LoRa™ Mote User's Guide

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Trademarks

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
═ ISO/TS 16949 ═

Object of Declaration: LoRa™ Mote

EU Declaration of Conformity

Manufacturer: Microchip Technology Inc.
2355 W. Chandler Blvd.
Chandler, Arizona, 85224-6199
USA

This declaration of conformity is issued by the manufacturer.

The development/evaluation tool is designed to be used for research and development in a laboratory environment. This development/evaluation tool is not a Finished Appliance, nor is it intended for incorporation into Finished Appliances that are made commercially available as single functional units to end users under EU EMC Directive 2004/108/EC and as supported by the European Commission's Guide for the EMC Directive 2004/108/EC (8th February 2010).

This development/evaluation tool complies with EU RoHS2 Directive 2011/65/EU.

This development/evaluation tool, when incorporating wireless and radio-telecom functionality, is in compliance with the essential requirement and other relevant provisions of the R&TTE Directive 1999/5/EC and the FCC rules as stated in the declaration of conformity provided in the module datasheet and the module product page available at www.microchip.com.

For information regarding the exclusive, limited warranties applicable to Microchip products, please see Microchip's standard terms and conditions of sale, which are printed on our sales documentation and available at www.microchip.com.

Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA

Derek Carlson (signature)   12-Sep-14
Derek Carlson   Date
VP Development Tools

LoRa™ Mote User's Guide

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXXXXA", where "XXXXXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu, and then Topics to open a list of available online help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the LoRa™ Mote and attached LoRa™ Technology Module. Topics discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Development Systems Customer Change Notification Service
- Customer Support
- Revision History

DOCUMENT LAYOUT

This document describes how to use the LoRa™ Mote as a demonstration to show how LoRa technology communication works. The document is organized as follows:

- **Chapter 1. "Introduction"** – This chapter describes the LoRa™ Mote and presents various modes of operation.
- **Chapter 2. "Getting Started"** – This chapter describes the two main communication methods, and the hardware requirements for getting started with the LoRa™ Mote.
- **Appendix A. "Board Schematics and Bill of Materials"** – This appendix provides the LoRa™ Mote schematics and the Bill of Materials (BOM).

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CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB® IDE User's Guide*
	Emphasized text	...is the *only* compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
Italic Courier New	A variable argument	`file`.o, where `file` can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options] file [options]`
Curly brackets and pipe character: {	}	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`
	Represents code supplied by user	`void main (void) { ... }`

RECOMMENDED READING

This user's guide describes how to use the LoRa™ Mote. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources:

RN2483 Low-Power Long-Range LoRa™ Technology Transceiver Module Data Sheet (DS50002346)

This data sheet provides detailed specifications for the RN2483 module.

RN2483 LoRa™ Technology Module Command Reference User's Guide (DS40001784)

This user's guide provides specifications about the commands to be used with the LoRa™ module.

RN2483 LoRa™ Technology PICtail™/PICtail Plus Daughter Board User's Guide (DS50002366)

This user's guide describes how to configure and use the LoRa™ Daughter Board.

RN2903 Low-Power Long-Range LoRa™ Technology Transceiver Module Data Sheet (DS50002390)

This data sheet provides detailed specifications for the RN2903 module.

RN2903 LoRa™ Technology Module Command Reference User's Guide (40001811)

This user's guide provides specifications about the commands to be used with the LoRa™ module.

To obtain any of Microchip's documents, visit the Microchip web site at www.microchip.com.

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

DEVELOPMENT SYSTEMS CUSTOMER CHANGE NOTIFICATION SERVICE

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To register, access the Microchip web site at www.microchip.com, click on Customer Change Notification and follow the registration instructions.

The Development Systems product group categories are:

- **Compilers** – The latest information on Microchip C compilers, assemblers, linkers and other language tools. These include all MPLAB C compilers; all MPLAB assemblers (including MPASM™ assembler); all MPLAB linkers (including MPLINK™ object linker); and all MPLAB librarians (including MPLIB™ object librarian).
- **Emulators** – The latest information on Microchip in-circuit emulators.This includes the MPLAB REAL ICE™ and MPLAB ICE 2000 in-circuit emulators.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debuggers. This includes MPLAB ICD 3 in-circuit debuggers and PICkit™ 3 debug express.
- **MPLAB® X IDE** – The latest information on Microchip MPLAB IDE, the Windows® Integrated Development Environment for development systems tools. This list is focused on the MPLAB IDE, MPLAB IDE Project Manager, MPLAB Editor and MPLAB SIM simulator, as well as general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include production programmers such as MPLAB REAL ICE in-circuit emulator, MPLAB ICD 3 in-circuit debugger and MPLAB PM3 device programmers. Also included are nonproduction development programmers such as PICSTART® Plus and PICkit 2 and 3.

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at:

http://www.microchip.com/support.

REVISION HISTORY

Revision A (August 2015)

Initial release of the document.

Advance Information

Chapter 1. Introduction

1.1 OVERVIEW

The LoRa™ Mote is a demonstration board that showcases the Microchip Low-Power Long Range LoRa™ Technology Transceiver Module.

The LoRa™ Mote provides access to the module through UART communications and supports connection points to all GPIO-controlled module pins.

This chapter discusses the following topics:

• Features
• Contents

1.2 FEATURES

The LoRa™ Mote has the following features, as represented in Figure 1-1:

1. 868/915 MHz High-Frequency SMA Connector
2. 433 MHz Low-Frequency Antenna Point
3. Module Breakout Header 1
4. Module Breakout Header 2
5. Module Connector
6. SSD1306 (128 x 64) Dot Matrix OLED
7. Module ICSP™ Programming Pads
8. Mote ICSP Programming Through Hole
9. S1 Switch (Navigation)
10. S2 Switch (Selection)
11. Sharp (GA1A1S202WP) Ambient Light Sensor
12. MCP9700T – Linear Active Thermistor
13. MCP1825S – LDO Regulator
14. PIC18LF25K50 8-bit MCU
15. Alternative Power Supply Through Hole Connectors
16. Descriptive LEDs, (2) Controlled by PIC18, (2) Controlled by Module
17. USB Mini-B Connector
18. Battery Power Switch
19. Web Site QR Code
20. (2) AAA Battery Pack
21. OLED SSD1306 Ribbon Connector

LoRa™ Mote User's Guide

FIGURE 1-1:   LoRa™ MOTE

Top   **Bottom**
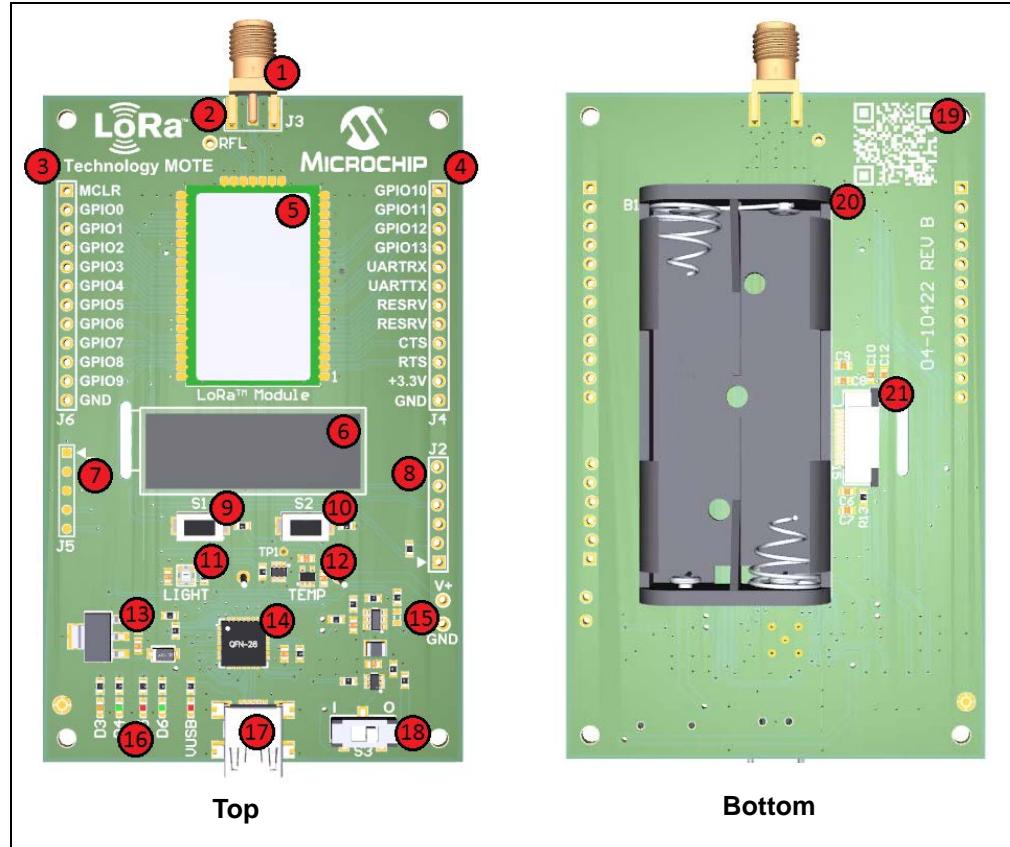
The high-speed UART interface and the GPIO ports are available on the module to configure, control and transfer data. The Mote board has an on-board PIC18 supporting USB-to-UART serial bridge, enabling easy serial connection.

Demonstration of the module can be performed by plugging the Mote into a USB port of a PC. The USB port powers the Mote board and enables the user to communicate using the module's ASCII commands.

Development using the module with Microchip's PIC® MCU line is possible via the 24-pin card edge connectors on the Mote board.

1.3   CONTENTS

The Mote contains the following tools, as listed in Table 1-1.

TABLE 1-1:   LoRa™ MOTE

Description
LoRa™ Mote populated with the LoRa™ Module
USB Cable (Male-A to Male Mini-B)
Antenna - 868/915 MHz

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Chapter 2. Getting Started

2.1 INTRODUCTION

This chapter describes the hardware requirements for the LoRa™ Mote board, and also provides descriptions of the different communication modes.

The module accepts commands via UART interface. Communication with the module is achieved through two methods of operation, USB and Battery.

This chapter discusses the following topics:

• Operation Methods
• Communication to the Module
• Hardware Description

2.2 METHODS OF OPERATION

2.2.1 USB

When the Mote board is connected to the host via USB, the device will operate automatically in USB mode. The on-board PIC18LF25K50 MCU will become a USB-to-UART bridge device. The host can run a simple terminal emulator application to issue commands directly to the module.

Supply voltage is provided via USB, and is regulated from 5V to the nominal 3.3V using the on-board LDO (U1).

2.2.2 Battery

When no USB cable is attached, and the board is powered by (2) AAA batteries (B1), the Mote is operating in Battery mode.

In Battery Operation mode, the Microchip PIC18LF25K50 PIC® MCU on the Mote unit can run custom functions and directly issue ASCII commands to the attached LoRa module via the UART interface.

The on-board MCU influences UART communications specific to operation states. Additional resources exist on the MCU, allowing further custom development by the user.

2.3 HARDWARE DESCRIPTION

The RF signal paths are connected to the SMA edge connector and the designated via through-hole point. The high-frequency (868/915 MHz band) RF signal is transmitted through the RFH (J3) SMA connector. The low-frequency (433 MHz) RF signal is transmitted via the through-hole point (RFL), this allows connection of a user-supplied wire antenna.

> **Note:** The North-American (915 MHz) module does not support the ability to transmit a (433 MHz) low-frequency signal.

The on-board PIC18LF25K50 MCU is programmable via ICSP™ through connector J2. In addition, the PIC18LF25K50 MCU application program is capable of being updated via the bootloader utility.

The Mote board will power-on automatically when a USB cable is connected. When powered by AAA batteries, power-on/off is controlled using the (S3) switch.

Mote environment data is measured by a light sensor (U4) and by a temperature sensor (U5). There are two on-board push buttons (S1, S2) used for menu navigation and selection. In addition, there are four LEDs. Two LEDs (D3-Orange, D4-Green) are connected to the module's GPIO10 and GPIO11 I/O's. Two LEDs (D5-Red, D6-Green) are connected to and controlled by the PIC18LF25K50 device.

Table 2-2 shows the LoRa™ Mote PIC18LF25K50 connections:

TABLE 2-2:   MOTE PIC18LF25K50 USAGE

Pin Name	Description	Mote Usage
General Purpose Pins		
RA0	USB_DET	USB Power Detection (Digital, Input)
RA1	VBAT	Battery Voltage (Analog, ADC)
RA2	TEMP_SENSE	MCP9700 Thermistor Sensor (Analog, ADC)
RA3	LIGHT_SENSE	GA1A1S202WP Ambient Light Sensor (Analog, ADC)
RA4	VOUT_EN	Boost Regulator Enable (Digital, Output)
RA5	SENSE_PWR	Power Reference Point
RA6	Red LED (D5)	Application Behavior Descriptor (Digital, Output)
RA7	Green LED (D6)	Application Behavior Descriptor (Digital, Output)
RB0	Unused	Unused
RB1	SCK	OLED SPI Clock Reference
RB2	$\overline{\text{RESET}}$	OLED Manual Reset Control
RB3	SDO	OLED SPI Communication
RB4	CS	OLED Chip-Select
RB5	D/C	OLED Data/Command Select
RB6	PGC	ICSP™ Programmer
RB7	PGD	ICSP Programmer
RC0	S1 Push-Button	Application Navigation Controller (Digital, Input)
RC1	S2 Push-Button	Application Navigation Controller (Digital, Input)
RC2	MODEM_WAKE	Module Wake Application from Sleep (Digital, Input) [Module GPIO9]
RC6	TX	PIC® MCU to Module Communication
RC7	RX	PIC® MCU to Module Communication
RE3	$\overline{\text{MCLR}}$	ICSP™ Programmer
Dedicated Pin		
VUSB3V3	+3.3V	Power Reference
D-	DN	USB Communications
D+	DP	USB Communications
V$_{DD}$	+3.3V	Power Source
V$_{SS}$	Ground Reference	Ground Reference

The populated module (U7) is re-programmable via the ICSP™ press pin pad programming connector point (J5). In addition, the populated LoRa module is capable of being updated via the LoRa™ bootloader GUI, as described in the *RN2483 LoRa™ Technology Module Command Reference User's Guide* (DS40001784).

All the pins of the module can be accessed via surface-mount pads located on both sides of the (U7) connection point. The user can mount two 1.27 mm pitched socket headers if desired. Sockets can connect the module pins to a custom board, whereas the Mote board is capable of providing power. The sockets are broken into two header breakout groupings used in supplying connection points to the module's power, ground and additional GPIO/UART pins.

Table 2-3 shows the LoRa module jumper breakout connections.

TABLE 2-3:   MODULE JUMPER CONNECTIONS

Signal Name	Description	Module Pin Connection	Mote Function
MCLR	Reset	32	ICSP™ Programmer
GPIO0	General Purpose I/O	35	Unused
GPIO1	General Purpose I/O	36	Unused
GPIO2	General Purpose I/O	37	Unused
GPIO3	General Purpose I/O	38	Unused
GPIO4	General Purpose I/O	39	Unused
GPIO5	General Purpose I/O	40	Unused
GPIO6	General Purpose I/O	43	Unused
GPIO7	General Purpose I/O	44	Unused
GPIO8	General Purpose I/O	45	Unused
GPIO9	General Purpose I/O	46	MODEM_WAKE
GPIO10	General Purpose I/O	14	D3 – Orange LED
GPIO11	General Purpose I/O	13	D4 – Green LED
GPIO12	General Purpose I/O	10	Unused
GPIO13	General Purpose I/O	9	Unused
UARTRX	Module Communication	7	PIC® MCU TX (RC6, Pin 14)
UARTTX	Module Communication	6	PIC® MCU RX (RC7, Pin 15)
CTS	Module Communication	3	Unused
RTS	Module Communication	2	Unused
+3.3V	Power Source	34, 12	+3.3V Rail
GND	Ground Reference	1,8,11,20,21, 22,24,26,27, 28,33,41,47	Ground

2.4   MOTE APPLICATION DESCRIPTION

This section describes the basic operation of the LoRa Mote application program.

The default LoRa Mote application comes with three methods of operation:

- USB CDC-Serial Communication
- Mobile Mote Sensor Emulation
- Application Update via Bootloader

2.4.1   USB CDC-Serial

When a USB Mini-B is connected to the LoRa Mote, it will power-on, regardless of the power switch S3. If the LoRa Mote is already in operation, the USB connection will take pre-emptive control and act only as a serial emulation device. After being connected to a host PC, the LoRa Mote will enumerate. In this operation mode, the user can enter the required LoRaWAN credentials for joining an existing LoRaWAN network.

There is a wide range of third-party serial communication programs which can be used to communicate with the module populated on the LoRa Mote. Refer to the *RN2483 LoRa™ Technology Module Command Reference User's Guide* (DS40001784) for additional information on parsing commands directly into the RN module for LoRa communications.

> **Note:**   MPCOMMS is required to be installed for USB enumeration. This is installed automatically together with MPLAB® X.

2.4.2   Mobile Mote Sensor Emulation

When powered using (2) AAA batteries, the LoRa Mote will act in Mobile Mote mode. This application is best used to demonstrate a real working Internet of Things (IoT) sensor design.

After power-on, the LoRa Mote will attempt to join a LoRaWAN network first through the Activation-By-Personalization (ABP) process. If the required ABP keys are not stored within the module, the Mote will then attempt to join through over-the-air activation (OTAA). If the proper keys are not stored for either a ABP or a OTAA join process, the LoRa Mote will display the message "Valid Keys Required". The user will then have to enter the required keys of the module through USB CDC-Serial mode, and store them using the "Mac Save" command. The minimal required credentials for each join process are indicated below:

- OTAA
  - DevEUI
  - AppEUI
  - AppKey
- ABP
  - DevAddr
  - NwkSKey
  - AppSKey

If the proper credentials are entered, the LoRa Mote will automatically join the system. After joining, the LoRa Mote will enter Running mode.

When running, the LoRa Mote acts as a demonstration device. It is capable of key LoRa communication events, such as manual uplink packets, automatic periodic uplink packets, and displaying last received downlink data.

Menu navigation is handled by using S1 for navigation and S2 for selection.

Table 2-4 shows the menus with operation descriptions:

TABLE 2-4:   DESCRIPTION OF MENU OPERATION

Menu	Description
Sensor Display	Displays Light and Temperature Sensor Data
Issue uplink	**(S1)** issues a **confirmed** uplink message with sensor data payload. **(S2)** issues an **unconfirmed** uplink message with sensor data payload.**(1)**
View downlink	When the red LED (D5) is lit, a downlink message is ready for viewing. This menu will display the received downlink payload.
Tx Sleep Events	Enables/Disables the automatic periodic uplink message transmission. If Tx Sleep Event is enabled, around every 15 minutes a unconfirmed (uncnf) uplink message will be sent. After (3) unconfirmed messages, the 4th will be in confirmed uplink form. The confirmed uplink will ensure expected Gateway unit is still active confirming system stability.
Sleep Control	The LoRa™ Mote will automatically enter Sleep if no buttons are pressed for 30 seconds. The LoRa Mote can be placed into Sleep manually by selecting the Sleep option in the menus. Wake-Up events include: • Pressing either S1 or S2 push buttons • A USB plug-in • Periodic WDT (Watchdog Timer) ticks • Module message reception

Note 1: The port number used for Mote uplink messages is randomly selected between 1-223.

2.4.3   Bootloader Behavior

The PIC18LF25K50 is pre-programmed with a bootloader application. Bootloader mode is initiated by holding either S1/S2 or both push buttons upon power-up.

The bootloader applications are based off the HID bootloader – PIC18 Non-J; the project is supplied with the Microchip Libraries for Applications (MLA) that can be found at www.microchip.com/mla.

In addition, the utility supplied with the MLA is used to handle all Mote PIC® MCU application bootloading behaviors.

> **Note:**   Additionally, the module contains its own bootloader application which can be accessed/updated as discussed in the *RN2483 LoRa™ Technology Module Command Reference User's Guide* (DS40001784)

2.4.4   Application Updates

• If powered by USB cable, the red LED (D5) and the green LED (D6) will begin to alternate ON/OFF.
• If the device is in Battery Operation mode and the Bootloader mode is entered, the red LED (D5) will stay ON, the green LED (D6) will remain OFF. Once the USB cable is plugged-in, the green/red LED will alternate.

The application firmware can be updated by launching the HID bootloader GUI application included with the Microchip Libraries for Applications (MLA) at www.microchip.com/mla.

DIR: \\mla\v2014_07_22\apps\usb\device\bootloaders\utilities\bin\win\HIDBootloader.exe

> **Note:**   If Bootloader mode is entered unintentionally, power cycling the board will re-enter the LoRa™ Mote default application.

NOTES:

Appendix A. Board Schematics and Bill of Materials

A.1 INTRODUCTION

This appendix provides the LoRa™ Mote board schematics and Bill of Materials (BOM).

- Board Schematics
- Bill of Materials

A.2 BOARD SCHEMATICS

Figure A-1 and Figure A-2 show the board schematics.

FIGURE A-1:   LoRa™ MOTE BOARD SCHEMATIC 1

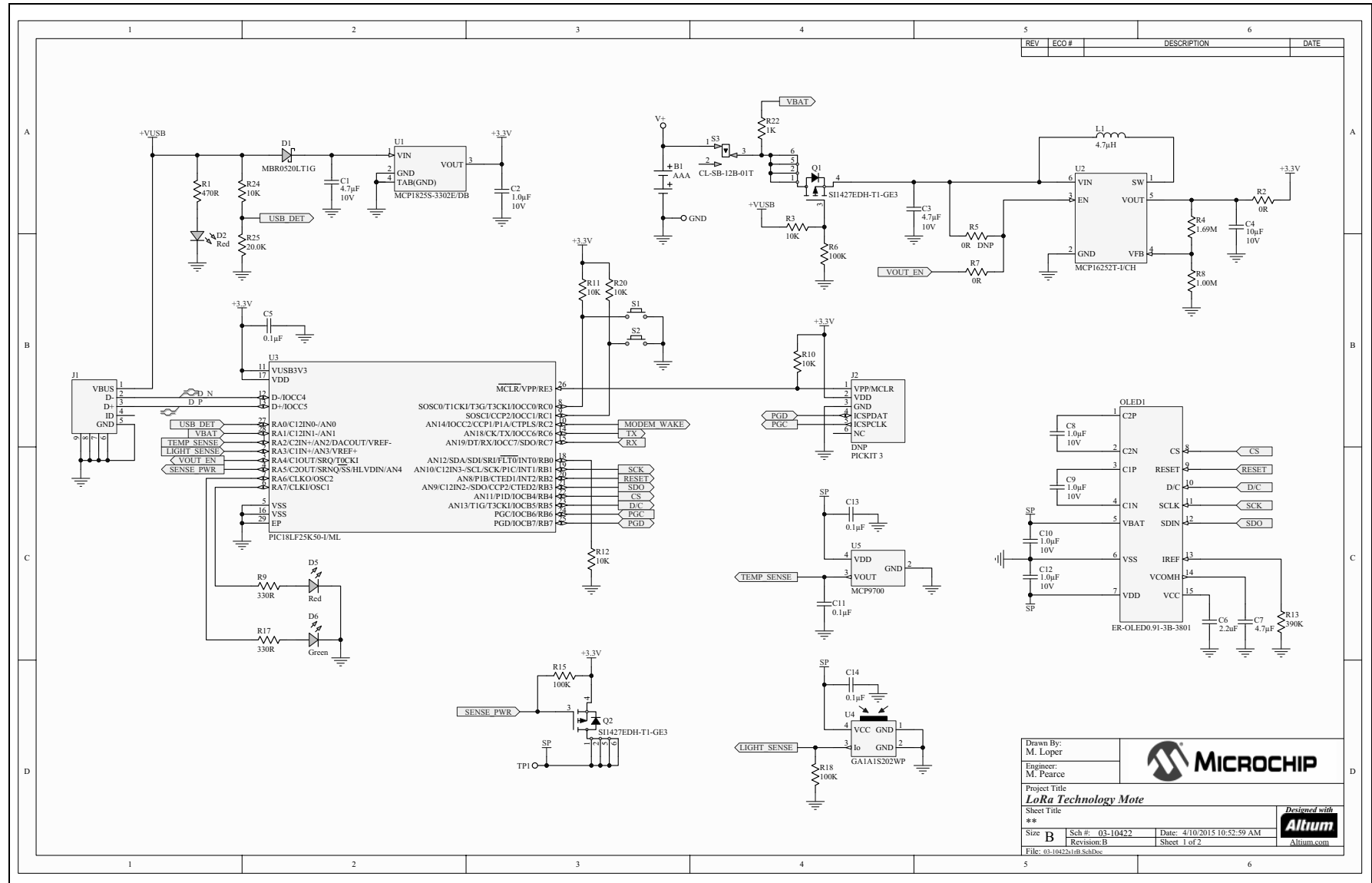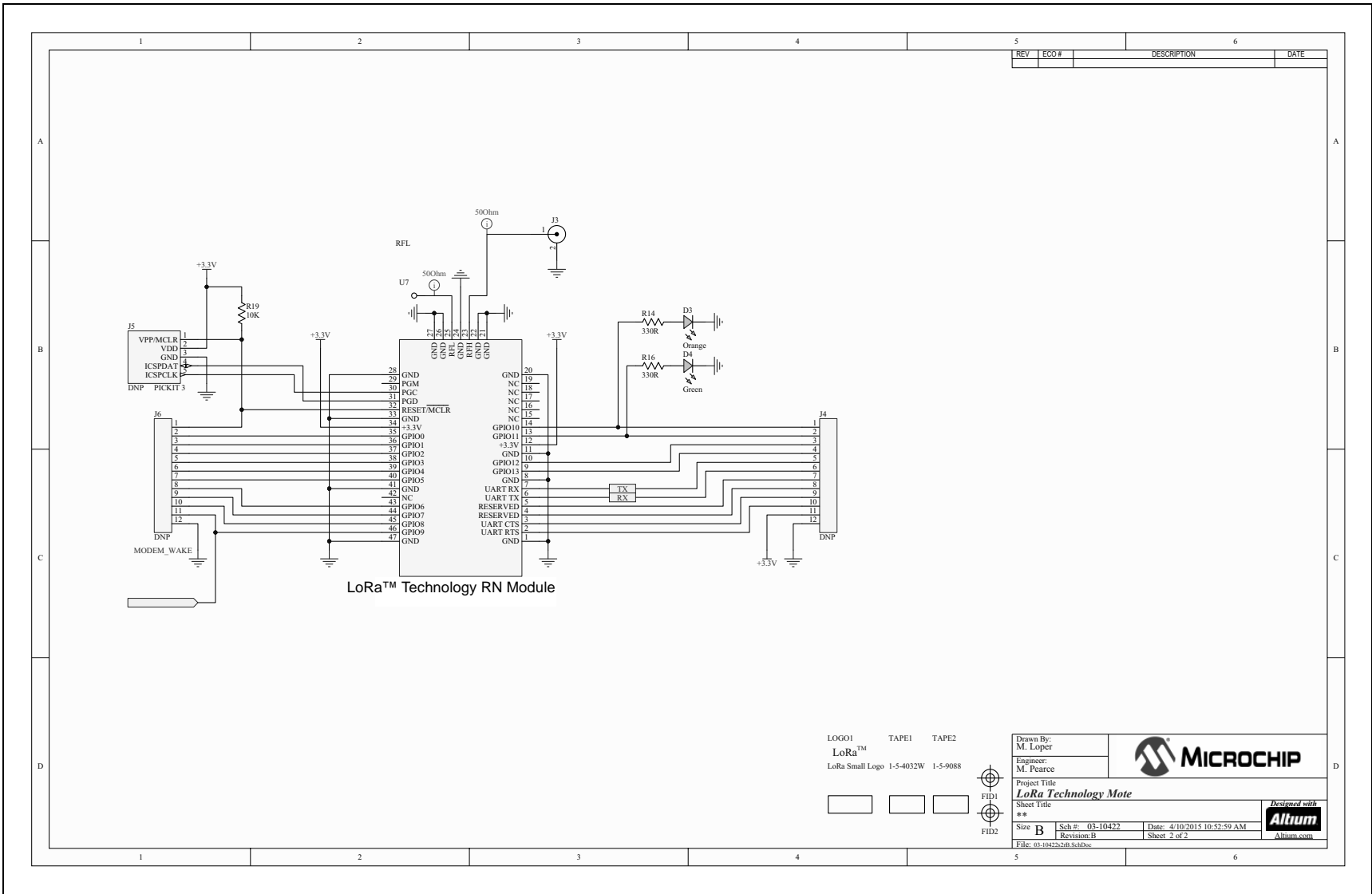LoRa™ Mote User's Guide

FIGURE A-2:   **LoRa™ MOTE BOARD SCHEMATIC 2**

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A.3   BILL OF MATERIALS

TABLE A-1:   LoRa™ MOTE BOARD BILL OF MATERIALS (BOM)

Quantity	Designator	Description	Manufacturer 1	Manufacturer Part No.
1	B1	Plastic battery holder, two AAA, series conn, 063 Elev, Tape Mount	Keystone Electronics	2468
2	C1, C3	Cap, Ceramic, 4.7uF, 10V 10% X5R	Kemet	C0603C475K8PACTU
5	C2, C8, C9, C10, C12	Cap, Ceramic, 1uF, 10V X5R	Kemet	C0603C105M8PACTU
1	C4	Cap, Ceramic, 10uF, 10V X5R 10%	TDK Corporation	C1608X5R1A106M
4	C5, C11, C13, C14	Cap, Ceramic, 0.1uF, 50V X5R	TDK Corporation	C1608X7R1H104M080AA
1	C6	Cap, Ceramic, 2.2uF, 16V X5R	TDK Corporation	C1608X5R1C225K080AB
1	C7	Cap, Ceramic, 4.7uF, 16V 10% X5R	Taiyo Yuden	EMK107ABJ475KA-T
1	D1	Diode, Schottky, 20V, 500mA, SOD123	ON Semiconductor	MBR0520LT1G
2	D2, D5	LED, SMD, RED, 0603 package	Kingbright	APT1608EC
1	D3	LED, SMD, AMBER, 0603 package	Lite-On Inc	LTST-C190AKT
2	D4, D6	LED, SMD, GRN, 0603 package	Kingbright	APT1608SGC
1	J1	Receptacle, Mini USB, UX60-MB-5ST, Type B	Hirose Electric Co Ltd	UX60-MB-5ST
1	J3	SMA Jack, 50 Ohm, Edge Mount	Samtec	SMA-J-P-H-ST-EM1

Advance Information

TABLE A-1: LoRa™ MOTE BOARD BILL OF MATERIALS (BOM) (CONTINUED)

Quantity	Designator	Description	Manufacturer 1	Manufacturer Part No.
1	L1	Inductor, 4.7uH, Wirewound, 20% SMD 2518	Taiyo Yuden	CBC2518T4R7M
1	OLED1	OLED Display Module, SPI, 128 X 32, Blue, with FPC Connector	East Rising	ER-OLED0.91-3B-3801
2	Q1, Q2	P-CHAN MOSFET, 20V 2A, Built-In ESD, SOT-363	Vishay Siliconix	SI1427EDH-T1-GE3
1	R1	Res, 470 Ohm, 1/10W 1%	Stackpole Electronics Inc	RMCF0603FT470R
4	R2, R7, R21, R26	Res, 0 Ohm, 1/10W	Stackpole Electronics Inc	RMCF0603ZT0R00
6	R3, R10, R11, R12, R19, R24	Res, 10K, 1/10W 1%	Panasonic Electronic Components	ERJ-3EKF1002V
1	R4	Res, 1.69M 1/10W 1%	Vishay Dale	CRCW06031M69FKEA
3	R6, R15, R18	Res, 100K, 1/10W 1%	Stackpole Electronics Inc	RMCF0603FT100K
1	R8	Res, 1M 1/10W 1%	Stackpole Electronics Inc	RMCF0603FT1M00
4	R9, R14, R16, R17	Res, 330 Ohm, 1/10W 1%	Stackpole Electronics Inc	RMCF0603FT330R
1	R13	Res, 390K, 1/10W 1%	Stackpole Electronics Inc	RMCF0603FT390K
1	R25	Res, 20K 1/10W 1%	Stackpole Electronics Inc	RMCF0603FT20K0
1	S1	Switch, Tact, PB MOM SMT, Series TL3302	E-Switch	TL3302AF180QJ
1	S2	Switch, Slide, SPDT, 0.2A, 12V	Copal Electronics Inc	CL-SB-12B-01T
1	U1	Regulator, LDO, 3.3V, 500mA, SOT223	Microchip Technology Inc.	MCP1825S-3302E/DB

TABLE A-1: LoRa™ MOTE BOARD BILL OF MATERIALS (BOM) (CONTINUED)

Quantity	Designator	Description	Manufacturer 1	Manufacturer Part No.
1	U2	Synchronous Boost Regulator with I/O Bypass	Microchip Technology Inc.	MCP16252T-I/CH
1	U3	USB 8-Bit Flash Microcontroller, 32Kb, QFN-28	Microchip Technology Inc.	PIC18LF25K50-I/ML
1	U4	Sensor, Ambient Light, 555nM, SMD	Sharp Microelectronics	GA1A1S202WP
1	U5	LP Linear Active Thermistor, SC70-5	Microchip Technology Inc.	MCP9700T-E/LT
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