SmartMesh-XD™ M2140 / M2040

2.4 GHz Wireless Mote

Product Description

Dust Network's network-ready SmartMesh-XD™ M2x40 allows OEMs to build solutions for the global market using ultra low-power, highly reliable system-on-chip (SoC) mesh networking solutions. The M2x40 combines a microprocessor and a standards-based 802.15.4 radio with robust networking capabilities built on top of the industry-leading Time Synchronized Mesh Protocol (TSMP) pioneered by Dust Networks.

The M2x40 is tailored for use in battery- and line-powered wireless devices for applications that demand proven performance and scalability. The innovative radio design in the M2x40 operates in the global license-free 2.4 GHz band, with 80% less receiver current than comparable radios in the market. 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 M2x40 provides all the functionalities of a mote in an easy-to-integrate Mote-on-Chip™ (MoC). The multi-functional interface of the M2x40 gives it the flexibility to be used in a wide variety of applications, from industrial process monitoring to building control to machine health monitoring. The M2x40 requires no embedded programming, enabling OEMs to reduce the development time and cost for wireless sensor networking solutions.

About SmartMesh®

Dust Networks SmartMesh® products combine robust networking capabilities with TSMP, pioneered by Dust Networks, and standards-based motes to provide proven wireless sensor networking systems. SmartMesh® systems achieve high network reliability in the face of unpredictable or harsh RF environments, utilize frequency hopping for interference rejection and have a typical battery life of 5-10 years. Each node in a SmartMesh-based network is a router, offering mesh-to-the-edge™ advantage for easy network integration, installation and maintenance. With a flexible platform and predictable network performance, OEMs can wirelessly enable a whole host of solutions for their industrial automation, building automation and defense markets.

Key Features

Ultra Low Power Consumption

- Innovative radio design that consumes 80% less power in receive mode than competing solutions
- Delivers additional 5X increase in battery life
- Automatic network-wide coordination for efficient power usage

Reliable Networking

- Uses the Time-Synchronized Mesh Protocol (TSMP) for high reliability (> 99.9% typical network reliability)
- Frequency hopping for interference rejection
- Mesh networking for built-in redundancy
- Every M2x40 acts as both an endpoint and a router, increasing network reliability: mesh-to-the-edge™
- Automatic self-organizing mesh networking capability built-in

Easy Integration

- M2x40 provides all the functionality of a mote with zero embedded programming, or complex configuration
- Complete RF stage—balun, antenna matching circuitry, Power Amplifier, and antenna connector included
- High-level Data Link Control (HDLC) serial interface with bidirectional flow control
- Industrial temperature range –40 °C to +85 °C
- FCC, IC and CE modular RF certifications (pending)

802.15.4 Standard Radio

- Global 2.4 GHz license-free band: suitable for use in North America, Europe and most of Asia
- +8 dBm (6.3 mW) conducted RF output power
- –90 dBm receiver sensitivity
- 300 m outdoor range (typical)
- Direct-sequence spread spectrum (DSSS) for additional interference rejection

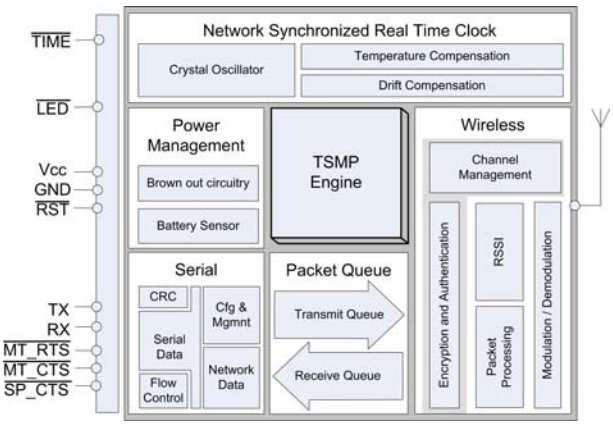


Table of Contents

1.0 Absolute Maximum Ratings

The absolute maximum ratings shown below should under no circumstances be violated. 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 (Vcc to GND)	–0.3		3.6	V	
Voltage on any digital I/O pin	–0.3		V_{CC} + 0.3 up to 3.6	V	
Input RF level			10	dBm	Input power at antenna connector
Storage temperature range	–45		+85	°C	
Lead temperature			+230	°C	For 10 seconds
VSWR of antenna			3:1		
* All voltages are referenced to GND					

Caution! The M2x40 can withstand an electrostatic discharge of up to 2 kV Human Body Model (HBM) or 200 V Machine Model (MM) applied to any header pin, except the antenna connector. The antenna input can withstand a discharge of up to 50 V.

2.0 Normal Operating Conditions

Table 2 Normal Operating Conditions

Parameter	Min	Typ	Max	Units	Comments
Operational supply voltage range (between Vcc and GND)	2.75		3.3	V	Including noise and load regulation
Voltage on analog input pins	0		1.8	V	
Voltage supply noise			200	mV_{p-p}	50 Hz–15 MHz
Peak current					
Power amplifier enabled			TBD	mA	TX during OTAP*. (TBD) ms max
			TBD	mA	TX, 5 ms maximum
			TBD	mA	Searching for network, 60 minutes maximum
			TBD	mA	Radio turn on, (TBD) µs max
			TBD	mA	boot_delay (see Table 7)
Peak current					
Power amplifier disabled			TBD	mA	TX during OTAP*. (TBD) ms max
			TBD	mA	TX, 5 ms maximum
			TBD	mA	Searching for network, 60 minutes maximum
			TBD	mA	Radio turn on, (TBD) µs max
			TBD	mA	boot_delay (see Table 7)
Average current					

Power amplifier enabled Power amplifier disabled		TBD TBD		µA µA	Assuming 80 byte packets, 1 per 2 minutes, data-only mote, 3V, 25 °C
Storage and operating temperatures	-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
*OTAP = over-the-air programming of motes					

Unless otherwise noted, Table 3 assumes V_{cc} is 3.0 V.

Table 3 Current Consumption

Parameter	Min	Typ	Max	Units	Comments
Transmit					
Power amplifier enabled		18		mA	
Power amplifier disabled		7		mA	
Receive		6		mA	
Sleep		5		µA	

3.0 Electrical Specifications

Table 4 Device Load

Parameter	Min	Typ	Max	Units	Comments
Total capacitance			15.5	µF	V_{cc} to GND

Unless otherwise noted, Vcc is 3.0 V and temperature is –40 °C to +85 °C

Table 5 Digital I/O Type 1

Digital Signal	Min	Typ	Max	Units	Comments
V_{IL} (low-level input voltage)	–0.3		0.6	V	
V_{IH} (high-level input voltage)	0.8 x V_{CC}		V_{cc} + 0.3	V	
V_{OL} (low-level output voltage)			0.4	V	
V_{OH} (high-level output voltage)	2.4			V	
Digital current*					
Output source (single pin)		3.7		mA	25 °C
Output sink (single pin)		2.0		mA	25 °C
Input leakage current		50		nA	25 °C
* This current level guarantees that the output voltage meets V_{OH} and V_{OL} specifications above.					

Table 6 Digital I/O Type 2

Digital Signal	Min	Typ	Max	Units	Comments
V_{IL} (low-level input voltage)	–0.3		0.6	V	
V_{IH} (high-level input voltage)	0.8 x V_{CC}		V_{CC} + 0.3	V	
V_{OL} (low-level output voltage, multi-function I/O configured as output)			0.6	V	I_{OL} < 0.6 mA, 85 °C
V_{OH} low-level output voltage, multi-function I/O configured as output)	V_{CC} – 0.6		V_{CC}	V	I_{OH} > –0.6 mA, 85 °C

Digital Signal	Min	Typ	Max	Units	Comments
Digital current*					
Output source (single pin, multifunction I/O configured as output)		0.6		mA	25 °C
Output sink (single pin, multifunction I/O configured as output)		0.6		mA	25 °C
Input leakage current		50		nA	25 °C
* This current level guarantees that the output voltage meets V_{OH} and V_{OL} specifications above.					

4.0 Timing Values

Table 7 Timing Values

Variable	Meaning	Min	Max	Units
$\overline{RST}$ pulse width	Reset timing	125		µs
interbyte_timeout	The time between consecutive data bytes on the serial port cannot exceed this time.		7	ms
interpacket_delay	The sender of an HDLC packet must wait at least this amount of time before sending another packet.	20		ms
ack_delay	The max time delay between the $\overline{MT\_RTS}$ and the receiver's acknowledge, $\overline{SP\_CTS}$.	1	500	ms
time_ack_timeout	The mote responds to all $\overline{TIME}$ pin activation requests within this time.		100	ms
diag_ack_timeout	The mote responds to all requests within this time.		125	ms
min_strobe_length	The length of the strobe signal.	500		ns
boot_delay	The time between mote power up and serial interface availability.		6250	ms

5.0 Radio

5.1 Detailed 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	-10	dBm	
Receiver sensitivity		–93		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					
Power amplifier enabled		+8		dBm	V_{DD} = 3 V, 25 °C
Power amplifier disabled		–3		dBm	V_{DD} = 3 V, 25 °C
Range*					
Power amplifier enabled:					
Indoor		100		m	25 °C, 50% RH, 1 meter above ground, +2 dBi omni-directional antenna
Outdoor		300		m	
Power amplifier disabled:					
Indoor		25		m	
Outdoor		200		m	
* 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 male connector is provided on board for the antenna connection. The antenna must meet specifications in Table 8. For a list of FCC-approved antennae see section 10.1.2.

Table 8 Antenna Specifications

Parameter	Value
Frequency range	2.4 – 2.4835 GHz
Impedance	50 Ω
Gain	+2 dBi maximum
Pattern	Omni-directional
Maximum VSWR	3:1
Connector	MMCX*
* The M2x40 can accommodate the following RF mating connectors: • MMCX straight connector such as Johnson 135-3402-001, or equivalent • MMCX right angle connector such as Tyco 1408149-1, or equivalent	

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

6.0 Pinout

The M2x40 has two 11-pin Samtec MTMM-111-04-S-S-175-3 (or equivalent) connectors on the bottom side for handling all of the I/O. The third pin in each of the connectors is not populated, and serves as a key for alignment. The connectors are mounted on opposite edges of the long axis of the M2x40.

6.1 M2x40 Pinout

The M2x40 provides a bidirectional flow-controlled serial interface (serial protocol is specified in section **Error! Reference source not found.**).

Table 9 M2x40 Pin Functions

Pin Number	Pin Name	Description	Type	Direction
1	GND	Ground	Power	–
2	VCC	Power	Power	–
3	KEY (no pin)	–	–	–
4	RX	UART Rx	Type 2	In
5	TX	UART Tx	Type 2	Out
6	$\overline{\text{LED}}$	Active low led turn on	Type 1	Out
7	$\overline{\text{MT\_RTS}}$	UART active low mote ready to send	Type 2	Out
8	$\overline{\text{MT\_CTS}}$	UART active low mote clear to send	Type 1	Out
9	$\overline{\text{SP\_CTS}}$	UART active low serial peripheral clear to send	Type 2	In
10	$\overline{\text{TIME}}$	Falling edge time request	Type 2	In
11	Mode_pin_B	Selects between Mode 1 & Mode 3 operation (9600bps & 115.2 kbps)	Type 2	In
12	$\overline{\text{FLASH\_P\_EN}}$	Active low flash power enable	–	–
13	*No connection*	–	–	–
14	*No connection*	–	–	–
15	*No connection*	–	–	–
16	*No connection*	–	–	–
17	SCK	SPI clock	–	–
18	MOSI	SPI master out slave in serial data	–	–
19	MISO	SPI master in slave out serial data	–	–
20	KEY (no pin)	–	–	–
21	$\overline{\text{SPI\_CS}}$	Active low flash chip select	–	–
22	$\overline{\text{RST}}$	Active low reset	Type 1	In

The $\overline{\text{RST}}$ input pin is internally pulled up, and connecting it is optional. When driven active low, the mote is hardware reset until the signal is deasserted. Refer to section 7.1 for timing requirements on the $\overline{\text{RST}}$ pin. Note that the mote may also be reset using the mote serial command (see Mote Serial API guide).

The $\overline{\text{TIME}}$ input pin is optional, and must either be driven or pulled up with a 5.1 MΩ resistor. Unless noted otherwise, all signals are active low.

7.0 Mote Boot Up

7.1 Power-on Sequence

The M2x40 mote has internal power-on-reset circuits that ensure that the mote will properly boot. However, for the power-on-reset circuitry to function properly, the external power supply must meet the timing shown in Figure 1 and specified in Table 10.

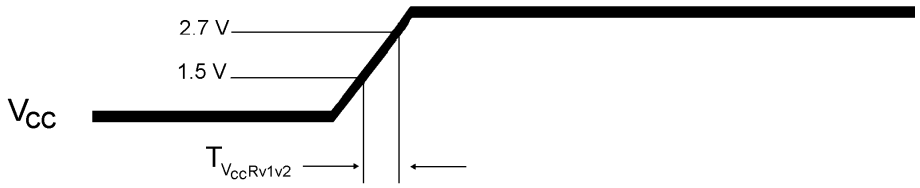


Figure 1 External Power Supply Timing Requirement

The following reset sequence (shown in Figure 2 and specified in Table 10) is required for external power supplies that fail to meet the requirement above.

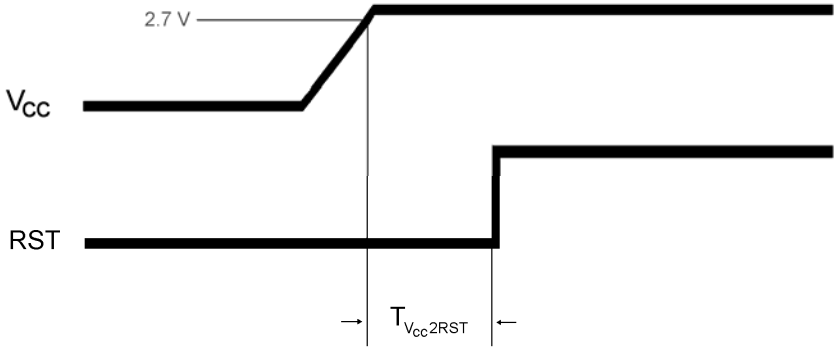


Figure 2 Power-on Sequence

Table 10 Power-on Sequence

Parameter	Min	Typ	Max	Units	Comments
$T_{Vcc2RST}$	0			ms	
$T_{VccRv1v2}$			10	µs	

7.2 Inrush Current

During power on, the mote can be modeled as a lumped impedance, as shown in Figure 3 . With a source impedance (R_{src}) of 1 Ω, the inrush current on the mote appears as shown in Figure 4.

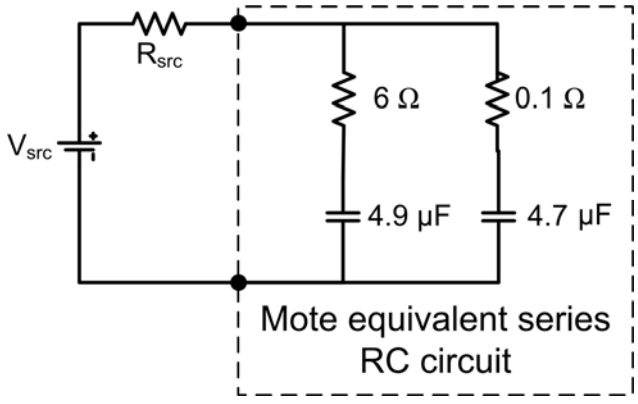


Figure 3 M2x40 Equivalent Series RC Circuit

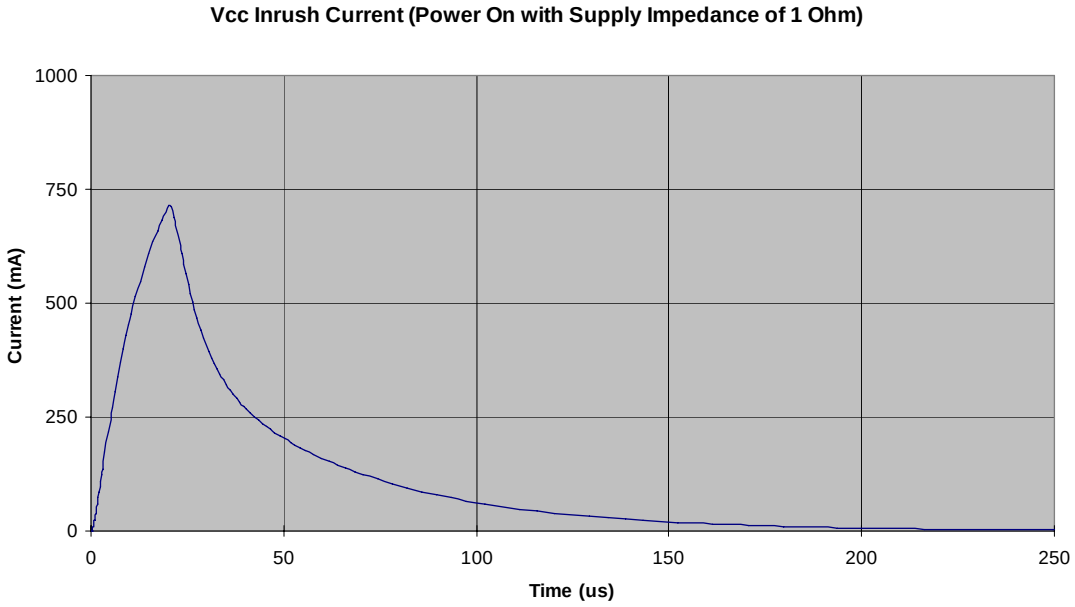


Figure 4 V_{CC} Inrush Current

7.3 Serial Interface Boot Up

7.3.1 M2x40 Serial Interface Boot Up

Upon M2x40 power up, the $\overline{\text{MT\_CTS}}$ line is high (inactive). The M2x40 serial interface boots within boot_delay (see **Error! Reference source not found.**) of the mote powering up, at which time the M2x40 will transmit an HDLC Mote Information packet. Note that full handshake (see section 8.3.2) is in effect and is required to receive this packet.

8.0 Interfaces

8.1 Timestamps

The M2x40 has the ability to deliver network-wide synchronized timestamps. The M2x40 sends a time packet (as described in **Error! Reference source not found.**) through its serial interface when one of the following occurs:

- Mote receives an HDLC Get Parameter request for time/state (see **Error! Reference source not found.**)
- On the M2x40, mote $\overline{\text{TIME}}$ signal is activated

The $\overline{\text{TIME}}$ pin is optional and has the advantage of being more accurate. The value of the timestamp is taken within approximately 1 ms of receiving a $\overline{\text{TIME}}$ signal activation. If the HDLC request is used, because of packet processing, the value of the timestamp may be captured several milliseconds after receipt of the packet. The real time delivered to the sensor processor is relative to the real time clock on the Manager, which serves as the Network Real Time Clock (NRTC). The time stamp skew across the network is guaranteed to be within ±250 ms of the NRTC.

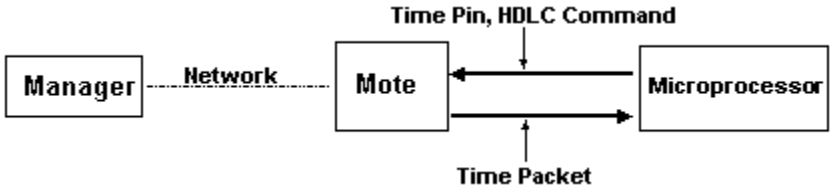
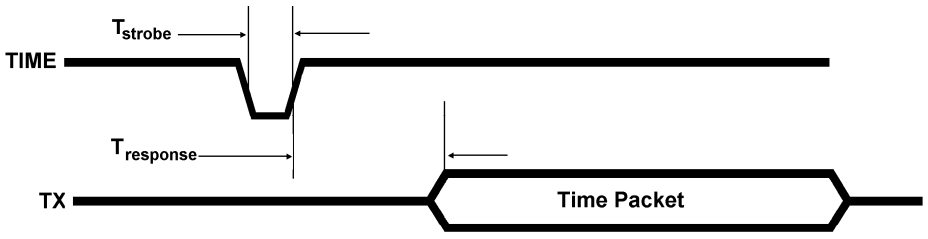


Figure 5 Network Real Time Clock

When the time pin is activated for at least min_strobe_length (see **Error! Reference source not found.**), the mote responds by sending the time packet within 100 ms delay.



T_{strobe} must be greater than or equal to min_strobe_length
$T_{response}$ is less than or equal to 100 ms

Figure 6 Operation of Time Pin

8.2 Status $\overline{LED}$ Signal

The M2x40 provides an output that can be used to drive a status $\overline{LED}$. This signal indicates network connectivity information which is most useful during mote installation. Alternatively, the mote's network status may be polled via serial using the Get Parameter request with the mote state parameter (see section Mote Serial API Guide).

Table 11 Status $\overline{LED}$ Signal

$\overline{LED}$ Signal Behavior	Mote State
High	Off, or in sleep mode
Single blink (750 ms low, 3 s high)	On, and searching for potential network
Double blink (750 ms low, 750 ms high, 750 ms low, 3 s high)	On, and attempting to join the network
Triple blink (750 ms low, 750 ms high, 750 ms low, 750 ms high, 750 ms low, 3 s high)	On, and attempting to establish redundant links
Low	On, fully configured into network with redundant parents

8.3 Serial Interface

8.3.1 Serial Interface Overview

The M2x40 offers a well-defined five-signal serial interface that is optimized for low-powered embedded applications. This serial interface offers a serial port comprised of the data pins (TX, RX) as well as handshake pins ($\overline{MT\_RTS}$, $\overline{MT\_CTS}$, $\overline{SP\_CTS}$) used for bidirectional flow control. Through this port, the M2x40 provides a means of transmitting and receiving serial data through the wireless network, as well as a command interface that provides synchronized time stamping, local configuration, and diagnostics.

The serial handshake provides for flow control of packets transmitted via the M2x40 serial interface. Packet delineation and error control are handled separately. The handshake supports the following:

- Full-duplex communication
- Bidirectional byte-level flow control

The five-signal serial port is comprised of the data pins (TX, RX) as well as the handshake pins ($\overline{MT\_RTS}$,$\overline{MT\_CTS}$, $\overline{SP\_CTS}$) used for bidirectional flow control. This port supports 9600 bps operation in full-duplex mode. The handshake signals are active low.

Table 12 Mode 1 and Mode 3 Serial Parameters

Parameter	Mode 1	Mode 3
Serial		
Control signals	5-signal	5-signal
Flow control	Bidirectional	Bidirectional
Bit rate	9600 bps	115.2 kbps

The following diagram illustrates the pins used in the handshaking protocol.

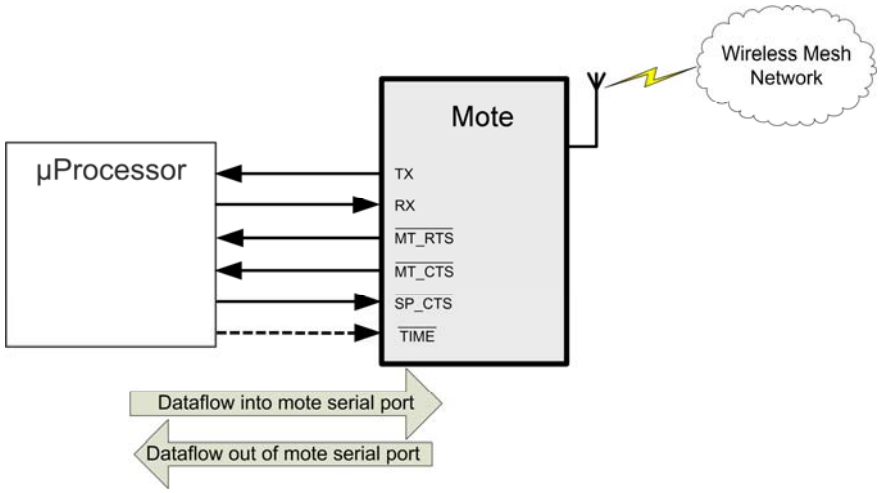


Figure 7 Diagram of Pins Used in Handshaking Protocol

Table 13 Pin Usage

Pin	Usage
RX, TX	Used for serial data flow into and out of the mote.
$\overline{\text{MT\_RTS}}$	This signal goes active low when the mote is ready to send a serial packet. The signal stays low until the $\overline{\text{SP\_CTS}}$ signal from the microprocessor goes active low (indicating readiness to receive a packet) or the ack_delay timeout (see **Error! Reference source not found.**) expires.
$\overline{\text{SP\_CTS}}$	$\overline{\text{SP\_CTS}}$ should transition from high to active low in response to the $\overline{\text{MT\_RTS}}$ signal from the mote. This indicates that the microprocessor is ready to receive serial packets. Following this, the microprocessor should strobe $\overline{\text{SP\_CTS}}$ after receiving each byte. After all packets are received, the microprocessor should de-assert the $\overline{\text{SP\_CTS}}$ signal.
$\overline{\text{MT\_CTS}}$	$\overline{\text{MT\_CTS}}$ indicates the state of the network connection and availability of data buffers to receive packets destined for the network. Once the mote has established wireless network connection, it will use the $\overline{\text{MT\_CTS}}$ pin to signify availability to accept serial packets for wireless transmission. At certain critical times during communication, the mote may bring $\overline{\text{MT\_CTS}}$ high. $\overline{\text{MT\_CTS}}$ will remain high if the mote does not have enough buffer space to accept another packet. It will also remain high if the mote is not part of the network. OEM designs must check that the $\overline{\text{MT\_CTS}}$ pin is low before initiating each serial packet for wireless transmission. Note that the mote may receive local serial packets at any time regardless of the $\overline{\text{MT\_CTS}}$ state. Upon receipt of the first byte of the HDLC packet, the mote strobes $\overline{\text{MT\_CTS}}$ in acknowledgement of each subsequent byte. After the last byte of the packet is received, $\overline{\text{MT\_CTS}}$ switches back to signaling the availability of the network connection and data buffers. The microprocessor should wait a minimum of interpacket_delay (see **Error! Reference source not found.**) before initiating another packet transmission. The mote can accept local commands (packets that are not sent through the network) at any time, and the status of the $\overline{\text{MT\_CTS}}$ pin may be ignored when initiating these packets. ($\overline{\text{MT\_CTS}}$ acknowledges each byte, as specified in section 8.3.2.1. For a list of local commands, see Mote Serial API guide.)
$\overline{\text{TIME}}$	The $\overline{\text{TIME}}$ pin is optional and can be used for triggering a timestamp packet. For details, refer to 8.1.

8.3.2 Serial Interface Timing Requirements

8.3.2.1 CTS Byte-level Handshake

The following diagram shows generic CTS byte-level flow control timing. The following details are applicable to both $\overline{\text{MT\_CTS}}$ and $\overline{\text{SP\_CTS}}$.

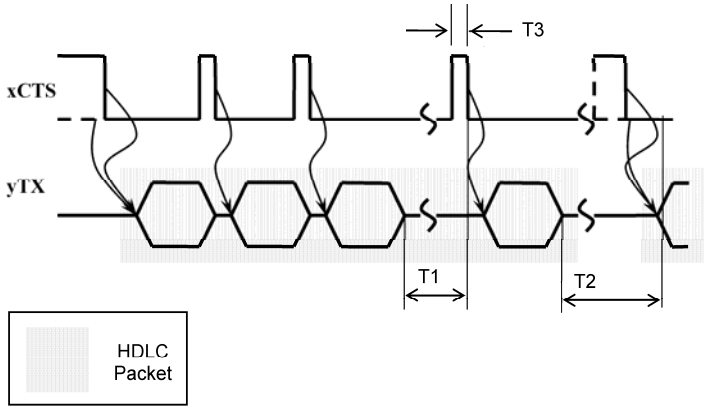


Figure 8 CTS Byte-level Flow Control Timing

Timeouts T1, T2, and T3 are defined as follows (refer to **Error! Reference source not found.** for values):

T1: interbyte_timeout—Maximum time between the transmit module sending a byte and the receiving module acknowledging the byte using CTS (requests the next byte).

T2: interpacket_delay—For communications into the mote, the minimum time after the mote receives the last byte of a packet before it can start receiving the next packet. For communications out of the mote, the minimum time between the mote receiving acknowledgement of the last byte reception (or timeout) and the mote driving $\overline{\text{MT\_RTS}}$ to request to send another packet.

T3: min_strobe_length—The minimum length of time that CTS must be held active to be recognized by the receiver.

In idle mode or upon expiration of the interbyte_timeout, the transmit side treats CTS as level triggered ($\overline{\text{MT\_RTS}}$ is disregarded in case of local serial packets). After transfer of the first byte of a packet, the meaning of CTS signal is changed to a byte acknowledgement strobe, active on a falling edge. In other words, CTS becomes a request signal for the next byte of a packet. This acknowledgement strobe will occur for all packets (both local and network packets). Whenever timeouts T1 or T2 occur, the packet is discarded and both sides switch to idle mode and start hunting for the next HDLC packet, assuming CTS active low. If a packet is transferred completely, the interbyte_timeout after the last byte naturally takes care of switching to idle mode.

8.3.2.2 Data Flow Out of the Mote Serial Port

Figure 9 illustrates the process that the mote uses to transmit serial data:

1. The mote ensures the interpacket_delay time has passed since the last transmission.
2. The mote drives $\overline{\text{MT\_RTS}}$ to active, waits for a falling edge on $\overline{\text{SP\_CTS}}$. Timeout is defined as ack_delay (see **Error! Reference source not found.**), and is long enough to handle the worst-case response.
3. If the mote times out before the $\overline{\text{SP\_CTS}}$ becomes active, the mote restores $\overline{\text{MT\_RTS}}$ to inactive and drops the packet.
4. If $\overline{\text{SP\_CTS}}$ is active, then the mote transmits the first byte and follows the CTS byte-level handshaking rules for subsequent bytes.
5. $\overline{\text{MT\_RTS}}$ is restored to inactive after the ack_delay timeout has expired.

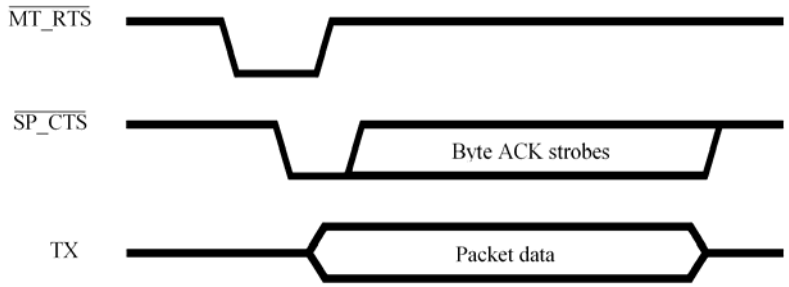


Figure 9 Packet Transmission from Mote

8.3.2.3 Data Flow Into the Mote Serial Port

Figure 10 illustrates the process the mote uses to receive serial data.

The mote may receive serial packets for local commands (not intended for wireless transmission) at any time regardless of the $\overline{\text{MT\_CTS}}$ status.

The mote signals its readiness to receive serial packets for wireless transmission (serial payload command 0x80) by driving $\overline{\text{MT\_CTS}}$ active low. The mote will drive $\overline{\text{MT\_CTS}}$ low within interpacket_delay time (see **Error! Reference source not found.**) after the transmission of the last packet.

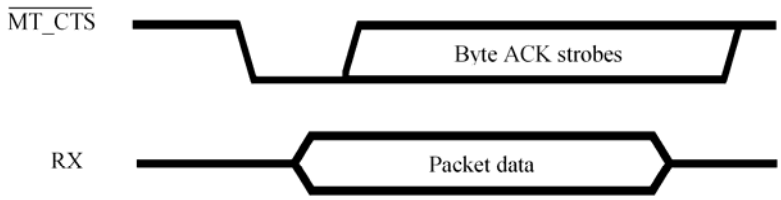


Figure 10 Packet Transmission to Mote

9.0 Packaging Description

9.1 Mechanical Drawing

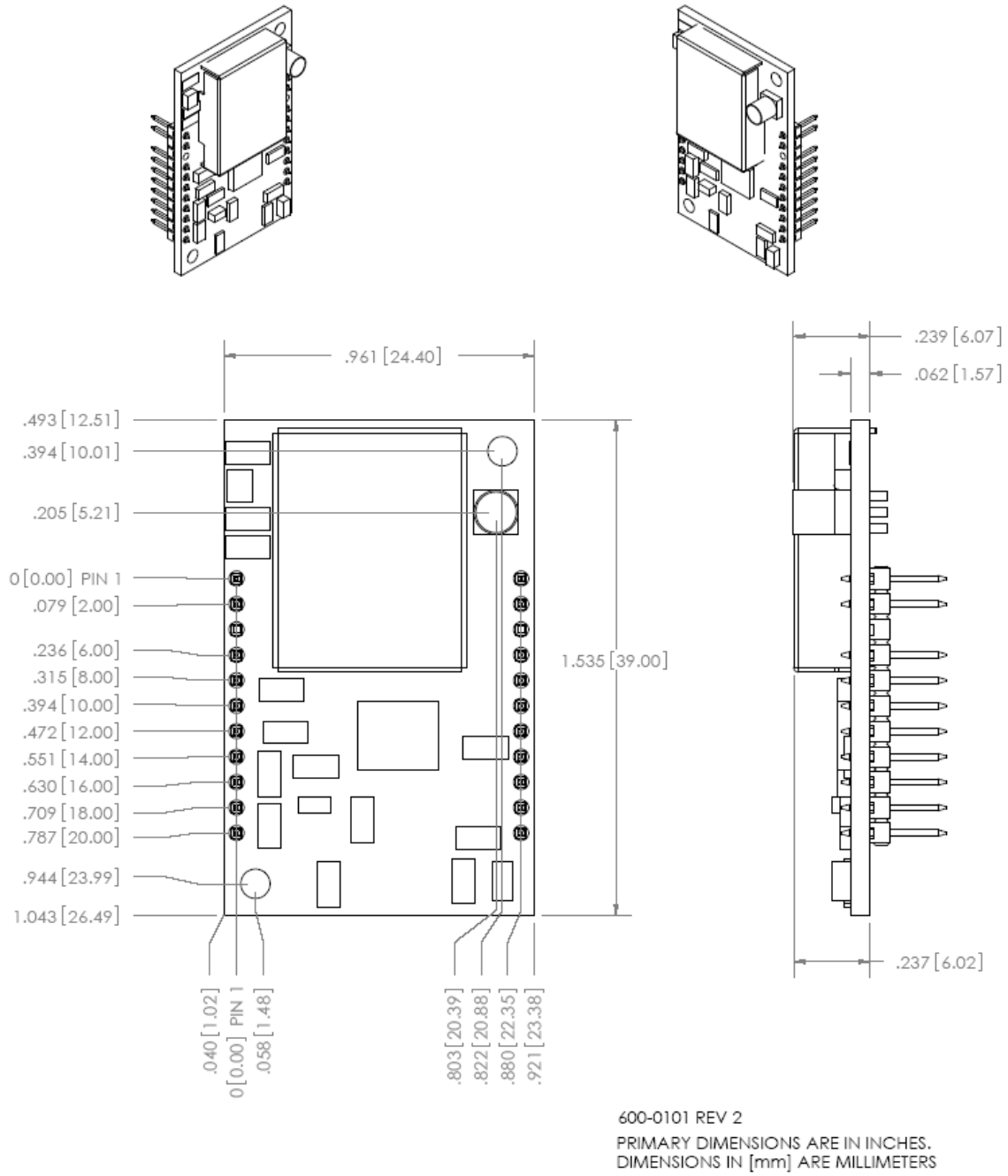


Figure 11 M2x40 Mote Mechanical Drawing

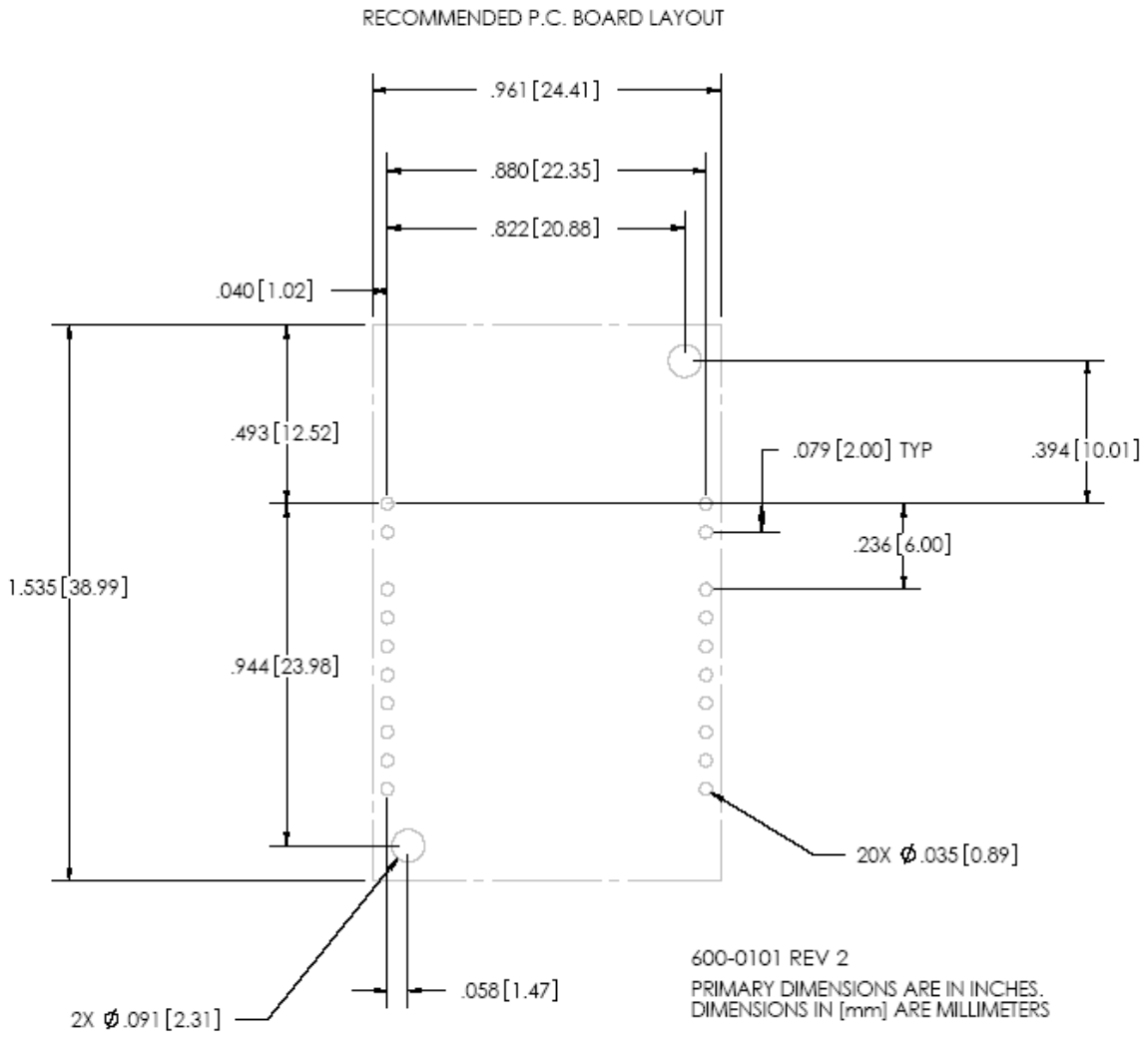


Figure 12 M2x40 Mote Footprint

9.2 Soldering Information

The M2x40 can be hand soldered with a soldering iron at 230 °C. The soldering iron should be in contact with the pin for 10 seconds or less. The M2x40 is also suitable for eutectic PbSn reflow.

10.0 Regulatory and Standards Compliance

10.1 FCC Compliance

The M2x40 mote complies with Part 15.247 modular (Intentional Radiator) of the FCC rules and regulations. Changes or modifications not expressly approved by Dust Networks could void the user's authority to operate the equipment.

10.1.1 FCC Testing

In order to fulfill FCC certification requirements, products incorporating the M2x40 mote 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 10.1.3 below.
2. The antenna must be electrically identical to the FCC-approved antenna specifications for the M2x40 as described in 10.1.2 with the exception that the gain may be lower than specified in Table 14.
3. The device integrating the M2x40 mote 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 M2x40 mote, 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 Antennae

The following are FCC-approved antenna specifications for the M2x40

Table 14 FCC-approved Antenna Specifications for the M2x40

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 Industry Canada (IC) Compliance

10.2.1 IC Testing

The M2x40 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 M2x40.

Table 15 IC-approved Antenna Specifications for the M2x40

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

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: 5853A-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 M2140 and M2040, 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 M2140 and M2040 motes 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 M2140/M2040 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 5mm 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 13 CE Label Requirements

10.3.4 Restrictions

France—France imposes restrictions on the 2.4 GHz band. Go to www.art-telecom.Fr or contact Dust Networks for more information.

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 M2x40 is designed to meet the specifications of a harsh industrial environments which includes:

- **Shock and Vibration**—The M2x40 complies with high vibration pipeline testing, as specified in IEC 60770-1.
- **Hazardous Locations**—The M2x40 design is consistent with operation in UL Class 1 Division 1 and Division 2 hazardous locations.
- **Temperature Extremes**—The M2x40 is designed for industrial storage and operational temperature range of –40 °C to +85 °C.

11.0 Ordering Information

Product List:

M2x40: Marconi / 2.4 GHz MHz Mote

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

Document Number: 020-0026 rev 1 M2140 / M2040 Datasheet

Last Revised: December 7, 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.