

Bluetooth® 4.0 Low Energy Module

FEATURES

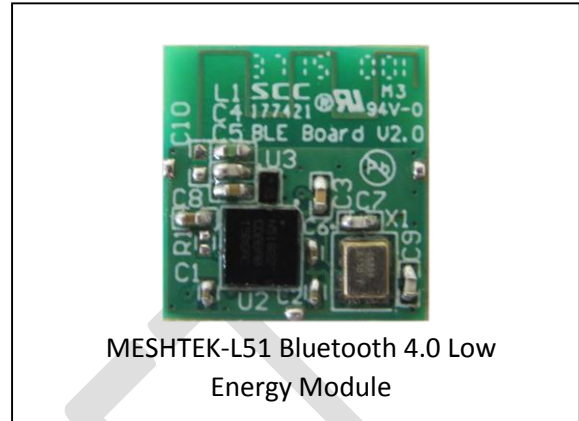
- Simple & fast integration with development kits and sample iOS & Android API
- Built-in reliable Connection based mesh to support large data packets, Mesh Network (Node and Bridge) for Android
- Connectivity range up to 25 meters
- Compact form factor 12.5mm X 13mm X 3.4mm
- SMT pads for easy and reliable PCB mounting
- Over the Air firmware update from one device to an entire network
- 32-bit ARM® Cortex™ M0 nRF51822 CPU
- Proximity support for beacon and location based services
- No. of GPIOs available for user - 17
- Configurable I/O mapping for analog and digital
- Simultaneous master and slave operation
- Certifications*: FCC, IC, CE and BT SIG (*testing in progress)
- RoHS compliant

OPERATIONAL

- Operating voltage range: 1.8V to 3.6VDC
- Temperature range: -30°C to 85°C
- Low-power consumption
- Interface: SPI, UART, I2C and 8/9/10bit ADC
- 256KB flash and 32KB RAM

APPLICATIONS

- Wearable devices
- Health & Fitness Equipment
- Lighting – bulbs and fixtures
- Bluetooth Dongle
- Home Automation
- Power plugs, routers
- Internet of Things (IoT) Sensor tag
- AV consoles, game controllers
- Industrial Control



DESCRIPTION

With the smartest and most robust Bluetooth Mesh Network technology on the market, ilumi's MeshTek provides an elegant and affordable solution for manufacturers looking to quickly and reliably bring BLE enabled **battery** IoT products to market.

The MESHTEK-L51 Smart Mesh Module reduces development time, lowers manufacturing costs, saves board space, eases certification and minimizes the RF expertise required. This complete platform solution includes software drivers, sample applications, API guide, user documentation, and a world-class support.

The MESHTEK-L51 internal controller to be used for applications up to 16KB/32KB flash without the need for external host MCU or software development tools.

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TO OUR VALUED CUSTOMERS

It is our intention to provide our valued customers with the best documentation possible to ensure successful use of your ilumi Solutions Inc products. To this end, we will continue to improve our publications to better suit your needs. Our publications will be refined and enhanced as new volumes and updates are introduced.

If you have any questions or comments regarding this publication, please contact the Marketing Communications Department via E-mail at info@ilumisolutions.com We welcome your feedback.

Errata

An errata sheet, describing minor operational differences from the data sheet and recommended workarounds, may exist for current devices. As device/documentation issues become known to us, we will publish an errata sheet. The errata will specify the revision of silicon and revision of document to which it applies.

To determine if an errata sheet exists for a particular device, please check with one of the following:

- Do contact to ilumi team
- Your local ilumi sales representative

When contacting a sales office, please specify which device, revision of MESHTEK-L51 and data sheet (include literature number) you are using.

1. DEVICE OVERVIEW

The MESHTEK-L51 Bluetooth Low Energy RF module integrates Bluetooth 4.0 radio baseband, 32-bit MCU, digital analog I/O, onboard stack. Figure 1 shows the module's Block diagram. Figure 2 shows the module's pinout and the description is shown in Table 1.

Figure 1: MESHTEK-L51 BLOCK DIAGRAM

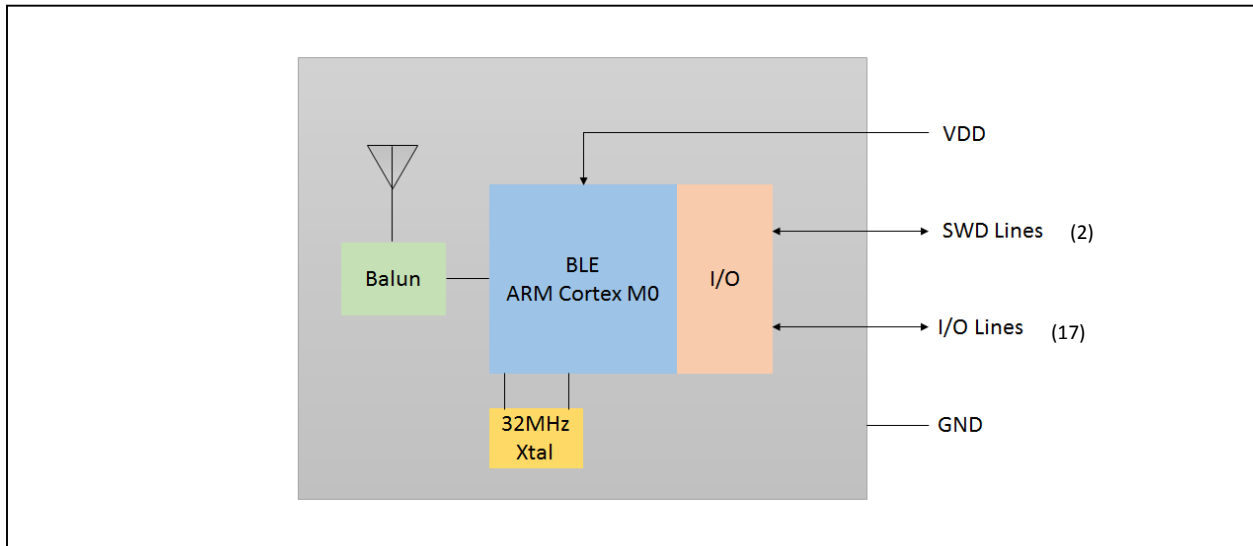


Figure 4: MESHTEK-L51 PINOUT

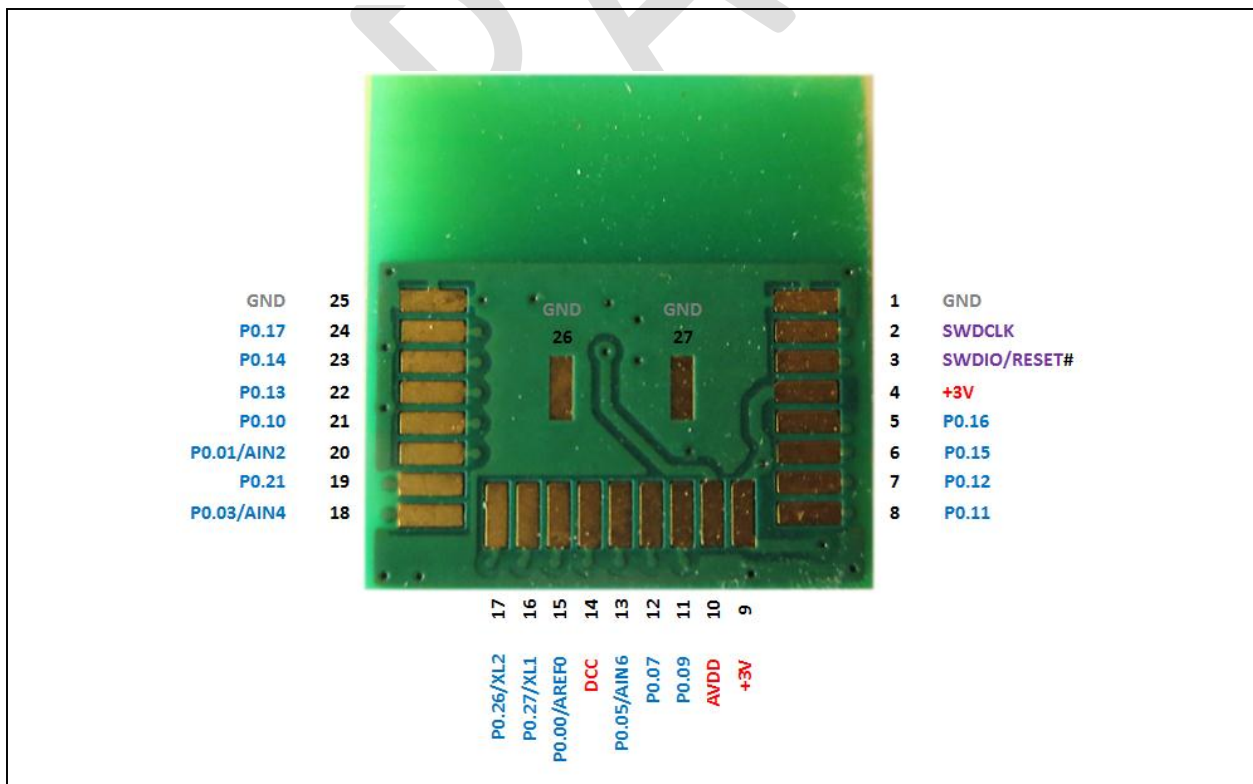


Table 1: PINOUT DESCRIPTION

Sr No.	Pin out	Pin Function	Description
1	GND	Power	Ground (0 V)
2	SWDCLK	Digital input	Hardware debug and flash programming I/O
3	SWDIO RESET#	Digital I/O	System reset (active low). Also Hardware debug and flash programming I/O
4	VDD	Power	Power supply
5	P0.16	Digital I/O	General purpose I/O pin
6	P0.15	Digital I/O	General purpose I/O pin
7	P0.12	Digital I/O	General purpose I/O pin
8	P0.11	Digital I/O	General purpose I/O pin
9	VDD	Power	Power supply
10	AVDD	Power	Analog power supply (Radio)
11	P0.09	Digital I/O	General purpose I/O pin
12	P0.07	Digital I/O	General purpose I/O pin
13	P0.05 AIN6	Digital I/O Analog input	General purpose I/O ADC input 6
14	DCC	Power	DC/DC output voltage to external LC filter
15	P0.00 AREF0	Digital I/O Analog input	General purpose I/O. ADC Reference voltage
16	P0.27 AIN1 XL1	Digital I/O Analog input Analog input	General purpose I/O ADC input 1 Crystal connection for 32.768 kHz crystal oscillator or external 32.768 kHz crystal reference
17	P0.26 AIN0 XL2	Digital I/O Analog input Analog output	General purpose I/O ADC input 0 Crystal connection for 32.768 kHz crystal oscillator
18	P0.03 AIN4	Digital I/O Analog input	General purpose I/O ADC input 4
19	P0.21	Digital I/O	General purpose I/O pin
20	P0.01 AIN2	Digital I/O Analog input	General purpose I/O ADC input 2
21	P0.10	Digital I/O	General purpose I/O pin
22	P0.13	Digital I/O	General purpose I/O pin
23	P0.14	Digital I/O	General purpose I/O pin
24	P0.17	Digital I/O	General purpose I/O pin
25	GND	Power	Ground (0 V)
26	GND	Power	Ground (0 V)
27	GND	Power	Ground (0 V)

Note: For more details, Check out nRF51822 (Package: **CFAC**) Cortex ARM M0 controller specifications

2. GENERAL SPECIFICATIONS

Table 2 provides the general specifications for the module and current consumption.

Table 2: ELECTRICAL SPECIFICATIONS

ELECTRICAL SPECIFICATIONS				
Description	Min	Nom	Max	Notes
VDD - Supply Voltage	1.8V	3.0V	3.6V	
ESD - Human Body Model Class 2			4 kV	
Built-in Crystal Frequency		16 MHz		
Crystal Frequency Tolerance			+/- 10ppm	
Reset pin time for successful reset	605 us			
Radio Operating Frequencies	2402 MHz		2481 MHz	1 MHz channel spacing
Radio Frequency Deviation @ BLE		+/-170KHz		
Radio On-Air data rate	250 kbps		2000 kbps	
Radio Output Power	-30 dBm		+4 dBm	
Receiver Sensitivity @ BLE		-96 dBm		Ideal transmitter
Radio RSSI Accuracy			+/- 6 dB	
UART Baud Rate	1.2 kbps		921.6 kbps	
SPI Bit Rate	0.125 Mbps		8 Mbps	
TWI Bit Rate	100 kbps		400 kbps	
Analog-to-Digital Converter (ADC) ENIB	8 bit		10 bit	
ADC Internal Reference Voltage	0.83V	1.2V	1.3V	
Internal Temperature Sensor Range	-25 °C		75 °C	
Internal Temperature Sensor Accuracy		0.25 °C		
General Purpose I/O (GPIO) input high voltage	0.7 * VDD		VDD	
General Purpose I/O (GPIO) input low voltage	VSS		0.3 * VDD	
Output standard drive current		20 mA		
Pull-up resistance	11k	13k	16k	
Pull-down resistance	11k	13k	16k	
Transmit Current		30mA		With ilumi mesh stack running
Receive Current		12mA		Radio/GPIO Active
ARM CPU Running Current		4.1mA		No Radio Active
ARM CPU Ideal Current		2.5uA		No Radio and GPIO active

3. PHYSICAL DIMENSIONS

Figure 3 shows the Top and Bottom for MESHTEK-L51 module. Figure 4 shows the recommended PCB layout.

Figure 3: MESHTEK-L51 MODULE TOP AND BOTTOM VIEW

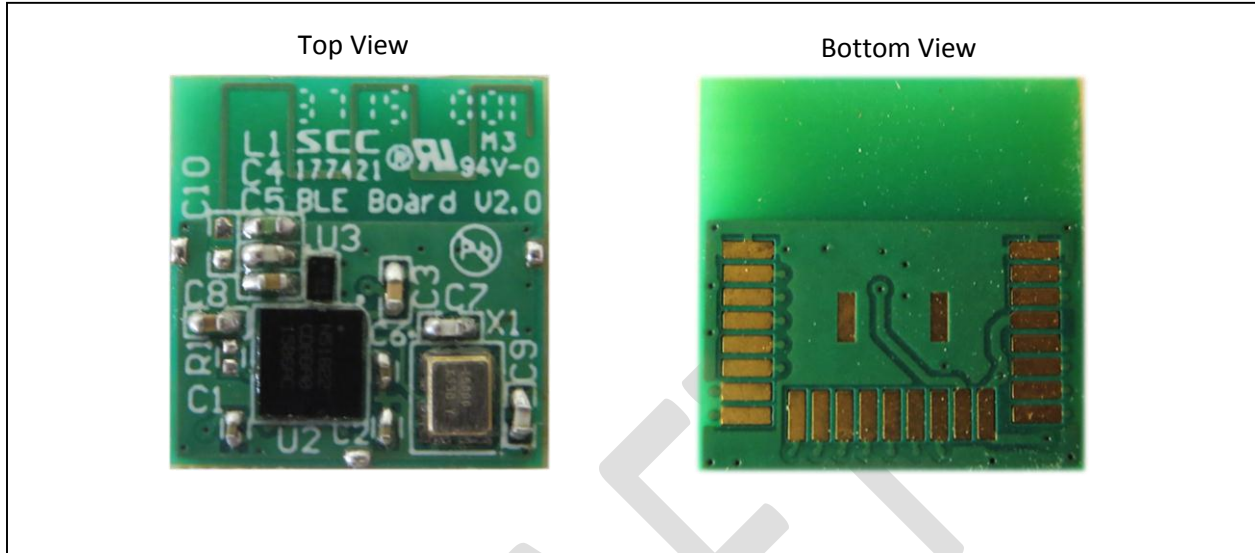
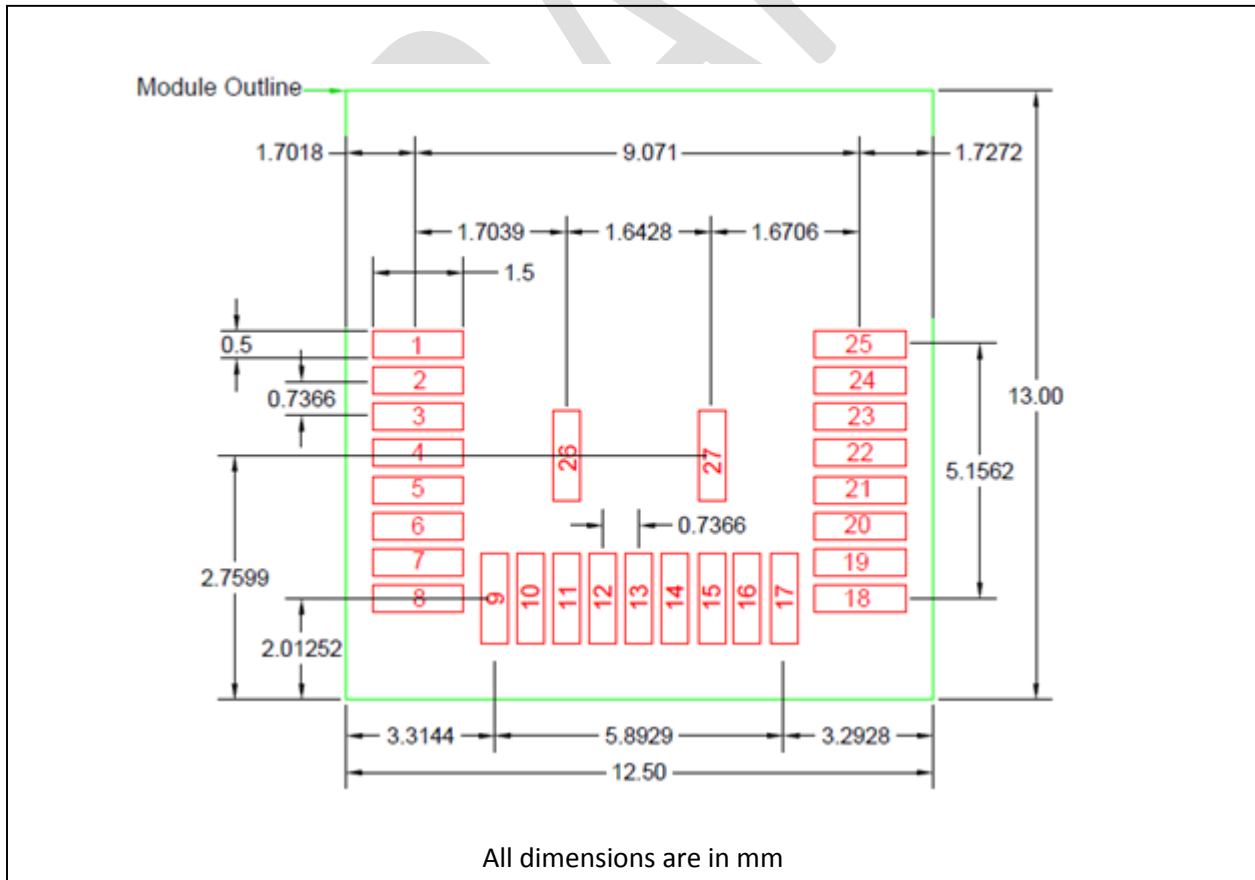
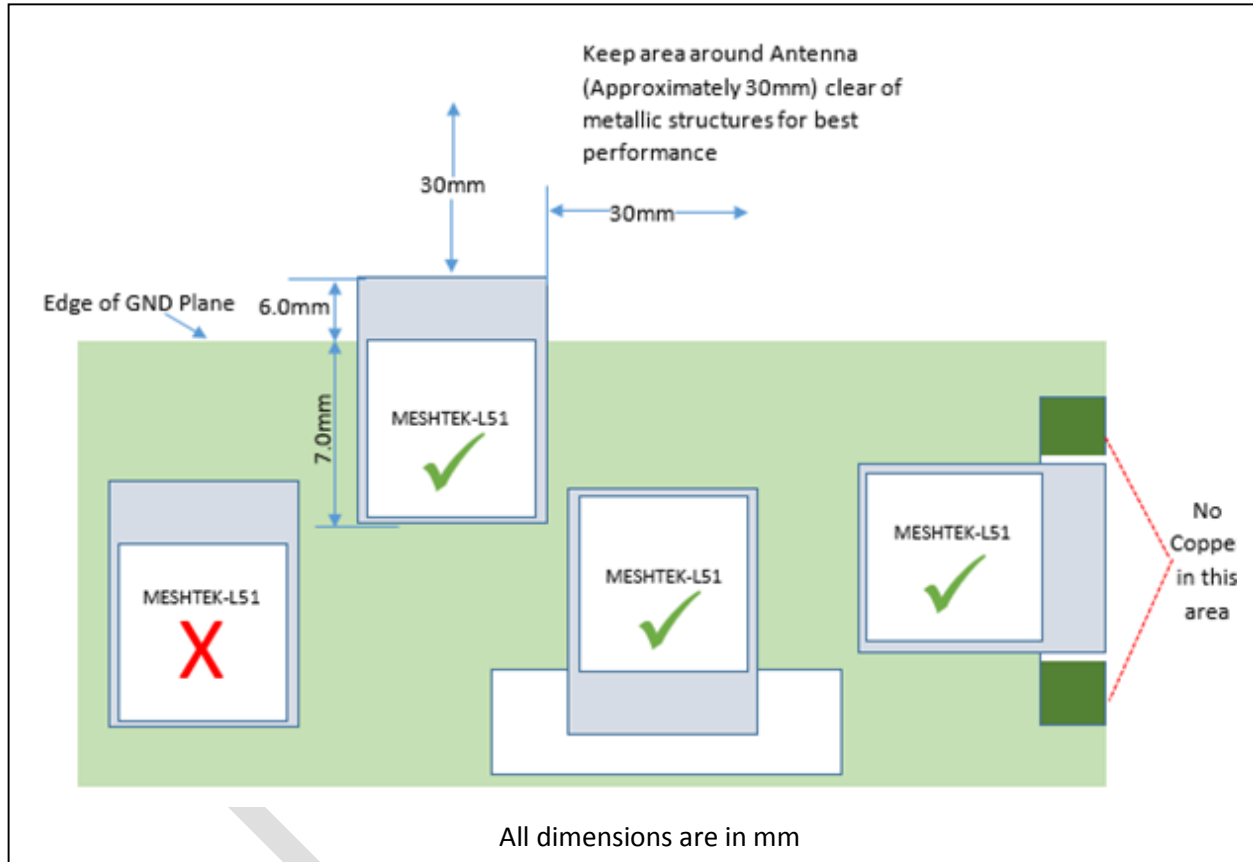


Figure 4: MESHTEK-L51 RECOMMENDED PCB FOOTPRINT



When laying out the carrier board for the MESHTEK-L51 module, the areas under the antenna, RF text point (semi-circular pad) and shielding connections should not have surface traces, ground planes, or exposed vias. Figure 5 shows the recommended mounting details and acceptable positioning of the MESHTEK-L51 on the host PCB. For optimal radio performance, the MESHTEK-L51 module's antenna end should protrude at least 30 mm beyond any metal enclosure.

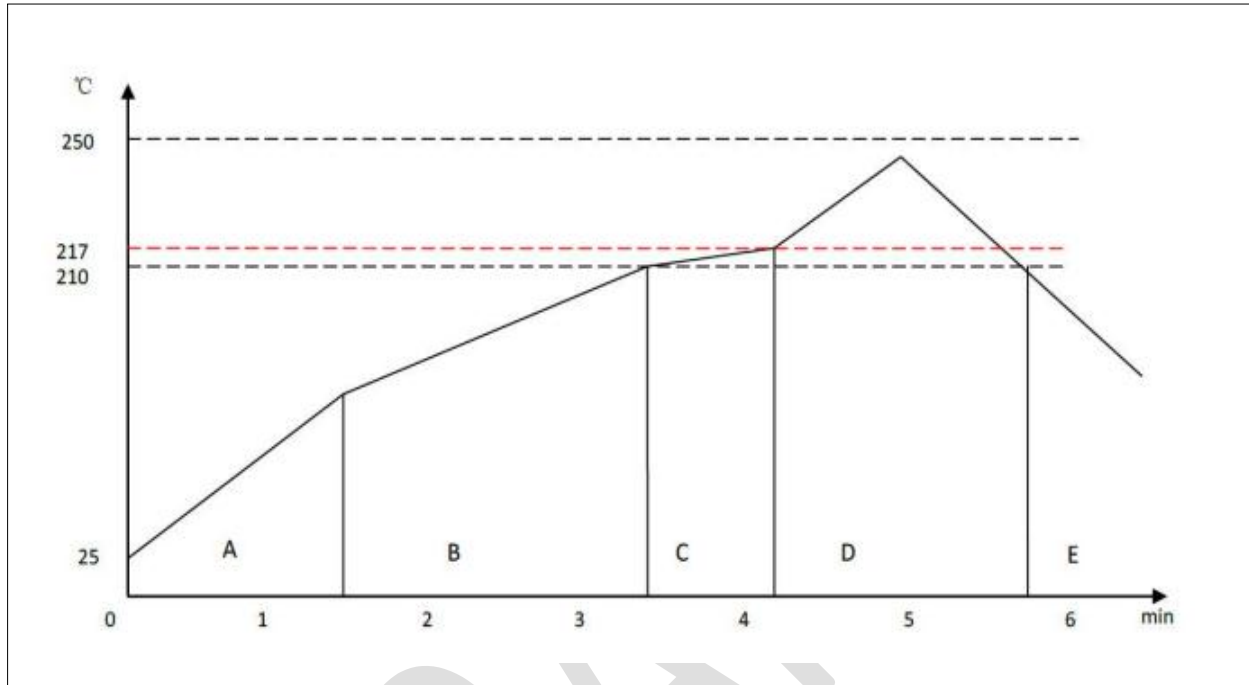
Figure 5: MESHTEK-L51 MODULE MOUNTING DETAILS



4. SOLDER REFLOW PROFILE

The solder profile is described below in Figure 6.

Figure 6: REFLOW PROFILE



- A. Zone A: Preheat: This raises the temperature at a controlled rate, typically 0.5 - 2C/s. This will preheat the component to 120°C to 150°C to distribute the heat uniformly to the PCB.
- B. Zone B: Equilibrium1: In this zone, the flux becomes soft and uniformly spreads solder particles over the PCB board, preventing re-oxidization. The recommended temperature for this zone is 150°C to 200°C for 60s to 120s.
- C. Zone C: Equilibrium2: This is optional and in order to resolve the upright component issue. Temperature is 210°C to 217°C for 20s to 30s.
- D. Zone D: Reflow zone: The temperature should be high enough to avoid wetting but low enough to avoid component deterioration. The recommended peak temperature is 230°C to 250°C. The soldering time should be 30s to 90s when the temperature is above 217°C.
- E. Zone E: Cooling: The cooling rate should be fast to keep the solder grains small which will give a longer lasting joint. A typical cooling rate is 4°C/s

5. REGULATORY APPROVAL

This section outlines the regulatory information for the MESHTEK-L51 module for the following countries:

- United States
- Canada
- Europe

3.1 United States

The MESHTEK-L51 module has received Federal Communications Commission (FCC) CFR47 Telecommunications, Part 15 Subpart C “Intentional Radiators” modular approval in accordance with Part 15.212 Modular Transmitter approval. Modular approval allows the end user to integrate the MESHTEK-L51 module into a finished product without obtaining subsequent and separate FCC approvals for intentional radiation, provided no changes or modifications are made to the module circuitry. Changes or modifications could void the user’s authority to operate the equipment. The end user must comply with all of the instructions provided by the Grantee, which indicate installation and/or operating conditions necessary for compliance.

The finished product is required to comply with all applicable FCC equipment authorizations regulations, requirements and equipment functions not associated with the transmitter module portion. For example, compliance must be demonstrated to regulations for other transmitter components within the host product; to requirements for unintentional radiators (Part 15 Sub-part B “Unintentional Radiators”), such as digital devices, computer peripherals, radio receivers, etc.; and to additional authorization requirements for the non-transmitter functions on the transmitter module (i.e., Verification, or Declaration of Conformity) (e.g., transmitter modules may also contain digital logic functions) as appropriate.

3.1.1 LABELING AND USER INFORMATION REQUIREMENTS

The MESHTEK-L51 module has been labeled with its own FCC ID number, and if the FCC ID is not visible when the module is installed inside another device, then the outside of the finished product into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording as follows:

MESHTEK-L51:

Contains Transmitter Module FCC ID*: **XXXX**

Contains FCC ID*: **XXXX**

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) this device may not cause harmful interference, and
- (2) this device must accept any interference received, including interference that may cause undesired operation

A user’s manual for the product should include the following statement:

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

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Consult the dealer or an experienced radio/TV technician for help.

Additional information on labeling and user information requirements for Part 15 devices can be found in KDB Publication 784748 available at the FCC Office of Engineering and Technology (OET) Laboratory Division Knowledge Database (KDB)

3.1.2 RF EXPOSURE

All transmitters regulated by FCC must comply with RF exposure requirements. KDB 447498 General RF Exposure Guidance provides guidance in determining whether proposed or existing transmitting facilities, operations or devices comply with limits for human exposure to Radio Frequency (RF) fields adopted by the Federal Communications Commission (FCC).

This module is approved for installation into mobile and/or portable host platforms and must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with FCC multi-transmitter guidelines. End users must be provided with transmitter operating conditions for satisfying RF Exposure compliance.

3.1.3 HELPFUL WEB SITES

Federal Communications Commission (FCC):
<http://www.fcc.gov>

FCC Office of Engineering and Technology (OET) Laboratory Division Knowledge Database (KDB):
<http://apps.fcc.gov/oetcf/kdb/index.cfm>

3.2 Canada

The MESHTEK-L51 module has been certified for use in Canada under Industry Canada (IC) Radio Standards Specification (RSS) RSS-210 and RSSGen. Modular approval permits the installation of a module in a host device without the need to recertify the device.

3.2.1 LABELING AND USER INFORMATION REQUIREMENTS

Labeling Requirements for the Host Device (from Section 3.2.1, RSS-Gen, Issue 3, December 2010): The host device shall be properly labeled to identify the module within the host device.

The Industry Canada certification label of a module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labeled to display the Industry Canada certification number of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

Contains transmitter module IC*: XXXX

User Manual Notice for License-Exempt Radio Apparatus (from Section 7.1.3 RSS-Gen, Issue 3, December 2010): User manuals for license-exempt radio apparatus shall contain the following or equivalent notice in a conspicuous location in the user manual or alternatively on the device or both:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement

Transmitter Antenna (from Section 7.1.2 RSS-Gen, Issue 3, December 2010): User manuals for transmitters shall display the following notice in a conspicuous location:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante

The above notice may be affixed to the device instead of displayed in the user manual.

3.2.2 RF EXPOSURE

All transmitters regulated by IC must comply with RF exposure requirements listed in RSS-102 - Radio Frequency (RF) Exposure Compliance of Radio Communication Apparatus (All Frequency Bands).

This module is approved for installation into mobile and/or portable host platforms and must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with

3.2.3 APPROVED EXTERNAL ANTENNA TYPES

Transmitter Antenna (from Section 7.1.2 RSS-Gen, Issue 3, December 2010):

The MESHTEK-L51 module can only be sold or operated with antennas with which it was approved. Transmitter may be approved with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns. Testing shall be performed using the highest gain antenna of each combination of transmitter and antenna type for which approval is being sought, with the transmitter output power set at the maximum level. Any antenna of the same type having equal or lesser gain as an antenna that had been successfully tested with the transmitter, will also be considered approved with the transmitter, and may be used and marketed with the transmitter.

3.2.4 HELPFUL WEB SITES

Industry Canada: <http://www.ic.gc.ca/>

3.3 Europe

The MESHTEK-L51 module is CE marked and has been manufactured and tested with the intention of being integrated into a final product.

The MESHTEK-L51 module has been tested to R&TTE Directive 1999/5/EC Essential Requirements for Health and Safety (Article (3.1(a)), Electromagnetic Compatibility (EMC) (Article 3.1(b)), and Radio (Article 3.2) and are summarized in Table 3-1: European Compliance Testing.

The R&TTE Compliance Association provides guidance on modular devices in document **Technical Guidance Note 01** available at

http://www.rtteca.com/html/download_area.htm.

Note: To maintain conformance to the testing, listed in [Table 8-1](#), the module shall be installed in accordance with the installation instructions in this data sheet and shall not be modified.

When integrating a radio module into a completed product the integrator becomes the manufacturer of the final product and is therefore responsible for demonstrating compliance of the final product with the essential requirements of the R&TTE Directive.

*Note: * indicates certifications under process*

3.3.1 LABELING AND USER

INFORMATION REQUIREMENTS

The label on the final product which contains the MESHTEK-L51 module must follow CE marking requirements.

The “*R&TTE Compliance Association Technical Guidance Note 01*” provides guidance on final product CE marking.

3.3.2 ANTENNA REQUIREMENTS

From R&TTE Compliance Association Document **Technical Guidance Note 01**:

Provided the integrator installing an assessed radio module with an integral or specific antenna and installed in conformance with the radio module manufacturer’s installation instructions requires no further evaluation under Article 3.2 of the R&TTE Directive and does not require further involvement of an R&TTE Directive Notified Body for the final product.

Table 3: MESHTEK-L51 EUROPEAN COMPLIANCE TESTING

Certification	Standards	Article	Laboratory	Report Number	Date
Safety	EN 60950-1:2006 (2ND Edition) & IEC 60950-1:2005	[3.1(a)]		Pending	
Health	EN 62479:2010			Pending	
EMC	EN 301 489-1 & EN 301 489-17	[3.1(b)]		Pending	
	EN 55022 Class B, EN 61000-3-2 Class A, EN 61000-3-3, & EN 55024				
Radio	ETSI EN 300 328 V1.9.1 (2015-02)	(3.2)	Pending		

6. ORDERING INFORMATION

Table 4 provides ordering information for the MESHTEK-L51 module.

Table 4: ORDERING INFORMATION

Part Number	Description
MESHTEK-L51	Bluetooth Low Power Module

Note: For custom applications, contact ilumi Solutions Inc. representative

APPENDIX A: REVISION HISTORY

Revision A (Feb, 2016)

This is the initial released version of the document in the ilumi Solutions Inc. format

DRAFT