LCD Serial Accessory Board 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.

Trademarks

ISBN: 978-1-60932-818-4

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.

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

LCD SERIAL ACCESSORY BOARD USER'S GUIDE

Table of Contents

NOTES:

LCD SERIAL ACCESSORY BOARD 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 LCD Serial Accessory Board User's Guide. 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 LAYOUT

This document describes how to use the LCD Serial Accessory Board to evaluate and experiment with Microchip wireless solutions. The manual layout is as follows:

- **Chapter 1. "Overview"** – This chapter introduces the LCD Serial Accessory Board and its features.
- **Chapter 2. "LCD Serial Accessory Board Hardware"** – This chapter provides a brief description of the hardware components on the board.
- **Chapter 3. "LCD Serial Accessory Board Software"**– This chapter describes the software structure of the LCD Serial Accessory Board and provides a brief description of its subsystems.
- **Appendix A. "LCD Serial Accessory Board"** – This appendix illustrates the LCD Serial Accessory Board schematics followed by the LCD Serial Accessory Board PCB Layout and the LCD Serial Accessory Board Bill of Materials.

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 LCD Serial Accessory Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

Readme Files

For the latest information on using other tools, read the tool-specific Readme files in the Readmes subdirectory of the MPLAB IDE installation directory. The Readme files contain 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 (January 2011)

- This is the initial release of the document.

Chapter 1. Overview

1.1 INTRODUCTION

The LCD Serial Accessory Board is a demonstration and development daughter board that is used along with the PIC18 Wireless Development Board and RS232 Serial Accessory Board. This daughter board can be interfaced directly to the PIC18 Wireless Development Board or through the RS232 Serial Accessory Board. The demonstration program for this board can be downloaded from the Microchip web site http://www.microchip.com/wireless.

The following topics are discussed in this chapter:

- LCD Serial Accessory Board
- Compatibility with Microchip's other Development Boards

1.2 LCD SERIAL ACCESSORY BOARD

The interface between the LCD Serial Accessory Board and PIC18 Wireless Development Board is through the Serial Accessory Port on the PIC18 Wireless Development Board. Serial Accessory Port basically supports the external sensors and modules, such as the LCD Serial Accessory Board, SPI, I^2C™ or USART connection. Serial Accessory Port from PIC18 Wireless Development Board is supported through any of the four Microcontroller options used.

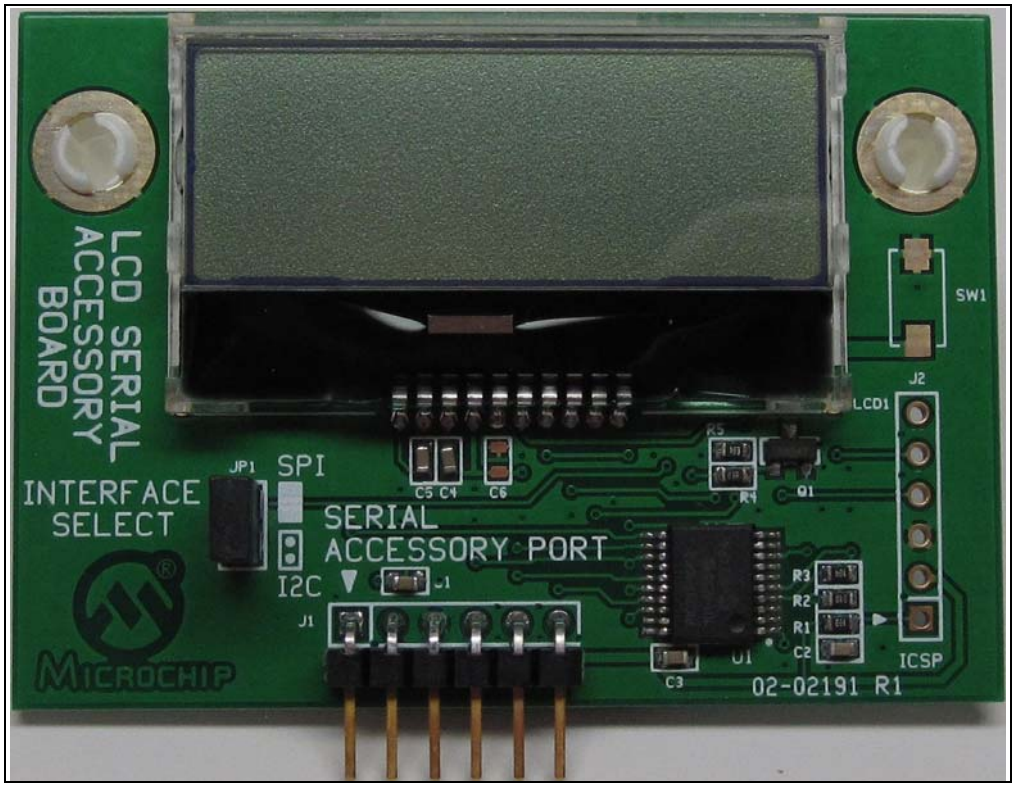
LCD Serial Accessory Board includes the following features:

- Display of 32 characters in two lines
- Automatic control of the LCD backlight
- Automatic contrast voltage adjustment
- Standard communication protocol for easy handling of the display
- 2.6–3.3V supply voltage
- XLP compatible power saving modes
- SPI and I^2C compatible selectable interface

1.3 COMPATIBILITY WITH MICROCHIP'S OTHER DEVELOPMENT BOARDS

Microchip has several development kits that may provide serial expansion ports for different peripherals. The names of these ports are different. These expansion ports may or may not be compatible with the LCD Serial Accessory Board's Serial Accessory Port. Users must check the hardware and software compatibilities between the development kit and the LCD Serial Accessory Board before connecting them.

FIGURE 1-1: LCD SERIAL ACCESSORY BOARD



Chapter 2. LCD Serial Accessory Board Hardware

2.1 INTRODUCTION

This chapter introduces the hardware layout of the LCD Serial Accessory Board. LCD Serial Accessory Board supports the following functions:

- Selectable 3 wire SPI or I^2C interface
- Supports Deep Sleep mode control
- LCD control line driving
- PWM Backlight driving

The control functions are supported by Microchip's NanoWatt XLP technology based PIC24F16KA101 Microcontroller. The microcontroller includes hardware modules such as SPI, I^2C interface and Output Compare to support the PWM signal generation, all in a 20 pin package. The LCD Serial Accessory Board from Newhaven Display Inc. (P/N NHD-C0216CZ-FSW-FBW COG) includes an integrated display controller with a white LED backlight. The backlight can be controlled by the host Microcontroller with simple commands. The commands are detailed in **Section 3.1 "Software Structure"**.

NOTES:

Chapter 3. LCD Serial Accessory Board Software

3.1 SOFTWARE STRUCTURE

This chapter introduces the software structure of the LCD Serial Accessory Board. The LCD Serial Accessory Board firmware, which is running on the on-board PIC24FKA101 XLP microcontroller, defines the subsystems for the internal functional groups. The LCD Serial Accessory Board defines the subsystems. These subsystems cover all the functionality of the LCD Serial Accessory Board. Each subsystem is responsible for a group of functionality as detailed below:

- LCD Module Subsystem (LMS): Responsible for all the low level functions that affect the behavior of the entire LCD Serial Accessory Board. It is also responsible for the hardware interface handling, Sleep mode control and data flow management between the three subsystems.
- LCD Backlight Subsystem (LBS): Handles the back light related functions.
- LCD Control Subsystem (LCS): Controls the LCD device.

These three subsystems have commands that affect and determine the operation of the subsystem. Each subsystem has both common and unique commands. Common commands can be executed by all the subsystems, while unique commands are interpreted only by the appropriate subsystem.

3.2 COMMAND STRUCTURE

The LCD Serial Accessory Board accepts the 8-bit frames that supports the physical interface protocol.

The following are the commands supported by the LCD Serial Accessory Board:

- Single-byte commands: Control the behavior of the internal functions.
- Multi-byte commands: Set internal parameters or write data to a specific address in the display RAM of the LCD Serial Accessory Board.

For more information, refer to the command description of the appropriate subsystems.

3.2.1 Command Byte Frame Format

This section describes the structure of the Command Byte Frame. The command byte structure is shown in Table 3-1:

TABLE 3-1: COMMAND BYTE FRAME FORMAT

Command Byte<7:0>	Argument(0)<7:0>	Argument(1)<7:0>	Argument(N)<7:0>

The first field is the Command Byte, it always determines the number of argument bytes following it. The Command Byte Frame must be transmitted in consecutive bytes as a single frame to prevent malfunctioning of the command interpreter. A single command can be given in a single frame.

The Table 3-2 describes the structure of the Command Byte:

TABLE 3-2: COMMAND BYTE STRUCTURE

Bit Position	7	6	5	4	3	2	1	0
Function	LMS	LBS	LCS	CMD<4:0>				

LMS: Requires LCD Module Subsystem command execution.

LBS: Requires LCD Backlight Subsystem command execution.

LCS: Requires LCD Control Subsystem command execution.

CMD<4:0>: Command Instruction code

3.2.2 Command Execution

This section describes the command execution method of the LCD Serial Accessory Board. LCD Serial Accessory Board supports parallel command execution for common commands. To execute LMS, LBS and LCS parallel, the corresponding bits of the command byte must be set. In this case all the three subsystems execute the same command in a single execution time.

The following are the steps used while executing a command:

1. The interpreter runs the command on the appropriate subsystems as per the values of LMS, LBS and LCS bits.
2. If the appropriate subsystem does not support the requested command, the command is ignored by the subsystem without any warning.
3. If a command is executed on multiple subsystems, the execution is carried out from the most global subsystem towards the least global subsystem. Initially, the LCD Module Subsystem is affected by the command execution followed by the LCD Backlight and the LCD Control Subsystem.

Note 1: If LBS and LCS bits are set in a Subsystem Initialize command, both LCD Backlight and LCD Control Subsystems will be initialized within a single command execution.

2: Few commands are executed only by the most global subsystem, LMS, which prevents the execution of the same command on the lower subsystem layers. For instance, if the Subsystem Initialize command is executed on the LCD Module Subsystem, it prevents the command execution on Backlight and LCD Control Subsystems as the microcontroller RAM data retention is not supported after software reset.

3.2.3 Common Subsystem Commands

The following are the Common Commands that are interpreted by all the Subsystems:

- Subsystem Initialize: Sets the default values of the subsystem.
- Subsystem ON: Enables the operation of the subsystem.
- Subsystem OFF: Disables the operation of the subsystem.
- Subsystem Set Parameter: Sets the changeable parameters of the subsystem.

3.3 LCD MODULE SUBSYSTEM

This section describes the most global subsystem called the LCD Module Subsystem. It handles the entire LCD Serial Accessory Board, the hardware, as a system. The hardware and the software environments of the module are affected by the functions of this subsystem. The following sub-sections describe the commands that are interpreted by the LCD Module Subsystem:

3.3.1 Subsystem Initialize

The Subsystem initialize command sets the power-on-default state. As the command is issued, the module executes a software reset. As a part of the usual power-on sequence, the module initializes the Serial Accessory Port interface and enables the subsystems to execute the Subsystem Initialize command. After Power-on Reset (POR) the firmware checks the state of the Interface Select jumper. Based on the current value of the jumper, the firmware initializes the appropriate interface. Table 3-3 lists the connection between the jumper values and the selected interface.

TABLE 3-3: INTERFACE SELECT JUMPER SETTINGS

Jumper JP1	Interface
Disconnected	I^2C
Connect (short pins)	SPI

The I^2C mode has its own default slave address, that is 0x3E. The SPI mode provides the standard 3 wire SPI slave interface.

3.3.2 Subsystem ON

The Subsystem ON command instructs the LCD Serial Accessory Board to exit from the Sleep mode and function at a full speed.

3.3.3 Subsystem OFF

The Subsystem OFF command instructs the LCD Serial Accessory Board to enter the Sleep mode. In Sleep mode the subsystem switches off the LCD screen and the microcontroller enters Sleep mode to conserve battery power. While the microcontroller is in Sleep mode its I^2C or SPI interface remains active to accept any command. After a command is issued, LCD Serial Accessory Board turns itself ON and executes the command and remains in ON state.

3.3.4 Subsystem Set Parameter

The Subsystem Set Parameter command rewrites the 7 bit I^2C slave address and handles the Deep Sleep mode Enable bit. Table 3-4 lists the parameter byte.

TABLE 3-4: PARAMETER SET BIT ASSIGNMENT

Bit position	7	6	5	4	3	2	1	0
Function	DE	I^2C Slave Address<6:0>						

- Deep Sleep mode Enable bit (DE): Deep Sleep mode is not supported after power ON or LCD Module Subsystem initialization. It must be enabled by this command. DSLEEP pin in hardware controls the Deep Sleep mode. DSLEEP pin is pin 1 of the Serial Accessory Port. If Deep Sleep mode is enabled DSLEEP pin must be driven by the host microcontroller.
  - DE = 0: No Deep Sleep mode support; the state of DSLEEP pin is ignored. This is the power ON default.
  - DE = 1: Switches on Deep Sleep mode support.
  - DSLEEP pin = 1: Forces the module to enter Deep Sleep mode.
  - DSLEEP pin = 0: Wakes up the module from Deep Sleep mode.
- I^2C Slave Address: The default I^2C slave address is 0x3E and the maximal value is 0x3F. Slave address can be changed by the Subsystem Set Parameter command.

Note 1: The '0' values of I^2C Slave Address is reserved as 'Don't Change' indicator. If this field contains '0' value, the I^2C Slave Address will not be changed by the command.

2: Parameter values can only be changed by the Subsystem Initialize and the Subsystem Set Parameter commands, else the actual parameter is used.

3.4 LCD BACKLIGHT SUBSYSTEM

The LCD Backlight Subsystem handles the backlight LED of the device. It handles both the brightness and delay values of the LCD backlight. The following are the backlight modes:

- Automatic Backlight mode: Backlight is switched ON after every LCD screen update. Backlight parameters can be set by the Subsystem Set Parameter command.
- Normal mode: Backlight is switched either ON or OFF by the appropriate subsystem commands. In the Normal mode the backlight does not follow the display update. Subsystem ON command switches ON the display with the given back light value.

Back light subsystem uses Soft ON/OFF mode to handle the back light. Soft ON/OFF mode can be either enabled or disabled.

The following sub-sections describes the commands that are interpreted by the LCD Backlight Subsystem:

3.4.1 Subsystem Initialize

The Subsystem Initialize command sets the subsystems default state and enables the Automatic Backlight mode with 1s time delay with Soft ON/OFF mode enabled.

3.4.2 Subsystem ON

This command function switches ON the back light with the actual delay and brightness values. If Soft ON/OFF mode is enabled the subsystem turns the backlight softly on. The backlight parameters can be changed by the Subsystem Set Parameter command.

3.4.3 Subsystem OFF

The Subsystem OFF command switches off the backlight. If Soft ON/OFF mode is enabled, the subsystem turns off the backlight gently.

3.4.4 Subsystem Set Parameter

The Subsystem Set Parameter command sets the backlight parameters. Table 3-5 interprets the single byte argument:

TABLE 3-5: SET PARAMETER BIT ASSIGNMENT

Bit position	7	6	5	4	3	2	1	0
Function	AM	Brightness<2:0>			SO	Delay<2:0>		

- AM: Enables and disables the Automatic mode
  - AM = 1: Enables the automatic back light switching for any display update.
  - AM = 0: Disables the function and back light will not be switched on automatically.
- Brightness<2:0>: Controls the brightness values of the backlight.
- SO: Enables and disables Soft ON/OFF mode back light handling
  - SO = 1: Enables Soft ON/OFF mode. Back light will be switched ON or OFF in discrete steps.
  - SO = 0: Disables Soft ON/OFF mode. Back light will be switched ON or OFF in single step.
- Delay<2:0>: Sets the ON time of the back light. After the preset delay time elapsed the subsystem turns OFF the backlight. The following formula is used to calculate the value: Delay Time = Delay<2:0>*1000 ms.

Note 1: The '0' values of Brightness and Delay are reserved as 'Don't Change' indicator for both fields. If the parameter field contains '0' value, the internal parameter of the subsystem will not be affected by the command.

2: Parameter values can only be changed by the Subsystem Initialize and the Subsystem Set Parameter commands, else the actual parameter is used.

3.5 LCD CONTROL SUBSYSTEM

The LCD Control Subsystem handles the LCD display. LCD Control Subsystem interprets the following commands:

3.5.1 Subsystem Initialize

This command sets the default values of the LCD device as:

- Initialize the LCD device's hardware
- Clears the display content
- Sets contrast to the default value

Note: Contrast value can be changed by the Subsystem Set Parameter command.

3.5.2 Subsystem ON

This command turns ON the display.

3.5.3 Subsystem OFF

This command turns OFF the entire display by switching down its power line.

3.5.4 Subsystem Set Parameter

This command sets the contrast value of the display as given in Table 3-6.

TABLE 3-6: SET PARAMETER BIT ORDERING

Bit position	7	6	5	4	3	2	1	0
Function	0	AC	Contrast<5:0>					

- AC bit: Enables and disables the Automatic Contrast Adjustment. If AC bit is set, LCD Control Subsystem automatically sets the LCD contrast value in every second according to the actual supply voltage requirements. The default value of AC is set.
- Contrast<5:0>: Sets the contrast value of the display.

Note 1: In some cases when LCD Subsystem is busy with display data processing it might happen that contrast adjustment is carried out after several seconds delay.

2: The parameter value can only be changed by the Subsystem Initialize and the Subsystem Set Parameter commands, else the actual parameter is used. If the subsystem is in an ON state, the command writes the parameter into the LCD device, otherwise it is only saved in the subsystem.

3.5.5 Subsystem Write Data

This command writes maximally 32 characters to a specific address of the LCD character RAM area. Table 3-7 lists the command structure. Character RAM addresses are interpreted as display positions of the LCD screen as it is detailed in Table 3-8 .

TABLE 3-7: WRITE DATA COMMAND

Byte Number	Function
1	Subsystem Write Data Command Byte
2	Start Address
3	Data Length
4	Character Byte #1
‘n’, maximally 35	Character Byte #N-3, max 32 characters

Table 3-8 lists the interpretation of the address.

TABLE 3-8: DISPLAY POSITION IN HEXADECIMAL FORMAT

Number of lines	1	2	3	4	5	6		38	39	40
First Line	00	01	02	03	04	05	—	25	26	27
Second Line	40	41	42	43	44	45	—	65	66	67

The number of characters are indicated in the Data Length byte of the frame. The command has the following behavior:

- The command is terminated at the end of the frame or automatically after Data Length count of character bytes.
- The Start Address is interpreted as the position of the first written character on the LCD screen. The internal address counter is incremented after every written character.
- If the Data Length is bigger than the actual line length of the display, the next characters are automatically written to the next line.
- If the Automatic Backlight mode is set, the LCD Backlight Subsystem automatically switches ON the backlight for the preset delay time after every command execution.
- The LCD Serial Accessory Board runs at a very low clock rate to conserve battery power. Therefore, the consecutive Subsystem Write Commands can follow each other after 300ms delay time.

3.5.6 Subsystem Direct Command

These command arguments are sent to the LCD device. For more information, refer to the data sheet of the LCD device.

3.6 SUBSYSTEM COMMAND SUMMARY

Table 3-9 summarizes the Subsystem commands.

TABLE 3-9: SUBSYSTEM COMMAND SUMMARY

Instruction or Working mode	Pin 1 of AUX. port (1)	Length in bytes	Arguments in bytes	LMS(2)	LBS(2)	LCS(2)	CMD <4:0>	Description
Subsystem Initialize	L	1	–	A	A	A	0x01	Initializes the appropriate Subsystem. **LMS**: Initialize the interfaces **LBS**: Automatic Backlight mode with 1s delay **LCS**: Clears the display
Subsystem ON	L	1	–	A	A	A	0x02	Switches ON the subsystem. **LMS**: Returns from the Power Saving mode **LBS**: Switches ON the backlight with the defined brightness value for the defined delay time. **LCS**: Switches ON the entire display
Subsystem OFF	L	1	–	A	A	A	0x04	Switches off the subsystem. **LMS**: Enters Sleep mode **LBS**: Switches OFF the back light **LCS**: Switches OFF the entire display
Subsystem Set Parameter	L	2	1	A	A	A	0x11	Sets the parameters of the subsystem **LMS**: The argument is interpreted as the Deep Sleep mode support enable and I^2C slave address redefinition **LBS**: The argument is interpreted as back light brightness and delay values and Automatic mode enable **LCS**: The lower six bits of the argument are interpreted as contrast value. Bit 6 of the argument controls Automatic Contrast Adjustment.
Subsystem Write Data	L	Max 35	Max 32	–	–	A	0x12	Writes data bytes to the subsystem **LCS**: Writes data bytes to a specific address of the character RAM. The arguments are interpreted as follows: • 1st argument byte: Start Address, automatically incremented • Additional argument bytes: Data bytes
Subsystem Direct Command	L	Max 33	Max 32	–	–	A	0x14	Sends direct commands to the LCD device.
Deep Sleep	H	–	–	–	–	–	–	LCD Serial Accessory Board enters Deep Sleep mode, all subsystems are turned OFF. This mode is not supported after LCD Module Subsystem Initialize command is issued or after power ON.

Note 1: Serial Accessory Port pin 1 handles Deep Sleep mode only if Deep Sleep mode support is enabled, else it is ignored.

2: The field shows whether the command is interpreted or not by the appropriate subsystem. The indicator of 'A' in table 3-8 indicates that the command execution on the subsystem can be requested by setting the bit.

3.7 POWER SAVING MODES

The Sleep and Deep Sleep modes are the power saving modes which are supported by LCD Serial Accessory Board.

3.7.1 Sleep Mode

After the LCD Module Subsystem executes the Subsystem OFF command, the entire display module enters the Sleep mode. In this mode the interfaces remain active. Therefore, any command wakes up the module to full operational mode. This mode gives the fastest response time from sleep but consumes more current than the Deep Sleep mode.

3.7.2 Deep Sleep Mode

Deep Sleep mode is the smallest power consuming state of LCD Serial Accessory Board. This mode restricts the entry of any command. By default the Deep Sleep mode is disabled, and it can be enabled by LCD Module Subsystem Set Parameter command. After power ON or LCD Module Subsystem Initialize command Deep Sleep mode becomes disabled again.

If Deep Sleep mode is enabled, it is automatically handled by the actual state of pin 1 of the Serial Accessory Port. If Deep Sleep mode is disabled the state of pin 1 of the Serial Accessory Port is ignored.

For normal operation when Deep Sleep mode is enabled, pin 1 of the Serial Accessory Port must be at logical low level. Logical high level disables all the internal functionality, switches OFF all subsystems and interfaces and enters the Deep Sleep mode. This mode is the smallest power consumption mode of the LCD Serial Accessory Board. In this mode the module is unable to accept any command. The only way to leave Deep Sleep mode is drive pin 1 of the Serial Accessory Port with logical low level.

The preset subsystem parameters, that were modified by Subsystem Write command, are maintained during Deep Sleep mode.

3.8 COMMUNICATION CONSTRAINTS

3.8.1 Hints for better communication with LCD Module

The following constraints need to be followed while communicating with the module:

- To conserve battery power, LCD Serial Accessory Board runs at slow clock rate. The module requires approximately 5 milliseconds delay between commands and command bytes.
- With the current clock rate the module needs approximately 250 milliseconds to wake up from the Deep Sleep mode. The same time is needed for normal operation after module or LCD Subsystem Initialize commands. However, it is not required to wait 250 milliseconds before sending the commands. After 5 milliseconds, the interface is ready to accept a single command but it will be executed only after the module is booted up.

3.8.2 Limitations for communication with LCD Module

The following are the limitations for communication with the LCD Module:

- There is no command queuing support in LCD Serial Accessory Board. The command buffer is cleared after every command execution.
- 300 milliseconds time delay must be issued between consecutive LCD screen updates.
- I^2C clock stretching is not used as I^2C and SPI hardware interfaces are common.
- User is responsible for maintaining the time constraints.

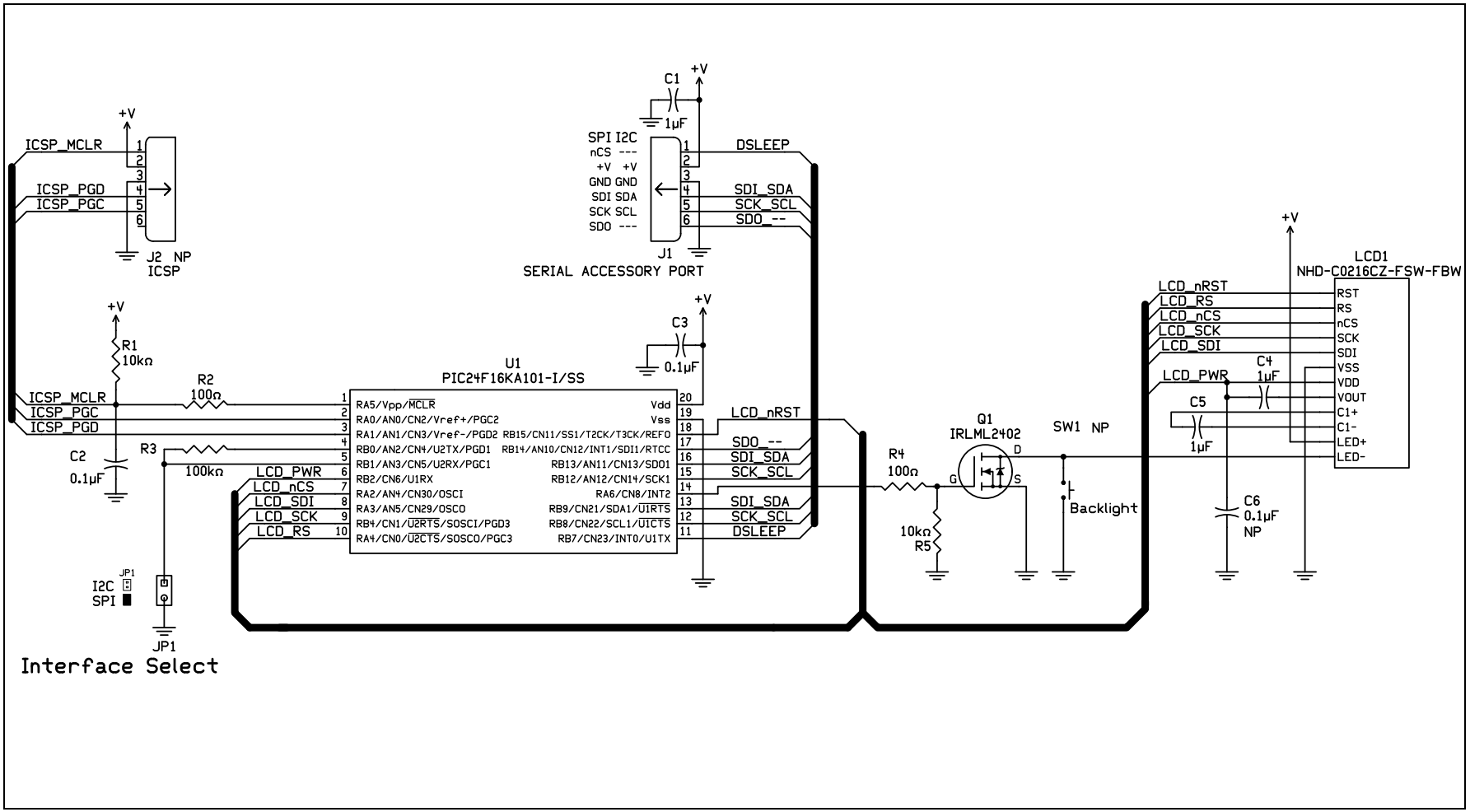
Appendix A. LCD Serial Accessory Board

A.1 INTRODUCTION

This appendix illustrates the LCD Serial Accessory Board schematics followed by the LCD Serial Accessory Board PCB Layout and the LCD Serial Accessory Board Bill of Materials.

A.2 LCD SERIAL ACCESSORY BOARD SCHEMATIC

FIGURE A-1: LCD SERIAL ACCESSORY BOARD SCHEMATIC



A.3 LCD SERIAL ACCESSORY BOARD PCB LAYOUT

The LCD Serial Accessory Board is a two-layer, FR4, 0.062 inch, plated through-hole PCB construction.

FIGURE A-2: LCD SERIAL ACCESSORY BOARD TOP SILK-SCREEN

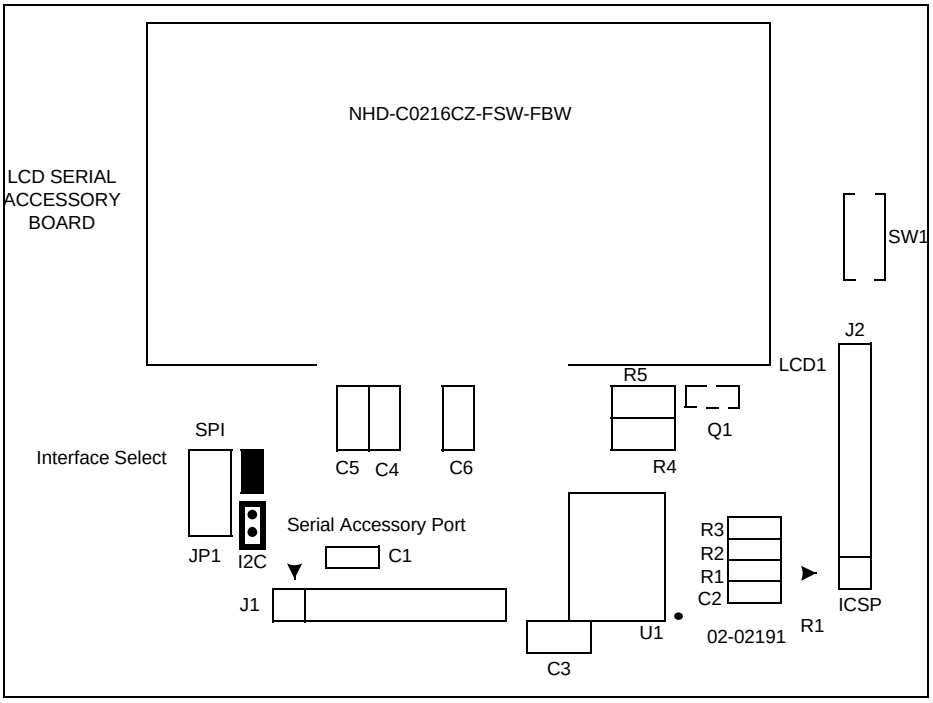


FIGURE A-3: LCD SERIAL ACCESSORY BOARD TOP COPPER

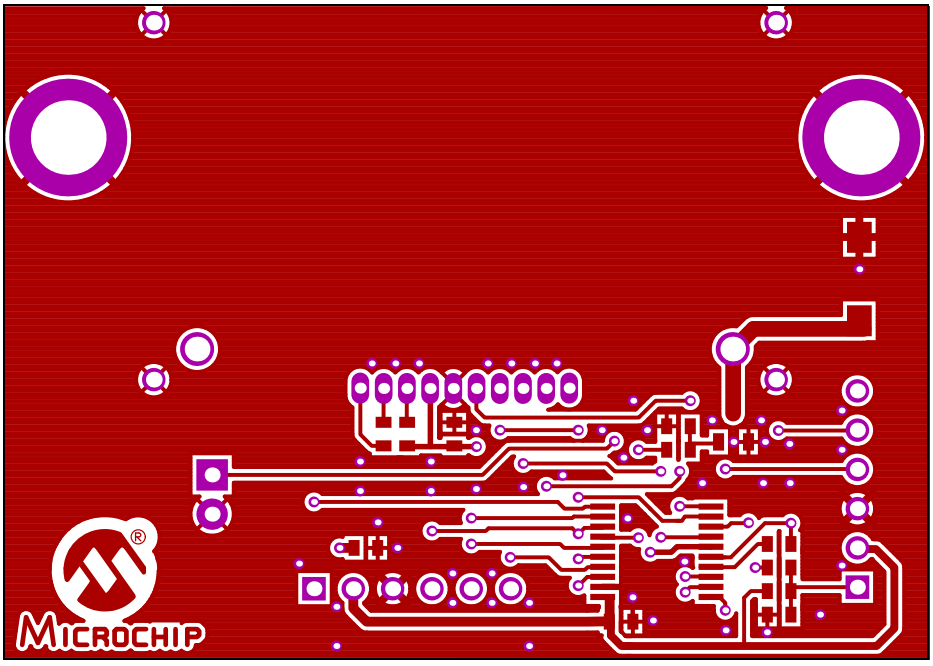
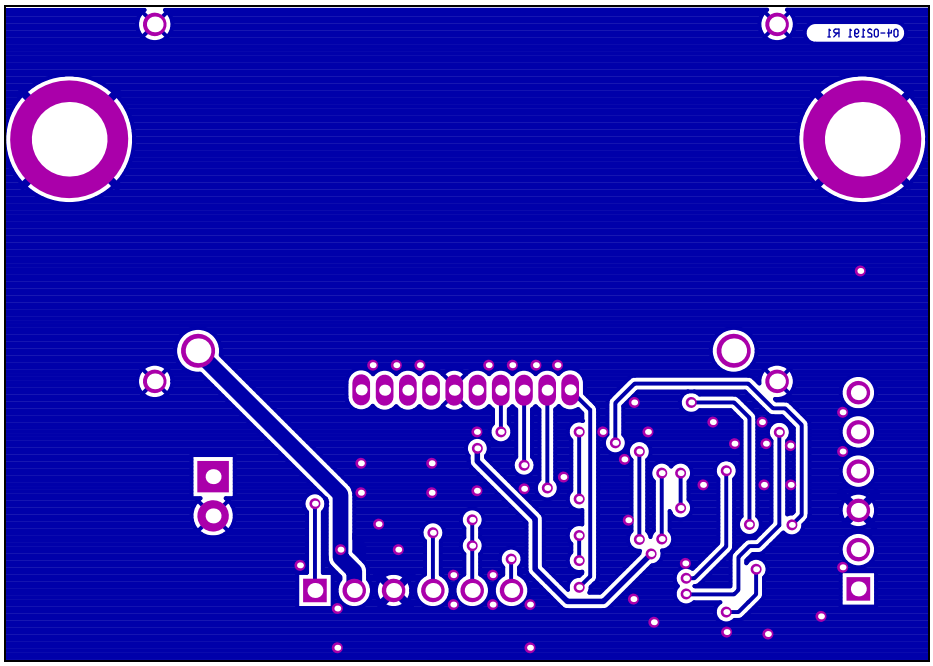


FIGURE A-4: LCD SERIAL ACCESSORY BOARD BOTTOM COPPER – MIRRORED



A.4 LCD SERIAL ACCESSORY BOARD BILL OF MATERIALS

TABLE A-1: LCD SERIAL ACCESSORY BOARD BILL OF MATERIALS

Name	Qty	Description	Type/Value	Manufacturer	Manufacturer Code
C1, C4, C5	3	Capacitor, Ceramic, 6.3V, 10%, X5R, SMT 0603	1µF	Panasonic – ECG	ECJ-1VB0J105K
C2, C3	2	Capacitor, Ceramic, 25V, 10%, X7R, SMT 0603	0.1uF	Panasonic – ECG	ECJ-1VB1E104K
J1	1	Connector, Header, Right Angle, 0.100" spacing, 0.025" sq.	–	Mill-Max	800-10-006-20-001000
JP1	1	Connector, Header, 2-pin, 0.100" spacing	–	SPC Technology	SPC20481
LCD1	1	2x16 Character: 3Vdd FSTN(+), WHITE LED backlight 3V, Transflective, 6:00, Wide Temp (-20 to +70c), Serial Interface, 1x14 hard pin, RoHS	NHD-C0216CZ-FSW-FBW-3V3	Newhaven Display International	NHD-C0216CZ-FSW-FBW-3V3
R1, R5	2	Resistor, SMT 0603	10k	Stackpole Electronics Inc	RMCF 1/16 10K 5% R
R2, R4	2	Resistor, SMT 0603	100R	Stackpole Electronics Inc	RMCF 1/16 100 5% R
R3	1	Resistor, SMT 0603	100 k	Stackpole Electronics Inc	RMCF 1/16 100k 5% R
U1	1	IC PIC MCU FLASH 16K 20-SSOP	PIC24F16KA101-I/SS	Microchip Technology Inc.	PIC24F16KA101-I/SS
Q1	1	MOSFET N-CH 20V 1.2A SOT-23	IRLML2402	International Rectifier	IRLML2402TRPBF
	2	SPACER STACKING #4 SCREW NYLON	Stand-off	Keystone Electronics	8834

Unpopulated parts					
C6	1	Capacitor, Ceramic, 25V, 10%, X7R, SMT 0603	0.1uF	Panasonic - ECG	ECJ-1VB1E104K
J2	1	Connector, Header, Right Angle, 0.100" spacing, 0.025" sq.	ICSP	Mill-Max	800-10-006-20-001000
SW1	1	Switch, Push button, Momentary, 6x3mm SMT	Backlight	C&K Components	PTS635SL25SMTR LFS

NOTES:

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

Cleveland
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

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 - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

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

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

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

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

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: 886-3-6578-300
Fax: 886-3-6578-370

Taiwan - Kaohsiung
Tel: 886-7-213-7830
Fax: 886-7-330-9305

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

08/04/10