



MICROCHIP

**MIC33M650 Evaluation 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.

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Trademarks

The Microchip name and logo, the Microchip logo, Adaptec, AnyRate, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, chipKIT, chipKIT logo, CryptoMemory, CryptoRF, dsPIC, FlashFlex, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Klear, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PackeTime, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TempTrackr, TimeSource, tinyAVR, UNI/O, Vectron, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

APT, ClockWorks, The Embedded Control Solutions Company, EtherSynch, FlashTec, Hyper Speed Control, HyperLight Load, IntelliMOS, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet-Wire, SmartFusion, SyncWorld, Temux, TimeCesium, TimeHub, TimePictra, TimeProvider, Vite, WinPath, and ZL are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BlueSky, BodyCom, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming, ICSP, INICnet, Inter-Chip Connectivity, JitterBlocker, KlearNet, KlearNet logo, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICKit, PICTail, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, SAM-ICE, Serial Quad I/O, SMART-I.S., SQL, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

The Adaptec logo, Frequency on Demand, Silicon Storage Technology, and Symmcom are registered trademarks of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2019, Microchip Technology Incorporated, All Rights Reserved.

ISBN: 978-1-5224-5090-0

For information regarding Microchip's Quality Management Systems, please visit www.microchip.com/quality.



MIC33M650 EVALUATION BOARD USER'S GUIDE

Table of Contents

Preface	5
Introduction.....	5
Document Layout	5
Conventions Used in this Guide	6
Recommended Reading.....	7
The Microchip Website.....	7
Customer Support	7
Document Revision History	8
Chapter 1. Product Overview	
1.1 Introduction	9
1.2 MIC33M650 Short Overview	9
1.3 MIC33M650 Evaluation Board Description	10
1.4 What Does the MIC33M650 Evaluation Board Kit Include?	10
Chapter 2. Installation and Operation	
2.1 Introduction	11
2.2 Features	12
2.3 Getting Started	12
2.3.1 Power Input and Output Connection	12
Appendix A. Schematic and Layouts	
A.1 Introduction	15
A.2 Board – Schematic	16
A.3 Board – Top Silk and Pads	17
A.4 Board – Top Copper Layer	17
A.5 Board – Inner Layer 1	18
A.6 Board – Inner Layer 2	18
A.7 Board – Bottom Copper Layer	19
Appendix B. Bill of Materials (BOM).....	19
Worldwide Sales and Service	23

MIC33M650 Evaluation Board User's Guide

NOTES:



MIC33M650 EVALUATION 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 website (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 “DSXXXXA”, where “XXXX” 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 on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MIC33M650 Evaluation Board. Items discussed in this chapter include:

- [Document Layout](#)
- [Conventions Used in this Guide](#)
- [Recommended Reading](#)
- [The Microchip Website](#)
- [Customer Support](#)
- [Document Revision History](#)

DOCUMENT LAYOUT

This document describes how to use the MIC33M650 Evaluation Board as a development tool. The manual layout is as follows:

- **Chapter 1. “Product Overview”** – Important information about the MIC33M650 module
- **Chapter 2. “Installation and Operation”** – Includes a description of the MIC33M650 Evaluation Board and instructions on how to get started
- **Appendix A. “Schematic and Layouts”** – Shows the schematic and layouts for the MIC33M650 Evaluation Board
- **Appendix B. “Bill of Materials (BOM)”** – Lists the parts used to build the MIC33M650 Evaluation Board

MIC33M650 Evaluation Board User's Guide

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	<i>MPLAB® IDE User's Guide</i>
	Emphasized text	...is the <i>only</i> 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	<u><i>File>Save</i></u>
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	<i>file.o</i> , where <i>file</i> can be any valid filename
Square brackets []	Optional arguments	mcc18 [options] <i>file</i> [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 MIC33M650 Evaluation Board. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource.

- **MIC33M650 Data Sheet - “6A, Pin-Strapping Power Module with HyperLight Load[®] Mode and Output Voltage Select” (DS20006253)**

THE MICROCHIP WEBSITE

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

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Subject Matter Expert Engineers (SMEs)
- Technical Support

Customers should contact their distributor, representative, field application engineer (FAE) or subject matter expert engineer (SME) 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 website at: <http://support.microchip.com>.

MIC33M650 Evaluation Board User's Guide

DOCUMENT REVISION HISTORY

Revision A (September 2019)

- Initial release of this document.

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MIC33M650 Evaluation Board and covers the following topics:

- [MIC33M650 Short Overview](#)
- [MIC33M650 Evaluation Board Description](#)
- [What Does the MIC33M650 Evaluation Board Kit Include?](#)

1.2 MIC33M650 SHORT OVERVIEW

The MIC33M650 is a high-efficiency, low-voltage input, 6A current, synchronous step-down regulator power module with integrated inductor. The HyperLight Load[®] provides very high efficiency at light loads, while still having ultra-fast transient response. The MIC33M650 output voltage is set by two three-state V_{SEL} (Voltage Selection) pins, thus offering nine different values. [Table 2-1](#) details the possible combinations and the resulting output voltage. The 2.4V to 5.5V input voltage range, low shutdown and quiescent currents make the MIC33M650 ideal for single cell Li-Ion battery-powered applications. 100% duty cycle capability provides low dropout operation, extending operating range in portable systems.

An open-drain Power Good output is provided to indicate when the output voltage is within 9% of regulation and facilitates the interface with an MCU. If set for shutdown (EN=GND), the MIC33M650 draws less than 10 μ A.

The MIC33M650 is available in a thermally-efficient, 53 Lead 6 mm x 10 mm x 3 mm B1QFN package, with an operating junction temperature range from -40°C to $+125^{\circ}\text{C}$. More detailed information regarding the capabilities of the MIC33M650 is available in the data sheet.

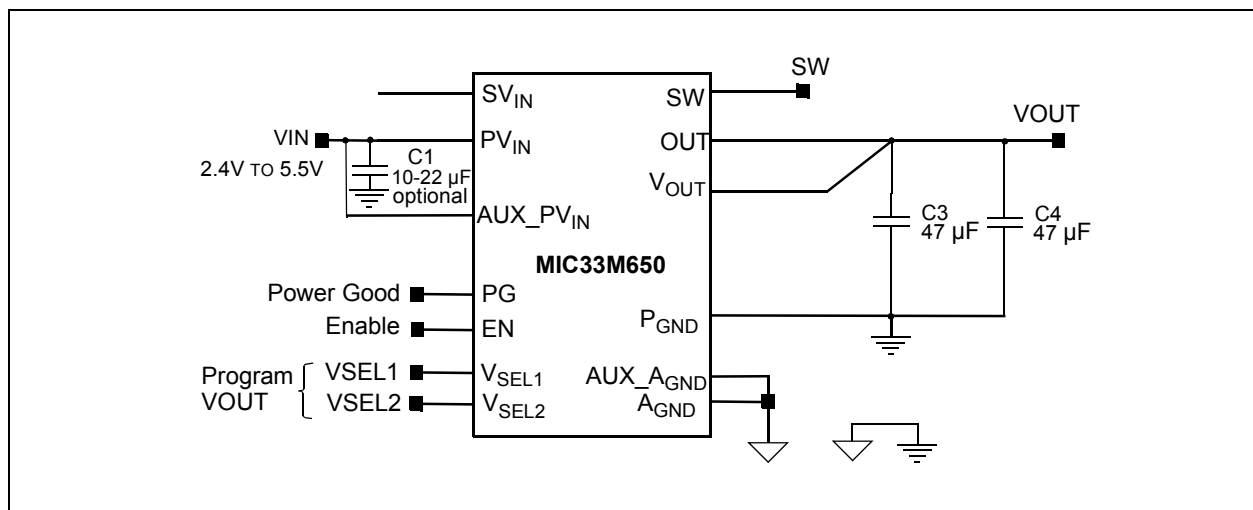


FIGURE 1-1: Typical MIC33M650 Step Down Application.

MIC33M650 Evaluation Board User's Guide

1.3 MIC33M650 EVALUATION BOARD DESCRIPTION

The MIC33M650 Evaluation Board is used to evaluate and demonstrate Microchip Technology's MIC33M650 module. This board demonstrates MIC33M650's capabilities in a Buck converter application supplied from an external voltage source (2.4V - 5.5V) to pin-programmed regulated output. Two jumpers are provided to select the desired output voltage from nine preset values.

1.4 WHAT DOES THE MIC33M650 EVALUATION BOARD KIT INCLUDE?

The MIC33M650 Evaluation Board kit includes:

- MIC33M650 Evaluation Board (DT100107)
- Important Information Sheet.

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MIC33M650 module has been developed for applications suited for 2.4V to 5.5V input voltage range, low shutdown, quiescent currents and high continuous output current. These characteristics make the MIC33M650 ideal for single-cell Li-Ion battery-powered applications. 100% duty cycle capability provides low dropout operation, extending the operating range in portable systems.

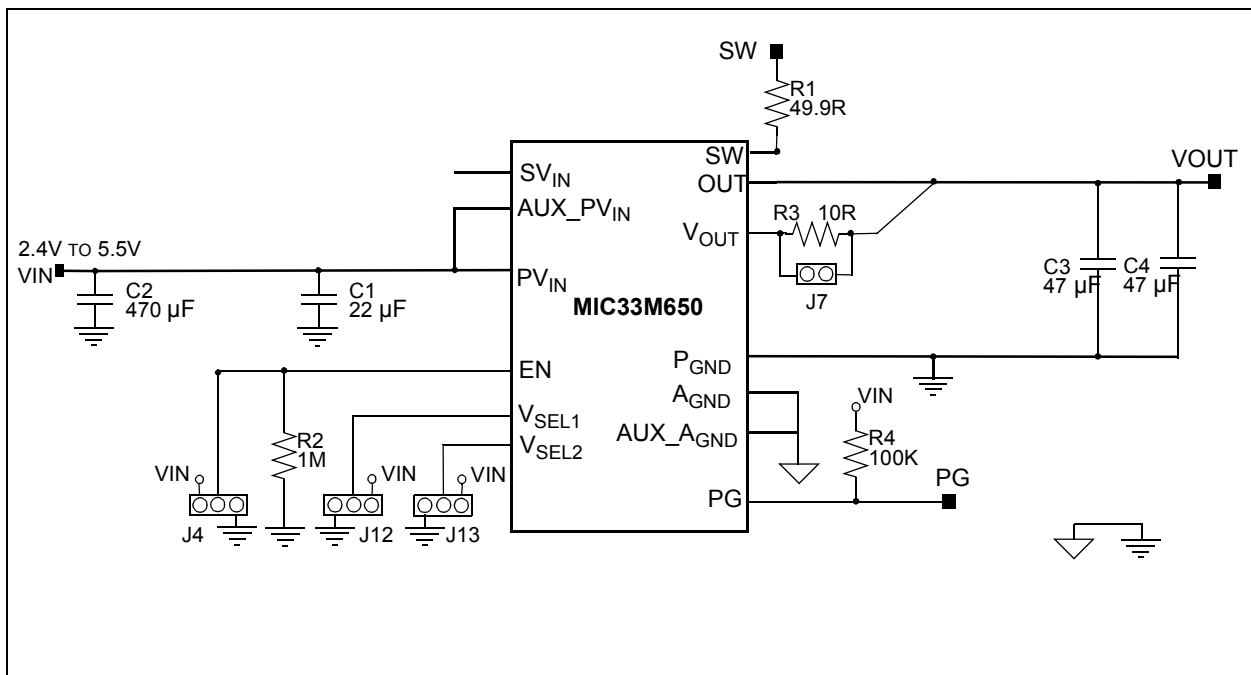


FIGURE 2-1: MIC33M650 Evaluation Board Step-Down Application with Pin-Selectable Output Voltage.

MIC33M650 Evaluation Board User's Guide

2.2 FEATURES

The MIC33M650 Evaluation Board has the following features:

- 2.4V to 5.5V Input Voltage Range
- 6A (maximum) Continuous Output Current
- Programmable VSEL (Voltage Selection):
 - 9 voltage combinations of 2 three-state pins
 - 0.6V, 0.8V, 0.9V, 1.0V, 1.2V, 1.5V, 1.8V, 2.5V, 3.3V output voltage
- High Efficiency (up to 95%)
- 2 MHz Switching Frequency
- $\pm 1.5\%$ Output Voltage Accuracy Over Line/Load/Temperature Range
- Supports Safe Start-Up with Pre-Biased Output
- Pull-Down when Disabled (typically 10 Ω)
- Less than 10 μ A Shutdown Supply Current
- Low Dropout Operation (100% Duty Cycle)
- Ultra-Fast Transient Response
- Latch-Off Thermal Shutdown Protection
- Latch-Off Current Limit Protection
- Power Good Open-Drain Output

2.3 GETTING STARTED

The MIC33M650 Evaluation Board is fully assembled and tested to evaluate and demonstrate the MIC33M650 module. This board requires the use of external lab supplies.

2.3.1 Power Input and Output Connection

2.3.1.1 POWERING THE MIC33M650 EVALUATION BOARD

When the board is ready for evaluation, apply positive input voltage to the "VIN" terminal and the corresponding return to the ground terminal "GND_IN". The maximum input voltage should not exceed 5.5V. An electronic load or a resistive load can be used for evaluation. The electronic loads attempt to sink current at 0V during startup. A resistive load or a constant resistance mode for electronic load is recommended for the startup evaluation. Connect the positive voltage terminal of the load to the "VOUT" terminal on the evaluation board and connect the negative or return side of the load to the ground terminal "GND_OUT". Make sure the three provided jumpers are readily available.

Installation and Operation

2.3.1.2 BOARD POWER-UP PROCEDURE:

1. Connect input supply, Voltmeter, Amperemeter and Load, as shown in [Figure 2-2](#).
2. Place VSEL1 ("J12") and VSEL2 ("J13") jumpers to obtain the desired output voltage, according to [Table 2-1](#).
3. Fit the enable jumper ("J4") according to [Figure 2-2](#).
4. Once the input is greater than 2.35V typically the device begins to switch.
5. The Voltmeter should now indicate an output voltage according to the VSEL1,2 combination.
6. Optionally, for more advanced readings, place Oscilloscope probe 1 on the "SW1" test point to measure the switching waveforms. To measure the AC ripple of the output voltage place probe 2 on the output header. Note that for a more accurate output voltage ripple measurement, probing is facilitated by the availability of test points for probe tip and ground spring connections close to the output capacitor. A U.FL connector is also available for the same purpose.
7. Remove the enable jumper "J4" and check the reading on the amperemeter. The measured shutdown current should be less than 10 μA if Power Good Open-Drain Output pull-up resistor is unpopulated. With the R4 populated the SHDN current should be around 55 μA .

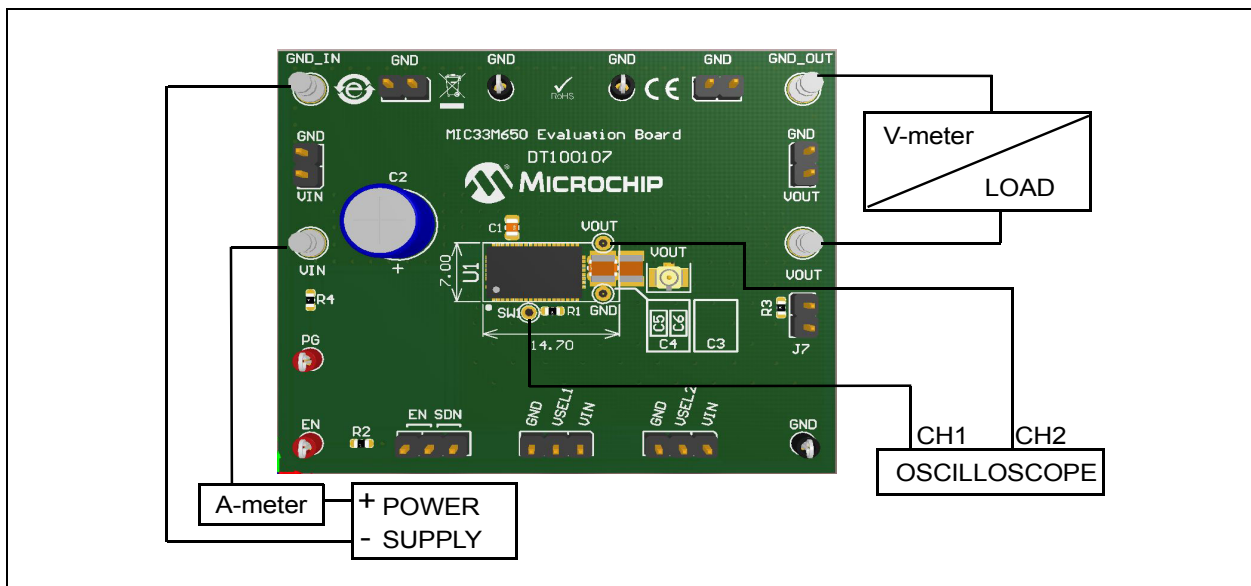


FIGURE 2-2: MIC33M650 Evaluation Board Setup.

MIC33M650 Evaluation Board User's Guide

2.3.1.3 ADJUSTING THE OUTPUT VOLTAGE

There is no need for a resistor divider network on the MIC33M650. The output voltage is simply selected before power-up by means of pins V_{SEL1} and V_{SEL2} . Below are the possible combinations.

TABLE 2-1: OUTPUT VOLTAGE SETTINGS

V_{SEL2}	V_{SEL1}	V_{OUT}
GND	GND	0.6V
GND	OPEN	0.8V
GND	VIN	0.9V
OPEN	GND	1.0V
OPEN	OPEN	1.2V
OPEN	VIN	1.5V
VIN	GND	1.8V
VIN	OPEN	2.5V
VIN	VIN	3.3V

The oscilloscope screen in [Figure 2-3](#) below illustrates the MIC33M650 switching waveforms during normal operation, when supplied from 5V input at full load (6A).

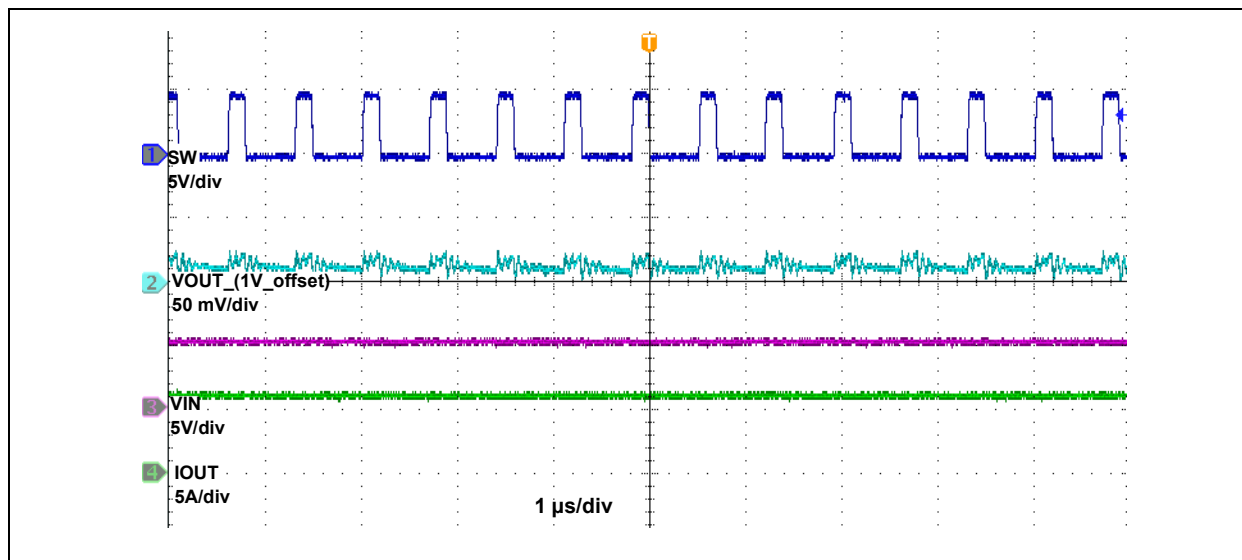


FIGURE 2-3: Normal Operation at 1V Output, 6A Load.

2.3.1.4 LOOP GAIN MEASUREMENT

The MIC33M650 Evaluation Board provides injection points and a termination resistor ($R3$) for AC loop gain measurements. If needed, the value of $R3$ can be changed to optimize the injection signal level. Inject the oscillator at J7 through the insulation transformer (i.e., across resistor $R3$) and connect the A (CH1) and B (CH2) channels to J7 pin 1 and J7 pin 2, respectively, or as indicated by the operating instructions of the particular loop gain analyzer in use.



MIC33M650 EVALUATION BOARD USER'S GUIDE

Appendix A. Schematic and Layouts

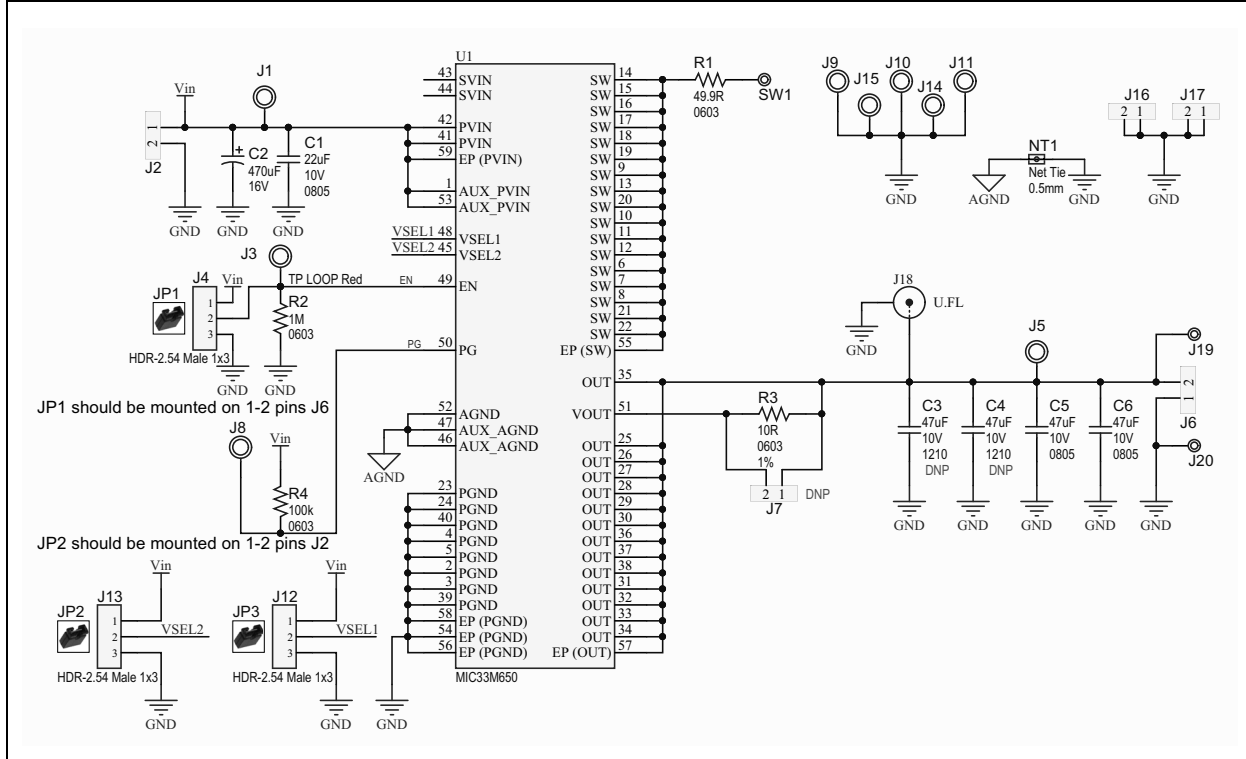
A.1 INTRODUCTION

This Appendix contains the following schematics and PCB layouts for the MIC33M650 Evaluation Board User's Guide:

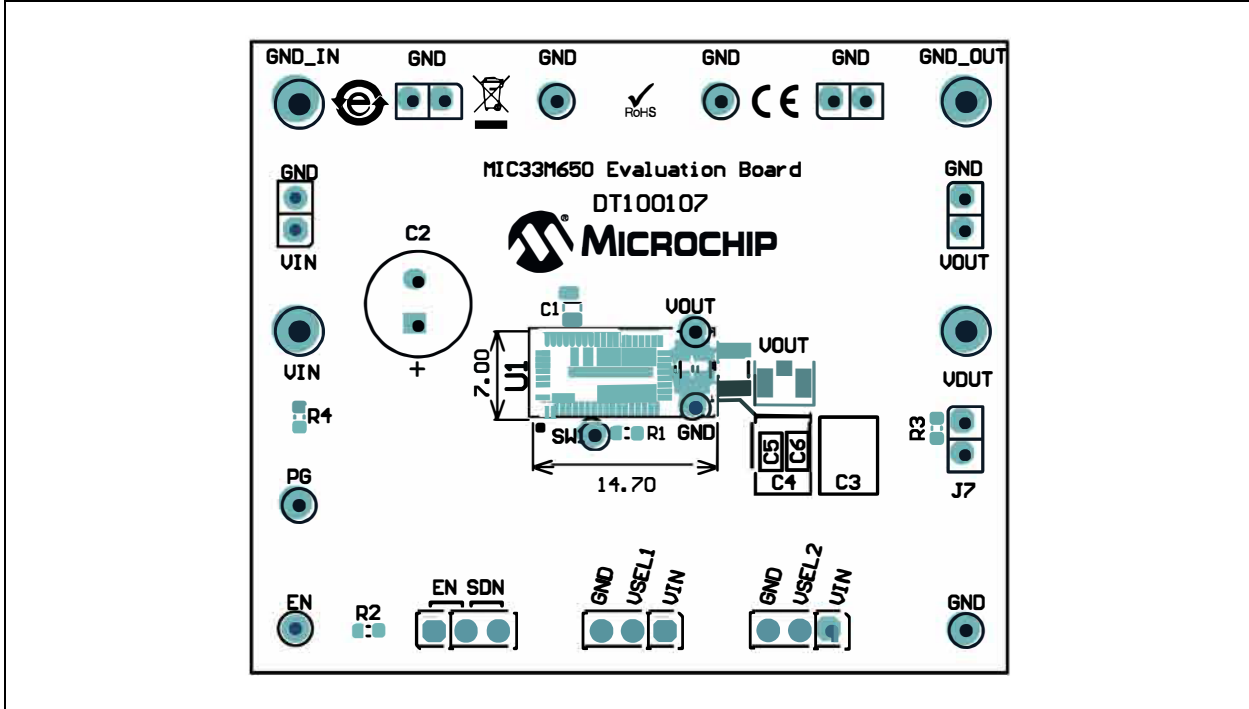
- [Board – Schematic](#)
- [Board – Top Silk and Pads](#)
- [Board – Top Copper Layer](#)
- [Board – Inner Layer 1](#)
- [Board – Inner Layer 2](#)
- [Board – Bottom Copper Layer](#)

MIC33M650 Evaluation Board User's Guide

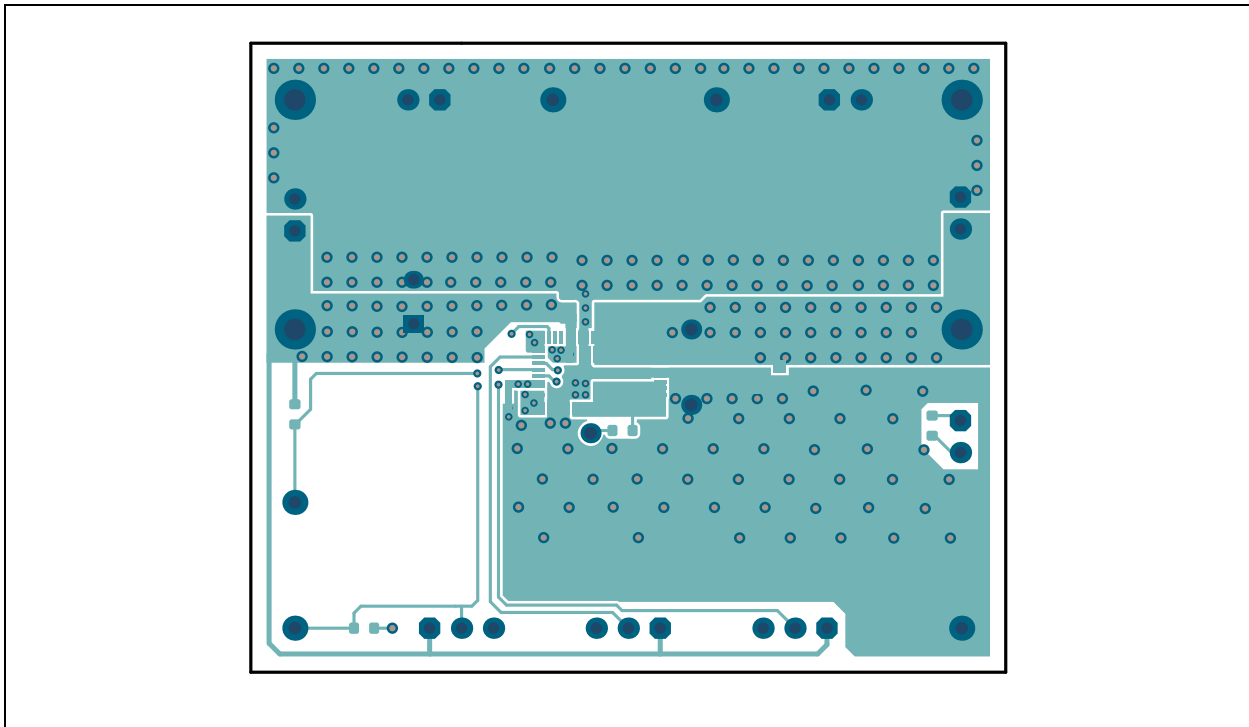
A.2 BOARD – SCHEMATIC



A.3 BOARD – TOP SILK AND PADS

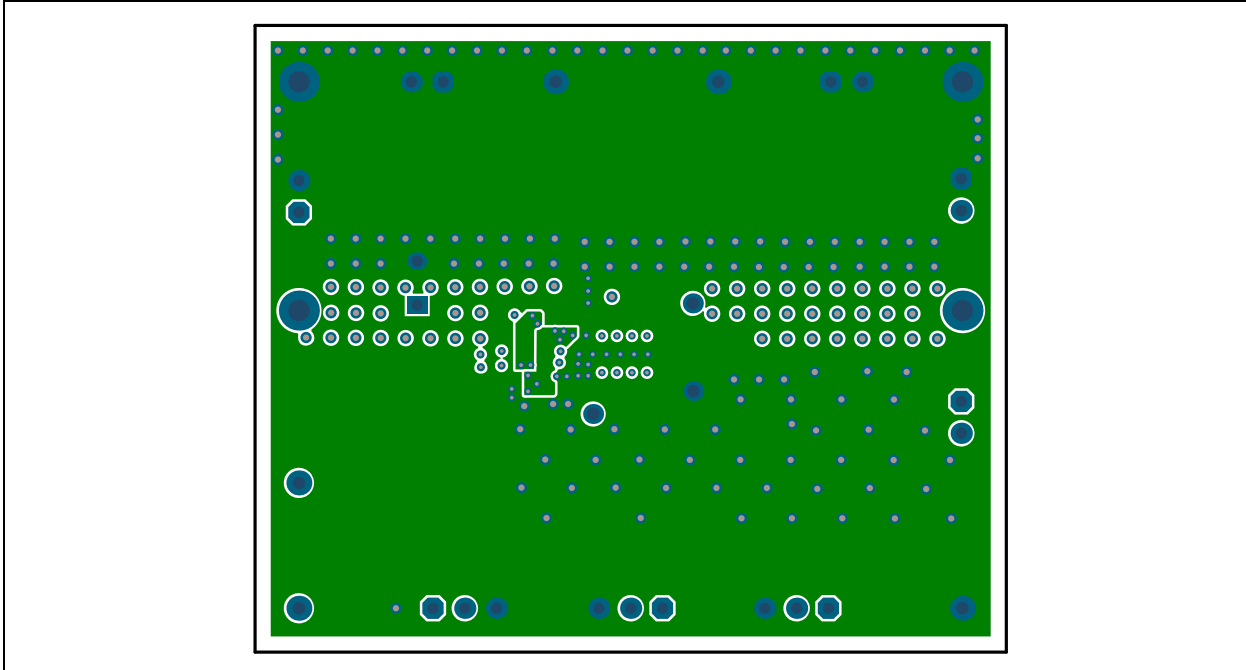


A.4 BOARD – TOP COPPER LAYER

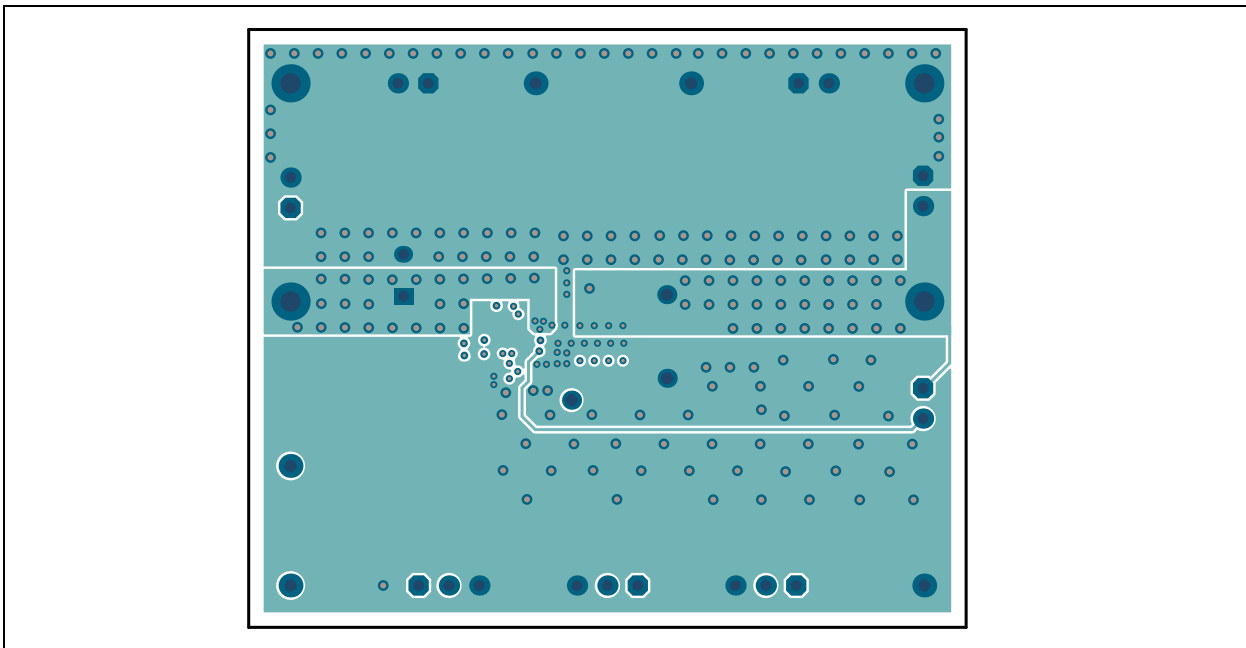


MIC33M650 Evaluation Board User's Guide

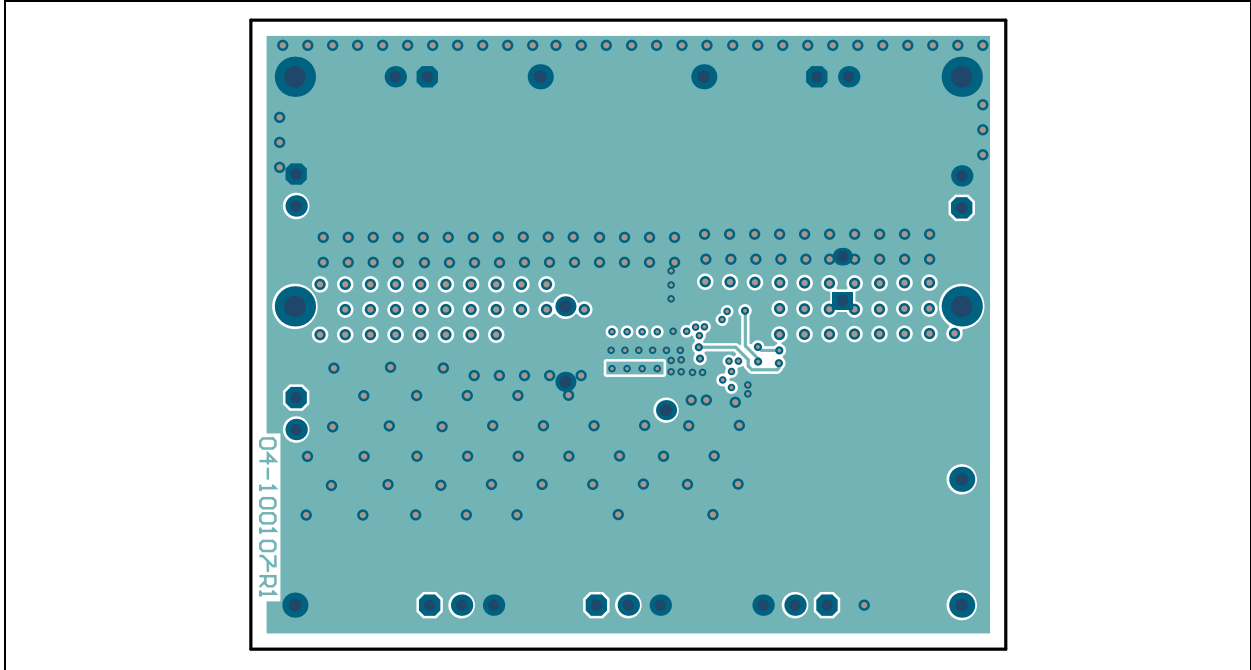
A.5 BOARD – INNER LAYER 1



A.6 BOARD – INNER LAYER 2



A.7 BOARD – BOTTOM COPPER LAYER



MIC33M650 Evaluation Board User's Guide

NOTES:



MIC33M650 EVALUATION BOARD USER'S GUIDE

Appendix B. Bill of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty	Reference	Description	Manufacturer	Part Number
1	C1	Capacitor ceramic 22uF 10V 20% X7S SMD 0805	TDK Corporation	C2012X7S1A226M125AC
1	C2	Capacitor aluminum 470uF 16V 20% RAD P3.5D8H11.5	Nichicon Corporation	UVZ1C471MPD
2	C5,C6	Capacitor ceramic 47uF 10V 20% X5R SMD 0805	TDK Corporation	C2012X5R1A476M125AC
4	J1, J5, J9, J11	Connector test point pin tin TH.	Harwin Plc.	H2121-01
4	J2, J6, J16, J17	Connector header-2.54 male 1x2 gold 5.84MH TH. vert.	Amphenol ICC	77311-118-02LF
4	J3, J8	Misc., test point multi-purpose mini red	Keystone® Electronics Corp.	5000
3	J4, J12, J13	Connector header-2.54 male 1x3 tin 5.84MH TH vert.	Samtec, Inc.	TSW-103-07-T-S
3	J10, J14, J15	Misc., test point multi-purpose mini black	Terminal	5001
1	J18	Connector RF coaxial ultra miniature male SMD vert.	Hirose Electric Co., Ltd.	U.FL-R-SMT-1(10)
1	R1	Resistor thick film 49.9R 1% 1/10W SMD 0603	Panasonic®	ERJ3EKF49R9V
1	R2	Resistor thick film 1M 1% 1/10W SMD 0603	Panasonic	ERJ-3EKF1004V
1	R3	Resistor thick film 10R 1% 1/10W SMD 0603	Panasonic	ERJ3EKF10R0V
1	R4	Resistor thick film 100k 1% 1/10W SMD 0603	TE Connectivity, Ltd.	1622827-1
1	U1	Microchip Analog switcher Buck 0.6V to 3.3V 6A MIC33M650YMP B1QFN-53	Microchip Technology Inc.	MIC33M650YMP
	JP1, JP2, JP3	Mech. HW jumper 2.54mm 1x2	3M	969102-0000-DA
	LABEL1	Label, Assy. v/rev level (small modules) per MTS-0002		
	PAD1, PAD2, PAD3, PAD4	Mech. HW rubber pad cylindrical D7.9 H5.3 black	3M	70006431483
	PCB1	Printed Circuit Board		04-11020-R1
0	C3, C4	DO NOT POPULATE	Murata	GRM32ER71A476KE15L
0	J7	DO NOT POPULATE	Amphenol ICC	77311-118-02LF

Note: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

MIC33M650 Evaluation Board User's Guide

NOTES:



MICROCHIP

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://www.microchip.com/support>
Web Address:
www.microchip.com

Atlanta

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

Austin, TX

Tel: 512-257-3370

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

Novi, MI
Tel: 248-848-4000

Houston, TX

Tel: 281-894-5983

Indianapolis

Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453
Tel: 317-536-2380

Los Angeles

Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608
Tel: 951-273-7800

Raleigh, NC

Tel: 919-844-7510

New York, NY

Tel: 631-435-6000

San Jose, CA

Tel: 408-735-9110
Tel: 408-436-4270

Canada - Toronto

Tel: 905-695-1980
Fax: 905-695-2078

ASIA/PACIFIC

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

China - Beijing
Tel: 86-10-8569-7000

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

China - Chongqing
Tel: 86-23-8980-9588

China - Dongguan
Tel: 86-769-8702-9880

China - Guangzhou
Tel: 86-20-8755-8029

China - Hangzhou
Tel: 86-571-8792-8115

China - Hong Kong SAR
Tel: 852-2943-5100

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

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

China - Shanghai
Tel: 86-21-3326-8000

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

China - Shenzhen
Tel: 86-755-8864-2200

China - Suzhou
Tel: 86-186-6233-1526

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

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

China - Xiamen
Tel: 86-592-2388138

China - Zhuhai
Tel: 86-756-3210040

ASIA/PACIFIC

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

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

India - Pune
Tel: 91-20-4121-0141

Japan - Osaka
Tel: 81-6-6152-7160

Japan - Tokyo
Tel: 81-3-6880-3770

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

Korea - Seoul
Tel: 82-2-554-7200

Malaysia - Kuala Lumpur
Tel: 60-3-7651-7906

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

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

Singapore
Tel: 65-6334-8870

Taiwan - Hsin Chu
Tel: 886-3-577-8366

Taiwan - Kaohsiung
Tel: 886-7-213-7830

Taiwan - Taipei
Tel: 886-2-2508-8600

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

Vietnam - Ho Chi Minh
Tel: 84-28-5448-2100

EUROPE

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

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

Finland - Espoo
Tel: 358-9-4520-820

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

Germany - Garching
Tel: 49-8931-9700

Germany - Haan
Tel: 49-2129-3766400

Germany - Heilbronn
Tel: 49-7131-72400

Germany - Karlsruhe
Tel: 49-721-625370

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

Germany - Rosenheim
Tel: 49-8031-354-560

Israel - Ra'anana
Tel: 972-9-744-7705

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

Italy - Padova
Tel: 39-049-7625286

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

Norway - Trondheim
Tel: 47-7288-4388

Poland - Warsaw
Tel: 48-22-3325737

Romania - Bucharest
Tel: 40-21-407-87-50

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

Sweden - Gothenberg
Tel: 46-31-704-60-40

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820