fully programmed—no software development required
- Ethernet interface for high-speed, feature-rich XML API
- Serial interface for resource-constrained systems

Scalable and Secure

- Manages up to 250 motes per manager
- Dynamic network key exchange for improved security
- Admin Toolset Web interface for device OEM or end-user device configuration

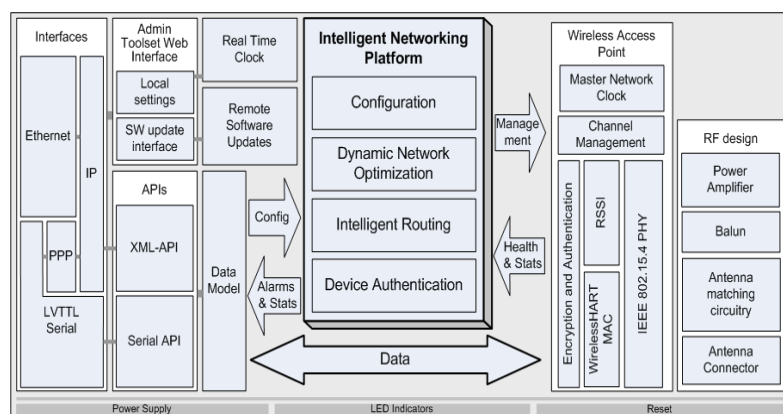


Table of Contents

1.0	Absolute Maximum Ratings	4
2.0	Normal Operating Conditions	4
3.0	Electrical Specifications	4
3.1	LVTTL Specifications	5
3.2	LED Specifications	5
3.3	3.3 V Output Supply	6
3.4	Device Load	6
3.5	AC Timing Specifications	6
4.0	Real-time Clock	6
5.0	Radio	6
5.1	Detailed Radio Specifications	6
5.2	Antenna Specifications	7
6.0	SmartMesh-XD Mesh Networking Software	7
6.1	Low-power Network	8
6.2	Data Reliability	8
7.0	Interfaces	8
7.1	Hardware Interfaces	8
7.1.1	10Base-T Ethernet Interface	8
7.1.2	Serial 1 Interface	9
7.1.3	Serial 2 Interface	9
7.1.4	Serial 3 Interface	9
7.1.5	LED Status Indicators	9
7.2	Software Interfaces	10
7.2.1	XML API	10
7.2.2	Admin Toolset	10
7.2.3	PPP	10
7.2.4	Serial API	10
7.2.5	Heartbeat (Manager Failover)	11
7.2.6	Command Line Interface	11
8.0	Board-to-board Connectors	12
8.1	Connector Pin Numbering	12
8.2	Pinout	13
8.3	Recommended Mating Connectors	15
9.0	Mechanical Specifications	15
9.1	PM2140-1 Mechanical Drawings	15
9.2	Mating Board Footprint	16
10.0	Regulatory and Standards Compliance	16
10.1	FCC Compliance	16
10.1.1	FCC Testing	16
10.1.2	FCC-approved Antenna	17

10.1.3 OEM Labeling Requirements	17
10.2 IC Compliance	17
10.2.1 IC Testing	17
10.2.2 IC-approved Antennae	17
10.2.3 OEM Labeling Requirements	17
10.3 CE Compliance	18
10.3.1 Declaration of Conformity	18
10.3.2 European Compliance	18
10.3.3 OEM Labeling Requirements	18
10.3.4 Restrictions	18
10.4 Industrial Environment Operation	18
11.0 Related Documentation	19
12.0 Ordering Information	19

1.0 Absolute Maximum Ratings

The absolute maximum ratings shown below should not be violated under any circumstances. Permanent damage to the device may be caused by exceeding one or more of these parameters.

Table 1 Absolute Maximum Ratings

Parameter	Min	Typ	Max	Units	Comments
Supply voltage (+5V_IN to GND)	−0.3		6	V	
Input RF level			10	dBm	Input power at antenna connector
Storage temperature range	−40		+85	°C	
VSWR of antenna			3:1		
ESD protection					
Antenna connector			±250	V	HBM
All other connectors			±2	kV	HBM
			±200	V	CDM
All voltages are referenced to GND					



Caution! ESD sensitive device. Precaution should be used when handling the device in order to prevent permanent damage.

2.0 Normal Operating Conditions

Table 2 Normal Operating Conditions

Parameter	Min	Typ	Max	Units	Comments
Operational supply voltage range (between +5V_IN and GND)	4.0	5.0	5.5	VDC	Including noise and load regulation
Voltage supply noise			100	mV _{p-p}	50 Hz–50 MHz
Peak current					
PM2140-1			210	mA	+3V3 out = 0 mA
PM2040-1			210	mA	+3V3 out = 0 mA
Average current					
PM2140-1, PM2040-1		100	140	mA	+5V_IN at 5.0 V, 25 °C, +3V3 out = 0 mA
PM2140-1, PM2040-1		175	245	mA	+5V_IN at 5.0 V, 25 °C, +3V3 out = 100 mA
Operating temperature range	−40		+85	°C	
Maximum allowed temperature ramp during operation			8	°C/min	−40 °C to +85 °C
Operating relative humidity	10		90	% RH	Non-condensing
The specifications listed are for the power supply connected to +5V_IN and GND, and apply over the operating temperature range unless otherwise specified.					

3.0 Electrical Specifications

I/O specifications are given below for each I/O level type given in the board-to-board connector tables in sections 7.1 and 8.2. Unless otherwise noted, +5V_IN is 5.0 V and temperature is −40 °C to +85 °C.

3.1 LVTTTL Specifications

Table 3 LVTTTL Type 1 Specifications

Parameter	Min	Typ	Max	Units	Comments
V_{IH} (logical high input)	$0.8 \times +3V3$		$+3V3 + 0.3$	V	
V_{IL} (logical low input)	-0.3		0.6	V	
I_{IN} (input leakage)			+10	μA	
V_{OH} (logical high output)	$+3V3 - 0.3$		$+3V3$	V	
V_{OL} (logical low output)	GND		0.4	V	
I_{OH} ($V_O = V_{OH}$) (source)	3			mA	
I_{OL} ($V_O = V_{OL}$) (sink)	3			mA	

Table 4 LVTTTL Type 2 Specifications (Schmitt Trigger)

Parameter	Min	Typ	Max	Units	Comments
V + Threshold	1.3		2.5	V	
V – Threshold	0.6		1.6	V	
I_{IN} (input leakage)			± 5	μA	

Table 5 LVTTTL Type 3 Specifications

Parameter	Min	Typ	Max	Units	Comments
V_{OH} (logical high output)	$+3V3 - 0.4$		$+3V3$	V	
V_{OL} (logical low output)	GND		0.5	V	
I_{OH} ($V_O = V_{OH}$) (source)	0.2			mA	
I_{OL} ($V_O = V_{OL}$) (sink)	0.2			mA	

Table 6 LVTTTL Type 4 Specifications

Parameter	Min	Typ	Max	Units	Comments
V_{OH} (logical high output)	2.6		$+3V3$	V	
V_{OL} (logical low output)	GND		0.4	V	
I_{OH} ($V_O = V_{OH}$) (source)	2			mA	
I_{OL} ($V_O = V_{OL}$) (sink)	2			mA	

Table 7 LVTTTL Type 5 Specifications

Parameter	Min	Typ	Max	Units	Comments
V_{IH} (logical high input)	2.6		$+3V3 + 0.3$	V	
V_{IL} (logical low input)	$GND - 0.3$		$GND + 0.8$	V	
I_{IN} (input leakage)			± 5	μA	

3.2 LED Specifications

Table 8 LED Specifications

Parameter	Min	Typ	Max	Units	Comments
V_{OH} (logical high output)	$+3V3 - 0.3$		$+3V3$	V	
V_{OL} (logical low output)	GND		$GND + 0.4$	V	
I_{OH} ($V_O = V_{OH}$) (source)	3			mA	$+3V3 = 3.3 V$
I_{OL} ($V_O = V_{OL}$), I/O = LED (sink)	1.5			mA	$+3V3 = 3.3 V$
I_{OL} ($V_O = V_{OH}$), I/O = LED low (sink)	0.5			mA	$+3V3 = 3.3 V$

3.3 3.3 V Output Supply

The PM2140-1/PM2040-1 includes a regulated 3.3 V output signal (labeled +3V3) for supplying power to user circuitry (for example, isolation or signal conditioning). Note that any power drawn on +3V3 circuitry results in an increase in power drawn on +5V_IN.

Table 9 +3.3 V Power Supply Output

Parameter	Min	Typ	Max	Units	Comments
+3V3 current source			100	mA	
+3V3 supply voltage	3.13		3.46	V	

3.4 Device Load

Table 10 Device Load

Parameter	Min	Typ	Max	Units	Comments
Total capacitance			322	μF	
Total reactance			33	μH	

3.5 AC Timing Specifications

Table 11 AC Timing Specifications

Parameter	Min	Typ	Max	Units	Comments
nRESET_IN pulse width	125			μs	

4.0 Real-time Clock

The PM2140-1 has a battery-backed real-time clock (RTC) with a lifetime of 15 years, assuming 60 °C average ambient temperature and 10% duty cycle. RTC accuracy is typically 1 minute/month but can drift up to 10 minutes/month at temperature extremes. The clock may be set manually using the Admin Toolset Web interface or periodically using NTP. See the *SmartMesh-XD Admin Toolset Reference Guide*.

5.0 Radio

5.1 Detailed Radio Specifications

Table 12 Radio Specifications

Parameter	Min	Typ	Max	Units	Comments
Operating frequency	2.4000		2.4835	GHz	
Number of channels		15			
Channel separation		5		MHz	
Occupied channel bandwidth		2.7		MHz	At -20 dBc
Frequency accuracy	-50		+50	kHz	
Modulation					IEEE 802.15.4 DSSS
Raw data rate		250		Kbps	
Receiver operating input level		0		dBm	
Receiver sensitivity		-92.5		dBm	At 50% PER, V _{DD} = 3 V, 25 °C
		-90		dBm	At 1% PER, V _{DD} = 3 V, 25 °C, (inferred by 50% PER measurement)

Parameter	Min	Typ	Max	Units	Comments
Output power, conducted PM2140: At 25 °C		+8		dBm	
PM2040: At 25 °C		-2		dBm	
Range** PM2140: Indoor Outdoor PM2040: Indoor Outdoor		100 300 25 200		m m m m	25 °C, 50% RH, 1 meter above ground, +2 dBi omni-directional antenna
**Actual RF range performance is subject to a number of installation-specific variables including, but not restricted to ambient temperature, relative humidity, presence of active interference sources, line-of-sight obstacles, near-presence of objects (for example, trees, walls, signage, and so on) that may induce multipath fading. As a result, actual performance varies for each instance.					

5.2 Antenna Specifications

A MMCX-compatible jack receptacle is provided on board for the antenna connection. For antenna location, refer to the mechanical drawing in section 9.1. The antenna must meet specifications in Table 13. For a list of antennae pre-approved for RF certification, see section 10.1.2.

Table 13 Antenna Specifications

Parameter	Value
Frequency range	2.4–2.4835 GHz
Impedance	50 Ω
Gain PM2140-1, PM2040-1	+2 dBi maximum
Pattern	Omni-directional
Maximum VSWR	3:1
Connector	MMCX*
* The PM2140-1 can accommodate the following RF mating connectors: <ul style="list-style-type: none"> • MMCX straight connector such as Johnson 135-3402-001, or equivalent • MMCX right angle connector such as Tyco 1408149-1, or equivalent 	

When the PM2140-1/PM2040-1 is placed inside an enclosure, the antenna should be mounted such that the radiating portion of the antenna protrudes from the enclosure, and connected using a MMCX connector on a coaxial cable. For optimum performance, allow the antenna to be positioned vertically when installed.

6.0 SmartMesh-XD Mesh Networking Software

The PM2140-1/PM2040-1 comes pre-programmed with SmartMesh-XD mesh networking software, which utilizes Time Synchronized Mesh Protocol (TSMP) to enable ultra low-power wireless sensors networks and unprecedented data reliability.

6.1 Low-power Network

With a PM2140-1/PM2040-1 as its embedded Manager, a SmartMesh-XD network can achieve five to ten year battery life across all its nodes. SmartMesh-XD owes its low-power operation to unmatched duty cycling and to time-synchronized transmissions. Duty cycling refers to operating a component at intervals and returning it to a quiescent (nearly zero-power) state when not in active use. Duty cycling dramatically reduces power consumption. SmartMesh-XD aggressively duty cycles motes and (when appropriate) their attached sensors. As a result, every network node can last for years using off-the-shelf batteries.

Once established in a mesh, SmartMesh motes do not transmit at will, since doing so would require other motes to listen at all times for potential transmissions, and radios (even the low-power radios used for these sensor networks) consume substantial power when listening. Instead, SmartMesh-XD networks use time-synchronized transmissions. A receiving mote powers on its radio only long enough to determine whether the transmitting mote has a packet to send, and then to receive and acknowledge the incoming packet if one is detected. Similarly, the transmitting mote activates its radio only if it has a packet to send. Finally, since the PM2140-1 time synchronizes the traffic in the network, there are no re-transmissions due to in-network collisions, thus reducing overall traffic and overall power consumption. SmartMesh-XD delivers not only low-power operation, but also outstanding data reliability.

6.2 Data Reliability

A SmartMesh-XD network can reach more than 99.9% data reliability through the way it performs network formation, route maintenance and network optimization. A SmartMesh-XD network will self-configure into a network with fully redundant paths to every mote, including the ones on the edge of the network. This *mesh-to-the-edge*[™] ensures that every mote has path redundancy. A PM2140-1/PM2040-1 continuously performs route maintenance on the network by monitoring regular health reports and network statistics and replacing unavailable paths. This *self-healing* aspect of SmartMesh-XD makes it ideally suited for harsh environments in which the RF characteristics are always changing. Finally, network optimization (also known as *active load balancing*) makes continuous, proactive network adjustments in network links to improve overall latency and power consumption, while maintaining the highest reliability.

7.0 Interfaces

The PM2140-1/PM2040-1 is designed for ease of integration by providing multiple data ports and well-defined software APIs. Section 7.1 describes the PM2140-1/PM2040-1 data ports, LEDs, and switches. Refer to the *SmartMesh-XD PM2140-1/PM2040-1 Integration Guide* for example application circuits. Section 7.2 describes the software functions that are available through the data ports.

7.1 Hardware Interfaces

Table 14 Hardware Interface Summary

Port	Description	Pins
Ethernet	10Base-T Ethernet	RX_P, TX_P, RX_N, TX_N, RX_CT, TX_CT, nACT_LED, nLINK_LED
Serial 1	UART 5-pin	S1_TX, S1_RX, S1_RTS, S1_CTS, GND
Serial 2	UART 9-pin	S2_TX, S2_RX, S2_RTS, S2_CTS, S2_RI, S2_DCD, S2_DSR, S2_DTR, GND
Serial 3	Reserved for future use	S3_TX, S3_RX, S3_RX_EN, S3_TX_EN, GND
LED Status Indicator	Status indicators	nLED_SUB, nLED_RADIO, nLED_RESERVED0, nLED_RESERVED1, nLED_RESERVED2, nLED_RESERVED3, RST

7.1.1 10Base-T Ethernet Interface

Ideal for remote or high-bandwidth access, the Ethernet interface provides full configuration management and data access to the PM2140-1/PM2040-1. The port is an IEEE 802.3 standard 10Base-T MAC/PHY, accessible through the board-to-board J10 connector.

RX_P and RX_N are the receive-side differential pair (see section 8.2 for pinout). The levels should conform to 10Base-T Ethernet. TX_P and TX_N are the transmit-side differential pair. The transmit level coming from the PM2140-1/PM2040-1 is about one-half the standard 10Base-T level.

7.1.2 Serial 1 Interface

The Serial 1 interface is designed for embedded integration with controllers. This serial interface provides programmatic access for configuration, management, and data access to the PM2140-1/PM2040-1. The port is a 5-pin flow-controlled LVTTTL (3.3 V) serial interface accessible through the board-to-board J10 connector.

Table 15 Serial 1 Parameters

Parameter	Value
Bit rate	115200
Parity	N
Data bits	8
Stop bit	1
Flow control	Hardware handshake

7.1.3 Serial 2 Interface

The PM2140-1/PM2040-1 provides a UART interface with TX, RX, RTS, CTS, DTR, DSR, and RI lines through the board-to-board J6 connector, operating up to 115 kbps at RS-232 voltage levels.

Table 16 Serial 2 Parameters

Parameter	Value
Bit rate	115200
Parity	N
Data bits	8
Stop bit	1
Flow control	None

7.1.4 Serial 3 Interface

The Serial 3 interface is reserved. These signals should not be connected.

7.1.5 LED Status Indicators

The PM2140-1/PM2040-1 has LED status indicators on the topside of the module, whose signals also pass through the board-to-board J10 connector.

Table 17 LED Status Indicators

LED Name	Signal Name	Description	Color
Power		Indicates 3.3V DC-DC converter is okay, lights when 5 V supply is connected	Green
Subscription	nLED_SUB	Indicates that a client program is subscribed to Manager via Ethernet or RS-232	Yellow
Radio	nLED_RADIO	Blinks with data activity over the radio	Yellow
Mode 1	nLED_RESERVED0	Reserved for future use	Yellow
Mode 2	nLED_RESERVED1	Reserved for future use	Yellow
Mode 3	nLED_RESERVED2	Reserved for future use	Green
Mode 4	nLED_RESERVED3	Reserved for future use	Green
RST	nRESET_IN	Indicates the manager is in the reset state	Red

7.2 Software Interfaces

The PM2140-1/PM2040-1 provides well-defined software interfaces for easy integration. Table 15 describes which interfaces are available via the various hardware ports. This section describes the software interfaces available via the hardware ports described in section 7.2.1.

Table 18 PM2140-1 Software Interfaces

Hardware Port	Software Interface	Comments
Ethernet	XML API, Admin Toolset	
Serial 1	PPP/Serial API/Heartbeat	Function is user selectable via Admin Toolset utility or command line interface. By default, PPP is enabled on this port.
Serial 2	Command line interface	

7.2.1 XML API

The XML API is an open Extensible Markup Language (XML) interface that lets a client application send Remote Procedure Call (RPC) requests to the PM2140-1/PM2040-1 and receive responses and other data from the PM2140-1/PM2040-1 via XML-RPC. The API consists of a Control Channel and a Notification Channel. The Control Channel is used to establish connection and exchange commands and information about the SmartMesh Network. The Notification Channel is used to stream data and network events to the client program. The API is fully documented in the *SmartMesh Manager XML API Guide*.

7.2.2 Admin Toolset

The PM2140-1/PM2040-1 provides a Web-based administrative tool called Admin Toolset. Through this interface, users may configure IP settings, view logs, manually configure the Real Time Clock or enable the Network Time Protocol (NTP) client. Also, users may update PM2140-1/PM2040-1 software as well as perform remote software updates on motes in the wireless network. These functions and others are described in further detail in the *Admin Toolset Reference Guide*.

7.2.3 PPP

The PM2140-1/PM2040-1 allows IP connection via the Serial 1 port using Point-to-Point Protocol (PPP). This connection provides access to the same interfaces that are available through the Ethernet interface, such as the XML API and the Admin Toolset utility. The PM2140-1/PM2040-1 acts as a PPP server. Note that the client is responsible for periodically pinging the PM2140-1/PM2040-1 and re-establishing PPP connection if necessary.

Table 19 PPP Interface Specifications

Parameter	Value
Serial port data rate	115.2 Kbps, 8 bits, no parity, 1 stop bit
Authentication required	None
Header compression	PPP header compression
Data compression supported	PPP deflate compression (preferred), BSD compression
IP addresses	Settable during connection
Default PM2140-1/PM2040-1 (server)	192.168.101.10
Default client	192.168.101.11

7.2.4 Serial API

The PM2140-1/PM2040-1 provides a packet-based serial API that allows communications with the PM2140-1/PM2040-1 over its asynchronous Serial 1 port. Ideal for resource constrained systems, the serial API requires less processing than the XML format, but covers a subset of features available through the TCP/IP-based XML-RPC interface. For details, refer to the *SmartMesh-XD Manager Serial API Guide*.

7.2.5 Heartbeat (Manager Failover)

When operating via Ethernet, a pair of PM2140-1/PM2040-1 Embedded Managers may be configured as a redundant pair, with the backup embedded manager acting as an emergency failover. The pair is connected via a null modem serial connection that acts as a “heartbeat” connection. When the backup embedded manager detects via the heartbeat connection that the primary embedded manager is down, the backup will assume the IP address of the primary and the network reforms to communicate with the new manager. During this “cold” failover, some data packet loss may occur while the network rebuilds to the new embedded manager.

The Serial 1 port on the PM2140-1/PM2040-1 may be configured as the heartbeat between the manager pair. For details on configuring manager redundancy, refer to the *SmartMesh-XD Admin Toolset Reference Guide*.

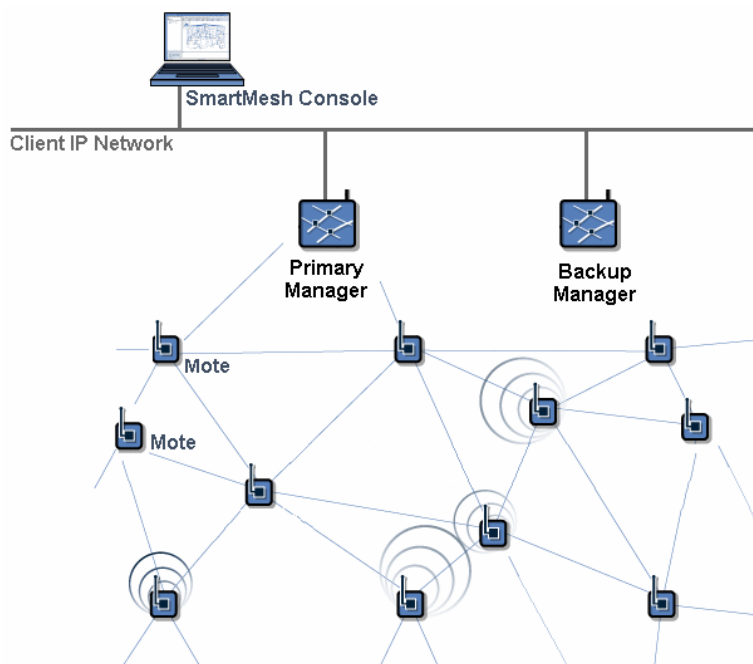


Figure 1 Network with Redundant Managers

7.2.6 Command Line Interface

The command line interface is used to set the software function of Serial 1 and for troubleshooting with the assistance of Dust Networks support.

8.0 Board-to-board Connectors

The PM2140-1/PM2040-1 has two 40-pin FCI/Berg 61083-042400LF board-to-board connectors. For connector and pin locations, see Figure 2 and Figure 3.

8.1 Connector Pin Numbering

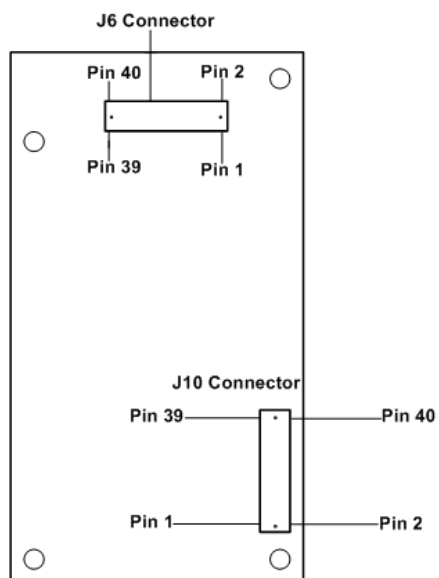


Figure 2 Connector Pin Numbering (Bottom View)

8.2 Pinout

Table 20 J10 Board-to-board Connector

Pin Number	Pin Name	I/O Direction	I/O Level	Interface Name
1	GND	–		
2	GND	–		
3	RX_P	In	10Base-T	Ethernet
4	TX_P	Out	10Base-T	Ethernet
5	RX_N	In	10Base-T	Ethernet
6	TX_N	Out	10Base-T	Ethernet
7	RX_CT	In	10Base-T	Ethernet
8	TX_CT	Out	10Base-T	Ethernet
9	nACT_LED	Out	LED	LED Status indicators
10	nLINK_LED	Out	LED	LED Status indicators
11	+3V3	Out	3.3 V \pm 5%	3.3 V Out
12	+3V3	Out	3.3 V \pm 5%	3.3 V Out
13	S1_RTS	Out	LVTTTL Type 3	Serial 1
14	<i>Reserved</i>			No connection
15	S1_CTS	In	LVTTTL Type 1	Serial 1
16	<i>Reserved</i>			No connection
17	S1_TX	Out	LVTTTL Type 3	Serial 1
18	Config Switch	In	LVTTTL Type 2	Switch In
19	S1_RX	In	LVTTTL Type 1	Serial 1
20	Restore Switch	In	LVTTTL Type 2	Switch In
21	GND	–		
22	nLED_SUB	Out	LED	LED status indicators
23	<i>Reserved</i>			No connection
24	nLED_RESERVED0	Out	LED	LED status indicators
25	+3V3	Out	3.3 V \pm 5%	3.3 V Out
26	nLED_RESERVED1	Out	LED	LED status indicators
27	<i>Reserved</i>			No connection
28	nLED_RESERVED2	Out	LED	LED status indicators
29	<i>Reserved</i>			No connection
30	nLED_RESERVED3	Out	LED	LED status indicators
31	<i>Reserved</i>			No connection
32	S3_RX	In	LVTTTL Type 1	Serial 3
33	GND			
34	S3_TX	Out	LVTTTL Type 1	Serial 3
35	<i>Reserved</i>			No connection
36	S3_RX_EN	Out	LVTTTL Type 1	Serial 3
37	<i>Reserved</i>			No connection
38	S3_TX_EN	Out	LVTTTL Type 1	Serial 3
39	GND			
40	GND			

Table 21 J6 Board-to-board Connector

Pin Number	Pin Name	I/O Direction	I/O Level	Interface Name
1	GND	–		
2	GND	–		
3	<i>Reserved</i>			No connection
4	S2_TX	Out	LVTTL Type 1	Serial 2
5	<i>Reserved</i>			No connection
6	S2_RX	In	LVTTL Type 1	Serial 2
7	<i>Reserved</i>			No connection
8	S2_RTS	Out	LVTTL Type 1	Serial 2
9	<i>Reserved</i>			No connection
10	S2_CTS	In	LVTTL Type 1	Serial 2
11	<i>Reserved</i>			No connection
12	S2_RI	In	LVTTL Type 1	Serial 2
13	<i>Reserved</i>			No connection
14	S2_DCD	In	LVTTL Type 1	Serial 2
15	GND			
16	S2_DSR	In	LVTTL Type 1	Serial 2
17	<i>Reserved</i>			No connection
18	S2_DTR	Out	LVTTL Type 1	Serial 2
19	<i>Reserved</i>			No connection
20	+3V3	Out	3.3 V \pm 5%	3.3 V Out
21	+3V3	Out	3.3 V \pm 5%	3.3 V Out
22	nRESET_OUT	Out	LVTTL Type 4	Reset low
23	<i>Reserved</i>			No connection
24	GND			
25	<i>Reserved</i>			No connection
26	RESET_OUT	Out	LVTTL Type 4	Reset high
27	<i>Reserved</i>			No connection
28	nRESET_IN	In	LVTTL Type 5	Switch In
29	<i>Reserved</i>			No connection
30	<i>Reserved</i>			No connection
31	<i>Reserved</i>			No connection
32	+5V_IN	In	5.0 V \pm 5%	Power In
33	<i>Reserved</i>			No connection
34	+5V_IN	In	5.0 V \pm 5%	Power In
35	GND			
36	+5V_IN	In	5.0 V \pm 5%	Power In
37	nLED_RADIO	Out	LED Low	LED status indicators
38	<i>Reserved</i>			No connection
39	GND			
40	GND			

8.3 Recommended Mating Connectors

The user connections are made through J6 and J10 on the PM2140-1/PM2040-1, which are FCI/Berg 61083-042400LF board-to-board connectors. The mating connector should be an FCI/Berg 61082-04x400LF, where 'x' depends on the desired stack height (see Table 22).

Table 22 Recommended Mating Connectors

Connector	Mated Height (mm)
FCI/Berg 61082-041400LF	6
FCI/Berg 61082-042400LF	10
FCI/Berg 61082-043400LF	14

9.0 Mechanical Specifications

9.1 PM2140-1 Mechanical Drawings

In laying out a design, locate the mating connectors by using the alignment pins and correlating pin numbers for orientation (see Figure 2).

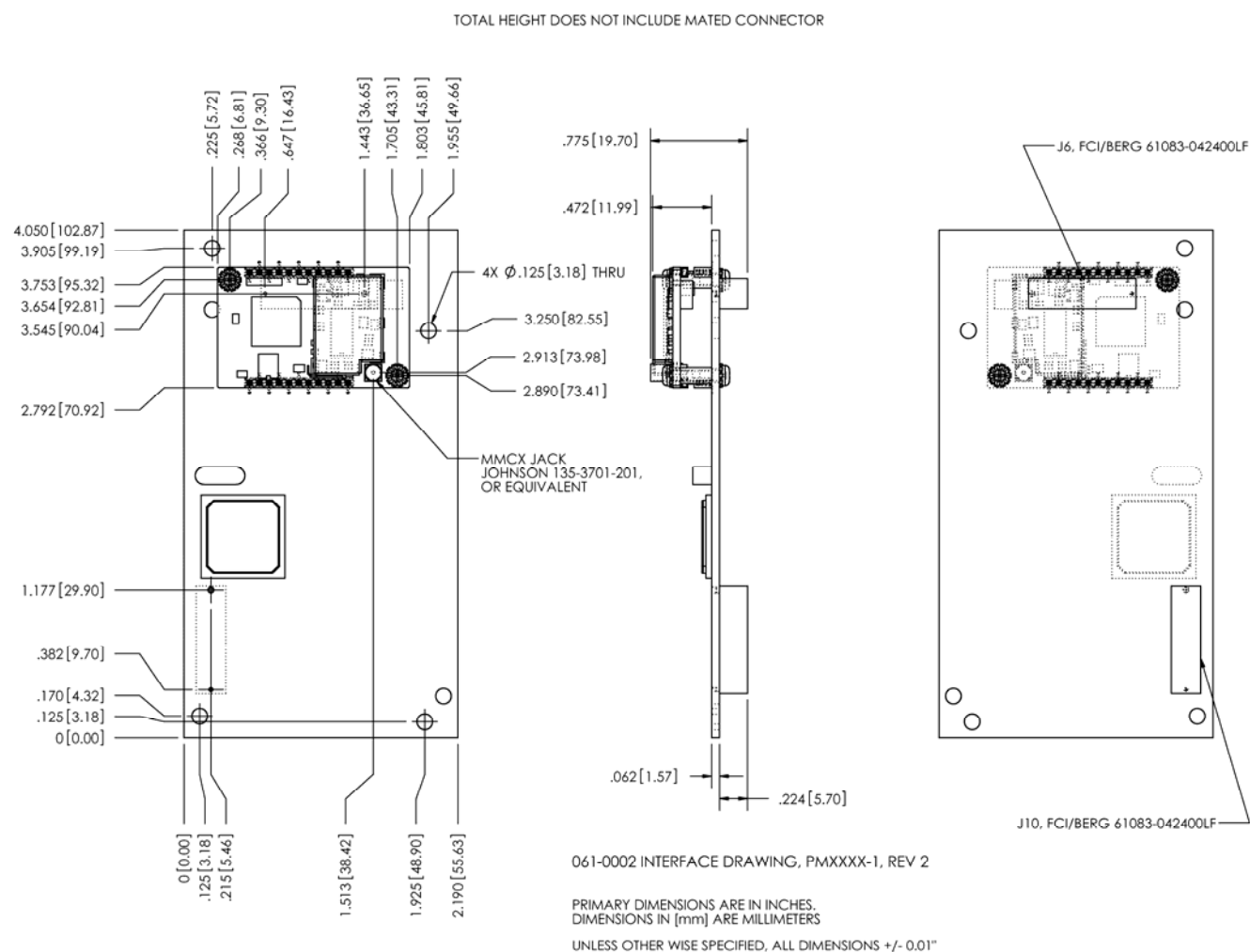


Figure 3 PM2140-1 Mechanical Drawing

9.2 Mating Board Footprint

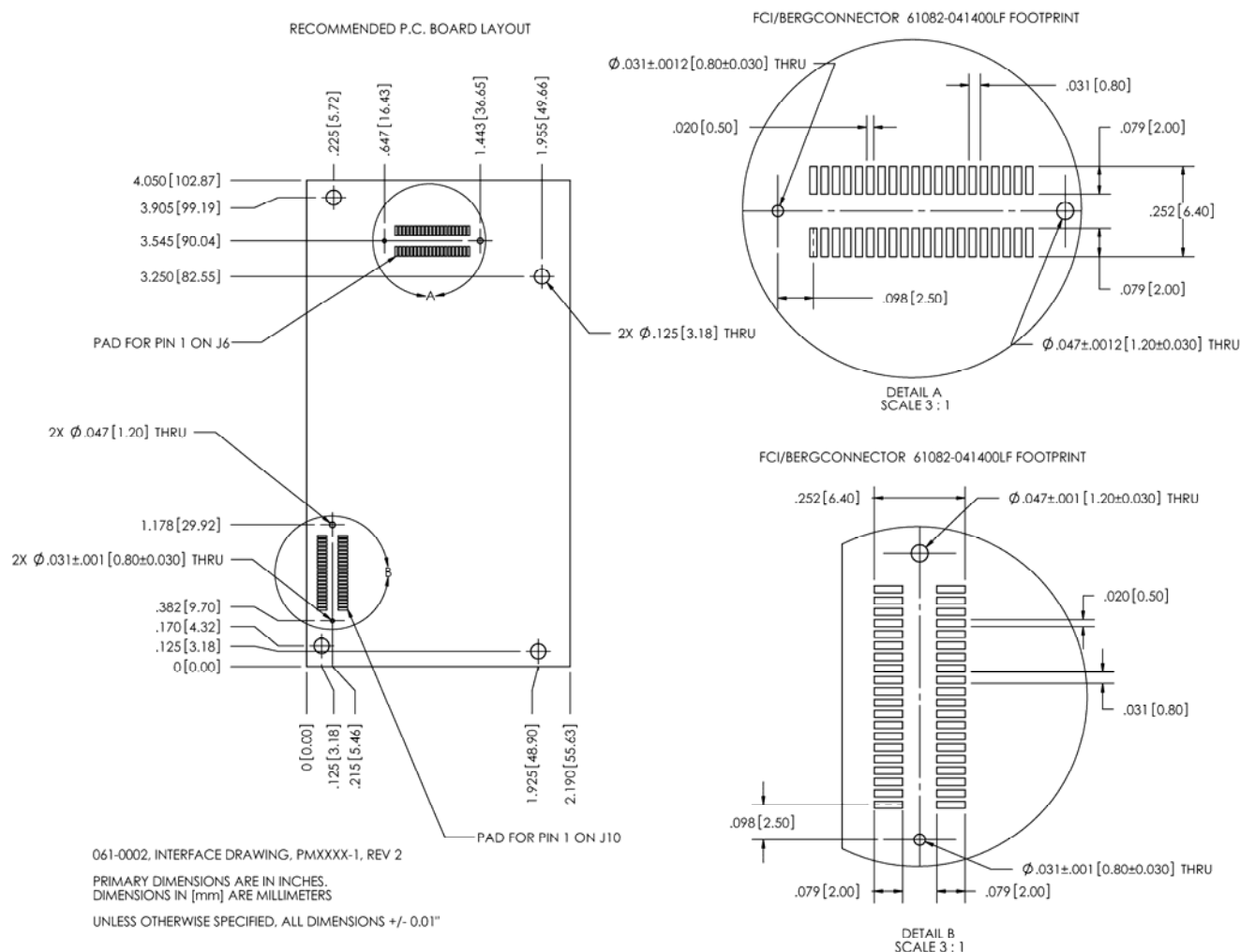


Figure 4 Mating Board Footprint (Top View)

10.0 Regulatory and Standards Compliance

10.1 FCC Compliance

10.1.1 FCC Testing

The PM2140-1/PM2040-1 Embedded Manager complies with Part 15.247 modular (Intentional Radiator) of the FCC rules and regulations. In order to fulfill FCC certification requirements, products incorporating the PM2140-1/PM22040-1 Embedded Manager must comply with the following:

1. An external label must be provided on the outside of the final product enclosure specifying the FCC identifier, as described in section 10.1.3 below.
2. The antenna must be electrically identical to the FCC-approved antenna specifications for the PM2140-1/PM2040-1 as described in 10.1.2, with the exception that the gain may be lower than specified in Table 23.
3. The device integrating the PM2140-1/PM2040-1 may not cause harmful interference, and must accept any interference received, including interference that may cause undesired operation.
4. An unintentional radiator scan must be performed on the device integrating the PM2140-1/PM2040-1 Embedded Manager, per FCC rules and regulations, CFR Title 47, Part 15, Subpart B. See FCC rules for specifics on requirements for declaration of conformity.

10.1.2 FCC-approved Antenna

The following are FCC-approved antenna specifications for the PM2140-1/PM2040-1.

Table 23 FCC-approved Antenna Specifications for the PM2140-1 and PM2040-1

Gain	Pattern	Polarization	Frequency	Connector
+2 dBi maximum	Omni-directional	Vertical	2.4–2.4835 GHz	MMCX

10.1.3 OEM Labeling Requirements

The Original Equipment Manufacturer (OEM) must ensure that FCC labeling requirements are met. The outside of the final product enclosure must have a label with the following (or similar) text specifying the FCC identifier. The FCC ID and certification code must be in Latin letters and Arabic numbers and visible without magnification.

Contains transmitter module FCC ID: SJC-M2140

or

Contains FCC ID: SJC-M2140

10.2 IC Compliance

10.2.1 IC Testing

The PM2140-1/PM2040-1 is certified for modular Industry Canada (IC) RSS-210 approval. The OEM is responsible for its product to comply with IC ICES-003 and FCC Part 15, Sub. B - Unintentional Radiators. The requirements of ICES-003 are equivalent to FCC Part 15 Sub. B and Industry Canada accepts FCC test reports or CISPR 22 test reports for compliance with ICES-003.

10.2.2 IC-approved Antennae

The following are IC-approved antenna specifications for the PM2140-1/PM2040-1.

Table 24 IC-approved Antenna Specifications for the PM2140-1 and PM2040-1

Gain	Pattern	Polarization	Frequency	Connector
+2 dBi maximum	Omni-directional	Vertical	2.4–2.4835 GHz	MMCX

The following are IC-approved antenna specifications for the PM2040-1.

10.2.3 OEM Labeling Requirements

The Original Equipment Manufacturer (OEM) must ensure that IC labeling requirements are met. The outside of the final product enclosure must have a label with the following (or similar) text specifying the IC identifier. The IC ID and certification code must be in Latin letters and Arabic numbers and visible without magnification.

Contains IC: 5853-M2140

10.3 CE Compliance

10.3.1 Declaration of Conformity

We, Dust Networks, of

30695 Huntwood Ave

Hayward, CA 94544 USA

declare under our sole responsibility that our product,

SmartMesh-XD PM2140 and PM2040,

and in combination with our accessories, to which this declaration relates is in conformity with the appropriate standards ETSI EN 300 328, ETSI EN 301 489-17 and EN 60950, following the provisions of Radio Equipment and Telecommunication Terminal Equipment directive 99/5/EC with requirements covering EMC directive 89/336/EEC, and Low voltage directive 73/23/EEC.

10.3.2 European Compliance

If the PM2140 and PM2040 managers are incorporated into a product, the manufacturer must ensure compliance of the final product to the European harmonized EMC and low-voltage/safety standards. A Declaration of Conformity must be issued for each of these standards and kept on file as described in Annex II of the R&TTE Directive. Furthermore, the manufacturer must maintain a copy of this PM2140/PM2040 user documentation and ensure the final product does not exceed the specified power ratings, antenna specifications, and/or installation requirements as specified in the user manual. If any of these specifications are exceeded in the final product, a submission must be made to a notified body for compliance testing to all required standards.

10.3.3 OEM Labeling Requirements

The 'CE' marking must be affixed to a visible location on the OEM product. The CE mark shall consist of the initials "CE" taking the following form:

- If the CE marking is reduced or enlarged, the proportions given in the drawing below must be respected.
- The CE marking must have a height of at least 5 mm except where this is not possible on account of the nature of the apparatus.
- The CE marking must be affixed visibly, legibly, and indelibly.

Furthermore, since the usage of the 2400 – 2483.5 MHz band is not harmonized throughout Europe, the Restriction sign must be placed to the right of the 'CE' marking as shown below. See the R&TTE Directive, Article 12 and Annex VII for more information.

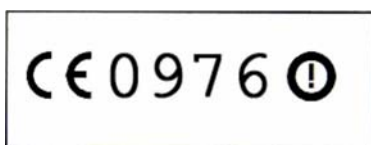


Figure 5 CE Label Requirements

10.3.4 Restrictions

Norway—Norway prohibits operation near Ny-Alesund in Svalbard. More information can be found at the Norway Posts and Telecommunications site (www.npt.no).

10.4 Industrial Environment Operation

The PM2140-1/PM2040-1 is designed to meet the specifications of a harsh industrial environments which includes:

- **Shock and Vibration**—The PM2140-1/PM2040-1 complies with high vibration pipeline testing, as specified in IEC 60770-1.
- **Temperature Extremes**—The PM2140-1/PM2040-1 is designed for industrial storage and operational temperature range of -40°C to $+85^{\circ}\text{C}$.

11.0 Related Documentation

- *SmartMesh-XD PM2140-1/PM2040-1 Integration Guide*
- *SmartMesh-XD Manager Serial API Guide*
- *SmartMesh-XD Manager XML API Guide*
- *SmartMesh-XD Admin Toolset Reference Guide*

12.0 Ordering Information

Product List:

PM2140-1: SmartMesh-XD 2.4 GHz Long Range Embedded Manager

PM2040-1: SmartMesh-XD 2.4 GHz Embedded Manager

Contact Information:

Dust Networks

30695 Huntwood Ave.

Hayward, CA 94544

Toll-Free Phone: 1 (866) 289-3878

Website: www.dustnetworks.com

Email: sales@dustnetworks.com

Trademarks

Dust Networks™, the Dust Networks logo, SmartMesh-XR™, SmartMesh-XD™, mesh-to-the-edge™, and Mote-on-Chip™ are trademarks of Dust Networks, Inc. Dust® and SmartMesh® are registered trademarks of Dust Networks, Inc. All third-party brand and product names are the trademarks of their respective owners and are used solely for informational purposes.

Copyright

This documentation is protected by United States and international copyright and other intellectual and industrial property laws. It is solely owned by Dust Networks, Inc. and its licensors and is distributed under a restrictive license. This product, or any portion thereof, may not be used, copied, modified, reverse assembled, reverse compiled, reverse engineered, distributed, or redistributed in any form by any means without the prior written authorization of Dust Networks, Inc.

RESTRICTED RIGHTS: Use, duplication, or disclosure by the U.S. Government is subject to restrictions of FAR 52.227-14(g) (2)(6/87) and FAR 52.227-19(6/87), or DFAR 252.227-7015 (b)(6/95) and DFAR 227.7202-3(a), and any and all similar and successor legislation and regulation.

Disclaimer

This documentation is provided “as is” without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for a particular purpose.

This documentation might include technical inaccuracies or other errors. Corrections and improvements might be incorporated in new versions of the documentation.

Dust Networks does not assume any liability arising out of the application or use of any products or services and specifically disclaims any and all liability, including without limitation consequential or incidental damages.

Dust Networks products are not designed for use in life support appliances, devices, or other systems where malfunction can reasonably be expected to result in significant personal injury to the user, or as a critical component in any life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness. Dust Networks customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify and hold Dust Networks and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Dust Networks was negligent regarding the design or manufacture of its products.

Dust Networks reserves the right to make corrections, modifications, enhancements, improvements, and other changes to its products or services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to Dust Network's terms and conditions of sale supplied at the time of order acknowledgment or sale.

Dust Networks does not warrant or represent that any license, either express or implied, is granted under any Dust Networks patent right, copyright, mask work right, or other Dust Networks intellectual property right relating to any combination, machine, or process in which Dust Networks products or services are used. Information published by Dust Networks regarding third-party products or services does not constitute a license from Dust Networks to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from Dust Networks under the patents or other intellectual property of Dust Networks.

© Dust Networks, Inc., 2007. All Rights Reserved.

Document Number: 020-0023 rev 2 PM2140-1/PM2040-1 Datasheet

Last Revised: November 16, 2007

Document Status	Product Status	Definition
Advanced Information	Planned or under development	This datasheet contains the design specifications for product development. Dust Networks reserves the right to change specifications in any manner without notice.
Preliminary	Engineering samples and pre-production prototypes	This datasheet contains preliminary data; supplementary data will be published at a later time. Dust Networks reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. The product is not fully qualified at this point.
No Identification Noted	Full production	This datasheet contains the final specifications. Dust Networks reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Obsolete	Not in production	This datasheet contains specifications for a product that has been discontinued by Dust Networks. The datasheet is printed for reference information only.