SmartMesh® IP LM6000

2.4 GHz Ultra Low-Power Embedded Network Manager

About SmartMesh IP

Dust Networks' new standards-based SmartMesh® IP product achieves unsurpassed levels of networking resilience and reliability, with advanced network management and comprehensive security. Based on Dust's breakthrough Eterna™ technology, SmartMesh IP enables up to 8x lower power consumption than competing solutions even in harsh, dynamically changing RF environments. Cost effective, IP compatible and widely applicable, SmartMesh IP serves an extensive range of applications. SmartMesh IP has an optional feature that provides for location awareness, which allows you to report the physical location of your mote upon request.

Product Description—LM6000

Based on 6LoWPAN and IEEE 802.15.4e Standards, the LM6000 SmartMesh IP embedded network manager anchors the SmartMesh IP product line. It serves not only as a wireless-to-wired access point, but more importantly provides the core networking functionality, enabling the network to achieve unsurpassed levels of resiliency, reliability, and scalability. The LM6000 continuously optimizes the network and provides robustness in the face of constantly changing RF environments. Furthermore, the network manager's load balancing algorithms add more bandwidth for the busiest motes while maintaining normal traffic flow for the rest of the network. The LM6000 optionally supports location awareness, so you now have the ability to identify the location of a device with a <4m accuracy.

The LM6000 embedded network manager comes in an easy-to-integrate 42 mm x 24 mm surface-mount module that includes U.FL antenna connector and modular FCC, IC, CE certifications. The manager offers a comprehensive set of serial APIs via UART interfaces, providing full visibility and control over network configuration, security administration, network status, and performance statistics. With its combination of low power, compact easy-to-integrate form factor, and sophisticated network management, the LM6000 embedded network manager is ideally suited for deploying resilient, reliable mesh networks in a wide variety of environments and applications.

Key Features

SmartMesh IP Mesh Networking Performance

- Advanced network management—dynamically optimizes mesh connectivity based on the changing RF environment
- Load balancing & optimization—adds bandwidth for the busiest motes while maintaining normal traffic flow for the rest of network
- Intelligent power management—balances traffic so that power consumption is also balanced within the network
- Battery powered routers—low power enables routers to run on batteries
- Auto-forming, self-healing, self-sustaining—automatically configures and maintains the network without requiring on-site wireless expertise.
- Compact manager design manages networks up to 32 motes
- Location aware (optional)—reports physical location

Time Synchronized Mesh Networking

- Zero collision packet exchange—for scalability and energy efficiency
- Advanced RF resiliency—hops channels to avoid inevitable RF interference and creates redundant routes through the mesh
- Highly Accurate Time Stamping—with millisecond accuracy

Full Application Flexibility

- Dynamic bandwidth—creates temporary high bandwidth "pipes"
- Low latency mode—mode for fastest packet transfer

Fast and Low Risk Integration

- Compact hardware module—42 mm x 24 mm surface mount module with U.FL antenna connector
- Low power manager operation—enables battery, energy-harvested, or line powered operation
- Advanced software design for simple integration—comprehensive set of APIs

Pre-Engineered RF

- Eterna-based IEEE 802.15.4 radio
  - Up to 8x lower power with Eterna™
  - RX current <5mA
  - TX current <10 mA @ 8dBm (< 6 mA @ 0dBm)
- Fully integrated RF capabilities—on-board PA/LNA, RF switches, antenna matching circuitry
- External PA/LNA support—optional timing signals for controlling an external power amplifier and low noise amplifier
- RF modular certifications (pending)—FCC, IC and CE

Comprehensive Security Management

- Three levels of device authentication
- Strong AES-based data encryption
- Key management with multiple keys
- Message integrity checking

Table of Contents

1.0 Features

1.1 Simple, Highly Configurable Network Formation

All SmartMesh IP networks are auto-forming, self-healing, and self-sustaining. By default, all motes are low power and routing capable, providing both ease of installation and ease of network expandability. For deployments with specific considerations, the LM6000 network manager provides advanced configurability for tailoring network formation to suit the needs of the application. Examples of the rich configurability of SmartMesh IP networks include:

- **Intelligent Power Management**—the network supports motes with different capacity power supplies, such as line-, battery-, or energy harvested powered devices. The network manager will allocate bandwidth as efficiently as possible without exceeding each mote's power supply capabilities.
- **Low Latency Mode**—the network can be configured to take advantage of line-powered motes to form a low latency backbone. In this mode, the mesh network reaches the low latency often associated with single-hop systems, but with the multi-hop reach and fault-tolerance of a fully-mesh network
- **Non-Routing Motes**—some deployments call for motes to have the absolute lowest power consumption (for example, a battery-powered mote that is physically difficult to reach). For such cases, SmartMesh IP networks support the ability to designate a mote as non-routing (sometimes referred to as leaf, or end nodes).

1.2 Highly Efficient Bandwidth and Energy Usage

With its time-synchronized packet exchange, a SmartMesh IP network has zero in-network data packet collisions, eliminating the wasted energy associated with packet retries. The LM6000 network manager automatically schedules bandwidth to each mote in the network, based on the needs of the application. The LM6000 can dynamically increase or decrease bandwidth to motes that change data rates over time. This efficient usage of the RF bandwidth results in even lower overall power consumption and greater network traffic capacity.

1.3 Advanced Software Design for Simple Integration

The LM6000 provides full configurability, visibility, and debug capability to the network through the UART-based API interface and a separate UART command line interface (CLI). Users may use the sample software utilities such as the GUI-based network viewing software included in the SmartMesh IP evaluation kit. Alternatively, OEMs may build custom management and diagnostics applications through the API interface. The CLI interface provides text-based network statistics, configuration, and diagnostics via a password protected human-readable interface.

1.4 Compact, Low Power Hardware

Built on Dust Networks' low power Eterna platform, the LM6000 enables battery, energy-harvested, or line powered operation, making it ideal for remote locations where available power may be sparse. With its compact size and pre-engineered RF, the LM6000 is equally well suited for embedding into existing OEM equipment or for deploying an unobtrusive small network that blends into the background.

2.0 Pinout

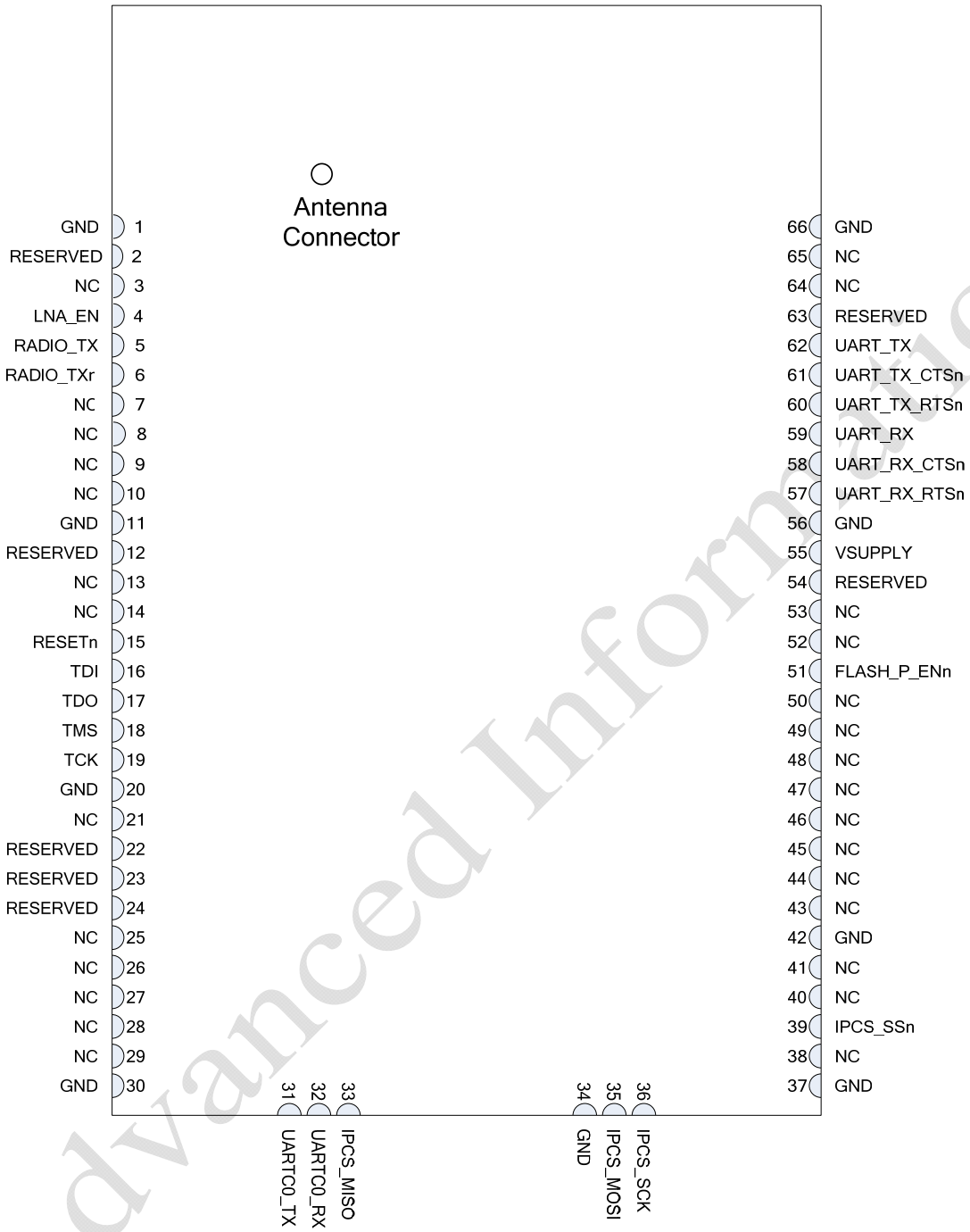

Figure 3 LM6000 – Manager Module with U.FL Antenna Connector

In the following table, pins are grouped by function. In some cases, a pin may have multiple possible functions.

Note: All unused input pins must be driven to an inactive state to avoid excess leakage and undesired operation. Leakage due to floating inputs can be substantially greater than the average power consumption.

Table 1 LM6000 Manager Pinout Assignments

No	Power Supply	Type	I/O	Description
1	GND	Power	-	Ground
11	GND	Power	-	Ground
20	GND	Power	-	Ground
30	GND	Power	-	Ground
34	GND	Power	-	Ground
37	GND	Power	-	Ground
42	GND	Power	-	Ground
56	GND	Power	-	Ground
66	GND	Power	-	Ground
55	VSUPPLY	Power	-	Power supply input
No	**Radio**	**Type**	**I/O**	**Description**
4	LNA_EN	1	O	External LNA enable
5	RADIO_TX	1	O	Radio TX active (external PA enable/switch control)
6	RADIO_TXn	1	O	Radio TX active (external PA enable/switch control), active low
No	**General**	**Type**	**I/O**	**Description**
15	RESETn	1	I	Reset, Input, active low
No	**JTAG**	**Type**	**I/O**	**Description**
16	TDI	1	I	JTAG test data in
17	TDO	1	O	JTAG test data out
18	TMS	1	I	JTAG test mode select
19	TCK	1	I	JTAG test clock
No	**CLI**	**Type**	**I/O**	**Description**
31	UARTC0_TX	2	O	CLI UART 0 transmit
32	UARTC0_RX	1	I	CLI UART 0 receive
No	**UART**	**Type**	**I/O**	**Description**
57	UART_RX_RTSn	1	I	UART receive (RTS) request to send, active low
58	UART_RX_CTSn	1	O	UART receive (CTS) clear to send, active low
59	UART_RX	1	I	UART receive
60	UART_TX_RTSn	1	O	UART transmit (RTS) request to send, active low
61	UART_TX_CTSn	1	I	UART transmit (CTS) clear to send, active low
62	UART_TX	2	O	UART transmit
No	**FLASH Programming**	**Type**	**I/O**	**Description**
33	IPCS_MISO	2	O	SPI flash emulation (MISO) master in slave out port
35	IPCS_MOSI	1	I	SPI flash emulation (MOSI) master out slave in port
36	IPCS_SCK	1	I	SPI flash emulation (SCK) serial clock port
39	IPCS_SSn	1	I	SPI flash emulation slave select, active low
51	FLASH_P_ENn	1	I	Flash program enable, active low Note that this functionality is available only when RESETn is asserted
Note: The following pins are reserved or NC and should not be connected: 2, 3, 7, 8, 9, 10, 12, 13, 14, 21, 22, 23, 24, 25, 26, 27, 28, 29, 38, 40, 41, 43, 44, 45, 46, 47, 48, 49, 50, 52, 53, 54, 63, 64, and 65.				

2.1 Power Supply

The LM6000 is powered from a single pin, VSUPPLY, generating all the internally required supplies. With two integrated DC/DC converters and four voltage regulators, the sensitivity to noise on VSUPPLY is minimal.

2.1.1 Power-on Reset Voltage Supervision

The LM6000 will enter power-on reset state when VSUPPLY dips below 1.5 V and will remain there until this minimum voltage is applied to VSUPPLY.

2.2 Radio

The LM6000 is built on the Eterna platform, the lowest power commercially available 2.4 GHz IEEE 802.15.4 radio by a substantial margin. (Refer to section 5.1 for current consumption numbers.) In addition to the functionality required to be a 2.4 GHz IEEE 802.15.4e–compliant transmitter, the LM6000's transmitter supports calibrated and temperature-compensated output power optimized to consistently provide power at a limit suitable for worldwide radio certifications. Additionally, the LM6000 leverages its MAC Co-Processor (MCP), which handles precise sequencing of radio-related functions, and other coprocessors like its AES engine to free the CPU to deliver the LM6000's advanced network management performance in a compact, low power package.

2.2.1 Antenna

The LM6000 allows direct connection to a single-ended 50-Ohm antenna, or optionally to an external power amplifier/low noise amplifier (PA/LNA) circuit. It incorporates a TX/RX switch, and because the transmit and receive signals are single-ended, a balun (and its associated transformer efficiency losses) are not required. With an on-board integrated PA, the LM6000 provides programmable output power typically at 0 dBm or at +8 dBm. In addition, the LM6000 can be configured to drive optional control signals for an external PA and/or LNA. The antenna must meet the specifications in Table 2. For further details on radio transmit and receive, see section 2.2.

Antenna Specifications

Parameter	Value
Frequency range	2.4–2.4835 GHz
Impedance	50 Ω
Maximum VSWR	3:1
Antenna jack	U.FL

2.2.2 External PA/LNA Control

The LM6000 features an on-board power amplifier (PA), optimized for +8 dBm conducted RF output power for worldwide license-free operation in the 2.4 to 2.4835 GHz frequency band. For controlling an external PA and/or LNA, the LM6000's MCP drives signals for external LNA enable (LNA_EN), and external PA enable and switch control (active high RADIO_TX and active low RADIO_TXn).

2.3 Reset

The RESETn input pin is internally pulled up. Given the LM6000's internal power-on reset circuit, externally driving RESETn is optional. Note that for a graceful shutdown, it is recommended that the software and networking layers be cleanly halted prior to assertion of the RESETn pin.

2.4 JTAG

The LM6000 includes an IEEE 1149.1-compliant JTAG port for boundary scan.

2.5 UARTs

The LM6000 includes two UARTs: the API UART and CLI UART, both of which are optimized to support operation consistently during both the Doze and Active states of operation.

Each UART supports the following:

- Configurable baud rate
- Even/Odd/No parity
- 1 or 2 stop bits
- 16x over-sampling with noise filtering
- Transmit scatter/gather DMA

CLI UART supports a four-byte receive FIFO and is limited to 57600 baud. In addition, the API UART supports:

- Receive scatter/gather DMA
- HDLC support in hardware
- Support of rates to 115.2 kBaud with only 2 wires when HDLC is enabled

Table 3 UART Details

UART Port	Pins	Software Function
UART (API)		API
UART (CLI)	UARTC0_TX, UARTC0_RX	CLI for debugging and troubleshooting

2.5.1 LM6000 UART Protocols

In a system design with more than one device communicating across a serial port, higher serial data rates translate into lower power consumption. In addition to receive and transmit signals the LM6000 provides an additional pair of signals, UART_TX_RTSn and UART_TX_CTSn, to support low power implementations when the LM6000 is connected to another low power microcontroller. When these pins are enabled, the LM6000 asserts the active low UART_TX_RTSn, transmit request to send, and waits for the assertion of UART_TX_CTSn prior to transmitting the packet. For details on the timing of the UART protocols, see section 5.10 (UART AC timing).

2.6 Flash Programming

When both RESETn and FLASH_P_ENn are asserted, the LM6000 disables normal operation and enters a mode to emulate the operation of a serial flash. To support in-circuit programming, the LM6000 can present itself as a serial flash device on the IPCS_SSn, IPCS_SCK, IPCS_MOSI, and IPCS_MISO pins. In this mode, its flash can be programmed with software updates.

2.7 Temperature Sensor

The LM6000 has an on-board temperature sensor. The temperature readings are available locally through the manager serial API.

3.0 Absolute Maximum Ratings

The absolute maximum ratings shown in Table 4 should not be violated under any circumstances. Permanent damage to the device may be caused by exceeding one or more of these parameters. Unless otherwise noted, all voltages in Table 4 are made relative to VSS.

Table 4 Absolute Maximum Ratings

Parameter	Min	Typ	Max	Units	Comments
Supply voltage (VSUPPLY to VSS)	–0.3		3.75	V	
Voltage on any digital I/O pin	–0.3		VSUPPLY + 0.3 up to 3.75	V	
Input RF level			10	dBm	Input power at antenna connector
Storage temperature range	–40		+125	°C	Extended storage above 105 deg C will reduce the device's operating life
Lead temperature			+245	°C	For 10 seconds
VSWR of antenna			3:1		
ESD protection					
Antenna pad			±700	V	HBM
All other pads			±2000	V	HBM
			±200	V	CDM

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

4.0 Recommended Operating Conditions

Table 5 Recommended Operating Conditions

Parameter	Min	Typ	Max	Units	Comments
Operational supply voltage range (between VSUPPLY and VSS)	2.1	3.6	3.75	V	Including noise and load regulation
Voltage supply noise			250	mV_{p-p}	50 Hz to 2 MHz
Operating temperature range	–40		+85	°C	
Operating relative humidity	10		90	% RH	Non-condensing
Power on Reset threshold		1.5		V	
Temperature ramp	–8		+8	°C/min	

5.0 Electrical Characteristics

5.1 Detailed Radio Specifications

The following characteristics are measured with VSUPPLY = 3.6 V at to 25 °C, unless otherwise specified.

Table 6 Detailed Radio Specifications

Parameter	Conditions	Min	Typ	Max	Units
Operating frequency	As specified by [1]	2.4000		2.4835	GHz
Number of channels			15		
Channel separation	As specified by [1]		5		MHz
Occupied channel bandwidth	At –20 dBc		2.7		MHz
Modulation	IEEE 802.15.4 DSSS				
Raw data rate	As specified by [1]		250		kbps
Range* Indoor† Outdoor† Free space	25 °C, 50% RH, +2 dBi omni-directional antenna		 100 300 1200		 m m 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.

† 1 meter above ground.

5.2 DC Characteristics

The following characteristics are measured with VSUPPLY = 3.6 V at to 25 °C, unless otherwise specified.

Table 7 LM6000 Current Consumption

Parameter	Conditions	Min	Typ	Max	Units
Reset	After power-on reset		1.2		µA
Serial Flash Emulation			20		mA
Peak Operating current at 8 dBm output power at 0 dBm output power	System operating at 14.7 MHz Radio Tx Flash Write			 30 26	 mA mA
Flash write	Single bank write		3		mA
Flash erase	Single bank page or mass erase		2.5		mA
Radio Tx†	Mesh Network - CLK = 7.3728 MHz, AES active 0 dBm output power 8 dBm output power		 5.4 9.7		 mA mA
Radio Rx†	Mesh Network - CLK = 7.3728 MHz, AES active Low Bias		 4.5		 mA

† CPU idle.

5.3 Radio Receive Characteristics

The following characteristics are measured with VSUPPLY = 3.6 V at to 25 °C, unless otherwise specified.

Table 8 Radio Receive Characteristics

Parameter	Conditions	Min	Typ	Max	Units
Frequency range		2.4000		2.4835	GHz
Receiver sensitivity	PER = 1%, as specified by [1]		–91		dBm
Saturation (maximum input level)			0		dBm
Adjacent channel rejection (high side)	Desired signal at -82 dBm, adjacent modulated channel at 5 MHz, PER = 1%, as specified by [1]		22		dBc
Adjacent channel rejection (low side)	Desired signal at -82 dBm, adjacent modulated channel at -5 MHz, PER = 1%, as specified by [1]		19		dBc
Alternate channel rejection (high side)	Desired signal at -82 dBm, adjacent modulated channel at 10 MHz, PER = 1%, as specified by [1]		40		dBc
Second alternate channel rejection (high side)	Desired signal at -82 dBm, adjacent modulated channel at 10 MHz, PER = 1%, as specified by [1]		42		dBc
Alternate channel rejection (low side)	Desired signal at -82 dBm, adjacent modulated channel at -10 MHz, PER = 1%, as specified by [1]		36		dBc
Second alternate channel rejection (low side)	Desired signal at -82 dBm, adjacent modulated channel at 10 MHz, PER = 1%, as specified by [1]		42		dBc
Co-channel rejection	Desired signal at -82 dBm. Undesired signal is 802.15.4 modulated at same frequency. PER = 1%.		–6		dBc
LO feed through			<–47		dBm
Frequency error tolerance	[1] requires ±40		±50		ppm
Symbol rate error tolerance			±50		ppm
RSSI input range			–10 to –90		dBm
RSSI accuracy			±4		dB
RSSI resolution			1		dB

5.4 Radio Transmitter Characteristics

The following characteristics are measured with VSUPPLY = 3.6 V at to 25 °C, unless otherwise specified

Table 9 Radio Transmitter Characteristics

Parameter	Conditions	Min	Typ	Max	Units
Output power Calibrated settings	Delivered to a 50 Ω load, over temperature and voltage ranges		0 8		dBm dBm
Frequency range		2.4000		2.4835	GHz
Spurious emissions 30 MHz to 1000 MHz 1 GHz to 12.75 GHz	Conducted measurement with a 50 Ω single-ended load, +8 dBm output power		 <–47 <–35		 dBm dBm
2nd Harmonic	Delivered to a 50 Ω load		–35		dBm
3rd Harmonic	Delivered to a 50 Ω load		–38		dBm

5.5 Digital I/O Characteristics

The following characteristics are measured with VSUPPLY = 3.6 V at to 25 °C, unless otherwise specified.

Table 10 Digital I/O Type 1

Parameter	Conditions	Min	Typ	Max	Units
V_{IL} (low-level input voltage)		–0.3		0.6	V
V_{IH} (high-level input voltage)		VSUPPLY - 0.3		VSUPPLY + 0.3	V
V_{OL} (low-level output voltage)	$I_{OL(max)}$ = 1.2 mA			0.4	V
V_{OH} (high-level output voltage)	$I_{OH(max)}$ = −1.8 mA	VSUPPLY - 0.3		VSUPPLY + 0.3	V
Input leakage current			50		nA

Table 11 Digital I/O Type 2

Parameter	Conditions	Min	Typ	Max	Units
V_{IL} (low-level input voltage)		–0.3		0.6	V
V_{IH} (high-level input voltage)		VSUPPLY - 0.3		VSUPPLY + 0.3	V
V_{OL} (low-level output voltage) Low Drive	$I_{OL(max)}$ = 2.2 mA			0.4	V
V_{OH} (high-level output voltage) Low Drive	$I_{OH(max)}$ = −3.2 mA	VSUPPLY - 0.3		VSUPPLY + 0.3	V
V_{OL} (low-level output voltage) High Drive	$I_{O(max)}$ = 4.5 mA			0.4	V
V_{OH} (high-level output voltage) High Drive	$I_{OH(max)}$ = −6.3 mA	VSUPPLY - 0.3		VSUPPLY + 0.3	V
Input leakage current			50		nA

5.6 Temperature Sensor Characteristics

The following characteristics are measured with VSUPPLY = 3.6 V at to 25 °C, unless otherwise specified.

Table 12 Temperature Sensor Characteristics

Parameter	Conditions	Min	Typ	Max	Units
Offset	Temperature offset error at 25 ºC		±0.25		°C
Slope error	Slope error from -40 to +85 ºC		±0.033		°C/°C
Current consumption			65		µA

5.7 System Characteristics

The following characteristics are measured with VSUPPLY = 3.6 V at to 25 °C, unless otherwise specified.

Table 13 System Characteristics

Parameter	Conditions	Min	Typ	Max	Units
Radio baud rate			250	2000	kbps
RESETn pulse width		125			µs

5.8 FLASH AC Timing

The following characteristics are measured with VSUPPLY = 3.6 V at to 25 °C, unless otherwise specified.

Table 14 FLASH AC Timing Values

Parameter	Conditions	Min	Typ	Max	Unit
$t_{32\text{-BIT\_WORD}}$	Writing a 32-bit word			21	µs
t_{PAGE_ERASE}	Page Erase			21	ms
t_{MASS_ERASE}	Bank Erase			21	ms

5.9 Flash SPI AC Timing

The following characteristics are measured with VSUPPLY = 3.6 V at to 25 °C, unless otherwise specified.

Table 15 Flash SPI AC Timing Values

Parameter	Conditions	Min	Typ	Max	Unit
t_{SSS}	IPCS_SSn setup to leading edge of IPCS_SCK	15			ns
t_{SSH}	IPCS_SSn hold from trailing edge of IPCS_SCK	15			ns
t_{CK}	IPCS_SCK period Active state Doze state	 125 5000			 ns ns
t_{DIS}	IPCS_MOSI data setup	15			ns
t_{DIH}	IPCS_MOSI data hold	5			ns
t_{DOV}	IPCS_MISO data valid	0		15	ns
t_{OFF}	IPCS_MISO data tri-state	0		15	ns

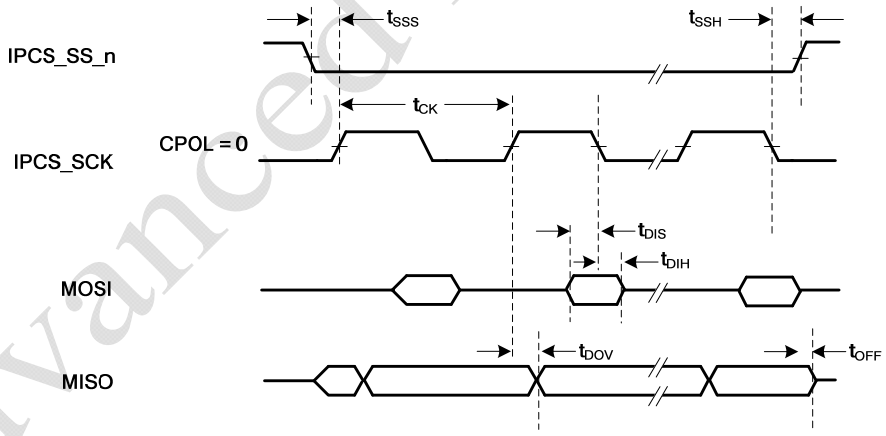

Figure 5 Flash SPI Timing – CPHA = 0

5.10 UART AC Timing

The following characteristics are measured with VSUPPLY = 3.6 V at to 25 °C, unless otherwise specified.

Table 16 UART Timing Values

Parameter	Conditions	Min	Typ	Max	Unit
t_{RX_BAUD}	Deviation from baud rate	–2		+2	%
t_{TX_BAUD}	Deviation from baud rate	–1		+1	%
$t_{RX\_RTS\_R\ to\ RX\_CTS}$	Assertion of UART_RX_RTSn to assertion of UART_RX_CTSn, or negation of UART_RX_RTSn to negation of UART_RX_CTSn	0		22	ms
$t_{CTS\_R\ to\ RX}$	Assertion of UART_RX_CTSn to start of byte	0		20	ms
$t_{EOP\ to\ RX\_RTS}$	End of packet (end of the last stop bit) to negation of UART_RX_RTSn	0		22	ms
$t_{TX\_RTS\_T\ to\ TX\_CTS}$	Assertion of UART_TX_RTSn to assertion of UART_TX_CTSn, or negation of UART_TX_RTSn to negation of UART_TX_CTSn	0		22	ms
$t_{TX\_CTS\_T\ to\ TX}$	Assertion of UART_TX_CTSn to start of byte	0		2	bit period
$t_{EOP\ to\ TX\_RTS}$	End of packet (end of the last stop bit) to negation of UART_TX_RTSn	0		1	bit period
$t_{RX\_INTERBYTE}$	Interbyte delay			100	ms
$t_{TX\ to\ TX\_CTS}$	Start of byte to negation of UART_TX_CTSn	0			ms

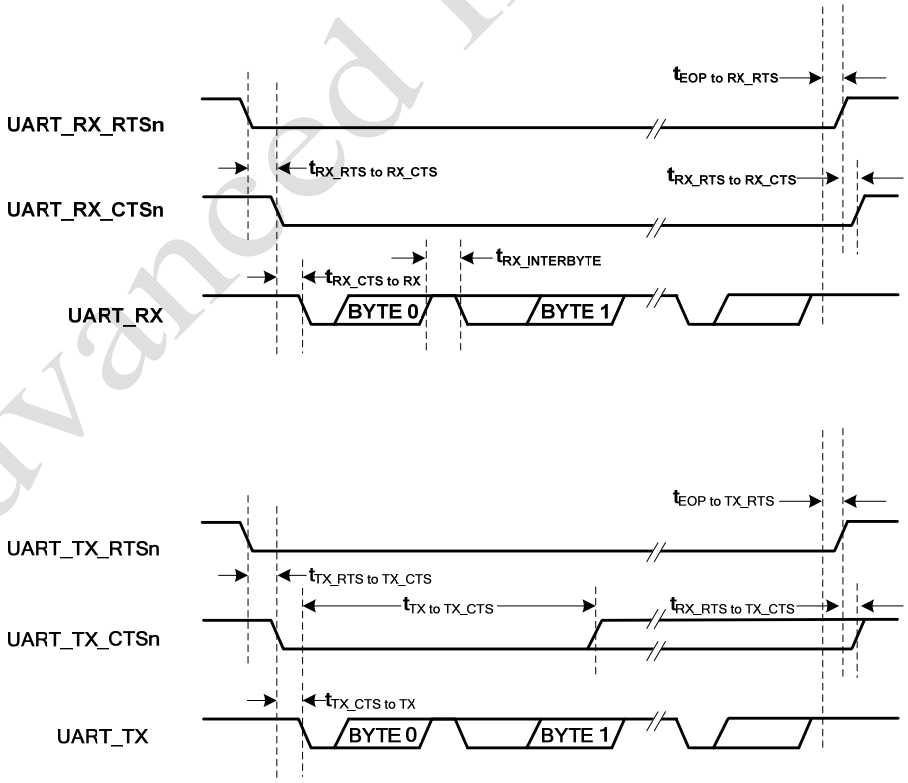

Figure 6 UART Timing

6.0 Mechanical Details

6.1 Manager Module

The LM6000 comes in 66-lead 24 x 37.465 mm, 1 mm lead pitch castellated PCB, as illustrated in Figure 7.

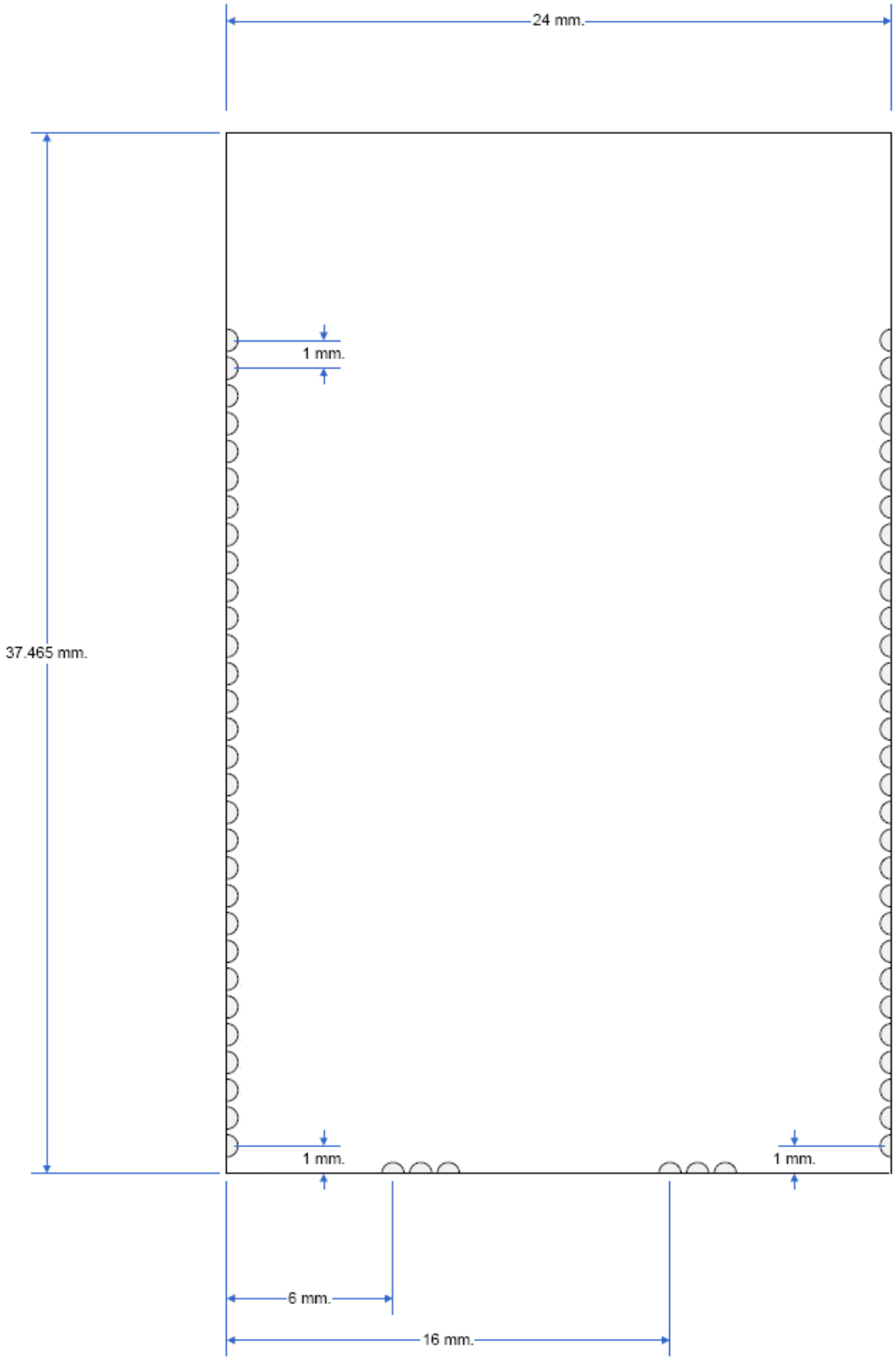

Figure 7 Mechanical Drawing – LM6000 Embedded Manager (with U.FL Antenna Connector)

6.2 Soldering Information

The LM6000 is suitable for both eutectic PbSn and RoHS-6 reflow. The maximum reflow soldering temperature is 260 ºC.

7.0 Regulatory and Standards Compliance

The LM6000 is suitable for systems targeting compliance with worldwide radio frequency regulations: ETSI EN 300 328 and EN300 440 class 2 (Europe), FCC CFR47 Part 15 (US), and ARIB STD-T66 (Japan).

7.1 Compliance to Restriction of Hazardous Substances (RoHS)

Restriction of Hazardous Substances (RoHS) is a directive that places maximum concentration limits on the use of cadmium (Cd), lead (Pb), hexavalent chromium (Cr+6), mercury (Hg), Polybrominated Biphenyl (PBB), and Polybrominated Diphenyl Ethers (PBDE). Dust Networks is committed to meeting the requirements of the European Community directive 2002/95/EC.

This product has been specifically designed to utilize RoHS-compliant materials and to eliminate or reduce the use of restricted materials to comply with 2002/95/EC.

The Dust Networks RoHS-compliant design features include:

- RoHS-compliant solder for solder joints
- RoHS-compliant base metal alloys
- RoHS-compliant precious metal plating
- RoHS-compliant cable assemblies and connector choices
- Lead-free QFN package
- Halogen-free mold compound
- RoHS-compliant and 245 °C re-flow compatible

Note: Dust Network customers may elect to use certain types of lead-free solder alloys in accordance with the European Community directive 2002/95/EC. Depending on the type of solder paste chosen, a corresponding process change to optimize reflow temperatures may be required.

8.0 References

[1] IEEE Std. 802.15.4-2006: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (LR-WPANs)
http://standards.ieee.org/getieee802/download/802.15.4-2006.pdf

9.0 Related Documentation

- *040-0102 Eterna Integration Guide*

10.0 Ordering Information

Order number for LM6000: LM6000-01EP-Sxx

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

SmartMesh-XR, SmartMesh-XT, SmartMesh-XD, SmartMesh IA-510, Eterna is a trademark of Dust Networks, Inc. The Dust Networks logo, Dust, Dust Networks, 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

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.

Document Number: 020-0042 rev 2 LM6000 Datasheet

Last Revised: September 15, 2011

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.