EV61A73A

MCP16364 Evaluation Board User's Guide

Introduction

The MCP16364/5/6 family of devices are highly integrated, high-efficiency, fixed-frequency, step-down DC-DC converters in a compact 8-lead 3 mm x 3 mm VDFN package that operates from input voltage sources up to 48V. Integrated features include a high-side switch, fixed-frequency Peak Current Mode Control, Internal Compensation, Power Good, Peak Current Limit and Overtemperature Protection. The MCP16364/5/6 family provides all the active functions for local DC-DC conversion, ensuring a fast transient response and accurate regulation.

High-efficiency conversion is achieved by integrating the current-limited, low-resistance, high-speed N-channel MOSFET and the associated driving circuitry. High-switching frequency minimizes the size of the external filtering components, resulting in a small size solution.

The MCP16364/5/6 devices can supply 1A of continuous current while regulating the output voltage from 2.0V to 24V. An integrated, high-performance peak current mode architecture keeps the output voltage tightly regulated, even during input voltage steps and output current transient conditions that are common in power systems.

The MCP16364 operates in PFM/PWM mode. It switches in PFM mode for light load conditions and for large buck conversion ratios. This results in a higher efficiency over all load ranges.

By comparison, the MCP16365 runs in PWM-only mode and is recommended for applications where the low-frequency component associated with the PFM mode of operation is not desirable.

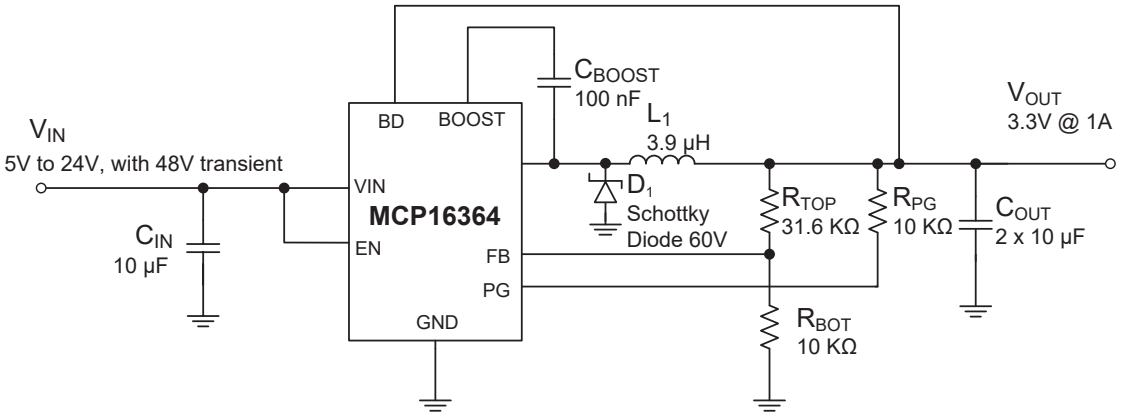
In addition to the two previously mentioned options, the MCP16366 is designed for EMI constrained applications, where reduced peak emissions are required. This is achieved by sweeping the switching frequency over a 10% range above the 2.2 MHz nominal value.

The output voltage is set with an external resistor divider. The Power Good Output pin will go from logic low to logic high (through an external pull-up resistor) once the output voltage is within 93% of the nominal set point. The EN input is used to turn the device on and off. While the device is off, only a few microamps (µA) of current are consumed from the input.

The MCP16364/5/6 is offered in a space-saving 8-lead 3 mm x 3 mm VDFN wettable flanks surface mount package.

The MCP16364/5/6 also passes automotive AEC-Q100 reliability testing.

Figure 1. Typical MCP16364 Buck Converter Application @ 3.3V Output



Features

The MCP16364 Evaluation Board has the following features:

- Input Voltage Range (V_{IN}): 4.0V (after start-up) to 48V
- Output Voltage: 3.3V
- Output Current: 1A @ 3.3V Output (typical), 12V Input
- Automatic PFM/PWM Operation for MCP16364
- PWM Switching Frequency: 2.2 MHz
- Low Device Shutdown Current: 3 µA, Typical
- Low Device Quiescent Current: 18 µA, Typical (not switching)
- Integrated N-Channel Buck Switch ON State Resistance: 500 mΩ
- Internal Compensation
- Internal Soft Start
- Internal Bootstrap Diode
- Internal Current Limit
- Power Good Output
- Overtemperature Protection (if the die temperature exceeds +155°C, with 25°C hysteresis)

What is the MCP16364 Evaluation Board

The MCP16364 Evaluation Board is used to evaluate and demonstrate the features of Microchip Technology's MCP16364 product. This evaluation board is compatible with the other two products in the family: MCP16365 and MCP16366. The input voltage range for a typical 3.3V output application is 5V-24V (transient up to 48V), and the load current can go up to 1A.

Kit contents

The MCP16364 Evaluation Board kit includes:

- MCP16364 Evaluation Board (EV61A73A)
- Important Information Sheet

1. Setup and Configuration

The MCP16364 Evaluation Board is fully assembled and tested to evaluate and demonstrate the features of the MCP16364 switching regulator. This board requires the use of an external laboratory power supply and load.

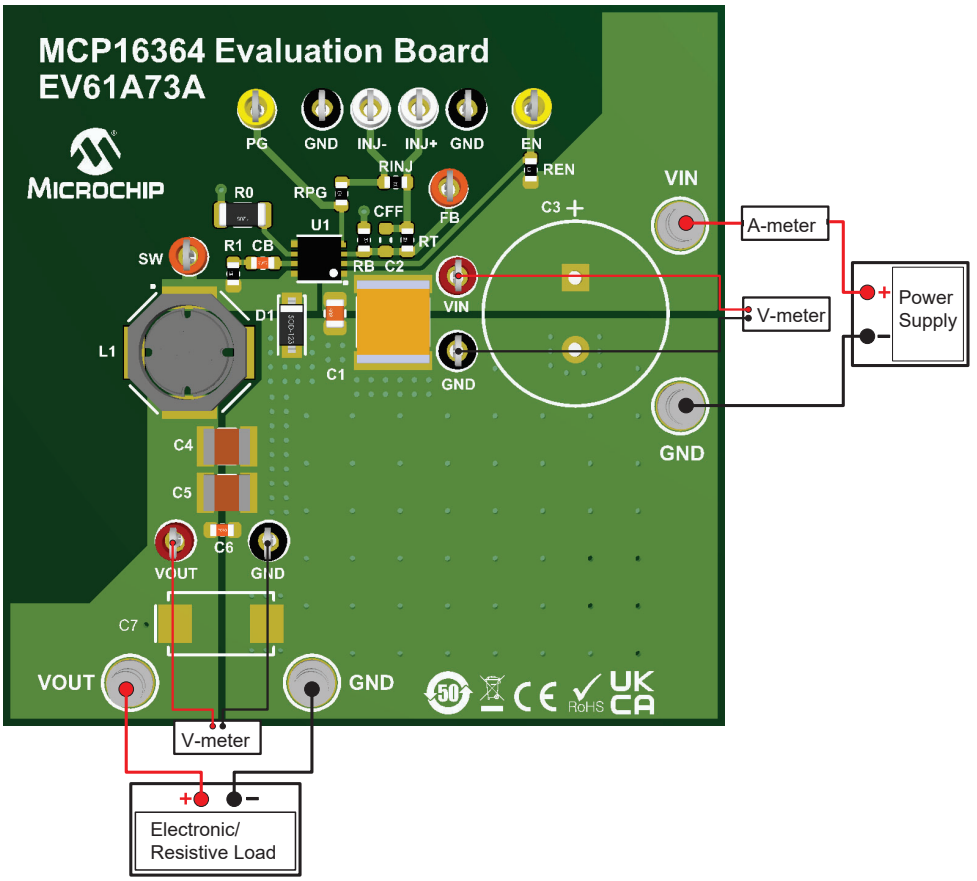
1.1 Powering the Evaluation Board

The Evaluation Board provides a typical circuit application for a 3.3V output, used to evaluate the MCP16364 product. The switch peak current limit will provide a safe maximum current value. The maximum output current for the converter will vary with input and output voltage. Refer to the MCP16364/5/6 Data Sheet (DS20006969) for more information on the maximum output current.

For the power-up procedure, follow these steps:

1. Connect the power supply to the input terminals of the evaluation board. The input voltage should be higher than V_{OUT}. Connect the load to the VOUT and GND terminals; connect the (+) side of the load to the VOUT terminal and the (-) side of the load to the GND terminal of the board. See Figure 1-1. The maximum load varies with input and output voltage (see the MCP16364/5/6 Data Sheet (DS20006969) for more information on the maximum load). By default, the EN pin is pulled high through a resistor.
2. When the power supply is turned on, a voltmeter can be used to monitor V_{OUT}. The measured output voltage should be 3.3V (± 200 mV) in PFM mode and 3.3V (± 20 mV) in PWM mode. Adjusting the input voltage and load should not cause the output to vary more than a few mV over the operating range of the converter.

Figure 1-1. MCP16364 Evaluation Board Test Setup



1.2 Adjustable V_{OUT} Setting

The resistive divider, consisting of R_{TOP} and R_{BOT}, is used to set the converter's output voltage. If the output voltage is modified by changing the feedback resistors, the inductor should also be changed. Refer to Table 1-1 for the inductor value or the MCP16364/5/6 Data Sheet (DS20006969) for more information. The output voltage can be calculated as shown in Equation 1-1:

Equation 1-1. Output voltage calculation

$$V_{OUT} = V_{FB} \times \left(1 + \frac{R_{TOP}}{R_{BOT}}\right)$$

Table 1-1. Recommended Inductor Values

V_{OUT}	Inductor value
2V	2.2 µH
3.3V	3.9 µH
5V	5.6 µH
9V	10 µH
12V	15 µH
15V	15 µH
18V	18 µH
24V	18 µH

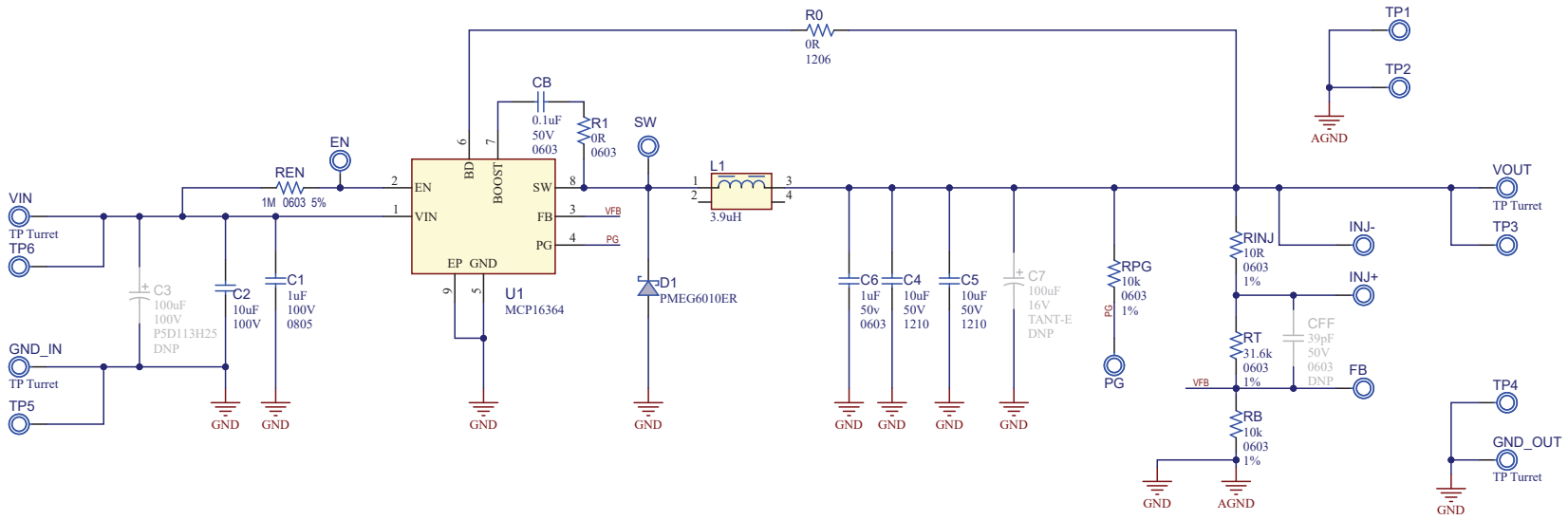
2. Board Design

This chapter contains the following schematic and layouts for the MCP16364 Evaluation Board:

- Board Schematic
- Top Silk
- Top Copper and Silk
- Top Copper
- Bottom Copper
- Bottom Copper and Silk
- Bottom Silk

2.1 Schematic

Figure 2-1. Board - Schematic



2.2 Layout

Figure 2-2. Top Silk

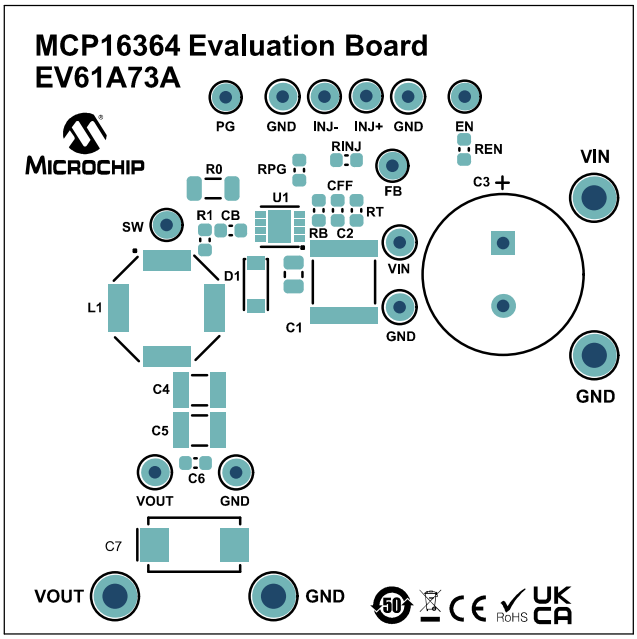


Figure 2-3. Top Copper and Silk

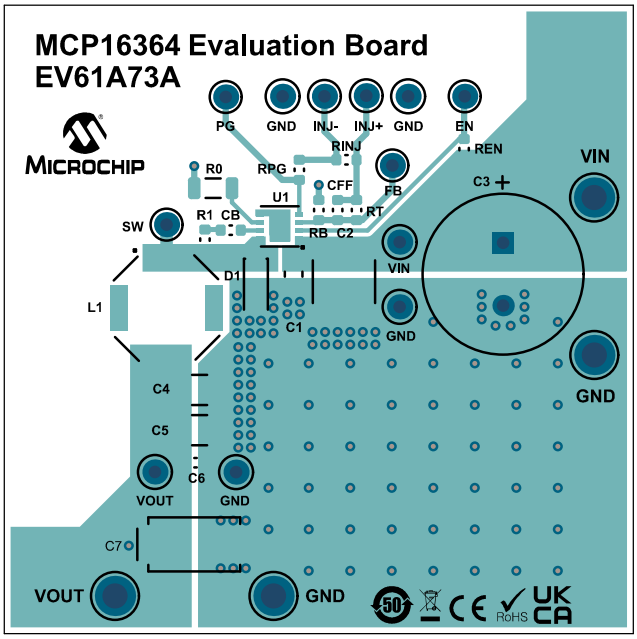


Figure 2-4. Top Copper

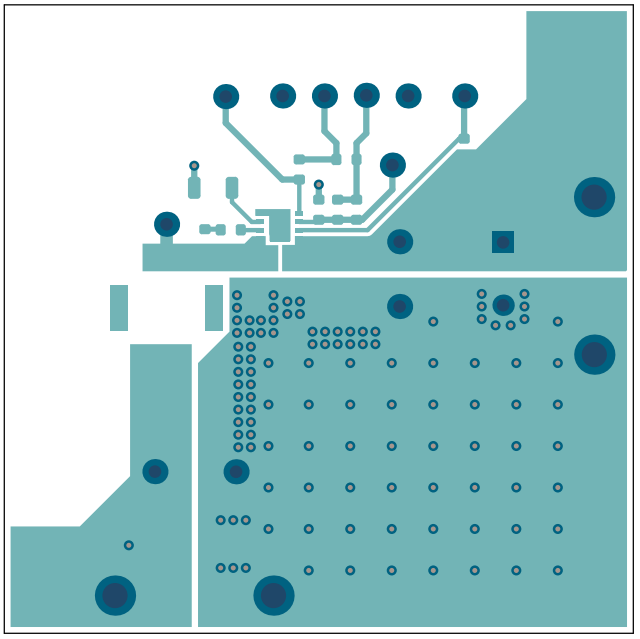


Figure 2-5. Bottom Copper

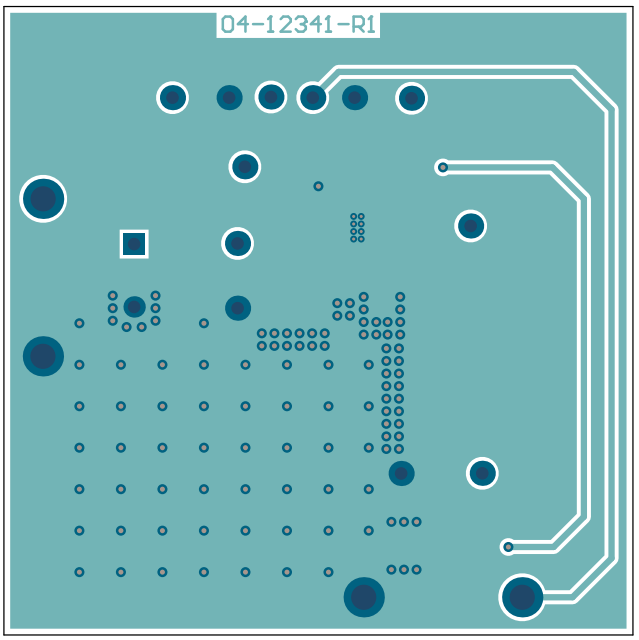


Figure 2-6. Bottom Copper and Silk

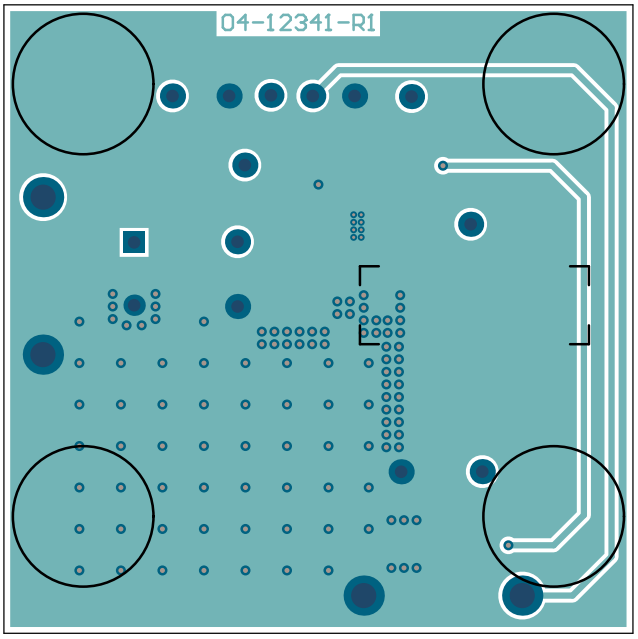
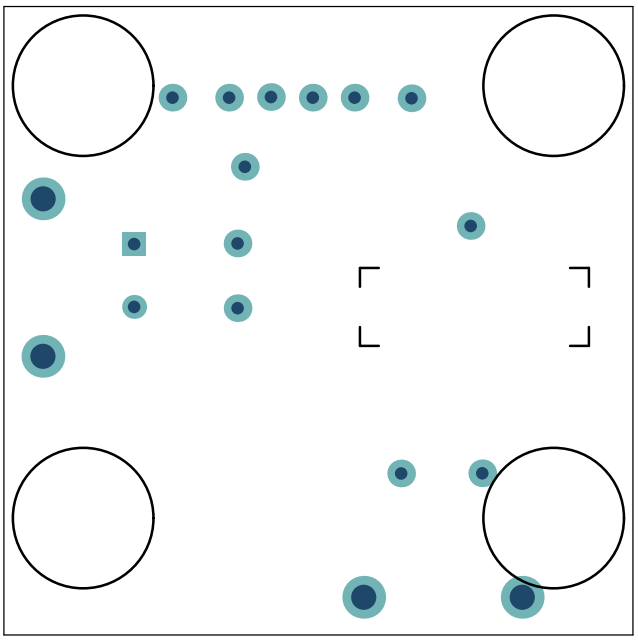


Figure 2-7. Bottom Silk



3. Bill of Materials (BOM)

Table 3-1. Bill of Materials (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
1	C1	Capacitor, Ceramic, 1 µF, 100V, 10%, X7S, SMD, 0805	Murata Electronics	GCM21BC72A105KE36L
1	C2	Capacitor, Ceramic, 10 µF, 100V, 10%, X7S, SMD, 2220	TDK Corporation	C5750X7S2A106M
2	C4, C5	Capacitor, Ceramic, 10 µF, 50V, 10%, X7R, SMD, 1210	TDK Corporation	CNA6P1X7R1H106K250AE
1	C6	Capacitor, Ceramic, 1 µF, 50V, 10%, X7R, SMD, 0603	Taiyo Yuden Co., Ltd.	UMK107AB7105KA-T
1	CB	Capacitor, Ceramic, 0.1 µF, 50V, 10%, X7R, SMD, 0603	Kyocera AVX®	06035C104K4Z4A
1	D1	Diode, Schottky, PMEG6010ER, 530 mV, 1A, 60V, SMD, SOD-123	Nexperia	PMEG6010ER,115
2	EN, PG	Test Point, Mini, Yellow	Keystone Electronics Corp.®	5004
2	FB, SW	Test Point, Loop Type, Orange	Keystone Electronics Corp.	5003
4	GND_IN, GND_OUT, VIN, VOUT	Connector, Turret, Single, Tin, Through Hole	Harwin Plc.	H2121-01
2	INJ-, INJ+	Test Point, Mini, White	Keystone Electronics Corp.	5002
1	L1	Inductor, 3.9 µH, 4.9A, 30%, SMD	Wurth Elektronik	744071039
1	R0	Resistor, TKF, 0Ω, SMD, 1206	Stackpole Electronics, Inc.	RMCF1206ZT0R00
1	R1	Resistor, TKF, 0Ω, SMD, 0603	Yageo Corporation	RC0603FR-070RL
2	RB, RPG	Resistor, TF, 10 kΩ, 1%, SMD, 0603	TE Connectivity, Ltd.	5-1879337-9
1	REN	Resistor, TKF, 1 MΩ, 5%, SMD, 0603	Yageo Corporation	9C06031A1004JLHFT
1	RINJ	Resistor, TF, 10Ω, 1%, SMD, 0603	TE Connectivity - Neohm	CPF0603F10RC1
1	RT	Resistor, TKF, 31.6 kΩ, 1%, SMD, 0603	Panasonic - ECG	ERJ-3EKF3162V
4	TP1, TP2, TP4, TP5	Test Point, Mini, Black	Keystone Electronics Corp.	5001
2	TP3, TP6	Test Point, Mini, Red	Keystone Electronics Corp.	5000
4	PAD1, PAD2, PAD3, PAD4	Mechanical HW Rubber Pad, Bumpon™ Hemisphere, 0.44" x 0.20", Black	3M™	SJ-5003 (BLACK)
1	**U1**	**MCHP Analog Switcher Buck 4V to 48V, VDFN-8**	**Microchip Technology Inc.**	**MCP16364-E/Q8B**
1	PCB1	Printed Circuit Board	—	04-12341-R1

Table 3-2. Bill of Materials (BOM) – Do Not Populate Parts

Qty.	Reference	Description	Manufacturer	Part Number
0	C3	Capacitor, Aluminum, 100 µF, 100V, 20%, Through Hole, P5D13H25	Wurth Elektronik	860130878011
0	C7	Capacitor, Tantalum, 100 µF, 16V, 20%, SMD, E	KEMET	T491X107M016AT

.....continued				
Qty.	**Reference**	**Description**	**Manufacturer**	**Part Number**
0	CFF	Capacitor, Ceramic, 39 pF, 50V, 5%, COG, SMD, 0603	Murata Electronics	GRM1885C1H390JA01D

4. Performance

This section provides specific operation waveforms and graphs. Refer to the MCP16364/5/6 Data Sheet (DS20006969) for more information.

Figure 4-1. MCP16364, Efficiency @ V_{OUT} = 3.3V, V_{IN} = 12V

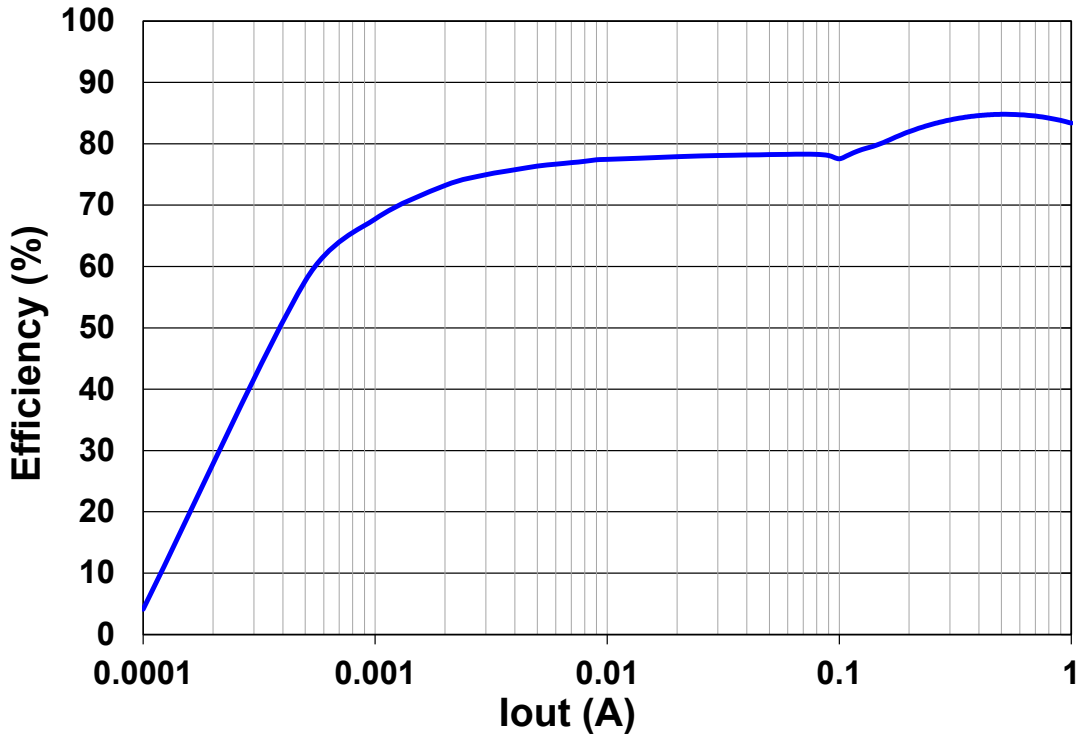


Figure 4-2. MCP16364, Load Step Response, I_{OUT} = 200 mA to 800 mA

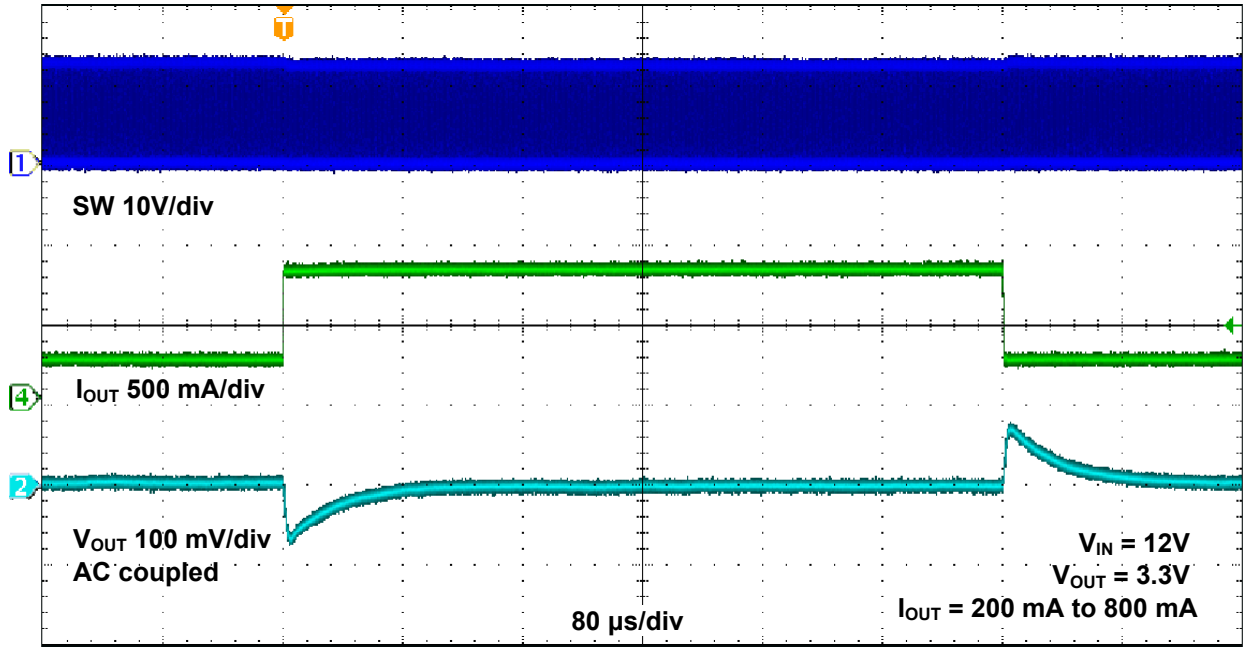


Figure 4-3. MCP16364, Load Step Response, I_{OUT} = 200 mA to 800 mA, Rising Edge

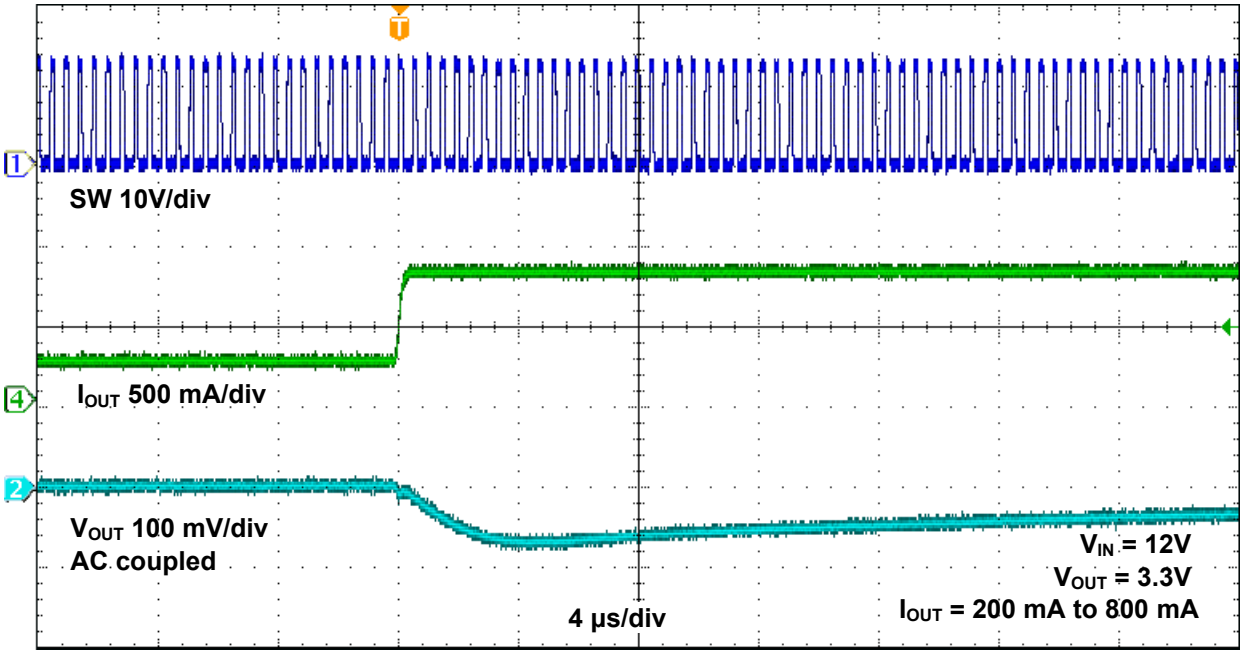
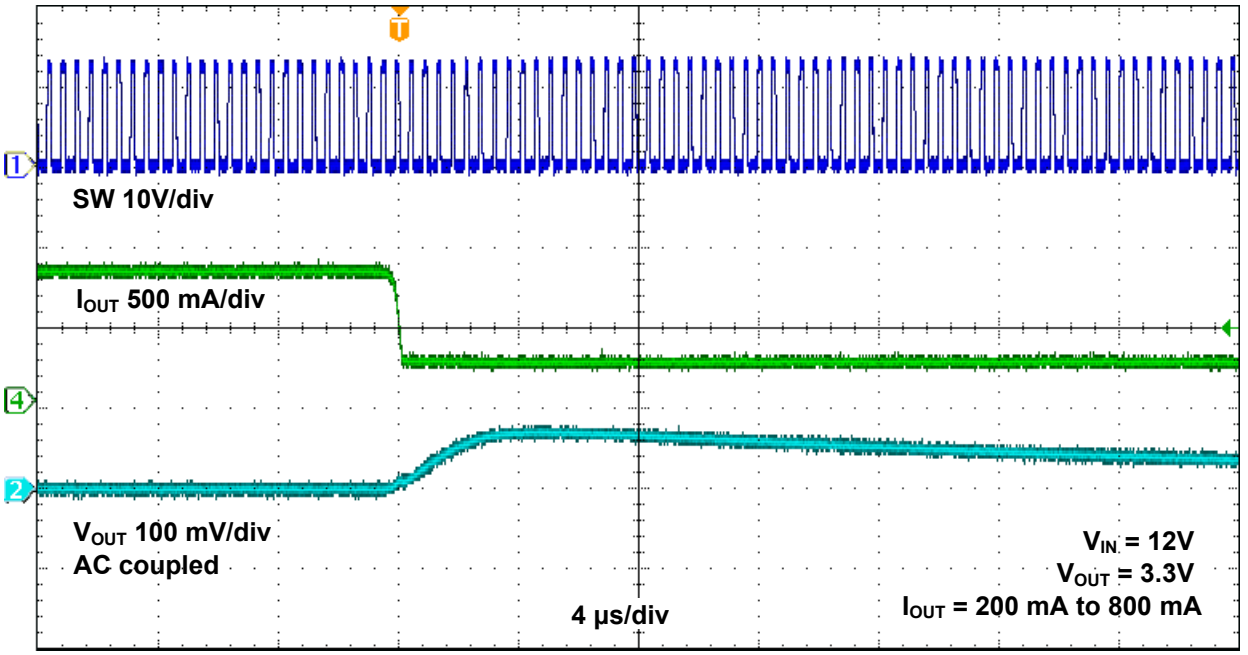


Figure 4-4. MCP16364, Load Step Response, I_{OUT} = 200 mA to 800 mA, Falling Edge



Microchip Information

Trademarks

The "Microchip" name and logo, the "M" logo, and other names, logos, and brands are registered and unregistered trademarks of Microchip Technology Incorporated or its affiliates and/or subsidiaries in the United States and/or other countries ("Microchip Trademarks"). Information regarding Microchip Trademarks can be found at https://www.microchip.com/en-us/about/legal-information/microchip-trademarks.

ISBN: 979-8-3371-0485-0

Legal Notice

This publication and the information herein may be used only with Microchip products, including to design, test, and integrate Microchip products with your application. Use of this information in any other manner violates these terms. Information regarding device applications 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. Contact your local Microchip sales office for additional support or, obtain additional support at www.microchip.com/en-us/support/design-help/client-support-services.

THIS INFORMATION IS PROVIDED BY MICROCHIP "AS IS". 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 ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSEQUENTIAL LOSS, DAMAGE, COST, OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP'S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION.

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.

Microchip Devices Code Protection Feature

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

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip products are strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is "unbreakable". Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.