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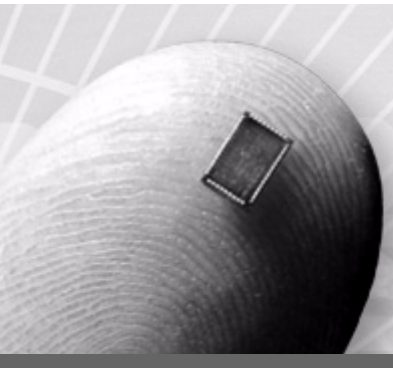

Rapid Prototyping Module Manual

Q32M210

M-20783-004

ON Semiconductor

May 2012

To maintain the quality of our publications, we request your comments on the accuracy, clarity, organization, and value of this document.

Address correspondence to:
ON Semiconductor
200-611 Kumpf Drive
Waterloo, Ontario, Canada N2V 1K8
Tel: +1 519 884 9696

Website
www.onsemi.com

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1 Introduction

1.1 Purpose

This manual provides detailed information about the configuration and use of the Q32M210 Rapid Prototyping Module (RPM). The RPM facilitates low-cost prototype system development and firmware development.

The RPM is designed for use with the software tools included with the Evaluation and Development Kit (EDK) and provides a subset of the features of the Evaluation and Development Board. To download the software tools in the EDK, go to the following link:

`http://www.onsemi.com/PowerSolutions/evalBoard.do?id=Q32M210GEVK`

1.2 Intended Audience

This manual is written for application developers who want to develop prototype systems and do firmware development.

1.3 Conventions

The following typographical conventions are used in this manual:

- Component and pin names, as well as file and path names are in a `monospace` font.
- Variable path names (where you fill in suitable information) and characters that you type are in a **`bold monospace`** font.
- Menu names and menu items are in **bold typeface**.

1.4 Manual Organization

The *Rapid Prototyping Module Manual* contains the following chapters and appendices:

- **Chapter 1: Introduction**, introduces this manual—explaining the purpose, intended audience, conventions used and organization. It also contains a list of further reading materials that provide information on other aspects of application development using the Q32M210 microcontroller.
- **Chapter 2: Overview**, provides a general description of the RPM.
- **Chapter 3: Getting Started**, provides brief introductory steps for readers who want to quickly start using the RPM.
- **Chapter 4: Rapid Prototyping Module**, provides detailed information about the RPM.
- **Chapter 5: RPM-JTAG Adaptor Board and J-Link Lite**, provides detailed information about the RPM-JTAG Adaptor Board and J-Link Lite, which are included with the full RPM development kit.
- **Chapter 6: Sample Application**, describes the sample application that is preloaded on the RPM and is also available in source code form.

- **Appendix A: Schematics**, contains the schematics for the RPM and the RPM-JTAG Adaptor Board.
- **Appendix B: Assembly Drawings**, contains the component placements for the top and bottom layers of the RPM and the RPM-JTAG Adaptor Board.

1.5 FURTHER READING

1.5.1 ON Semiconductor Documents

For more information about the Q32M210 microcontroller and other products manufactured by ON Semiconductor, refer to the following documents:

- *Q32M210 EDK Installation Guide*
- *Q32M210 Hardware Reference Manual*
- *Q32M210 Firmware Reference Manual*
- *Q32M210 Programmer's Guide*
- *Q32M210 Engineering Tool Quick Start Guide*
- ON Semiconductor Q32M210 microcontroller datasheet
- ON Semiconductor datasheet CMPWR025
- ON Semiconductor datasheet NCP551/D
- ON Semiconductor datasheet NCV8560/D

Note: ON Semiconductor datasheets are available from www.onsemi.com.

1.5.2 ARM Documents

For more information about the ARM® Cortex™-M3 processor, refer to the following documents:

- *ARM Core Cortex-M3/Cortex-M3 with ETM (AT420/AT425) Errata Notice*
- *ARM and Thumb-2 Instruction Set Quick Reference Card*
- Yiu, Joseph *The Definitive Guide to the ARM Cortex-M3* (Newnes, December 2009) or a similar book describing the ARM Cortex-M3 architecture

1.5.3 Miscellaneous Documents

- For more information about the IAR Systems® Embedded Workbench® for ARM, refer to the *IAR Embedded Workbench IDE User Guide for Advanced RISC Machines Ltd's ARM® Cores* and other associated documentation included with the IAR Embedded Workbench for ARM package.
- For more information about J-Link™ and J-Link™ Lite, visit www.segger.com.

2 Overview

2.1 INTRODUCTION

The RPM is designed for evaluating the Q32M210 microcontroller and for application development. The board provides application developers with convenient access to all input and output connections via standard 0.1" through-holes. In contrast with the Evaluation and Development Board, the low cost and small form factor of the RPM make it conducive to hand assembling prototype systems for learning and experimental purposes, and for the early stages of product development.

2.2 RPM KEY FEATURES

The RPM enables developers to evaluate the performance and capabilities of the Q32M210 microcontroller in addition to developing, demonstrating, and debugging applications.

Key features of the board include:

- A Q32M210 Precision Mixed-Signal Microcontroller and all required passive components
- A power supply unit that provides a regulated supply to the Q32M210 microcontroller, either from the USB bus, JTAG interface, or an external power supply
- Access to all I/O pins via standard 0.1" through-holes
- An edge connector for interfacing with adaptor boards such as the RPM-JTAG adaptor
- A mini-USB connector, providing access to the Q32M210 microcontroller USB interface
- A bank of LEDs for monitoring IF4 GPIOs
- Pushbutton switches connected to the reset and NMI pins on the Q32M210 microcontroller
- An additional pushbutton switch connected to the IF5.0 pin, which serves as a GPIO pin and a wakeup source

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3 Getting Started

This section describes how to quickly begin using the full RPM kit, including the RPM-JTAG Adaptor Board and the J-Link Lite.

You can connect the RPM to your computer in one of two ways:

1. By connecting a mini-USB cable between your computer and the mini-USB connector on the RPM board. This is discussed in Section 3.1, “Connecting the RPM to Your Computer”.
2. By connecting a JTAG interface to the RPM-JTAG Adaptor Board and connecting the adaptor board to the RPM. This is discussed in Section 3.2, “Connecting the Rapid Prototyping Module, RPM-JTAG Adaptor Board and J-Link Lite”.

If another application is loaded onto the RPM, special drivers might be required. If the new application does not include support for the USB interface, the computer still tries to enumerate the device due to the R13 pull-up resistor connected to the USBDP pin. In this case, the computer will report that an unknown device has been detected; however, you can safely ignore this error message.

3.1 Connecting the RPM to Your Computer

This method uses the USB interface to communicate with the application running on the Q32M210 microcontroller. The USB interface can also be used to provide power to the board, without communication. This method allows access to the USB application running on the Q32M210 microcontroller, but does not allow you to directly debug the microcontroller.

The RPM is initially installed with a sample application that can be used to verify the RPM’s functionality. This application is described in detail in Chapter 6, “Sample Application” on page 17. After connecting the mini-USB cable between the computer and the mini-USB connector on the RPM, you will see a sequence of flashing LEDs. You do not have to install any drivers on the computer prior to connecting the USB cable.

3.2 Connecting the Rapid Prototyping Module, RPM-JTAG Adaptor Board and J-Link Lite

To download or debug firmware on the RPM, you must use the JTAG interface on the Q32M210 microcontroller. The edge connector makes the JTAG interface available. The RPM-JTAG Adaptor Board allows the RPM to be interfaced with the standard 20-pin JTAG connector that is supported by many JTAG adaptor manufacturers. The SEGGER J-Link and J-Link Lite are supported by ON Semiconductor and the J-Link Lite is included in the full RPM kit. Figure 1 below shows the RPM, RPM-JTAG Adaptor Board, and J-Link Lite connected together. The following steps describe the use of the J-Link Lite. Using a standard J-Link is very similar in setup and operation.

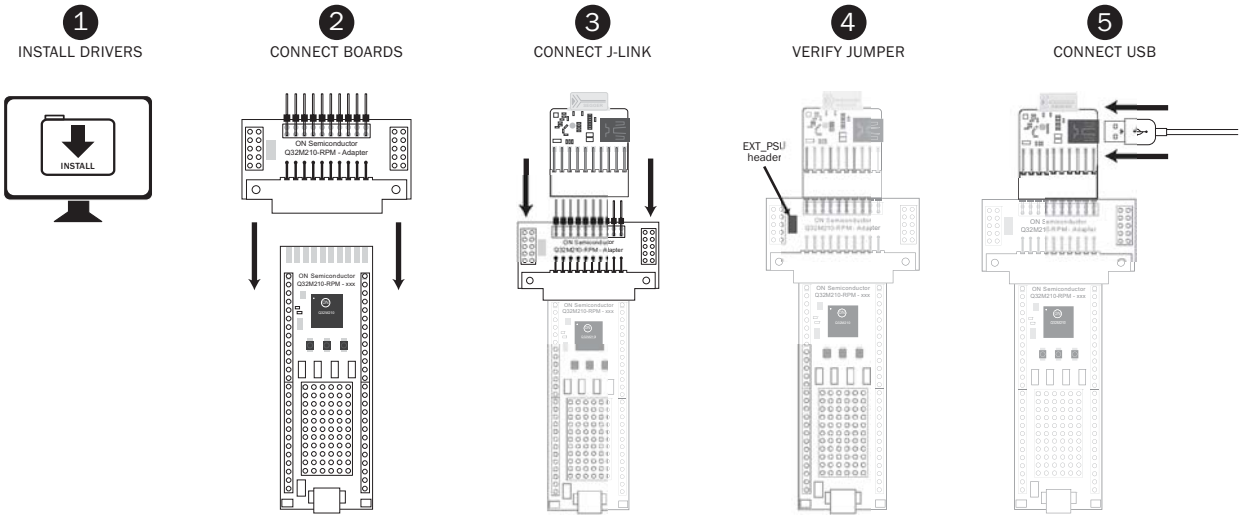

Figure 1: Connecting the Adaptor to the J-Link Lite Debugger

Note: Appropriate J-Link drivers must be installed before you connect the J-Link Lite to your computer.

To set up the RPM kit for firmware downloading and debugging, do the following:

1. Install J-Link drivers, if they are not already installed. These are often installed as part of the development environment installation. IAR Embedded Workbench installation is described in the *Q32M210 EDK Installation Guide*.
2. Connect the RPM-JTAG Adaptor Board to the RPM's edge connector.
3. Connect the J-Link Lite to the 20-pin connector on the RPM-JTAG Adaptor Board. Ensure that the J-Link Lite has the same orientation as shown in Figure 1.
4. To supply power to the RPM from the J-Link Lite, verify that a jumper is connected to the EXT_PSU pins on the RPM-JTAG Adaptor Board.
5. Connect a mini-USB cable between your computer and the mini-USB connector on the J-Link Lite.

   Note: Due to J-Link hardware limitations, older J-Link interfaces might not be able to supply power to the RPM.

4 Rapid Prototyping Module

The following sections describe the various blocks of the RPM; refer to the block diagram in Figure 2.

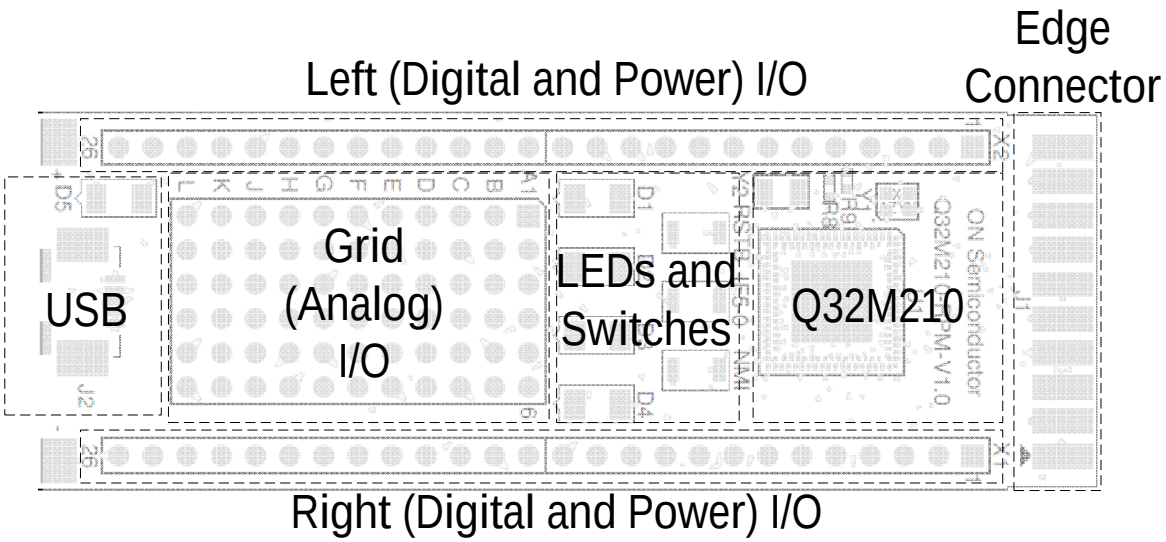

Figure 2: RPM Block Diagram

4.1 Power Supplies

The RPM can be powered by several sources, listed in Table 1 below in priority order. These power sources include USB, external power, JTAG, and battery terminals. An ON Semiconductor power switch (CMPWR025) is included on the RPM board to provide automatic switching between external power (`EXT_PSU`) and USB power.

TABLE 1: RPM POWER SUPPLY

Priority	Power Source	Description
1	Battery terminals	A power source (such as a CR2032 battery) can be connected directly to the VBAT_TERM terminals at the bottom of the RPM board, on either side of the mini-USB connector. These are labelled + and -. A zero-ohm resistor (R10) is installed between the output of the power switch and the battery terminal to allow the on-board regulators to be disconnected, if desired.
2	EXT_PSU	When an external supply (4.5 V to 9 V) is connected to the EXT_PSU network, either through the card edge connector or the left side connector, the on-board regulator provides a stable 3.3 V output. The 3.3 V output is directed to the power switch and subsequently becomes the main power supply (VBAT).
3	J-Link or J-Link Lite	Power can also be provided to the RPM through the J-Link's supply pin (4.5 – 5 V). This voltage is provided to the EXT_PSU network through the card edge connector. The RPM-JTAG adaptor contains a jumper (EXT_PSU) that, when fitted, shorts the J-Link supply pin to the EXT_PSU pin on the card edge receptacle. The behavior is identical to applying external power to the EXT_PSU network, as described above.
4	USB	When a powered USB cable is connected to the RPM, the on-board regulator will provide a stable 3.3V supply from the nominal USB +5 V supply. The 3.3 V output is then directed to the power switch. If the EXT_PSU supply is not available, this 3.3 V output automatically becomes the main power supply (VBAT). The red LED (D5) is lit whenever the +5 V USB supply is available.

The RPM's power supply is illustrated in Figure 3.

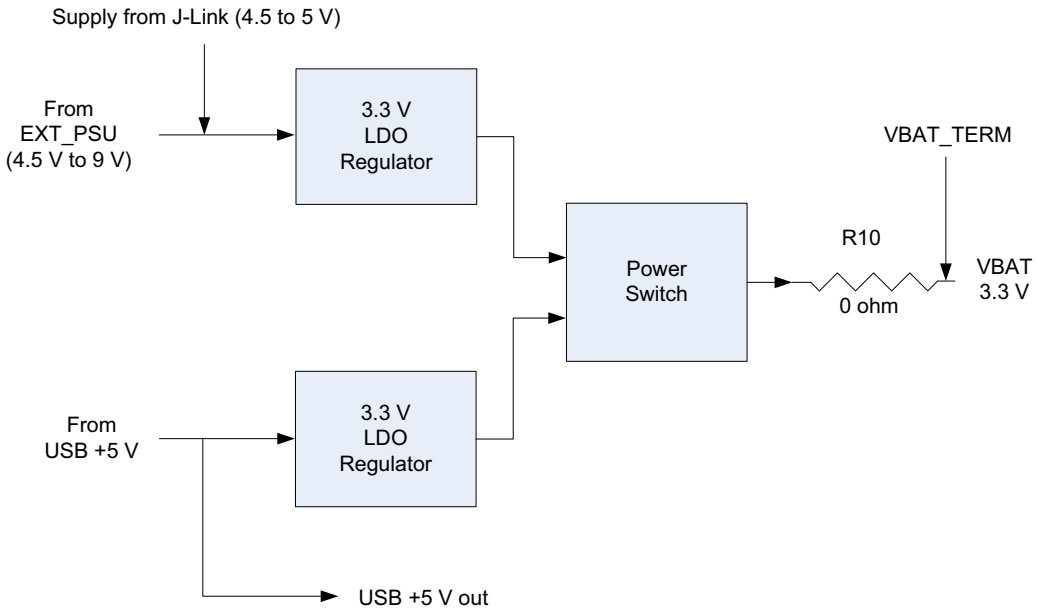

Figure 3: RPM Power Supply

4.2 THE Q32M210 MICROCONTROLLER

The Q32M210 microcontroller 140-pin TLLGA package is mounted between the left-side and right-side connectors, as shown in Figure 2 on page 7. Most of the Q32M210 microcontroller signals applicable to developer applications are routed to the available interfaces.

4.2.1 Passive Components

All of the passive components required for proper operation of the Q32M210 microcontroller are included on the RPM. This includes all decoupling capacitors, the 32 kHz and 48 MHz crystals, and resistors. The values for the passive components are taken from the Q32M210 microcontroller datasheet.

4.2.2 Power Supplies

The Q32M210 microcontroller receives its main power from the RPM's `VBAT` network. The `VBAT` network is connected to the Q32M210 microcontroller `VBAT` pin.

The other Q32M210 microcontroller voltage domains (`VBATA`, `VLCD`, `VDDIO0`, and `VDDIO1`) are connected to VBAT through zero-ohm resistors. You can remove these resistors to reconfigure the power supply to any of the Q32M210 microcontroller voltage domains. For example, you can remove the zero-ohm resistor going into `VBATA` and instead short `VDBL` to `VBATA`. This configuration would provide a stable 3.5 V supply to the Q32M210 microcontroller sensor interface and is desirable in some applications.

The Q32M210 microcontroller USB power supply (VDDUSB) is supplied directly from the RPM's USB 3.3 V regulator.

The Q32M210 microcontroller's power supply configuration is illustrated in Figure 4.

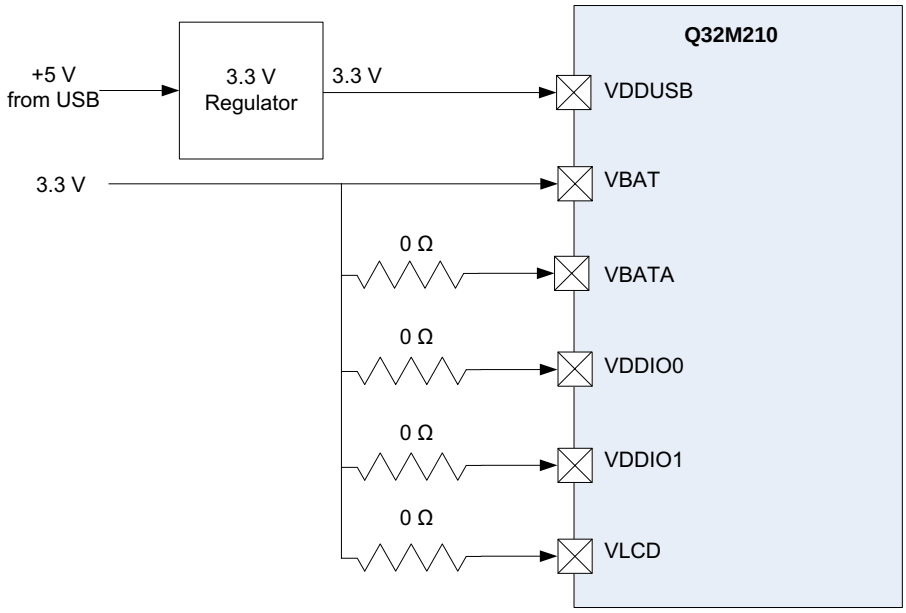

Figure 4: The Q32M210 Microcontroller Power Supply Configuration

4.3 INTERFACES

The RPM includes several interfaces that are described in the following sections. To maximize flexibility, the left and right input/output interfaces and grid input/output interface have been designed without connectors or headers. This allows the developer to attach pins or headers as desired or solder components directly to the RPM.

4.3.1 Left and Right Input/Output

The left and right connectors each consist of a single row of through-holes designed for 0.1" headers. Each connector consists of 26 signals. Typical DIP sockets contain 50 (25 x 2) rows of receptacles. The design allows for either the first row or the last row to be skipped when inserting the RPM into a DIP receptacle.

The left and right side connector signals and their positions are listed in Table 2.

TABLE 2: LEFT AND RIGHT INPUT/OUTPUT CONNECTORS

Row	X2 (Left)	X1 (Right)
1	GND	VBAT
2	EXT_PSU	VDDD
3	NMI	VDDIO0
4	RSTB	VDDIO1

TABLE 2: LEFT AND RIGHT INPUT/OUTPUT CONNECTORS

Row	X2 (Left)	X1 (Right)
5	SPI0_SO	VDBL
6	SPI0_SI	VLCD
7	SPI0_CLK	ILV
8	SPI0_CS	EXTCLK
9	UART0_TX	IF5.0
10	UART0_RX	IF5.2
11	SPI1_SO	AUX_IN0
12	SPI1_SI	SDA
13	SPI1_CLK	SCL
14	SPI1_CS	UART1_TX
15	IF4.0	UART1_RX
16	IF4.1	IF4.11
17	IF4.2	IF4.12
18	IF4.3	IF4.13
19	IF4.4	IF4.14
20	IF4.5	IF4.15
21	IF4.6	IF4.16
22	IF4.7	IF4.17
23	IF4.8	IF4.18
24	IF4.9	IF4.19
25	IF4.10	IF4.20
26	USB_5V_OUT	GND

4.3.2 Grid Input/Output

The centre grid connector consists of a grid of 6 x 11 through-holes designed for 0.1" headers. The connector contains a total of 66 signals. The signals and their positions are described in Table 3.

TABLE 3: GRID INPUT/OUTPUT CONNECTOR

Row / Column	1	2	3	4	5	6
A	A0_OUTB	A1_OUTB	A2_OUTB	IF5.0	IF5.1	IF4.21
B	A0_OUTA	A1_OUTA	A2_OUTA	IF5.2	IF5.3	IF4.22
C	A0_IN	A1_IN	A2_IN	SPST0_A	SPST0_B	IF4.23
D	A0_IN0	A0_IN3	A0_IN6	SPST1_A	SPST1_B	IF4.24
E	A0_IN1	A0_IN4	A0_IN7	SPST2_A	SPST2_B	IF4.25
F	A0_IN2	A0_IN5	ALT0	SPST3_A	SPST3_B	IF4.26
G	MSW0_A	MSW1_A	MSW2_A	VREF	MSW3_A	IF4.27

TABLE 3: GRID INPUT/OUTPUT CONNECTOR

Row / Column	1	2	3	4	5	6
H	DAC0	DAC1	DAC2	GND	ALT1	IF4.28
J	A0_REF	A1_REF	A2_REF	VBATA	VBAT	IF4.29
K	MSW0_C	MSW1_C	MSW2_C	AUX_IN1	MSW3_C	IF4.30
L	MSW0_B	MSW1_B	MSW2_B	AUX_IN2	MSW3_B	IF4.31

4.3.3 Edge Connector

The edge connector interfaces with a standard 10-position card edge receptacle. The edge connector is designed primarily as a JTAG interface. It also exposes several power supplies, an SPI interface, a UART interface, and the `IF5.0` pin, which serves as a GPIO and a wakeup source. Having these signals available provides flexibility for future application-specific adaptor boards.

The top-side and bottom-side signals and their positions on the edge connector are described in Table 4.

TABLE 4: EDGE CONNECTOR

Pin #	Top	Bottom
1	SPI1_CLK	RSTB
2	SPI1_SI	VBAT
3	SPI1_SO	VDDIO0
4	SPI1_CS	JRSTB
5	EXT_PSU	IF5.0
6	GND	N/C
7	JTDO	UART1_RX
8	JTDI	UART1_TX
9	JTMS	UART0_RX
10	JTCK	UART0_TX

4.3.4 Pushbutton Switches

Three small form factor buttons (described in Table 5) are provided for user input. `RSTB` and `NMI` are fixed functions. `IF5.0` can be configured as a general purpose I/O or a wake-up pin in the Q32M210 microcontroller firmware. No hardware debounce circuitry is provided on the `IF5.0` input. If required, debouncing must be handled in firmware.

TABLE 5: PUSHBUTTON SWITCHES

Button	Signal	Action
RSTB	Q32M210 microcontroller reset	Set to `GND` when pressed

TABLE 5: PUSHBUTTON SWITCHES

Button	Signal	Action
IF5.0	User-defined GPIO and wakeup signal	Set to GND when pressed
NMI	Q32M210 microcontroller non-maskable interrupt	Set to VDDIO0 when pressed

4.3.5 Light-Emitting Diodes (LEDs)

Five small form factor LEDs (described in Table 6) are provided as user indicators. D1, D2, D3, and D4 are connected to the Q32M210 microcontroller IF4 pins and are thus programmable via firmware. These pins are powered from VDDIO1. The D1-D4 LEDs require a minimum voltage to operate and will only light up if sufficient voltage is applied to VDDIO1. They can be disabled by removing the zero-ohm resistor labeled R7. D5 is connected to the USB 5V power supply and will be lit when a proper USB power supply is provided through the USB connector.

TABLE 6: LEDS

LED	Color	Signal
D1	Green	Q32M210 IF4.4
D2	Green	Q32M210 IF4.5
D3	Green	Q32M210 IF4.6
D4	Green	Q32M210 IF4.7
D5	Red	USB +5V power present

4.3.6 Universal Serial Bus (USB)

The USB connector consists of a USB Mini B right-angle socket. The connector contains the USB D+ and D- signals, a +5V power supply, and GND.

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5 RPM-JTAG Adaptor Board and J-Link Lite

The following sections describe the RPM-JTAG Adaptor Board and J-Link Lite interface, which are included as part of the full RPM kit.

5.1 RPM-JTAG ADAPTOR BOARD

5.1.1 Overview

The RPM-JTAG adaptor board (hereafter called "the adaptor") is a small form factor PCB designed to interface an RPM and a JTAG adaptor such as the SEGGER J-Link Lite. On one edge of the adaptor, a card edge receptacle is mounted, which is compatible with the RPM edge connector. On the other edge of the adaptor is a standard J-Link-compatible 20-pin JTAG connector.

5.1.2 Power Supply

A 2-pin header on the adaptor allows the 4.5 to 5 V power supply from the 20-pin J-Link connector to be connected to the `EXT_PSU` network on the card edge receptacle. The connection is made when the 2-pin header is shorted.

5.1.3 Other Interfaces

The adaptor contains two sets of 2x5 through-holes that are compatible with standard 0.1" headers. The signals from the card edge connector are routed to these through-holes to provide additional flexibility for accessing the card edge signals. The signals are assigned as shown in Table 7 and Table 8.

TABLE 7: X3 SIGNALS

Pin #	Signal Name
1	SPI1_CLK
2	VBAT
3	SPI1_SI
4	VDDIO0
5	SPI1_SO
6	IF5.0
7	SPI1_CS
8	EXT_PSU
9	GND
10	GND

TABLE 8: X4 SIGNALS

Pin #	Signal Name
1	UART0_TX
2	RSTB
3	UART0_RX
4	JRSTB
5	UART1_TX
6	JTCK
7	UART1_RX
8	JTMS
9	JTDO
10	JTDI

5.2 J-LINK LITE

The SEGGER J-Link Lite is used to support debugging of the ARM Cortex-M3 processor. To communicate using the J-Link Lite interface, connect a mini-USB cable between the computer and the mini-USB connector on the J-Link Lite. For more information about J-Link Lite, visit www.segger.com.

6 Sample Application

A sample application is installed on the RPM during production. The source code for the sample application is available from the Q32M210 Evaluation and Development Kit (EDK), which you can download from the website: http://onsemi.com/Q32M210GEVK.

The sample applications that are included with the EDK are also compatible with the RPM, but might require additional connectors, headers, LEDs or switches to be added to the PCB. The `D1` to `D4` LEDs on the RPM correspond to `D0` to `D3` LEDs on the Evaluation and Development Board. The `IF5.0` switch has the same function as the WAKEUP0 switch on the Evaluation and Development Board.

The RPM sample application demonstrates using GPIO outputs and timers by displaying blinking patterns on the LEDs. It also demonstrates the use of a GPIO input (`IF5.0`) to trigger a secondary mode that results in the Q32M210 microcontroller entering its ultra-low-power sleep mode. Two wake-up sources are configured: `IF5.0` and the real-time clock (RTC) alarm.

The RPM sample application also supports USB communication, including a set of commands that enable the following features:

- Reading and writing peripheral registers and memory
- Configuring the internal oscillator frequency, MCLK divider setting, and ADC sampling rate
- Capturing ADC data

For more information about sample applications, see the *Q32M210 Programmer's Guide*.

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A Schematics

This appendix contains all the schematics for the RPM:

- Q32M210 microcontroller RPM schematic (Figure 5 on page 20)
- Power supply schematic (Figure 6 on page 21)
- Analog input/output schematic (Figure 7 on page 22)
- Edge connection schematic (Figure 8 on page 22)
- LEDs and switches schematic (Figure 9 on page 23)
- Digital and power input/output schematic (Figure 10 on page 24)

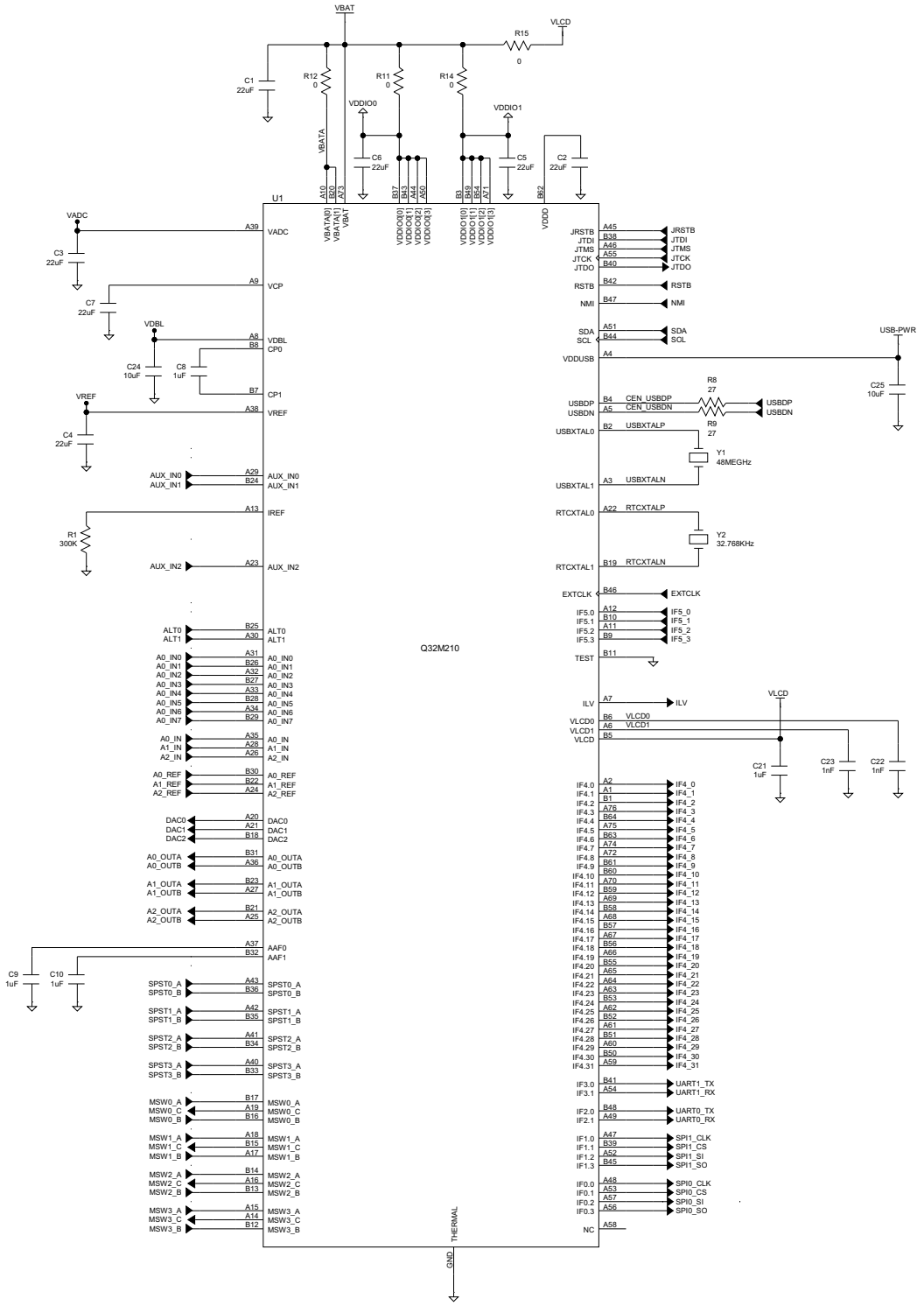


Figure 5: Q32M210 Microcontroller RPM Schematic

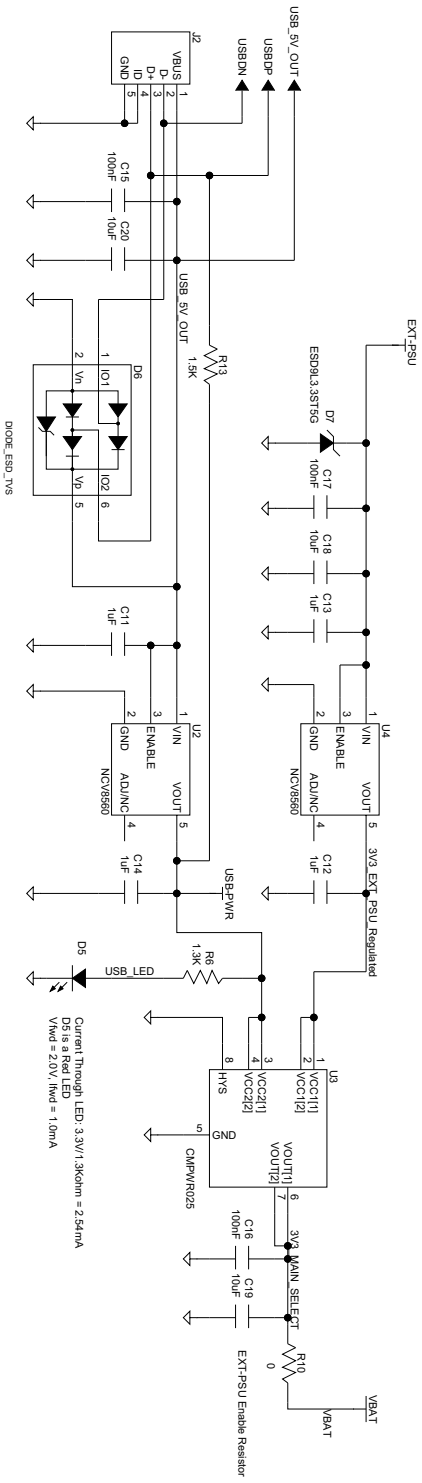


Figure 6: Power Supply Schematic

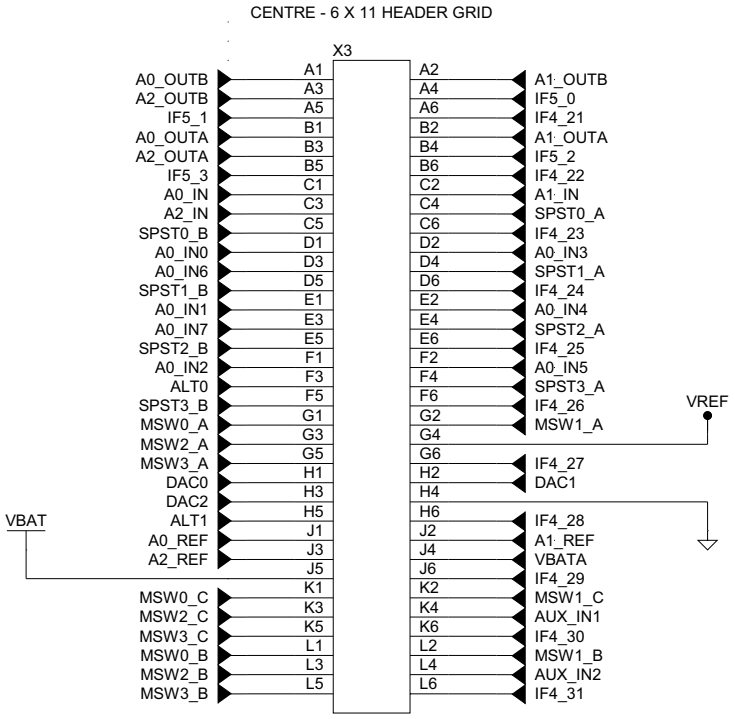


Figure 7: Analog Input/Output Schematic

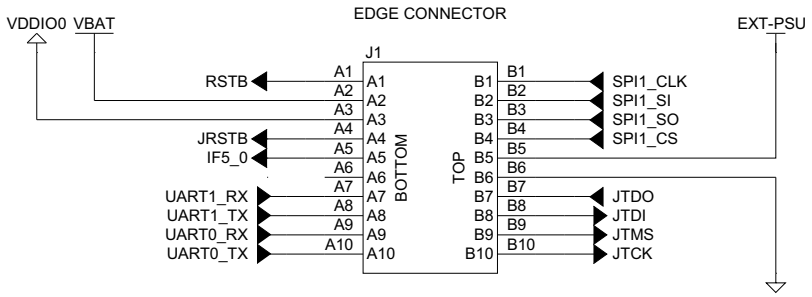
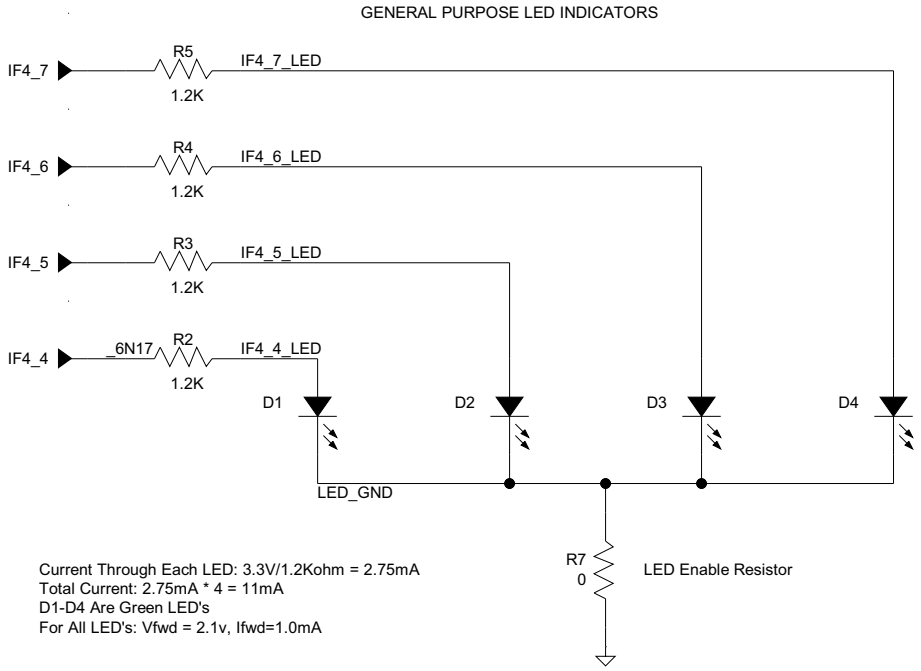


Figure 8: Edge Connection Schematic



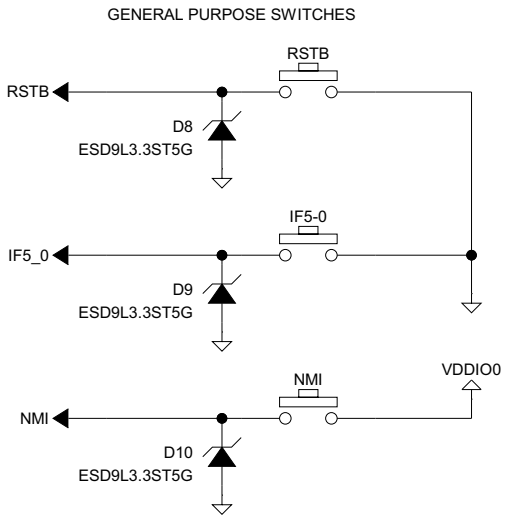


Figure 9: LEDs and Switches Schematic

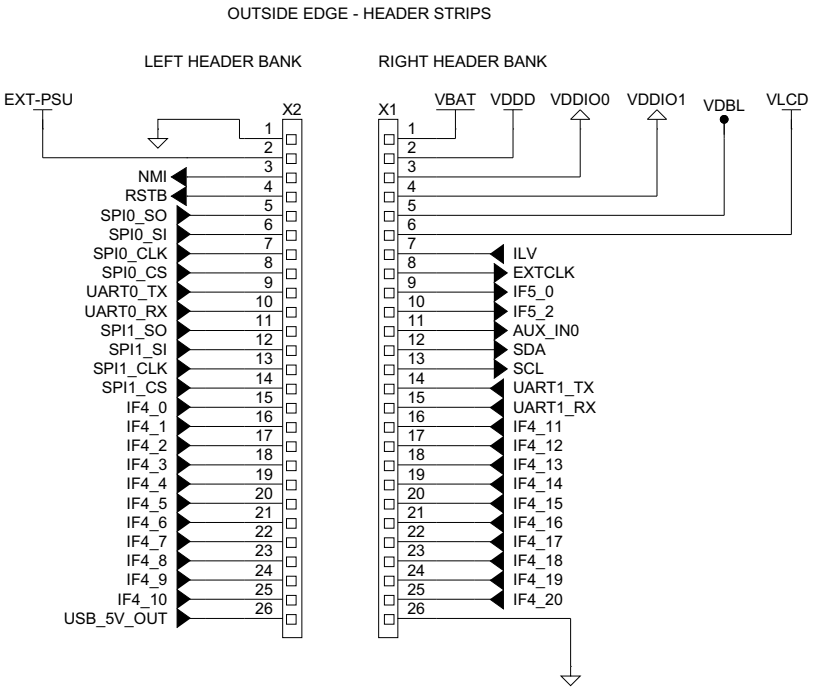


Figure 10: Digital and Power Input/Output Schematic

B

Assembly Drawings

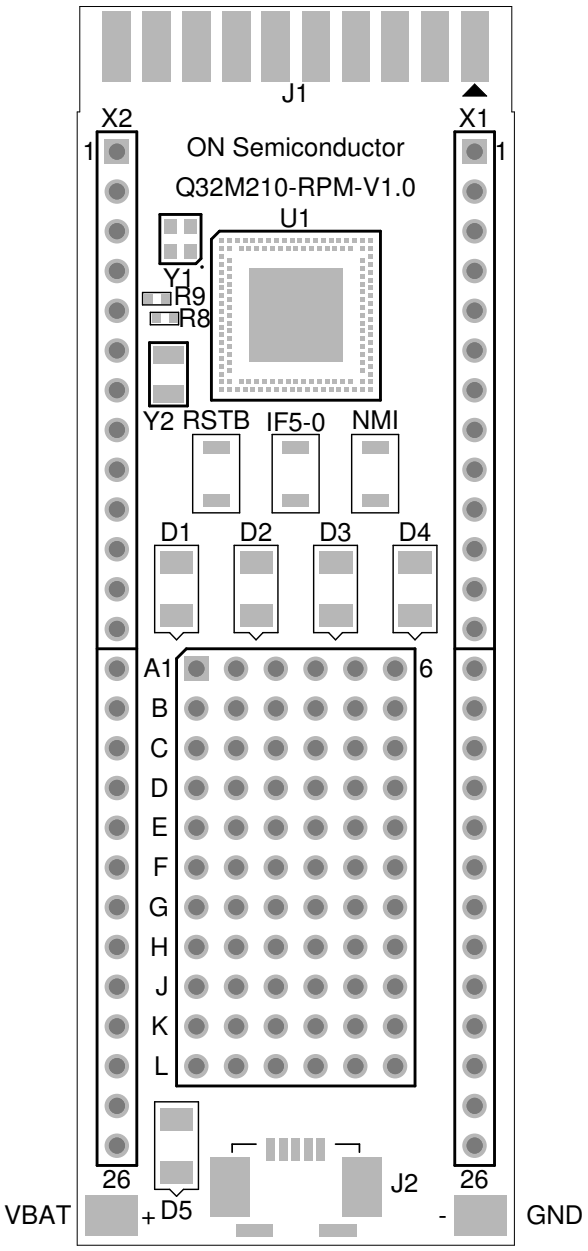


Figure 11: Top Component Assembly Drawing

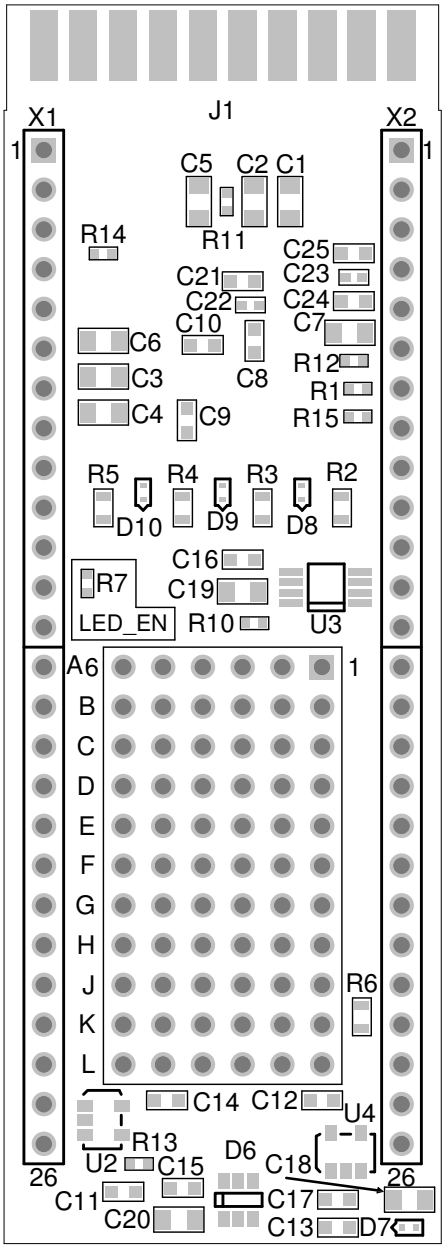


Figure 12: Bottom Component Placement Drawing (View from Bottom)

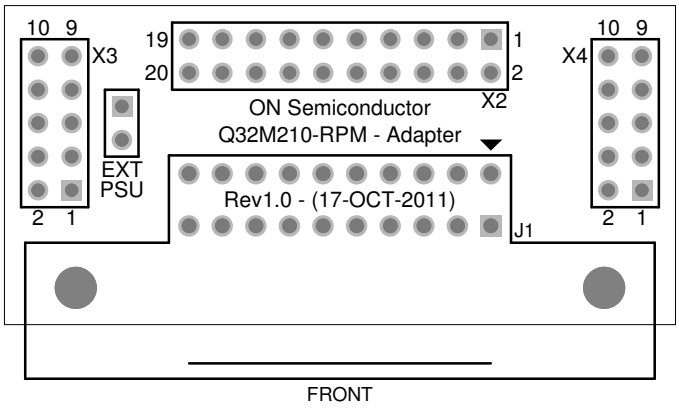


Figure 13: Adaptor Board Component Placement Drawing (Top View)

Global Headquarters
ON Semiconductor
5005 East McDowell Road
Phoenix, Arizona 85008 USA
Tel: +1 602 244 6600

Website
www.onsemi.com