# MCP16322 Evaluation Board User's Guide

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# MCP16322 EVALUATION BOARD USER'S GUIDE

## Table of Contents

# Preface

## NOTICE TO CUSTOMERS

**All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.**

**Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level of the document.**

**For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.**

## INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP16322 Evaluation Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Customer Support
- Document Revision History

## DOCUMENT LAYOUT

This document describes how to use the MCP16322 Evaluation Board. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP16322 Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with the MCP16322 Evaluation Board and a description of the user's guide.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP16322 Evaluation Board.
- **Appendix B. "Bill of Materials"** – Lists the parts used to build the MCP16322 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 MCP16322 Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

- **MCP16321/2 Data Sheet – *"24V Input, 1A/2A Output, High Efficiency Synchronous Buck Regulator with Power Good Indication"* (DS22285)**

## THE MICROCHIP WEB SITE

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- Field Application Engineer (FAE)
- Technical Support

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Technical support is available through the web site at: http://support.microchip.com.

## DOCUMENT REVISION HISTORY

### Revision A (November 2011)

- Initial Release of this Document.

**NOTES:**

# Chapter 1. Product Overview

## 1.1 INTRODUCTION

This chapter provides an overview of the MCP16322 Evaluation Board and covers the following topics:

- MCP16322 Short Overview
- What is the MCP16322 Evaluation Board?
- MCP16322 Evaluation Board kit contents

## 1.2 MCP16322 SHORT OVERVIEW

The MCP16322 is a highly integrated, high-efficiency, fixed frequency, synchronous, step-down DC-DC converter in a popular 16-pin QFN package that operates from input voltage sources up to 24V. Integrated features include a low resistance high-side switch, low resistance low-side switch, 1.0 MHz fixed-frequency peak-current mode control, internal compensation, power good output, peak current limit, $V_{OUT}$ overvoltage and overtemperature protection. Minimal external components are necessary to develop a complete step-down DC-DC converter power supply. The MCP16322 draws less than 10 µA while disabled.

High converter efficiency is achieved by integrating the current limited, low resistance, high-speed N-Channel MOSFETs and associated drive circuitry. Incorporating both the upper and lower switches reduces the need for external components. High switching frequency minimizes the size of external filtering components resulting in an overall small solution size.

The MCP16322 can supply 2A of continuous current while regulating the output voltage from 0.9V to 5V. 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.

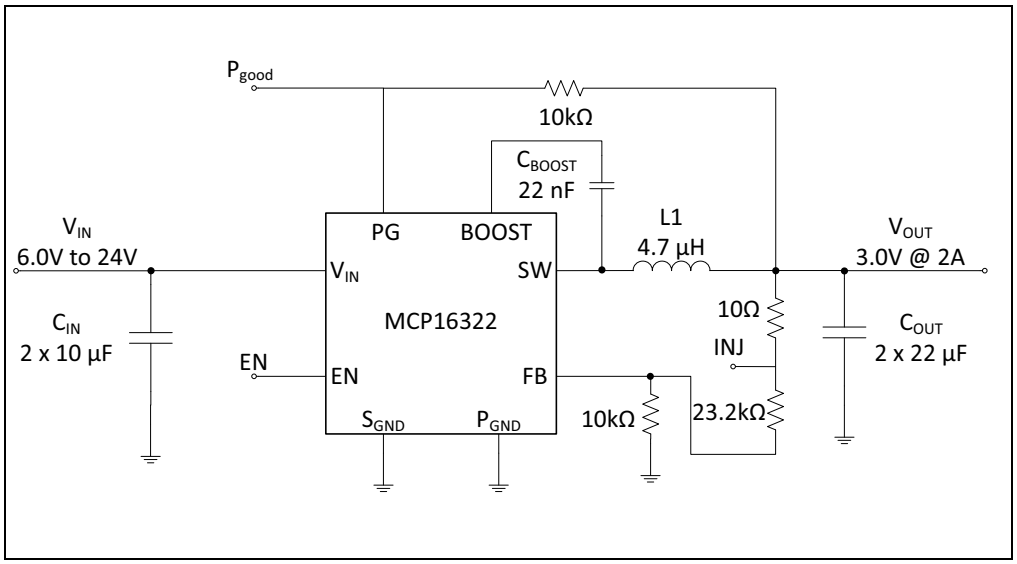



***FIGURE 1-1:*** *Typical MCP16322 Buck Application.*

## 1.3 WHAT IS THE MCP16322 EVALUATION BOARD?

The MCP16322 Evaluation Board is designed to operate from a 6V to 24V input and regulate the output to 3.0V. Test points for input power and load are provided to demonstrate the capability of the MCP16322 Evaluation Board over the entire range. The MCP16322 Evaluation Board was designed using small surface-mount components to show application size for a high-voltage buck design.

## 1.4 MCP16322 EVALUATION BOARD KIT CONTENTS

This MCP16322 Evaluation Board kit includes the following items:

- MCP16322 Evaluation Board, 102-00423
- Important Information Sheet

# Chapter 2. Installation and Operation

## 2.1 INTRODUCTION

### 2.1.1 MCP16322 Features

The MCP16322 devices have been developed to provide high input voltage, high current applications with a precisely regulated rail while operating at high efficiency.

The key features of the MCP16322 include:

- Up to 95% Typical Efficiency
- Input Voltage Range: 6.0V to 24V
- Output Voltage Range: .9V to 5V
- 1.5% Output Voltage Accuracy
- Integrated High-Side N-Channel Switch: 180 mΩ
- Integrated Low-Side N-Channel Switch: 120 mΩ
- 2A Output Current MCP16322
- 1 MHz Fixed Frequency
- Adjustable Output Voltage
- Low Device Shutdown Current
- Peak Current Mode Control
- Internal Compensation
- Stable with Ceramic Capacitors
- Internal Soft-Start
- Cycle by Cycle Peak Current Limit
- Under Voltage Lockout (UVLO): 5.75V (typical)
- Output Overvoltage Protection
- Overtemperature Protection
- Available Package: QFN-16

A high-performance peak-current mode control system is used to deliver a fast response to sudden line and load changes.

### 2.1.2 MCP16322 Evaluation Board Features

The MCP16322 Evaluation Board is developed to demonstrate how the MCP16322 device operates as a Buck Topology over a wide input voltage and load range. Test points are provided for input and output, allowing the MCP16322 Evaluation Board to be connected directly to a system. Test vias are also included to give the user easy access to the switch, power good, enable and injection nodes for easy evaluation of the device. There are also ancillary vias provided for attaching extra input and output connections. The 2A maximum continuous output current is available over the entire $V_{IN}$ range (6.0V to 24.0V), along with the entire adjustable output voltage range (0.9V to 5.0V).

A copper via, labeled $P_{good}$, connected to the power good pin on the device can be populated to monitor the power good output of the device. The power good pin is externally pulled up to $V_{OUT}$ with a 10 kΩ resistor (R2).

A copper via, labeled INJ, connected between the 10Ω injection resistor (R1) and the $R_{top}$ resistor can be populated to allow a convenient injection point for stability analysis.

A copper via, labeled Enable, connected to the enable input on the device can be populated and used to turn the MCP16322 on and off. Turning the device on (Enable > 2.2V) when the undervoltage lockout threshold is met ($V_{IN}$ > 5.75V), will enable the device. This pin must be pulled low (Enable < 0.8V) to disable the device.

A copper via, labeled SW, connected to the switch node of the device can be populated to analyze the switch node of the device.

## 2.2 GETTING STARTED

The MCP16322 Evaluation Board is fully assembled and tested to evaluate and demonstrate the MCP16322 operational capabilities.

### 2.2.1 Power Input and Output Connection

#### 2.2.1.1 POWERING THE MCP16322 EVALUATION BOARD

The MCP16322 Evaluation Board is fully assembled, tested and ready to begin evaluation. Apply positive input voltage to the $V_{IN}$ terminal and its return to the GND terminal. The maximum input voltage should not exceed 24V. An electronic load or resistive load can be used for evaluation, or the intended system load can be connected. Electronic loads attempt to sink current at 0V during startup; a resistive load or constant resistance is recommended for startup evaluation. Connect the positive voltage terminal of the load to the $V_{OUT}$ terminal on the MCP16322 Evaluation Board and connect the negative or return side of the load to the GND terminal.

#### 2.2.1.2 BOARD TESTING

To test the board:

1. Apply greater than 6V to the input for proper operation; no minimum load is required to regulate the output to 3.0V.
2. The EN input is internally pulled up to a low voltage internal source enabling the device. To disable the device, the EN input can be pulled below 0.8V.
3. The measured output voltage should be 3.0V typical. Adjusting the input voltage and load should not cause the output to vary significantly over the operating range of the converter.

### 2.2.2 How the MCP16322 High-Side Drive Boost Circuit Operates

The MCP16322 integrates both high-side and low-side, low resistance N-Channel MOSFETs. A high-side or floating supply is needed to drive the gate of the high-side N-Channel MOSFET above the input voltage to turn it on. The evaluation board uses the output voltage to charge the boost cap while the inductor current flows. Prior to startup, there is no inductor current, so an internal pre-charge circuit charges the boost cap up to a minimum threshold. Once charged, the N-Channel can be turned on, ramping current into the inductor.

The worst case operating conditions for charging the boost capacitor occur at minimum $V_{IN}$ and no load. At minimum $V_{IN}$ (6V), there is not enough headroom to pre-charge the boost cap to a high value. At no load, the converter is operating at a minimum or very low duty cycle, putting a small amount of current into the inductor. When the switch turns off, the inductor current decays very quickly, resulting in a short time to recharge the boost capacitor.

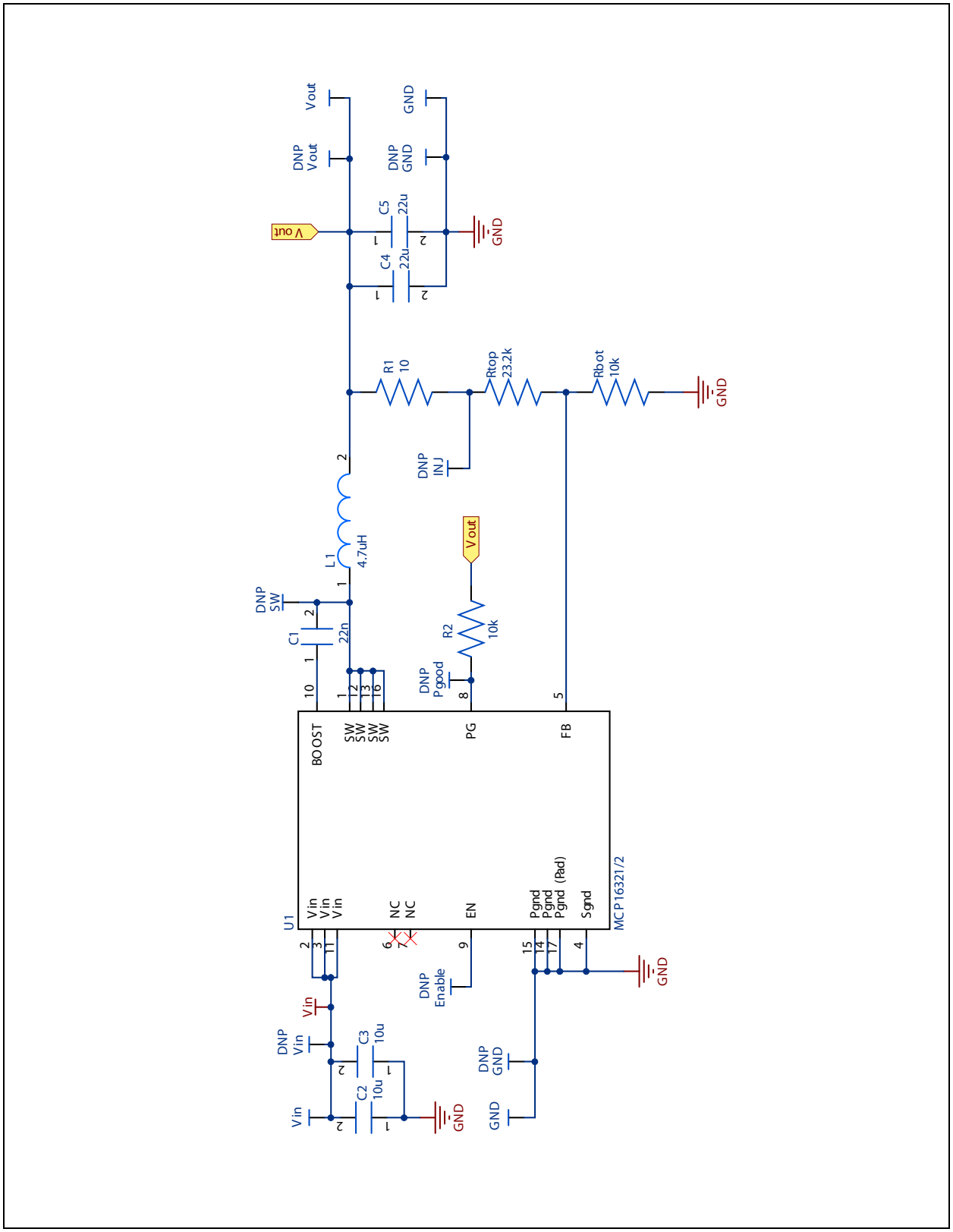
# Appendix A. Schematic and Layouts

## A.1 INTRODUCTION

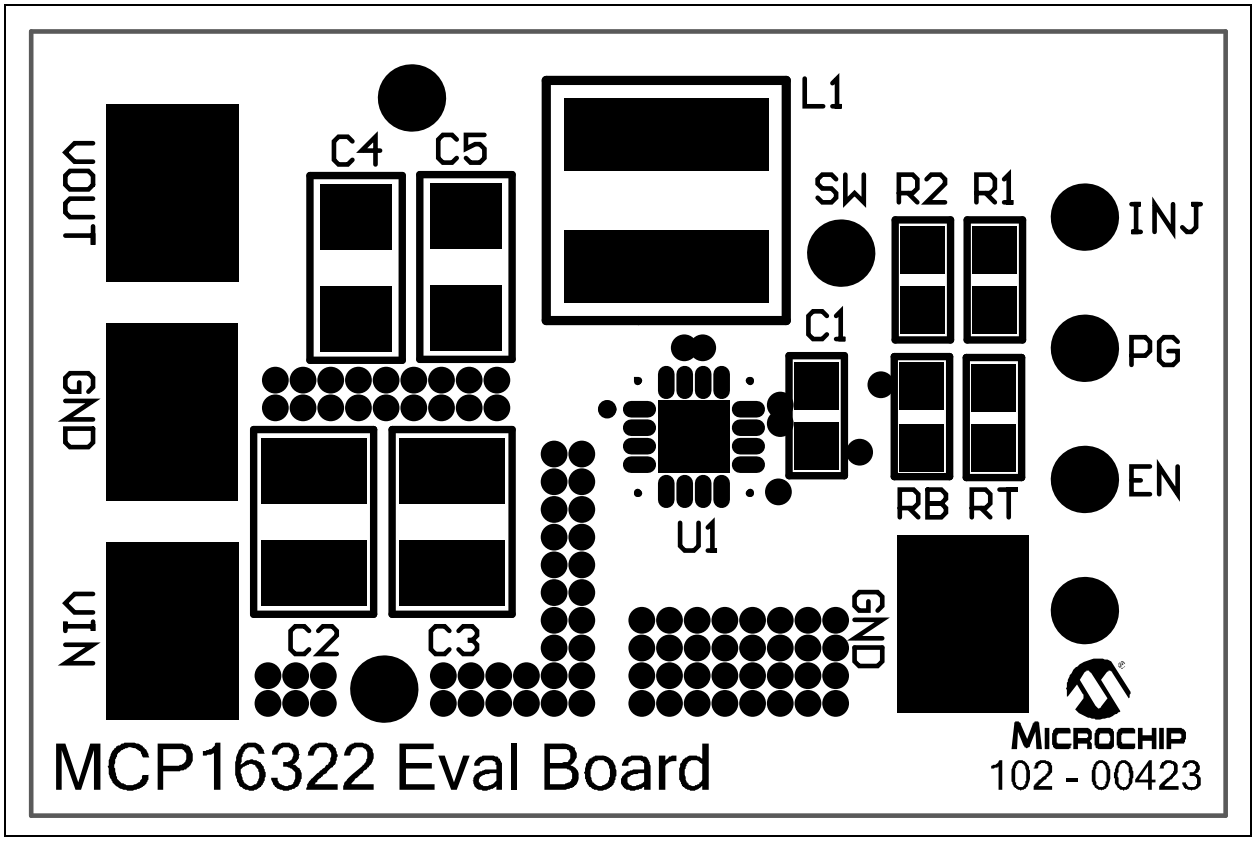
This appendix contains the following schematics and layouts for the MCP16322 Evaluation Board:

- Board – Schematic
- Board – Top Layer
- Board – Top Copper Layer
- Board – Bottom Copper Layer

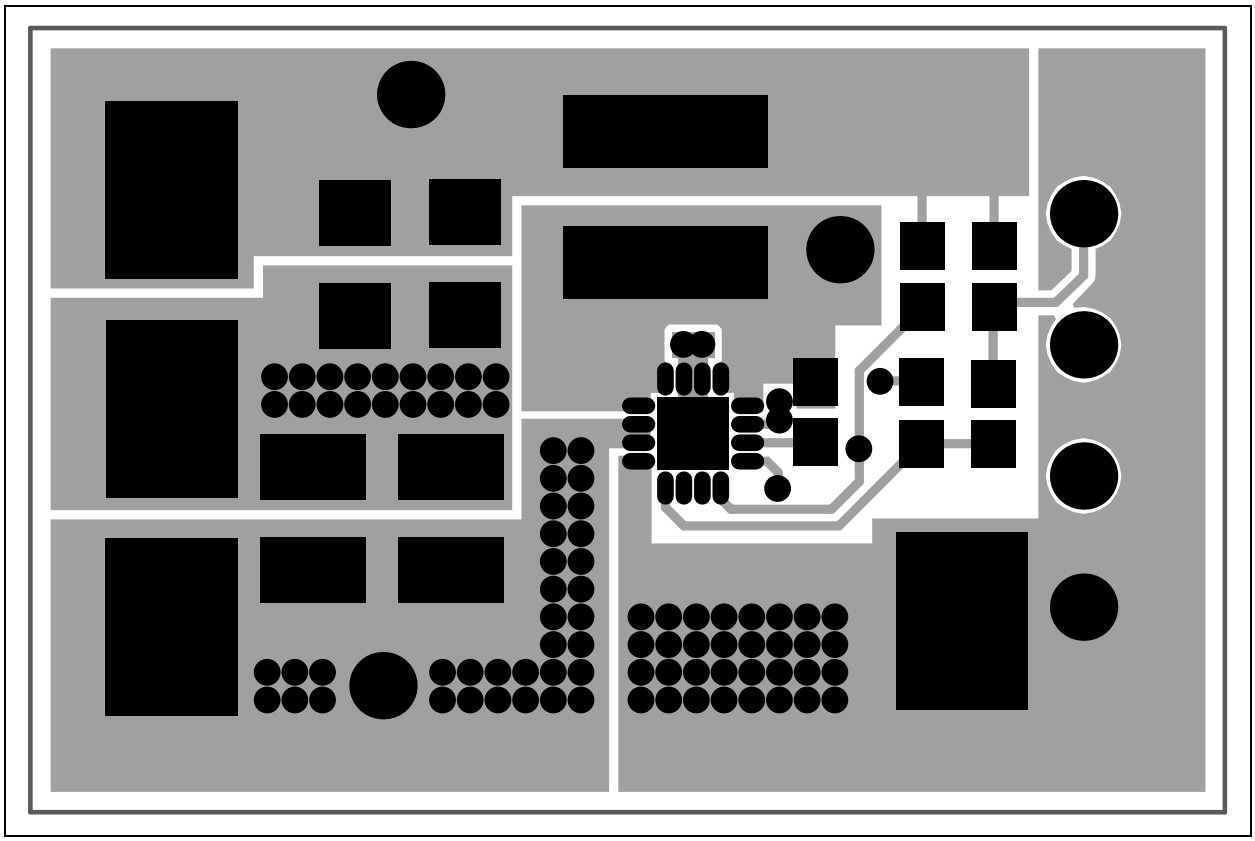
## A.2 BOARD – SCHEMATIC



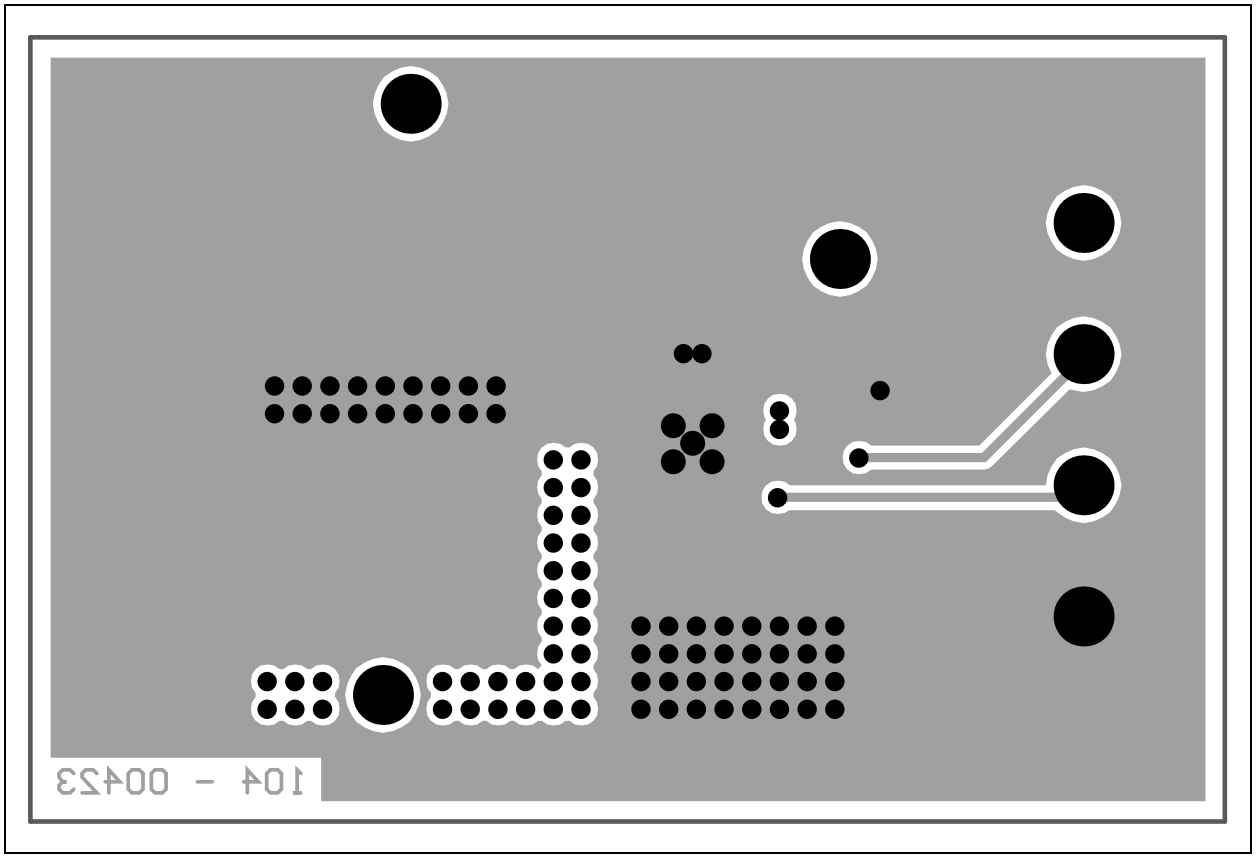
## A.3 BOARD – TOP LAYER




## A.4 BOARD – TOP COPPER



## A.5 BOARD – BOTTOM COPPER



# Appendix B. Bill of Materials

**TABLE B-1: BILL OF MATERIALS (BOM)**

| Qty | Reference | Description | Manufacturer | Part Number |
|---|---|---|---|---|
| 1 | C1 | CAP 22000pF 25V CERAMIC X7R 0603 10% | AVX Corporation | 0603YC104KAT2A |
| 2 | C2, C3 | CAP 10uF 35V CERAMIC X7R 1210 20% | Taiyo Yuden | GMK325AB7106MM-T |
| 2 | C4, C5 | CAP 22uF 6.3V CERAMIC X7R 1206 10% | Murata | GCM31CR70J226KE23L |
| 1 | L1 | XAL5030 4.7uH Shielded Power Inductor | Coilcraft | XAL5030-472MEB |
| 1 | PCB | MCP16322 6V to 24V VIN, 3.3V Printed Circuit Board | Microchip Technology Inc. | 104-00423 |
| 1 | R1 | RES 10.0 OHM 1/10W 1% 0603 SMD | Yageo | RC0603FR-0710RL |
| 2 | R2, Rbot | RES 10.0K OHM 1/10W 1% 0603 SMD | Yageo | RC0603FR-0710KL |
| 1 | Rtop | RES 23.2K OHM 1/10W 1% 0603 SMD | Yageo | RC0603FR-0723K2L |
| 1 | U1 | MCP16322 High Input Buck Converter QFN16 | Microchip Technology Inc. | MCP16322 |
| 4 | VIN, VOUT, GND, GND | PC TEST POINT COMPACT SMT | Keystone | 5016 |

**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.

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