Interior Ambient Lighting Module with LIN Interface User's Guide

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
ISO/TS 16949:2002

Microchip received ISO/TS-16949:2002 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

Table of Contents

NOTES:

INTERIOR AMBIENT LIGHTING MODULE WITH LIN INTERFACE USER'S GUIDE

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 "DSXXXXXA", where "XXXXX" 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 on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the Interior Ambient Lighting Module with LIN Interface. Items discussed in this chapter include:

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

DOCUMENT LAYOUT

This document describes how to use the Interior Ambient Lighting Module with LIN Interface as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- **Chapter 1. "Interior Ambient Lighting Module with LIN Interface"** – This chapter provides an overview of this product, its features, the functional overview and the contents of this product package.
- **Chapter 2. "Hardware Components"** – This chapter lists the hardware components of this product.
- **Chapter 3. "Software Components"** – This chapter lists the software components of this product.
- **Appendix A. "Schematic for the PC Board"** – The appendix provides a detailed PC board schematic and the LIN handler flowchart.
- **Index** – The index lists the user guide content in an alphabetical order.
- **Worldwide Sales and Service** – This is a list of Microchip owned sales and service centers.

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) { ... }`

WARRANTY REGISTRATION

Please complete the enclosed Warranty Registration Card and mail it promptly. Sending in the Warranty Registration Card entitles users to receive new product updates. Interim software releases are available at the Microchip web site.

RECOMMENDED READING

This user's guide describes how to use Interior Ambient Lighting Module with LIN Interface. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

Readme for Interior Ambient Lighting Module with LIN Interface

For the latest information on using Interior Ambient Lighting Module with LIN Interface, read the `Readme.txt` file (an ASCII text file) in the CD supplied with the module. The Readme file contains update information and known issues that may not be included in this user's guide.

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

Microchip's customer notification service helps keep customers current on Microchip products. Subscribers will receive e-mail notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

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 and other language tools. These include the MPLAB C18 and MPLAB C30 C compilers; MPASM™ and MPLAB ASM30 assemblers; MPLINK™ and MPLAB LINK30 object linkers; and MPLIB™ and MPLAB LIB30 object librarians.
- **Emulators** – The latest information on Microchip in-circuit emulators.This includes the MPLAB ICE 2000 and MPLAB ICE 4000.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debugger, MPLAB ICD 2.
- **MPLAB® 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 SIM simulator, MPLAB IDE Project Manager and general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include the MPLAB PM3 and PRO MATE® II device programmers and the PICSTART® Plus and PICkit™ 1 development programmers.

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://support.microchip.com

DOCUMENT REVISION HISTORY

Revision A (March 2008)

- Initial Release of this Document.

Chapter 1. Interior Ambient Lighting Module with LIN Interface

Thank you for purchasing Microchip Technology's Interior Ambient Lighting Module with Local Interconnect Network (LIN) interface PC board.

This chapter provides an over view of this product, lists its features and also provides a brief about the device functionality (see Figure 1-1).

It comprises the following topics:

- Product Overview
- Product Features
- Product Functional Overview
- Product Sales and Packaging

1.1 PRODUCT OVERVIEW

The Automotive Interior Ambient Lighting Module is designed to control one remote RGB LED device residing on a LIN protocol bus, and communicating to a master body control module.

1.2 PRODUCT FEATURES

This device comprises the following features:

- Multi-color mixing to achieve 7 to 16,383 colors
- Color intensity of 1,023 levels
- Constant voltage/current drive
- LIN 2.0 and J2602 bus slave compatibility

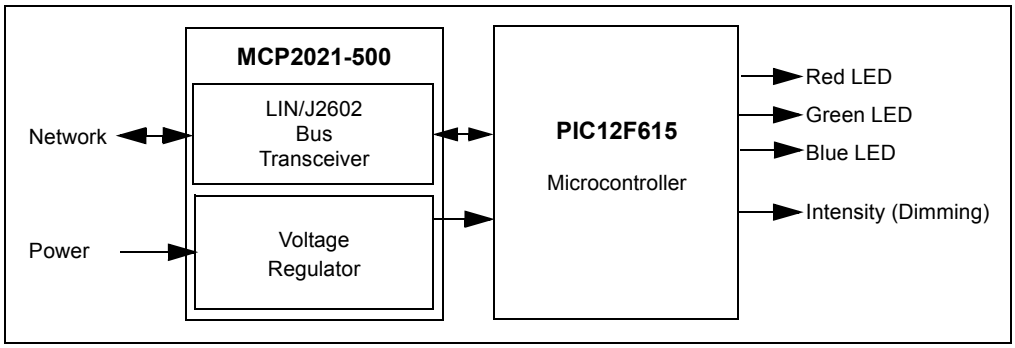
1.3 PRODUCT FUNCTIONAL OVERVIEW

The circuit supports a number of Microchip 8-pin microcontrollers to meet varying functional and cost factors.

The printed circuit board also is laid out to provide In-Circuit Serial Programming™ (ICSP™) for end-of-line software trimming, for LED binning and color adjustment.

Figure 1-1 illustrates the LED lighting module.

FIGURE 1-1: INTERIOR AMBIENT LIGHTING MODULE WITH LIN INTERFACE BLOCK DIAGRAM



For information on hardware components of this device, see **Chapter 2. "Hardware Components"**.

For information on software components of this device, see **Chapter 3. "Software Components"**.

For a detailed flowchart of the LIN handler, see **Appendix A. "Schematic for the PC Board"**.

1.4 PRODUCT SALES AND PACKAGING

This product comes with:

- The PC board – (see Figure A-1)
- The firmware (see Table 3-1)

> **Note:** The firmware files are located on the included software CD-ROM and are located in a directory called `Source`.

The PDF files for additional reference are on the software CD.

Chapter 2. Hardware Components

2.1 HARDWARE COMPONENTS

This chapter lists and describes the PC board hardware. The following topics are described:

- Microcontroller
- Network Interface
- Power Supply
- Connectors

For a detailed illustration of the PC board, see **Appendix A. "Schematic for the PC Board"**.

2.1.1 Microcontroller

The PC board is supplied with the PIC12F615 microcontroller and a MCP2021-500 LIN transceiver with voltage regulator.

The alternative microcontroller devices and their advantages are:

- PIC12F683 – More program and data memory plus EEPROM
- PIC12F609 – Lower cost without hardware PWM

For applications requiring more I/O pins or additional features, the software can be ported to higher pin count devices. It is also expandable to drive more LED channels with additional I/O ports.

Table 2-1 lists the I/O port connections.

TABLE 2-1: I/O CONNECTIONS

PORT Pin	Function	Notes
Output		
RA0	Green LED Drive Output	ICSP™ Data
RA1	Blue LED Drive Output	ICSP Clock
RA2	Intensity Drive Output	CCP Out
RA4	Red LED Output	—
Network Transceiver		
RA3	LIN RX Input	ICSP $\overline{\text{MCLR}}$
RA5	LIN TX Output	—

Note: The microcontroller Flash program and E^2 data memory (E^2 is available in PIC12F683) may be programmed through the five test points located on the edge of the PC board. These test points are ordered so that they are pin out compatible with PICkit™ 1 and 2 programmers. Alternatively, Microchip MPLAB® ICD 2 may be used with an appropriately pinned cable (not supplied).

For more information, refer to "*PIC12F609/HV609, PIC12F615/HV615 Data Sheet" (*DS41302) and *"PIC12F683 Data Sheet" (*DS41211) available on the Microchip web site.

2.1.2 Network Interface

An MCP2021-500 LIN bus transceiver connects to a LIN or J2602 compatible network. The MCP2021 also contains a voltage regulator that outputs 5.0 VDC. A Zener diode protects the LIN bus pin from transient voltages. The capacitor between the LIN bus pin and ground should have its value adjusted to the particular network topology.

For more information on the LIN transceiver, refer to the *"MCP202X LIN Transceiver with Voltage Regulator*" (DS22018).

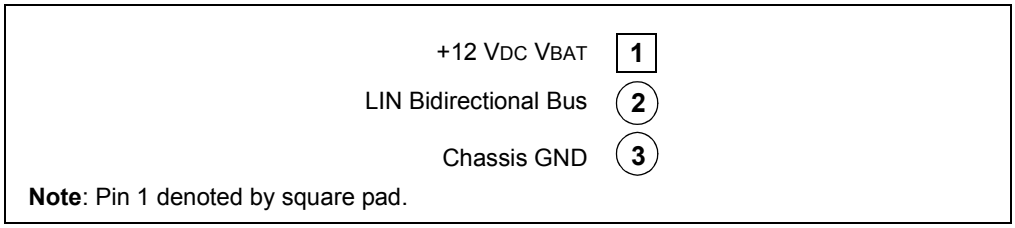
2.1.3 Power Supply

The board gets the power supply and the bus connection through three through-hole pads. The voltage should be in the range of 8-18 VDC. The MCP2021-500 transceiver's integrated, automotive grade voltage regulator is reverse battery, transient and load dump protected.

2.1.4 Connectors

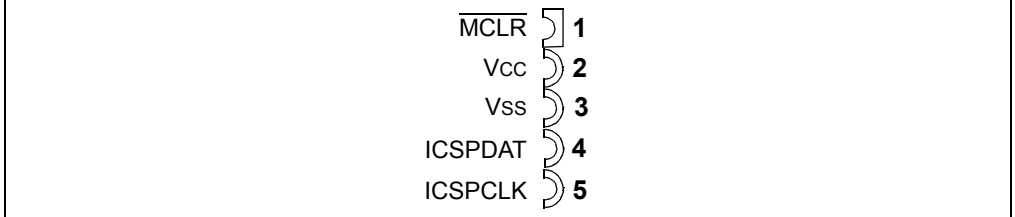
Figure 2-1 illustrates the system connector and Figure 2-2 illustrates the programming connector.

FIGURE 2-1: SYSTEM CONNECTOR



Note: Pin 1 denoted by square pad.

FIGURE 2-2: PROGRAMMING CONNECTOR



Note: Pin 1 denoted by semi-square pad.

Chapter 3. Software Components

3.1 SOFTWARE COMPONENTS

This chapter lists and describes the firmware components in this device and is composed of:

- Software Module Overview – The individual files that make up the firmware.
- Local Interconnect Network (LIN) – LIN is a single-wire, serial communications protocol based on the common asynchronous byte word interface.
- Command Message Frame – LIN identifiers.
- LIN Slave Protocol Handler – This complies to the LIN 2.0 protocol.

The displayed color of the three-element RGB LEDs is controlled by varying the brightness of the individual LEDs with three software Pulse-Width Modulator (PWM) outputs. The overall intensity of all three LEDs is set by the hardware PWM output.

For detailed information, refer to the Microchip application note *AN1074, "Software PWM Generation for LED Dimming and RGB Color Applications"* (DS01074).

The function of the firmware is:

- Based on the internal 8 MHz oscillator
- Interrupt driven Pulse-Width Modulation routine
  - Frequency of 976 Hz PWM
  - Color resolution of 8 bits
- LED brightness, controlled by hardware PWM generated by the on-chip Capture/Compare/PWM module
  - Frequency of 3968 Hz PWM
  - Brightness resolution of 10 bits
- Ramp up and ramp down dimming functions
  - Range of 0 to 65 seconds
  - Resolution of 1 ms

3.1.1 Software Module Overview

Table 3-1 lists and describes the basic modules of this software.

TABLE 3-1: BASIC SOFTWARE MODULE

Module	Description
BBSLAVE.asm	LIN handler/driver slave task routines.
IDTABLE.inc	LIN identifier descriptor table.
RGB615_xxxxxx.asm	Initialization and main program.

The software includes two assemble time conditional options:

1. Select the microcontroller, PIC12F615 or PIC12F683, by removing the comment semicolon in front of one of the two lines of code shown below:

```
#define proc 12F615; remove comment semi-colon to select processor.
#define proc 12F683;
```

2. Select the lighting zone number.

Note: The software provides for any combination of four zones.

```
  #defineZone0; comment out those zones not to be responded to.
; #defineZone1
; #defineZone2
; #defineZone3
```

3.1.2 Local Interconnect Network (LIN)

The size of a LIN network is restricted to a maximum of 16 nodes (one master and fifteen slaves). The clock synchronization, the simplicity of UART communication and the single-wire medium are the major factors for the cost efficiency of LIN.

For more information on the LIN communications protocol, refer to Microchip application note *AN729* "*LIN Protocol Implementation Using PICmicro® MCUs"* (DS00729).

The firmware in the LED lighting module has been optimized for a baud rate of 10417. This is the standard bit rate advocated by SAE J2602.

3.1.3 Command Message Frame

The firmware responds to the following two LIN identifiers:

- Command Frame
- Status Request Frame

3.1.3.1 COMMAND FRAME

ID Byte provides the functional ID bits, and Register 3-2 to Register 3-7 provide the command format.

REGISTER 3-1: ID BYTE

Parity		**ID Number**					
bit7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
1	0	1	0	0	0	1	1
bit 7-6	**Parity:** As Defined in the LIN Specification						
bit 5-0	**ID Number:** Ambient Light ID 0x23						

REGISTER 3-2: FIRST DATA BYTE (CONTROL)(1)

DIMDWN	RAMPUP	(Reserved)	Select Intensity				
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
x	x	0	0 to 0x1F				

bit 7	**DIMDWN:** Dim Down to Zero From Intensity Selected by bits<4:0> 1 = Dim out 0 = No dim
bit 6	**RAMPUP:** Ramp Up From Zero to Intensity Selected by bits<4:0> 1 = Ramp up 0 = No ramp
bit 5	**Reserved**
bit 4-0	**INTENS<4:0>:** Select Intensity 00000 (off) through 11111 (maximum intensity)

Note 1: The first data byte selects the overall intensity of the RGB LEDs, and also sets a request to ramp up to the chosen intensity, or to ramp down from that intensity level, to zero. The intensity value is scaled to 10 bits of resolution with an increment of 16 bits. The intensity value can be in the range of 0 to 63.

REGISTER 3-3: SECOND DATA BYTE (RED)(1)

Red Saturation							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
0 to 0xFF							

bit 7-0	**RED<7:0>**

Note 1: The second data byte selects the level of red for the desired color mix. The intensity value can be in the range of 0 to 255.

REGISTER 3-4: THIRD DATA BYTE (GREEN)(1)

Green Saturation							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
0 to 0xFF							

bit 7-0	**GREEN<7:0>**

Note 1: The third data byte selects the level of green for the desired color mix. The intensity value can be in the range of 0 to 255.

REGISTER 3-5: FOURTH DATA BYTE (BLUE)(1)

Blue Saturation							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
0 to 0xFF							

bit 7-0	**BLUE<7:0>**

Note 1: The fourth data byte selects the level of blue for the desired color mix. The intensity value can be in the range of 0 to 255.

REGISTER 3-6: FIFTH DATA BYTE (ZONE)(1)

(Reserved)				Zone Selection			
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
0	0	0	0	ZONE3	ZONE2	ZONE1	ZONE0

bit 7-4	**Reserved**
bit 4-0	**ZONE<3:0>:** Zone Select 0000 = No zones 0001 = Zone 1 0010 = Zone 2 0011 = Zone 1 and 2 0100 = Zone 3 0101 = Zone 1 and 3 0110 = Zone 2 and 3 0111 = Zone 1, 2 and 3 1000 = Zone 4 1001 = Zone 4 and 1 1010 = Zone 4 ad 2 1011 = Zone 4, 1 and 2 1100 = Zone 4 and 3 1101 = Zone 4, 1 and 3 1110 = Zone 4, 2 and 3 1111 = All zones

Note 1: The fifth byte selects a particular zone that is to respond to this message. Each of four bits represents a zone; thus, four zones are defined. Zones can be individually addressed or in any combination.

REGISTER 3-7: SIXTH DATA BYTE (CHECKSUM)

Checksum							
bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0

bit 7-0	**Checksum<7:0>:** Checksum of Data Bytes as Defined in the LIN Specification

Table 3-2 lists some typical command frames.

TABLE 3-2: COMMAND FRAME BIT VALUES

Frame	ID	Intensity%	Red%	Green %	Blue %	Zone	Color
2 3 1F 8 0 8 0 8 0 0 15 E	23	100	50	50	50	1	White
2 3 1 0 FF 0 0 0 0 0 2 ED	23	50	100	0	0	2	Red
2 3 5 0 0 0 FF 0 0 0 4 AB	23	Ramp from 0 to 50	0	100	0	3	Green
2 3 9 8 0 0 0 0 FF 0 7 6 0	23	Ramp from 75 to 0	0	0	100	3	Blue
2 3 0 8 8 0 8 0 0 0 0 8 EE	23	25	50	50	0	4	Amber
2 3 1F 0 0 8 0 8 0 0F D 0	23	100	0	50	50	All	Cyan

3.1.3.2 STATUS REQUEST FRAME

Register 3-8 lists the status request frame format.

REGISTER 3-8: STATUS REQUEST

Parity		ID Number					
bit7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
1	0	1	0	0	1	0	0
bit 7-6	**Parity:** As Defined in the LIN Specification						
bit 5-0	**ID Number:** Ambient Light Status ID 0x24						

The response to a status request is four bytes followed by a checksum. The four bytes returned are not defined by this version of code.

3.1.4 LIN Slave Protocol Handler

The LIN handler routine is illustrated in Figure B-1. This code includes:

- LIN 2.0 compatible slave interface
- USART function is software-based (bit-bang)
- Break characters are detected and validated for length
- Baud rate is measured and the register values are calculated based on the incoming Sync character

If either the Break or Sync character causes an error, or the identifier is not listed in the table, an error condition is flagged.

With a valid Break Sync header, the process of the LIN handler routine continues:

1. The identifier byte is passed through an ID look-up table to check applicability to this slave.
2. The message length is extracted from the look-up table.
3. The look-up table supplies a bit to determine whether this message data field is supplied or will be consumed.
4. The received data is stored in a buffer.
5. The identifier parity bits and the message frame checksum are checked.

Or:

4. The transferable data is taken from the buffer and transmitted.
5. The appropriate checksum is generated.

3.1.4.1 PROPOSED SOFTWARE ENHANCEMENT

Some enhancements that can easily be implemented to the LIN handler:

- Although various types of errors are detected, none are accumulated.
  - For additional error reporting, error counters could be added.
- Transmitted data bit testing is not done.
  - This could be added at point 'A' marked in the LIN handler flowchart. Bus errors, thus detected, can be accumulated and reported.
- The usage of the internal timer/counter to determine bus time-out and Idle conditions.

NOTES:

Appendix A. Schematic for the PC Board

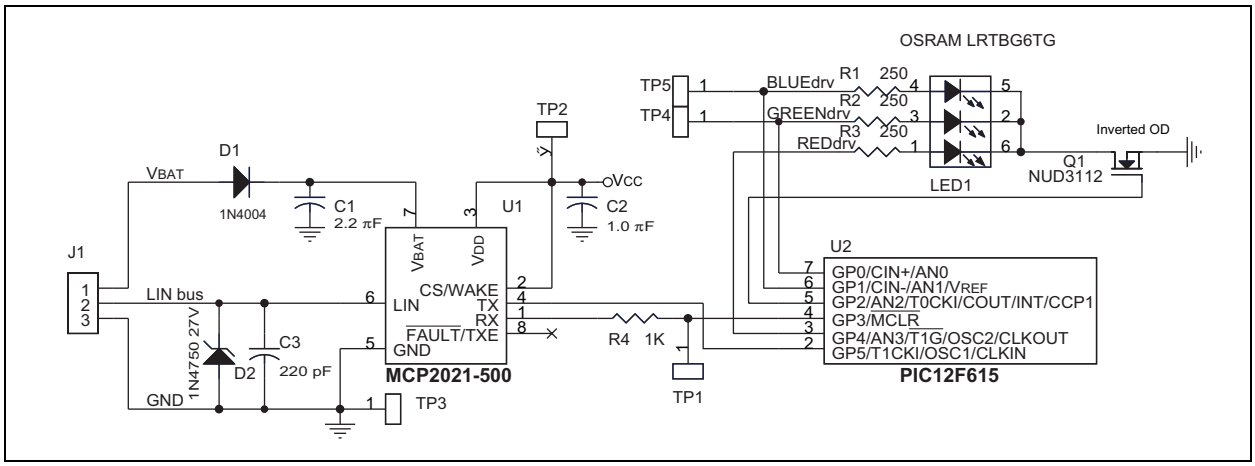
A.1 HIGHLIGHTS

This appendix provides a detailed schematic for getting started using the Interior Ambient Lighting Module with LIN Interface.

A.1.1 Schematic for the PC Board

Figure A-1 illustrates the schematic.

FIGURE A-1: PC BOARD SCHEMATIC



NOTES:

Appendix B. LIN Handler Flowchart

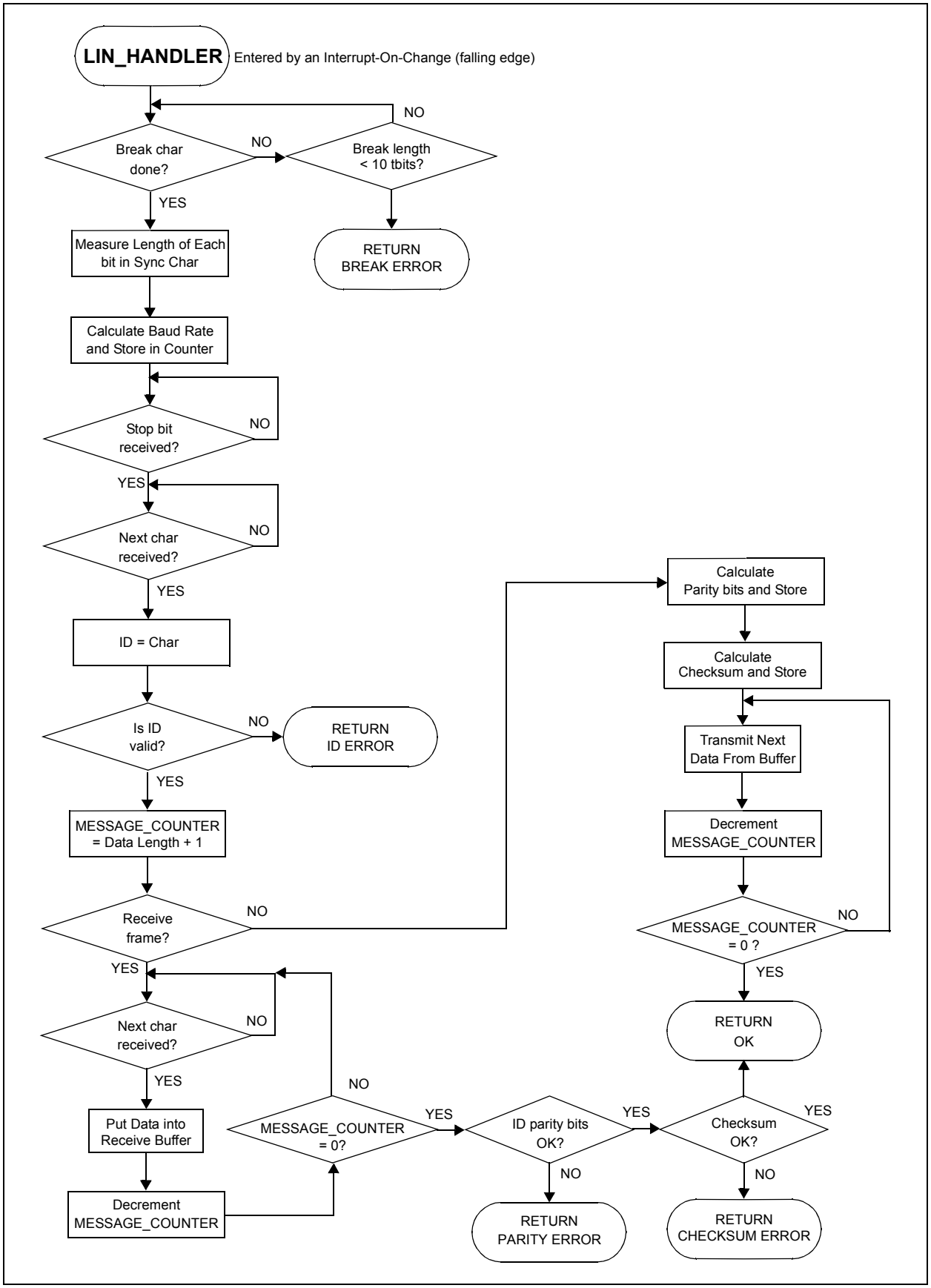
B.1 HIGHLIGHTS

This appendix provides a detailed flowchart for getting started using the Interior Ambient Lighting Module with LIN Interface.

B.1.1 LIN Handler Flowchart

Figure B-1 illustrates the flowchart.

FIGURE B-1: LIN HANDLER FLOWCHART



Index

WORLDWIDE SALES AND SERVICE

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://support.microchip.com
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Farmington Hills, MI
Tel: 248-538-2250
Fax: 248-538-2260

Kokomo
Kokomo, IN
Tel: 765-864-8360
Fax: 765-864-8387

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

Santa Clara
Santa Clara, CA
Tel: 408-961-6444
Fax: 408-961-6445

Toronto
Mississauga, Ontario,
Canada
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon
Hong Kong
Tel: 852-2401-1200
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8528-2100
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Hong Kong SAR
Tel: 852-2401-1200
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8203-2660
Fax: 86-755-8203-1760

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-4182-8400
Fax: 91-80-4182-8422

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-2566-1512
Fax: 91-20-2566-1513

Japan - Yokohama
Tel: 81-45-471- 6166
Fax: 81-45-471-6122

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-572-9526
Fax: 886-3-572-6459

Taiwan - Kaohsiung
Tel: 886-7-536-4818
Fax: 886-7-536-4803

Taiwan - Taipei
Tel: 886-2-2500-6610
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

UK - Wokingham
Tel: 44-118-921-5869
Fax: 44-118-921-5820

01/02/08