MIC69303RT_P-EV Evaluation Board User's Guide

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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 "DSXXXXXXXXA", where "XXXXXXXX" 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 online help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MIC69303RT_P-EV 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 MIC69303RT_P-EV Evaluation Board as a development tool. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MIC69303RT_P-EV Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on installing and using the MIC69303RT_P-EV Evaluation Board.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MIC69303RT_P-EV Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MIC69303RT_P-EV Evaluation Board.

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) { ... }`

RECOMMENDED READING

This user's guide describes how to use the MIC69303RT_P-EV Evaluation Board. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource.

- **MIC69303RT Data Sheet – *"Radiation Tolerant Single Supply V_{IN}, Low V_{IN}, Low V_{OUT}, 3A LDO"* (DS20006757)**

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
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- 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 website at:
https://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (March 2023)

- Initial release of this document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MIC69303RT_P-EV Evaluation Board and covers the following topics:

- MIC69303RT Device Overview
- MIC69303RT_P-EV Evaluation Board Overview
- MIC69303RT_P-EV Evaluation Board Kit Contents

1.2 MIC69303RT DEVICE OVERVIEW

The MIC69303RT is a high reliability, radiation tolerant, high current, low voltage, adjustable output regulator, which supports output currents of 3A, built to sustain the most demanding requirements of the Aerospace environment.

The MIC69303RT is available in an 8-pin SOIC ePAD package, with a -55°C to +125°C ambient operating temperature range.

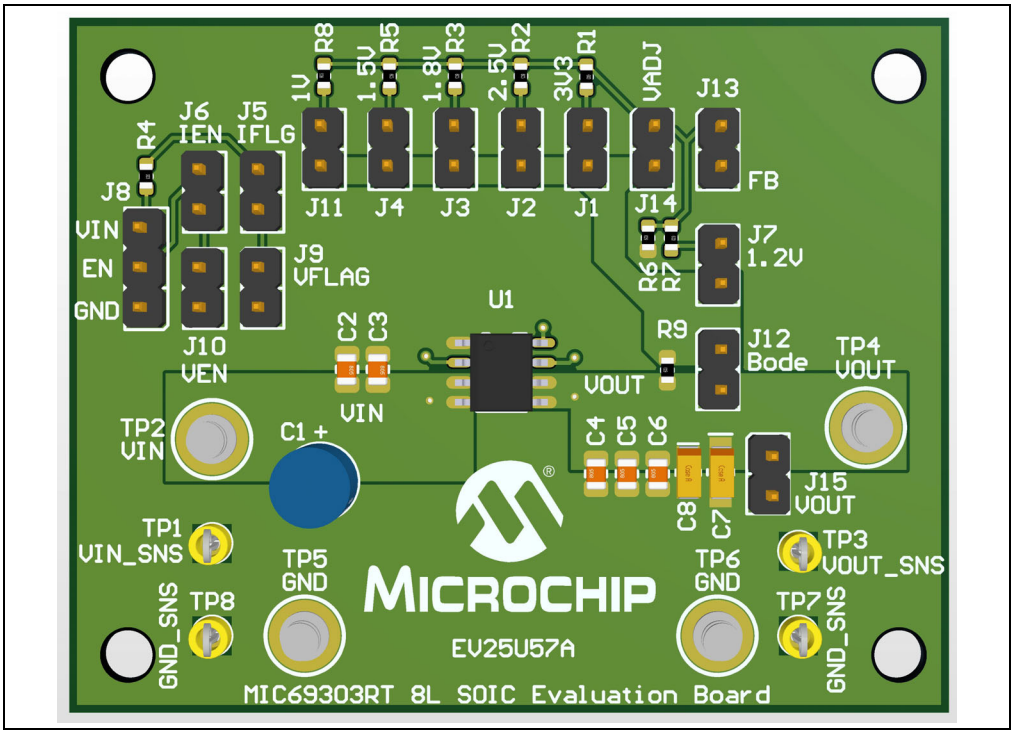


FIGURE 1-1: *Typical MIC69303RT_P-EV Evaluation Board, (Top 3D View).*

1.3 MIC69303RT_P-EV EVALUATION BOARD OVERVIEW

The MIC69303RT_P-EV Evaluation Board features:

- 8 pin SOIC ePAD MIC69303RTYME-ENG Engineering Sample IC
- Adjustable output voltage down to 0.5V

- Logic controlled startup and shutdown
- Input Voltage UVLO
- Output voltage Soft Start up
- Thermal shutdown and current-limit protection
- Failure flag output
- Adjustable output voltage determined by external resistor divider selected by jumper
- Input load resistance for Bode plot generator equipment
- Enable ON-OFF selectable by jumper
- Enable jumper provision for current measurement
- Fail Flag jumper provision for current measurement
- Output short to ground jumper provision for maximum current protection measurement and failure flag test
- Input voltage and output voltage sense for accurate measurement
- Four-layer PCB board with ground planes for device heat removal
- Features thermal shutdown with hysteresis

The basic parameters of the evaluation board are:

- Input voltage range: 1.65V to 5.5V
- Adjustable output voltage from 0.5V to 4.5V at $V_{IN} = V_{OUT} + 1V$
- Output current from 10 mA to 3A.

1.4 MIC69303RT_P-EV EVALUATION BOARD KIT CONTENTS

The MIC69303RT_P-EV Evaluation Board kit includes:

- MIC69303RT_P-EV Evaluation Board (EV25U57A)
- Important Information Sheet

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MIC69303RT_P-EV Evaluation Board is fully assembled and tested to evaluate and demonstrate MIC69303RT's capabilities. The board is based on an LDO topology and can deliver 4.5V output voltage, with a maximum current of 3A when supplied with 1.65-5.5V at the input.

2.1.1 Powering the MIC69303RT_P-EV Evaluation Board

The power supply for the board requires an output capability of at least 5A and a voltage range of 1 to 6V, at a minimum of 30W. A proper resistor or an electronic load device capable to sustain output voltage and current can be used as a load (see Figure 2-1).

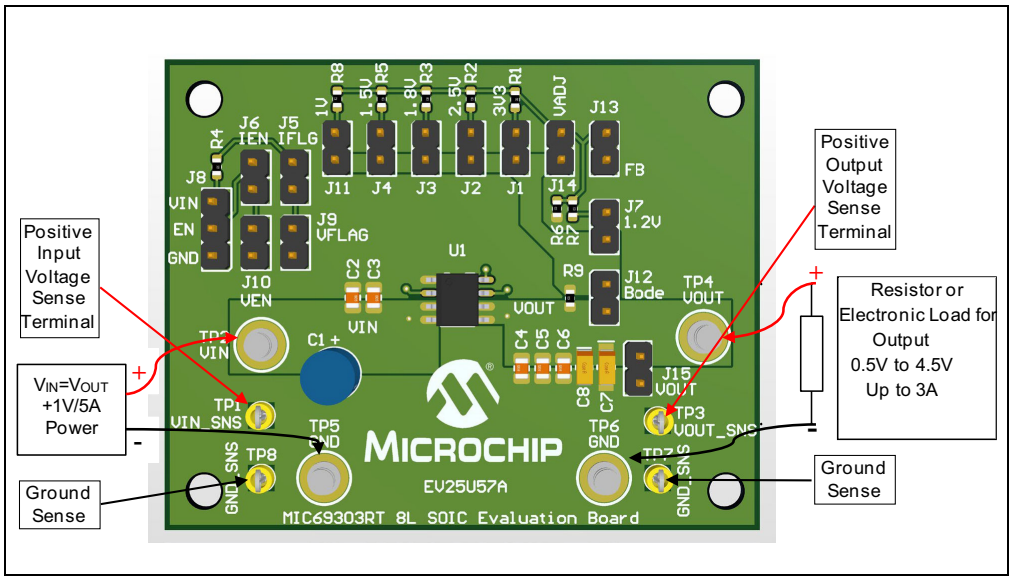


FIGURE 2-1: *MIC69303RT_P-EV Evaluation Board Connection Diagram.*

2.2 SETUP/CONFIGURATION

2.2.1 IC

To enable IC, a jumper should be placed vertically on J8 between pin J8-2 (EN) and J8-3 (VIN).

2.3 TEST

Apply 2V input voltage at the VIN and GND terminals and measure the output voltage, which should be regulated to 1V for 0A load to 3A load.

2.4 CIRCUIT DESCRIPTION

This section describes the working principles and limitations that should be considered when using the MIC69303RT_P-EV Evaluation Board. The external components have been selected to optimize the performance for the specific conditions of $V_{IN} = V_{OUT}+1V$ minimum. Although the application will behave correctly for other output and input voltages, further optimization (fine-tuning the inductors and ripple injection components) can be done to improve the efficiency and transient response. Please refer to the MIC69303RT_P-EV data sheet for the table with recommended values.

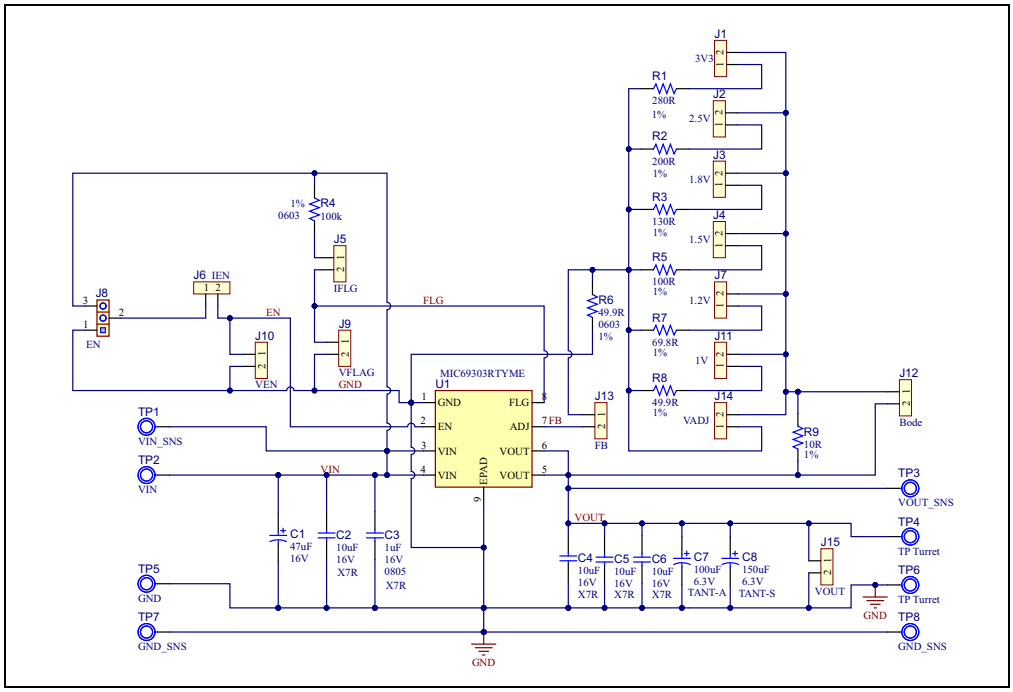


FIGURE 2-2: *MIC69303RT_P-EV Evaluation Board Circuit.*

2.4.1 Input Supply Voltage

V_{IN} provides the supply for the controller and the high current to the collector of the pass transistor. The minimum input voltage is 1.65V allowing conversion from low voltage supplies.

An input capacitor of 1 µF or greater is recommended when the device is more than 4 inches away from the bulk supply capacitance or when the supply is a battery. Small, surface mount, ceramic chip capacitors can be used for the bypassing. The capacitor should be placed within 1 inch of the device for optimal performance. Larger values will help improve ripple rejection by bypassing the input to the regulator, further improving the integrity of the output voltage.

2.4.2 Output Voltage

The output voltage can be adjusted using a resistor divider from output to AGND whose mid-point is connected to FB pin as shown the Figure 2-2.

The output voltage can be calculated using Equation 2-1.

EQUATION 2-1:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_{1\text{-}8}}{R_6}\right)$$

Where:

V_{REF} = 0.5V

Note: Output voltage should not exceed V_{IN} -1V due to the dropout V_{IN}-V_{OUT}. The minimum input voltage is 1.65V. A 10 mA minimum load current is necessary for proper operation and is achieved by the proposed resistor divider.

Use Table 2-1 for setting various application voltages as shown in Figure 2-2.

TABLE 2-1: POWER COMPONENTS FOR VARIOUS APPLICATION

Power Components for Various Application							
V_{OUT} Config.	C4	C5	C6	C7	C8	R	R6
0.5V	0.1 µF	10 µF	10 µF	100 µF	150 µF	0Ω	49.9Ω
1V	0.1 µF	10 µF	10 µF	100 µF	150 µF	49.9Ω	49.9Ω
1.2V	0.1 µF	10 µF	10 µF	100 µF	150 µF	69.8Ω	49.9Ω
1.5V	0.1 µF	10 µF	10 µF	100 µF	150 µF	100Ω	49.9Ω
1.8V	0.1 µF	10 µF	10 µF	100 µF	150 µF	130Ω	49.9Ω
2.5V	0.1 µF	10 µF	10 µF	100 µF	150 µF	200Ω	49.9Ω
3.3V	0.1 µF	10 µF	10 µF	100 µF	150 µF	280Ω	49.9Ω

22 µF is the minimum capacitance required to maintain stability, in radiation environments, additional tantalum capacitors of 100 µF and 150 µF are necessary to mitigate the SEU transient effects.

2.4.3 Enable

By closing the pins 3 and 2 in J8, directly tie the ENABLE pin to VIN, allowing the ON control of the regulator. We will have the same effect by applying an external voltage to pin 2 in J8 with a maximum value of V_{IN} and a minimum value of 1.65V with respect to ground.

2.4.4 Fail Flag

The error flag circuit monitors the output voltage and signals an error condition when the ADJ voltage is 10% below the reference voltage. Low output voltage can be caused by several problems, including an overcurrent fault (device in current limit), over temperature protection, or low input voltage.

2.4.5 Setting the Board for Bode Plot

By opening J12 and populating R9 with a value of 10Ω, a sweep sine wave generator can be connected across J15 to apply a sine wave modulated in frequency from 100 Hz to 1 MHz to obtain the voltage ratio input-output to calculate the gain and measure the phase over the frequency.

2.4.6 Recommended Test Procedure Jumper Settings

TABLE 2-2: RECOMMENDED TEST PROCEDURE JUMPER SETTINGS

Test #	Parameter	Description	V_{OUT}	Load	V_{IN}	Temp	Test Conditions& Results	Jumper Shorted	Jumper Opened
1	Input Voltage Range	Startup and shut-down with enable and input power	1V	10 mA	1.65, 5.5	25C	Operational	J8(3,2), J6, J5, J13, J11, J12	J10, J9, J1, J2, J3, J4, J7, J14, J15
2	Ground Pin Current	Measure current from ground pin to ground	1V	10 mA, 1.5A, 3A	2	25C	I_{IN} - I_{OUT}	J8(3,2), J6, J5, J13, J11, J12	J10, J9, J1, J2, J3, J4, J7, J14, J15
3	Ground Pin Current in Shutdown	Measure ground pin current when Enable = 0V and Output shorted to ground	Grounded	Shorted to ground	2	25C	I_{IN} at EN = 0	J8(1,2), J6, J5, J13, J11, J12	J10, J9, J1, J2, J3, J4, J7, J14, J15
4	Output Voltage Tolerance	Measure output voltage tolerance	1V	0.5A	2	25C	V_{OUT}	J8(3,2), J6, J5, J13, J11, J13	J10, J9, J1, J2, J3, J4, J7, J14, J15
5	Load Regulation	Measure output voltage regulation at different loads	1V	10 mA, 3A	2.5	25C	(V_{OUT}@10 mA-V_{OUT}@3A)/V_{OUT}@ 10 mA	J8(3,2), J6, J5, J13, J11, J14	J10, J9, J1, J2, J3, J4, J7, J14, J15
6	Line Regulation	Measure output voltage at different input voltages	1V	1A	1.65V, 5.5V	25C	(V_{OUT}@V_{IN}5.5V-V_{OUT}@V_{IN}=2.65V)/ V_{OUT}@V_{IN}=5.5V	J8(3,2), J6, J5, J13, J11, J15	J10, J9, J1, J2, J3, J4, J7, J14, J15
7	V_{REF}	Measure feedback reference voltage	1V	1A	2V	25C	Measure voltage at J3 pin 2 (FB pin)	J8(3,2), J6, J5, J13, J11, J16	J10, J9, J1, J2, J3, J4, J7, J14, J15
8	Feedback Bias Current	Measure feedback bias pin current	0.5V	1A	2	25C	Measure current between J13 pin 1,2 (FB pin current)	J8(3,2), J6, J5, J11, J17	J10, J9, J1, J2, J3, J4, J13, J7, J14, J15
9	Dropout Voltage	Measure voltage dropout of the PNP output transistor	1V	1.5A, 3A	Ramp down from 2V to 0.5V	25C	Drop V_{IN} from 2V until V_{OUT} = 0.99V Measure V_{OUT}-V_{IN}	J8(3,2), J6, J5, J13, J11, J16	J10, J9, J1, J2, J3, J4, J7, J14, J15
10	Current Limit	Measure overcurrent protection when output shorted to ground	0V	Output shorted to ground	2.5	25C	Measure I_{IN}	J8(3,2), J6, J5, J13, J11, J12, J15	J10, J9, J1, J2, J3, J4, J7, J14
11	Enable Operation	Verify Enable ON Measure Enable OFF	1V	1A	2	25C	V_{OUT} is present when En voltage = 2V V_{OUT} is zero when En voltage = 0V	J8(3,2), J6, J5, J13, J11, J13	J10, J9, J1, J2, J3, J4, J7, J14, J15
12	Turn-on Time	Measure time to reach 0.9 V_{OUT} when start	1V	0.5A	2	25C	Start with enable and verify softstart	J8(3,2), J6, J5, J13, J11, J12	J10, J9, J1, J2, J3, J4, J7, J14, J15
13	Fault Operation	Fault is on when startup until V_O > 0.9V_O setting	1V	0.5V	2	25C	Start with enable and check FLT signal	J8(3,2), J6, J5, J13, J11, J12	J10, J9, J1, J2, J3, J4, J7, J14, J15
14	Output Voltages	Closing one at the time: J1, J2, J3, J4, J7, J11, and J14 while keeping the others open, select output voltage.	0.5, 1V, 1.2V,1.5V, 1.8V, 2.5V, 3.3V	10 mA	5V	25C	Measure V_{OUT}	J8(3,2), J6, J5, J13, J12	J10, J9, J15

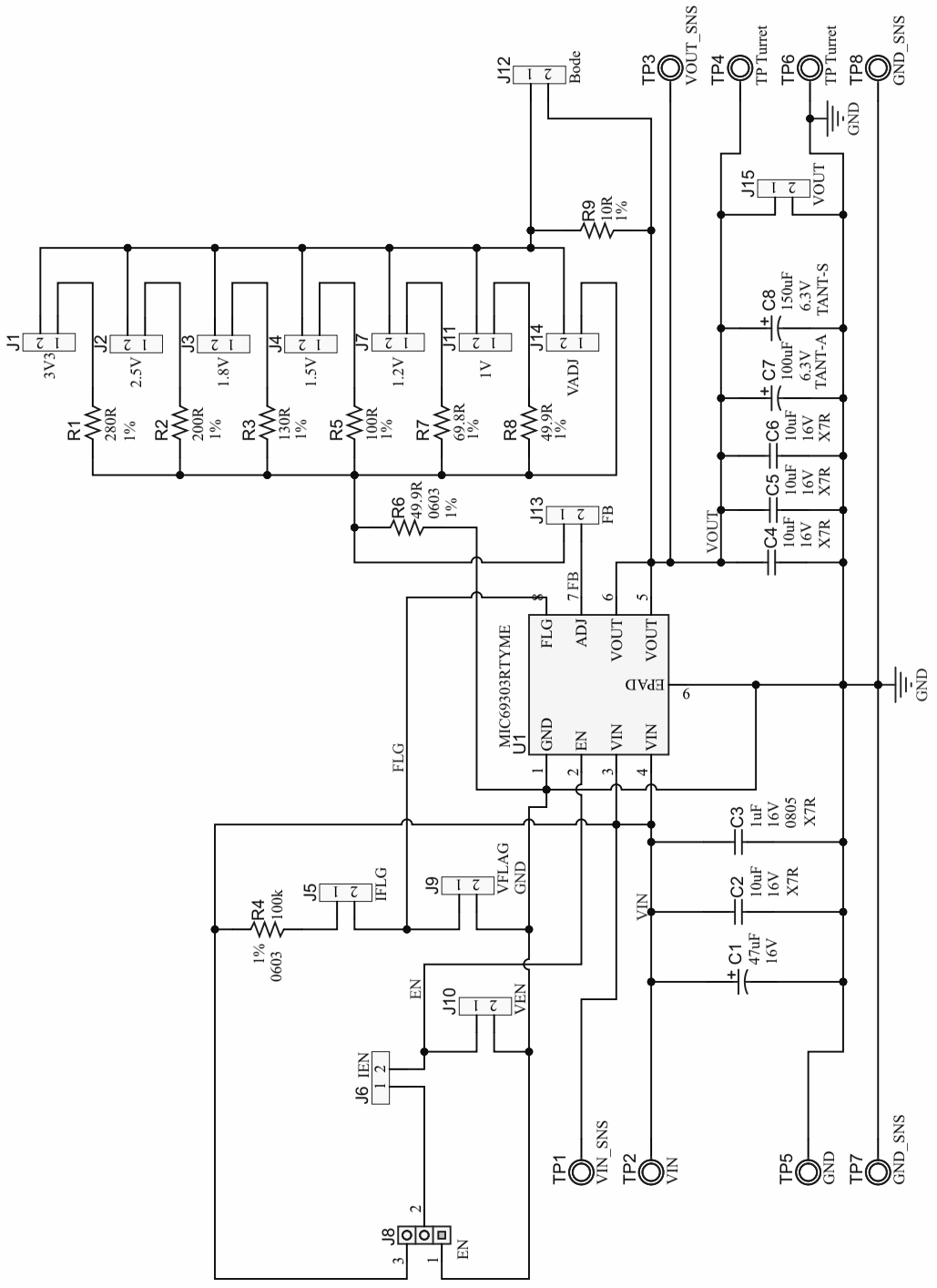
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

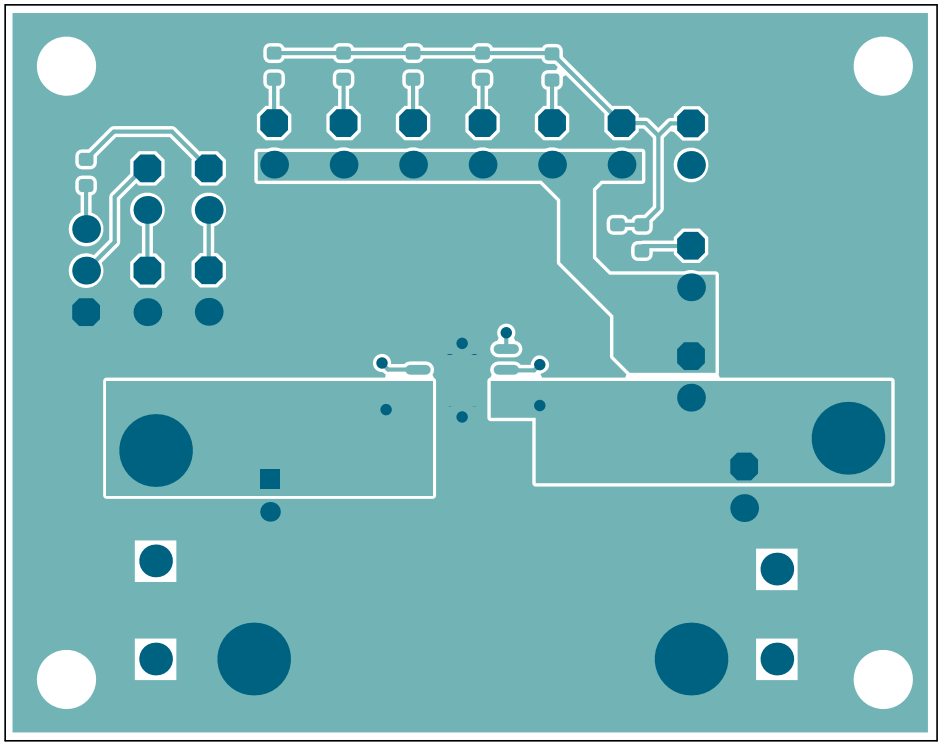
This appendix contains the following schematic and layouts for the MIC69303RT_P-EV Evaluation Board:

- Board – Schematic
- Board – Top Copper
- Board – Inner Layer 1
- Board – Inner Layer 2
- Board – Bottom Copper

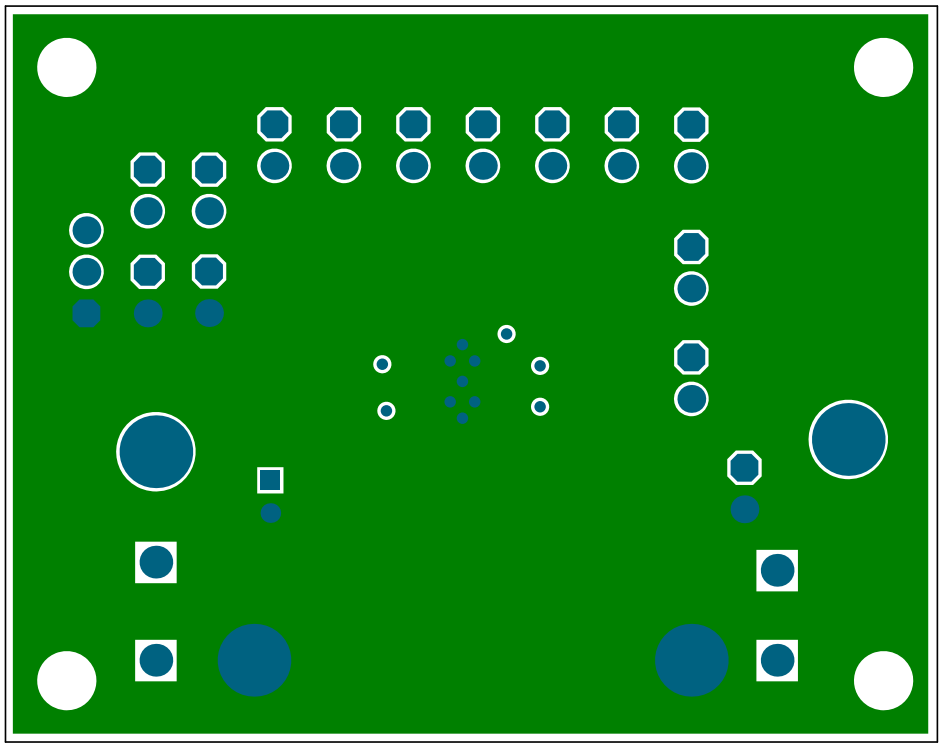
A.2 BOARD – SCHEMATIC



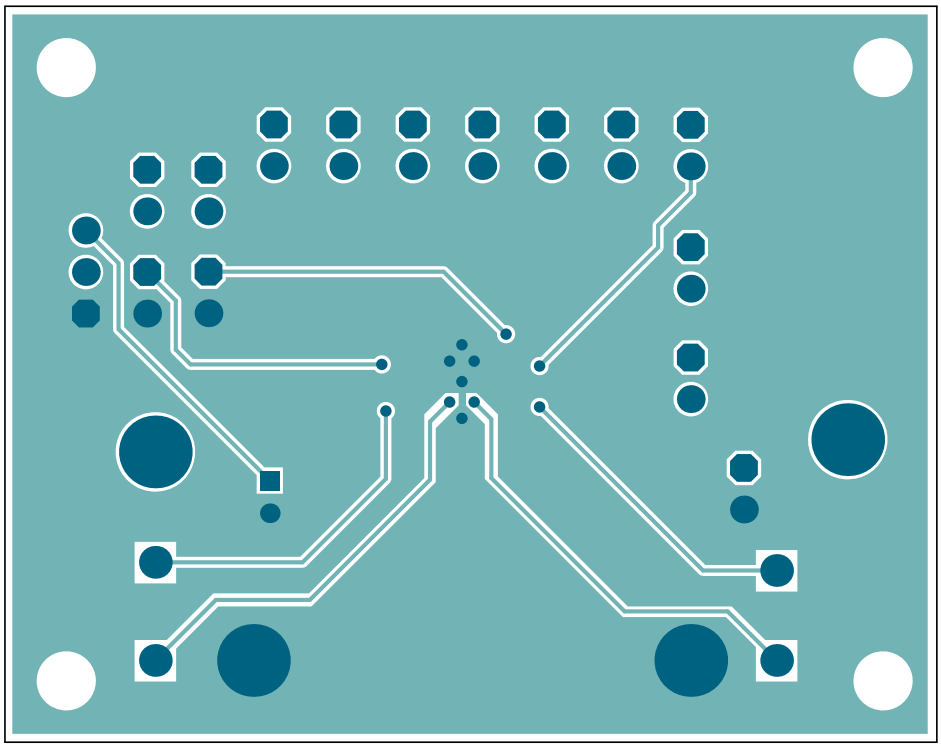
A.3 BOARD – TOP COPPER



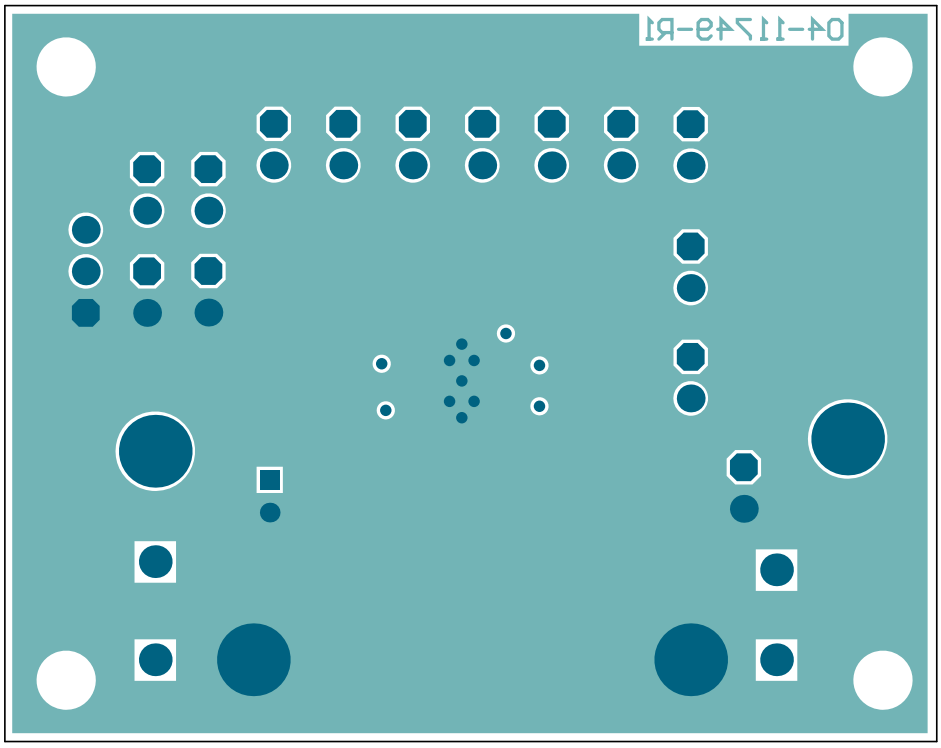
A.4 BOARD – INNER LAYER 1



A.5 BOARD – INNER LAYER 2



A.6 BOARD – BOTTOM COPPER



Appendix B. Bill of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
1	C1	Capacitor, aluminum, 47 µF, 16V, 20%, RAD, P2D5H,12.5, TH	Rubycon Corporation	16PK47MEFC5X11
4	C2, C4, C5, C6	Capacitor, ceramic, 10 µF, 16V, 10%, X7R, SMD, 0805	Samsung Electro-Mechanics America, Inc.	CL21B106KOQNNNE
1	C3	Capacitor, ceramic, 1 µF, 16V, 10%, X7R, SMD, 0805	KEMET	C0805C105K4RAC7800
1	C7	Capacitor, Tantalum, 100 µF, 6.3V, 20%, 0.5Ω, SMD, A	AVX Corporation	TLJA107M006R0500
1	C8	Capacitor, Tantalum, 150 µF, 6.3V, 20%, 2.5Ω, SMD S	Kyocera AVX	TLNS157M006R2500
14	J1, J2, J3, J4, J5, J6, J7, J9, J10, J11, J12, J13, J14, J15	Connector, header, 2.54, male, 1x2, gold, 5.84MH, TH, vertical	Würth Elektronik	61300211121
1	J8	Connector, header, 2.54, male, 1x3, gold, 5.84MH, TH, vertical	FCI	68000-103HLF
1	PCB1	MIC69303RT_P-EV Evaluation Board – Printed Circuit Board	Microchip Technology Inc.	**04-11749-R1**
1	R1	Resistor, TKF, 280R, 1%, 1/10W, SMD, 0603	Vishay/Dale	CRCW0603280RFKEAC
1	R2	Resistor, TKF, 200R, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF2000V
1	R3	Resistor, TKF, 130R, 1%, 1/10W, SMD, 0603	Vishay/Dale	CRCW0603130RFKEA
1	R4	Resistor, TKF, 100k, 1%, 1/10W, SMD, 0603, AEC-Q200	Panasonic - ECG	ERJ-3EKF1003V
1	R5	Resistor, TKF, 100R, 1%, 1/10W, SMD, 0603, AEC-Q200	ROHM Semiconductor	KTR03EZPF1000
2	R6, R8	Resistor, TKF, 49.9R, 1%, 1/10W, SMD, 0603	ROHM Semiconductor	MCR03EZPFX49R9
1	R7	Resistor, TKF, 69.8R, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF69R8V
1	R9	Resistor, TKF, 10R, 1%, 1/10W, SMD, 0603	Panasonic - ECG	ERJ-3EKF10R0V
4	TP1, TP3, TP7, TP8	Misc., test point. PC. mini, 0.040" D, yellow	Keystone® Electronics Corp.	5004
4	TP2, TP4, TP5, TP6	Connector, TP, pin, tin, TH	Keystone Electronics Corp.	1502-2
1	U1	Microchip, Analog LDO, ADJ, MIC69303RTYME, SOIC-8	Microchip Technology Inc.	**MIC69303RTYME-HP**

Note 1: 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.

TABLE B-2: BILL OF MATERIALS (BOM) – MECHANICAL PARTS

Qty.	Reference	Description	Manufacturer	Part Number
6	JP1, JP2, JP3, JP4, JP5, JP6	Mechanical, hardware, jumper, 2.54mm, 1x2	FCI	63429-202LF

Note 1: 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.

Appendix C. Waveforms and Performance Curves

C.1 INTRODUCTION

This chapter shows some of the typical performance parameters and curves of the MIC69303RT_P-EV Evaluation Board.

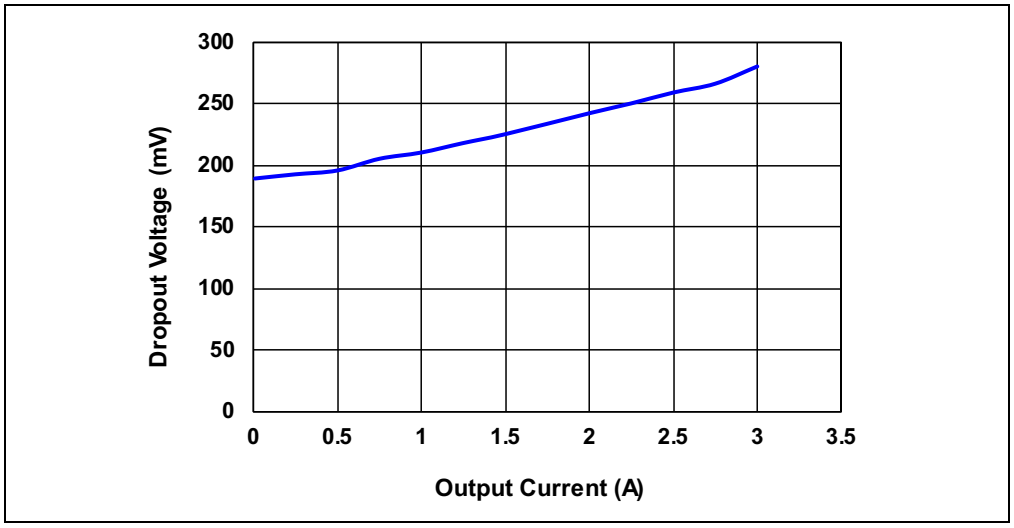


FIGURE C-1: *Dropout Voltage vs. Output Current.*

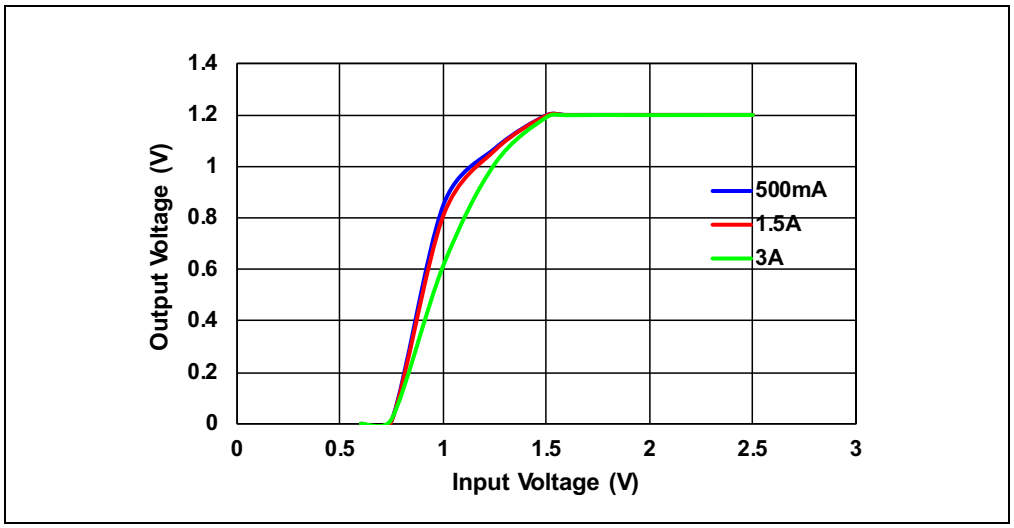


FIGURE C-2: *Output Voltage vs Input Voltage.*

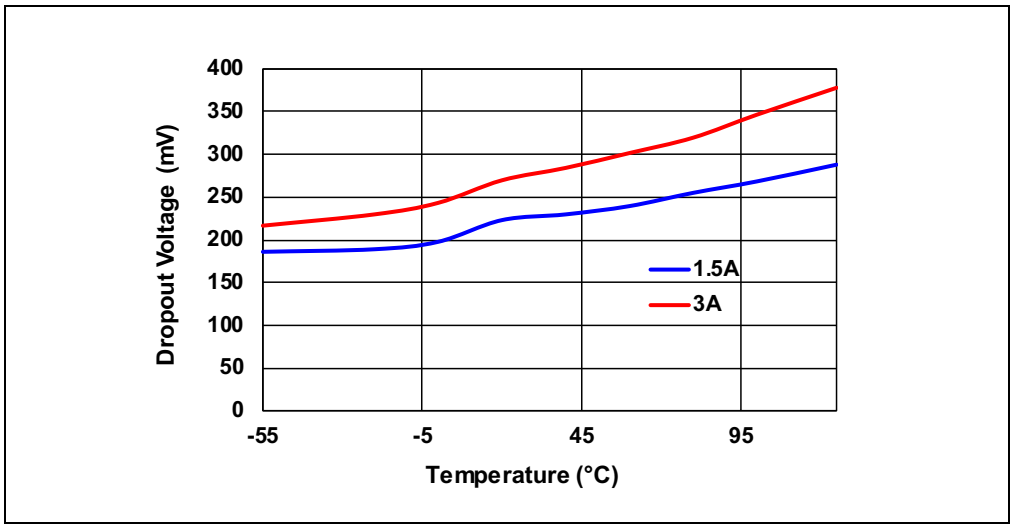


FIGURE C-3: *Dropout Voltage vs. Temperature.*

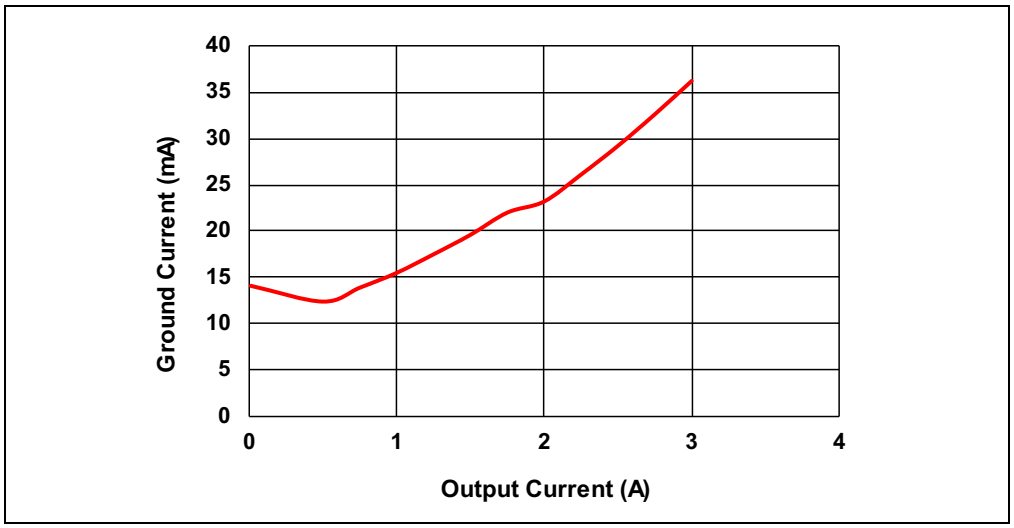


FIGURE C-4: *Ground Current vs. Output Current.*

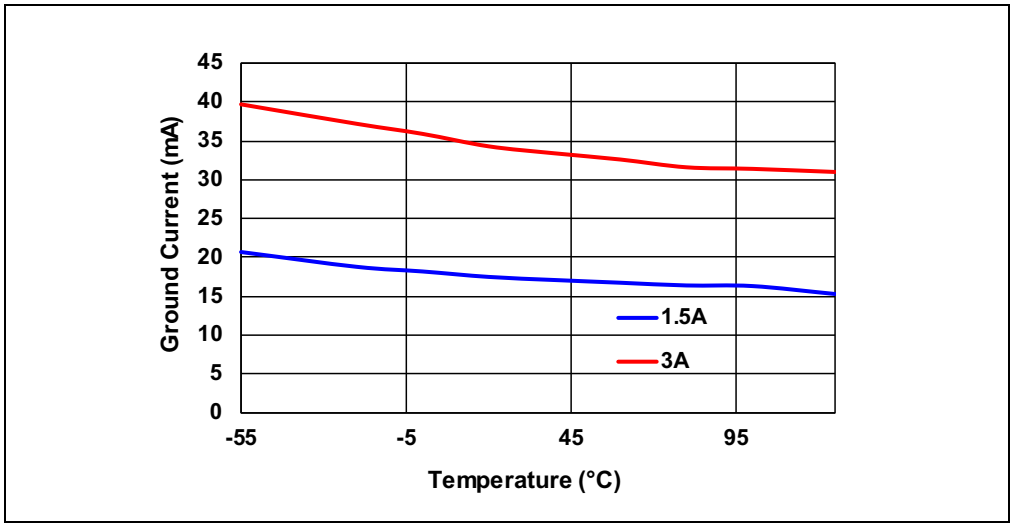


FIGURE C-5: *Ground Current vs. Temperature.*

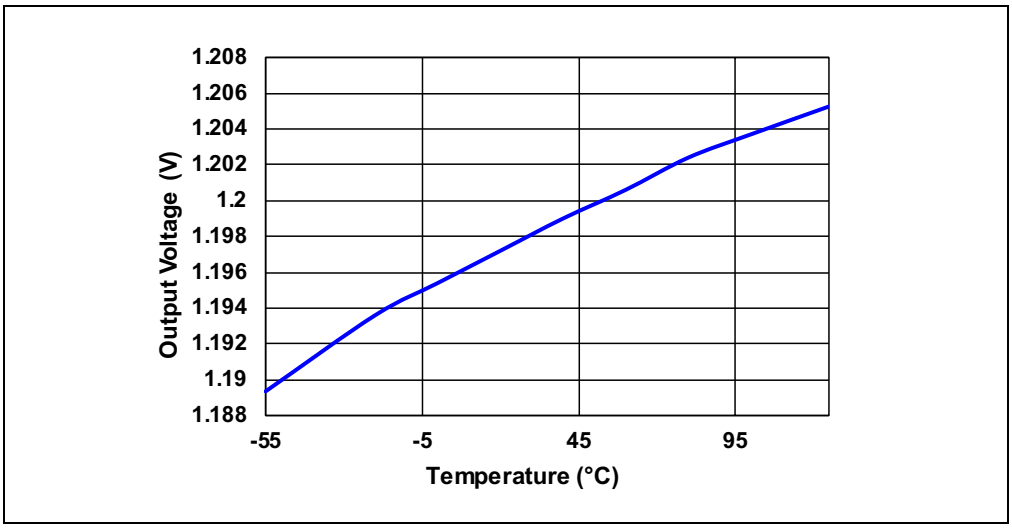


FIGURE C-6: *Output Voltage vs. Temperature.*

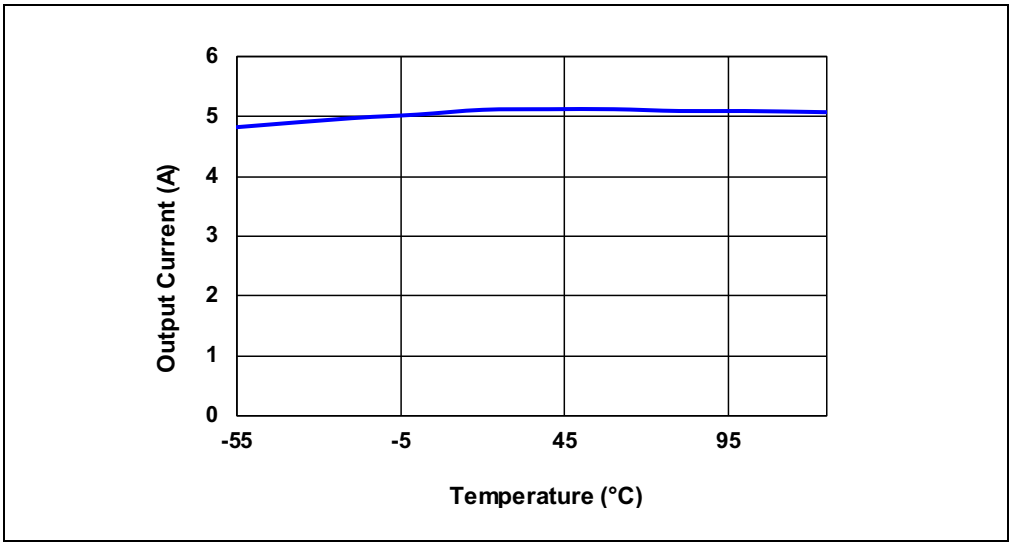


FIGURE C-7: *Current Limit vs. Temperature.*

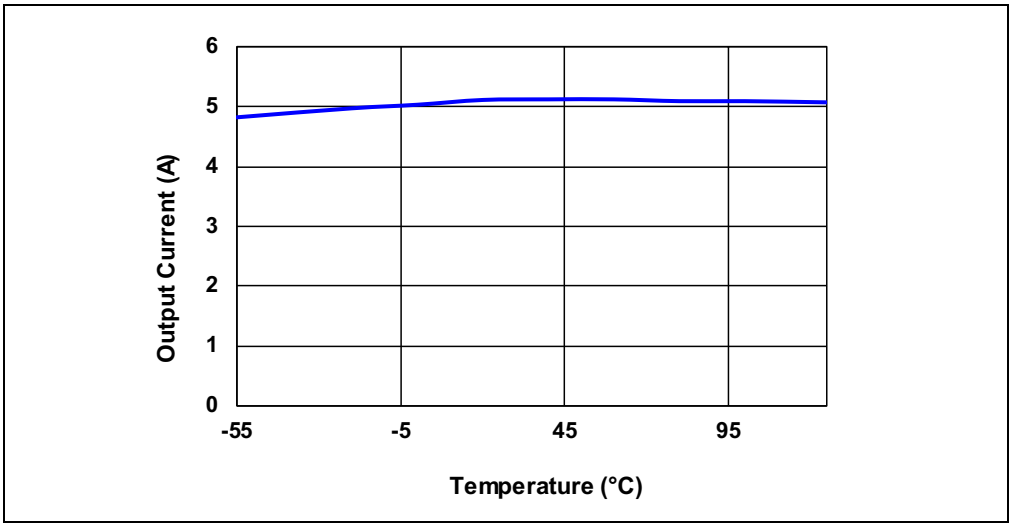


FIGURE C-8: *Load Regulation.*

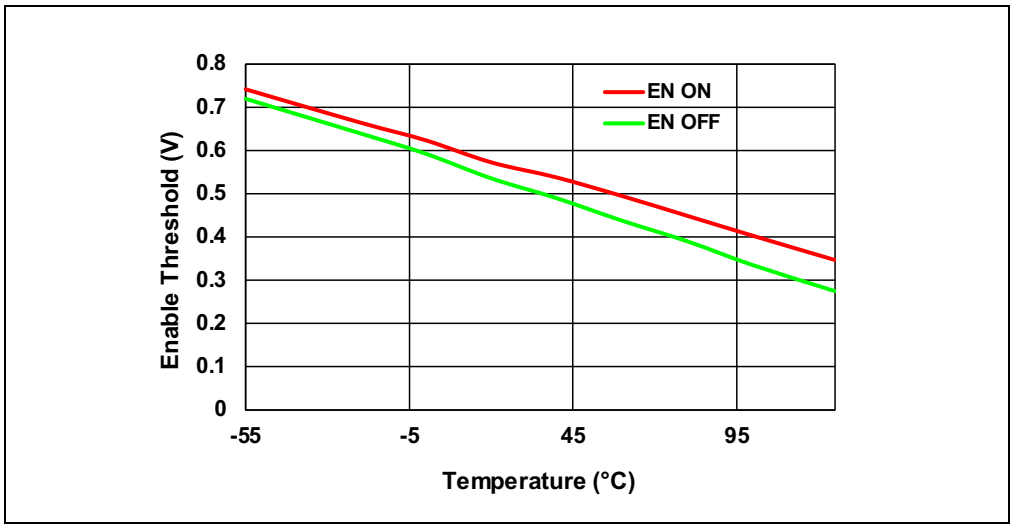


FIGURE C-9: *Enable Threshold vs. Temperature.*

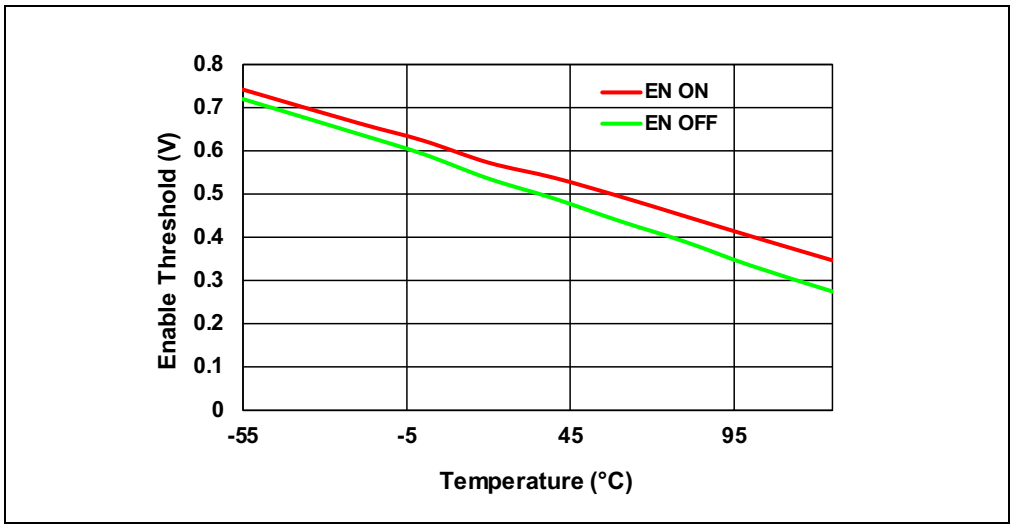


FIGURE C-10: *PSRR.*

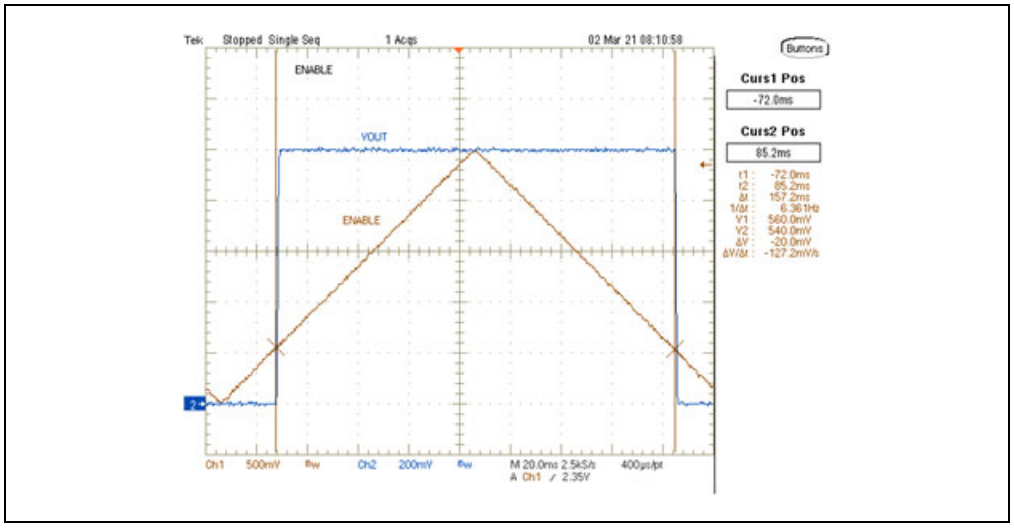


FIGURE C-11: *Enable Thresholds at 25°C.*

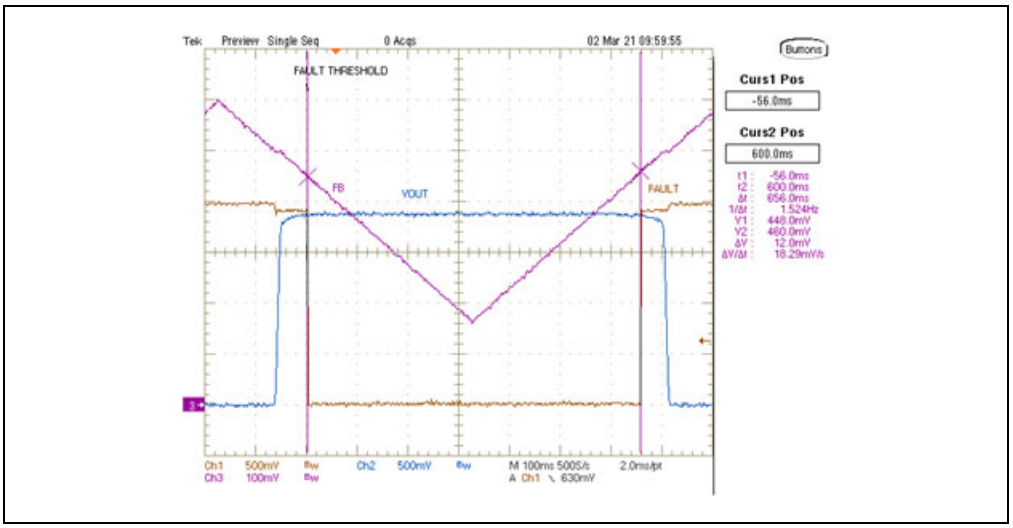


FIGURE C-12: *Fault Thresholds at 25°C.*

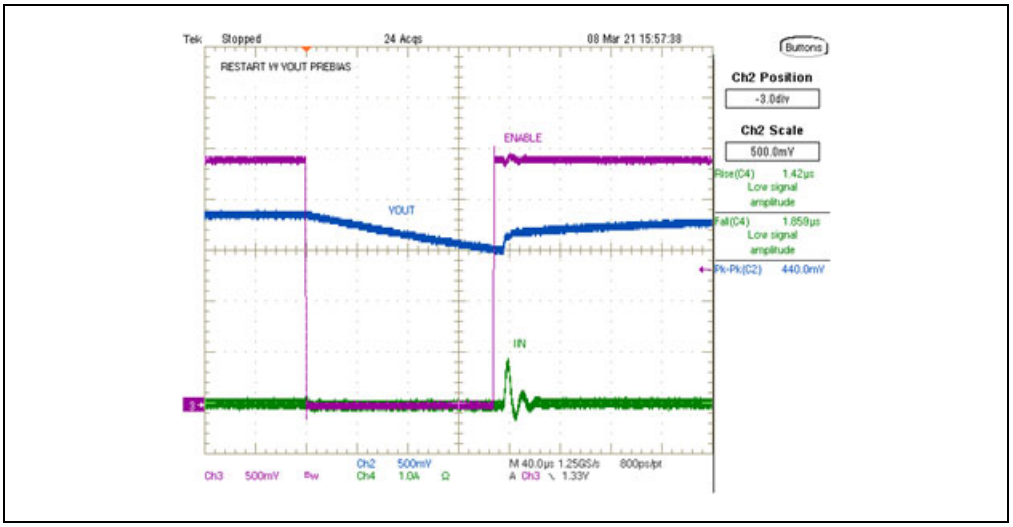


FIGURE C-13: *Restart with V_{OUT} Pre-bias.*

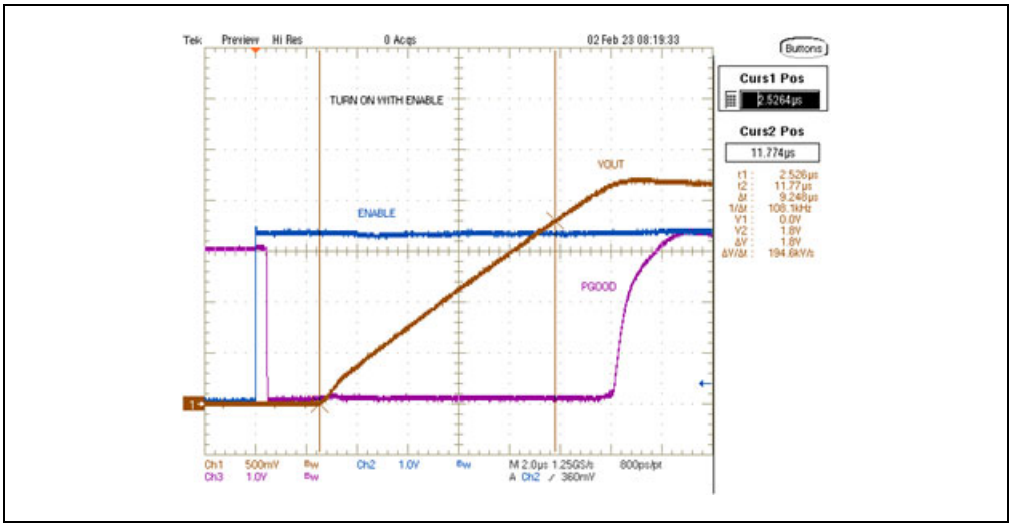


FIGURE C-14: *Turn ON time with Enable at 25°C.*

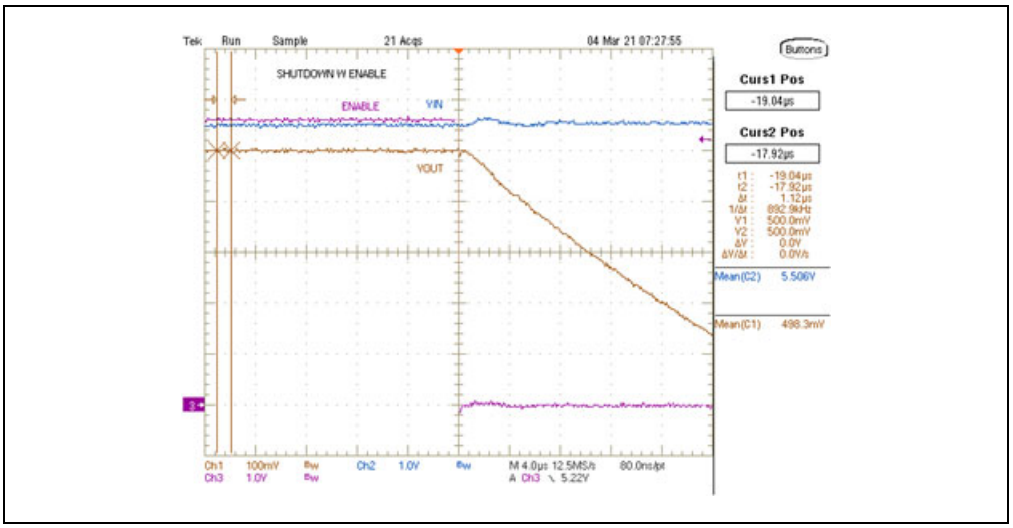


FIGURE C-15: *Shutdown with Enable at 25°C.*

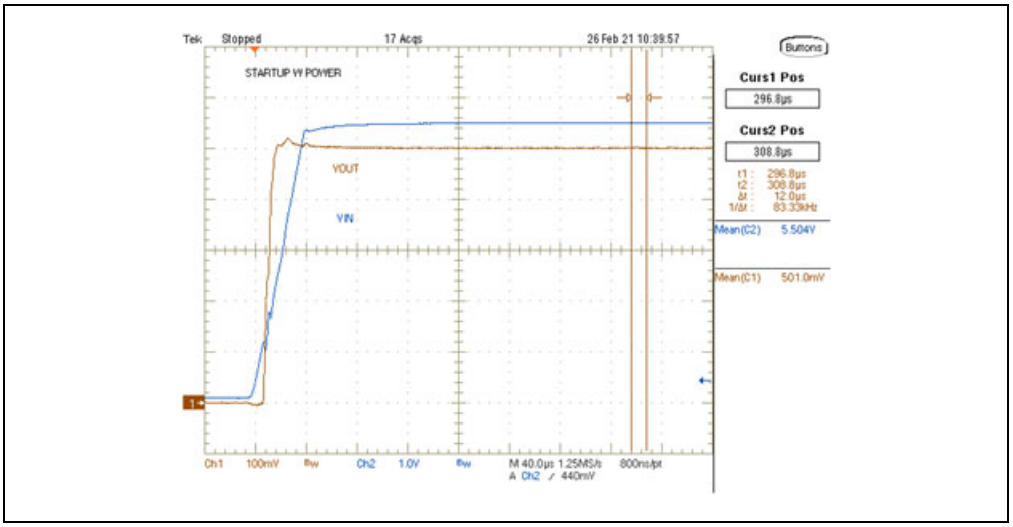


FIGURE C-16: *Startup with Power at 25°C.*

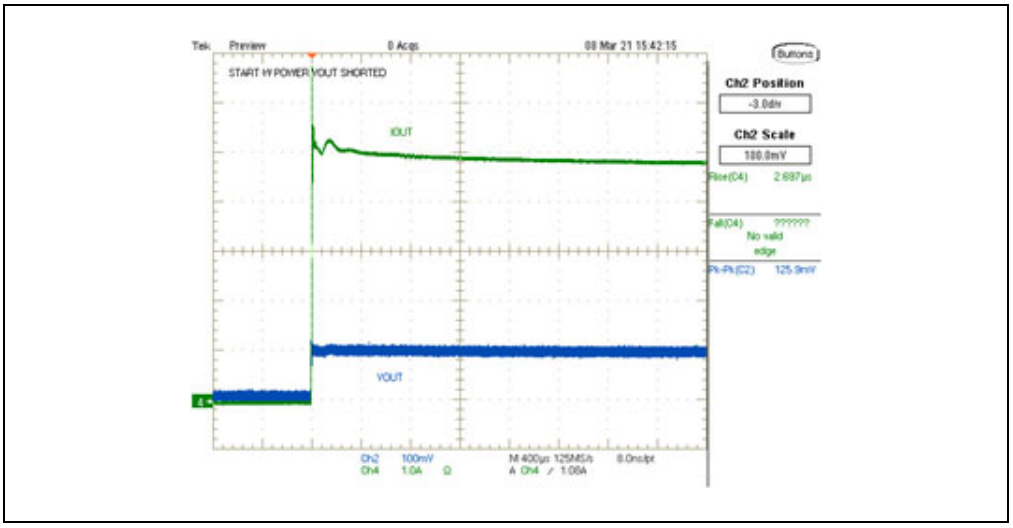


FIGURE C-17: *Startup with Enable V_{OUT} = Shorted to Ground.*

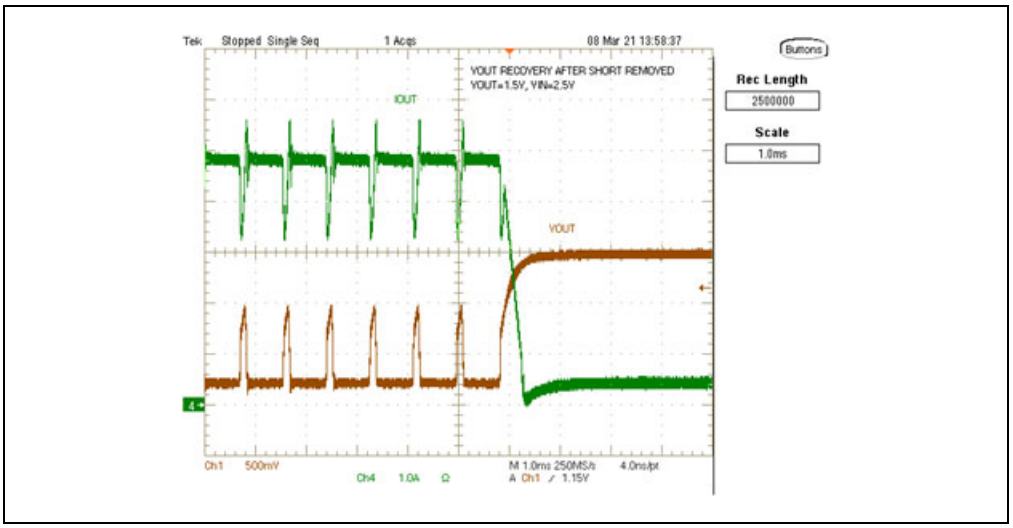


FIGURE C-18: *V_{OUT} Recover after Short to Ground.*

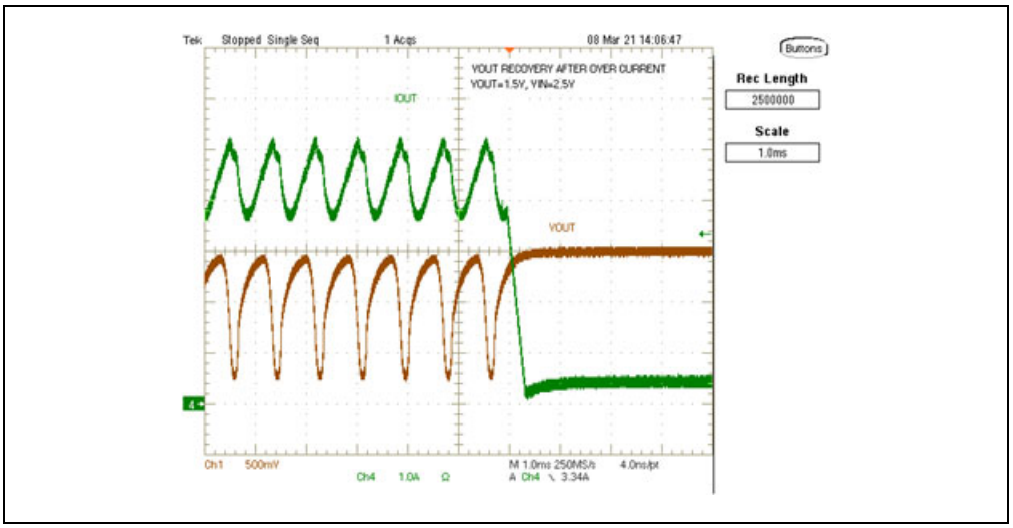


FIGURE C-19: *V_{OUT} Recover after Overcurrent.*

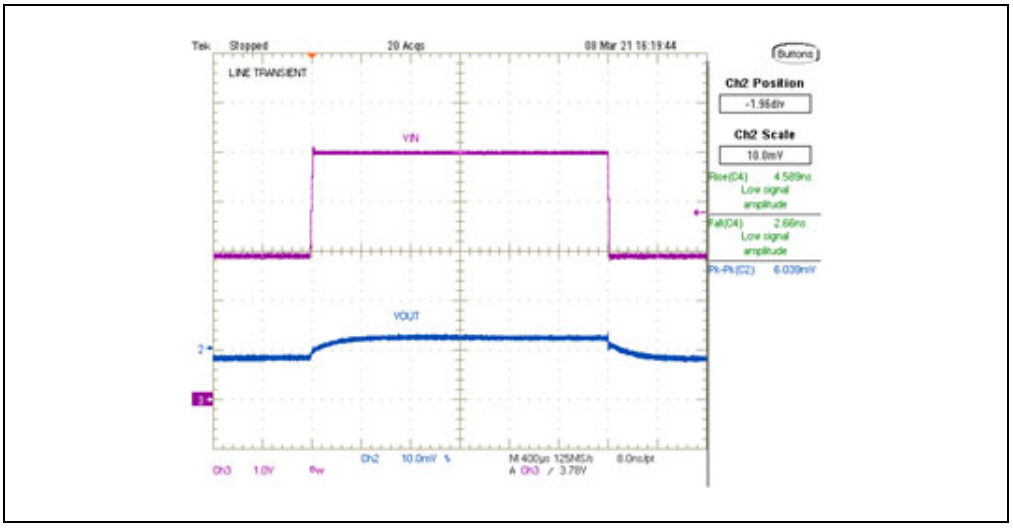


FIGURE C-20: *V_{OUT} Line Transient Response.*

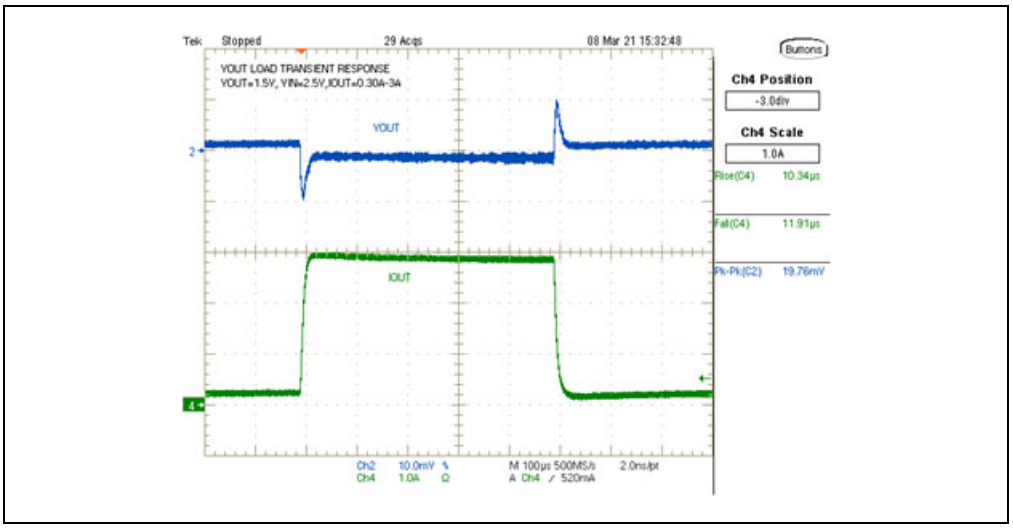


FIGURE C-21: *V_{OUT} Load Step Transient Response 0.3A to 3A.*

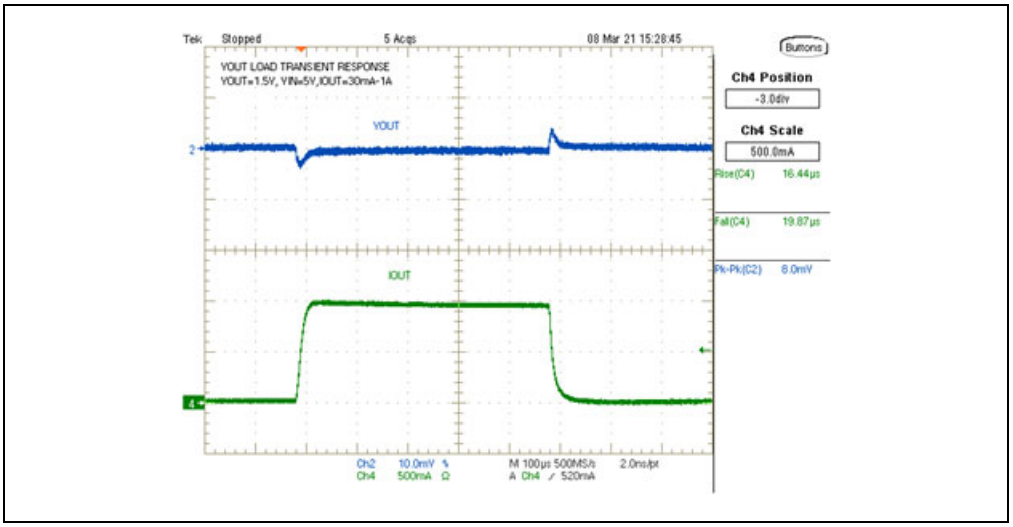


FIGURE C-22: *V_{OUT} Load Step Transient Response 30 mA - 1A.*

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