MIC2127A Evaluation Board User's Guide

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The development/evaluation tool is designed to be used for research and development in a laboratory environment. This development/evaluation tool is not a Finished Appliance, nor is it intended for incorporation into Finished Appliances that are made commercially available as single functional units to end users under EU EMC Directive 2004/108/EC and as supported by the European Commission's Guide for the EMC Directive 2004/108/EC (8th February 2010).
This development/evaluation tool complies with EU RoHS2 Directive 2011/65/EU.
This development/evaluation tool, when incorporating wireless and radio-telecom functionality, is in compliance with the essential requirement and other relevant provisions of the R&TTE Directive 1999/5/EC and the FCC rules as stated in the declaration of conformity provided in the module datasheet and the module product page available at www.microchip.com.
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Derek Carlson
VP Development Tools

11-NOV-16
Date

NOTES:

MIC2127A 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 MIC2127A Evaluation Board. Items discussed in this chapter include:

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

DOCUMENT LAYOUT

This document describes how to use the MIC2127A Evaluation Board. The document is organized as follows:

- **Chapter 1. “Product Overview”** – Important information about the MIC2127A Evaluation Board.
- **Chapter 2. “Installation and Operation”** – Includes instructions on how to get started with the MIC2127A Evaluation Board.
- **Appendix A. “Schematic and Layouts”** – Shows the schematic and layout diagrams for the MIC2127A Evaluation Board.
- **Appendix B. “Bill of Materials (BOM)”** – Lists the parts used to build the MIC2127A Evaluation Board.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

<table>
<tr><th>Description</th><th>Represents</th><th>Examples</th></tr>
<tr><td colspan="3">Arial font:</td></tr>
<tr><td rowspan="2">Italic characters</td><td>Referenced books</td><td>MPLAB® IDE User’s Guide</td></tr>
<tr><td>Emphasized text</td><td>...is the only compiler...</td></tr>
<tr><td rowspan="3">Initial caps</td><td>A window</td><td>the Output window</td></tr>
<tr><td>A dialog</td><td>the Settings dialog</td></tr>
<tr><td>A menu selection</td><td>select Enable Programmer</td></tr>
<tr><td>Quotes</td><td>A field name in a window or dialog</td><td>“Save project before build”</td></tr>
<tr><td>Underlined, Italic text with right angle bracket</td><td>A menu path</td><td><u>File>Save</u></td></tr>
<tr><td rowspan="2">Bold characters</td><td>A dialog button</td><td>Click OK</td></tr>
<tr><td>A tab</td><td>Click the Power tab</td></tr>
<tr><td>N‘Rnnnn</td><td>A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.</td><td>4‘b0010, 2‘hF1</td></tr>
<tr><td>Text in angle brackets < ></td><td>A key on the keyboard</td><td>Press <Enter>, <F1></td></tr>
<tr><td colspan="3">Courier New font:</td></tr>
<tr><td rowspan="7">Plain Courier New</td><td>Sample source code</td><td><code>#define START</code></td></tr>
<tr><td>Filenames</td><td><code>autoexec.bat</code></td></tr>
<tr><td>File paths</td><td><code>c:\mcc18\h</code></td></tr>
<tr><td>Keywords</td><td><code>_asm, _endasm, static</code></td></tr>
<tr><td>Command-line options</td><td><code>-Opa+, -Opa-</code></td></tr>
<tr><td>Bit values</td><td><code>0, 1</code></td></tr>
<tr><td>Constants</td><td><code>0xFF, ‘A’</code></td></tr>
<tr><td>Italic Courier New</td><td>A variable argument</td><td><code>file</code><code>.o</code>, where <code>file</code> can be any valid filename</td></tr>
<tr><td>Square brackets [ ]</td><td>Optional arguments</td><td><code>mcc18 [options] </code><code>file</code>
<code>[options]</code></td></tr>
<tr><td>Curly brackets and pipe character: { | }</td><td>Choice of mutually exclusive arguments; an OR selection</td><td><code>errorlevel {0|1}</code></td></tr>
<tr><td rowspan="2">Ellipses...</td><td>Replaces repeated text</td><td><code>var_name [,</code>
<code>var_name...]</code></td></tr>
<tr><td>Represents code supplied by user</td><td><code>void main (void)</code>
<code>{ ...</code>
<code>}</code></td></tr>
</table>

RECOMMENDED READING

This user's guide describes how to use MIC2127A Evaluation Board. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource:

- **MIC2127A Data Sheet - "*75V, Synchronous Buck Controller Featuring Adaptive On-Time Control*" (DS20005676)**

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
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- Field Application Engineer (FAE)
- Technical Support

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Technical support is available through the website at:

http://www.microchip.com/support.

REVISION HISTORY

Revision A (December 2016)

- Original release of this document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This document describes the MIC2127A Evaluation Board and covers the following topics:

- MIC2127A Evaluation Board Overview
- MIC2127A Evaluation Board Features
- What the MIC2127A Evaluation Board Kit Contains

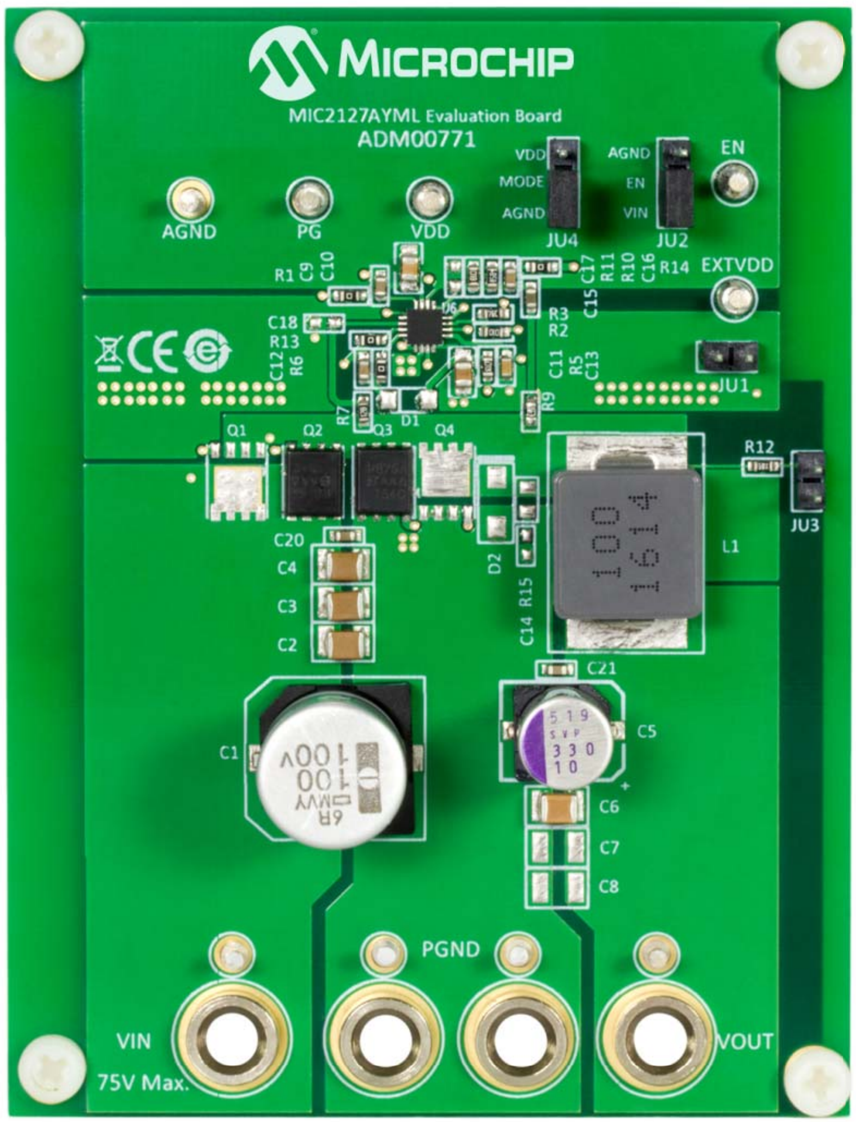


FIGURE 1-1: MIC2127A Evaluation Board Overview.

1.2 MIC2127A EVALUATION BOARD OVERVIEW

The MIC2127A is a constant-frequency, synchronous buck controller featuring a unique adaptive on-time control architecture and HyperLight Load® mode. The MIC2127A operates over an input supply range of 4.5V to 75V. The output voltage is adjustable from 0.6V to 30V with an ensured accuracy of ±1%. The device features programmable switching frequency from 270 kHz to 800 kHz.

1.3 MIC2127A EVALUATION BOARD FEATURES

The MIC2127A Evaluation Board features:

- Wide input voltage range from 9V to 75V
- 5V preset output voltage
- Up to 5A load current support
- 300 KHz switching frequency
- Light load mode selection jumper (JU4)
- An option to supply the MIC2127A internal circuits bias power and gate drive from output voltage (JU1)
- Enable jumper to enable/disable the MIC2127A
- Power Good (PG) test point

1.4 WHAT THE MIC2127A EVALUATION BOARD KIT INCLUDES

The MIC2127A Evaluation Board kit includes the following items:

- MIC2127A Evaluation Board (ADM00771)
- Important Information Sheet

Chapter 2. Installation and Operation

2.1 SYSTEM AND CONFIGURATION REQUIREMENTS

The MIC2127A Evaluation Board requires the following:

- DC Power supply which is rated for 9V to 75V with at least 5A current capability.
- Load that can sink up to 5A. The load can either be a resistive or an active load.
- A multimeter or a voltmeter for output voltage measurement

Note: The MIC2127A Evaluation Board does not have reverse polarity protection. Applying a negative voltage to the VIN and PGND terminals may damage the device. The maximum input voltage for the board is 75V. Exceeding 75V could damage the device.

2.2 BOARD SETUP

Follow these steps prior to using the MIC2127A Evaluation Board:

1. Set the DC power supply output voltage within the range of 9V to 75V. Do not connect the DC power supply until Step 4.
2. Set the supply current limit to 0.1A.
3. Disable the DC power supply
4. Connect the positive terminal of the power supply to the VIN connector and the negative terminal to the PGND terminal on the evaluation board. Do not apply power until Step 9.
5. Connect a voltmeter across the VOUT and PGND terminals.
6. Ensure that a shunt is placed between the EN and VIN on jumper JU2.
7. Ensure that a shunt is placed either between MODE and VDD or MODE and AGND, on the jumper JU4.
8. Turn on the power supply and verify that the output voltage is regulated to 5V ± 5%.
9. Disable the supply.
10. Increase the supply current limit to at least 5A and connect load across the VOUT and PGND terminals. In case of resistive load, ensure that the resistor power rating is high enough to dissipate the output power
11. Turn on the supply and verify the output voltage is regulated to 5V ± 5%.

2.3 CIRCUIT DESCRIPTION

This section describes the working principles and limitations that should be taken into account when using the MIC2127A Evaluation Board.

2.3.1 Enabling and Disabling the MIC2127A Evaluation Board

The MIC2127A features a logic level enable pin (EN) which can be used to enable/disable switching. Table 2-1 shows the jumper JU2, setting for enabling/disabling the MIC2127A switching:

TABLE 2-1: ENABLE/DISABLE JUMPER (JU2) SETTING

Shunt Position	Enable/Disable
Between EN and VIN	Enabled
Between EN and AGND	Disabled

2.3.2 Selecting the Light Load Operating Mode (MODE)

The MIC2127A features a MODE pin which allows the user to select either continuous conduction mode or HyperLight Load (HLL) mode at light loads. Continuous conduction mode results in almost constant switching frequency over the entire load current range. HLL mode results in higher efficiency at light loads by varying the switching frequency with load current.

Table 2-2 shows the jumper JU4, setting for selecting light load mode.

TABLE 2-2: LIGHT LOAD MODE JUMPER (JU4) SETTING

Shunt Position	Enable/Disable
Between MODE and VDD	Continuous Conduction Mode
Between MODE and AGND	Hyper Light Load Mode

2.3.3 Auxiliary Bootstrap LDO (EXTVDD)

The MIC2127A features an auxiliary bootstrap LDO which improves the system efficiency by supplying the MIC2127A internal circuit bias power and gate drivers from the converter output voltage. This LDO is enabled when the voltage on the EXTVDD pin is above 4.6V (typical) and at the same time, the main LDO which operates from VIN, is disabled to reduce power consumption.

Place a shunt on the JU1 jumper to supply the MIC2127A internal circuits bias power and gate drivers from the output of the converter.

2.3.4 Setting the Output Voltage

The output voltage on the MIC2127A Evaluation Board is determined by the feedback divider as given in Equation 2-1:

EQUATION 2-1: EQUATION 1

$$V_{OUT} = V_{FB} \times \left(1 + \frac{R10}{R11}\right)$$

The MIC2127A output is preset to 5V. All other voltages can be set by modifying R11 value according to Equation 2-2:

EQUATION 2-2: EQUATION 2

$$R11 = \frac{R10}{\frac{V_{OUT}}{V_{FB}} - 1}$$

where:

V_{FB} = 0.6V

For output voltage higher than 5V, output capacitors and EXTVDD pin bypass capacitor (C13) of voltage rating higher than the set output voltage should be used.

2.3.5 SW Node

Test point JU3 (VSW) is placed for monitoring the switching waveform, one of the most critical waveforms for the converter.

2.3.6 Current Limit

The MIC2127A Evaluation Board uses the low-side MOSFET $R_{DS(ON)}$ to sense inductor current. In each switching cycle of the MIC2127A converter, the inductor current is sensed by monitoring the voltage across the low-side MOSFET during the OFF period of the switching cycle during which low-side MOSFET is ON. An internal current source of 100 µA generates a voltage across the external current limit setting resistor R7 as show in Figure 2-1.

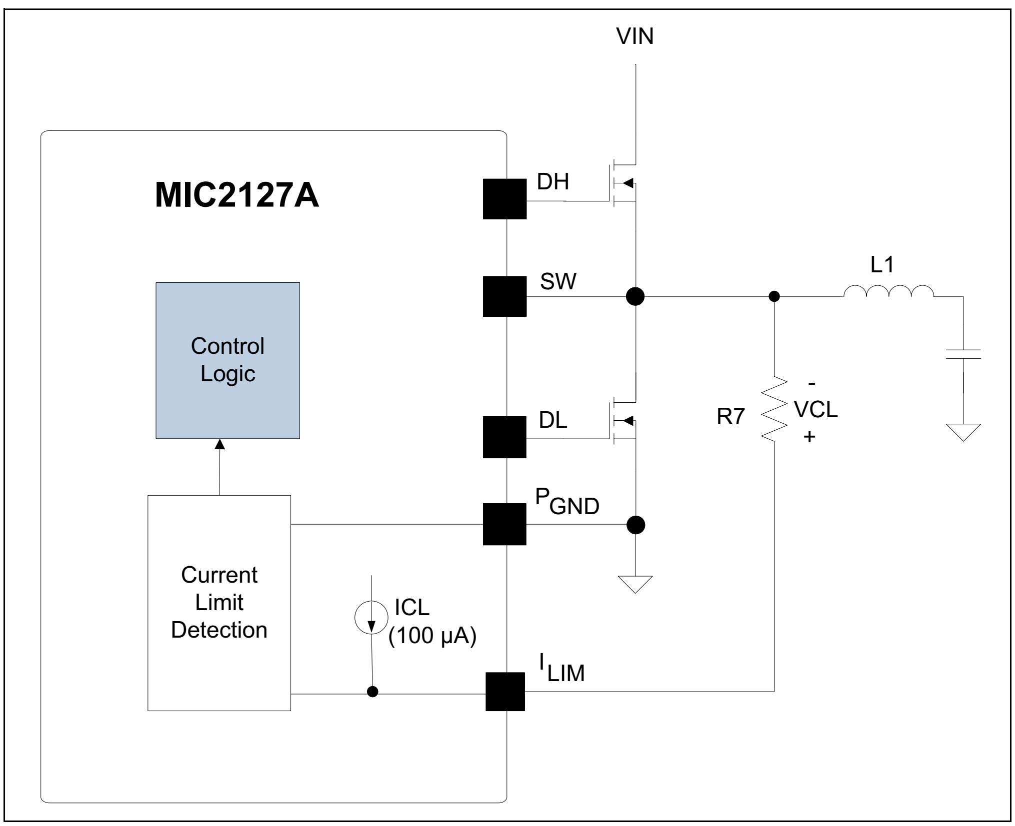


FIGURE 2-1: *Switching Frequency Adjustment.*

The ILIM pin voltage (V_{ILIM}) is the difference of the voltage across the low-side MOSFET and the voltage across the resistor (VCL). The sensed voltage V_{ILIM} is compared with the power ground (P_{GND}) after a blanking time of 150 ns.

If the absolute value of the voltage drop across the low-side MOSFET is greater than the absolute value of the voltage across the current setting resistor (VCL), the MIC2127A triggers the current limit event. Consecutive eight current limit events trigger the Hiccup mode. The hiccup sequence, including the soft start, reduces the stress on the switching field-effect transistors (FETs) and protects the load and supply from severe short conditions.

The current limit can be programmed by modifying the R7 resistor according to Equation 2-3:

EQUATION 2-3: EQUATION 3

$$R_7 = \frac{\left(I_{CLIM} + \frac{\Delta IL_{PP}}{2}\right) \times R_{DS(ON)} + V_{offset}}{I_{CL}}$$

where:

I_{CLIM}	=	Desired current limit
ΔIL_{PP}	=	Inductor peak-to-peak ripple current
$R_{DS(ON)}$	=	On resistance of low-side power MOSFET
V_{offset}	=	Current-limit comparator offset. Maximum value is +15 mV.
I_{CL}		Current-limit source current. Typical value is 100 µA.

It is mandatory to make sure that the peak inductor current during soft start, which includes the output capacitor charging current along with load current, is under the current limit, otherwise the supply will go in Hiccup mode and may not finish the soft start successfully.

The MOSFET $R_{DS(ON)}$ varies 30% to 40% with temperature. Therefore, it is recommended to add a 30% margin to I_{CL} in the above equation to avoid false current limiting due to increased MOSFET junction temperature rise. It is also recommended to connect the SW pin directly to the drain of the low-side MOSFET to accurately sense the MOSFET's $R_{DS(ON)}$.

To improve the current limit variation, the MIC2127A adjusts the internal current limit source current (ICL) at a rate of 0.3 µA/°C when the MIC2127A junction temperature changes to compensate the $R_{DS(ON)}$ variation of external low side MOSFET. The effectiveness of this method depends on the thermal gradient between the MIC2127A and the external low side MOSFET. The lower the thermal gradient is, the better the current limit variation is.

2.3.7 Setting the Switching Frequency

The MIC2127A is an adjustable-frequency, synchronous buck controller. The switching frequency can be adjusted between 270 kHz and 800 kHz by changing the resistor divider network consisting of R2 and R3.

The following formula provides the estimated switching frequency:

EQUATION 2-4: EQUATION 4

$$f_{SW} = f_o \times \frac{R3}{R2 + R3}$$

where:

f_o = Switching Frequency when R2 is 100K and R3 is open, f_O is typically 800 kHz. For a more precise setting, it is recommended to use the Switching Frequency graph from the data sheet.

The evaluation board design is optimized for a switching frequency of 300 kHz. If the switching frequency is programmed to either lower end or higher end, the design needs optimization. The switching frequency adjustment is depicted in Figure 2-2:

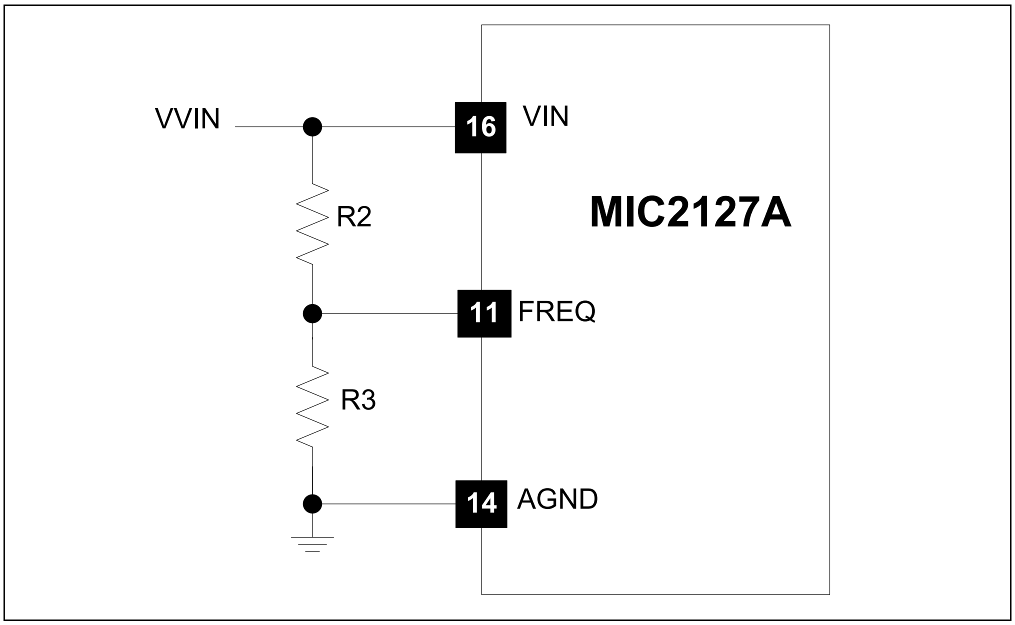


FIGURE 2-2: *Switching Frequency Adjustment.*

2.3.8 Loop Gain Measurement

The resistor R14, which is in series with the feedback divider, can be used for loop gain measurements. For loop gain measurements, replace R14 by a 20Ω to 50Ω resistor and apply network analyzer signal source across it. Use the end of R14, which is connected to VOUT, with respect to A_{GND} as output and the other end of R14, with respect to A_{GND} as input for loop gain measurement.

NOTES:

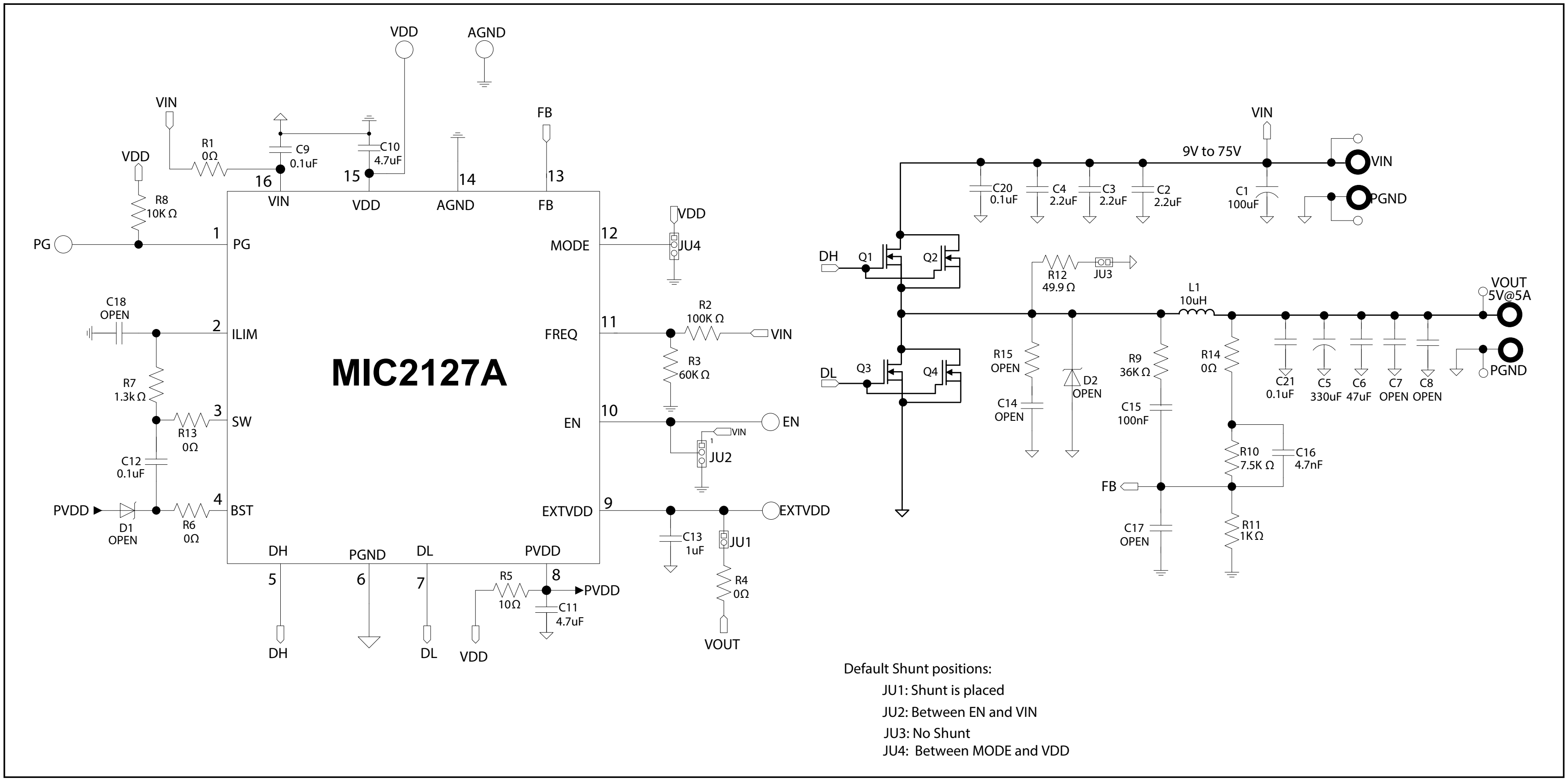
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

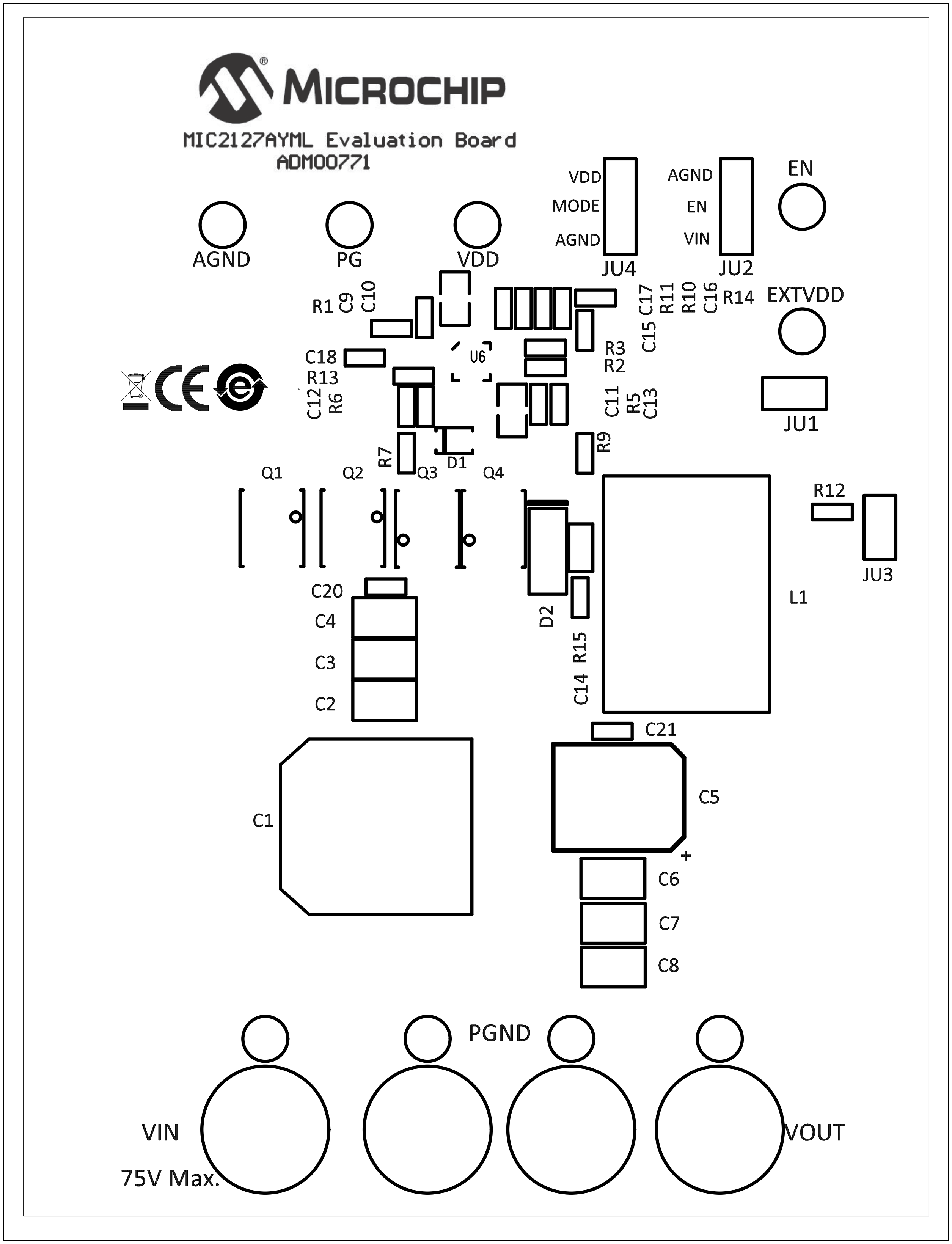
This appendix contains the following schematics and layouts for the MIC2127A Evaluation Board:

- Board – Schematic
- Board – Top Silk Layer
- Board – Top Copper Layer
- Board – Mid Copper Layer 1
- Board – Mid Copper Layer 2
- Board – Bottom Copper Layer
- Board – Bottom Silk Layer

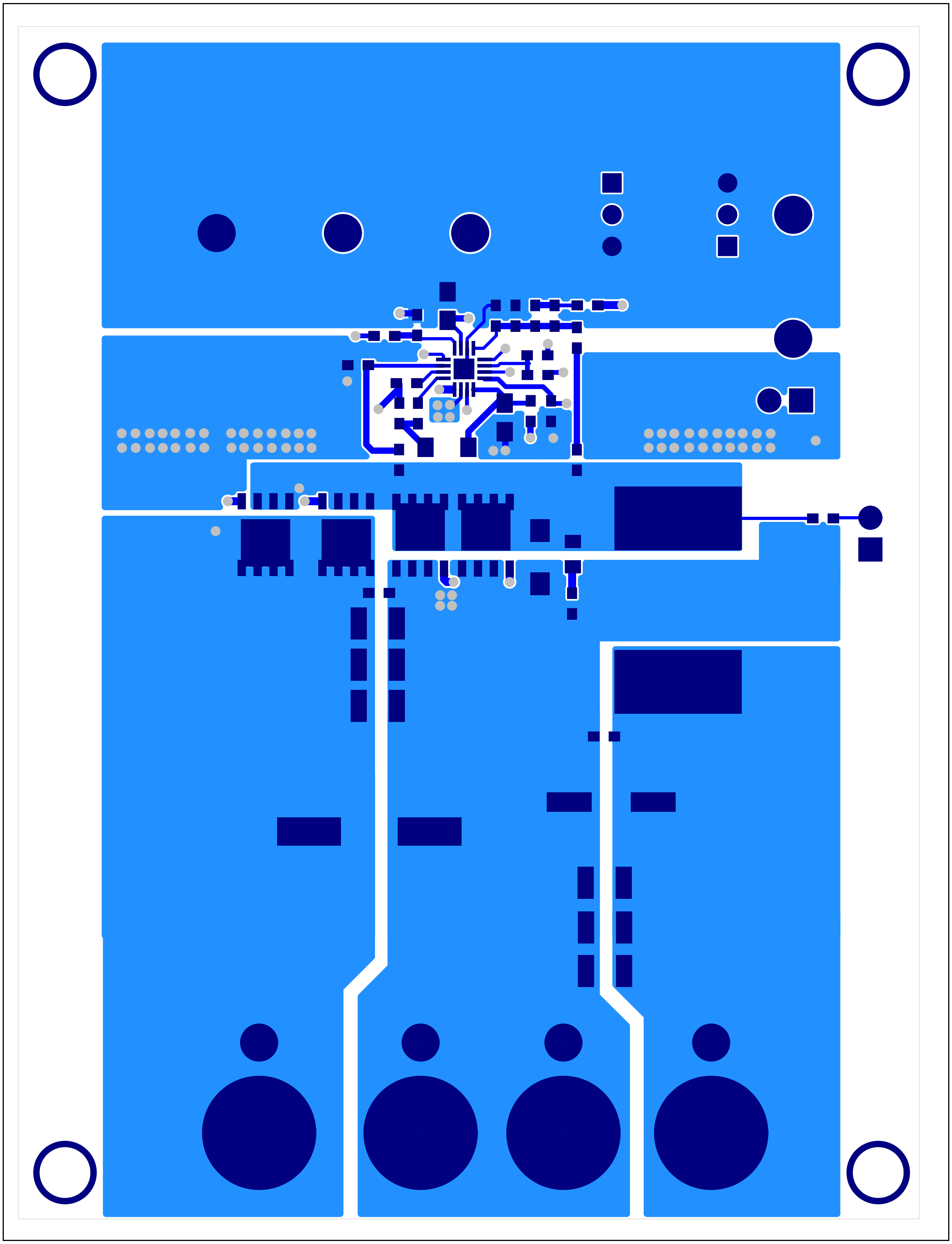
A.2 BOARD – SCHEMATIC



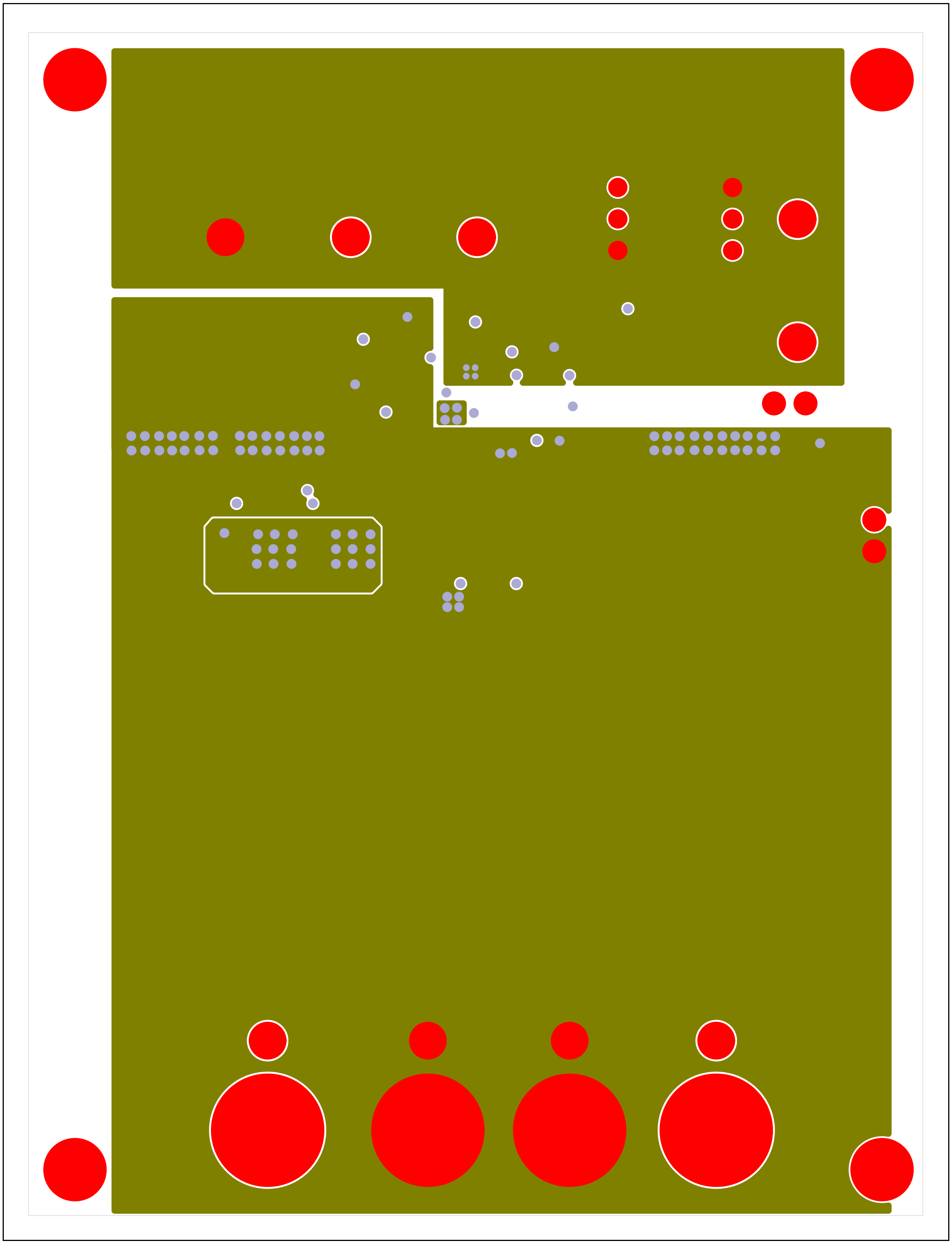
A.3 BOARD – TOP SILK LAYER



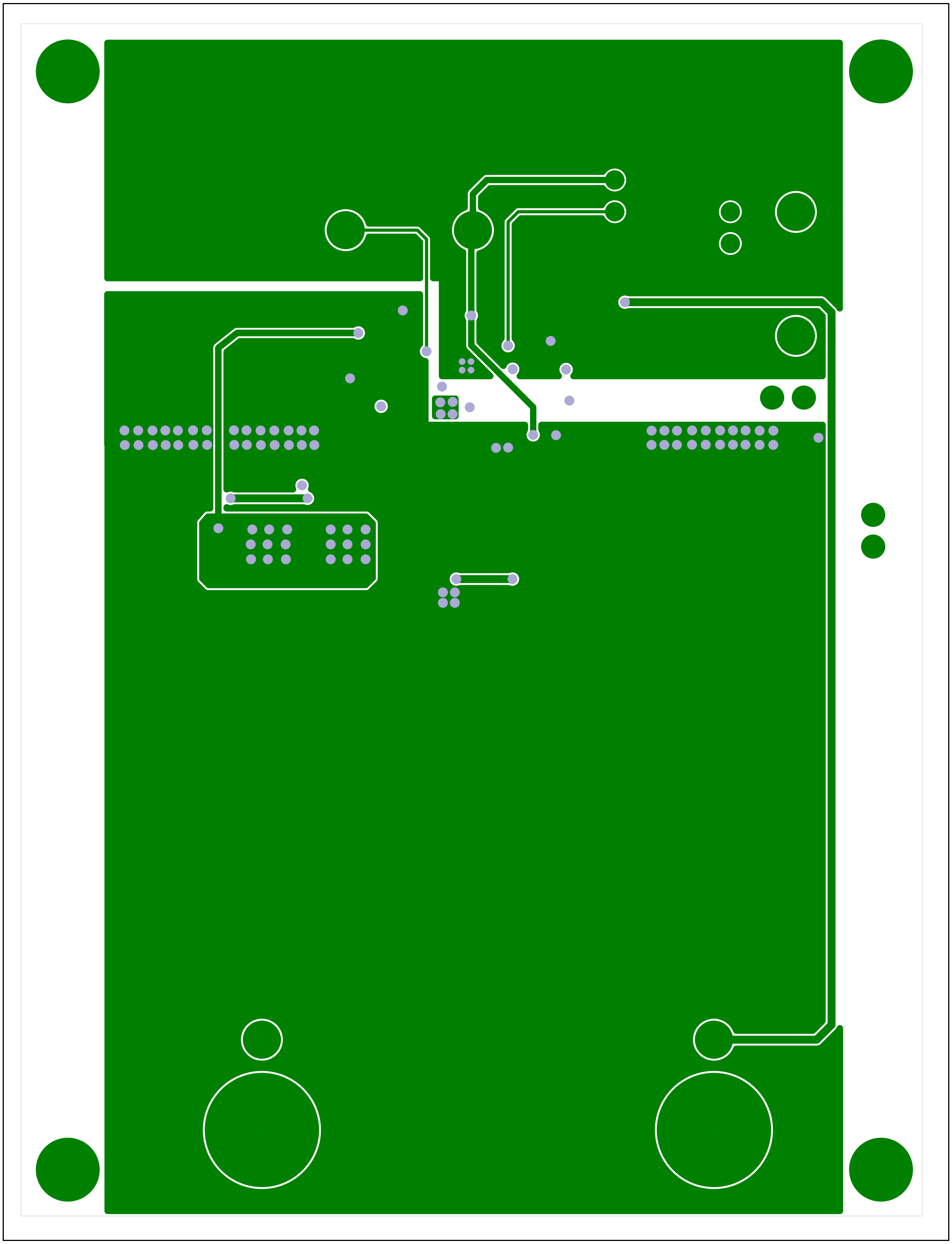
A.4 BOARD – TOP COPPER LAYER



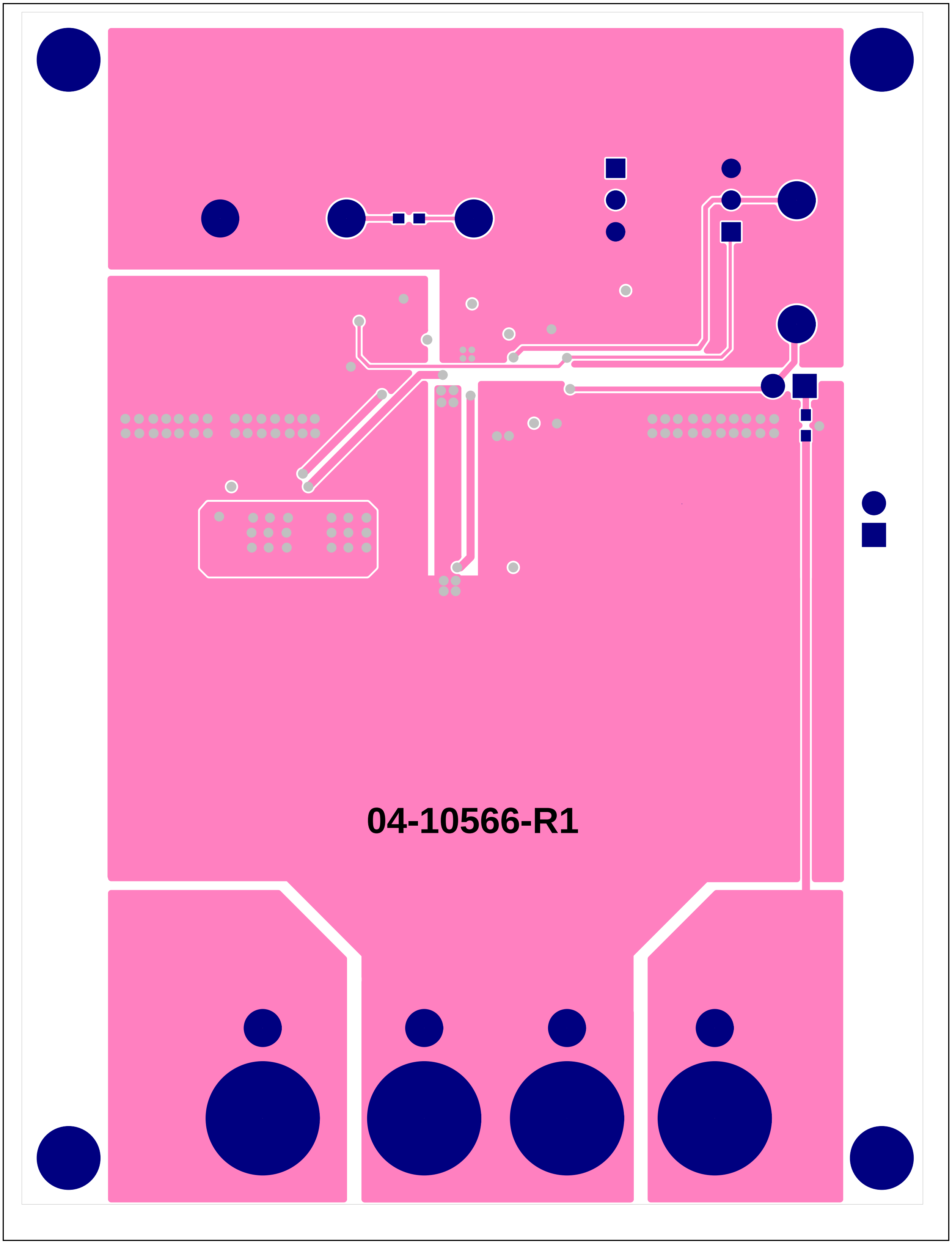
A.5 BOARD – MID COPPER LAYER 1



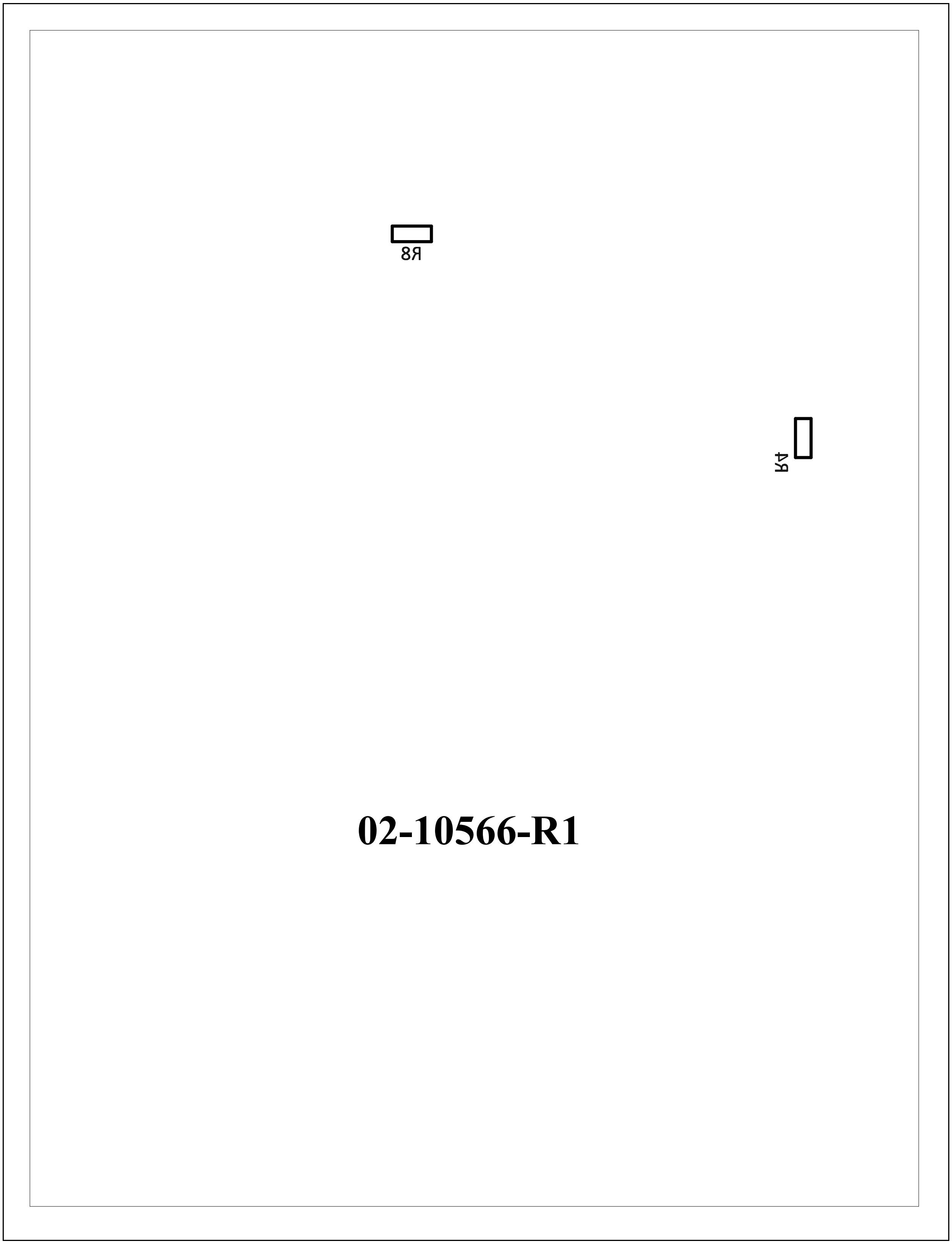
A.6 BOARD – MID COPPER LAYER 2



A.7 BOARD – BOTTOM COPPER LAYER



A.8 BOARD – BOTTOM SILK LAYER



Appendix B. Bill of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
1	C1	Capacitor electrolytic 100 µF,100V, 20%, 330 mΩ	United Chemi-Con	EMVY101ARA101MKE0S
3	C2, C3, C4	Capacitor ceramic 2.2 µF, X7R, 100V, 10%	Murata Electronics North America, Inc.	GRM32ER72A225K
1	C5	Capacitor electrolytic 330 µF, 10V, 17 mΩ	Panasonic® - ECG	10SVP330M
1	C6	Capacitor ceramic 47 µF, X7R, 10V, 10%	Murata Electronics North America, Inc.	GRM32ER71A476K
3	C9, C15, C20	Capacitor ceramic 0.1 µF, X7R, 100V, 10%	Murata Electronics North America, Inc.	GRM188R72A104K
2	C10, C11	Capacitor ceramic 4.7 µF, X7R, 10V, 10%	Murata Electronics North America, Inc.	GRM21BR71A475KA73K
2	C12, C21	Capacitor ceramic 0.1 µF, X7R, 16V, 10%	Murata Electronics North America, Inc.	GRM188R71C104K
1	C13	Capacitor ceramic 1 µF, X7R, 10V, 10%	Murata Electronics North America, Inc.	GRM188R71A105K
1	C16	Capacitor ceramic 4.7 nF, X7R,1 6V	Murata Electronics North America, Inc.	GRM188R71C472KA
1	PCB	Printed Circuit Board - MIC2127A Evaluation Board	—	**02-10566**
5	R1,R4,R6,R13,R14	0Ω, 0603 size resistor	Yageo Corporation	RC0603FR-070RL
1	R2	100K, 0603 size resistor	Yageo Corporation	RC0603FR-07100KL
1	R3	60K, 0603 size resistor	Yageo Corporation	RC0603FR-0760K4L
1	R5	10Ω, 0603 size resistor	Yageo Corporation	RC0603FR-0710RL
1	R7	1.3K, 0603 size resistor	Yageo Corporation	RC0603FR-071K3L
1	R8	10K, 0603 size resistor	Yageo Corporation	RC0603FR-0710KL
1	R9	36K, 0603 size resistor	Yageo Corporation	RC0603FR-0718KL
1	R10	7.5K, 0603 size resistor	Yageo Corporation	RC0603FR-077K5L
1	R11	1K, 0603 size resistor	Yageo Corporation	RC0603FR-071KL
1	R12	49.9Ω, 0603 size resistor	Yageo Corporation	RC0603FR-0749R9L
2	JU1, JU3	2-pin header (100 mil pitch)	TE Connectivity, Ltd.	5-146278-2
2	JU2, JU4	3-pin header (100 mil pitch)	TE Connectivity, Ltd.	5-146282-3
9	PG, AGND, VDD, EN, EXTVDD, VIN, PGND, VOUT, PGND	Terminal double turret (through hole, noninsulated)	Keystone Electronics Corp.	1593-2

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-1: BILL OF MATERIALS (BOM) (CONTINUED)

Qty.	Reference	Description	Manufacturer	Part Number
1	L1	10 µH inductor, size 13.5 mm X 12.5 mm X 6.2 mm	Bourns®, Inc.	SRP1265A-100M
2	Q2, Q3	100V, 40A N-Channel MOSFET, power PAK S08 (5.15 mm X 6.15 mm)	Vishay Intertechnology, Inc.	SIR878ADP
4	VIN, PGND, VOUT, PGND	Noninsulated banana jack	Keystone Electronics	575-4
2	Shunt	Shunts with closed top, (100 mil pitch)	Sullins Connector Solutions	SPC02SYAN

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) - DO NOT POPULATE

Qty.	Reference	Description	Manufacturer	Part Number
0	C7, C8	1210 mm size MLCC capacitor	—	—
0	C14	0603 size capacitor	—	—
0	C17	0603 size MLCC capacitor	—	—
0	C18	0603 size MLCC capacitor	—	—
0	D1	100V Schottky diode, power SOD123	—	—
0	D2	100V Schottky diode, power PAK S08 (5.15 mm X 6.15 mm)	—	—
0	R15	0805 size resistor	—	—
0	Q1, Q4	N-Channel MOSFET, power PAK S08 (5.15 mm X 6.15 mm)	—	—

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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